Stile

Teacher Guide

NGSS Middle School

2022–2023
Grade 6, 7, & 8

PDF View Recommendations

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1. In **Google Chrome**, maximise the window and select *Fit to page*.

2. In **Adobe Acrobat** select *Full Screen Mode* from the *View* menu.

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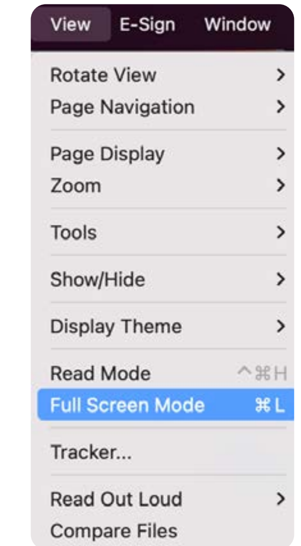


Stile helps teachers bring their science classes to life with beautiful lessons based on real-world science and global issues.

2022–2023 Edition, Version 1.3

Stile’s office is located at 4250 Wilshire Boulevard, Los Angeles, California, on the land once known as Tovangaar, home of the Gabrieleño-Tongva people.

We honor their connection to this region and give thanks for the opportunity to live, work, and learn on their traditional homeland.
We show our respects to the Gabrieleño-Tongva people, as well as all indigenous people, past, present, and future.

Contents

A note from our CEO, Danny

We want our young people to graduate from school scientifically literate and ready to tackle tomorrow's problems.

The Stile Curriculum has been crafted to make this possible, while making it easy for educators to implement the Next Generation Science Standards both in letter and spirit.

This Teacher Guide has been designed by our team of science teachers, all of whom understand the unique demands of day-to-day life at school.

It aims to streamline your planning process, helping you to integrate Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts while engaging students with the latest science news and global issues that matter to them.

We're here, by your side, to ensure you have everything you need to help your students reach their full potential and graduate with the brightest possible futures.

Don't forget, you're welcome to reach out to us at any time. If you need help, contact us at support@stileeducation.com. We're a bunch of teachers and science nerds who love chatting with teachers about awesome science education.

Danny Pikler
CEO & Co-founder

Optional Extra

*Optional extras are not required for coverage of the NGSS, but they provide students with opportunities to further engage with Science and Engineering Practices and collaborative learning through group work.

Sequence of learning

Grade 6

Introduction to Science

How do scientists work?

Food Chains and Food Webs

Why do cats have slit-shaped pupils?

The Importance of Biodiversity

Do we need to save the bees?

Cells

Are you ready to meet lab-grown meat?

Semester 1

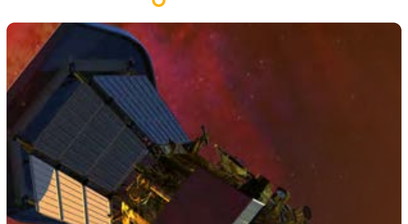
Week 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Unit 1 | Unit 2 | Unit 3 | Unit 4

Semester 2

Week 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18

Unit 5 | Unit 6 | Opt. Ex | Unit 7 | Unit 8 | Optional Extra



Our Place in Space

Can we travel to the Sun?

Heat

How can I cook the perfect pizza?

Optional Extra

Engineering challenge: Build a solar oven

Light

How can my smartphone be used as a microscope?

Elements and Compounds

What happens if the world runs out of helium?

Student Research Project

Sequence of learning

Grade 7

Genetics

How can genes increase the risk of cancer?

Plants

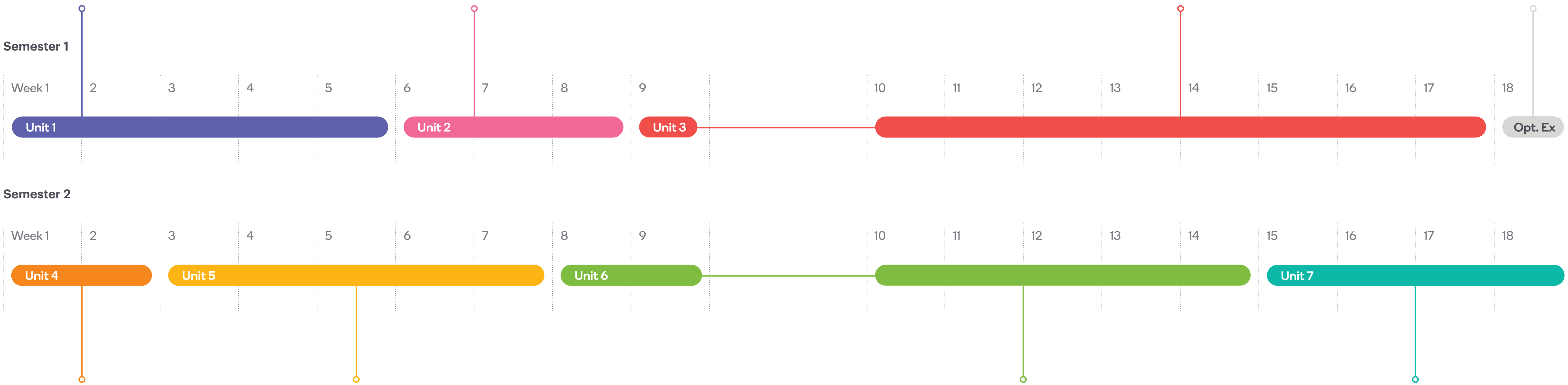
Why are some plants carnivorous?

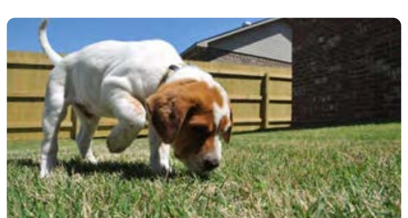
Ecosystems

How can we prevent plastic from harming marine life?

Optional Extra

Project: Communicate the issue





The Nervous System

Could machines sniff out cancers better than dogs?

Active Earth

How do we build future-ready cities?

Newton's Laws of Motion

How can we use Newton's Laws in car crash investigations?

States of Matter

Why is liquid water so important for humans to live on Mars?

Sequence of learning

Grade 8

Earth Systems

How does our planet recycle?

Climate Change

Climate change... is there even a debate?

Evolution

Are we responsible for the rise of superbugs?

Semester 1

Week 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18

Unit 1

Unit 2

Unit 3

Semester 2

Week 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18

Unit 4

Unit 5

Optional Extra

Unit 6

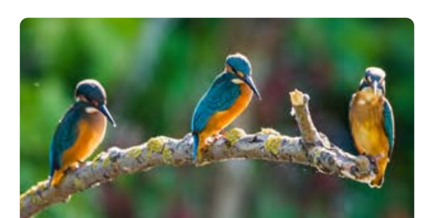
Unit 7

Human Impacts on Ecosystems

Can we prevent a mass extinction event?

Energy

What can we learn from nature's energy engineers?



Optional Extra

Engineering challenge: Biomimicry design

Energy Conservation

Can we use ocean waves to produce electricity?

Non-contact Forces

Are we on track for sustainable transport?

Stile is designed for the NGSS

Stile's learning resources, technology, and professional learning draw from phenomenon-based, student-driven, three-dimensional approaches to science education. We refer to research from John Hattie, Robert Marzano, Dylan Wiliam, and Jean Piaget, to name a few, and align with and extend the popular 5E model.

Stile is the ultimate curriculum to encourage evidence-based teaching strategies

Students engage in real-world phenomena

Every Stile unit is centered around an intriguing phenomenon, intentionally selected to motivate curiosity. Upon their introduction to the anchoring phenomenon, students are driven to ask questions and seek answers that explain it.

Students design solutions

Stile's lessons draw direct links between real-world technologies and the science that underpins them. In all Stile units, students engage in phenomena, ask questions, and design possible solutions anchored by the real world.

Activating prior knowledge

Every student contributes a unique history to the classroom environment. To effectively build on their existing understanding, learners must forge connections between their individual past experiences and the new information they encounter. Stile units include opportunities for students to reflect on their current knowledge and experiences, providing a sound foundation from which they can build new learning.

Student inquiry and discovery

Once students have been introduced to the anchoring phenomenon, they'll be itching to get going. The process of inquiry, however, requires intentional scaffolding by the teacher to ensure that students achieve success. Stile's lessons and teacher support materials offer direction and guidance to ensure students are achieving the intended outcomes, while still allowing them to drive the learning process.

Collaborative problem-solving

Stile's platform is designed to be used as a blended learning tool, where technology enhances classroom experiences. This means that students and teachers engage with the lesson together and students work cooperatively to explore and unpack the anchoring phenomenon. Students have the chance to express their ideas in pairs, small groups, and whole-class situations. Collaborative widgets, such as the Live Brainstorm and the Live Poll, are particularly effective for facilitating conversation between students.

Lab activities, Socratic seminars, and engineering challenges have students working in groups to complete investigations, design solutions, and engage in scientific argument. Working together helps students to develop communication and social skills, and provides each member of the group with access to alternative perspectives through their peers' ideas.

Explicit teaching and setting learning goals

While student curiosity and questioning drives the learning, students are guided toward specific outcomes through learning goals. Evidence shows that students who know what is expected of them are more likely to engage in the learning process (Hattie, 2012). Each Stile lesson identifies learning goals that describe what students should know, understand, and be able to do.

Metacognition

Students are continually encouraged to build an understanding of, and reflect upon, the process of their own learning. As they work through a unit, they consider what they need to work on and how they can improve, using the learning goals as their point of reference. Self-assessment checkpoints found throughout a unit are included as useful prompts to consider their confidence in relation to a lesson's learning goal. Visible Thinking Routines are also incorporated to guide the process of scientific thinking, and to support students to express and share their ideas (Ritchhart, Church & Morrison, 2011).

Formative assessment

Formative assessment informs the teaching and learning process for both students and teachers. Teach Mode, a feature within Stile's online platform, gives teachers access to live analytics that lets them formatively assess work and respond to students' needs on the spot. Combined with Analyze Mode, which shows a summary of student progress within a lesson, teachers have everything they need to determine their next teaching steps. Key Questions are questions that match the success criteria of the lesson and allow teachers to formatively assess student learning.

Feedback, reflection, and differentiation

Students receive feedback in many forms in Stile. As they work, teachers can provide verbal feedback to guide their progress. Upon submission, Stile grades and gives automated feedback for multiple choice and Interactive Canvas questions, before teachers release model answers for all question types. These various forms of feedback provide students with information from which they can reflect and determine their next steps. They also allow teachers to differentiate learning material to support students in achieving learning goals, whether by modifying content or applying specific teaching strategies.

Revision and mastery

Research suggests that note-taking is best when done with a pen and paper. In fact, compared with digital note-taking, handwritten notes have a higher impact on cognitive understanding, recall, and grades (Mueller & Oppenheimer, 2014).

Stile X is a student notebook and revision guide that promotes student agency and helps students learn how to study, while they study. Rigorous scaffolding within Stile X supports students in taking handwritten notes to consolidate knowledge from class.

The glossary section lets them record their own definitions for scientific terminology, and test preparation questions allow students to check their understanding against learning goals.

The accompanying Stile X phone app incorporates 60-second summary videos, flashcards, flash quizzes, model answers, and an interactive glossary to further support students in reviewing the learning material.

Summative assessment

Units in Stile include tests, engineering challenges, and Socratic seminars as summative assessment opportunities. Tests include a variety of question types and three-dimensional questions are incorporated to assess Disciplinary Core Ideas, Science and Engineering Practices, and Crosscutting Concepts simultaneously. Engineering challenges and Socratic seminars require students to apply a three-dimensional approach to problem-solving and include detailed rubrics against which both peer assessment, self-assessment, and teacher assessment can be completed.

John Hattie. (2012). *Visible Learning for Teachers: Maximizing Impact on Learning* (1st ed.), Routledge.

Ron Ritchhart, Mark Church, Karin Morrison. (2011). *Making Thinking Visible: How to Promote Engagement, Understanding, and Independence for All Learners* (1st Ed), Wiley.

Mueller, P. A., Oppenheimer, D. M. (2014). The Pen Is Mightier Than the Keyboard: Advantages of Longhand Over Laptop Note Taking. Psychological Science, 25(6), 1159-1168. https://doi.org/10.1177/0956797614524581

What's included in each unit?

Stile classroom lessons	A sequence of activities where student learning is motivated by the desire to figure out a specific anchoring phenomenon. These include labs and engineering challenges, investigations, and projects.
Summative tests	Units conclude with a summative assessment, designed to measure students' overall achievement.
Formative assessment	Opportunities to formatively assess student understanding are included with What do you know? pre-tests at the beginning of the unit and within each lesson through Key Questions.
Comprehensive teacher support	Documents like this one support teachers as they plan to deliver a Stile unit. Teaching notes within each lesson also act as prompts to help with specific teaching strategies.
Hands-on lab activities	Each unit includes lab activities that allow students to apply Science and Engineering Practices as they investigate phenomena. These activities use resources that are easily and cheaply available and require minimal time to set up in class.
Parent communication template	Every unit includes an editable template designed to help teachers communicate with parents and caregivers about what students are learning. Simply copy the template into an email, modify it to suit, and send it out to keep parents informed.
Stile X student notebook	A companion student notebook and revision guide accompanies every Stile unit, providing scaffolding for students to develop study notes and revise learning material.

Embracing diversity

Representation

The importance of representing diversity and providing relatable role models for all students cannot be overstated. Stile's lessons incorporate diversity at every opportunity, and we are proud to include representation of a broad range of people in our resources. You'll notice a higher proportion of women in our career profiles, racial diversity in images (including hands-on labs), representation of people with disabilities, and portrayal of non-binary genders.

Culturally responsive teaching

As educators, we have a responsibility to provide all students with equitable access to science education. Traditionally, the education system has been built around a Eurocentric approach to learning, which puts many students at a disadvantage. Stile can be used to incorporate a culturally responsive approach that recognizes and values the perspectives of students from diverse backgrounds. We provide multiple and diverse examples in our units.

Collectivism through collaborative learning

Incorporating a collaborative approach to learning is one way to enhance learning experiences for students whose cultures lean toward collectivism, including many African American, Latino, Pacific Islander, and Native American communities.

Stile lessons are deliberately crafted to incorporate collaboration through discussion and the use of Live Brainstorms and Live Polls.

Accessibility and ELL support

Screen-reader compatibility

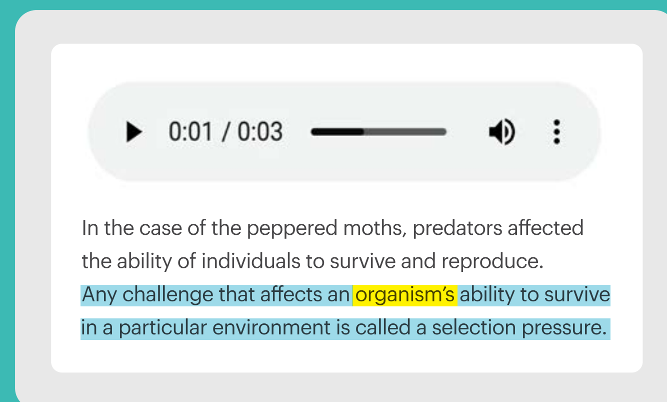
Stile is fully compatible with screen-reader software so that students with low vision can have a lesson read and described to them. Images in Stile also include alternative text captions, which provide screen readers with information to describe the contents of an image to the user.

Captions for videos

All videos included in Stile's lessons have captions to support accessibility for a range of students. Captions can be used to support language comprehension for students with lower-level literacy or to allow students with hearing impairments to engage with the video. For those learning English, reading video captions while hearing the audio supports language development, reading comprehension, and literacy.

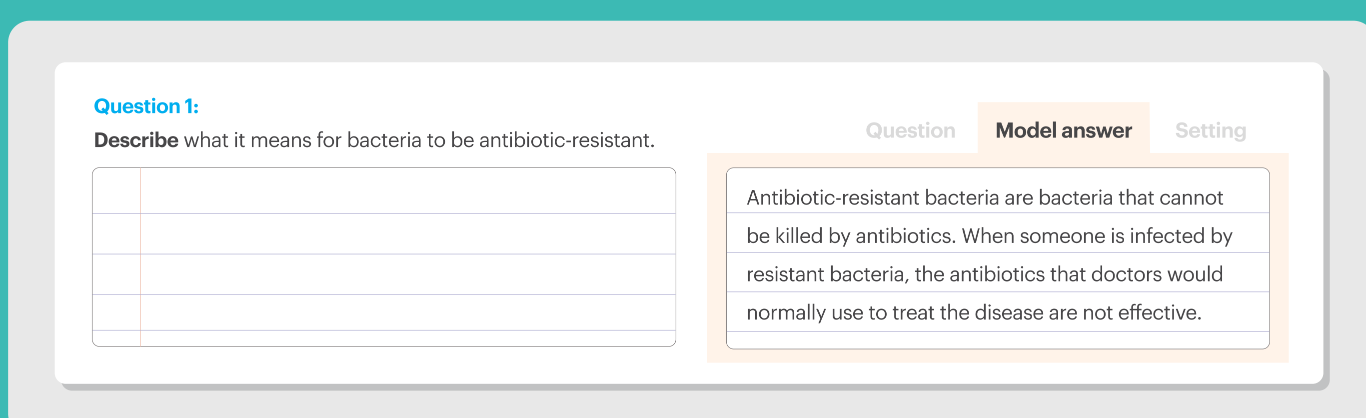
Writing exemplars

For every Written Response question there is a model answer available to students once their work has been reviewed. These model answers provide students with examples of proficient written responses that can be used to reshape and improve their own work.



Audio narration

The audio narration tool is available in all lessons to read text aloud to students. This allows those with visual impairments to engage with written text. Word-by-word highlighting accompanies narration so that students can follow along with the text as they listen. This supports comprehension for English Language Learners and students with lower-level literacy as they are able to associate the written and spoken versions of a word with one another.



Multimodal learning

Lessons are intentionally designed to show information in a variety of ways alongside written text. This includes the use of images, graphics, videos, and simulations. These varied representations support students to understand key scientific ideas and processes by communicating information in a way that supports their interpretation of written text. There are also options for students to communicate their understanding that don't require a written response, such as interactive drag-and-drop questions and the ability to record an audio response.

Compatible with Google Translate

Where direct translation of English words into a foreign language is the only possible means of access, students can use the Google Translate browser plugin to interpret Stile lessons. Beware of over-reliance on translation tools, which can present a barrier to language acquisition if they prevent students from engaging with English altogether. Translation is most appropriate when students encounter unfamiliar words for the first time, or want to confirm the accuracy of their interpretation.

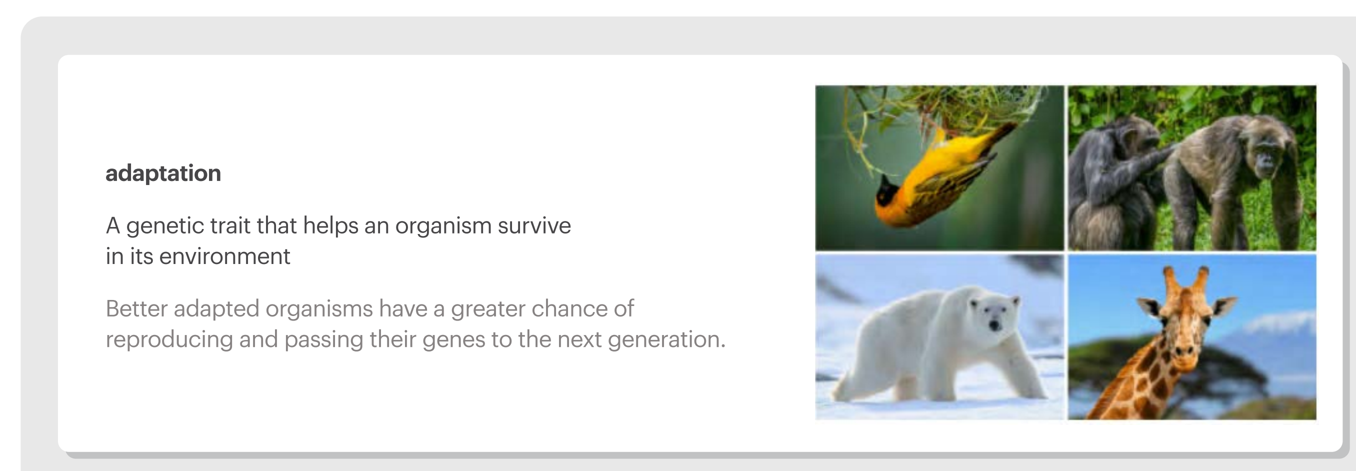
Visual glossaries

Every unit of learning includes a glossary of domain-specific language. Each word in the glossary appears alongside a definition and an image to support comprehension. This is particularly helpful to activate or consolidate connections between languages.

Print resources

Stile X is a printed student revision and mastery booklet that provides visual aids and scaffolded learning opportunities to make learning accessible for all students. It supports students to build vocabulary by providing opportunities to create their own glossaries as well as scaffolded mind maps and flow charts. Having students include familiar terminology from their dominant language or images to assist with comprehension will make these activities even more valuable.

The Stile X app includes illustrated flashcards, and short summary videos of key ideas. Using the Stile X phone app to master terminology is a way to further build science-related English vocabulary through spaced repetition.



Prior knowledge: Grade 6

Through The Stile Curriculum, students will build on their existing knowledge across all three dimensions of the Next Generation Science Standards.

Introduction to Science is an orientation to middle school science that focuses on Science and Engineering Practices and Crosscutting Concepts. Students will develop skills in observing, inferring, measuring, and using data. They then take these newly honed skills forward for the remainder of their middle school science education.

Grade 6 units incorporate **Disciplinary Core Ideas** from all domains. Students have an existing understanding of the way in which the food of almost any animal can be traced back to plants. In Food Chains and Food Webs, they build on this by using food webs to model the transfer of matter and energy in ecosystems. In The Importance of Biodiversity, they further their knowledge of the interconnectedness of an ecosystem's components as they use simulations to analyze the effect of changes in biodiversity on food resources. Students already know that organisms have internal structures that allow for growth, survival, behavior, and reproduction. In Cells, they learn that these internal structures are cells and that they work together to form tissues and organs with specialized functions.

Our Place in Space introduces students to Earth and Space Sciences at this grade band. Their prior knowledge that the Earth's orbit and tilt, along with the orbit of the Moon, cause observable patterns is built upon as they use models of the Solar System to explain eclipses, lunar phases, and seasons. By learning about Light and Heat, students extend their knowledge of waves as regular patterns of motion by exploring the way they transmit energy and can transfer digital information. Elements and Compounds takes students from understanding that matter exists as particles, to knowing that it is composed of atoms and molecules which explain the properties of substances.

Science and Engineering Practices are embedded in all units. In Food Chains and Food Webs, students build on their knowledge of using models by developing models of food webs that show the flow of energy in an ecosystem. In Light, they extend upon this by using models to describe unobservable light waves. The Importance of Biodiversity has them asking questions and defining problems about the disappearance of bees, while in Cells, they engage in argumentation using evidence in a Socratic seminar.

In Our Place in Space, students plan and carry out investigations using models to explain seasons, eclipses, and the phases of the Moon. While learning about Heat, they gather, analyze, and interpret data using mathematics and computational thinking to identify types of heat transfer. Elements and Compounds further develops students' understanding of conservation of mass by connecting this with the conservation of atoms.

Crosscutting Concepts are also addressed in every unit. In Food Chains and Food Webs, students will build on their knowledge of energy and matter as they learn that decomposition restores some materials back into the soil. The Importance of Biodiversity builds on students' experience of measuring change as they analyze data that describes changes in bee populations over time. Existing knowledge of structure and function, and how materials serve specific functions, is built upon in Cells, where students relate this to the structure and function of specialized cells. Our Place in Space has them extending their knowledge of systems as groups of related parts as they describe how a system's components interact with one another.

In Heat, students build on the understanding that matter is conserved through an investigation where they discover the total weight of substances doesn't change in a chemical reaction. In Light, students build on their experience with evaluating the merit and accuracy of ideas by communicating technical information about how light waves interact with various surfaces. Students use models once more in Elements and Compounds to predict how elements react with one another.

Prior knowledge: Grade 7

In Grade 7 of The Stile Curriculum, students will build upon their knowledge across all three dimensions of the NGSS. A summary of their anticipated prior knowledge and how they will extend this is included below.

Grade 7 units incorporate **Disciplinary Core Ideas** from all domains. Using their understanding of cells from Grade 6, students build their knowledge of both human and plant systems. They examine the processes of meiosis and mitosis, and the role of genes in inheritance. They use Punnett squares and pedigrees to analyze characteristics and traits. Students discover the way in which the human nervous system functions through stimulus-response pathways, and investigate taste and smell as an example of this.

In Plants, they uncover how the structure of a plant's organs supports their specific functions, specifically in the process of photosynthesis. They also explore the sexual and asexual reproduction of plants by inspecting the structures of flowers and identifying their target pollinators. Knowledge of food chains and food webs from sixth grade helps them to understand ecosystems as the broader environmental context within which predator–prey relationships exist. Students evaluate human impacts on marine ecosystems by analyzing data about population changes. While students explored the Solar System last year, they will now zoom in on the Earth to learn about its internal structure, and the cause of natural hazards.

In the physical sciences, students further their foundational understanding of elements and compounds as they learn about states of matter through the particle model, and gain an understanding of the properties of each of the states. They also learn how Newton's Laws can be applied to better understand phenomena on Earth, such as gravity, recoil, and collisions. They explore these phenomena through simulations and investigations where students create balloon cars and water rockets.

Throughout Grade 7, students build on their understanding of **Science and Engineering Practices**. They use and develop a number of models to describe phenomena, and unobservable mechanisms such as DNA. They define design problems through engineering challenges, and design and develop solutions through the engineering-design process, such as devices to remove plastic from the ocean in the Ecosystems unit.

Students begin to work more independently on investigations, and refine their processes for improved accuracy and validity. They interpret data across units, and analyze this data to identify relationships, such as the relationship between exposure to light and carbon dioxide absorbed from a sample of pond water. Mathematical and computational thinking is used as students apply mathematical concepts to scientific and engineering questions and problems. In Active Earth, for instance, students must work within budget constraints to create a solution that fits the brief. Students engage in argument from evidence across units as they construct written arguments and evaluate competing design solutions against criteria in engineering challenges.

Crosscutting Concepts are applied across the grade level. Students identify patterns in data through evaluating graphs and charts in the Ecosystems unit, where they consider the impact of plastic pollution on the planet. They further interpret such relationships to determine whether specific outcomes can be classified as causal, such as a decrease in carbon dioxide levels in pond-water samples with higher exposure to light.

Students consider scale and proportion as they learn about the particle model in States of Matter. They use models to represent systems, such as the cycling of matter through the rock cycle, while also analyzing their limitations. Through learning about photosynthesis, students connect a structure's shape, composition, and the relationship between its parts to the specific functions it provides.

Prior knowledge: Grade 8

Grade 8 units incorporate **Disciplinary Core Ideas** from all domains. Having learned about the structure of the Earth in Grade 7, the Earth Systems unit gives students a closer look at Earth and how energy and matter cycle through its systems. Students then unpack the factors contributing to climate change, and how human activities contribute to this, by evaluating data of carbon dioxide emissions over a 150-year period. Student knowledge of inheritance from last year contributes to their understanding of the process of evolution, including natural selection and adaptation. They apply this to understand the phenomena of antibiotic resistance and engage in scientific argument around their use to treat illnesses.

Prior learning about Newton's Laws helps students to understand non-contact forces, and how these can be harnessed to create sustainable transport solutions. Knowledge of heat and light from Grade 6 supports students to develop an understanding of energy and energy conservation.

Students continue to develop experience with **Science and Engineering Practices** through Grade 8, building on their understanding from the previous two years of The Stile Curriculum. An engineering challenge in the Energy unit has students clearly defining the design problem and developing a biomimicry-inspired solution to generate energy that meets multiple criteria and constraints.

Students interact with a digital model in Evolution to describe the process through which evolution of superbugs occurs and thus antibiotic resistance arises. As they conduct an investigation into sea-level rise in Climate Change, students identify independent, dependent, and control variables, along with the tools required to gather information. They analyze and interpret their results to provide evidence for the phenomena of rising sea levels, and use their findings to construct an explanation.

Using the understanding they've developed throughout the Climate Change unit, students engage in scientific argument as they consider perspectives both for and against the idea that the media should give equal weight to climate experts and non-experts. They communicate the information regarding both perspectives in written form.

Knowledge of **Crosscutting Concepts** also continues to expand in Grade 8. Students evaluate patterns in rates of change as they examine data related to climate change, such as the amount of carbon dioxide emissions, and determine whether these are an effect of human activity or natural trends. As they learn about the evolution of superbugs, they encounter the scale of microorganisms and consider this in relation to the significant impact of antibiotic resistance. Students understand that evolution results in change within a population, and engage with models of the human immune system that represent its inputs, processes, and outputs.

In Energy, they learn about the different forms of energy, and the transfer and transformation of energy through lab activities where they create rubber band racers, and water wheels.

Common Core Standards Integration

Comprehension activities

Science news articles

Audio narration

Creative writing

Persuasive writing

Glossary of terms

Mobile revision app

Scientific literacy

Graphing

Math skill builders

Data interpretation

Statistics

Arithmetic

Measurement

Spatial reasoning

Estimating

English Language Arts and Literacy Standards

Stile integrates opportunities to learn and practice literacy skills throughout all lessons. Creative and persuasive writing activities are included to challenge students to make connections while improving their literacy skills. For example, students are introduced to the nervous system through the context of dogs that can sniff out cancer and, after exploring stimulus-response pathways, write a report about the role of synapses.

Students apply reading comprehension skills in most lessons. They are tested with different question types, such as definition matching tasks and fill-the-blank questions, to ensure they have understood the terminology before moving to higher order questions. Science news stories are lessons that require students to draw on their comprehension skills as they learn about relevant, up-to-date scientific phenomena.

Our student notebook and revision guide, Stile X, further supports literacy skills, where students take handwritten notes. The glossary section lets them record their own definitions of scientific terminology, and in the test preparation section, they practice communicating their knowledge in written form by answering test questions. The accompanying Stile X app incorporates flashcards and quizzes for multiple exposures to vocabulary, which support mastery of scientific terminology. Students are also provided access to model answers as examples of fluent language use.

Mathematics

Great science teaching reinforces the fundamental mathematics required for effective science practice. It should also draw direct links between scientific discovery and the practical technologies that result. Students should graduate from school with a working knowledge of the engineering practice that turns science into technology. Mathematics is the language of science; it's a core tool essential for all scientific endeavors.

Stile lessons promote math through both explicit and integrated opportunities. A set of dedicated lessons peppered throughout The Stile Curriculum explicitly build students' math skills. For example, students are taught how to calculate measures of central tendency within the context of body systems. They are frequently asked to extract meaning from graphical representations of real world data and are challenged to use arithmetic through our in-app tools. For example, students learn how to examine trends in data sets while analyzing real data sets on trends in vaping. Further to this, all core units intentionally integrate the application of math skills within science lessons. For example, students are taught how to calculate ratios when learning about the layers of the Earth and use this mathematical knowledge to create a scale model.

Revision materials are also provided for these skills to support the scientific process, including statistics and data interpretation. Formative assessments and end-of-unit summative assessments integrate math so teachers can easily see the learning progression of all students to inform their teaching.

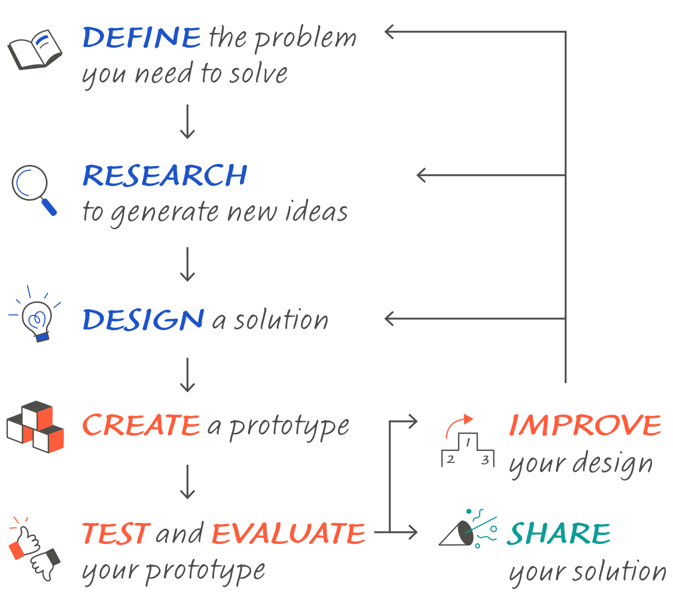
Engineering ideas into practical technologies

Technology isn't just a smartphone. It's vaccinations, genetic modification and wind turbines. Stile's lessons draw direct links between these real world technologies and the science that underpins them.

Engineering challenges are featured within many units in Stile and they guide students through the process of creating novel solutions to problems.

This starts with students defining the problem. For example, in Non-contact forces: Are we on track for sustainable transport? students define the current problems with how we travel; issues like pollution, friction and traffic so they can begin thinking about how non-contact forces might provide a solution.

Throughout the unit they follow the engineering design process of designing a solution, optimizing their design and then communicating it. This promotes problem-solving by focusing students on specifying criteria and constraints and identifying how the solution will meet the need. They use systematic methods to compare solutions and then test and revise solutions to create an optimal design.

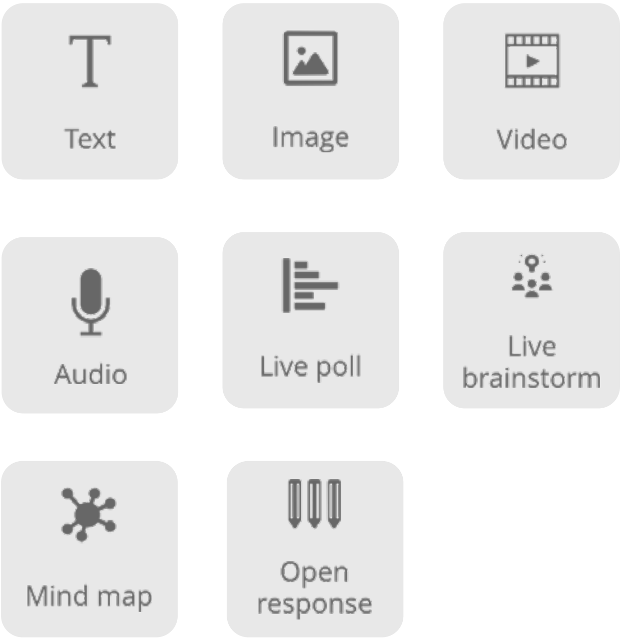


Customize for your classroom

The ability to edit and customize Stile lessons means that teachers can adapt lessons to best suit their students' needs.

Modifications can be made to give students options for how they demonstrate their understanding, or to incorporate phenomena that are relevant to the local area.

The Stile Guide has plenty of information about using customization and editing tools to modify a lesson's content. Below are some examples of how these can be used to support student learning.



Integrating locally relevant phenomena

The anchoring phenomena within Stile's units are carefully selected so that all students can relate to and engage with them. In some cases, however, there may be specific examples of a phenomenon that are especially relevant to a group of students. For instance, a school might be located close to a rock formation that illustrates the processes of the rock cycle.

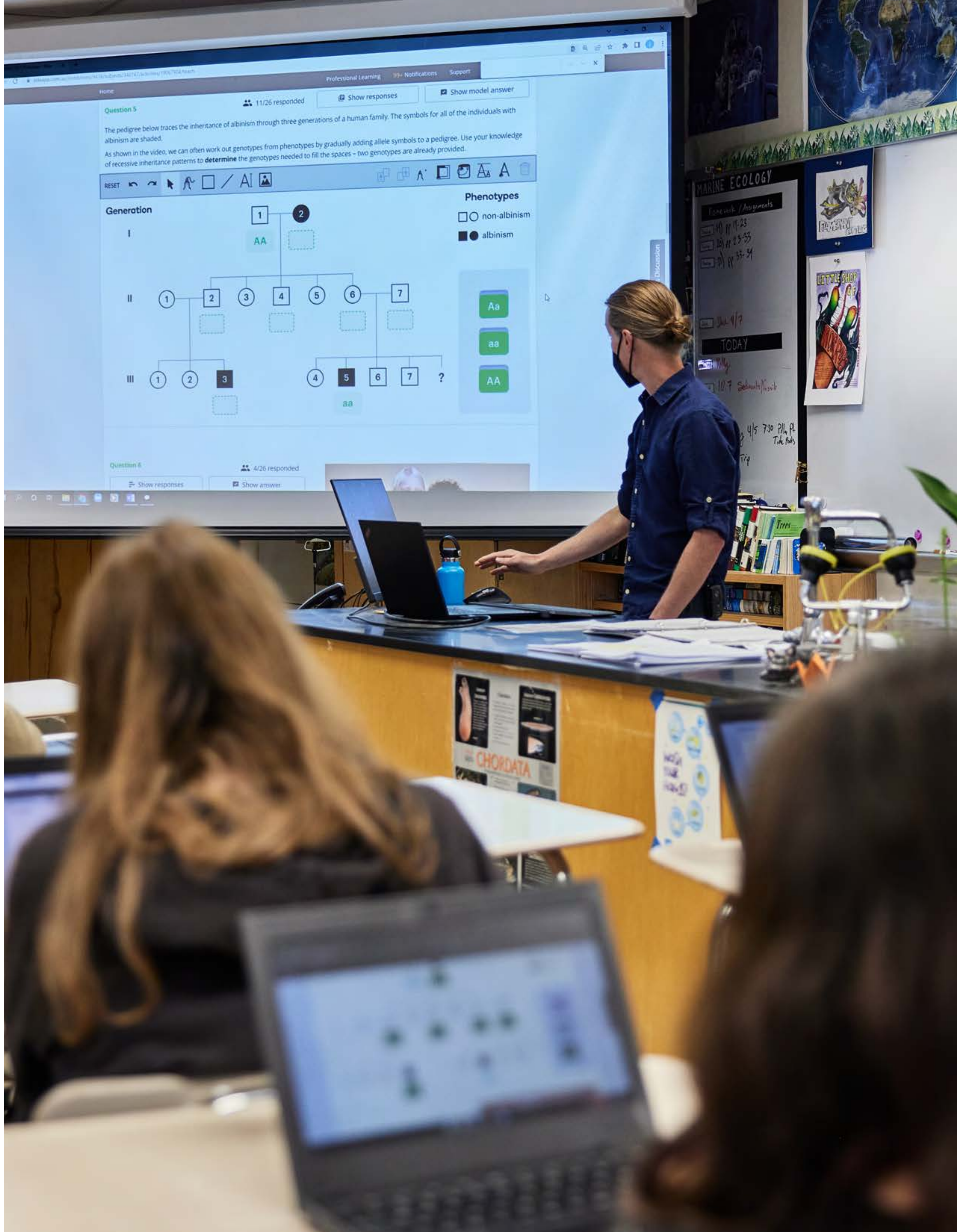
Using Stile's customization tools, teachers can incorporate imagery of this local rock formation into their lessons, add questions about it, and discuss its significance thereby making learning especially relevant and engaging for this group of students. The same principle can be applied to any phenomenon that might have particular importance for students, including culturally significant examples.

Modification of vocabulary

Sometimes the terminology used in science varies from school to school or even from teacher to teacher. Editing functions allow teachers to ensure that the vocabulary used in Stile aligns with that used in the classroom to avoid confusion. Students can focus on learning a core set of words to describe concepts without needing to decode or translate unfamiliar terms.

Adding personal narration

All text in Stile lessons is narrated automatically, but teachers have the option to record their own voices reading a section of text. This provides a uniquely personal touch and offers a model of fluent reading that supports students' language skills.



Opportunities for differentiation

Stile resources are universally designed to make learning material accessible to all students. We understand, however, that one size doesn't fit all and modifications may be required to support specific needs. The techniques below can be used to adapt teaching and learning activities to accommodate a variety of student needs.

Stile X in class

Stile X booklets can be used in class to provide additional structure and scaffolding in the form of graphic organizers, sentence stems, and fill-in-the-blank activities. These approaches are beneficial for students who may have difficulty accessing the material in a Stile Classroom lesson, including English Language Learners or students with lower-level literacy. Have students open to the relevant Stile X page for the lesson, and work through it as you're going through each section as a class. You can do this in addition to the student's work on their own laptop, or even in lieu of it.

Partner work

For students with lower-level literacy or who are English Language Learners, working alongside another student can provide them with additional language support. Students can verbally discuss and confirm their thoughts with one another, providing a scaffold to record their ideas in a written format.

Key and Challenge Questions

Use Key and Challenge Questions to guide students in selecting an appropriate level of challenge. Key Questions are an opportunity for students to demonstrate their understanding of the learning goal.

Other questions scaffold toward the Key Question to help them develop the knowledge required to answer it.

Students shold attempt to answer Key Questions to the best of their ability, though they may require additional support to do so (see details below about alternative modes of expression).

Challenge Questions take students above and beyond the level of the learning goal. These are perfect for extending students who are feeling confident that they have met the learning goal. For English Language Learners or students with additional learning needs, it's okay to focus more time on the Key Questions rather than wrestling with the Challenge Questions.

Extension

Where appropriate, lessons may include a section specifically for the purpose of extension. These explore ideas in greater depth, giving advanced learners a chance to consider new contexts and apply higher order thinking skills. Some units include whole extension lessons, which can be assigned as optional extra or homework tasks, or used as in-class activities when a student already has a sound grasp of the concepts being taught to other students.

Providing alternative modes of expression

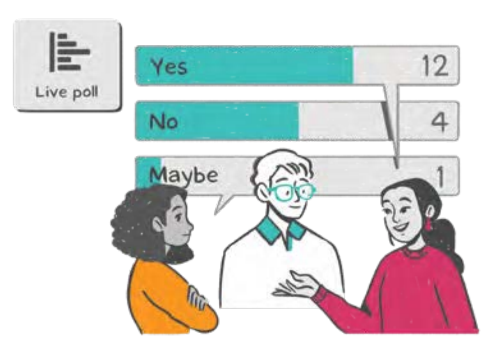
Questions that require a written response are used in all curriculum areas to measure students' understanding. For many students, particularly English Language Learners or students with additional learning needs, recording an answer in written form is a boundary to communicating their knowledge. Teachers can edit and customize Stile lessons to give students options for how they demonstrate their learning. Replacing Written Response with Open Response questions makes them accessible to all students.

Promoting collaborative classrooms

A number of tools and features in Stile's platform are used to encourage students to work cooperatively. These are designed to allow all students to participate in class activities and discussions.

Live Brainstorms
The Live Brainstorm tool lets students collectively contribute their ideas in response to an open-ended question. The shared brainstorm makes the perfect starting point for group or class conversations, as students can view, compare, and build on one another's contributions.

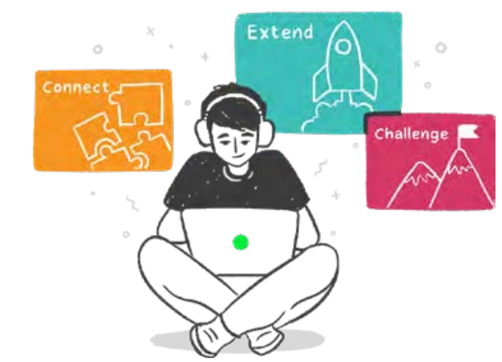
Live Polls
Live Poll questions provide an opportunity for students to express their thoughts by selecting a statement from along a spectrum that represents their opinion. These selections can then form the basis of rich discussion, where students must provide evidence to justify their choice and learn to accept the opinions of others.



Group activities
Stile lessons incorporate activities where students work together to deepen their understanding of phenomena. Examples of this range from carefully structured group work, like Socratic seminars and engineering challenges, where each student plays a pre-defined role, to more flexible pair and group discussions embedded within a classic lesson's structure.

Visible Thinking Routines
The use of Visible Thinking Routines is another way in which collaboration and sharing of student ideas are incorporated into Stile lessons.

Routines are selected to encourage the types of thinking most appropriate for the lesson, while graphic organizers and sentence frames provide an accessible way for students to communicate their thinking. Once students have completed the routine, teachers can use Teach Mode to facilitate the sharing and discussion of student ideas and provide space for peer feedback.



Teach Mode
The tools available in Teach Mode can be used to facilitate sharing and comparison of student ideas throughout the learning journey. By selecting "Show Responses," teachers can display student answers for the class to discuss. They can even decide whether students remain anonymous. This provides a non-threatening way for students to share their ideas and consider the perspectives of their peers. Students should have an opportunity to reshape their responses after seeing others' work to encourage reflection and refinement of their own thinking.

The same approach can be used for all question types, where both student answers and model answers are displayed and discussed together. By providing verbal feedback in this open forum, and encouraging peers to give feedback too, teachers can support students in the process of reflecting upon and further developing their ideas.

Assessment

Pre-test: What do you already know?

Where relevant, Stile units include a lesson that is specifically designed to activate students' prior knowledge. "What do you already know?" lessons introduce concepts that will be addressed in the unit, and provide students with an opportunity to demonstrate their understanding of these. They also allow teachers to identify any misconceptions that a student may have early in the unit, so that these can be addressed through subsequent lessons.

Formative assessment

It's important to know where a student is at so we can support them to reach their next steps. Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson.

Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goals. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Short quizzes are included between lessons as an additional measure of student learning. Usually containing approximately five multiple-choice questions, quizzes are auto-graded on submission so that teachers can easily see if students have grasped a concept or require further teaching.

Summative assessment

Every unit concludes with a test that can be used as a summative assessment of student learning. Tests are between thirty and forty-five minutes long and include a combination of multiple choice, drag-and-drop, and short written answer questions. Multiple choice and drag-and-drop questions are auto-graded, while written answer questions are accompanied by model answers that support the grading process and give additional feedback to students.

Lab activities, investigations, projects, and engineering challenges require students to integrate Science and Engineering Practices as they carry out the task at hand. As such, these activities can be used as summative assessments of these practices.

Stile Professional Learning

Stile Professional Learning is about great science teaching. Our engaging professional learning offerings aim to develop teachers' capacity by scaffolding the process of implementing evidence-based teaching practices.

The structure of each session includes opportunities for teachers to collaborate with their colleagues and to apply their knowledge in an authentic context. Participants walk away ready to incorporate their new learning, guided by helpful resources and follow-up activities.

Our expert team designs and delivers workshops around the specific needs of science teachers. We also provide options to develop a customized professional learning package that caters to district priorities.

Stile's professional learning workshops include:

Facilitating productive discourse in the science classroom

Teachers explore the importance of talk as an inclusive practice. They will be given specific tools to establish a "safe-talk" environment in the science classroom, learn questioning methods designed to promote scientific thinking, and plan to include these in an upcoming Stile lesson.

Integrating engineering design with Stile

Teachers break down the structure of an NGSS performance expectation and build confidence using Stile features to teach Science and Engineering Practices across content and disciplines.

Using Visible Thinking Routines to develop metacognition and critical thinking

Teachers delve into the research behind Visible Thinking Routines and become familiar with a set of routines specifically suited to science learning. They learn how to effectively apply these to support students in thinking critically and prepare to include one of the routines in an upcoming lesson.

Customization through the lens of local phenomena

Teachers explore the variety of ways in which lessons can be tailored to their specific context using Stile's customization tools. They learn how to apply these tools to incorporate local phenomena into lessons and collaborate to create an example based on a model lesson.

Evidence-based teaching strategies in Stile

Teachers play the role of students as specific teaching strategies are modeled for them using Stile. They then reflect on their teaching practice and set goals to implement Stile to make the most of technology in the science classroom.

One-on-one coaching

In addition to group sessions, we offer one-on-one coaching with a Stile expert. This targeted teacher support consists of in-depth training, co-planning sessions, or co-teaching a Stile lesson, depending on the teacher's needs.

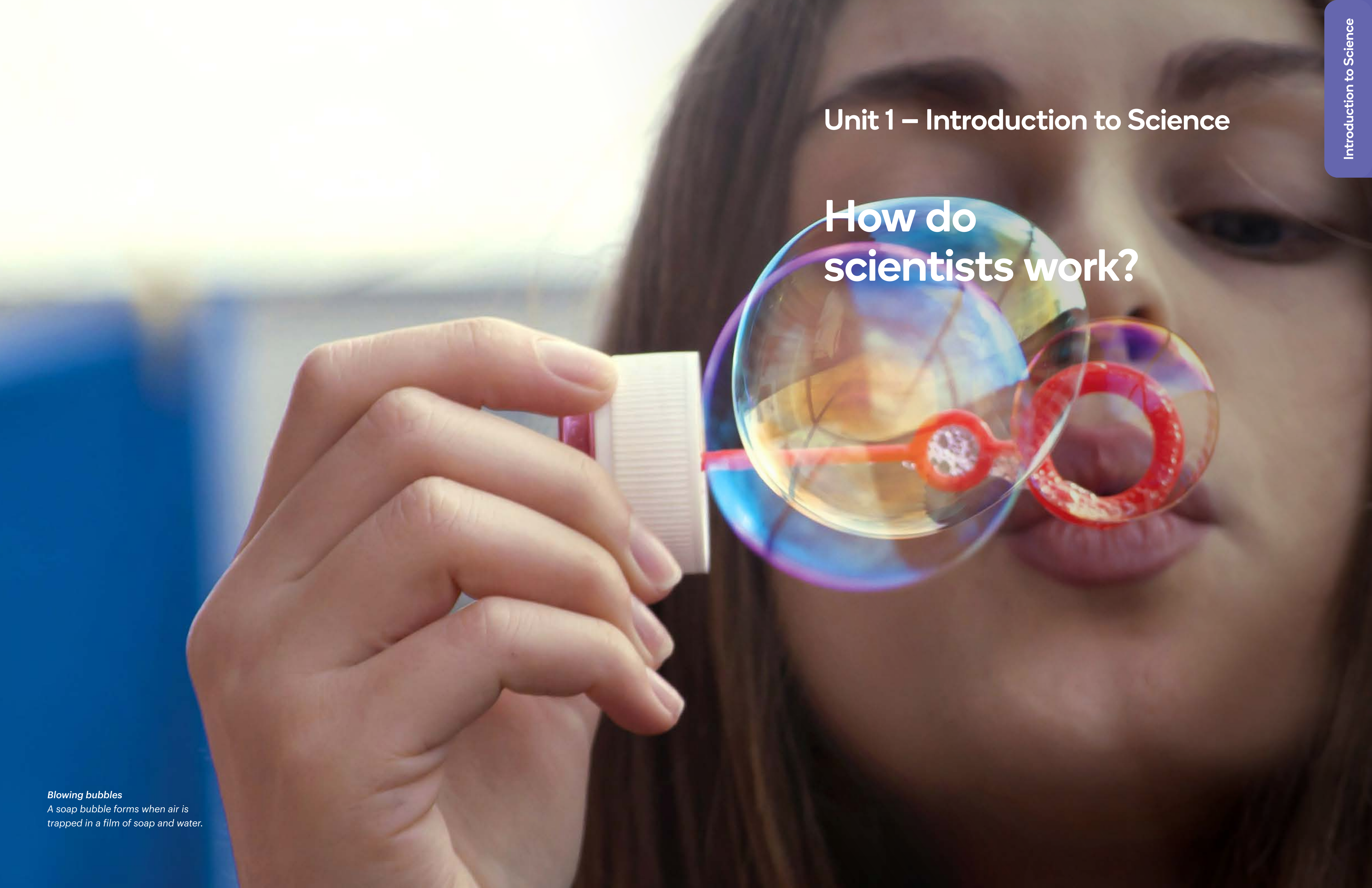
Visit stileapp.com/go/pl for more information.

Grade

6

Unit 1 – Introduction to Science

How do scientists work?



Blowing bubbles
A soap bubble forms when air is trapped in a film of soap and water.

Storyline and anchoring phenomenon

This unit is designed to introduce middle school students to Stile and get them excited about the wonderful world of science! Students are hooked in with the question: What is science, and how can it help us solve global problems?

They initially learn about what science is and why we do science. By exploring different science careers, students uncover that science is the best way to understand how the world works.

Students are introduced to scientific skills like observing, inferring, measuring, and using data. They learn that these skills help us create new technologies and that science has the power to change the way we live and solve some of our most pressing issues. Students' investigation skills are introduced to the what, who, where, and why of science as they investigate questions like, "What skills does a scientist need?" and "How do you plan and conduct your own investigation?"

The unit culminates with students conducting their own scientific investigation about growing tomatoes in space. Working with an interactive simulation, they manipulate variables like water, light, fertilizer, and temperature to determine the perfect formula for growing tomatoes in space.

The simulation allows students to ask questions, write an aim, determine variables, write a hypothesis, and conduct the investigation. They then observe, collect and analyze data, and communicate their results. Students reflect on and evaluate their investigation and draw conclusions. They then self-assess using an investigation rubric to promote reflection for future improvements.

We recommend that this lesson be taught over several class sessions, as it applies various ideas from the unit.

This unit at a glance

Elicit students' current ideas about science with a tuning-in activity and **spark curiosity by observing an everyday phenomenon** – bubbles!

Science as a way of knowing is explored as students are introduced to science and scientists.

An in-house simulation provides students with the opportunity to apply the scientific method to **observe cause and effect relationships**.

Intro to Science

Introduction: Welcome to science

1.1 Lesson: What is science?
1.2 Lesson: Why do we do science?
1.3 Lesson: Who does science?
1.4 Lesson: Where does science happen?
1.5 Lesson: Summing up

2.1 Scientist skills: Observing and inferring
2.1 Quiz: Scientist skills: Observing and inferring
2.2 Scientist skills: Measuring
2.2 Quiz: Scientist skills: Measuring
2.3 Lab activity: Measurement stations
2.4 Scientist skills: Using data
2.4 Quiz: Scientist skills: Using data
2.5 Conducting science investigations

Glossary: Introduction to Science

Students learn that science investigations use a variety of methods and tools to **make measurements and observations**.

Students **apply scientific reasoning** to show why the data or evidence is adequate for the explanation or conclusion.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Nature of Science

- Scientific Investigations Use a Variety of Methods
- Science Addresses Questions About the Natural and Material World
- Science is a Way of Knowing

Science and Engineering Practices

- Constructing Explanations and Designing Solutions
- Asking Questions and Defining Problems

Students are exposed to a number of core scientific principles throughout this unit.

The process of asking scientific questions is scaffolded and students are guided to determine a hypothesis. They then test this hypothesis using a simulation to run multiple trials and determine the best conditions to grow tomatoes in space. Students learn about observations and inferences and use their understanding of the construct to create explanations and design solutions.

Crosscutting Concept

- Patterns

Students observe cause and effect relationships by identifying patterns.

Students follow the scientific method to an in-house simulation to observe and determine how best to grow tomatoes in space.

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in the two relevant dimensions is included below, along with information about how students will use this knowledge.

Science and Engineering Practices

Students build on their prior knowledge of a number of Science and Engineering Practices in Introduction to Science. Their ability to compare and contrast data to discuss similarities and differences is further developed through a skills-based lesson where students compare two sets of data. They learn how to apply concepts of statistics and probability to analyze and characterize data by comparing averages from data they have collected.

Students' experience with collaboratively planning and conducting investigations allows them to take a more independent approach when investigating questions. Where they previously controlled variables and the number of trials, as students manipulate variables to investigate growing tomatoes in space, they begin to consider dependent, independent, and control variables. Interacting with the simulation that forms the basis of their investigation drives students to ask questions based on their observations and to clarify the information they have gathered.

Crosscutting Concepts

Where students' understanding of patterns has previously been used to make predictions, they begin to apply this understanding to identify cause and effect relationships.

For instance, through modifying variables in their tomato plant investigation, students can identify a causal connection between these changes and the resulting yield from the tomato plant.

Making observations
Students examine this image as they learn about the difference between observations and inferences.

Up and away!
Bubbles can fly higher on colder days because the warm air from your breath is lighter than the cold air outside.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 Week 2

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Welcome to science	How can we use bubbles to think like scientists?	Review teaching notes in Prepare Mode Prepare the materials for the blowing bubbles activity (see link in teaching notes)	Assign Stile X app: Flashcards	Article linked in lesson, *Kids Discover*, "The Science Behind Bubbles"
Lesson 2	1.1 Lesson: What is science?	What is science?	Review teaching notes in Prepare Mode Review questions from the previous lesson in Analyze Mode	Assign Stile X app: What is science? video Assign Stile X Review notes: What is science?	1.2 Lesson: Why do we do science? Stile X Review notes: Why do we do science? Stile X app: Why do we do science? video Stile X app: Flashcards
Lesson 3	1.3 Lesson: Who does science?	Who does science?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Assign Stile X app: Who does science? video Assign Stile X Review notes: Who does science?	1.4 Lesson: Where does science happen? Stile X app: Where does science happen? video Stile X Review notes: Where does science happen? Poster: Celebrating women in STEM. Posters are available in the Stile Shop
Lesson 4	2.1 Scientist skills: Observing & inferring	Why is it important to make observations and inferences?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Assign Stile X app: Observing & inferring video Assign Stile X Review notes: Observing & inferring Assign Stile X app: Observing & inferring video	2.1 Quiz: Scientist skills: Observing & inferring 1.5 Lesson: Summing up Stile X app: Summing up video Stile X Review notes: Summing up Stile X app: Flashcards

Lesson Planning Guide

Week 1 Week 2

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Consolidation and preparation	Extra resources
Lesson 5	2.2 Scientist skills: Measuring	What is the difference between quantitative and qualitative observations?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Assign Stile X app: Scientist skills: Measuring video Assign Stile X Revision notes: Scientist skills: Measuring	2.2 Quiz: Scientist skills: Measuring 2.3 Lab activity: Measurement stations Stile X app: Flashcards
Lesson 6	2.4 Scientist skills: Using data	Why is it important to repeat measurements?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Assign Stile X app: Scientist skills: Using data video Assign Stile X Review notes: Scientist skills: Using data	2.4 Quiz: Scientist skills: Using data Stile X app: Flashcards
Lesson 7	2.5 Conducting science investigations	How do I grow tomatoes in space?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode, these contain multiple opportunities for differentiation and extension	Assign Stile X app: Conducting science investigations video Assign Stile X Review notes: Conducting science investigations	Stile X app: Flash Quiz Glossary: Introduction to Science Poster: Science Investigations poster set. Posters are available for purchase from the Stile Shop
Lesson 8				Ask students to complete Stile X Reflection Ask students to complete Stile X Glossary	Poster: STEM skills poster. Posters are available for purchase from the Stile Shop

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical skills.

As students are introduced to science they make measurements using scientific equipment, learn the importance of accurate measurements, and analyze results in a number of different types of graphs.

In the science investigation, they use the scenario of growing tomatoes in space to explore independent and dependent variables and their relationship.

Common Core State Standards Connections: Math

6.RP.A.3.D

Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities.

6.SP.B.4

Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

6.EE.C.9

Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable.

Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation $d = 65t$ to represent the relationship between distance and time.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Lessons within this unit incorporate many opportunities for students to develop and use their reading, writing, listening, and speaking skills.

Students build on literacy skills as they are introduced to a range of vocabulary associated with science.

Throughout this unit, students demonstrate their understanding of the conventions of English through a range of written tasks. They collaborate and demonstrate their speaking skills through group and teacher-led conversations centered around science and interpret information, for example, fake news articles, photographs, and flow charts.

Common Core State Standards Connections: English Language Arts

SL.6.1

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.

SL.6.2

Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.

L.6.2

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

L.6.6

Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions, and how to replace question types in The Stile Guide.

Note that not *all* written response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Introduction: Welcome to science**
  Questions 5, 6, 7
- **1.1 Lesson: What is science?**
  Question 5
- **1.2 Lesson: Why do we do science?**
  Question 3
- **1.3 Lesson: Who does science?**
  Questions 3, 4, 5, 6, 7
- **1.4 Lesson: Where does science happen?**
  Questions 4, 6
- **2.1 Scientist skills: Observing and inferring**
  Questions 8, 14
- **2.2 Scientist skills: Measuring**
  Questions 13, 16, 17
- **2.3 Lab activity: Measurement stations**
  Questions 9, 11, 12
- **2.4 Scientist skills: Using data**
  Questions 11, 12, 13

Science helps protect endangered species
Scientists collect information that helps us understand how to protect threatened and endangered species, like the orangutan.

ELL support

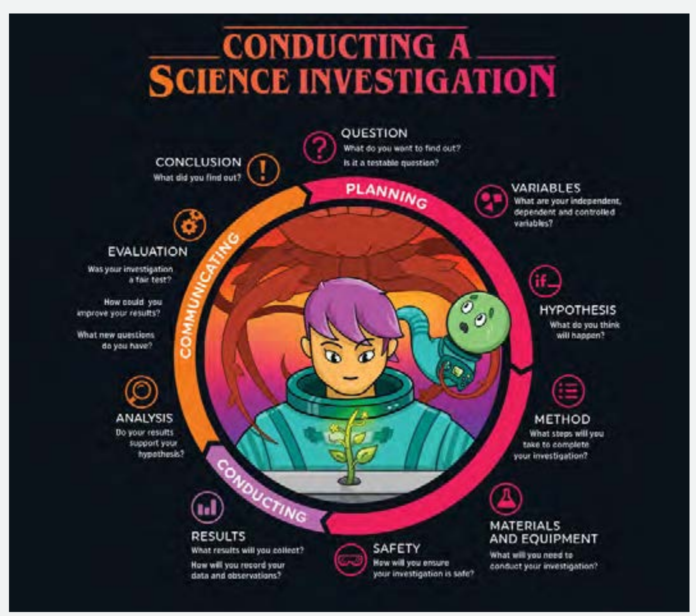
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

Introduction to Science lessons include a number of flow charts and diagrams. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

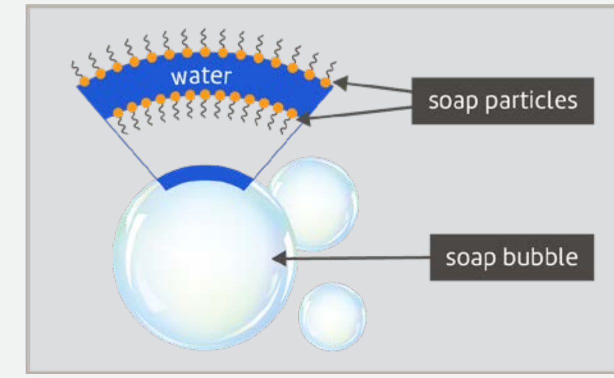
2.5 Conducting science investigations

This infographic represents the process of conducting a scientific investigation. The use of icons and short questions provides students with guidance as they work through each of the steps. These questions, along with the use of representative icons, allow students to build their understanding of the associated vocabulary, such as "hypothesis," "analysis," and "conclusion."



Introduction: Welcome to science

This diagram shows the structure of a soap bubble using clear illustration alongside simple labels. It helps students to pair the visual representation with the appropriate terminology, and develop their understanding of what each of the words means. This supports their development of scientific vocabulary as they gain familiarity with these terms.

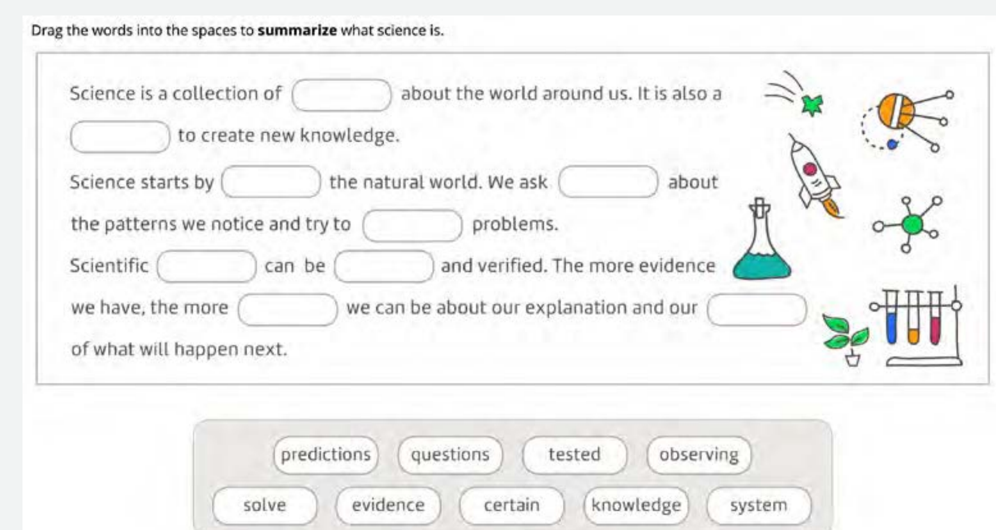


Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.1 Lesson: What is science?

In this activity, students drag unit-specific terminology to fill-in-the-blanks within a paragraph about science. This supports the development of students' vocabulary as they are required to interpret each of the words in order to place them correctly within the context of the paragraph.



Scientific equipment
Students become familiar with equipment used to measure and observe substances in the lab. .

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative Assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes
Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5–10 minutes. Quizzes provide students and teachers with information about student progress towards specific learning goals.

- **2.1 Quiz: Scientist skills: Observing and inferring**
  Multiple choice: 5–10 minutes
- **2.2 Quiz: Scientist skills: Measuring**
  Multiple choice: 5–10 minutes
- **2.4 Quiz: Scientist skills: Using data**
  Multiple choice and drag-and-drop: 5–10 minutes

Summative Assessment

Science investigations
The unit culminates with students completing a scientific investigation using a simulation where they construct explanations to communicate manipulating variables to grow tomatoes in space.

- **2.5 Conducting science investigations**
  Lesson: 100–120 minutes

Lab Activities

Lab Activity

Observing and inferring

Activity purpose: Practice observing using different senses.

stileapp.com/go/observing

45–60 minutes

3–4 students per group

Materials

Lab Equipment

- 1 item that will either produce a scent, squeak, or make a noise when shaken, such as:
  - balloon filled with marbles
  - balloon filled with a squirt of aerosol deodorant or body spray
  - squeezable pet toy that squeaks or has a bell inside
- blindfold

Chemicals

None required

Preparation

None required

Notes

None

Method

Method that students will follow

1. Hold the object for the blindfolded group member to touch with one finger. You may need to guide their hand.
2. Place the object in their hands.
3. Ask them to listen to the object. Does it make a sound? What if they shake it gently?
4. Ask them to smell the object.

Activity purpose: Introduce the difference between qualitative and quantitative observations, the importance of accurate measurement, and how to read common measuring equipment.

stileapp.com/go/measuring

45–60 minutes

3–4 students per group

Lab Activity

Measuring

Materials

Lab Equipment
- 3 x 100 mL beakers
- test tube rack
- 6 x 30 mL test tubes or boiling tubes
- 3 mL plastic transfer pipette
- 10 mL measuring cylinder
- 25 mL measuring cylinder
- felt-tip marker

Chemicals
- 25 mL of strongly colored red water in a 50 mL beaker
- 25 mL of strongly colored yellow water in a 50 mL beaker
- 25 mL of strongly colored blue water in a 50 mL beaker

Preparation

Prepare the different colored water in advance, using food coloring, and make sure that the colors are strong and dark.
- yellow: 5 mL of food dye per 100 mL water
- blue: 1 mL of food dye per 100 mL water
- red: 2 mL of food dye per 100 mL water

Measure out 25 mL into each beaker before class so that each group is given one beaker of each color.

Rinse the measuring equipment before using it to avoid contamination of colors.

Notes

After students perform the activity, the final colors should be:
- A - red
- B - orange
- C - yellow
- D - green
- E - blue
- F - purple

It's a good idea to test these results before the class to ensure that the colors are correctly prepared.

Method

Method that students will follow
1. Using the pipette and the graduations on the side of the measuring cylinders, measure 17 mL of red water and pour it into test tube A.
2. Measure 21 mL of yellow water and pour it into test tube C.
3. Measure 22 mL of blue water and pour it into test tube E.
4. Measure 5 mL of water from test tube A and pour it into test tube B.
5. Measure 6 mL of water from test tube C and pour it into test tube D.
6. Measure 8 mL of water from test tube E and pour it into test tube F.
7. Measure 5 mL of water from test tube C and pour it into test tube B.
8. Measure 2 mL of water from test tube A and pour it into test tube F.
9. Measure 4 mL of water from test tube E and pour it into test tube D.
10. Mix the colors by gently swirling each test tube. Record the final colors in the results table below.
11. Measure the final volume of water in test tube A by pouring it into the measuring cylinder. Record this measurement in the table and pour the water back into the test tube. Repeat for the other test tubes.

Activity purpose: Give students practice making measurements with a range of equipment.

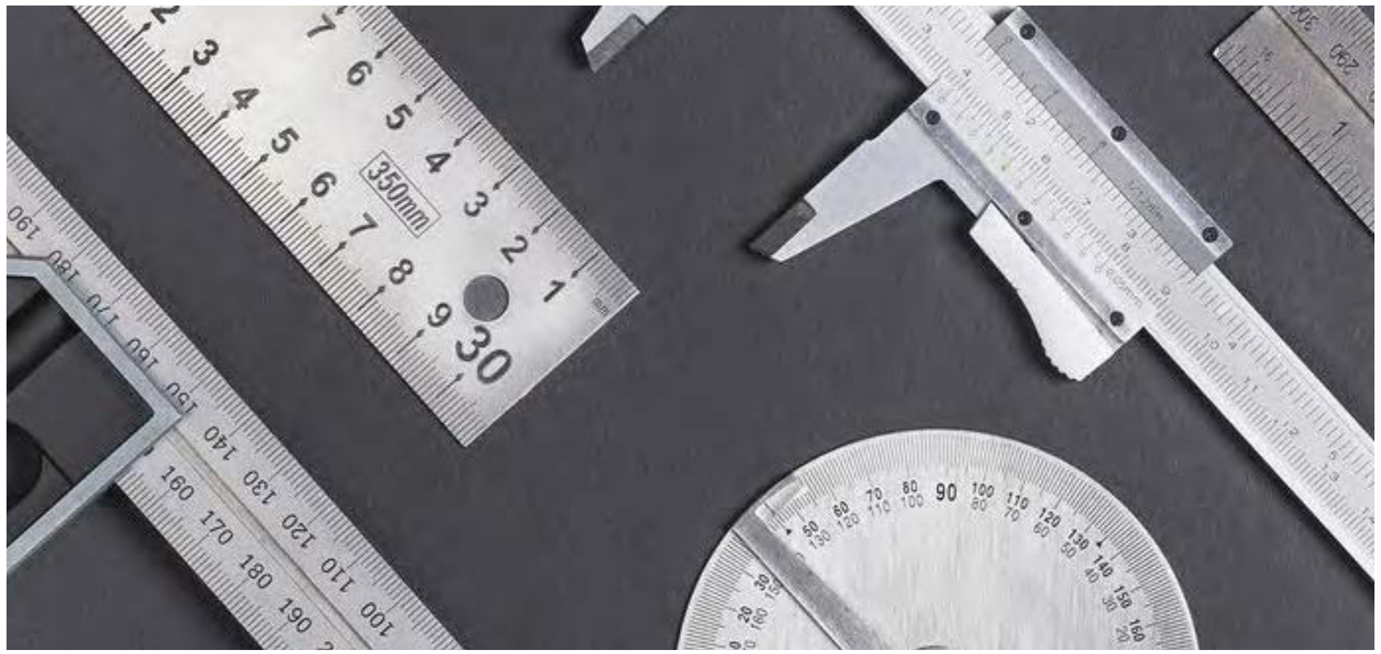
stileapp.com/go/measurestations

45–60 minutes

3–4 students per group

Lab Activity

Measurement stations



Materials

Lab Equipment
Activity 1: Length
- meter ruler
- cotton balls

Activity 2: Temperature
- 3 thermometers
- 100 mL beaker labeled "ice"
- 100 mL beaker labeled "hot"
- ice cubes
- hot water (boiled from a kettle)
- 250 mL measuring jug (for transporting hot water)
- felt-tip marker

Activity 3: Time
- 2 toy cars
- ramp (approx 1 m–1.5 m)
- stopwatch

Activity 4: Mass
- 0.01 g electronic mass balance
- selection of toys: plastic dinosaurs, animals, lump of play dough, etc.

Activity 5: Volume
- 100 mL beaker
- 250 mL beaker
- 100 mL measuring cylinder
- 100 mL conical flask
- 250 mL conical flask
- 500 mL water

Preparation

This activity is best set up as a round robin, where students rotate between activity stations around the classroom.

Ice cubes should be made ahead of time.

Students will also need boiling water.

Notes

None

Method

Method that students will follow

Activity 1:
1. Throw a cotton ball with your right hand.
2. Measure the distance it traveled.
3. Throw a cotton ball with your left hand.
4. Measure the distance it traveled.

Activity 2:
1. Measure the temperature of the following and record the results:
   - the room temperature of the classroom
   - cold water with ice cubes in it
   - hot water
   - your armpit

Activity 3:
1. Set up a ramp and hold one of the cars at the top.
2. Time how long it takes for the car to roll down the ramp.
3. Repeat with the second car.

Activity 4:
1. Turn on the balance and wait for the screen to read 0.00 g. If it doesn't, press the "zero" or "tare" button.
2. Place one of the toys on the balance and wait for the reading to stop changing.
3. Record the mass of the toy in the table below.
4. Repeat steps 1 to 3 with three other toys.

Activity 5:
1. Without using the measuring cylinder, pour 52 mL of water into the 100 mL beaker. Use the measurement markings on the side of the beaker to guide you.
2. Pour the water from the beaker into the measuring cylinder to see how accurate you were.
   Record these results in the table below.
3. Repeat steps 1 and 2 with the 100 mL beaker, 50 mL conical flask and 100 mL conical flask.

Activity purpose: Provide an opportunity for students to apply the qualitative/quantitative distinction and learn how to analyze and communicate data.

stileapp.com/go/usingdata

60 minutes

2 students per group

Lab Activity

Using data

Materials

Lab Equipment
- 30 cm clear plastic ruler
- 0.01 g electronic mass balance
- device to take photos
- calculator

Other
- three different brands of gummy worms
- 3 worms of each brand per group (9 worms per group in total)

Preparation

None required

Notes

Gummy worms should not be eaten in a laboratory setting.

This activity is a great starting point to discuss:
- the differences between qualitative and quantitative data and how they are used
- how to make accurate measurements of mass and length
- the importance of repeating measurements to improve accuracy
- sample sizes and uncertainty

Method

Method that students will follow
1. Divide worms into 3 species (sort by color, should have 3 of each color).
2. Collect qualitative observations.
3. Using the scales, weigh each worm and record its weight in the data table provided.
4. Using a ruler, measure the length of each worm recording its length in the data table provided.

Unit 2 – Food Chains and Food Webs

Why do cats have slit-shaped pupils?

A cat hunting its prey
A cat's slit-shaped pupils help it to judge the distance it needs to pounce to capture its prey.

Storyline and anchoring phenomenon

What makes a predator great? Turns out, it's more than just sharp teeth and claws or the ability to run fast. It's about their pupils too!

In this unit, students engage with the question "Why do cats have slit-shaped pupils?" They consider a range of predators and examine the shape of their pupils to identify patterns across these animals, from freshwater to treetops. By connecting their prior knowledge of predator–prey relationships and the different diets of animals, students consider the idea of energy flow in an ecosystem and are immediately hooked by discovering patterns in nature. They consider examples of their favorite animals and recognize the features that make them a perfect fit for the niche they occupies within their environment.

Through asking questions about how organisms produce or consume food to meet energy requirements, students discover food chains and webs. They then unpack the cycling of nutrients in ecosystems and develop models to represent the multiple interactions that take place.

Students further explore the flow of energy through these systems using a digital model of a desert ecosystem and in a hands-on activity where students collaboratively create a model of a food web using food web cards and a ball of wool. They use this model to investigate what happens when the fine balance of a food web is disturbed by population changes, and the impacts of invasive species.

Lastly, students consider invasive species within their own region and use researched information to construct an argument about the most effective control method for this organism.

This unit at a glance

Food Chains and Food Webs

Introduction: Why do cats have slit-shaped pupils?
Science news: The scoop on wombats' cube-shaped poo
Career profile: Zoo researcher
Career profile: Wildlife researcher

Students meet a zoo researcher and learn how they help endangered species.

1.1 Lesson: Food chains
1.1 Quiz: Food chains
1.2 Lesson: Food webs
1.2 Quiz: Food webs
1.3 Simulation: Feed the dingo
1.4 Lab activity: Modeling a food web

Students engage in the flow of energy through an ecosystem and **connect ideas** around an organism's need for energy.

Students explore the **cause and effect** of changes in populations.

Students **actively model food webs** by role-playing broken links in a connected ecosystem.

2.1 Lesson: The impact of invasive species
2.2 Lesson: Controlling invasive species
2.3 Project: Research a case study

Students research an invasive species to **solve problems** that occur in ecosystems when they're introduced.

Glossary: Food chains and food webs
Test: Food chains and food webs

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-LS2-2

Construct an explanation that predicts patterns of interactions among organisms across multiple ecosystems.

MS-LS2-3

Develop a model to describe the cycling of matter and flow of energy among living and nonliving parts of an ecosystem.

Disciplinary Core Ideas

- **LS2.A**: Interdependent Relationships in Ecosystems
- **LS2.B**: Cycle of Matter and Energy Transfer in Ecosystems

Students explore the interactions between organisms and the way in which energy flows between them in an ecosystem.

They analyze models that represent these relationships and create their own models of a specific ecosystem.

Science and Engineering Practice

- Developing and Using Models

Students engage with models of how energy flows within ecosystems in the form of food chains and food webs.

They interpret the meaning of these models and analyze the effects of imbalance within parts of the system they represent. Students create their own models to represent relationships between organisms and illustrate the flow of energy between them.

Crosscutting Concepts

- Patterns
- Energy and Matter

Students identify patterns in the interactions between organisms.

They explore how these patterns influence the flow of energy within and between ecosystems.

Nature of Science

- Scientific Investigations Use a Variety of Methods
- Science is a Way of Knowing
- Science Addresses Questions about the Natural and Material World

Science, Technology, Society and the Environment

- Interdependence of Science, Engineering, and Technology
- Influence of Engineering, Technology, and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

By exploring how food chains impact the flow of energy across an ecosystem, students build on their knowledge that organisms are related through food webs where some animals eat plants, and other animals eat those animals.

They extend their understanding by classifying living organisms into producers and consumers. Students review how some organisms, such as fungi and bacteria, break down dead organisms and therefore operate as "decomposers." To deepen student understanding of these concepts, they explore the relationships between organisms, food webs, and the impact of removing different organisms from an ecosystem.

This builds on the idea that a healthy ecosystem is one in which multiple species of different types are able to meet their needs in a relatively stable web of life and that newly introduced species can damage the balance of an ecosystem.

Science and Engineering Practices

Students' experience with Science and Engineering Practices likely included using a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.

They also practiced repeatedly revising simple models and using models to represent and design solutions. Food Chains and Food Webs builds on this prior knowledge by providing students with opportunities to develop models of simple systems with uncertain and less predictable factors.

Students apply their understanding to create food chains that show the flow of energy in an ecosystem, model food webs, and create a food web for a desert ecosystem.

Crosscutting Concepts

Students' prior knowledge should consist of identifying similarities and differences in order to sort and classify objects.

For this unit, they will need to be able to compare and contrast predator and prey, and classify or sort living things as producers or consumers. Building on this knowledge, students will use a variety of graphs, charts, and images to analyze patterns related to the impact of removing organisms from an ecosystem.

Within Food Chains and Food Webs, students build on their understanding of energy and matter. They develop their understanding of food webs, that decomposition eventually restores some materials back into the soils, and that a healthy ecosystem is one where all species' needs are met. Students deepen their thinking around these topics by analyzing the flow and cycle of energy amongst organisms.

Chipmunks enjoy red currant berries
Chipmunks eat nuts, seeds, and berries. This makes them primary consumers.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Why do cats' have slit-shaped pupils? Career profile: Zoo researcher	Why do cats have slit-shaped pupils?	Review teaching notes in Prepare Mode	Developing and Using Models	**LS4.C** Adaptation	Patterns	Assign Stile X Flashcards	Article linked in lesson, *Cosmos Magazine*, "Why do cats have slit-shaped eyes?"
Lesson 2	1.1 Lesson: Food chains	What are food chains?	Review What do you already know? in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**LS2.B** Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter	Assign Stile X app: Food chains video Assign Stile X Review notes: Food chains	1.1 Quiz: Food chains
Lesson 3	1.2 Lesson: Food webs	What are food webs?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**LS2.B** Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter	Assign Stile X app: Food webs video	1.2 Quiz: Food webs
Lesson 4	1.3 Simulation: Feed the dingo	Why are dingoes so important in the Australian desert food web?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**LS2.B** Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter	Assign Stile X Review notes: Food webs	Science news: The scoop on wombats' cube-shaped poo

Lesson Planning Guide

Week 1 · Week 2 · Week 3

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.4 Lab activity: Modeling a food web	How can we model food webs?	Review Key Question from previous lesson in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter Review teaching notes in Prepare Mode	Developing and Using Models	**LS2.B** Cycles of Matter and Energy Transfer in Ecosystems	Energy and Matter	Assign Stile X Glossary	Stile X app: Flashcards
Lesson 6	2.1 Lesson: The impact of invasive species	Why do we need to worry about invasive species?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**LS2.A** Interdependent Relationships in Ecosystems	Patterns	Assign Stile X app: The impact of invasive species video Assign Stile X Review notes: The impact of invasive species	Stile X app: Flashcards
Lesson 7	2.2 Lesson: Controlling invasive species	How can we fight an invasion?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**LS4.B** Natural Selection	Patterns	Introduce students to 2.3 Project Assign Stile X app: Controlling invasive species video Assign Stile X Review notes: Controlling invasive species	Stile X app: Flashcards
Lesson 8	Unit review Glossary: Food chains and food webs	How can I be prepared for the Food Chains and Food Webs test?	Review Key Questions from the unit in Analyze Mode to identify areas to revisit	Developing and Using Models	**LS2.A**: Interdependent Relationships in Ecosystems **LS2.B**: Cycle of Matter and Energy Transfer in Ecosystems **LS4.B**: Natural Selection **LS4.C**: Adaptation	Patterns Energy and Matter	Assign Stile X Test preparation Assign Stile X app: Flash Quiz Assign Stile X Glossary	Stile X app: Flashcards

Lesson Planning Guide

Week 1 · Week 2 · **Week 3**

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	Test: Food chains and food webs	How much have I learned about food Chains and Food Webs?	Ensure each student has access to a device	Developing and Using Models	**LS2.A**: Interdependent Relationships in Ecosystems **LS2.B**: Cycle of Matter and Energy Transfer in Ecosystems **LS4.B**: Natural Selection **LS4.C**: Adaptation	Patterns Energy and Matter		
Lesson 10 **Lesson 11**	2.3 Project: Research a case study	What kind of impact do invasive species have on an ecosystem?	Review teaching notes in Prepare Mode Complete grading of test ahead of test review	Developing and Using Models	**LS2.A** Interdependent Relationships in Ecosystems	Energy and Matter	Students may work on this task as homework	Extra SEP support 1.1: Researching
Lesson 12	Test review Career profile: Wildlife researcher	How successful was my revision of Food Chains and Food Webs?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these				Assign Stile X Reflection Ask students to review feedback from the test and to identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical and literacy skills.

Students use the populations of animals and plants in a food web to quantify how other populations will change. The relationships between these quantities are explored and analyzed.

Common Core State Standards Connections: Math

6.SP.B.5

Summarize numerical data sets in relation to their context.

6.EE.C.9

Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable.

Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation.

6.RP.A.1

Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Students gather information throughout the unit through specific case study examples.

They draw on these studies to analyze how relationships could change in similar, but different contexts.

They discuss the possibilities of change and convey the summary of these findings via written expression as well as by presenting a case study using multimedia to demonstrate the control strategies for invasive species.

Common Core State Standards Connections: English Language Arts

WHST.6-8.2

Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

WHST.6-8.8

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

WHST.6-8.9

Draw evidence from literary or informational texts to support analysis, reflection, and research.

Apex predators
If an animal is at the top of a food chain and has no natural predators, it is known as an apex predator. The hawk is one example of an apex predator.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Career profile: Zoo researcher**
  Questions 2, 4
- **Career profile: Wildlife researcher**
  Questions 1, 2
- **1.1 Lesson: Food chains**
  Questions 16, 20, 21
- **1.2 Lesson: Food webs**
  Questions 3, 15, 18, 19
- **1.3 Simulation: Feed the dingo**
  Questions 8, 9
- **1.4 Lab activity: Modeling a food web**
  Questions 4, 5, 6
- **2.1 Lesson: The impact of invasive species**
  Questions 6, 12, 13
- **2.2 Lesson: Controlling invasive species**
  Questions 6, 7, 11, 12, 13

ELL support

To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

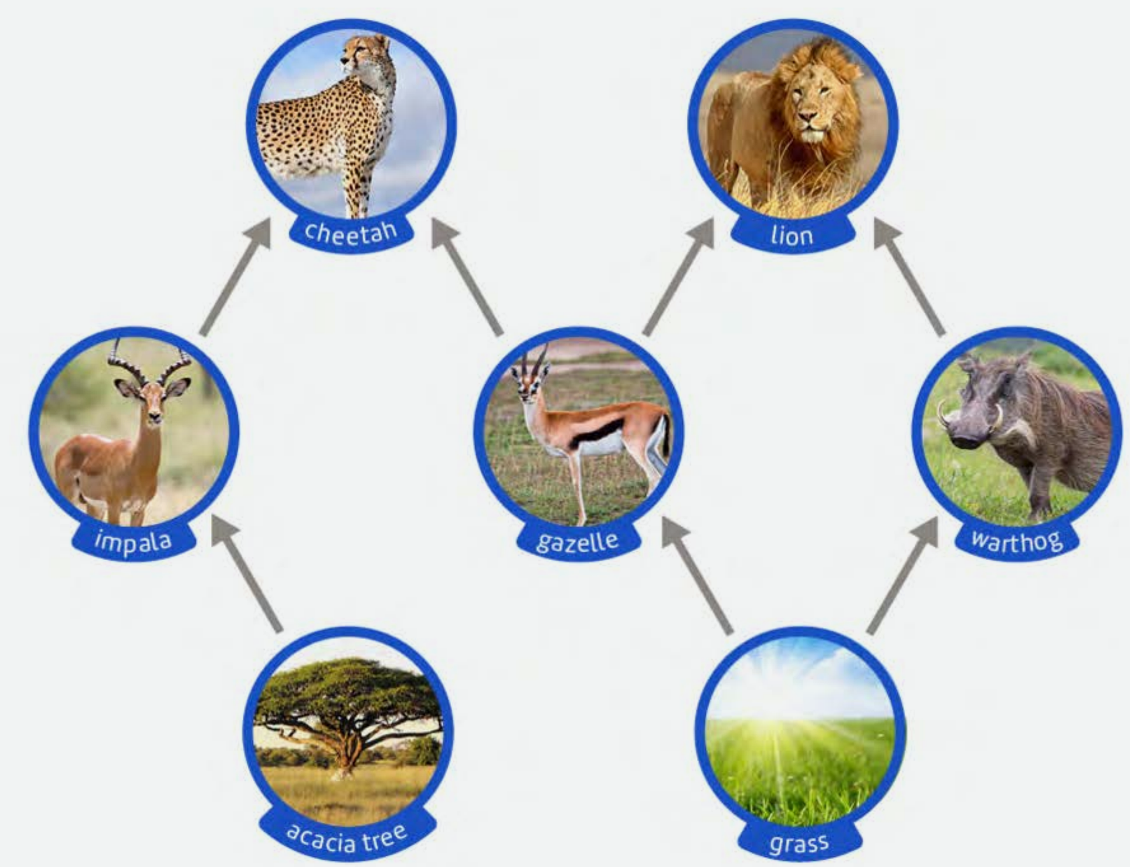
Food Chains and Food Webs lessons include a number of flow charts and diagrams to help students understand the intricacies of food webs. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

Introduction: Why do cats have slit-shaped pupils?

Examples of the differences in animals' pupils will assist learners who aren't familiar with the animals mentioned in this lesson. The image provides examples of two similar words – slit and bar – alongside their definition.

2.2 Lesson: Controlling invasive species

The use of a food web with images of each of the animals and directional arrows showing the flow of energy within a system supports students' understanding of the relationships between organisms described in the lesson.

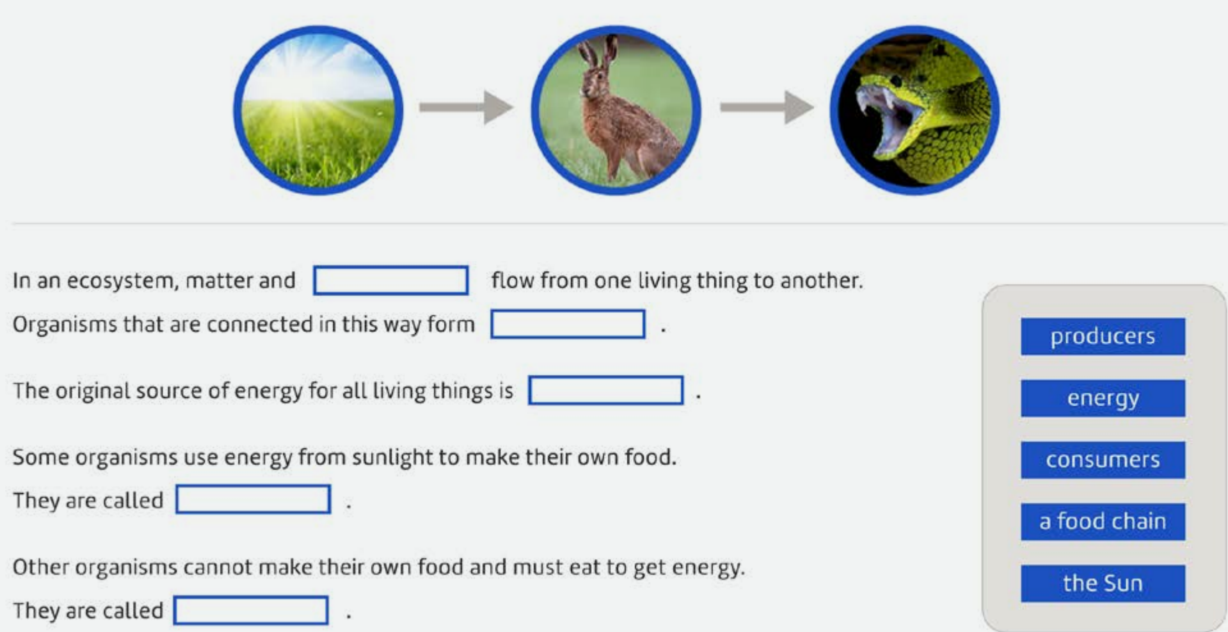


Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.1 Lesson: Food chains

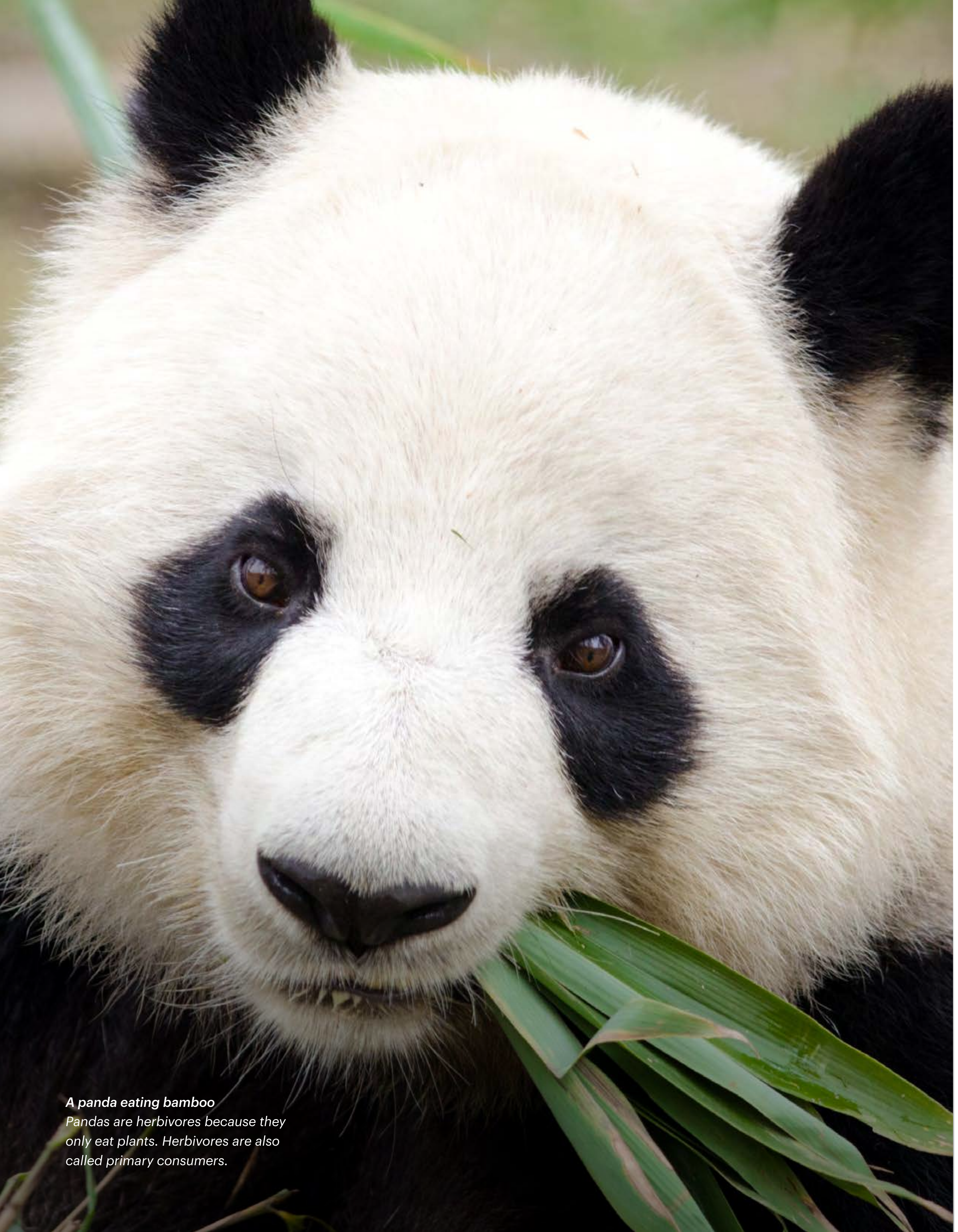
A drag-and-drop function allows English Language Learners to use new subject-specific vocabulary from the content in a scaffolded way in the beginning of the unit. As the unit progresses, students become more familiar with the terminology and will be encouraged to use this vocabulary in written answers.



Customization

2.3 Project: Research a case study has students investigate an invasive species. Consider including animal or plant species that are known invasive species in your region for students to choose from. This will require you to edit the lesson ahead of time under the heading "Your task."

A link to the National Invasive Species Information Center is provided in this text, which could be used to inform your choice of plant or animal.



Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes
Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5–10 minutes. Quizzes provide students and teachers with information about student progress towards specific learning goals.

- **1.1 Quiz: Food chains**
  Multiple choice: 5–10 minutes
- **1.2 Quiz: Food webs**
  Multiple choice and fill-in-the-blank: 5–10 minutes

Summative assessment

Test
This unit contains a test to provide summative assessment of student learning across the whole unit.

- **Test: Food chains and food webs**
  Multiple choice and short answer: 45–60 minutes

Science and Engineering Practices
A lab activity and project within the unit can be used as summative assessments of Science and Engineering Practices.

- **1.4 Lab activity: Modeling a food web**
  Lab activity: 45–60 minutes
- **2.3 Project: Research a case study**
  Project: 45–60 minutes

Lab Activities

Lab Activity

Modeling a food web

Activity purpose: Apply an understanding of food webs and the impact of removing a species from an ecosystem.

stileapp.com/go/foodweb

45–60 minutes

Whole class or large group

Materials

Lab Equipment
Each group of students will need:
- ball of wool
- food web cards (included on following pages)

Chemicals
None required

Preparation

Print and laminate the food web cards in advance.

Notes

This activity could also be used as a hook to start the unit, allowing students to appreciate the close links between organisms in an ecosystem.

On the other hand, you can have a much richer discussion if students have learned about food chains and food webs. For example, in Part 2 of this activity, you could discuss which organisms would benefit or be harmed if one organism were to go extinct.

Method

Method that students will follow

PART 1
1. To begin, each person will get a card describing which organism they will represent in the food web.
2. Read your food web card to find out what your organism eats and what eats it.
3. Stand up and form a circle.
4. Choose one member of the group to start with the ball of wool.
5. The person with the wool holds on tightly to one end and passes the ball to someone who represents an organism that they eat or are eaten by.
   While they pass the ball of wool, they should describe the connection out loud. For example, they might say, "I am a stingray and I get energy by eating the shrimp."
6. Repeat step 5 until every person in the circle has at least one or two connections to others in the group.

PART 2
1. Nominate one organism in the group to become "extinct." That person should drop any pieces of wool they're holding on to.
2. Observe what happens to the appearance of the food web.
3. Identify the organisms that were directly connected to the one that went extinct. These organisms have been affected by the extinction. The people who represent these organisms should drop any pieces of wool they are holding on to.
4. Observe what happens to the appearance of the food web.
5. Repeat steps 3 and 4 once more.

Food web cards

coral

I get energy from the algae that live with me. I also eat zooplankton.

I am eaten by sea snails, starfish, and parrotfish.

seaweed

I am a producer.

I am eaten by jellyfish, sea urchins, sea turtles, butterflyfish, and sea snails.

algae

I am a producer.

I am eaten by butterflyfish, clownfish, parrotfish, and clams.

anemone

I eat zooplankton, shrimp, and mussels.

I am eaten by starfish, eels, butterflyfish, and crabs.

mussel

I eat phytoplankton and zooplankton.

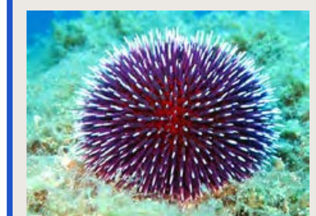
I am eaten by anemones, starfish, and humans.

lionfish

I eat shrimp, sea snails, clownfish, butterflyfish, and crabs.

I am eaten by eels and stingrays.

sea urchin



I eat seaweed and dead animals like fish and jellyfish.

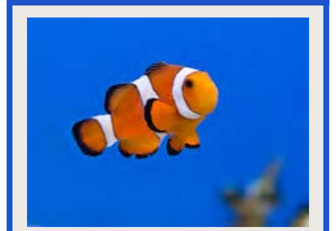
I am eaten by crabs, eels, and humans.

jellyfish

I eat seaweed, phytoplankton, zooplankton, and butterflyfish.

I am eaten by sea turtles.

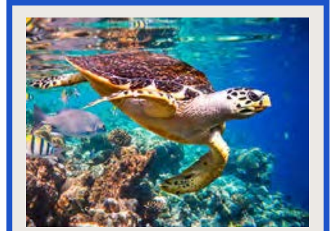
clownfish



I eat algae, zooplankton, phytoplankton, and shrimp.

I am eaten by eels, reef sharks, lionfish, and octopi.

sea turtle



I eat seaweed, jellyfish, crabs, and sea cucumbers.

In the reef, I am safe from most of my natural predators, except for humans.

stingray

I eat clams, shrimp, sea snails, and lionfish.

In the reef, I am safe from most of my natural predators, except for humans.

octopus

I eat clams, sea snails, shrimp, and clownfish.

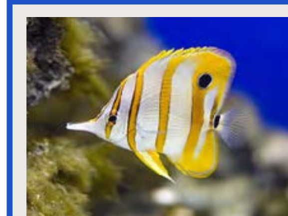
I am eaten by reef sharks and humans.

crab

I eat anemones, clams, sea snails, sea urchins, sea cucumbers, and starfish.

I am eaten by butterflyfish, lionfish, sea turtles, and humans.

butterflyfish



I eat seaweed, algae, zooplankton, small crabs, and shrimp.

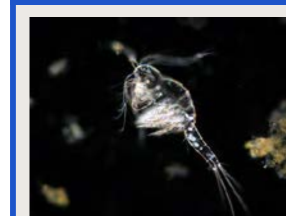
I am eaten by lionfish, eels, reef sharks, and jellyfish.

phytoplankton

I am a producer.

I am eaten by zooplankton, clams, clownfish, shrimp, and jellyfish.

zooplankton



I eat phytoplankton.

I am eaten by butterflyfish, clownfish, clams, corals, shrimp, mussels, and jellyfish.

Food web cards

parrot fish

I eat algae and dead coral.

I am eaten by eels and reef sharks.

eel

I eat clownfish, butterflyfish, and anemones.

I am eaten by reef sharks and humans.

clam

I eat algae, phytoplankton, and zooplankton.

I am eaten by crabs, starfish, octopi, stingrays, and humans.

shrimp

I eat algae, phytoplankton, and zooplankton.

I am eaten by butterflyfish, anemones, clownfish, and lionfish.

sea cucumber

I eat phytoplankton, algae, zooplankton, dead animals, and waste material.

I am eaten by crabs, sea turtles, and starfish.

reef shark

I eat clownfish, octopi, parrotfish, butterflyfish, eels, and starfish.

In the reef, I am safe from most of my natural predators, except for humans.

starfish

I eat corals, clams, sea cucumbers, mussels, and anemones.

I am eaten by crabs and reef sharks.

sea snail

I eat corals, seaweed, algae, dead animals, and waste material.

I am eaten by crabs and humans.

human

I eat crabs, sea turtles, sea snails, reef sharks, sea urchins, mussels, clams, eels, octopi, and stingrays.

In the reef, I don't have any natural predators.

Unit 3 – The Importance of Biodiversity

Do we need to save the bees?

A honey bee pollinating a flower
Bees have specific structures that function to collect pollen from particular flower species.

Storyline and anchoring phenomenon

Bee populations are on the decline but should we be concerned? Do we need to save the bees? This unit introduces students to the challenging topic of biodiversity by exploring the anchoring phenomenon of disappearing bees.

Students first evaluate the claim that bees are disappearing and, through data analysis and discussion, discover the real problem is not a decline in the number of bees, but in the number of bee species.

Natural curiosity leads students to understand the role bees play as pollinators within our ecosystems, the impact of human activity on a range of wild bee species, and why a reduction in biodiversity ultimately threatens global food security. Presented with this confronting problem, students must choose: save the bees or replace them!

Within the engineering process framework, students develop skills in defining a problem, brainstorming, researching, and designing possible solutions that either save or replace a particular bee species they adopt along the journey. This culminating engineering challenge supports students' skills in developing a range of possible solutions to a specific problem and shows how individuals can impact global issues.

This unit at a glance

The Importance of Biodiversity

1. Do we need to save the bees?
2. Why are bees important?
3. How do bees impact biodiversity?
4. Engineering challenge: Defining the problem
5. How do humans impact bee populations?
6. How do humans impact biodiversity?
7. Why do bees dance?
8. Engineering challenge: Research and brainstorm
9. Engineering challenge: Designing a solution
10. Engineering challenge: Improving your solution
11. Engineering showcase

Test: Do we need to save the bees?
Glossary: Do we need to save the bees?

Students use **graphical representations** to decide whether they need to take action to save the bees.

Students learn how bees pollinate flowers with a **Stile-made video** about flower reproduction.

An **interactive game** has students compete to create a biodiverse farm that sends the most produce to market.

Students use a **digital model** to see how humans impact biodiversity and bee habitats.

Students engage in **Engineering Practices** to find creative ways to solve the problem.

Definitions of key terms are accompanied by images. These are perfect for supporting ELL students to build scientific vocabulary.

Summative tests assess students' **three-dimensional** understanding of concepts.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-LS1-4

Use argument based on empirical evidence and scientific reasoning to support an explanation for how characteristic animal behaviors and specialized plant structures affect the probability of successful reproduction of animals and plants respectively.

MS-LS2-4

Construct an argument supported by empirical evidence that changes to physical or biological components of an ecosystem affect populations.

MS-LS2-5

Evaluate competing design solutions for maintaining biodiversity and ecosystem services.*

MS-ETS1-2

Evaluate competing design solutions.

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Disciplinary Core Ideas

- **LS1.B:** Growth and Development of Organisms
- **LS2.C:** Ecosystem Dynamics, Functioning, and Resilience
- **LS2.D:** Social Interactions and Group Behavior
- **LS4.D:** Biodiversity and Humans
- **ETS1.B:** Developing Possible Solutions

Students will learn about the lifecycle of bees and how bees' habitats and reproductive styles may play a role in the decline of their populations.

Students will engage with ecosystem-wide thinking to explore biodiversity and the impact that humans have on fragile environments. They will use their knowledge to develop possible solutions to help bee species around the world.

Science and Engineering Practices

- Asking Questions and Defining Problems
- Developing and Using Models
- Obtaining, Evaluating, and Communicating Information
- Constructing Explanations and Designing Solutions

The Science and Engineering Practices thread this unit together, asking students to solve the problem of declining bee populations.

By engaging with models of bee decline through engineering processes, students will ask questions about what bees will need. They will define the problems so that they can construct explanations and design solutions and communicate the information gathered over the unit.

Crosscutting Concepts

- Cause and Effect

Students will address the cause and effect of the decline of bees that have made headlines around the world.

Nature of Science

– Science is a Way of Knowing

Science, Technology, Society and the Environment

– Influence of Engineering, Technology, and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

Prior to this unit, students should know that being part of a group helps animals obtain food, defend themselves, and cope with changes.

Furthermore, plants and animals have both internal and external structures that serve various functions in growth, survival, behavior, and reproduction. Finally, students should have some understanding of how plants and animals are impacted by changes in the environment. In The Importance of Biodiversity, students build on this prior knowledge by exploring how bees work as members of a hive to survive, in addition to contributing to the reproduction of plants and a diverse ecosystem. They connect these ideas to evaluate the importance of biodiversity and how humans impact biodiversity.

In addition to understanding these life science concepts, students should know that it is important to research a problem before beginning to design a solution and that testing a solution involves investigating how well it performs under a range of likely conditions. Throughout this unit, students build on this knowledge by researching the problem of “disappearing bees” and exploring possible solutions with respect to how well they meet the criteria and constraints of a problem.

Science and Engineering Practices

Students’ experience with Science and Engineering Practices likely included using a model to test cause and effect relationships or interactions concerning the functioning of a natural or designed system.

They would also have practiced repeatedly revising simple models and using models to represent and design solutions. Prior knowledge likely includes evaluating the limitations of models and working collaboratively throughout the engineering process. Through The Importance of Biodiversity, students build on this knowledge by obtaining, evaluating, and communicating information, asking questions, defining problems, constructing explanations, designing solutions, and creating models. Students ask questions that challenge the idea of whether or not bees are actually disappearing, or if there is another problem.

Students also spend time throughout the unit describing and justifying scientific and technical information through different modes of communication such as written and performance-based tasks. Once students define the problem connected to the phenomenon of “disappearing bees” they undertake a design project where they develop and revise a model for saving different bee species.

Crosscutting Concepts

Prior to this grade, students should have routinely identified and tested causal relationships and used these relationships to explain change.

Additionally, students should be able to explain how events that occur together with regularity may or may not signify a cause and effect relationship. This unit builds on this understanding by providing students with the opportunity to explore causal and correlational relationships, use cause and effect relationships to make predictions, and analyze phenomena that may have more than one cause. Students should also be familiar with measuring change in terms of differences over time and observe that change may occur at different rates.

In The Importance of Biodiversity, students analyze data that describes changes in bee populations over time and take part in simulations to determine and evaluate the potential causes of the changes represented in the data. Students come back to this data and their simulation to explore potential relationships between variables.

Honey bee
Bees have specific structures that function to collect pollen from particular flower species.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle
This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Do we need to save the bees?	Are bees actually disappearing?	Review teaching notes in Prepare Mode Allow extra time for discussion of new concepts	Asking Questions and Defining Problems Analyzing and Interpreting Data	**LS2.C** Ecosystem Dynamics, Functioning, and Resilience	Patterns	Assign Stile X app: Do we need to save the bees? video Assign Stile X Review notes: Do we need to save the bees?	Extra SEP support: 2.1 Observing and inferring
Lesson 2	Why are bees important?	How important are bees for plant reproduction?	Review the Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**LS1.B** Growth and Development of Organisms	Structure and Function Cause and Effect	Assign Stile X app: Why are bees important? video Assign Stile X Review notes: Why are bees important?	Article linked in reference notes, *National Geographic*, "We haven't seen a quarter of known bee species since the 1990s"
Lesson 3	How do bees impact biodiversity?	How can I help Farmer Camilla get to market?	Review the Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Experiment with the simulation to familiarize yourself with what students are expected to do	Developing and Using Models	**LS4.D** Biodiversity and Humans	System and System Models Stability and Change	Assign Stile X app: How do bees impact biodiversity? video Assign Stile X Review notes: How do bees impact biodiversity?	Stile X app: Flashcards
Lesson 4	Engineering challenge: Defining the problem	How can I define a problem to solve?	Review teaching notes in Prepare Mode Review the Key Questions from the previous lesson in Analyze Mode	Asking Questions and Defining Problems	**LS4.D** Biodiversity and Humans	Cause and Effect	Ask students to note the questions they would like answers to through the unit	Extra SEP support: 0.3 The engineering process

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	How do humans impact bee populations?	How do humans impact bee populations and ecosystems that we live near?	Review the Key Questions from the previous lesson in Analyze Mode Review questions that students would like the answer to in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**LS2.C** Ecosystem Dynamics, Functioning, and Resilience	Stability and Change	Assign Stile X app: How do humans impact bee populations? video Assign Stile X Review notes: How do humans impact bee populations?	Blog linked in reference notes, *PQ Systems*, "Data in everyday life: Are honeybees on the decline?"
Lesson 6	How do humans impact biodiversity?	How could a change to ecosystems threaten our food production?	Review teaching notes in Prepare Mode Review the Key Questions from the previous lesson in Analyze Mode	Developing and Using Models	**LS2.C** Ecosystem Dynamics, Functioning, and Resilience **LS4.D** Biodiversity and Humans	Cause and Effect Stability and Change	Assign Stile X app: How do humans impact biodiversity: video Assign Stile X Review notes: How do humans impact biodiversity?	Stile X app: Flashcards
Lesson 7	Why do bees dance?	How does bee behavior help them survive?	Review teaching notes in Prepare Mode Review the Key Questions from the previous lesson in Analyze Mode	Constructing Explanations and Designing Solutions	**LS1.B** Growth and Development of Organisms	Patterns	Assign Stile X app: Why do bees dance? video Assign Stile X Review notes: Why do bees dance?	Stile X app: Flashcards
Lesson 8	Engineering challenge: Research and brainstorm	How can I save or replace bees?	Review teaching notes in Prepare Mode Review the Key Questions from the previous lesson in Analyze Mode	Engaging in Argument from Evidence	**ETS1.B** Developing Possible Solutions **LS4.D** Biodiversity and Humans	Cause and Effect	Assign Stile X app: Engineering challenge video Assign Stile X Review notes: Engineering challenge	Extra SEP support: 1.1 Researching

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	Engineering challenge: Designing a solution	How do I evaluate my prototype?	Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**ETS1.B** Developing Possible Solutions	Structure and Function		Extra SEP support: 5.2 What is creativity?
Lesson 10	Engineering challenge: Improving your solution	How can I modify my design to make it better?	Review teaching notes in Prepare Mode Copies of the evaluation rubric tool should be printed in advance	Constructing Explanations and Designing Solutions	**ETS1.B** Developing Possible Solutions	Structure and Function	Ensure students have filled out a list of materials required for the next lesson	Stile X app: Flash Quiz
Lesson 11	Unit review Glossary: Do we need to save the bees?	How can I be prepared for The Importance of Biodiversity test?	Review Key Questions from the unit using Analyze Mode to identify areas to revisit	Constructing Explanations and Designing Solutions Asking Questions and Defining Problems Developing and Using Models	**LS1.B** Growth and Development of Organisms **LS2.C** Ecosystem Dynamics, Functioning, and Resilience **LS4.D** Biodiversity and Humans	Cause and Effect Structure and Function	Assign Stile X Glossary Assign Stile X Test preparation Ask students to review teacher feedback from lessons in the unit	Stile X app: Flash Quiz
Lesson 12	Engineering showcase	How can I best present my design to save or replace the bees?	Prepare any stationery items that will support your students' presenta-tions, including colored paper, sticky notes, col-ored pencils or markers, scissors, glue, etc.	Obtaining, Evaluating, and Communicating Information Engaging in Argument from Evidence	**ETS1.B** Developing Possible Solutions	Structure and Function	Ask students to reflect on the most important thing they learned through the engineering process	Extra SEP support: 6.2 Creative thinking

Lesson Planning Guide

Week 1 Week 2 Week 3 **Week 4**

The guide below is based on two 45-minute lessons.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	Test: Do we need to save the bees?	How much have I learned about the Importance of Biodiversity and Bees?	Ensure every student has access to a device	Constructing Explanations and Designing Solutions Asking Questions and Defining Problems Developing and Using Models	**LS1.B** Growth and Development of Organisms **LS2.C** Ecosystem Dynamics, Functioning, and Resilience **LS4.D** Biodiversity and Humans **ETS1.B** Developing Possible Solutions	Cause and Effect Structure and Function		
Lesson 14	Test review	How successful was my revision of The Importance of Biodiversity?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these				Assign Stile X Reflection Ask students to reflect on the effectiveness of their revision, and to identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Students open this unit by analyzing data in the context of the mystery of the disappearing bees. By analyzing graphs and models of bee populations, students can formulate opinions informed by data. These opinions are used as the basis for their engineering and design projects.

Common Core State Standards Connections: Math

6.SP.B.4

Summarize numerical data sets in relation to their context.

MP.4

Model with mathematics.

MP.2

Reason abstractly and quantitatively.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Students analyze data and articles from multiple sources to enable them to form an opinion.

Students will read texts on the topic of bee and insect decline and evaluate arguments with reason.
They will use this knowledge to form arguments and support their analysis, reflection, and research.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.8

Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

RI.6.8

Trace and evaluate the argument and specific claims in a text, distinguishing claims that are supported by reasons and evidence from claims that are not.

WHST.6-8.1

Write arguments focused on discipline content.

WHST.6-8.9

Draw evidence from literary or informational texts to support analysis, reflection, and research.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions, and how to replace question types in The Stile Guide.

Note that not *all* written response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **1. Why are bees important?**
  Question 5
- **3. How do bees impact biodiversity?**
  Question 5
- **4. Engineering challenge: Defining the problem**
  Question 8
- **7. Why do bees dance?**
  Questions 3, 6

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize them within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
1. Do we need to save the bees?	All bees are honey bees.	There are over 20,000 different bee species globally and around 4,000 in the US alone. Use lesson 1: Do we need to save the bees? Draw students' attention to the number of species identified in Thanh's field notes, and the representation of the number of bee species in the graph associated with question 5.
	All bees make honey.	Less than 5% of bee species make honey. Explain to students that this will be addressed and discussed in lesson 2: Why are bees important?
	All bees live in hives.	Only social bees live in hives, and only 10% of bee species are social. Explain to students that this will be addressed and discussed in Lesson 7: Why do bees dance?
	All bees sting.	Not all bees can sting. The stinger is used in the egg-laying process, so only females have them. Even then, the females of many bee species can't sting. Most bees don't sting unless they're provoked, feel threatened, or are trying to defend themselves. This isn't touched on within the lessons, but it's worth having the above information on hand if students raise this point. You'll find these details in the lesson's teaching notes.

Common misconceptions

Lesson	Misconception	Addressing the misconception
1. Do we need to save the bees?	Bees and wasps are the same.	Bees and wasps are different in many ways. For example, bees are vegetarian and usually non-aggressive. On the other hand, wasps are carnivores or omnivores and can be very aggressive. This isn't touched on within the lessons, but it's worth having the above information on hand if students raise this point. You'll find these details in the lesson's teaching notes.
	Bees can repeatedly sting.	Stinging bees, such as female honey bees, can sting other insects many times. But their stingers get stuck in the thick skin of mammals, and they die when their stingers are ripped off. This isn't touched on within the lessons, but it's worth having the above information on hand if students raise this point. You'll find these details in the lesson's teaching notes.
2. Why are bees important?	Bees are making honey when they visit flowers.	Not all bees make honey. Those that do make honey collect nectar from flowers to take to their hive. They then pass this nectar mouth-to-mouth from bee to bee. This reduces moisture and adds enzymes that sterilize the product. Emphasize the descriptions of what bees could be doing when they visit a flower at the beginning of the lesson. These include feeding on nectar and storing it to make honey later and transferring pollen for pollination. The video that describes the pollination process can be used for direct teaching by playing it.
	Bees eat pollen when they visit flowers.	Bees collect pollen from flowers, but they turn some of this pollen into "bee bread." This is a combination of honey and pollen which is a source of proteins and fats for bees.

A bee covered in pollen
Collecting pollen is just one of the many things that a bee does when they visit a flower.

ELL support

To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

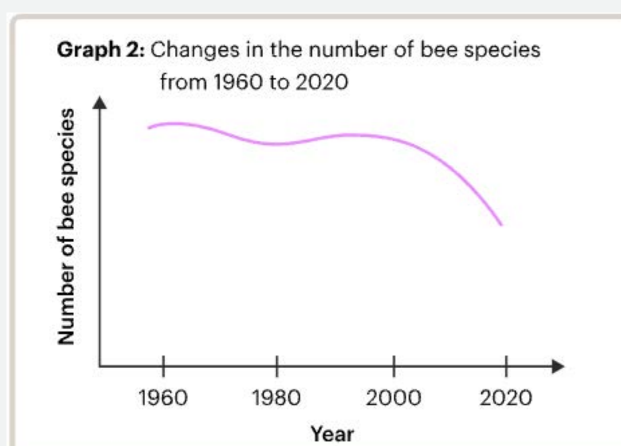
Visual representations

The Importance of Biodiversity lessons include a number of flow charts and diagrams to help students understand the key to biodiversity and helping bee species across America and the world. Encourage students to draw on these visual representations and to actively interpret the information they contain.

Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

1. Do we need to save the bees?

This graphical representation assists English Language Learners with their comprehension of texts and videos within the lesson by displaying information graphically.



2. Why are bees important?

This video shows new content by verbal delivery as well as with annotated diagrams. Students can rewatch the video as many times as required before being introduced to the same information in text.

Interactive question type

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

3. How do bees impact biodiversity?

This interactive occurs throughout the lessons within the unit. Students can manipulate scenarios and create new outcomes every time they play the game. There are reflection questions within this lesson that allows students to summarize their knowledge.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Summative assessment

Test
This unit contains a test to provide summative assessment of student learning across the whole unit.

- **Test: Do we need to save the bees?**
  Multiple choice and short answer: 45–60 minutes

Science and Engineering Practices
The engineering challenge within the unit can be used as a summative assessment of Science and Engineering Practices.

- **Engineering challenge: Designing a solution for the disappearing bees**
  The engineering challenge is broken into full lessons across the unit that allow students to gather knowledge before progressing with their ultimate design.
  Four lessons of 60-minutes plus a showcase lesson at the end.

Unit 4 – Cells

Are you ready to meet lab-grown meat?

Lab-grown meat
Scientists can produce meat using cultured cells instead of livestock.

Storyline and anchoring phenomenon

What if the meat in a hamburger could be produced without any animals having to die? What would the consequences be for farming, and for the environment? Students are introduced to lab-cultured meat and discuss their ideas about this phenomenon.

To understand how the incredible biology of cells can be harnessed through technological advancements, students must ask questions and define problems to solve.

Students explore how cells are organized into tissues, organs, and organ systems. They compare the sizes of cells to familiar objects, and through the use of microscopes, consider their scale.

Students learn about the structure and organization of plant and animal cells and craft their own analogies as models of cellular organelles. They explore the specialization of cells, and recognize their diversity within organisms, as well as between them.

Student learning culminates with a Socratic seminar where they take on the perspectives of different stakeholders in the development of cultured meat and engage in arguments using evidence gathered throughout the unit. Using a detailed rubric, they provide one another with peer feedback and complete a self-assessment about their participation in the seminar.

This unit at a glance

The real-world phenomena of plant-based meat drives the unit and connections are made to demonstrate advances in science, engineering, and technology.

Disciplinary Core Ideas are covered throughout the core lessons of the unit.

Crosscutting Concepts are explored as students learn about the structure and function of cells.

Cells

What do you already know?
Introduction: Battle of the burgers

Career profile: Food innovator
Career profile: Stem cell researcher

1.1 Lesson: Living or non-living?
1.1 Quiz: Living or non-living?
1.2 Lesson: The building blocks of life
1.3 Lesson: One cell or many?
1.4 Lesson: Levels of organization
1.4 Quiz: The building blocks of life
1.5 Lesson: Sizes of cells
1.6 Extension: Cell theory

2.1 Lesson: Introduction to microscopes
2.1 Quiz: Introduction to microscopes
2.2 Lab activity: Using a microscope
2.3 Lab activity: Measuring with microscopes

Students discover the diversity of cell biology and the potential impact of new research on **science as a human endeavor.**

Students apply **Science and Engineering Practices** as they develop an understanding of cell models.

Students zoom in on the magical world of microscopy, and learn how the microscope changed the way we study cells.

Students learn how the **structure** of an organelle is related to a cell's **function** within a system.

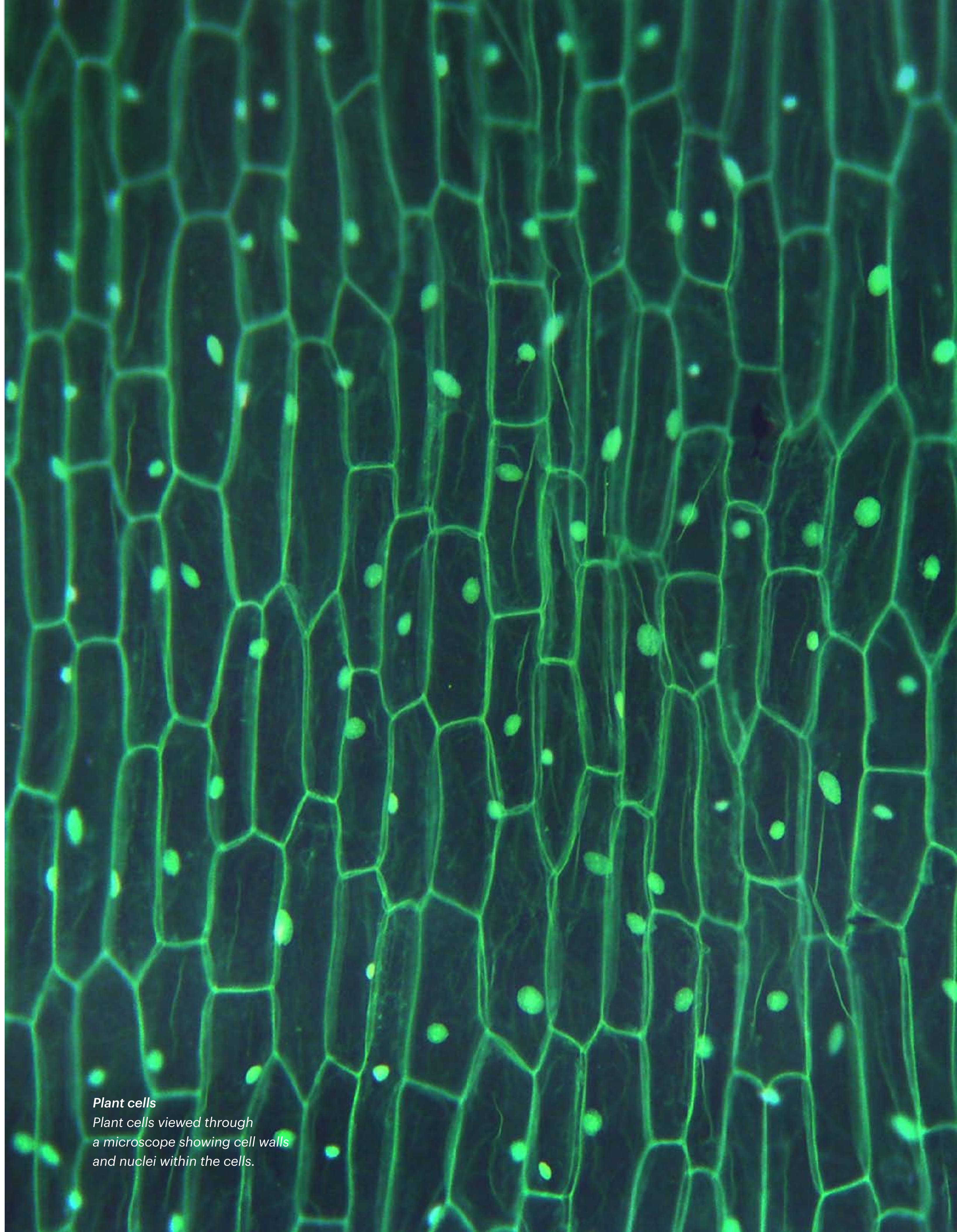
Students learn different specialized cell structures have different functions. They **propose relationships** between the structures and their functions.

Students **develop a physical model** that represents all parts of a plant or animal cell, and analyze its limitations.

Connections to **Common Core State Standards in Literacy** are possible as students conduct a short research project on specialized cells, drawing on several sources.

A summative test checks for understanding across the **Disciplinary Core Ideas**, as well as Science and Engineering Practices and Crosscutting Concepts.

Students engage in a **scientifically founded discussion** from the perspective of a variety of stakeholders in relation to lab-grown meat.



Plant cells
Plant cells viewed through a microscope showing cell walls and nuclei within the cells.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-LS1-1

Conduct an investigation to provide evidence that living things are made of cells; either one cell or many different numbers and types of cells.

MS-LS1-2

Develop and use a model to describe the function of a cell as a whole and ways the parts of cells contribute to the function.

MS-LS1-3

In multicellular organisms, the body is a system of multiple interacting subsystems. These subsystems are groups of cells that work together to form tissues and organs that are specialized for particular body functions.

Disciplinary Core Idea

LS1.A: Structure and Function

Students consider what makes something alive, and what living things are made up of.

They are introduced to cells and unpack the levels of organization that allow a collection of cells to work together as an organ. Students investigate the structure and function of cells generally, and of specific cell organelles.

They create analogies that act as a model of an organelle and the role it plays within a cell. Students further build on this understanding by constructing a physical model of a cell that reinforces ideas of structure and function within the building blocks of life.

Science and Engineering Practices

- Engaging in Argument From Evidence
- Asking Questions and Defining Problems
- Obtaining, Evaluating, and Communicating Information

At the beginning of this unit, students ask questions about the problems meat production could cause for future generations.

Once they define these problems, they gather information about cells and their structures. Students use data they have collected through microscopy and analyze representations of data collected by others to formulate opinions. At the end of the unit, they engage in constructive conversations to consider all sides of the argument for lab-cultured meat.

Crosscutting Concepts

- Structure and Function

Students examine the structure and function of organelles through microscopy in this unit.

The observation of these structures and patterns is upscaled from microscopic views to patterns throughout larger scaled systems. The notion of structure and function is extended to the universe in extension lessons towards the end of the unit.

Nature of Science

– Science is a Human Endeavor

Science, Technology, Society and the Environment

– Interdependence of Science, Engineering, and Technology
– Influence of Engineering, Technology, and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

In previous grades, students learned that all living things are made up of diverse, external, and internal structures that help them grow, survive, and reproduce.

In this unit, students will build on this prior knowledge by applying these concepts, and the relationships between structure and function, at the cellular level. They will interact with a variety of mixed media including videos, activities, and interactive questions, in order to learn what it means to be alive by investigating essential life functions and distinguishing between living and non-living things.

Using this information as a foundation, students will begin their exploration of cell theory and the levels of organization within single and multicellular organisms. They will deepen their examination of cells using simulations and tools to identify parts of the cell, their role, and how their structure is related to their function. With this understanding, students will be able to investigate how cells become specialized and begin to learn about cell division.

Science and Engineering Practices

Students' experience with Science and Engineering Practices includes engaging in discussion and argument based on evidence.

In Cells, students will expand on these skills as they examine the development of cell theory and debate the merits of early scientists' theories about cells. Prior science classes would also have prepared students to ask critical questions, define problems, and obtain, synthesize, and comprehend information from a variety of sources.

Throughout Cells, students take an inquiry-based approach to learning about cells. They are encouraged to ask questions about cells' structure and function before engaging with various information sources to construct explanations about cells' role in our natural world. Finally, these three Science and Engineering Practices are extended in the end-of-unit Socratic seminar, in which students investigate the anchoring phenomenon: Feeding the future with cultured meat.

Crosscutting Concepts

In previous grades, students would have explored the Crosscutting Concept of structure and function and how different materials have different substructures, shapes, and parts that serve specific functions.

In Cells, students will continue to discover the relationship between structure and function as they relate to the levels of organization of living things, including the substructures of plant and animal cells. They will observe these microscopic structures using a simulation (and real microscopes, if available) to make observations, gather information, and then ultimately create their own model of a cell.

The exploration of the similarities and differences of plants and animal cells, as well as the process of specialization, will allow students to examine how cells and the organisms they comprise have unique structures that relate to their functions and keep them alive.

Ostrich Eggs
Eggs start as a single cell. Once they are fertilized, they divide into daughter cells and specialize into tissues, organs, systems, and organisms.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Battle of the Burgers	Is it possible to grow beef burgers in a lab?	Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**LS1.A** Structure and Function	Systems and System Models	Stile X app: Flashcards	Article linked in lesson, *Cosmos Magazine*, "Meet the biochemist who wants to save the world by making the perfect meat-free burger"
Lesson 2	Career profile: Stem cell researcher	How could stem cells help people with cystic fibrosis?	Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Assign Stile X Glossary	Stile X app: Flash-cards
Lesson 3	1.1 Lesson: Living or non-living	What makes something a living thing?	Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Stile X app: Living or non-living video Assign Stile X Review notes: Living or non-living	1.1 Quiz: Living or non-living Extra SEP support: 2.1 Observing and inferring
Lesson 4	1.2 Lesson: The building blocks of life Career profile: Food innovator	How do cells complete different functions in our bodies?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Assign Stile X app: The building blocks of life video Assign Stile X Review notes: The building blocks of life	Stile X app: Flashcards

Lesson Planning Guide

Week 1 · **Week 2** · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.3 Lesson: One cell or many?	How do cells complete different functions in our bodies?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Optional: Observing pond organisms. Collect pond organisms; see teacher notes at the beginning of this lesson	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Assign Stile X app: One cell or many? video Assign Stile X Review notes: One cell or many?	Stile X app: Flashcards
Lesson 6	1.4 Lesson: Levels of organization	How do cells complete different functions in our bodies?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Systems and System Models	Assign Stile X app: Levels of organization video Assign Stile X Review notes: Levels of organization	1.4 Quiz: The building blocks of life Stile X app: Flashcards
Lesson 7	1.5 Lesson: Sizes of cells	How big is a cell?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Assign Stile X app: Sizes of cells video Assign Stile X Review notes: Sizes of cells	1.6 Extension: Cell Theory Stile X app: Flashcards
Lesson 8	2.1 Lesson: Introduction to microscopes	How do light microscopes work?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Assign Stile X app: Introduction to microscopes video Assign Stile X Review notes: Introduction to microscopes	2.1 Quiz: Introduction to microscopes Extra SEP support: 0.1 Conducting science investigations Stile X app: Flashcards

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	2.2 Lab activity: Using a microscope	How do everyday objects look under a microscope?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Finish any lab activity questions	Extra SEP support: 2.2 Measuring
Lesson 10	2.3 Lab activity: Measuring with microscopes	How can microscopes be used to measure objects?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Engaging in Argument From Evidence	**LS1.A** Structure and Function	Structure and Function	Finish any lab activity questions	Extra SEP support: 2.2 Measuring
Lesson 11	3.1 Lesson: Parts of a cell	Do cells have organs?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Assign Stile X app: Parts of a cell video Assign Stile X Review notes: Parts of a cell	3.1 Quiz: Parts of a cell
Lesson 12			Review student progress in Analyze Mode Review teaching notes in Prepare Mode				Stile X app: Flashcards	Science news: Meet your new organ

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · **Week 4** · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	3.2 Lesson: Animal vs. plant cells	How are my cells different to that of a plant?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Assign Stile X app: Animal vs. plant cells video Assign Stile X Review notes: Animal vs. plant cells	3.2 Quiz: Animal vs. plant cells Extra SEP support: 2.1 Observing and inferring Stile X app: Flashcards
Lesson 14	3.3. Lesson: Cells under the microscope	What does a cell look like under a microscope?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**LS1.A** Structure and Function	Structure and Function	Assign Stile X app: Cells under the microscope video Assign Stile X Review notes: Cells under the microscope	3.3 Quiz: Cells under the microscope Extra SEP support: 2.1 Observing and inferring Stile X app: Flashcards
Lesson 15	3.4 Lab activity: Observing plant and animal cells	What do cells look like up close?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Obtaining, Evaluating, and Communicating Information	**LS1.A** Structure and Function	Structure and Function	Ensure all students have completed question 4	Extra SEP support: 0.1 Conducting science investigations
Lesson 16							Finish any lab activity questions not completed	

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	3.5 Project: Make a cell model	How can you build a scale model of a cell?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**LS1.A** Structure and Function	Structure and Function	Students should complete their cell model in this lesson	Extension: Cell analogy
Lesson 18								Extension: Cell analogy
Lesson 19	4.1 Lesson: Specialized Cells	What specialized cells do humans have?	Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Assign Stile X app: Specialized cells video Assign Stile X Review notes: Specialized cells	4.1 Quiz: Specialized cells Stile X app: Flashcards
Lesson 20	4.2 Project: Putting cells to work Introduce Socratic seminar	What jobs are specialized cells built for?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Watch the Socratic seminar in action video linked in the teaching notes	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Ask students to begin to research to prepare for the Socratic seminar	Extra SEP support: 5.2 What is creativity?

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 21	4.2 Project: Putting cells to work	What jobs are specialized cells built for?	Check student progress in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.A** Structure and Function	Structure and Function	Complete research and prepare for the Socratic seminar	Extra SEP support: 5.3 Creative thinking
Lesson 22							Assign Stile X Glossary Assign Stile X app: Flash Quiz	Stile X app: Flashcards
Lesson 23	Glossary: Cells Unit review	How can I be prepared for the Cells test?	Review Key Questions from the unit using Analyze Mode to identify areas to revisit	Engaging in Argument From Evidence Asking Questions and Defining Problems Obtaining, Evaluating, and Communicating Information	**LS1.A** Structure and Function	Structure and Function Systems and System Models	Assign Stile X Reflection Assign Stile X Test preparation	
Lesson 24	Test: Cells	How much have I learned about Cells?	Ensure each student has access to a device					

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on three 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 25	Socratic seminar: Feeding the future with cultured meat	What are some different perspectives of the risks and benefits of cultured meat?	Watch the Socratic seminar in action video linked in the teaching notes Review teaching notes in Prepare Mode	Engaging in Argument From Evidence	**LS1.A** Structure and Function	Structure and Function	Prepare to participate in the Socratic seminar in the next lesson	Extra SEP support: 6.2 Critical thinking
Lesson 26			Download and print the stakeholder name tags found in the top teaching note Complete grading of test ahead of test review session				Assign Stile X app: Flash Quiz	
Lesson 27	Test review	How successful was my revision of cells?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Engaging in Argument From Evidence Asking Questions and Defining Problems Obtaining, Evaluating, and Communicating Information	**LS1.A** Structure and Function	Structure and Function Systems and System Models	Assign Stile X Reflection Ask students to review feedback from the test and to identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Students quantify and compare the sizes of objects under the microscope using micrometers.

Common Core State Standards Connections: Math

6.EE.A.1

Write and evaluate numerical expressions involving whole-number exponents.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Students research the structure and function of cells and present their understanding on cell specialization in various forms.

They use this knowledge to present an argument and clarify information through a Socratic seminar.

Common Core State Standards Connections: English Language Arts

WHST.6-8.7

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

SL.6.1

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions, and how to replace question types in The Stile Guide.

Note that not *all* written response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Introduction: Battle of the burgers**
  Questions 2, 7, 11
- **Career profile: Food innovator**
  Questions 1, 3, 4, 5
- **Career profile: Stem cell researcher**
  Questions 2, 3, 4
- **1.1 Lesson: Living or non-living?**
  Questions 2, 3, 4, 14, 16, 17
- **1.2 Lesson: The building blocks of life**
  Questions 2, 6, 7, 8
- **1.3 Lesson: One cell or many?**
  Questions 3, 6, 7, 8
- **1.4 Lesson: Levels of organization**
  Question 8
- **1.5 Lesson: Sizes of cells**
  Questions 3, 4, 10
- **1.6 Extension: Cell theory**
  Questions 3, 7, 10, 11, 12
- **2.1 Lesson: Introduction to microscopes**
  Questions 4, 15, 17
- **2.2 Lab activity: Using a microscope**
  Questions 7, 10
- **2.3 Lab activity: Measuring with microscopes**
  Questions 2, 11
- **3.1 Lesson: Parts of a cell**
  Question 11
- **3.2 Lesson: Animal vs. plant cells**
  Questions 3, 4, 5, 8, 9, 11
- **3.3 Lesson: Cells under the microscope**
  Question 7
- **3.4 Lab activity: Observing plant and animal cells**
  Question 6
- **3.5 Project: Make a cell model**
  Question 3
- **4.1 Lesson: Specialized Cells**
  Questions 2, 3, 9, 11, 12
- **4.3 Extension: Cell biology and Aboriginal art**
  Questions 3, 4, 5
- **Socratic seminar: Feeding the future with cultured meat**
  Questions 3, 4, 5, 6, 7

Extension opportunities in this unit

Challenge Questions
Most lessons contain one or more Challenge Questions, which are an opportunity for students to show they are working above the level of the learning goal.

When answering these questions, students can extend themselves by applying their knowledge to new contexts, or to solve more complex problems. These provide a great extension opportunity.

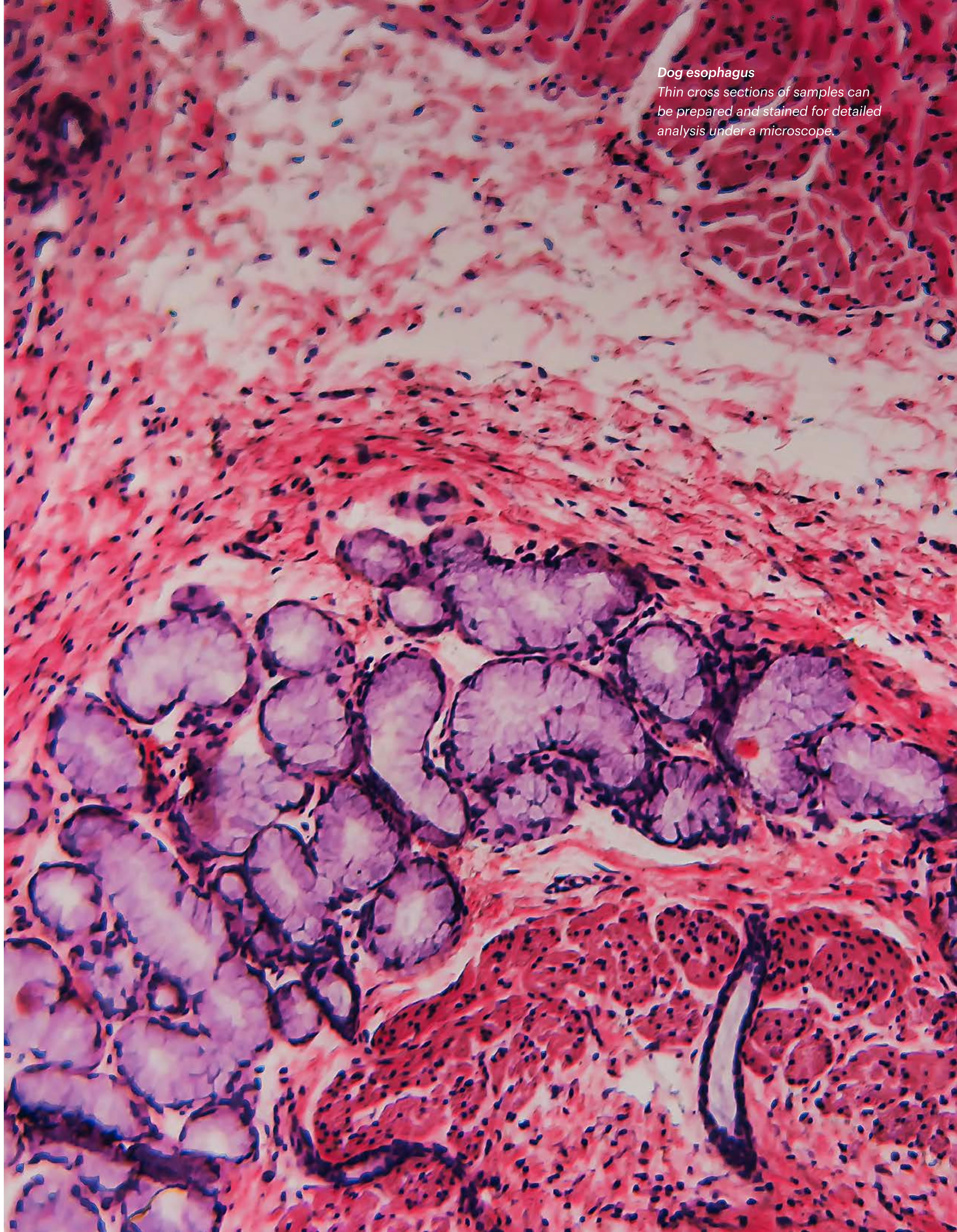
Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC
1.6 Extension: Cell theory	How did scientists find out there were cells in all living things?	Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**LS1.A** Structure and Function	Structure and Function
4.3 Extension: Cell biology and Aboriginal art	Are patterns like cells seen elsewhere in nature?	Review teaching notes in Prepare Mode	Engaging in Argument From Evidence	**LS1.A** Structure and Function	Structure and Function
4.4 Extension: Mythbusters – Cell division	How do we grow from just one cell?	Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**LS1.A** Structure and Function	Structure and Function

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
4.4 Extension: Mythbusters – Cell Division	Different types of cells (such as red blood cells, skin cells, nerve cells, etc.) cannot develop from a single fertilized egg cell.	Cells carry out essential life functions and need to grow and replace themselves if they get damaged. Skin needs to be able to shed and also repair damage quickly, so the cell turn-over time is very short. Some cells in our bodies live for much longer. The "From a single cell" section of the lesson is focused on this idea.
	Cells in adults are larger than those in babies, and cell growth (rather than cell division) is the primary cause of an organism's growth.	By increasing the number of cells in our bodies, cell division allows us to grow to adulthood. The "Growth and repair" section of the lesson is focused on this idea.



Dog esophagus
Thin cross sections of samples can be prepared and stained for detailed analysis under a microscope.

ELL support

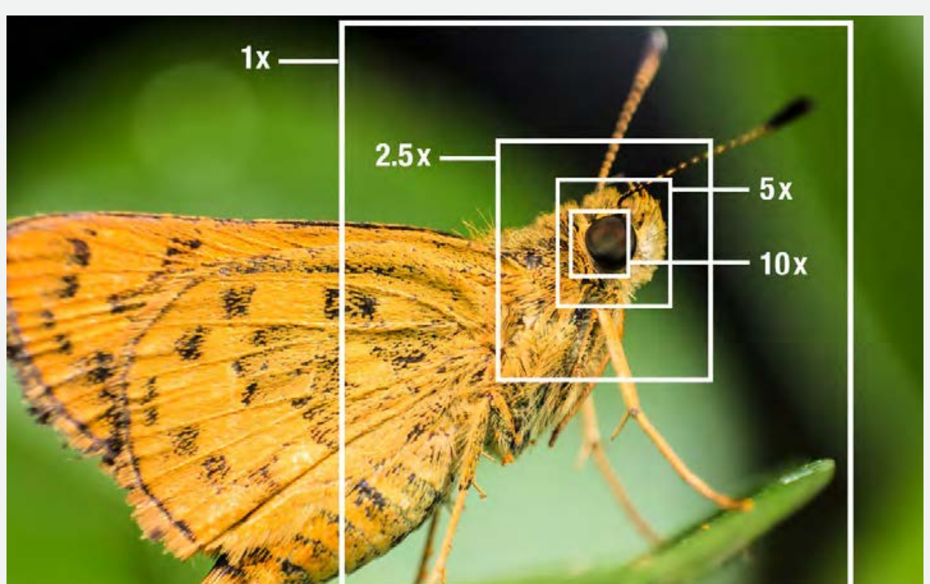
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

Cells lessons include a number of flow charts and diagrams to help students understand the structure and function of cells, systems, and organelles. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

2.1 Lesson: Introduction to microscopes

This image illustrates the inverse relationship between magnification and field of view. The use of shapes and labeling on the image helps students to understand scale and magnitude and supports the process of attaching meaning to new vocabulary.



4.1 Lesson: Specialized cells

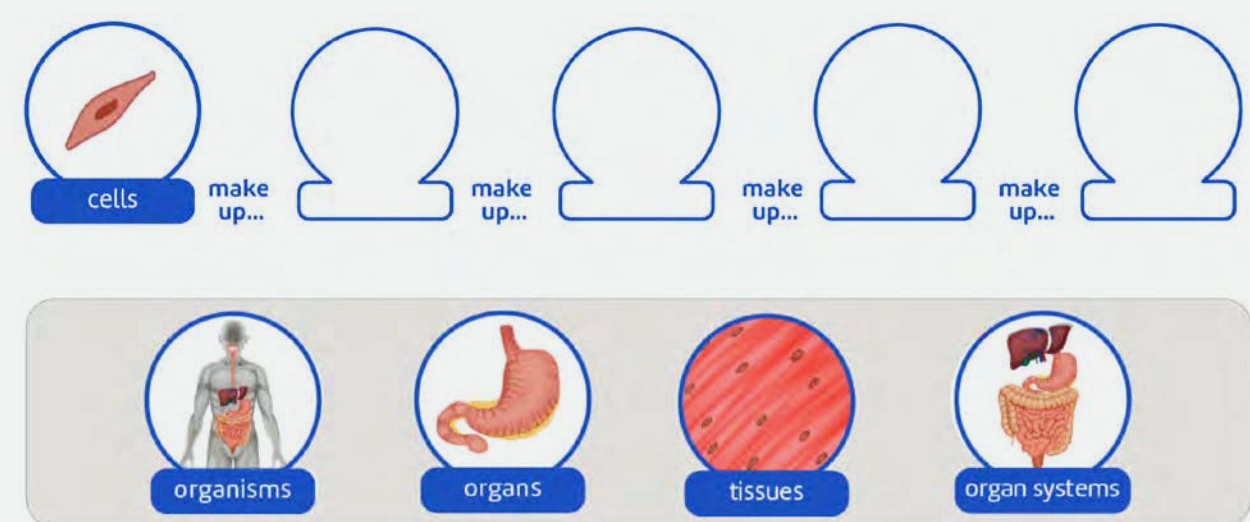
This diagram provides a clear visual contrast between a healthy red blood cell and the red blood cell of a person with sickle-cell anemia. It allows students to understand the drastic difference in the structure of these two cells, and therefore guides the inference that this significantly impacts their function. The information in this diagram links subject-specific vocabulary to images that support their meaning.

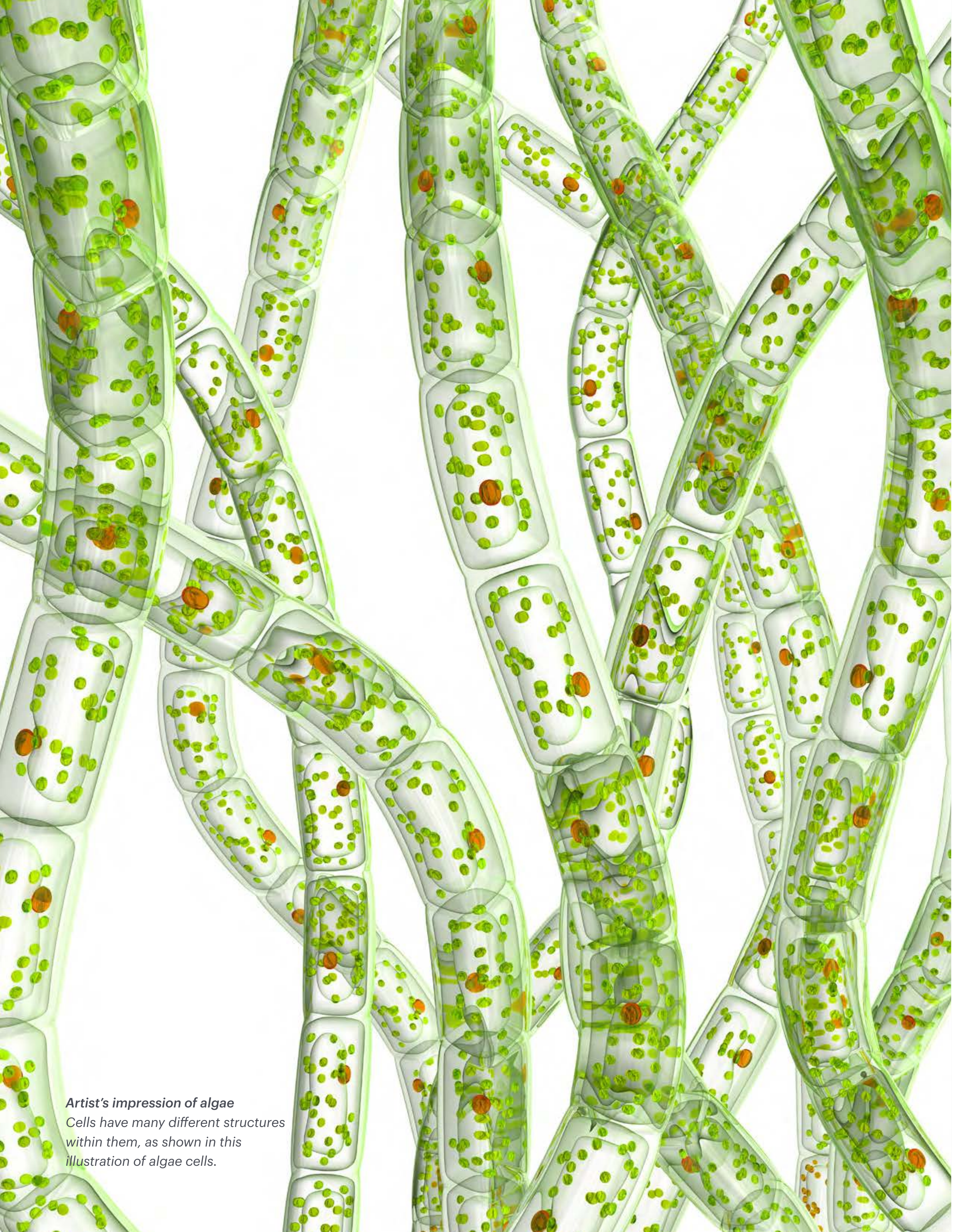
Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.4 Lesson: Levels of organization

By pairing vocabulary with illustrative diagrams, students are able to connect the word's written form with a matching image. By doing this, they make links between the word shown on the label and any existing knowledge or vocabulary they associate with the image. This question also reiterates the levels of organization through clear visuals and the repetition of the simple phrase "make up," allowing students to demonstrate their understanding of this concept.





Artist's impression of algae
Cells have many different structures within them, as shown in this illustration of algae cells.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes
Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5–10 minutes. Quizzes provide students and teachers with information about student progress towards specific learning goals.

- **1.1 Quiz: Living or non-living?**
  Multiple choice: 5–10 minutes
- **1.2–1.4 Quiz: The building blocks of life**
  Multiple choice: 5–10 minutes
- **2.1 Quiz: Introduction to microscopes**
  Multiple choice and fill-in-the-blank: 5–10 minutes
- **3.1 Quiz: Parts of a cell**
  Multiple choice and fill-in-the-blank: 5 –10 minutes
- **3.2 Quiz: Animal vs. Plant Cells**
  Multiple choice: 5–10 minutes
- **3.3 Quiz: Cells under the microscope**
  Multiple choice: 5–10 minutes
- **4.1 Quiz: Specialized Cells**
  Multiple choice: 5–10 minutes

Summative assessment

Tests
This unit contains a test and a Socratic seminar to provide summative assessment of student learning across the whole unit.

- **Test: Cells**
  Multiple choice, short answer, and fill-in-the-blank: 45–60 minutes
- **Socratic seminar: Feeding the future with cultured meat**
  Socratic seminar: 60 minutes

Science and Engineering Practices
Two lab activities and two projects within the unit can be used as summative assessments of Science and Engineering Practices.

- **2.3 Lab activity: Measuring with microscopes**
  Lab activity: 45–60 minutes
- **3.4 Lab activity: Observing plant and animal cells**
  Lab activity: 100–120 minutes
- **3.5 Project: Make a cell model**
  Project: 100–120 minutes
- **4.2 Project: Putting cells to work**
  Project: 100–120 minutes

Lab Activities

Lab Activity

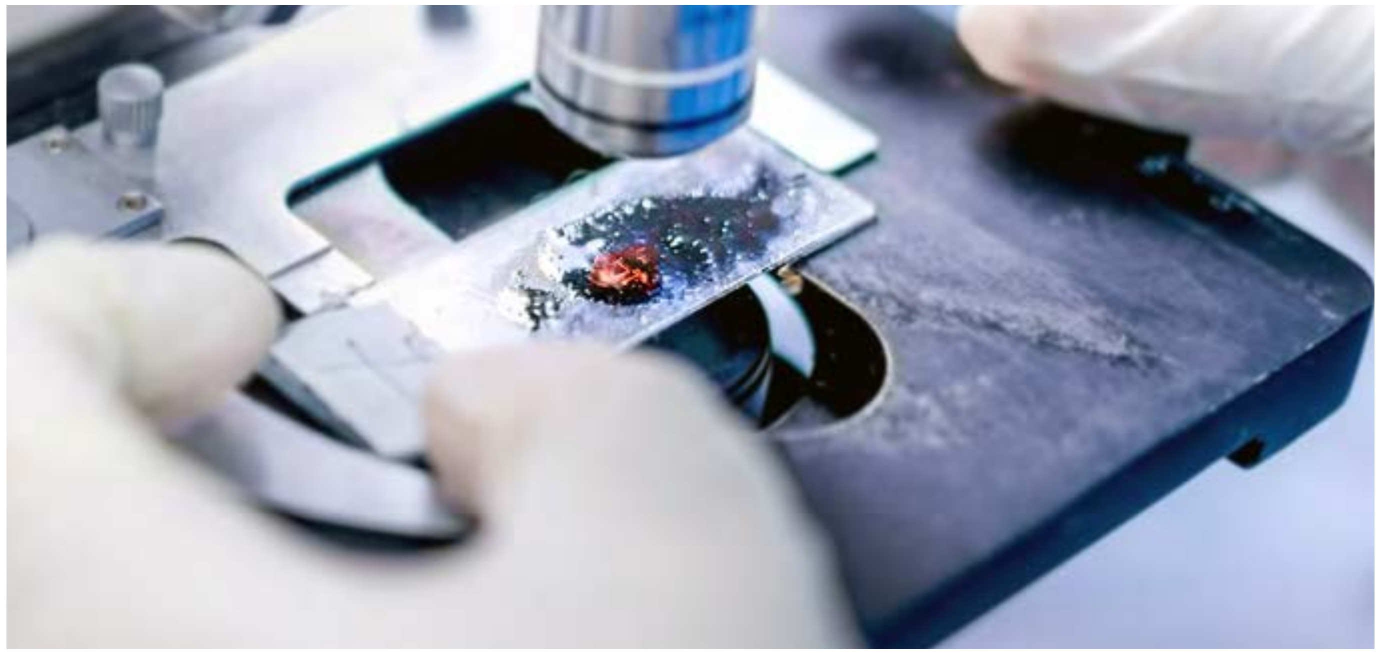
Using a microscope

Activity purpose: Basic microscope skills, including how to prepare, view and draw dry mount slides.

stileapp.com/go/usingmicroscope

45–60 minutes

1–2 students per group



Materials

Lab Equipment

Each group of students will need:

- microscopes
- flat microscope slide (for newspaper, wool, string, etc.)
- 2 x concave microscope slide (for sugar, salt, seeds, etc.)
- sticky tape
- 1 cm^2 squares of printed text containing the letter “e”
- small chattaway spatula

Chemicals

- tip of a small chattaway spatula of table salt
- tip of a small chattaway spatula of white sugar

Preparation

Prepare 1 cm^2 squares of printed text containing the letter “e” in advance.

Notes

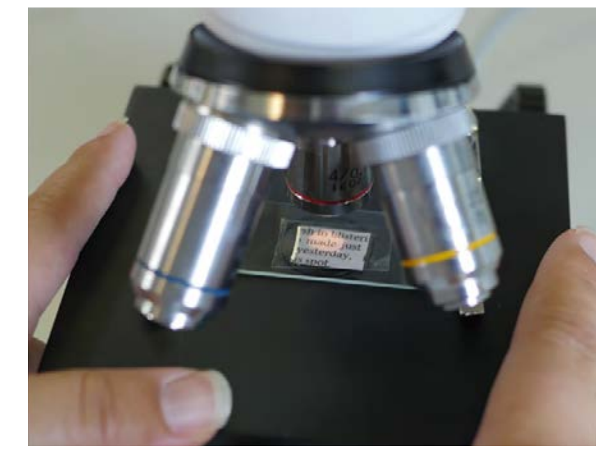
None

Method

Method that students will follow

PART 1

1. Use sticky tape to attach the square of printed text to the microscope slide.
2. Locate a letter “e” and place it over the center of the light on the microscope stage.
3. Rotate the slide so the “e” is the right way up when you look at it without the microscope (as shown in the photo, right).
4. With the lowest power objective lens, locate the “e.” Move it to the center of the field of view and adjust the focus.
5. Zoom in to the next power objective lens and re-adjust the focus if necessary.



PART 2

1. Observe sugar and salt without a microscope.
2. Record observations.
3. Observe sugar and salt with a microscope.
4. Record observations.

PART 3

1. Explore which magnification is best to view your specimen. When you’re ready, draw the specimen on paper with a pencil so you can erase any mistakes.

Lab Activity

Measuring with microscopes

Activity purpose: Explain how to use a microscope's field of view to measure the size of a specimen.

stileapp.com/go/measuremicroscope

45–60 minutes

3–4 students per group

Materials

Lab Equipment
Each group of students will need:
- compound light microscopes
- 4 concave microscope slides
- small beakers or cupcake liners (to carry seeds)
- transparent metric rulers (without sloped or beveled edges)
- tweezers (to transfer seeds from the beaker)
- variety of small seeds

Chemicals
None required

Preparation

None required

Notes

We recommend poppy, sesame, fennel, and mustard seeds as these are commonly found in grocery stores. You may also like to use flower or vegetable seeds from gardening stores, such as celery, basil, and carrot seeds. Note that seeds like dandelion, radish, and coriander are too big to measure with a microscope.

This activity requires students to have been introduced to micrometers and how to convert between different units of length (as covered in 1.5 Lesson: Sizes of cells).

Microscopic measurement size reference chart:

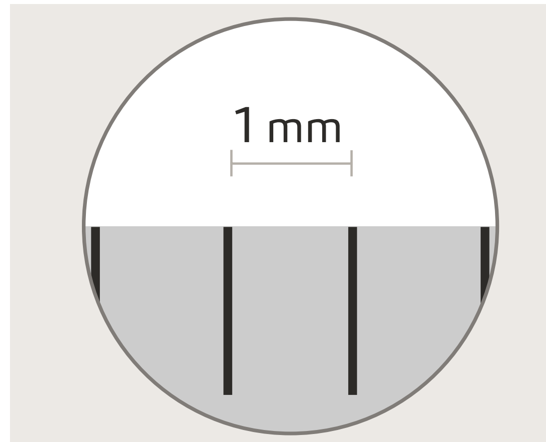
Item	Magnification used	Items/ diameter	Calculation: field diameter / numbers of items	Length of item (mm)	Length (μm)
Field diameter	40x	1	none	4 (direct measure)	4000
Field diameter	100x	1	none	1.5 (direct measure)	1500
Field diameter	400x	1	none	0.375	375
Hair	40x	45	4 mm / 45 hair widths	0.089	89
Onion cell	40x	15	4 mm / 15 hair cells	0.27	270
Onion cell	100x	6	1.5 mm / 6 cells	0.25	250
Spinach cell	100x	10	1.5 mm / 10 cells	0.15	150
Human cheek cell	400x	8	0.375 mm / 8 cells	0.047	47
Poppy seed	40x	4	4 mm / 4 seeds	1	1000
Black mustard seed	40x	3	4 mm / 3 seeds	1.33	1330
Celery seed	40x	3	4 mm / 3 seeds	1.33	1330
Basil seed	40x	2.5	4 mm / 2.5 seeds	1.6	1600
Yellow mustard seed	40x	2	4 mm / 2 seeds	2	2000
Carrot seed	40x	2	4 mm / 2 seeds	2	2000
Sesame seed	40x	1.5	4 mm / 1.5 seeds	2.67	2670
Dill seed	40x	1.25	4 mm / 1.25 seeds	3.2	3200
Caraway seed	40x	1	4 mm / 1 seed	4	4000
Fennel seed	40x	0.75	4 mm / 0.75 seeds	5.33	5330
Dandelion seed	40x	too big to measure			
Radish seed	40x	too big to measure			
Coriander seed	40x	too big to measure			

Method

Method that students will follow

PART 1: Measuring the field of view

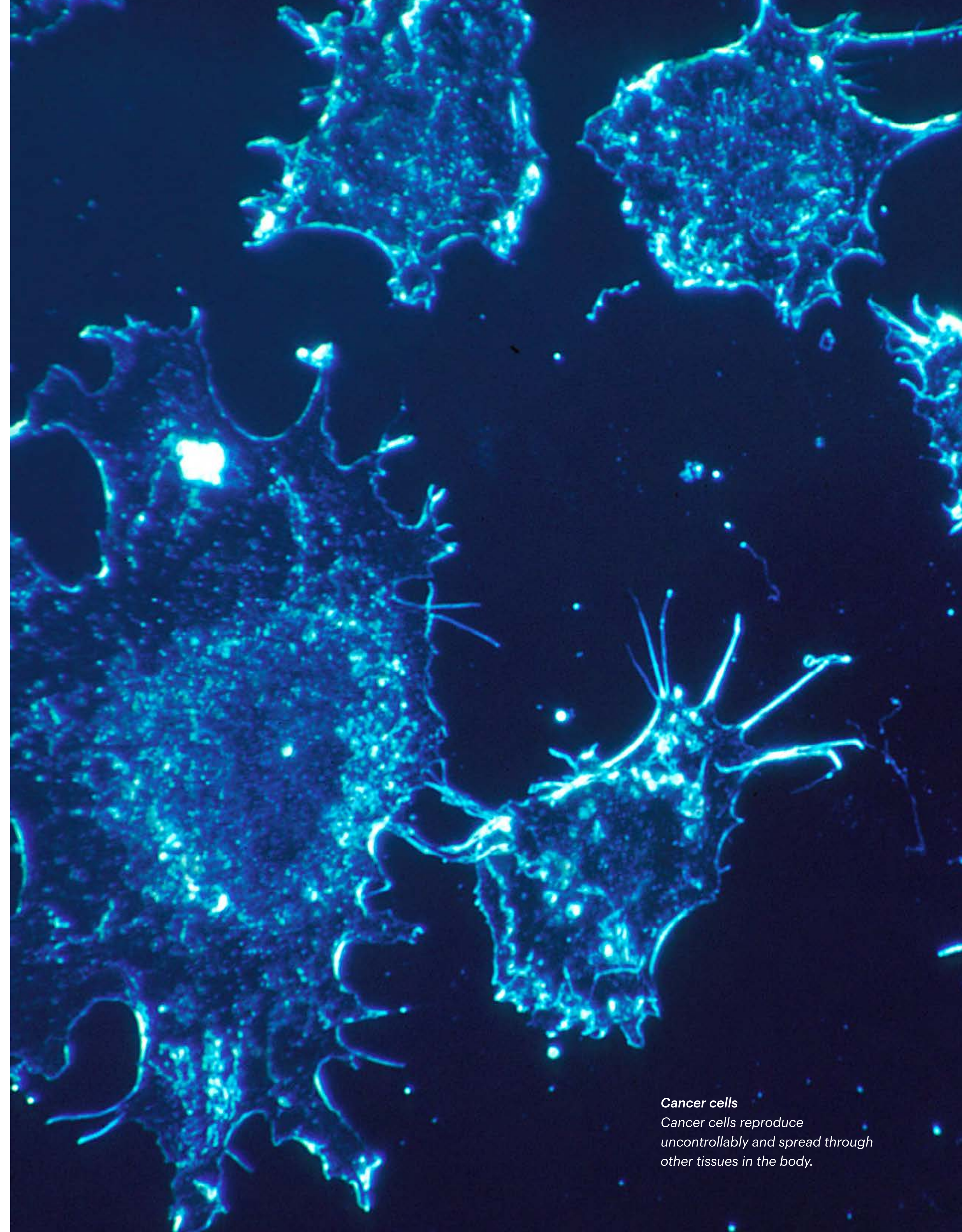
1. Set up the microscope with the lowest power objective lens. Calculate the total magnification and enter it into the first row of the results table below.
2. Place the ruler on the stage and focus the microscope on the ruler markings.
3. Line up the ruler so that it crosses the full diameter of the field of view, as shown in the diagram. Check that the left-hand marking is on the edge of the field of view.
4. Starting from the left-hand marking (zero), count the markings on the ruler. This is the diameter. Record the measurement (in mm) in the results table. (Note: If you can, use decimals to improve accuracy. e.g, 3.2 mm if there is an extra 0.2 mm in view)
5. Repeat Steps 1–4 using the other objective lenses.
6. Convert the measurements to μm and complete the results table.



Line up the ruler across the diameter of the field of view. Notice how the left-hand marking is right on the edge of the field of view.

PART 2: Calculating the sizes of specimens

1. Using the tweezers provided, place one poppy seed on your microscope slide. Use the lowest power objective lens to focus on the poppy seed.
2. If appropriate, select a higher-powered objective lens. If the seed takes up the whole field of view after zooming in, zoom back out until the whole seed is in view.
3. Estimate the number of seeds that would fit across the diameter by imagining a row of them (right). Record this number and the total magnification in the results table below.
4. Repeat Steps 1–3 for the other types of seeds.



Cancer cells
Cancer cells reproduce uncontrollably and spread through other tissues in the body.

Lab Activity

Make a cell model

Activity purpose: Build a physical model of a plant or animal cell, or create an analogy to illustrate the functions of the parts of a cell.

stileapp.com/go/cellmodel

100–120 minutes

3–4 students per group

Materials

Lab Equipment
To be determined by students.

If this lesson is being completed in the classroom, rather than as a homework assignment, assorted materials will need to be provided for students to create their models. These may include craft materials, household items, food items, stationery, etc. Students could also be encouraged to gather their own materials which can be assessed by the teacher as suitable for this task.

Chemicals
None required

Preparation

None required

Notes

Linked within the Stile lesson are the following:
- Examples of physical models: jelly cell model, play dough cell model
- Examples of analogies: amusement park, circus, restaurant, Harry Potter – you might like to suggest these to students who struggle to come up with their own ideas

Other alternatives to this activity:
- Throw a class "cell party" and have each student bring along a food item that could be used as a model for a cell, e.g., a cell pizza, cell cupcakes, etc.
- Prepare cupcakes and different colored icing in piping bags. Have students create "cell cupcakes" by decorating the cupcakes with different organelles and structures

Method

Method that students will follow
Students will create a model cell using materials of their own choice.

Instructions provided to students include:

- Build a model of either a plant or an animal cell

Other alternatives to this activity:

- All parts of the cell must be clearly labeled
- All parts of the cell must be accurately represented in terms of their size and shape
- For a plant cell, you must include the following parts: cell wall, cell membrane, nucleus, vacuole, mitochondria, chloroplasts, cytosol
- For an animal cell, you must include the following parts: cell membrane, nucleus, vacuoles, mitochondria, cytosol

Lab Activity

Observing plant and animal cells

Activity purpose: Compare and contrast plant and animal cells using a microscope.

- stileapp.com/go/plantanimalcells
- 100–120 minutes
- 3–4 students per group

Materials

Each group of students will need:

Lab Equipment
- light microscopes
- pre-prepared slide sets:
  - slide 1, labeled "Meat sample" and containing animal cells (we recommend cheek cells)
  - slide 2, labeled "Plant sample" and containing plant cells (preferably containing chloroplasts so they can easily be recognized as plant cells) note: *Leaf epidermis cells are not ideal for this activity because they tend to lack chloroplasts*
  - slide 3, labeled "Sample X" and containing plant cells (similar to Slide 2 and preferably containing chloroplasts)

Chemicals
- None required

Preparation

None required

Notes

This lab activity builds on the previous lesson and assumes that students are familiar with the rules of scientific drawing, as well as the main structural differences between plant and animal cells.

We also assume that students are familiar with how to use microscopes safely and how to choose the best magnification for observing and drawing cells (as covered earlier in the unit). The 40x magnification is usually too weak for this lab. Cell features will be easier to observe at 100x or 400x magnification.

However, you may want to limit the students to 100x to avoid the risk of damaging the slides at 400x.

Method

Method that students will follow

PART 1
1. Use a microscope to observe Slide 1: Meat sample. Focus and zoom in until you can clearly see the structure of individual cells.
2. Draw a diagram of one or more cells, following the rules of scientific drawing. Write a detailed description of what you observe.
3. Repeat steps 1–2 for Slide 2: Plant sample.

PART 2
1. Use a microscope to observe Slide 3: Sample X. Focus and zoom in until you can clearly see the structure of individual cells.
2. Draw a scientific diagram of what you observe and write a detailed description.

Unit 5 – Our Place in Space

Can we travel to the Sun?

The Parker Solar Probe
On August 11th, 2018, NASA launched the Parker Solar Probe to touch the Sun for the first time.

Storyline and anchoring phenomenon

Students first engage with this unit through an engineering challenge motivated by the question: Can we travel to the Sun? They're introduced to the Parker Solar Probe and must use Science and Engineering Practices to create a shield that will allow astronomical instruments to reach the Sun to collect data.

Before examining the Solar System and our place in it, students are first assessed using a "What do you already know?" pre-test that activates their prior knowledge and brings misconceptions to light. Through a hands-on activity, they create models of day and night, and use these to explain what we see on Earth as sunrise and sunset – the same phenomena that helped early astronomers understand the tilt of the Earth and its orbit around the Sun!

Students explore the role of gravity in the context of the Solar System and construct diagrams to demonstrate how we orbit around the Sun. The scale of the Solar System is contextualized in an activity where students calculate what their age would be on different planets.

Building on the knowledge gained from the models of the Solar System, students investigate smaller-scale change and stability by learning about solar eclipses, phases of the Moon, and tides. They manipulate variables with a hands-on model of sunlight intensity, which helps them discover and explain the mechanism behind seasons.

Students' questioning about the phases of the Moon drives them to return to physical models to problem-solve and clarify their understanding before they conclude the unit with an investigation into how the distance between the Sun and the Moon impacts an eclipse.

This unit at a glance

Our Place in Space

Introduction: Journey to the Sun
Career profile: Astrophysicist
What do you already know?
Engineering challenge: Heat shields
Project: Making a photo story

0.1 Lab activity: Modeling day and night
0.2 Lesson: Day and night

1.1 Lesson: The Solar System
1.1 Quiz: The Solar System
1.2 Lesson: The role of gravity
1.2 Quiz: The role of gravity
1.3 Lab activity: Modeling the Solar System
1.4 Skill builder: Rounding
1.5 Lesson: Changing models of the Solar System
1.5 Quiz: Changing models of the Solar System

2.1 Lesson: Seasons
2.1 Quiz: Seasons
2.2 Lab activity: Modeling sunlight intensity
2.3 Lesson: Daylight hours
2.3 Quiz: Daylight hours

Students apply Science and Engineering Practices as they **develop a model** of a heat shield.

Students complete a **metacognitive activity** to encourage them to reflect on their learning.

Students **use mathematics and computational thinking** to calculate their age on other planets.

Students explore the **real-world phenomena** of the Sun and the challenges to studying it up close.

Students **activate their prior knowledge** of the Solar System.

Students explore the origins of our Solar System **using a model.**

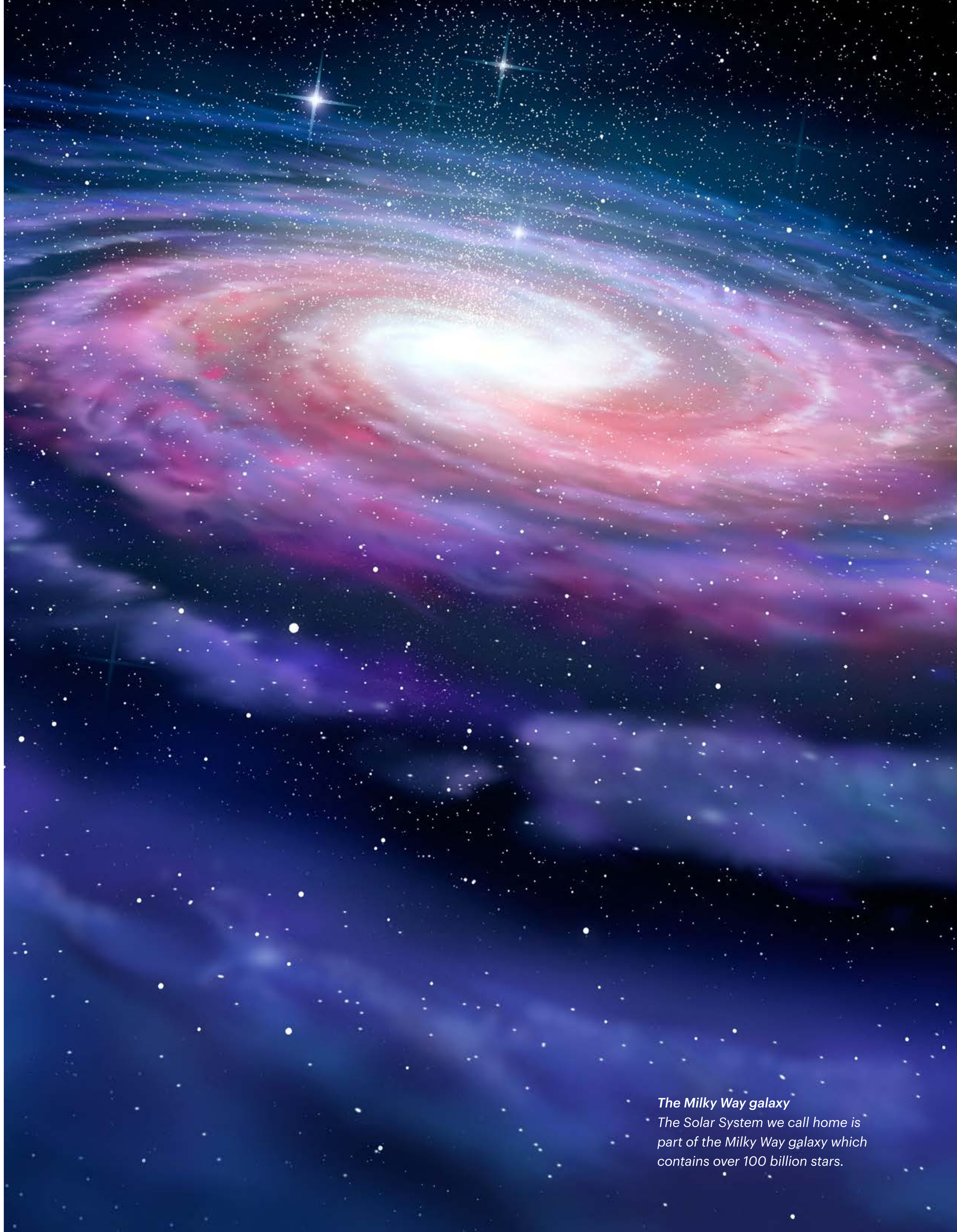
Students **use and develop models** to justify why seasons are different in the northern and southern hemispheres.

Students have multiple opportunities to complete **formative assessment**.

Students **collaborate and solve problems** while modeling the orbits of the Earth and Moon.

Students complete **summative assessments** to check their understanding.

Students use **observations** of tides to **make predictions** about how tides change over a 24-hour period.



The Milky Way galaxy
The Solar System we call home is part of the Milky Way galaxy which contains over 100 billion stars.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-ESS1-1

Develop and use a model of the Earth–Sun–Moon system to describe the cyclic patterns of lunar phases, eclipses of the Sun and Moon, and seasons.

MS-ESS1-2

Develop and use a model to describe the role of gravity in the motions within galaxies and the Solar System.

MS-ESS1-3

Analyze and interpret data to determine the scale properties of objects in the Solar System.

MS-PS2-4

Construct and present arguments using evidence to support the claim that gravitational interactions are attractive and depend on the masses of interacting objects.

Disciplinary Core Ideas

- **ESS1.A**: The Universe and Its Stars
- **ESS1.B**: Earth and the Solar System
- **PS2.B**: Types of Interactions

This unit looks through the Solar System and its formation.

The mass of planets and moons is used to explore the force of gravity. Students develop models of the Solar System, the Moon, and stars in the sky, and the patterns of their movement. They explain that this model is the reason for solar and lunar eclipses, seasons, and tides.

Science and Engineering Practices

- Developing and Using Models
- Planning and Carrying Out Investigations

Students engage with the movements of space giants and the shadows they cast by creating and manipulating models to simulate how the planets, moons, and stars move.

By planning and carrying out investigations, students use their models to explain phenomena including seasons, eclipses, and the phases of the Moon.

Crosscutting Concept

- Systems and System Models
- Scale, Proportion, and Quantity

Students engage with both pre-developed models and models of their own creation to explore ideas.

Students investigate the results of small shifts in tilt and arrangements of planets and the Sun. Students also consider the limitations of these models and discuss how they could become more accurate.

Nature of Science

- Science Addresses Questions About the Natural and Material World
- Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Science is a Way of Knowing

Science, Technology, Society and the Environment

- Influence of Engineering, Technology, and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

Students will have an understanding that the orbits of Earth and the Moon cause observable patterns such as day and night.

They will also understand how gravitational force can pull an object toward the planet's center. Students will build upon these foundational concepts by exploring the Solar System and its formation. They will extend that idea by looking at the mass of planets and moons to explore the force of gravity.

Ultimately, students deepen their understanding through developing models of the Solar System, the Moon, and stars in the sky, and the patterns of their movement. They explain that this model is the reason for solar and lunar eclipses, seasons, and tides.

Science and Engineering Practices

Students' prior knowledge of Science and Engineering Practices likely included building and revising simple models and using models to represent events and design solutions.

They will have also conducted investigations where they controlled variables and provided evidence to support explanations or design solutions. Prior experience with Science and Engineering Practices will have included developing, using, and testing multiple models to determine which better meets criteria for success.

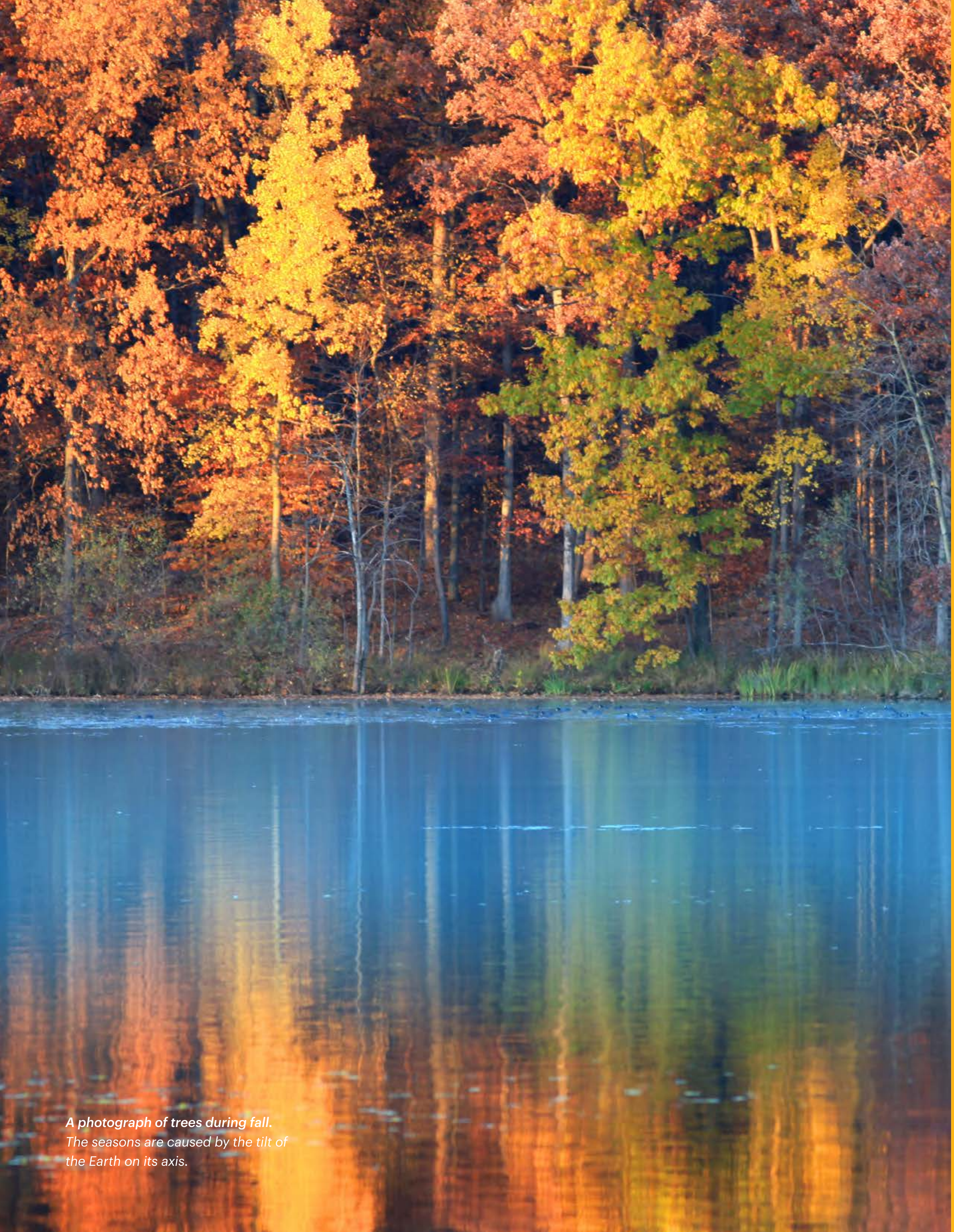
Through Our Place iIn Space, students build on this knowledge through engaging with the movements of space giants and the shadows they cast by creating and manipulating models to simulate how the planets, moons, and stars move. Students plan and carry out investigations and use their models to explain phenomena including seasons, eclipses, and the phases of the Moon.

Crosscutting Concepts

Prior to middle school, students should understand the idea that a system is a group of related parts that make up a whole and can carry out functions its individual parts cannot.

They are able to describe a system in terms of its components and their interactions. This unit builds upon these understandings by providing students with the opportunity to engage with both pre-developed models and models of their own creation to explore ideas.

They investigate the results of small shifts in tilt and arrangements of planets and the Sun. Students also consider the limitations of these models and discuss how they could become more accurate.



A photograph of trees during fall.
The seasons are caused by the tilt of the Earth on its axis.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Journey to the Sun What do you already know?	How does the Parker Solar Probe provide new ways to explore the Sun?	Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**ESS1.A** The Universe and Its Stars	Stability and Change	Assign Stile X app: Flashcards	0.1 Lab activity: Modeling day and night 0.2 Lesson: Day and night
Lesson 2	Engineering challenge: Heat shields	What is required for a spacecraft to travel to the Sun?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the engineering challenge. See the relevant lab activity pages at the end of this chapter	Asking Questions and Defining Problems Planning and Carrying Out Investigations	**ESS1.B** Earth and the Solar System	Structure and Function	Ask students to complete questions 1–5	Extra SEP support: 0.3 The engineering process
Lesson 3							Ask students to complete questions 6–9	Extra SEP support: 2.2 Measuring
Lesson 4							Ask students to complete questions 10–15	Extra SEP support: 5.1 Validity and reliability

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	Engineering challenge: Heat shields	What is required for a spacecraft to travel to the Sun?	Prepare some materials for presentations such as construction paper, glue, scissors, etc.	Asking Questions and Defining Problems Planning and Carrying Out Investigations	**ESS1.B** Earth and the Solar System	Structure and Function	Ask students to finalize their group presentation and complete any remaining questions	Extra SEP support: 0.1 Conducting science investiga-tions
Lesson 6	Project: Making a photo story	How do different cultures explain phenomena related to the Earth, Moon, and Sun?	Review teaching notes in Prepare Mode Students will need access to software for making photo stories, such as Microsoft Photo Story (Windows) or iMovie (Mac) – these are both free to download You may also like to provide them with a printed storyboard template	Developing and Using Models	**ESS1.B** Earth and the Solar System	Systems and System Models	Encourage students to research images for their photo stories	Extra SEP support: 5.2 What is creativity?
Lesson 7	(as Lesson 6)	(as Lesson 6)	(as Lesson 6)	(as Lesson 6)	(as Lesson 6)	(as Lesson 6)	Ask students to review Stile X app: Flashcards	Extra SEP support: 5.3 Creative thinking
Lesson 8	1.1 Lesson: The Solar System	How have observations over time changed models of Earth in space?	Use results from What do you already know? to determine whether to revisit the concept of day and night Review teaching notes in Prepare Mode Optional: Use VR headsets and smartphones for a virtual reality experience of the night sky. VR headsets are available to purchase from the Stile Shop	Obtaining, Evaluating, and Communicating Information	**ESS1.A** The Universe and Its Stars	Patterns	Assign Stile X app: The Solar System video Assign Stile X Review notes: The Solar System	1.1 Quiz: The Solar System

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	1.2 Lesson: The role of gravity	How was the Solar System, and the planets within it, formed?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**ESS1.B** Earth and the Solar System **PS2.B** Types of Interactions	Systems and System Models	Assign Stile X app: The role of gravity video Assign Stile X Review notes: The role of gravity	1.2 Quiz: The role of gravity
Lesson 10	1.3 Lab activity: Modeling the Solar System	Is it possible to make a scale model of the Solar System?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Analyzing and Interpreting Data	**ESS1.A** The Universe and its Stars	Scale, Proportion, and Quantity	Ask students to complete all questions in Part 1: Size model	Revisit Extra SEP support: 0.1 Conducting science investigations
Lesson 11							Ask students to complete all questions in Part 2: Distance model	Stile X app: Flashcards
Lesson 12	1.4 Skill builder: Rounding	How old would I be on another planet?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**ESS1.B** Earth and the Solar System	Scale, Proportion, and Quantity	Assign Stile X app: Flashcards	1.2 Quiz: The role of gravity

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	1.5 Lesson: Changing models of the Solar System	How do we know the Sun is at the center of our Solar System?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**ESS1.B** Earth and the Solar System	Systems and System Models	Assign Stile X app: Changing models of the Solar System video Assign Stile X Review notes: Changing models of the Solar System	1.5 Quiz: Changing models of the Solar System Stile X app: Flashcards
Lesson 14	2.1 Lesson: Seasons	Why do we have seasons on Earth?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**ESS1.B** Earth and the Solar System	Systems and System Models	Assign Stile X app: Seasons video Assign Stile X Review notes: Seasons	2.1 Quiz: Seasons
Lesson 15	2.2 Lab activity: Modeling sunlight intensity	Why am I more likely to get sunburned in summer than winter?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Developing and Using Models Analyzing and Interpreting Data	**ESS1.B** Earth and the Solar System	Scale, Proportion, and Quantity	Assign Stile X app: Flashcards	Extra SEP support: 3.5 Reading line graphs
Lesson 16	2.3 Lesson: Daylight hours	Why is it hotter in summer than in winter?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**ESS1.B** Earth and the Solar System	Patterns	Assign Stile X app: Daylight hours video Assign Stile X Review notes: Daylight hours	2.3 Quiz: Daylight hours

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · **Week 5** · Week 6

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	3.1 Lesson: Phases of the Moon	Why does the Moon change over time in the night sky?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Optional: Use VR headsets and smartphones for a virtual reality experience of the night sky. VR headsets are available to purchase from the Stile Shop	Developing and Using Models	**ESS1.B** Earth and the Solar System	Patterns	Assign Stile X app: Phases of the Moon video Assign Stile X Review notes: The phases of the Moon	3.1 Quiz: The phases of the Moon
Lesson 18	3.2 Lesson: Eclipses	How do solar and lunar eclipses occur?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**ESS1.B** Earth and the Solar System	Cause and Effect	Assign Stile X app: Eclipses video Stile X Review notes: Eclipses	3.2 Quiz: Eclipses Stile X app: Flashcards
Lesson 19	3.3 Lab activity: Modeling phases of the Moon and eclipses	Why does the Moon change over time in the night sky? How do solar and lunar eclipses occur?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Developing and Using Models	**ESS1.B** Earth and the Solar System	Systems and System Models	Assign Stile X Glossary	Extra SEP support: 2.1 Observing and inferring
Lesson 20	3.4 Lesson: Tides	Why was Mont Saint-Michel the perfect place to defend during the Hundred Years' War?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**ESS1.B** Earth and the Solar System **PS2.B** Types of Interactions	Systems and System Models	Assign Stile X app: Flash Quiz	3.4 Quiz: Tides Stile X app: Flashcards

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5 Week 6

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required
Lesson 21	Unit review Glossary: Our Place in Space	How can I be prepared for the Our Place in Space test?	Review Key Questions from the unit in Analyze Mode to identify areas to revisit
Lesson 22	Test: The Solar System Career Profile: Astrophysicist	How much have I learned about the Solar System?	Ensure each student has a device
Lesson 23	Test: The Earth, Moon, and Sun	How much have I learned about the Earth, Moon, and Sun?	Ensure each student has access to a device
Lesson 24	Test review	How successful was my revision of Our Place in Space?	View common errors from the tests in Analyze Mode

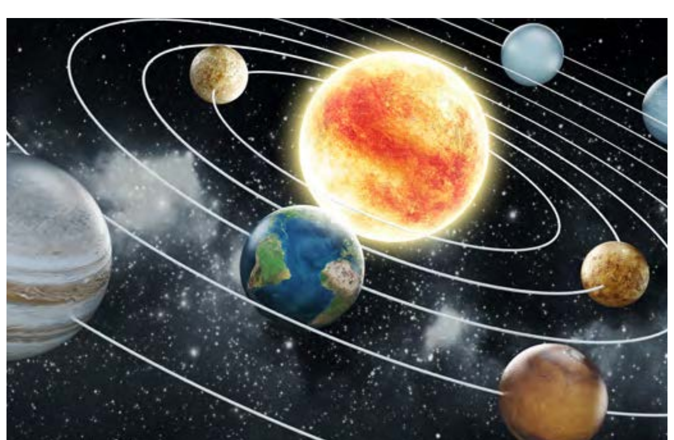
	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 21	Developing and Using Models Planning and Carrying Out Investigations	**ESS1.A** The Universe and Its Stars **ESS1.B** Earth and the Solar System **PS2.B** Types of Interactions	Systems and System Models	Assign Stile X Test preparation Ask students to review teacher feedback from lessons in the unit	Stile X app: Flash Quiz
Lesson 22				Assign Stile X app: Flash Quiz	
Lesson 23					
Lesson 24				Assign Stile X Reflection	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Students develop models to use throughout the unit. They explore ratios of time in days, weeks, and months and scale the ratios of years on different planets.

Students use variables to define relationships and develop skills in rounding.



Common Core State Standards Connections: Math

MP.2

Reason abstractly and quantitatively.

MP.4

Model with mathematics.

6.RP.A.1

Understand the concept of a ratio and use ratio language to describe a ratio relationship between two quantities.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Students comprehend multimedia texts and written text to gain knowledge in this topic. They use models to look into the relationships within the Solar System and express their knowledge by creating their own model and explanation for phenomena.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g.,, in a flow chart, diagram, model, graph, or table).

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions, and how to replace question types in The Stile Guide.

Note that not *all* written response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Career profile: Astrophysicist**
  Questions 1, 2, 4, 5
- **Engineering challenge: Heat shields**
  Questions 10, 14, 15
- **Project: Making a photo story**
  Question 5
- **0.1 Lab activity: Modeling day and night**
  Questions 6, 7
- **0.2 Lesson: Day and night**
  Questions 6, 8, 9, 14
- **1.1 Lesson: The Solar System**
  Questions 3, 8, 13, 14, 16
- **1.2 Lesson: The role of gravity**
  Questions 3, 7, 8, 10, 13
- **1.3 Lab activity: Modeling the Solar System**
  Questions 9, 10
- **1.4 Skill builder: Rounding**
  Questions 12, 13, 14, 19
- **1.5 Lesson: Changing models of the Solar System**
  Questions 7, 9, 10, 11, 12, 13, 14
- **2.1 Lesson: Seasons**
  Questions 2, 3, 4, 15, 16, 18, 21
- **2.2 Lab activity: Modeling sunlight intensity**
  Questions 5, 6, 7, 8, 13, 15
- **2.3 Lesson: Daylight hours**
  Questions 6, 7, 9, 10, 17
- **3.1 Lesson: The phases of the Moon**
  Questions 9, 10, 11, 13, 14
- **3.2 Lesson: Eclipses**
  Questions 4, 5, 6, 7, 10, 11, 12, 13, 16, 17
- **3.3 Lab activity: Modeling phases of the Moon and eclipses**
  Questions 5, 6
- **3.4 Lesson: Tides**
  Questions 1, 5, 9, 10, 11, 16, 17

Extension opportunities in this unit

Challenge Questions
Most lessons contain one or more Challenge Questions, which are an opportunity for students to show they are working above the level of the learning goal.

When answering these questions, students can extend themselves by applying their knowledge to new contexts, or to solve more complex problems. These provide a great extension opportunity.

Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC
2.1 Lesson: Seasons Question 21	Why do we have seasons on Earth?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**ESS1.B** Earth and the Solar System	Systems and System Models
3.4 Lesson: Tides Question 18 and articles linked in teaching notes	Why was Mont Saint-Michel the perfect place to defend during the Hundred Years' War?	Review Key Questions and Quiz from previous lesson Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**ESS1.B** Earth and the Solar System **PS2.B** Types of Interactions	Systems and System Models

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
0.2 Lesson: Day and night This lesson is included as an extra resource in the Lesson Planning Guide to address any misconceptions identified in the What do you already know? lesson	The Moon is only visible at night.	**Use 0.1 Lab activity: Modeling day and night** The Moon is visible in the daytime during certain times in its orbit around Earth. See if you can point this out to students in the sky! This phenomenon can then be represented using the model created to show that light being reflected by the Moon would be visible from Earth.
	The Moon causes night.	**Use 0.1 Lab activity: Modeling day and night** Night is caused by the relative position of the Earth and the Sun as the Earth moves through its orbit. The relative positioning of objects within the model supports the conclusion that night takes place due to the Earth's orbit around the Sun. Ask questions directly about the cause of night, like, "Why isn't this part of the Earth getting any light?"
	The Moon makes its own light.	**Use 0.1 Lab activity: Modeling day and night** Demonstrate that the Moon reflects the light of the Sun. Ask questions like "Where is the light coming from?"

Lesson	Misconception	Addressing the misconception
0.2 Lesson: Day and night (Continued) This lesson is included as an extra resource in the Lesson Planning Guide to address any misconceptions identified in the 'What do you already know?' lesson	The Moon orbits the Sun.	**Use 0.1 Lab activity: Modeling day and night** Demonstrate that the Moon orbits the Earth. The Moon orbits the Earth, while the Earth orbits the Sun. You may also refer to 1.2 Lesson: The role of gravity to explain that the Earth's gravitational pull on the Moon is greater than that of the Sun.
	The Moon absorbs the light of the Sun and then slowly releases it again.	**Use 0.1 Lab activity: Modeling day and night** The Moon only reflects the light of the Sun. Demonstrate the way that light is reflected. Ask questions like, "Where is the light coming from?"
1.2 Lesson: The role of gravity	The word "satellite" only refers to objects built by humans that orbit the Earth.	**Use 1.2 Lesson: The role of gravity** This lesson explicitly addresses satellites in questions 11–14. The glossary definition of the term satellite will also be helpful. Any object that orbits a planet or star is called a satellite. For example, the Moon is a satellite because it orbits the Earth. The Earth is a satellite because it orbits the Sun. The Earth and Moon are examples of natural satellites. There are also thousands of human-made satellites that travel in orbit around the Earth. These are known as artificial satellites. The largest artificial satellite is the International Space Station. This is where astronauts live while they do research in space.
1.4 Skill builder: Rounding	A planet's orbit is a perfect circle.	**Use 2.1 Lesson: Seasons** All orbits are actually oval-shaped. This shape is known as an ellipse. Use visual representations of the path of Earth's orbit to demonstrate this.

Lesson	Misconception	Addressing the misconception
2.1 Lesson: Seasons	Earth's elliptical orbit causes seasons.	**Use 2.1 Lesson: Seasons** The seasons are caused by the tilt of the Earth on its axis. Summer occurs in one of the hemispheres when it tilts towards the Sun. This increases the number of daylight hours experienced in that hemisphere. It also changes the angle of the sunlight so the heat is more concentrated. Use Part 1 of the "Why do we have seasons?" video to debunk this myth. The video shows that if this were true, summer would occur for both hemispheres at the same time. You may like to have students use physical models to confirm this.
	The side of the Earth facing toward the Sun experiences summer.	**Use 0.1 Lab activity: Modeling day and night** Actually, this is what causes daytime. When that part of the Earth rotates into shadow, it will be night. Refer back to or repeat 0.1 Lab activity: Modeling day and night to show how the side of the Earth that faces the Sun experiences daytime.
	The Earth is closer to the Sun in summer.	**Use 2.1 Lesson: Seasons** Actually, the Earth is slightly closer to the Sun during the southern hemisphere's summer, but this is the northern hemisphere's winter. So this does not explain summer. Any temperature change due to the elliptical shape of the Earth's orbit is negligible. Use Part 1 of the "Why do we have seasons?" video to debunk this myth. The video shows that if this were true, summer would occur for both hemispheres at the same time. You may like to have students use physical models to confirm this.
	The Sun gets hotter in summer and colder in winter.	This is incorrect as the Sun's temperature does not change periodically in this way. This idea can also not account for why the two hemispheres experience different seasons at the same time.

Lesson	Misconception	Addressing the misconception
3.1 Lesson: The phases of the Moon	The phases of the Moon are caused by the Earth's shadow.	**Use 0.1 Lab activity: Modeling phases of the Moon and eclipses** The phases of the Moon depend on where the Moon is in its orbit around the Earth. Half of the Moon is always lit up by the Sun and the other half is always in shadow. From Earth, we see different amounts of the bright side at different times of the month. Help students recognize that the phases relate to the Moon's position in its orbit around the Earth.

ELL support

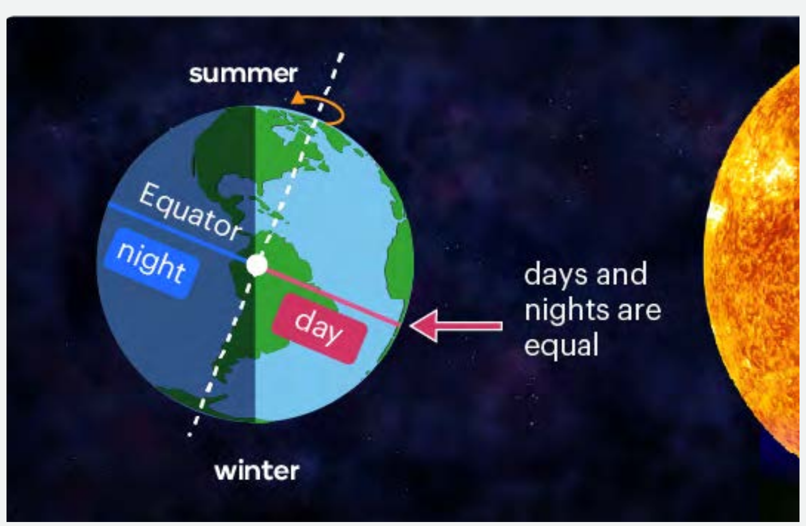
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

The lessons in Our Place in Space include a number of flow charts and diagrams to help students understand the complex arrangement of the planets and moons in our Solar System. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included, though there are many more.

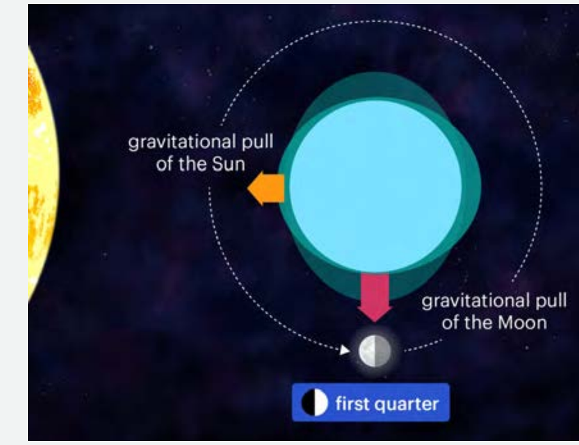
2.3 Lesson: Daylight hours

Students can see the tilt of the Earth's axis in relation to the Sun, and how this impacts which parts of the Earth receive sunlight. This helps them to visualize the information communicated in the text within the lesson and therefore supports connections between the written and visual forms of information. Terms and phrases such as equator, night, day, summer, and winter are clearly represented here, helping students to unpack the meaning of these terms as they appear in the text and connect them to the terminology used within their own language.



3.4 Lesson: Tides

Complex systems that are discussed in the written text are displayed visually in a diagram that demonstrates force arrows and the key components of the model. The arrows clearly represent the direction of gravitational pull and their relationship to the Moon and Sun. The use of simple labels helps students to connect the terminology used to the concepts that are visually represented.

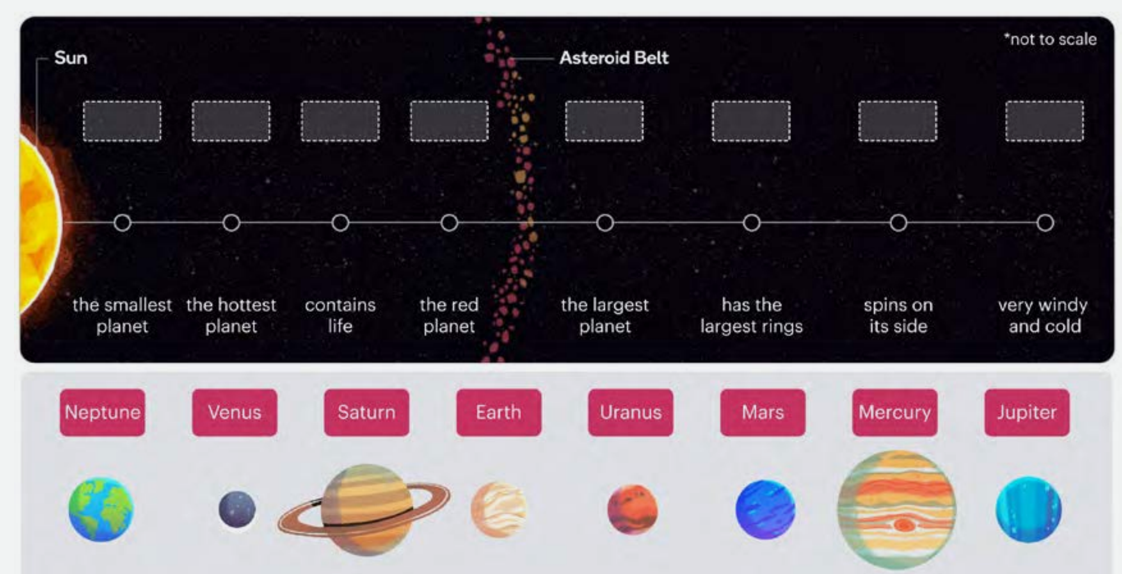


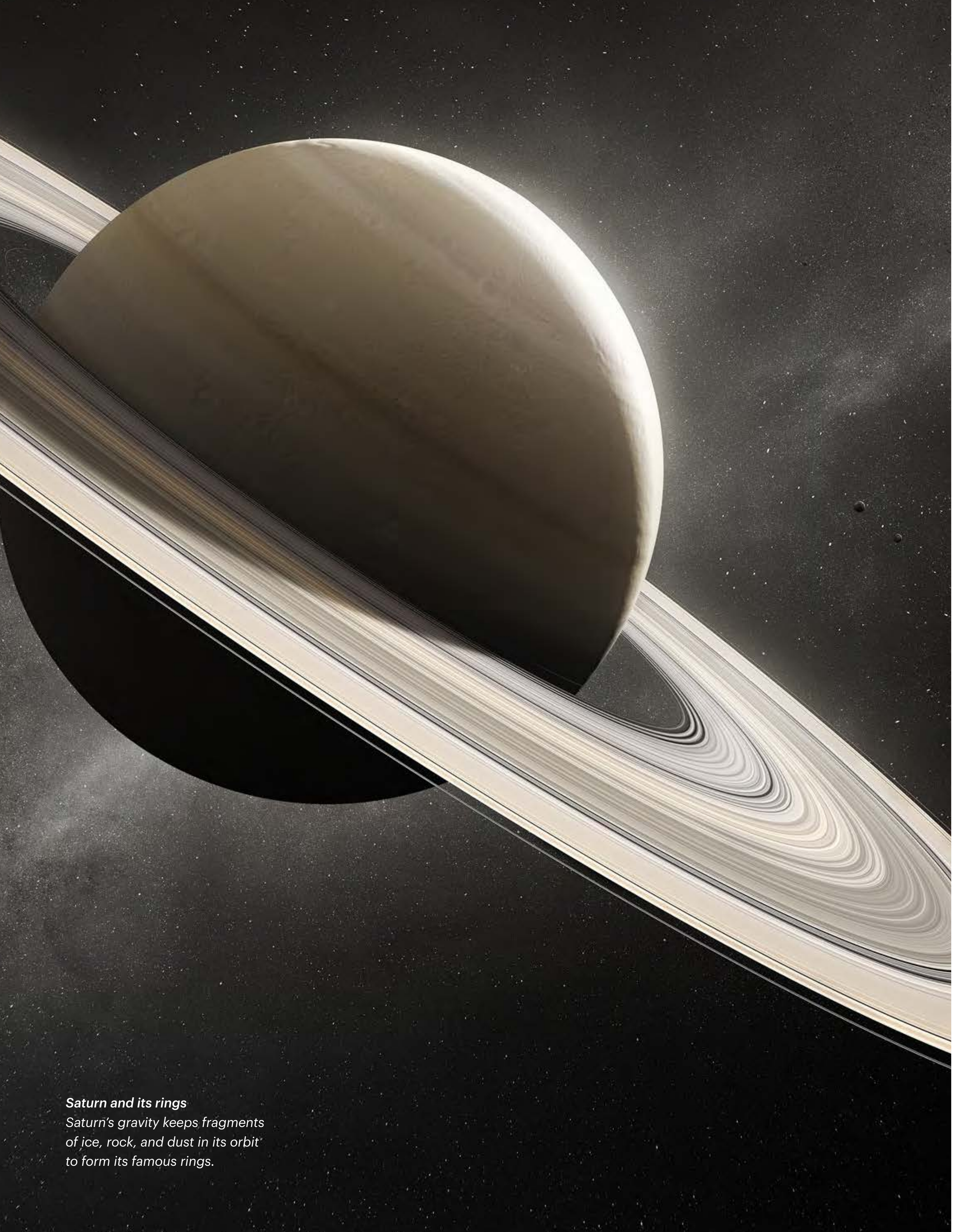
Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.1 Lesson: The Solar System

Ordering the planets represented alongside their English names allows English Language Learners to connect the English names for planets with names they may already know in another language. The use of simple phrases and images to describe each of the planets further supports this connection and the association between their existing knowledge and the language used in the diagram.





Saturn and its rings
Saturn's gravity keeps fragments of ice, rock, and dust in its orbit to form its famous rings.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Pre-test: What do you already know?
Activate students' prior knowledge of relevant concepts about the Solar System including the relative positions of the Earth, Sun, and Moon, and what causes day and night. Use this as a pre-test to identify misconceptions and areas where students may need additional challenge or support in subsequent lessons.

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes
Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5–10 minutes. Quizzes provide students and teachers with information about student progress toward specific learning goals.

- **1.1 Quiz: The Solar System**
  Multiple choice: 5–10 minutes
- **1.2 Quiz: The role of gravity**
  Multiple choice: 5–10 minutes
- **1.5 Quiz: Changing models of the Solar System**
  Multiple choice: 5–10 minutes
- **2.1 Quiz: Seasons**
  Multiple choice: 5–10 minutes
- **2.3 Quiz: Daylight hours**
  Multiple choice: 5–10 minutes
- **3.1 Quiz: The phases of the Moon**
  Multiple choice, fill-in-the-blank: 5–10 minutes
- **3.2 Quiz: Eclipses**
  Multiple choice: 5–10 minutes
- **3.4 Quiz: Tides**
  Multiple choice, fill-in-the-blank: 5–10 minutes

Summative assessment

Test
This unit contains two tests to provide summative assessment of student learning across the whole unit.

- **Test: The Solar System**
  Multiple choice and short answer: 30–40 minutes
- **Test: The Earth, Moon, and Sun**
  Multiple choice and short answer: 50–60 minutes

Science and Engineering Practices
The engineering challenge and three lab activities within the unit can be used as summative assessments of Science and Engineering Practices.

- **Engineering challenge: Heat shields**
  Engineering challenge: 180–240 minutes
- **1.3 Lab activity: Modeling the Solar System**
  Lab activity: 90–120 minutes
- **2.2 Lab activity: Modeling sunlight intensity**
  Lab activity: 45–60 minutes
- **3.3 Lab activity: Modeling phases of the Moon and eclipses**
  Lab activity: 45–60 minutes

Lab Activities

Lab Activity

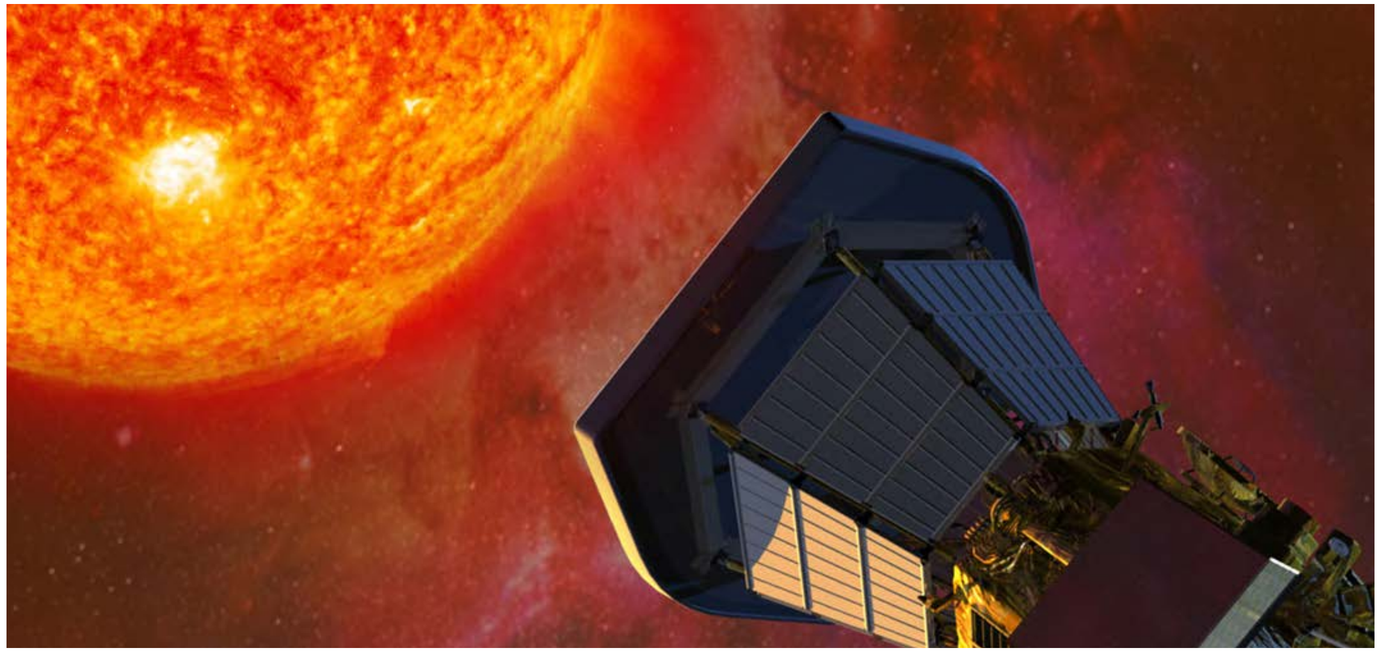
Heat shields

Activity purpose: Design, build, and test a model heat shield.

stileapp.com/go/heatshields

180–240 minutes

2–4 students per group



Materials

Lab Equipment
Each group of students will need:
- scissors
- tape
- PVA glue
- rulers
- 2 mini or fun-size chocolate bars without nuts
- wire mesh (e.g., stainless steel gauze mat)
- a selection of materials, such as newspaper, cardboard, cotton wool, bubble wrap, electrical tape, woolen cloth, styrofoam, steel wool

To test the heat shield:
- hair dryer
- 2 tongs
- oven mitts or heat proof gloves
- thermometer
- stopwatch

Chemicals
None required

Preparation

You will need to set up at least one testing station for the class, though more are recommended if you have access to more hair dryers. Remember that the testing area may become warm with the hair dryers running so should be located in a ventilated area. If using multiple hair dryers, check beforehand that they can run at the same time without overloading a circuit. It is also helpful to mark out where the heat shield and hair dryer should be placed (about 10cm or 4 in. apart) for consistency.

Notes

The wire mesh or cloth can provide structure and stability to the heat shield. You can use any type, but something that will not conduct the heat is ideal. If your budget allows, you could offer a variety for students to test and select from.

We recommend that students work individually to define the problem, research, and brainstorm solutions before they join together in a group.

Method

Method that students will follow
Students will design their own method, which will require teacher approval before commencement.

Instructions provided to students include:
- Design a heat shield that will keep a "space probe" safe from the Sun's heat.
- Your "space probe" will be a small chocolate bar and the Sun will be simulated by a hair dryer.

Your heat shield model must:
- only use materials supplied by your teacher
- have a maximum surface area of 20 cm x 20 cm
- be 10 cm from the hair dryer
- be 5 cm from the space probe
- protect the chocolate from melting for 5 minutes

A template outlining the engineering design process, as well as further scaffolding, is also provided to students in the Stile lesson.

To test the heat shield, students will use the following method:

1. Use tongs to hold the heat shield 10 cm from the hair dryer.
2. Use another pair of tongs to hold the chocolate bar 5 cm behind the heat shield. Place the thermometer on the surface of the chocolate.
3. Turn on the hair dryer. Record the temperature every minute for 5 minutes and record any changes you observe.

Activity purpose: Investigate how the rotation of the Earth results in day and night.

- stileapp.com/go/daynightmodel
- 20–30 minutes
- 2–3 students per group

Lab Activity

Modeling day and night

Materials

Lab Equipment
Each group of students will need:
- styrofoam ball, about 10 cm in diameter
- bamboo skewer
- flashlight
- 2 pins (colored head pins and drawing pins work well)
- felt-tip marker

Chemicals
None required

Preparation

None required

Notes

This activity works best in a dark classroom. We assume that students have already learned the cause of day and night.

Method

Method that students will follow

1. Gently push the skewer through the center of the styrofoam ball. The ball represents the Earth and the skewer represents the Earth's axis.
2. On the styrofoam ball draw:
   a. north, south, east, and west
   b. the country where you live
3. Place a pin in the country where you live.
4. Turn on the flashlight and point it directly at the styrofoam ball.
5. Slowly rotate the styrofoam ball from west to east, using the bamboo skewer.
6. Take a photo or video or draw a diagram of the model.

Activity purpose: Examine why most models of the Solar System are inaccurate and create a size model and a distance model of the Solar System.

stileapp.com/go/solarsystemmodel

90–120 minutes

3–4 students per group

Lab Activity

Modeling the Solar System

Materials

Lab Equipment
Each group of students will need:

Part 1: Size model
- 1 exercise ball, approximately 700 mm (2 ft 3 in) diameter balls and objects of various sizes, such as beads, sand, marbles, tennis balls, basketballs, seeds, etc.
- ruler or measuring tape
- pens or markers
- 3 sheets of paper

Part 2: Distance model
- 9 flags on sticks
- open space, e.g., a playing field, about 100 m (330 ft) long
- 30 m (100 ft) measuring tape

Chemicals
None required

Preparation

This activity will need to be conducted in a large outdoor space.

Notes

None

Method

Method that students will follow

Part 1: Size model
Calculate the scaled size of each planet in the model by following the instructions below.

1. Measure the diameter of each ball or object. Identify which object is the right size to represent each planet.
2. Create a label for each planet.
3. Take a photo to show the size comparison between the planets and the Sun.

To calculate the scaled size for each planet:

1. Divide its diameter by 2000

2. Round to the nearest milimeter

Worked example

The diameter of Mercury is 4880 km.

Scaled diameter of Mercury = 4880 : 2000 = 2.44 mm

2.44 is less than 2.5, so we round down to 2 mm

So in the model, Mercury will have a diameter of 2 mm

Part 2: Distance model
Calculate the scaled distance of each planet from the Sun by following the instructions below.

1. On the playing field, place the flag for the Sun at one end of the 100 m (about 330 feet) long line.
2. Measure out the scaled distances to each of the planets and mark their positions with flags.
3. Take a photo of your distance scale model.

To calculate the scaled distance for each planet:
1. Divide its real distance by 45,000,000
2. Round to one decimal place

Worked example

The distance of Mercury from the Sun is 57,000,000 km

Scaled distance of Mercury =
57,000,000 : 45,000,000 = 1.266 m

1.266 is more than 1.25, so we round up to 1.3 m
(one decimal place)

So in the model, Mercury will be 1.3 m from the Sun

Lab Activity

Modeling sunlight intensity

Activity purpose: Model direct and indirect sunlight and explain how this relates to seasonal temperature changes.

stileapp.com/go/sunintensity

45–60 minutes

2–3 students per group

Materials

Lab Equipment
Each group of students will need:
- flashlight
- cardboard tube
- tape
- 2 large sheets of 1 cm^2 graph paper
- pen or marker
- protractor
- 30 cm ruler

Chemicals
None required

Preparation

None required

Notes

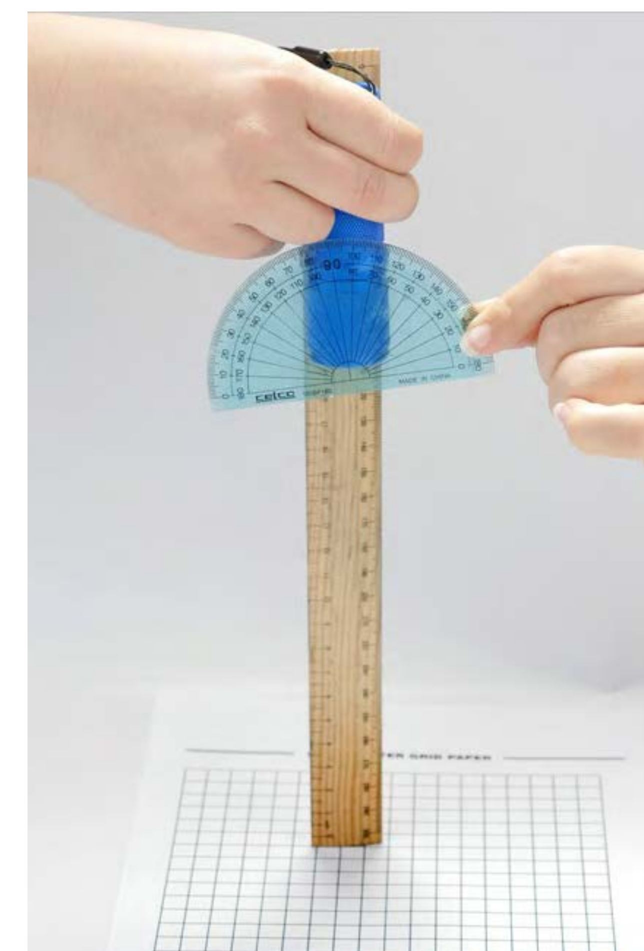
A variation of this activity is to measure the heat intensity from a heat lamp using thermometers or strips of thermochromic paper.

As a variation to this activity, students could measure light intensity by using the free Science Journal app. The app is available for download from the Apple Store (iOS) or Google Play (Android).

Students could graph this data and examine how light intensity changed according to the angle of light from the flashlight.

Method

Method that students will follow
1. Tape the cardboard roll around the flashlight so it makes a narrow beam of light.
2. Hold the flashlight above the piece of graph paper. Use the ruler to make sure the flashlight bulb is 20 cm above the paper. Use the protractor to make sure the flashlight is at a 90° angle to the paper.
3. Observe how bright the light appears to be on the paper. This is the light intensity.
4. While one person holds the flashlight steady, another person traces the outline of the beam on the paper. Clearly label this first trace as "90°".
5. Using the ruler and protractor, tilt the flashlight so that the flashlight bulb is still 20 cm above the paper but now angled at 75°. Again, observe how bright the light is on the paper.
6. Trace the outline of the beam and label it as "75°".
7. Repeat steps 5 and 6 for the angles 60°, 45° and 30°.



Lab Activity

Modeling the phases of the Moon and eclipses

Activity purpose: Create a model that shows how the phases of the Moon and eclipses are formed.

stileapp.com/go/moonphases

45–60 minutes

2–3 students per group

Materials

Lab Equipment

Each group of students will need:

- cardboard tube (e.g., an empty toilet paper roll)
- pair of scissors
- sticky tape
- styrofoam ball the size of a large orange
- ping pong ball
- aluminum foil
- sturdy but bendable piece of wire, about 40 cm (15 in) long
- ruler
- flashlight or other strong light source
- stack of books

Chemicals

None required

Preparation

None required

Notes

This activity works best in a dark room.

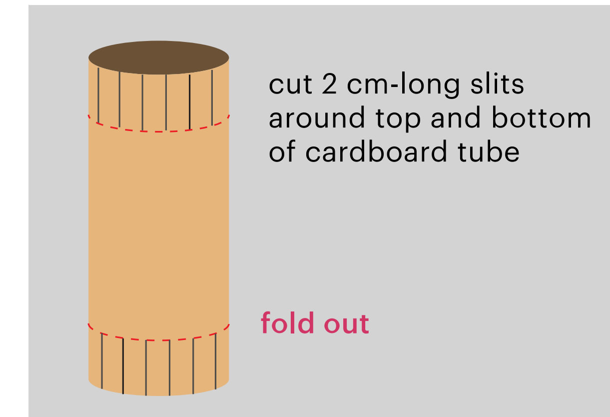
An alternative way to do this activity would be to provide students with a flashlight, a basketball, and a tennis ball. Students could then use these items to act out the phases of the Moon.

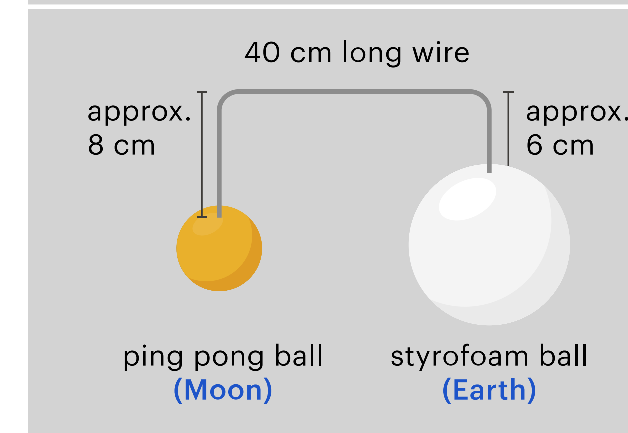
Method

Method that students will follow

To create the model:

1. Cut at least 8 vertical slits around each end of the cardboard tube. Each slit should be about 2 cm long.
2. Stand the tube vertically so that the strips at the bottom lie flat on the table. Fold out the strips at the top so they fan out like a flower.
3. Using sticky tape, attach the cardboard tube to the table.
4. Attach the styrofoam ball to the open "flower" at the top of the tube using sticky tape. This ball represents the Earth.
5. Wrap the ping pong ball with a sheet of aluminum foil. This ball represents the Moon.
6. Insert one end of the wire into the top of the Earth so that the wire is vertical.
7. Measure 6 cm along the wire and bend the wire at a right angle to create a horizontal arm.
8. Insert the other end of the wire into the Moon.
9. Measure 8 cm along the wire from the Moon and make another right-angled bend so that the Moon hangs vertically. The center of the Moon should be at the same height as the center of the Earth.



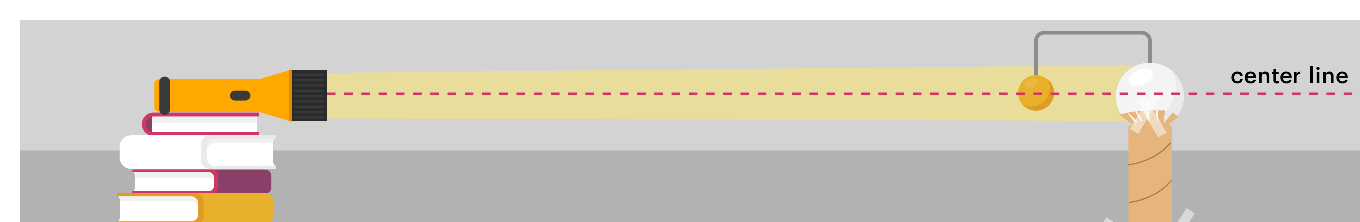


Using the model:

1. Balance the flashlight on a stack of books at the other end of the table. The flashlight represents the Sun. Adjust the height of the stack of books so that the flashlight beam is at the same height as the centers of the Earth and Moon.
2. Slowly rotate the wire so that the Moon orbits around the Earth. By viewing the Moon from the opposite side of the Earth, you can observe the phases of the Moon.
3. To capture the full moon phase without the Earth's shadow, you will need to temporarily raise the Moon. *Students can do this by pulling the wire slightly further out of the styrofoam ball.*
4. Take photos or a video of the phases.

For question 5:

1. Rearrange your model so that the Earth is positioned directly between the Moon and the Sun.



Unit 6 – Heat

How can I cook the perfect pizza?

Pizza in a wood-fired oven
Researchers have found that the magic formula for cooking a pizza is two minutes at about 600°F.

Back to Contents

Storyline and anchoring phenomenon

Mmmm – pizza. How do we cook it so it's just right? Students engage with the idea of cooking the perfect pizza and explore how to cook food so it's exactly right - the key is the ideal balance of heat. But what is heat, and how can we make sure the right amount is transferred to our dinner?

Students investigate the way that energy and heat transfer through different mediums, including solids, liquids, and gases and how to create the perfect balance between conduction, convection, and radiation.

The unit concludes with an engineering challenge, where students must build and test a solar oven that uses radiation. They practice analyzing and interpreting data as well as designing solutions to share with their peers, before practicing self-reflection against an assessment rubric.

This unit at a glance

Heat

Introduction: The perfect pizza
Career profile: Head pizza chef
What do you already know?

1.1 Lesson: What is heat?

2.1 Lesson: Conduction
2.2 Investigation: Which material is the best insulator?

3.1 Lesson: Convection
3.2 Lab activity: Modeling convection currents

4.1 Lesson: Radiation
4.2 Investigation: Which color absorbs the most radiation?
4.3 Engineering challenge: Build a solar oven

Glossary: Heat
Test: Heat

Students **gather observations and ask questions** about how heat is transferred.

Students **engage in the phenomena of cooking a pizza** and look at the net transfer of energy from one object to another.

Students practice scaffolded **designing of solutions, data gathering, and communication of ideas**.

Students **gather their own data and manipulate variables** to engineer an insulation solution.

Students **analyze models of invisible phenomena** to explain convection.

Students **collaborate, problem-solve,** and **practice laboratory skills** to explore convection currents.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-PS1-4

Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

MS-PS3-3

Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.

MS-PS3-4

Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

Disciplinary Core Ideas

- **PS3.A**: Definitions of Energy
- **PS3.B**: Conservation of Energy and Energy Transfer

Students examine the transfer of energy between particles at different distances to discover how kinetic energy converts to thermal energy.

They look at the changes in motion and energy at the particle level, and relate this to the amount of energy needed to change the temperature of matter.

Students build an understanding that this energy transfer changes depending on how close particles are. They learn about the rate of energy transfer between particles and connect this to the rate of heat transfer from one object to another or throughout substances.

Science and Engineering Practices

- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking

In this unit, students investigate heat as energy transfer. They gather, analyze, and interpret data and consider secondary data to support content knowledge.

Students use mathematics and computational thinking to justify which type of heat transfer they are observing during practical tasks and use these skills to justify which solar oven design is best.

Crosscutting Concept

- Energy and Matter

Students explore different types of energy and focus on developing an understanding of thermal energy.

They look at tracking energy flows in diagrams and use interactive questions to model interactive systems.

Nature of Science

– Science is a Human Endeavor

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

In previous years, students would have learned that energy can move from place to place through moving objects or through sound, light, or electric currents.

They would have observed that the faster a given object is moving, the more energy it possesses and when objects collide, energy can be transferred from one object to another. Students will build upon these foundational concepts to examine the transfer of energy between particles at different distances and to discover how kinetic energy converts to thermal energy.

They will extend this idea by looking at the changes in motion and energy at the particle level, and relating this to the amount of energy needed to change the temperature of matter. Ultimately, students build an understanding that the process of energy transfer changes depending on the distance between particles, and explain how the rate of energy transfer between particles relates to the rate of heat transfer from one object to another or throughout substances.

Science and Engineering Practices

Students' prior knowledge of Science and Engineering Practices likely included using quantitative approaches to collecting data and conducting multiple trials of qualitative observations.

They also practiced representing data in graphs and tables, analyzing data to refine a problem statement, and using data to evaluate and refine design solutions. Prior experience with of Science and Engineering Practices was likely to include applying quantitative measurements to a variety of physical properties and using computation and mathematics to analyze data and compare alternative design solutions. Through Heat, students build on this knowledge by applying statistical techniques to the analysis of data and identifying patterns in large data sets and using mathematical concepts to support explanations and arguments.

Students investigate heat as energy transfer. They gather, analyze, and interpret data and consider secondary data to support content knowledge. Students use mathematics and computational thinking to justify which type of heat transfer they are observing during practical tasks, and use these skills to undertake an engineering challenge to build a solar oven.

Crosscutting Concepts

Prior to this grade, students should understand the idea that matter is made of particles and energy can be transferred in various ways and between objects.

Additionally, students should have observed the conservation of matter in substances and will understand that the total weight of substances does not change in a chemical reaction.

This unit builds upon this Crosscutting Concept by providing students with the opportunity to explore different types of energy and develop an understanding of thermal energy. They also look at tracking energy flows in diagrams and use interactive questions to model interactive systems.

Hot air balloons
As the air inside the balloon heats up, it expands and becomes less dense than the cooler air outside. The difference in density causes the balloon to rise.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
This refers to the Science and Engineering Practice that is the focus of this lesson. The SEPs that are assessed at grade band level within this unit are listed in the NGSS alignment overview.

Focus DCI
This refers to the Disciplinary Core Idea that is the focus of this lesson. The DCIs that are assessed at grade band level within this unit are listed in the NGSS alignment overview.

Focus CCC
This refers to the Cross Cutting Concept that is the focus of this lesson. The CCCs that are assessed at grade band level within this unit are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: The perfect pizza What do you already know? Career profile: Head pizza chef	How can I make the perfect pizza every time?	Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**PS3.A** Definitions of Energy	Energy and Matter	Ask students to read article linked in lesson, *Cosmos Magazine*, "The physics of perfect pizza"	Science news lesson: California wildfires
Lesson 2	1.1 Lesson: What is heat?	How does a barbecue cook food?	Review What do you already know? in Analyze Mode to guide areas to emphasize Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**PS3.A** Definitions of Energy	Energy and Matter	Assign Stile X app: What is heat? video Assign Stile X Review notes: What is heat?	Stile X app: Flashcards
Lesson 3	2.1 Lesson: Conduction	Why does metal feel cold?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**PS3.A** Definitions of Energy	Energy and Matter	Assign Stile X app: Conduction video Assign Stile X Review notes: Conduction	Stile X app: Flashcards
Lesson 4	2.2 Investigation: Which material is the best insulator?	Why is my pizza always cold when it gets delivered to my house?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the investigation. See the relevant lab activity pages at the end of this chapter	Analyzing and Interpreting Data	**PS3.A** Definitions of Energy	Energy and Matter	Ask students to complete questions 1–11	Extra SEP support: 0.1 Conducting science investigations

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	2.2 Investigation: Which material is the best insulator?	Why is my pizza always cold when it gets delivered to my house?	Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Analyzing and Interpreting Data	**PS3.A** Definitions of Energy	Energy and Matter		
Lesson 6							Ask students to complete all remaining questions	Stile X app: Flashcards
Lesson 7	3.1 Lesson: Convection	How do hot air balloons stay in the sky?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Using Mathematics and Computational Thinking	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Assign Stile X app: Convection video Assign Stile X Review notes: Convection	Stile X app: Flashcards
Lesson 8	3.2 Lab activity: Modeling convection currents	How can I see convection currents in action?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Analyzing and Interpreting Data	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Ask students to complete lab questions	Extra SEP support: 2.1 Observing and inferring

Lesson Planning Guide

Week 1 · Week 2 · **Week 3** · Week 4 · Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	4.1 Lesson: Radiation	How do infrared cameras work?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Assign Stile X app: Radiation video Assign Stile X Review notes: Radiation	Poster: Heat & pizza. Posters are available for purchase from the Stile Shop
Lesson 10	Glossary: Heat Unit review	How much have I learned about Heat?	Review Key Questions from the unit using Analyze Mode to identify areas to revisit	Analyzing and Interpreting Data Using Mathematics and Computational Thinking	**PS3.A** Definitions of Energy **PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Assign Stile X Glossary Assign Stile X Test preparation	Stile X app: Flash Quiz
Lesson 11	Test: Heat	How can I be prepared for the Heat test?	Ensure students have access to a device					Extra SEP support: 1.2 Identifying testable questions Extra SEP support: 1.3 Writing a hypothesis
Lesson 12	4.2 Investigation: Which color absorbs the most radiation?	What color roof will keep me the warmest?	Review teaching notes in Prepare Mode Prepare the materials for the investigation. See the relevant lab activity pages at the end of this chapter	Analyzing and Interpreting Data	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Ask students to complete questions 1–11	Extra SEP support: 2.4 Controlled variables (Part 1) Extra SEP support: 2.5 Controlled variables (Part 2)

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	4.2 Investigation: Which color absorbs the most radiation?	What color roof will keep me the warmest?	Review teaching notes in Prepare Mode Prepare the materials for the investigation. See the relevant lab activity pages at the end of this chapter	Analyzing and Interpreting Data	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Ask students to complete questions 12–13	Extra SEP support: 2.2 Measuring Extra SEP support: 2.6 Method and materials
Lesson 14			Complete grading of test ahead of test review session				Ask students to complete all remaining questions	Extra SEP support: 2.7 Results
Lesson 15	Test review	How successful was my revision of Heat?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Analyzing and Interpreting Data Using Mathematics and Computational Thinking	**PS3.A** Definitions of Energy **PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Assign Stile X Reflection Ask students to review feedback from the test and to identify areas for improvement	
Lesson 16	Optional Extra 4.3 Engineering challenge: Build a solar oven	How do I build a solar oven?	Review teaching notes in Prepare Mode Prepare the materials for the engineering challenge. See the relevant lab activity pages at the end of this chapter	Using Mathematics and Computational Thinking	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Ask students to complete questions 1–4	Extra SEP support: 0.3 The engineering process

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · **Week 5**

The guide below is based on three 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	Optional Extra 4.3 Engineering challenge: Build a solar oven	How do I build a solar oven?	Review teaching notes in Prepare Mode Prepare the materials for the engineering challenge. See the relevant lab activity pages at the end of this chapter	Using Mathematics and Computational Thinking	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Ask students to complete questions 5–7	Extra SEP support: 1.1 Researching, Extra SEP support: 5.3 Creative thinking
Lesson 18							Ask students to complete questions 8–9	Extra SEP support: 3.8 Analyzing data to test a hypothesis
Lesson 19							Ask students to complete any remaining questions and reflect on their team's performance using the rubric	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical skills.

Students use data to support their observations of energy transfer within this unit. They gather their own data from activities that include positive and negative integers and dissect the meaning of 0 as no net change.

They summarize numerical data and use it in context to justify the best design for their solar oven.

Common Core State Standards Connections: Math

6.NS.C.5

Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation.

MP.2

Reason abstractly and quantitatively.

6.SP.B.5

Summarize numerical data sets in relation to their context.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Lessons within this unit incorporate many opportunities for students to develop and use their reading, writing, listening, and speaking skills.

Students use their English language skills to follow procedures when investigating the rate of heat transfer. Through short research projects, students answer questions that guide their learning and draw from several sources of information to justify their responses.

They integrate technical information into written summaries, annotate diagrams, and use flow charts to model the flow of energy from one substance to another.

Common Core State Standards Connections: English Language Arts

RST.6-8.3

Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flow chart, diagram, model, graph, or table).

WHST.6-8.7

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

Thermal energy
When you lick an ice cream, thermal energy is transferred from your tongue to the ice cream.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Career profile: Head pizza chef**
  Question 2
- **What do you already know?**
  Questions 5, 6
- **1.1 Lesson: What is heat?**
  Questions 8, 9, 14
- **2.1 Lesson: Conduction**
  Questions 6, 12, 13, 15, 17, 20
- **2.2 Investigation: Which material is the best insulator?**
  Questions 7, 14, 15, 16, 18, 19
- **3.1 Lesson: Convection**
  Questions 5, 11, 15, 17, 22
- **3.2 Lab activity: Modeling convection currents**
  Questions 1, 2, 6, 7
- **4.1 Lesson: Radiation**
  Questions 8, 12, 16
- **4.2 Investigation: Which color absorbs the most radiation?**
  Questions 7, 15, 16, 18, 19
- **4.3 Engineering challenge: Build a solar oven**
  Question 3

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points

Lesson	Misconception	Addressing the misconception
What do you already know?	Heat is something that warm objects have and cold objects lack.	In science, heat is a form of energy that always moves from a warmer object to a cooler one.
2.1 Lesson: Conduction	During heat transfer, one object transfers all of its energy to the other.	Different materials conduct heat differently. Any material that allows thermal energy to flow through it easily is called a good conductor. All metals are good conductors, although some metals are better than others. We use metals to make pots and pans because they conduct heat to the food quickly. A material that doesn't allow thermal energy to flow through it easily is called an insulator. Plastics, air, wood, and cloth are examples of good insulators.
	If one object feels colder than another, it must have a lower temperature.	Heat transfer will cease when the two objects reach the same temperature.

Wood fire
Heat is a form of energy that moves from warmer objects to cooler ones. The transfer of heat is the movement of thermal energy.

ELL support

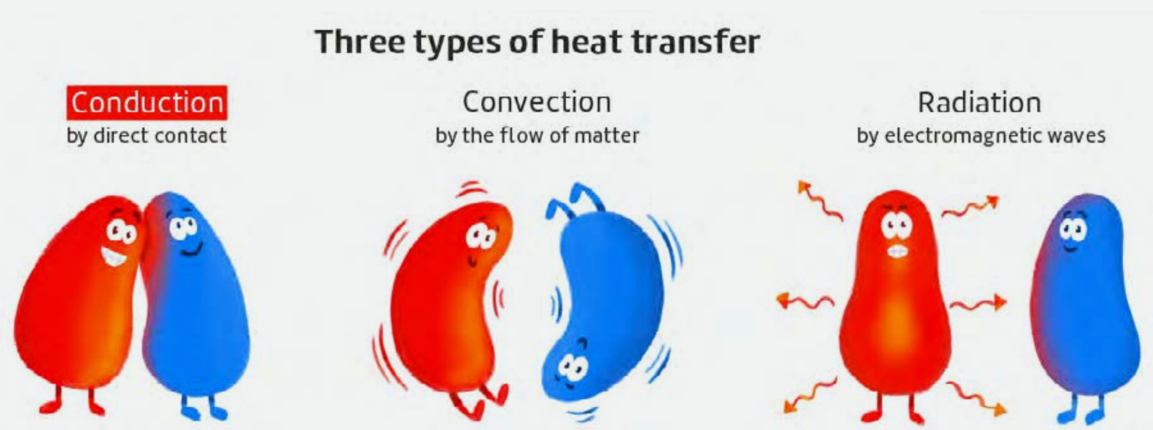
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

Heat lessons include a number of flow charts and diagrams to help students understand the exchange of energy from one particle to another. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

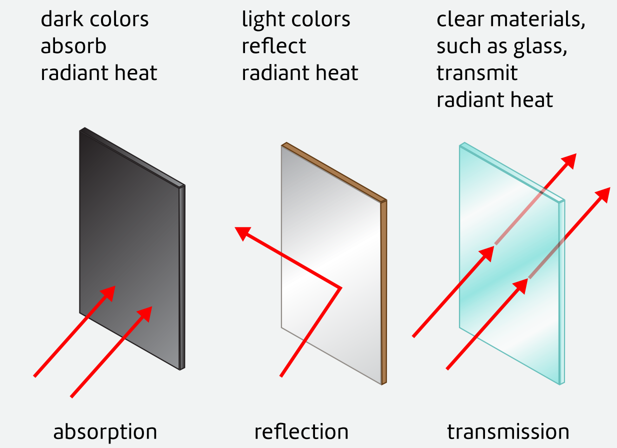
2.1 Lesson: Conduction

This cartoon representation of the transfer of heat is used to illustrate the three types of heat transfer. Showing particles in red and blue, the universal colors for hot and cold supports students to recognize what is being shown. The mechanisms of transfer are also represented in the illustrations, and clear labels alongside them help students to link the visual representation to the appropriate terminology.



4.1 Lesson: Radiation

An illustration of light radiation interacting with different types of material provides a simple summary of terminology and relevant definitions. Students are able to connect the visual representation with the associated English vocabulary shown alongside the image.



Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.1 Lesson: What is heat?

The use of drag-and-drop arrows assist students to easily convey the transfer of energy from one medium to another. The labels are color-coordinated to help students to add simple descriptors to the arrows to convey their understanding of energy transfer as things heat and cool.

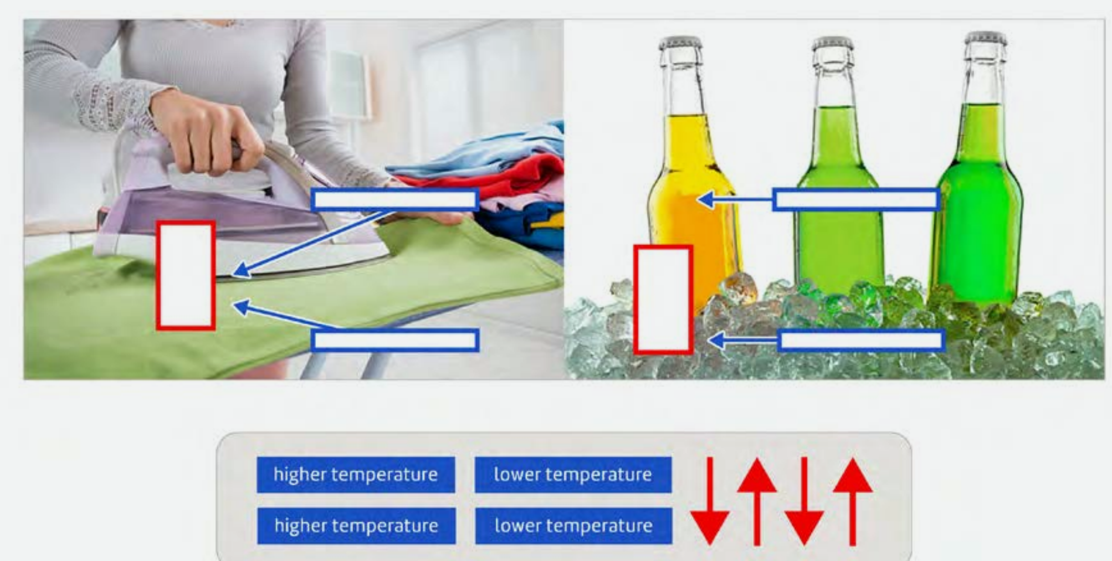


Image taken by an infrared camera
Radiation is the transfer of heat by electromagnetic waves. Known as "infrared radiation," most radiant heat is invisible because it has longer waves than red light. Infrared radiation can be viewed using infrared cameras.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Pre-test: What do you already know?
Activate students' prior knowledge of relevant concepts including conduction, convection, and radiation. Use this as a pre-test to identify misconceptions and areas where students may need additional challenge or support in subsequent lessons.

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Summative assessment

Test
This unit contains a test to provide summative assessment of student learning across the whole unit.

- **Test: Heat**
  Multiple choice and short answer: 45–60 minutes

Science and Engineering Practices
One lab activity, two investigations, and an engineering challenge within the unit can be used as summative assessment of Science and Engineering Practices.

- **2.2 Investigation: Which material is the best insulator?**
  120–180 minutes
- **3.2 Lab activity: Modeling convection currents**
  45–60 minutes
- **4.2 Investigation: Which color absorbs the most radiation?**
  120–180 minutes
- **4.3 Engineering challenge: Build a solar oven**
  180–240 minutes

Lab Activities

Lab Activity

Which material is the best insulator?

Activity purpose: Investigate the best material for insulating a hot pizza.

stileapp.com/go/bestInsulator

120–180 minutes

2–3 students per group

Materials

Lab Equipment
The materials needed will depend on the experimental design that each group of students comes up with. It's likely that you'll need to provide the following materials:
- 3 aluminum cans (minimum)
- 3 thermometers (1 per aluminum can)
- scissors
- tape or glue
- different materials: cotton, nylon, wool, polyester, cardboard
- kettle (to dispense hot water)
- stopwatch

Chemicals
None required

Preparation

None required

Notes

This lesson is designed to guide students through the steps of an open inquiry. It's important to consider if this type of inquiry is appropriate for your students and the type of investigation they're pursuing.

You can easily modify the template in the Stile lesson by:
- varying the level of inquiry, e.g., defining a particular aim, set of materials or method, or allowing students to generate their own questions for investigation
- focusing on a particular aspect of inquiry, e.g., devising a hypothesis, identifying variables, or analyzing data
- adding extra scaffolding to support less experienced students

This investigation could also be turned into an engineering challenge. Rather than asking students to investigate which material would make the best insulator, you could ask students to create the ideal pizza delivery box using the engineering challenge template in the Stile lesson library.

Method

Students will design their own method, to be approved by their teacher.

Instructions provided to students include:
Conduct an investigation to find out which type of material will keep an object hot for the longest time.

The design of the investigation is up to you, but here are some points to help guide you:
- We recommend that you use something to act as a model for a hot pizza. For example, you might use an aluminum can filled with hot water.
- Consider what types of materials you want to compare and how you will arrange them around your model.
- How often will you measure temperature and for how long?

Further scaffolding to plan, conduct, and communicate a science investigation is provided for students in the Stile lesson.

Lab Activity

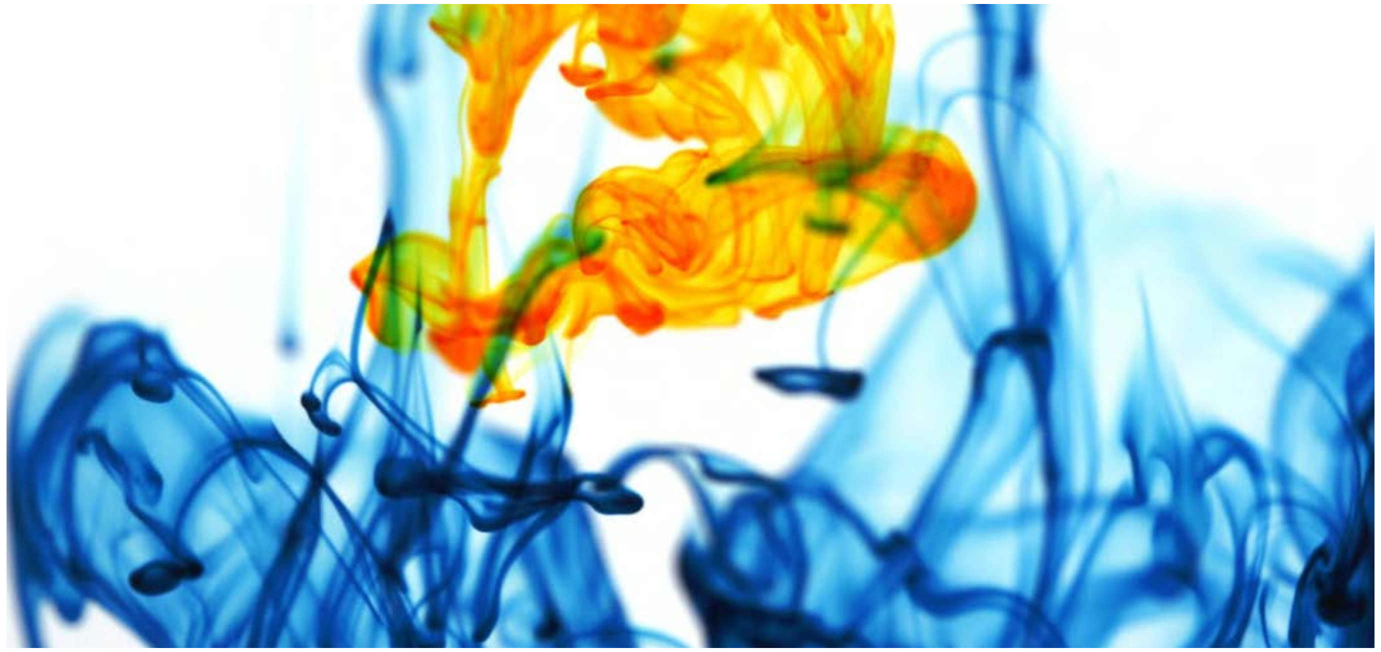
Modeling convection currents

Activity purpose: Observe and explain the movement of convection currents.

stileapp.com/go/convection

45–60 minutes

3–4 students per group



Materials

Lab Equipment
Each group of students will need:
- 500 mL beaker
- straw
- tweezers
- beaker
- Bunsen burner
- heatproof mat
- gauze mat
- tripod
- lighter or matches
- gloves
- safety glasses
- large stoppered flasks for waste

Chemicals
- 2 or 3 small pieces of potassium permanganate (small enough to fit through a straw)
- 400 mL cold water

Preparation

None required

Notes

If you do not have potassium permanganate, you may like to use some other material instead. Alternatives include tea leaves, beans, golden raisins, rice, and food dye.
If using tea leaves, dampen the tea leaves in tea bags prior to cutting them open, as dry tea leaves tend to float on top of the water.

Raisins need to be organic, without the coating of oil on them.

Ensure potassium permanganate is added to the cold water before the Bunsen burner is lit as it's an oxidizer (may intensify fire).

Collect all stoppered flasks and materials at the conclusion of the lesson for correct disposal.

Method

Method that students will follow
1. Set up the Bunsen burner, heatproof mat, tripod, and gauze mat.
2. Add 400 mL of cold water to the beaker and place it on the tripod. Allow the beaker to rest until the water is still.
3. Place the straw into the beaker so that it's touching the side. Using tweezers, carefully slide the pieces of potassium permanganate down the straw to the bottom of the beaker.
4. Carefully remove the straw to prevent it from disturbing the water.
5. Observe the movement of the dissolved potassium permanganate in the still cold water.
6. Light the Bunsen burner and change it to the blue flame. Position the Bunsen burner so that the flame is directly beneath the potassium permanganate crystals.
7. Observe what happens to the dissolved potassium permanganate as the water is heated.
8. Pour all waste into large stoppered flasks and return to your teacher for correct disposal.

Lab Activity

Which color absorbs the most radiation?

Activity purpose: Investigate heat absorption of different colored surfaces.

stileapp.com/go/whichcolor

120–180 minutes

3–4 students per group

Materials

Lab Equipment
The materials needed will depend on the experimental design that each group of students comes up with. It's likely that you'll need a collection of the following materials per group:

- 3 aluminum cans (minimum)
- 1 thermometer per aluminum can
- access to room temperature water
- 500 mL measuring jug
- paint, paper, or foil to cover the cans
- paintbrushes (if using paint)
- tape (if using paper or foil)
- flashlight or lamp
- stopwatch

Chemicals
None required

Preparation

None required

Notes

This lesson is designed to guide students through the steps of an open inquiry. It is important to consider if this type of inquiry is appropriate for your students and the type of investigation they are pursuing. You can easily modify the template in the Stile lesson by:

- varying the level of inquiry, e.g., defining a particular aim, set of materials or method, or allowing students to generate their own questions for investigation
- focusing on a particular aspect of inquiry, e.g.,devising a hypothesis, identifying variables, or analyzing data
- adding extra scaffolding to support less experienced students

Method

Method that students will follow
Students will design their own method, which will require teacher approval before commencement.

Instructions provided to the student include:

Conduct an investigation to find out which color is the best at absorbing radiation.

The design of the investigation is up to you, but here are some points to help guide you.

Consider what you will be heating. For example, you might heat cans filled with water. You could paint the cans different colors or place different colored paper around them.

Decide what the source of radiation will be. Will you use a lamp, sunlight, or something else?

How often will you measure temperature and for how long?

Further scaffolding to plan, conduct, and communicate a science investigation is provided for students in the Stile lesson.

Activity purpose: Follow the engineering design process to design, build, and test a solar oven

stileapp.com/go/solaroven

180–240 minutes

3–4 students per group

Lab Activity

Build a solar oven

Materials

Lab Equipment
- 1 fun-sized chocolate bar (alternatives include marshmallows or cheese)
- cardboard box, such as a shoe or cereal box
- aluminum foil (1 roll for class to share)
- cling wrap (1 roll for class to share)
- colored paper
- a selection of other materials, such as newspaper, styrofoam, black paper, or bubble wrap
- scissors
- tape
- ruler

To test the oven:
- paper plate
- thermometer

Chemicals
- PVA glue

Preparation

Sunlight is the intended heat source; this activity should be conducted on a sunny day.

Notes

We recommend that students work individually to initially define the problem, research, and brainstorm solutions before they join together in groups.

Method

Method that students will follow
Students will design their own method, which will require teacher approval before commencement.

Instructions provided to students include:

Design a solar oven that can melt a fun-sized chocolate bar. Your solar oven must:
- only use materials supplied by your teacher
- only use sunlight as a heat source
- melt the chocolate bar within an hour

To test your solar oven you will:

1. Place the solar oven outside. Position the oven so that it receives the maximum amount of sunlight.
2. Place the chocolate bar on the paper plate inside the oven.
3. Place a thermometer inside the oven and record the initial temperature.
4. One hour later, record the temperature of your oven. Examine the chocolate bar.

A template outlining the engineering design process and further scaffolding is provided to students in the Stile lesson.

Unit 7 – Light

How can my smartphone be used as a microscope?

Light trails
Lenses can capture light with long exposure. These light trails show the path of light as it moves past the lens.

Storyline and anchoring phenomenon

Completely by accident, scientist Dr. Steve Lee found a way to turn an iPhone into a microscope. In this unit about light, students engage with the idea that something in their pocket could replace a microscope that's bigger than a shoebox!

Dr. Lee guides students through the unit as they explore the power of using a smartphone as a microscope and consider the impact it could have on a range of industries, including medicine and agriculture.

Students activate their prior knowledge and discussing examples of technologies that use light. They are then introduced to light waves and the different ways that light interacts with objects. They then apply everything they have learned about light absorption, reflection and transmission to a lab activity where they observe the properties of bubbles.

As students unpack the electromagnetic spectrum, they meet the Perseverance Rover and examine how and why it uses radio waves to send digital images from Mars to Earth. They apply their knowledge in a three-dimensional task, where they prepare and deliver an oral presentation to a partner explaining how technologies use electromagnetic radiation to capture and transmit information.

Back on Earth, students experiment with digital models of reflection and refraction, and explore how light interacts with various objects. Using what they have learned, they examine the use of lenses and revisit Dr. Lee's microscope with a fresh perspective on how it works.

This unit at a glance

Light

Introduction: Smartphones just got smarter
Career profile: Optical engineer

1.1 Lesson: Light waves
1.2 Lesson: The interaction of light with objects
1.3 Lab activity: Properties of bubbles
1.4 Lesson: Electromagnetic spectrum
1.5 Lesson: Communicating with electromagnetic radiation

2.1 Lesson: Reflection
2.2 Lesson: Refraction
2.3 Lesson: Lenses
2.4 Lesson: The use of lenses

Glossary: Light
Test: Light

The real-world phenomenon of light's interaction with objects drives the unit and motivates student learning.

Students learn how animals and plants use **patterns** of the **invisible spectrum** of light to communicate.

Students learn how **engineering processes** have enabled us to **see the surface of Mars** using electromagnetic radiation.

Students engage with the engineering process by meeting an engineer and scientist who accidentally discovered how to make mini-lenses.

Students explore **how energy from the sun changes form** when it interacts with water and curved surfaces.

Students examine how Dr. Lee engaged in the engineering practice of **designing solutions.**

Assessment
Summative tests measure student achievement across the unit.

A language glossary provides definitions of key terms accompanied by images. These are perfect for supporting ELL students to build scientific vocabulary.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-PS4-1

Use mathematical representations to describe a simple model for waves that includes how the amplitude of a wave is related to the energy in a wave.

MS-PS4-2

Develop and use a model to describe that waves are reflected, absorbed, or transmitted through various materials.

MS-PS4-3

Integrate qualitative scientific and technical information to support the claim that digitized signals are a more reliable way to encode and transmit information than analog signals.

Disciplinary Core Ideas

- **PS4.A:** Wave Properties
- **PS4.B:** Electromagnetic Radiation
- **PS4.C:** Information Technologies and Instrumentation Wave Properties

Students explore the use of mathematical representations to describe the behavior of light waves.

Students use models to observe how light waves are reflected, absorbed, or transmitted through various materials depending on their properties. Students learn how electromagnetic radiation is used to capture and transmit information via digital signals and consider the advantages and disadvantages of this compared to analog signals.

Science and Engineering Practices

- Constructing Explanations and Designing Solutions
- Developing and Using Models
- Obtaining, Evaluating, and Communicating Information

Students ask questions and construct explanations to communicate how light works throughout the unit.

Students use both digital and physical models to examine how light interacts with objects, reflects, and refracts.

Crosscutting Concepts

- Structure and Function
- Systems and System Models
- Patterns
- Energy and Matter
- Scale, Proportion, and Quantity

Students consider the structure of lenses and how this relates to how they refract light.

Students recognize patterns and commonalities in how light interacts with objects with specific properties. Students engage with models of the flow of light energy that represent inputs, processes, and outputs.

Nature of Science

- Scientific Knowledge is Based on Empirical Evidence

Science, Technology, Society and the Environment

- Influence of Engineering, Technology, and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

In previous years, students would have learned that waves are regular patterns of motion that can be produced in water by disturbing its surface.

They have observed that while a wave moves across the surface, the water itself merely goes up and down in place, and that waves of the same type can produce different amplitudes and wavelengths. They will have also learned that objects can be seen due to the reflection of light waves, and that many technologies exist because of the ability to transfer information over long distances via electromagnetic waves.

Students will build upon these foundational concepts to show that light waves have qualitative and quantitative patterns of specific wavelengths, frequencies, and amplitudes as demonstrated by the various colors that can be absorbed, reflected, or transmitted by the objects light waves interact with. They will go further into theories of light to learn that in many scenarios light can be appropriately described by a wave model, but because light can travel through space, it cannot be a matter wave in the way that sound waves, or water waves travel.

Students will deepen their understanding of electromagnetic information transfer by comparing the reliability of digitized signals to other less effective means of communication.

Science and Engineering Practices

Building upon prior experiences with constructing and revising simple models, students will evaluate the limitations of both digital and physical models they built to demonstrate properties of light waves.

Furthermore, the more complex models they now develop will be able to describe the unobservable mechanisms of information transmission through electromagnetic waves. Students will also have prior knowledge of evaluating the merit and accuracy of ideas and methods, and will progress to communicating technical information both orally and in writing about how light waves interact with various surfaces and objects.

Students will already have experience with using evidence to construct explanations where specified variables are used to make predictions and design solutions to design problems. Building upon this skill, students will be able to use a representation of light wave interactions to construct an explanation of how light interacts with various surfaces and objects.

Crosscutting Concepts

Students' prior knowledge in the Crosscutting Concepts would have them using standard units to measure physical quantities such as weight, time, temperature, and volume.

They would also have experience in identifying patterns related to time and cycles. In this unit they will progress to using algebraic expressions to show the scientific relationships between the physical properties of light waves and the macroscopic patterns they produce.

Also in previous years students would have learned that structures and/or systems have shapes and parts that serve functions. They would have also learned that such parts can belong to a system serving a function that the individual parts alone cannot.

Building off this knowledge, students will visualize and model light wave interactions as a system of substructures and describe how the function of these substructures depends on their shape and the relationships among the system's parts. Regarding energy and matter, students will already know that matter is made of particles and that energy can be transferred in various ways and between objects.

Students will now strengthen their understanding of this concept by showing that electromagnetic radiation can be tracked as a form of energy flowing through a system of communication used in many modern technologies.

Spectacular sunset
At sunrise and sunset, the Sun's light has to travel a greater distance through the atmosphere. Due to its short wavelength, the blue light is scattered while the red light remains visible and causes the sky to turn beautiful colors.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 Week 2 Week 3

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Smartphones just got smarter Career profile: Optical engineer	Can I fit a microscope in my pocket?	Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**ETS1.C** Optimizing the Design Solution	Structure and Function		Extra SEP support: 0.3 The engineering process
Lesson 2	1.1 Lesson: Light waves	How can light from the Sun be so many colors?	Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS4.A** Wave Properties **PS4.B** Electromagnetic Radiation	Systems and System Models	Assign Stile X Review notes: Light waves Assign Stile X app: Light waves video	Poster: Light & color. Posters are available in the Stile Shop
Lesson 3	1.2 Lesson: The interaction of light with objects	How do we see colors of objects?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**PS4.A** Wave Properties **PS4.B** Electromagnetic Radiation	Systems and System Models	Assign Stile X app: The interaction of light with objects video Assign Stile X Review notes: The interaction of light with objects	Stile X app: Flashcards
Lesson 4	1.3 Lab activity: Properties of bubbles	How can we see two types of light interaction at once?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Asking Questions and Defining Problems	**PS4.B** Electromagnetic Radiation	Patterns	Ask students to complete lab activity	Extra SEP support: 2.1 Observing & inferring Stile X app: Flashcards

Lesson Planning Guide

Week 1 · Week 2 · Week 3

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.4 Lesson: The electromagnetic spectrum	How does the electromagnetic spectrum describe the properties of light?	Review Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**PS4.B** Electromagnetic Radiation	Patterns	Assign Stile X app: The electromagnetic spectrum video Assign Stile X Review notes: The electromagnetic spectrum	Stile X app: Flashcards
Lesson 6	1.5 Lesson: Communicating with electromagnetic radiation	How can we talk to someone on Mars?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**PS4.A** Wave Properties **PS4.B** Electromagnetic Radiation **PS4.C** Information Technologies and Instrumentation	Cause and Effect	Assign Stile X Review notes: The electromagnetic spectrum Assign Stile X app: Communicating with electromagnetic radiation video	Stile X app: Flashcards
Lesson 7	2.1 Lesson: Reflection	How can some reflections be clear while others are distorted?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS4.B** Electromagnetic Radiation	Patterns	Assign Stile X app: Reflection video Assign Stile X Review notes: Reflection	Stile X app: Flashcards Stile X app: Flash Quiz
Lesson 8	2.2 Lesson: Refraction	How can I make a rainbow?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**PS4.B** Electromagnetic Radiation	Patterns	Assign Stile X app: Refraction video Assign Stile X Review notes: Refraction	Stile X app: Flashcards Stile X app: Flash Quiz

Lesson Planning Guide

Week 1 · Week 2 · **Week 3**

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	2.3 Lesson: Lenses	How can we bend light to get a better view of tiny things?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**PS4.B** Electromagnetic Radiation	Structure and Function Investigations	Assign Stile X app: Lenses video Assign Stile X Review notes: Lenses	Stile X app: Flashcards Stile X app: Flash Quiz
Lesson 10	2.4 Lesson: The use of lenses	How have lenses shaped the history of scientific discoveries?	Review Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**PS4.B** Electromagnetic Radiation **PS4.C** Information Technologies and Instrumentation	Structure and Function Investigations	Assign Stile X app: The use of lenses video Assign Stile X Review notes: The use of lenses	Stile X app: Flashcards Stile X app: Flash Quiz
Lesson 11	Unit review Glossary: Light	How can I be prepared for the Light test?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Constructing Explanations and Designing Solu-tions Asking Questions and Defining Problems Developing and Using Models Obtaining, Evaluat-ing, and Communi-cating Information	**ETS1.C** Optimizing the Design Solution **PS4.A** Wave Properties **PS4.B** Electromagnetic Radiation **PS4.C** Information Technologies and Instrumentation	Structure and Function Systems and System Models Patterns	Assign Stile X Glossary Assign Stile X Test preparation	Stile X app: Flashcards Stile X app: Flash Quiz
Lesson 12	Test: Light	How much have I learned about Light?	Ensure every student has access to a device				Assign Stile X Reflection	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to give students multiple opportunities to build and apply mathematical skills.

An explanation of integration is below, followed by a list of specific common core connections.

Students will use data to justify relationships that are observed within the Light unit and use ratios of wavelength and frequency to solve problems. These relationships are represented in graphical format and are used to identify changes in the visible and invisible sections of the electromagnetic spectrum.

Common Core State Standards Connections: Math

MP.2

Reason abstractly and quantitatively.

MP.4

Model with mathematics.

6.RP.A.3

Use ratio and rate reasoning to solve real-world and mathematical problems.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

This unit allows students to use multiple texts and exposures to information to create their own definitions of their knowledge.

By summarizing the subject-specific knowledge during lessons and while using Stile X, students will be able to succinctly convey their knowledge using relevant scientific vocabulary.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.2

Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge.

You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* written response questions within a lesson are suggested below, as students should still be given the opportunity to practice and develop their written language skills.

- **1.1 Lesson: Light waves**
  Questions 15, 16
- **1.2 Lesson: The interaction of light with objects**
  Questions 2, 6
- **1.4 Lesson: The electromagnetic spectrum**
  Questions 9, 10, 13
- **1.5 Lesson: Communicating with electromagnetic radiation**
  Questions 12, 13
- **2.1 Lesson: Reflection**
  Questions 5, 9
- **2.4 Lesson: The use of lenses**
  Question 6

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified in the Lesson Planning Guide and listed below. These can also be found as teaching notes within the lessons where students encounter these ideas.

Highlighting possible misconceptions helps teachers to anticipate them, recognize them within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
What do you already know?	All objects absorb and reflect light to different degrees.	**Use 2.1 Lesson: Reflection** Students will observe the phenomenon of reflection on multiple different surfaces. Incorporate specific questioning around the types of materials that reflect light to support students in rectifying this misconception.

ELL support

To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

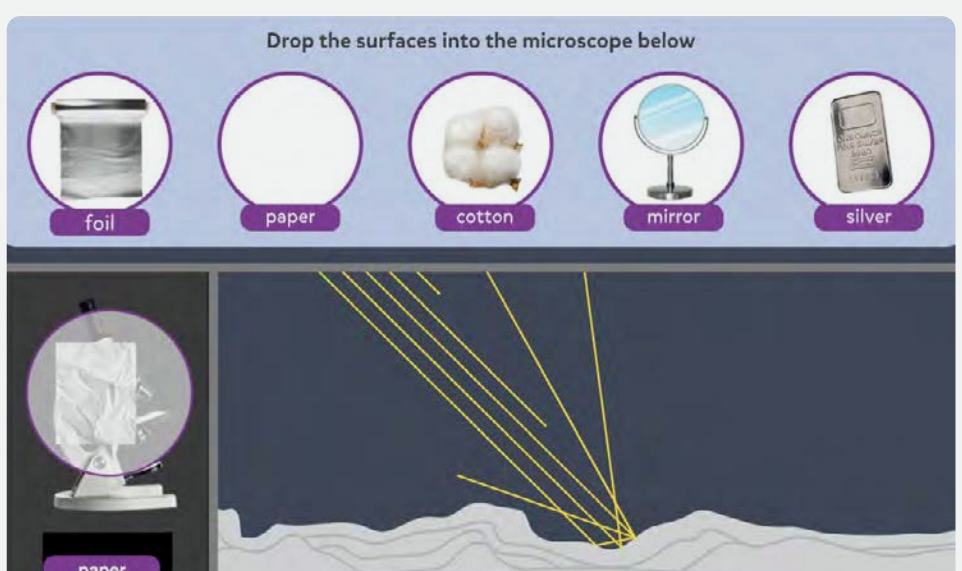
Visual representations

Lessons in the Light unit include a number of flow charts and diagrams to help students understand how invisible and visible light interacts with objects. Encourage students to draw on these visual representations and actively interpret the information they contain.

Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

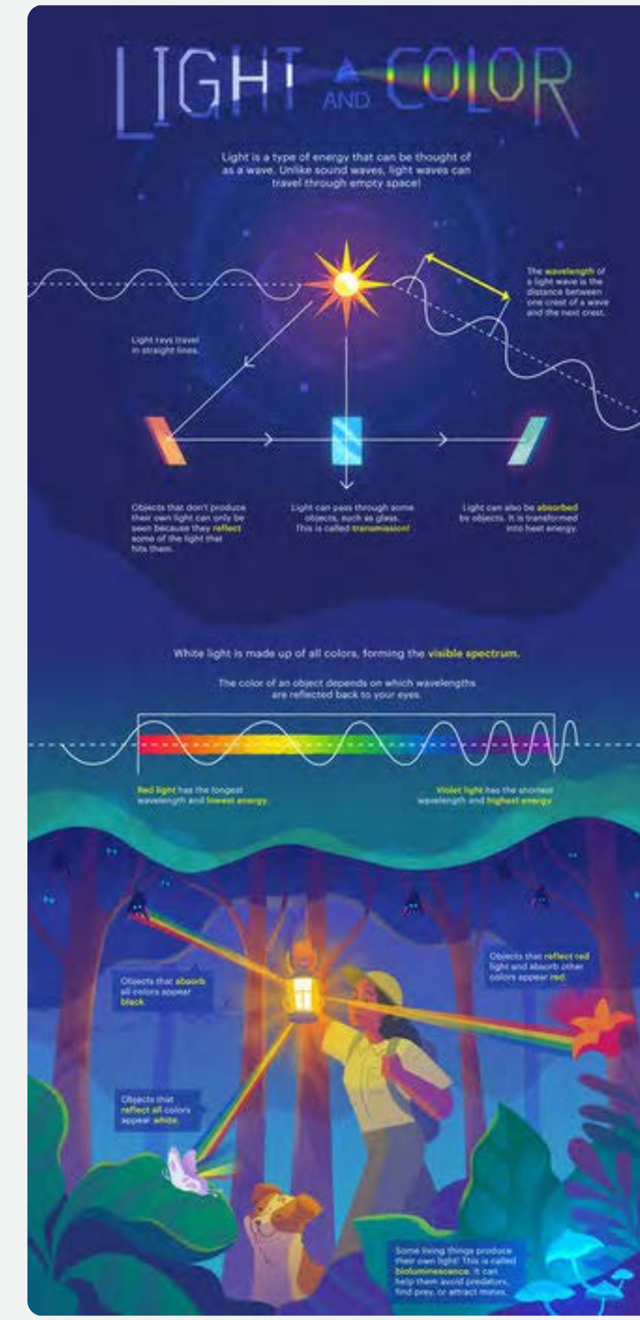
2.1 Lesson: Reflection

This digital model allows students to observe how light interacts with many objects. By showing the light rays that are emitted and their reflection, students can visualize the invisible phenomenon that has been described through language earlier in the lessons.



1.2 Lesson: The interaction of light with objects

The key ideas within the unit are summarized in an infographic for a visual demonstration as well as in written form. Each of the visual elements is carefully considered to communicate specific ideas and is combined with short sections of text to elaborate on these in a way that combines language and imagery to support understanding.

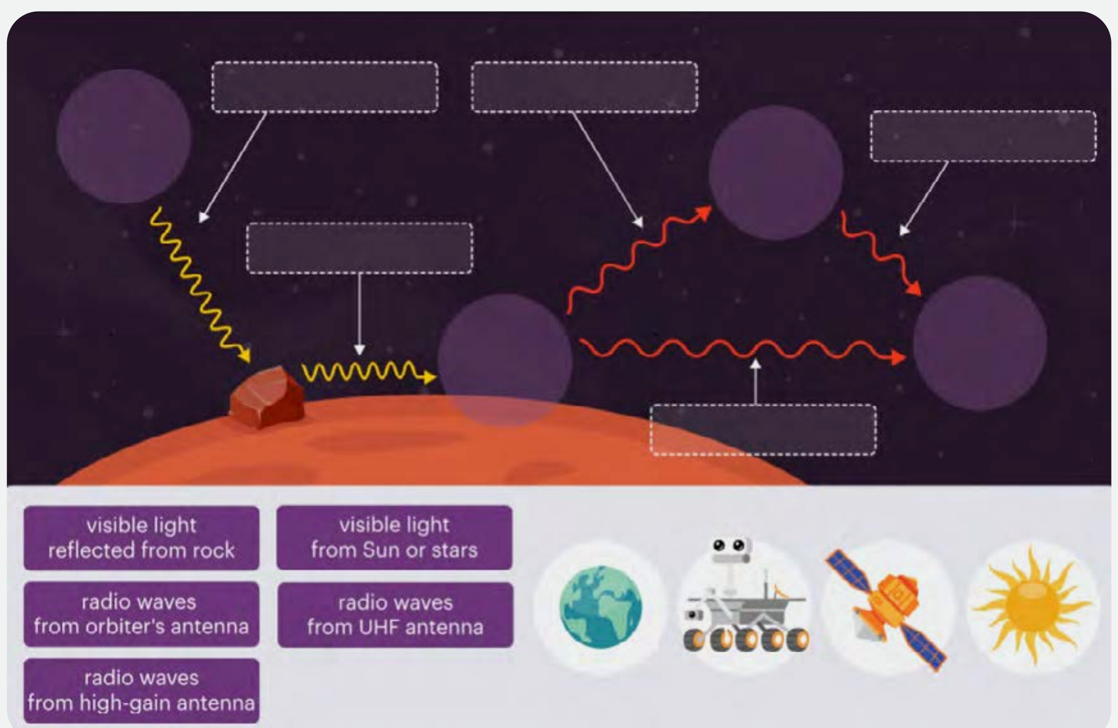


Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.5 Lesson: Communicating using the electromagnetic spectrum

This interactive question helps students summarize the complex order of processes in a way that combines visual representation of ideas alongside short phrases that include key terminology. This activity supports students in communicating their knowledge by providing pre-written labels. It also allows them to further develop their understanding of the connection between visual elements and scientific vocabulary.



Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Summative assessment

Test
This unit contains a test to provide summative assessment of student learning across the whole unit.

- **Test: Light**
  Multiple choice and short answer: 20–30 minutes

Science and Engineering Practices
One lab activity within the unit can be used as a summative assessment of Science and Engineering Practices, along with questions from two specific lessons. These questions require in-depth problem-solving using Science and Engineering Practices.

- **1.3 Lab activity: Properties of bubbles**
  Lab activity: 45 minutes
- **1.2 Lesson: The interaction of light with objects**
  Challenge Question: Question 14–20 minutes
- **1.5 Lesson: Communicating with electromagnetic radiation**
  Key Question: Question 16–20 minutes

Lab Activities

Activity purpose: Examine the properties of bubbles.

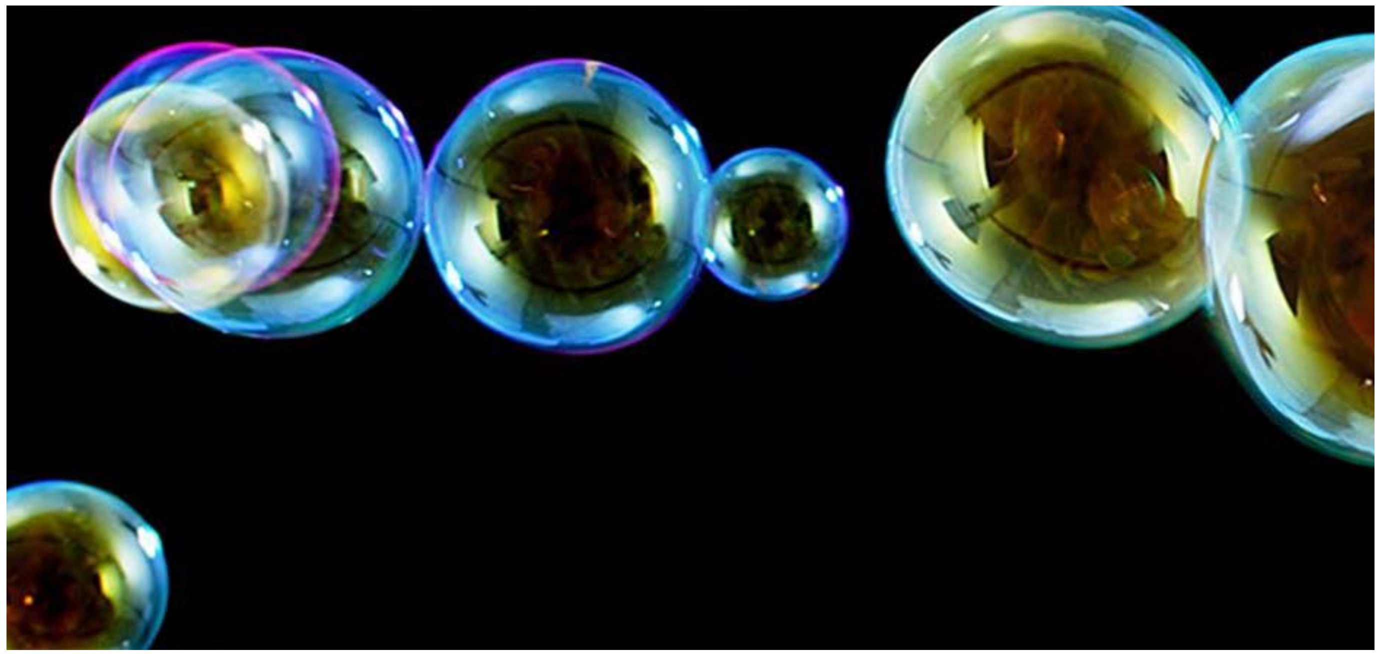
stileapp.com/go/bubbles

45–60 minutes

3–4 students per group

Lab Activity

Properties of bubbles



Materials

Lab Equipment
Per group:
- 1.2 L water bottle or soft drink bottle
- 2 straws
- 1.5 m piece of string
- plastic tray or container
- device for taking photos (optional)
- 200 mL measuring cylinder
- 50 mL measuring cylinder

For class to share:
- electronic mass balances

Chemicals
Per group:
- 200 mL concentrated pure soap liquid
- 50 mL glycerine
- 1 L water

Preparation

The bubble mixture can be made ahead of time to reduce the class time required to complete this activity (see Part 1 below).

Allow time to purchase supplies as these quantities are not normally kept on hand. The glycerine and detergent will probably be best purchased in bulk bottles, along with measuring jugs to dispense.

Notes

None

Method

PART 1: Making your bubble mixture
- Simply mix the water, soap liquid, and glycerine in the soft drink bottle. Shake the mixture well then let it settles (for the best mixture let the mixture sit for 24 hours).

PART 2: Making your bubble wand
- Cut a piece of string to about 1.5 m in length. Thread the string through both straws and tie it off.

PART 3: Make your bubbles
- Go to an open, outdoor space with little to no wind. Pour your bubble mixture into your plastic tray or container. Dip your bubble wand into your bubble mixture. Wave the wand or use the breeze and watch the bubble form before your eyes.

* Try to make a bubble as big as possible.
* Try to make a bubble last as long as possible.

Unit 8 – Elements and Compounds

What happens if the world runs out of helium?

Sulfur deposits
The element sulfur often forms bright yellow deposits around volcanic vents and hot springs.

Storyline and anchoring phenomenon

Students follow the path of the first chemists to observe the behavior of elements and compounds to find common properties.

Students discover that mixtures of compounds create different flavor profiles and that predicting how individual elements behave or how combinations of elements will interact in food is a real job!

Students identify patterns and consider cause and effect as they investigate how the elements are arranged within the periodic table.

They build on this understanding using an interactive reactor model to make molecules and lattices. Students apply mathematical skills to explore ratios between the elements of a compound, and compare and contrast elements, compounds, and mixtures.

The unit concludes with a "Science and society" lesson, which offers students an opportunity to apply critical thinking and knowledge of elements and compounds to a new context. In this lesson, they must consider the problematic compound that is plastic, and the impact that it has on the environment.

After formulating and describing ways in which science could help us solve the problem of plastic pollution, students must decide whether we need plastic after all.

This unit at a glance

Elements and Compounds

Introduction: A precious gas
Career profile: Flavor chemist

1.1 Lesson: Elements
1.1 Quiz: Elements

2.1 Lesson: The periodic table
2.1 Quiz: The periodic table
2.2 Project: Build a periodic table

3.1 Lesson: Compounds
3.1 Quiz: Compounds
3.2 Investigation: Burning magnesium

Science and society: Do we need plastics?
Glossary: Elements and compounds
Test: Elements and compounds

Students engage with the **phenomenon** of flavor with chemist, Joe Peragine.

Students use Crosscutting Concepts to examine **patterns of elemental properties**.

Students apply **collaborative problem-solving** to construct their own solution for ordering the elements.

Students **explore** the formation of compounds by **planning and carrying out an investigation**.

Students **engage in argument from evidence** to evaluate the role of single-use plastics in society.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress towards the performance expectations listed below:

MS-PS1-1

Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS1-2

Analyze and interpret data on the properties of substances before and after the substances interact to determine if a chemical reaction has occurred.

MS-PS1-3

Gather and make sense of information to describe that synthetic materials come from natural resources and impact society.

MS-PS1-5

Develop and use a model to describe how the total number of atoms does not change in a chemical reaction and thus mass is conserved.

MS-PS1-6

Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

Disciplinary Core Ideas

- **PS1.A:** Structure and Properties of Matter
- **PS1.B:** Chemical Reactions

Students investigate the structure of individual elements in their pure form.

They observe their characteristics and how they can be arranged to make compounds. Students learn that the properties of chemicals determine how they react and are introduced to the relationship between products created in chemical reactions.

Science and Engineering Practice

- Developing and Using Models

Students use and develop models to visualize chemical reactions at the molecular level.

They use these models to infer how compounds change as they go through chemical reactions.

Crosscutting Concept

- Energy and Matter
- Patterns

Students connect the conservation of matter to the conservation of atoms in physical and chemical processes.

Nature of Science

- Scientific Knowledge is Based on Empirical Evidence

Science, Technology, Society and the Environment

- Influence of Engineering, Technology, and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

Students build on their prior knowledge that matter is subdivided into particles that are too small to see. They examine models of different substances at the particle level to learn that substances are made from different types of atoms.

By reviewing additional models, they recognize that these atoms combine with one another in various ways. Students recognize that atoms form molecules of different sizes as they interpret elemental symbols to identify particle arrangement.

Science and Engineering Practices

Students extend their understanding that various properties can be used to classify a substance as they discover how pure substances have physical and chemical properties that can be used to identify it.

They classify familiar elements by their state, color, and reflectance to recognize some of these properties. Students already know that substances can combine to create a new substance which may have different properties. By completing an investigation about burning magnesium, they are able to link that this is due to the atoms of the original substances regrouping into molecules with different properties.

This investigation also furthers their existing knowledge about conservation of mass by integrating the idea that the total number of each atom is conserved. This is also an extension of prior knowledge of the Crosscutting Concept, Energy and Matter.

Crosscutting Concepts

Students build on their experience with using models to predict and describe phenomena. They use and develop models throughout the unit and interact with a digital model that lets them visualize chemical reactions at the molecular level. They predict how compounds change as they go through these reactions.

Students also use the periodic table as a model of the properties of elements to identify the properties that an element will have based on its location.

Bright-burning sparklers
The bright white glow of sparklers and other fireworks is caused by burning magnesium.

How to use the Lesson Planning Guide

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What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

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Focus CCC
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Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 Week 2 Week 3

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: A precious gas Career profile: Flavor chemist	Where in the world is helium?	Review teaching notes in Prepare Mode	Developing and Using Models	**PS1.A** Structure and Properties of Matter	Energy and Matter	Assign Stile X app: Flashcards	Article linked in lesson, *Cosmos Magazine*, "Vast new reserves of helium discovered"
Lesson 2	1.1 Lesson: Elements	What metal melts in your hand?	Review teaching notes in Prepare Mode	Developing and Using Models	**PS1.A** Structure and Properties of Matter	Energy and Matter	Assign Stile X app: Elements video Assign Stile X Review notes: Elements	1.1 Quiz: Elements
Lesson 3	2.1 Lesson: The periodic table	Can the class build a full periodic table?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**PS1.A** Structure and Properties of Matter	Energy and Matter	Assign Stile X app: The periodic table video Assign Stile X Review notes: The periodic table	2.1 Quiz: The periodic table
Lesson 4	2.2 Project: Build a periodic table	What can the periodic table tell us?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Print and cut out class set of periodic table element templates	Developing and Using Models	**PS1.A** Structure and Properties of Matter	Energy and Matter	Assign Stile X app: Flashcards	Extra SEP support: 5.3 Creative thinking Poster: Periodic Table. Posters are available in the Stile Shop

Lesson Planning Guide

Week 1 · Week 2 · Week 3

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	3.1 Lesson: Compounds	What are compounds and which compound is the largest?	Review teaching notes in Prepare Mode	Developing and Using Models	**PS1.A** Structure and Properties of Matter	Energy and Matter	Assign Stile X app: Compounds video Assign Stile X Review notes: Compounds Ask students to pre-read 3.2 Investigation: Burning magnesium	Stile X Flashcards
Lesson 6	3.2 Investigation: Burning magnesium	What compound forms when magnesium burns?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Developing and Using Models	**PS1.B** Chemical Reactions	Energy and Matter	Ensure students get up to documenting their results	Stile X Flashcards Stile X Flash Quiz
Lesson 7			Review student progress from the last lesson in Analyze Mode				Assign Stile X app: Flashcards Assign Stile X app: Flash Quiz	Extra SEP support: 0.1 Conducting science investigations
Lesson 8	Unit review Glossary: Elements and compounds	How can I be prepared for the Elements and Compounds test?	Review Key Questions from the unit in Analyze Mode to identify areas to revisit	Developing and Using Models	**PS1.A** Structure and Properties of Matter **PS1.B** Chemical Reactions	Energy and Matter	Ask students to review teacher feedback from lessons in the unit Assign Stile X Test preparation: Elements and compounds	Stile X app: Flashcards Stile X app: Flash Quiz Stile X Glossary

Lesson Planning Guide

Week 1 · Week 2 · Week 3

The guide below is based on three 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	Test: Elements and compounds	How much have I learned about Elements and Compounds?	Organize appropriate seating arrangements for the test	Developing and Using Models	**PS1.A** Structure and Properties of Matter **PS1.B** Chemical Reactions	Energy and Matter		
Lesson 10	Science and society: Do we need plastics?	Should we ban use single-use plastics?	Complete grading of test ahead of test review session Review teaching notes in Prepare Mode	Engaging in Argument From Evidence	**PS1.A** Structure and Properties of Matter	Energy and Matter		Article linked in lesson, *Cosmos Magazine*, "Edible plastic food wrappers"
Lesson 11	Test review	How successful was my revision of Elements and Compounds?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Developing and Using Models	**PS1.A** Structure and Properties of Matter **PS1.B** Chemical Reactions	Energy and Matter	Assign Stile X Reflection Ask students to reflect on the effectiveness of their revision and to identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Students use numerical data to identify patterns between the melting points of elements. They also recognize patterns in the periodic table that show how elements have similar properties. Students use ratios to observe fixed proportions in compounds.

Common Core State Standards Connections: Math

MP.2

Reason abstractly and quantitatively.

MP.4

Model with mathematics.

6.RP.A.3

Use ratio and rate reasoning to solve real-world and mathematical problems.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Students follow procedures to observe phenomena within the unit. They use comprehension strategies from text, diagrams, and models to answer questions and create definitions in their own words.

Common Core State Standards Connections: English Language Arts

RST.6-8.3

Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flow chart, diagram, model, graph, or table).

WHST.6-8.8

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Introduction: A precious gas**
  Questions 2, 3
- **Career profile: Flavor chemist**
  Questions 2, 3
- **1.1 Lesson: Elements**
  Questions 7, 16
- **2.1 Lesson: The periodic table**
  Questions 14, 18, 27
- **3.1 Lesson: Compounds**
  Questions 6, 17
- **3.2 Investigation: Burning magnesium**
  Questions 1, 6, 10, 11, 12

Gallium is a metal that melts in your hand!
Gallium has a surprisingly low melting point of 86 degrees Fahrenheit. Chemists use it to play practical jokes on guests. For example, they make gallium forks that appear just like ordinary forks… until the guests try to eat with them.

ELL support

To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

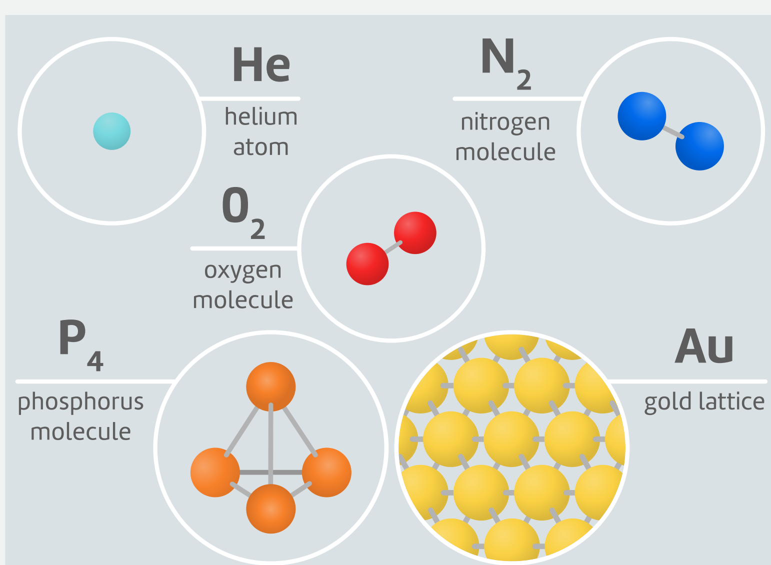
Visual representations

Elements and Compounds lessons include a number of flow charts and diagrams to help students understand the structure and properties of matter and chemical reactions. Encourage students to draw on these visual representations, and to actively interpret the information they contain.

Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

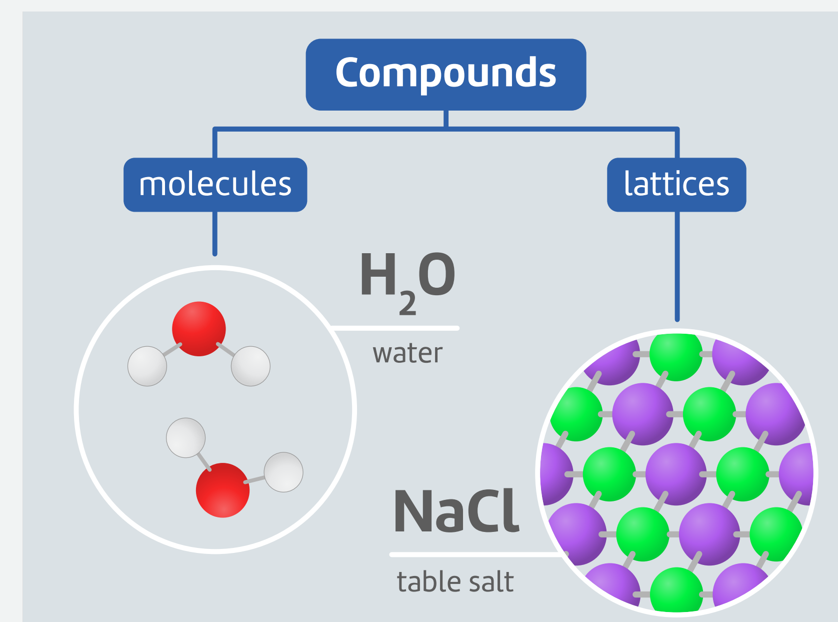
2.1 Lesson: The periodic table

Students can see the chemical formulas of some elements as simplified 3D models in this image. These visual representations support students to decode the same information provided in written language within the lesson.



3.1 Lesson: Compounds

The content-specific language from this lesson is reiterated with images that help to explain the worded definition. Students can connect the visual representation of the terminology with the description provided in the text.



Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.1 Lesson: Elements

Students revisit the properties of elements by matching them to terms that describe their state, color, and reflectance. The use of single-word labels helps students to connect the meaning of these words to their image.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes
Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5–10 minutes. Quizzes provide students and teachers with information about student progress toward specific learning goals.

- **1.1 Quiz: Elements**
  Multiple choice and written response: 5–10 minutes
- **2.1 Quiz: The periodic table**
  Multiple choice and written response: 5–10 minutes
- **3.1 Quiz: Compounds**
  Multiple choice and written response: 5–10 minutes

Summative assessment

Test
This unit contains a test to provide a summative assessment of student learning across the whole unit.

- **Test: Elements and compounds**
  Multiple choice and short answer: 45–60 minutes

Science and Engineering Practices
One investigation within the unit can be used as a summative assessment of Science and Engineering Practices.

- **3.2 Investigation: Burning magnesium**
  Lab activity: 45–60 minutes

Lab Activities

Lab Activity

Burning magnesium

Activity purpose: Measure the change in mass when magnesium burns in air and determine which compound is produced.

stileapp.com/go/magnesium

45–60 minutes

2+ students per group

Materials

Lab Equipment
Each group of students will need:
- 0.001 g electronic mass balance
- matches or gas lighter
- crucible with lid
- heat-resistant mat
- metal tongs
- tripod
- clay triangle
- Bunsen burner
- sandpaper or steel wool (to clean the magnesium ribbon)

Chemicals
- 15–20 cm magnesium ribbon

Preparation

None required

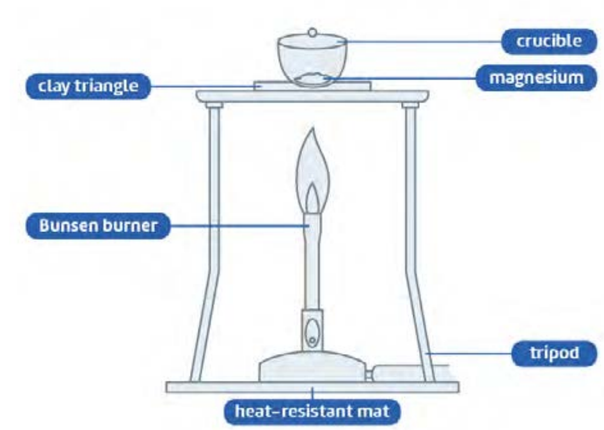
Notes

Students must wear safety glasses at all times.

Collect all crucibles and their contents at the conclusion of the lesson for correct disposal.

Method

Method that students will follow
1. Set up the equipment as in the diagram below.
2. If the magnesium strip is dull or black then clean it using the sandpaper or steel wool. Loosely wrap around finger to create a small coil, small enough to fit inside the crucible.
3. Use the 0.001 g balance to weigh the empty crucible and lid. Record the mass of the crucible and lid.
4. Place the strip in the crucible, add the lid, and reweigh. Record the weight of the crucible + lid + magnesium strip.
5. Light the Bunsen burner and heat the crucible with a gentle blue flame.
6. As the crucible heats up, fully open the air hole on the burner to produce a roaring blue flame. Gently lift the lid with the tongs to allow some oxygen to get in. Don't leave the lid off for too long or some of the product might escape.
7. Continue heating the crucible and regularly lift the lid until you observe no further change. Allow the crucible to heat for a few minutes after reaction is complete, prior to removing from flame.
8. Turn off the Bunsen burner and allow to cool. Record the weight of the crucible + lid + contents.



Optional Extra – Student Research Project

How can I create my own scientific research project?

Identifying variables
Students learn about different types of variables using an experiment about plant growth as an example.

Storyline and anchoring phenomenon

This unit will build students' skills in using the scientific method, all the way from researching and referencing to writing a conclusion of their findings. Each lesson scaffolds a different stage of the investigation process, providing helpful pro-tips and opportunities for students to develop their scientific inquiry skills.

Students are guided step by step through a research project of their choosing, where they will analyze research, plan a testable question, develop a hypothesis, and create a method to test it. They'll analyze their results and, most importantly, communicate their findings. Scaffolding throughout the process will set their engineering practices in good stead for the remainder of middle school. This two-week project is supported with specific skill builder lessons, which enable students to view every step of the process in isolation and build core skills at their own pace. In the final presentation, students will demonstrate all the skills they have learned through the unit, which will set them up for exploring and testing scientifically for the remainder of their schooling.

This unit at a glance

Student Research Project

1.1 Skill builder: Planning – Research
1.2 Skill builder: Planning – Question
1.3 Skill builder: Planning – Hypothesis
1.4 Skill builder: Planning – Method and materials
1.5 Skill builder: Conducting – Results
1.6 Skill builder: Communicating – Analyzing and evaluating

2.1 Template: Student research project

Students identify variables and **write testable questions**.

Using Visible Thinking Routines, students connect, extend, and challenge ideas around how best to **plan a scientific investigation**.

Explicit videos scaffold the process of **analyzing data** and generating graphs in Excel.

A customizable template is provided that can be **adapted** to relevant DCIs, depending on each student's project.

Optional Extra

This unit is an optional extra and is not required for coverage of the NGSS, but provides students with opportunities to further engage with science investigations and collaborative learning through group work.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Nature of Science

- Scientific Investigations Use a Variety of Methods

Disciplinary Core Idea

Students engage in SEP learning as core in this unit, but will select their own DCIs to investigate.

Science and Engineering Practices

- Analyzing and Interpreting Data
- Planning and Carrying Out Investigations
- Using Mathematical and Computational Thinking

Students engage in the full scientific process beginning with planning and carrying out investigations.

Once students have a method and testable question, they gather, analyze and interpret data using mathematical and computational thinking to draw conclusions and communicate their findings.

Qualitative and quantitative data
Students learn the distinction between qualitative and quantitative data. Qualitative observations of ice cream include its color and texture, whereas quantitative observations are its temperature and volume.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 Week 2

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	1.1 Skill builder: Planning – Research 2.1 Template: Student Research Project	How do I conduct a scientific investigation?	Review teaching notes in Prepare Mode Teach skill builder before students complete the Research section of their own project	Asking Questions and Defining Solutions Planning and Carrying Out Investigations		Students can engage in assessing an online resource using the CRAAP test linked in the teaching notes	Extra SEP support: 6.2 Critical thinking
Lesson 2	1.2 Skill builder: Planning – Question 2.1 Template: Student Research Project	How can I make sure I'm testing what I want to test?	Review Key Questions from 1.1 Skill builder: Planning – Research in Analyze Mode Review teaching notes in Prepare Mode Teach skill builder before students complete the Question section of their own project	Asking Questions and Defining Solutions Planning and Carrying Out Investigations			Article linked in teaching notes, *Explorable*, "Falsifiability"
Lesson 3	1.3 Skill builder: Planning – Hypothesis 2.1 Template: Student Research Project	How can I make an educated guess before I test it?	Review Key Questions from 1.2 Skill builder: Planning – Question in Analyze Mode Review teaching notes in Prepare Mode Teach skill builder before students complete the Hypothesis section of their own project	Asking Questions and Defining Solutions Planning and Carrying Out Investigations			Extra SEP support: 2.4 Controlled variables (Part 1) Extra SEP support: 2.5 Controlled variables (Part 2)
Lesson 4	1.4 Skill builder: Planning – Method and materials 2.1 Template: Student Research Project	How can I create a method to test my hypothesis?	Review Key Questions from 1.3 Skill builder: Planning – Hypothesis Review teaching notes in Prepare Mode Teach skill builder before students complete the Method and materials section of their own project	Asking Questions and Defining Solutions Planning and Carrying Out Investigations			Extra SEP support: 2.6 Method and materials Extra SEP support: 5.1 Validity and reliability

Lesson Planning Guide

Week 1 Week 2

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.5 Skill builder: Conducting – Results 2.1 Template: Student Research Project	How can I gather data to demonstrate my findings?	Review Key Questions from 1.4 Skill builder: Planning – Method and materials Review teaching notes in Prepare Mode Teach skill builder before students complete the Results section of their own project	Analyzing and Interpreting Data Asking Questions and Defining Solutions Planning and Carrying Out Investigations	Patterns	Ask students to finish questions 1–10	Extra SEP support lessons: 3.1 Types of data, 4.1 Mean, median, and mode (Part 1), 4.1 Mean, median, and mode (Part 2)
Lesson 6						Ask students to finish questions 11–18	Extra SEP support lessons: 3.2 Identifying errors, 3.3 Minimizing random errors, 3.4 Minimizing systematic errors
Lesson 7	1.6 Skill builder Communicating – Analyzing and evaluating 2.1 Template: Student Research Project	How can I evaluate the data that I have gathered?	Review Key Questions from 1.5 Skill builder: Conducting – Results Students will need access to Excel or similar graphing software Review teaching notes in Prepare Mode Teach skill builder before students complete the Communicating section of their own project	Analyzing and Interpreting Data Asking Questions and Defining Solutions	Patterns	Students should complete questions 1–9	Extra SEP support lessons: 3.5 Reading line graphs, 3.6: Selecting data in spreadsheets
Lesson 8						Students should complete the remainder of the template including the analysis of errors	Extra SEP support lessons: 3.8 Analyzing data to test a hypothesis

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical skills.

As students complete their student research project they make measurements using scientific equipment, learn the importance of accurate measurements, and analyze results in a number of different types of graphs. In the science investigation, they explore independent and dependent variables and their relationship.

Common Core State Standards Connections: Math

6.SP.B.4

Display numerical data in plots on a number line, including dot plots, histograms, and box plots.

6.EE.C.9

Use variables to represent two quantities in a real-world problem that change in relationship to one another; write an equation to express one quantity, thought of as the dependent variable, in terms of the other quantity, thought of as the independent variable.

Analyze the relationship between the dependent and independent variables using graphs and tables, and relate these to the equation. For example, in a problem involving motion at constant speed, list and graph ordered pairs of distances and times, and write the equation $d = 65t$ to represent the relationship between distance and time.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Lessons within this unit incorporate many opportunities for students to develop and use their reading, writing, listening, and speaking skills.

Throughout this unit they demonstrate their understanding of the conventions of English through a range of written tasks. They collaborate and demonstrate their speaking skills through one-on-one, group and teacher-led conversations centered around science and they interpret information, for example, fake news articles, photographs, and flow charts.

Common Core State Standards Connections: English Language Arts

SL.6.1

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 6 topics, texts, and issues, building on others' ideas and expressing their own clearly.

SL.6.2

Interpret information presented in diverse media and formats (e.g., visually, quantitatively, orally) and explain how it contributes to a topic, text, or issue under study.

L.6.2

Demonstrate command of the conventions of standard English capitalization, punctuation, and spelling when writing.

L.6.6

Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases; gather vocabulary knowledge when considering a word or phrase important to comprehension or expression.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions, and how to replace question types in The Stile Guide.

Note that not *all* written response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **1.1 Skill builder: Planning – Research**
  Questions 7, 8
- **1.2 Skill builder: Planning – Question**
  Questions 2, 8, 12, 13
- **1.3 Skill builder: Planning – Hypothesis**
  Questions 4, 13, 16
- **1.4 Skill builder: Planning – Method and materials**
  Questions 5, 7, 9, 11, 15, 16
- **1.5 Skill builder: Conducting – Results**
  Questions 13, 17
- **1.6 Skill builder: Communicating – Analyzing and evaluating**
  Questions 9, 11, 16
- **2.1 Template: Student research project**
  Question 16, 17, 18, 19, 20, 22

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
1.5 Skill builder: Conducting – Results	Line graphs are best used when two variables are connected or the rate of change between two individual data points is important. Students commonly join the dots of scatter plots to make them line graphs.	To avoid confusion, we have suggested line graphs be used when a continuous variable is plotted against time. When the variables are not connected, we suggest using a scatter plot. Here, students should not join the dots but instead add a line of best fit.

ELL support

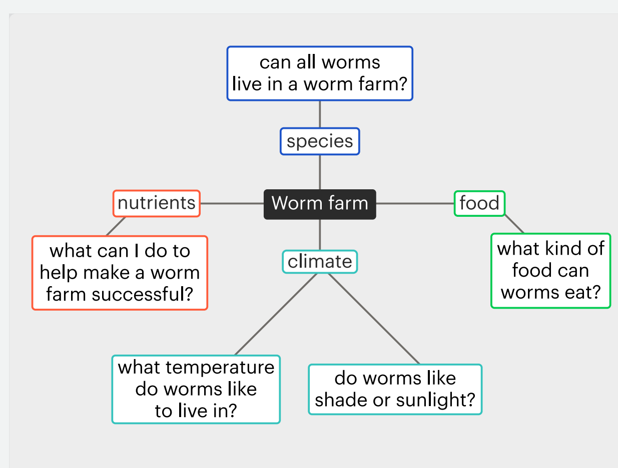
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

The lessons include a number of flow charts and diagrams to help students understand the scientific research process. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

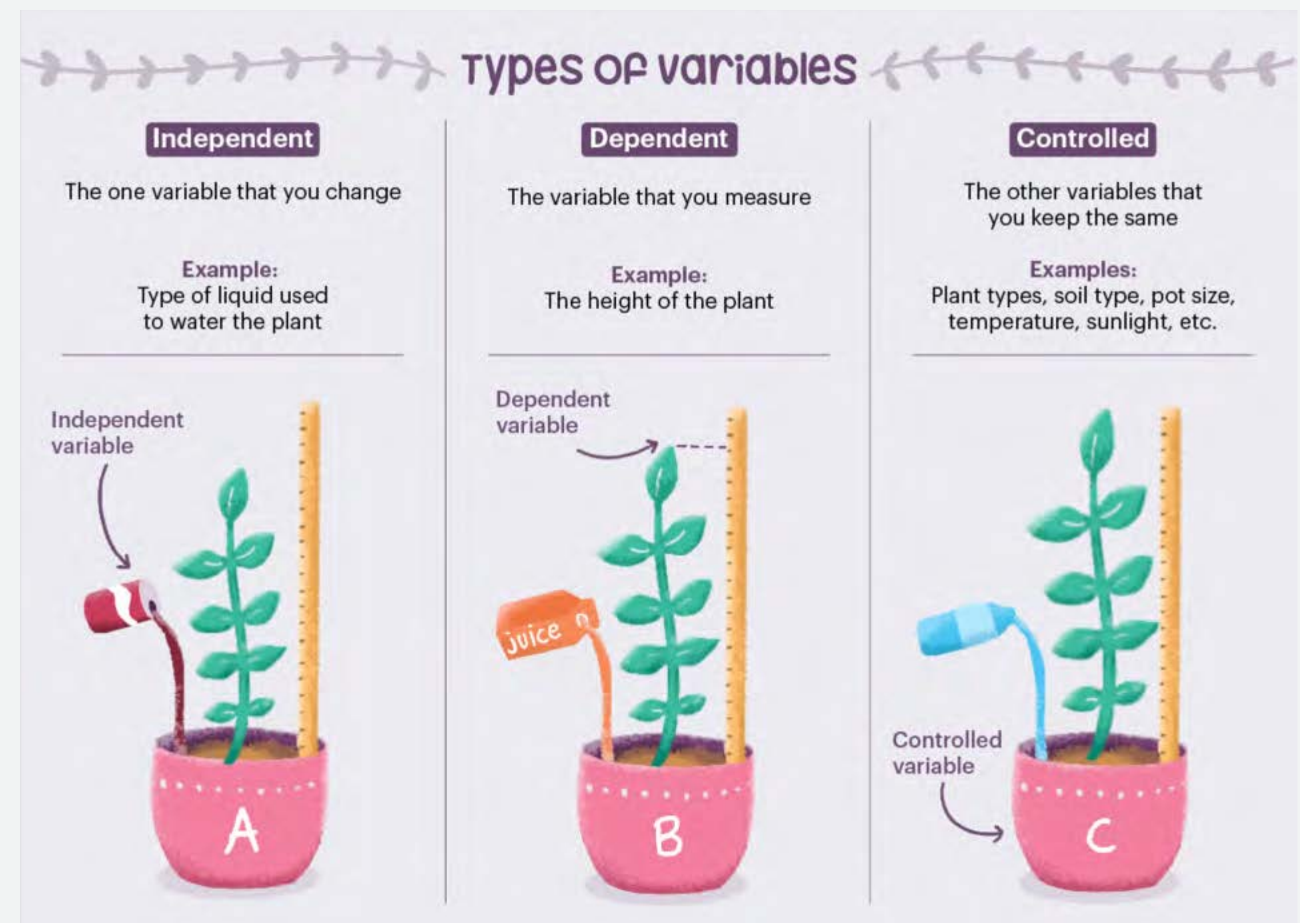
1.1 Skill builder: Planning – Research

Mind mapping is a way for students to use key vocabulary and connect ideas without having to worry about the syntax of lists in large paragraphs.



1.2 Skill builder: Planning – Question

This infographic defines the three types of variables, and provides written examples along with a contextualized example in the form of an illustration. Seeing the name of the variable, definition, examples, and illustration alongside one another supports students to make associations between visual and verbal forms of information which assists with comprehension.

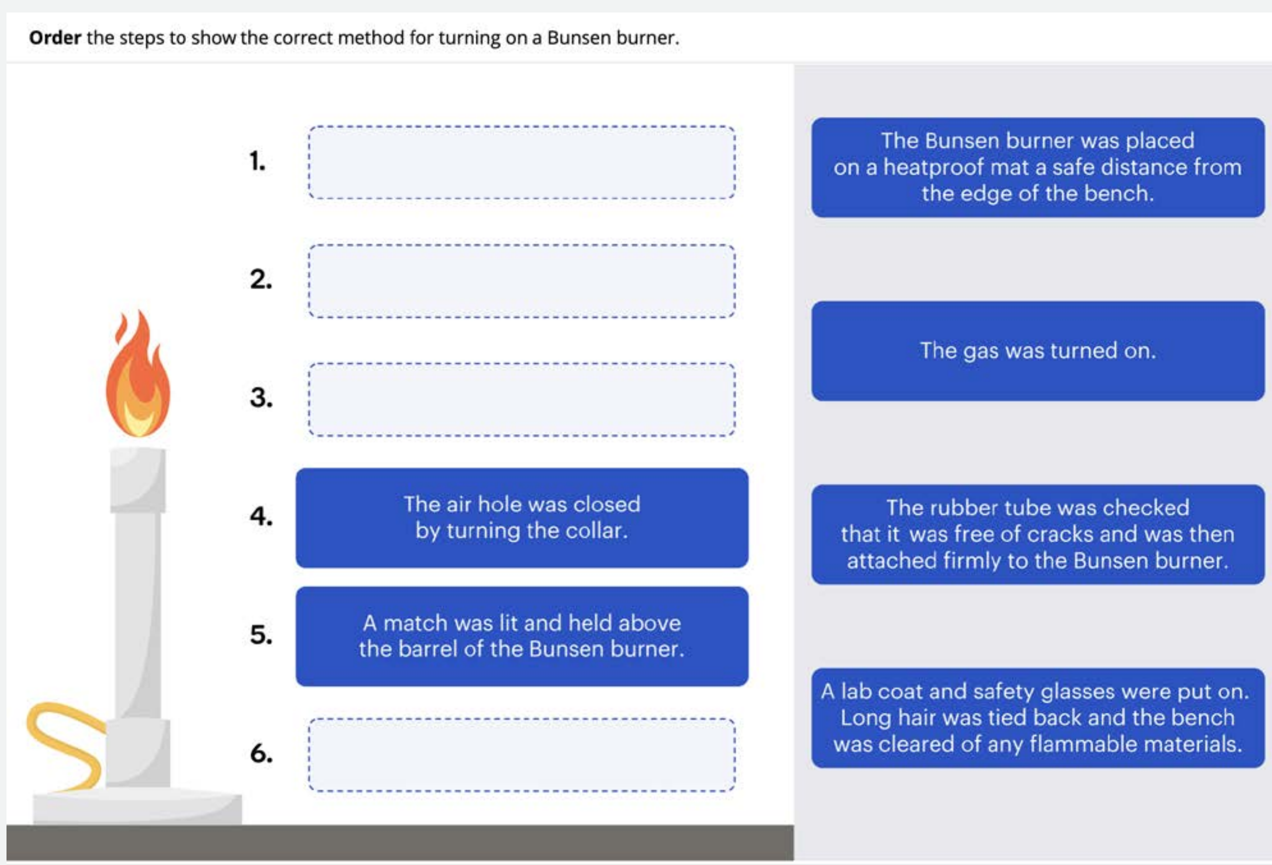


Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.4 Skill builder: Planning – Method and materials

The ability to drag complex sentences into order encourages comprehension and reinforces key parts of the scientific method and considerations for safety.



Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Summative assessment

Students apply Science and Engineering Practices and Crosscutting Concepts as they complete their research project. Their completed research project is a summative assessment of their learning for this unit.

Hands-on labs in Stile

Units in Stile have hands-on labs integrated throughout. Listed below are each of the units in Grade 6 of The Stile Curriculum and the materials required for one group of students to complete the labs within that unit.

Introduction to Science

Observing and inferring

- 1 item that will either produce a scent, squeak, or make a noise when shaken, such as
- balloon filled with marbles
- balloon filled with a squirt of aerosol deodorant or body spray
- squeezable pet toy that squeaks or has a bell inside
- blindfold

Observing and inferring

- meter ruler
- cotton balls
- 3 thermometers
- 100 mL beaker labeled “ice”
- 100 mL beaker labele” ‘hot”
- ice cubes
- hot water (boiled from a kettle)
- 250 mL measuring jug (for transporting hot water)
- felt-tip marker

Measuring

- 3 x 100 mL beakers
- test tube rack
- 6 x 30 mL test tubes or boiling tubes
- 3 mL plastic transfer pipette
- 10 mL measuring cylinder
- 25 mL measuring cylinder
- felt-tip marker

Using data
- 30 cm clear plastic ruler
- 0.01 g electronic mass balance
- device to take photos
- calculator

Food Chains and Food Webs

Modeling a food web

- Ball of wool
- Food web cards

Cells

Using a microscope

- microscopes
- flat microscope slide (for newspaper, wool, string, etc.)
- 2 x concave microscope slide (for sugar, salt, seeds)
- sticky tape
- 1 cm^2 squares of printed text containing the letter “e”
- small chattaway spatula
- tip of a small chattaway spatula of table salt
- tip of a small chattaway spatula of white sugar
  Optional:
- a range of small objects to observe, e.g. sand, glitter, different fabric swatches, wool, string, pipe cleaners, tiny seeds, surfaces with interesting textures (provide just a few options to limit student choice if timing is an issue)
- a microscope camera to project microscope images for the whole class to see

Measuring with microscopes

- compound light microscopes
- 4 concave microscope slides
- small beakers or cupcake liners (to carry seeds)
- transparent metric rulers (without sloped or beveled edges)
- tweezers (to transfer seeds from the beaker)
- variety of small seeds

Make a cell model

- light microscopes
- pre-prepared slide sets:
  - slide 1, labeled “Meat sample” and containing animal cells (we recommend cheek cells)
  - slide 2, labeled “Plant sample” and containing plant cells (preferably containing chloroplasts so they can easily be recognized as plant cells)
  - note: Leaf epidermis cells are not ideal for this activity because they tend to lack chloroplasts.
  - slide 3, labeled “Sample X” and containing plant cells (similar to Slide 2 and preferably containing chloroplasts)

Make a cell model

- To be determined by students.
  If this lesson is being completed in the classroom (rather than as a homework assignment), assorted materials will need to be provided for students to create their models. These may include craft materials, household items, food items, stationery, etc. Students could also be encouraged to gather their own materials which can be assessed by the teacher as suitable for this task

Our Place in Space

Heat shields

- scissors
- tape
- PVA glue
- rulers
- 2 mini or fun-size chocolate bars without nuts
- wire mesh (e.g. stainless steel gauze mat)
- a selection of materials, such as newspaper, cardboard, cotton wool, bubble wrap, electrical tape, woolen cloth, styrofoam, steel wool
- hair dryer
- 2 tongs
- oven mitts or heat proof gloves
- thermometer
- stopwatch

Modeling day and night

- styrofoam ball, about 10 cm in diameter
- bamboo skewer
- flashlight
- 2 pins (colored head pins and drawing pins work well)
- felt-tip marker

Modeling the Solar System

- 1 exercise ball
- ruler or measuring tape
- pens or markers
- 3 sheets of paper
- 9 flags on sticks
- open space, e.g. a playing field, about 100 m (330 ft) long
- 30 m (100 ft) measuring tape

Our Place in Space (continued)

Modeling sunlight intensity

- flashlight
- cardboard tube
- tape
- 2 large sheets of 1 cm^2 graph paper
- pen or marker
- protractor
- 30 cm ruler

Modeling the phases of the Moon and eclipses

- cardboard tube (e.g. an empty toilet paper roll)
- pair of scissors
- sticky tape
- styrofoam ball the size of a large orange
- ping pong ball
- aluminum foil

Heat

Which material is the best insulator?

- 3 aluminum cans (minimum)
- 3 thermometers (1 per aluminum can)
- scissors
- tape or glue
- different materials: cotton, nylon, wool, polyester, cardboard
- kettle (to dispense hot water)
- stopwatch

Modeling convection currents

- 500 mL beaker
- straw
- tweezers
- beaker
- Bunsen burner
- heatproof mat
- gauze mat
- tripod
- lighter or matches
- gloves
- safety glasses
- large stoppered flasks for waste
- 2 or 3 small pieces of potassium permanganate (small enough to fit through a straw)
- 400 mL cold water

Build a solar oven

- 1 fun-sized chocolate bar (alternatives include marshmallows or cheese)
- cardboard box, such as a shoe or cereal box
- aluminum foil (1 roll for class to share)
- cling wrap (1 roll for class to share)
- colored paper
- a selection of other materials, such as newspaper, styrofoam, black paper, or bubble wrap
- scissors
- tape
- ruler
- paper plate
- thermometer
- PVA glue

Elements and Compounds

Burning magnesium

- 0.001 g electronic mass balance
- matches or gas lighter
- crucible with lid
- heat-resistant mat
- metal tongs
- tripod
- clay triangle
- Bunsen burner
- sandpaper or steel wool (to clean the magnesium ribbon)
- 15–20 cm magnesium ribbon

Light

Properties of bubbles

- 1.2 L water bottle or soft drink bottle
- 2 straws
- 1.5 m piece of string
- plastic tray or container
- device for taking photos (optional)
- 200 mL measuring cylinder
- 50 mL measuring cylinder
- 200 mL concentrated pure soap liquid
- 50 mL glycerine
- 1 L water

Grade

7

Unit 1 – Genetics

How can genes increase the risk of cancer?

Inheriting traits from parents
Children often look similar to their parents with some family resemblances running for generations.

Storyline and anchoring phenomenon

Students engage with the phenomenon of genetic inheritance. They explore how genetics is relevant to them by exploring their own traits and family tree, and create a campaign to raise awareness about a specific type of cancer.

Students' prior knowledge is activated by answering simple true or false questions about genetic traits and inheritance. They participate in a poll that facilitates discussion around the nature of genetic mutations before being introduced to Nobel Prize winners Jennifer Doudna and Emmanuelle Charpentier. By learning about the discovery of gene editing technology by these two biochemists, students go deeper into the phenomenon of mutations and examine data to uncover the issues faced by women who work in STEM. They generate ideas about how to address these issues and design a social media post to bring further awareness to the work of female scientists.

By engaging with the career profile of a genetic counselor, students are urged to find the "why" behind the role genes play in growth and development. A hands-on lab where students extract DNA from strawberries allows them to visualize the usually invisible genetic material.

Students must then connect their learning about DNA to relevent real-world examples like their own family trees and identifiable traits, or those of a fictional family provided. Students are required to solve puzzles, and observe patterns to dissect the phenomenon of genetic backgrounds and the possibilities of genetic traits in offspring.

This unit at a glance

Genetics

Introduction: How can genes increase the risk of cancer?
Science news: The 2020 Nobel Prize for the discovery of CRISPR
Career profile: Genetic counselor

1.1 Lesson: DNA and genes
1.2 Lesson: The genetic code
1.3 Lesson: Mutations
1.4 Lab activity: Extracting DNA

2.1 Lesson: Mitosis
2.2 Project: Cancer cells
2.3 Lesson: Meiosis

3.1 Lesson: Simple inheritance
3.2 Lesson: Punnett squares
3.3 Lesson: Sex-linked inheritance
3.4 Lesson: Pedigrees
3.5 Project: Construct a family tree
3.6 Extension: Codominant inheritance

Glossary: Genetics
Test: Genetics
Test: Simple inheritance
Science news: Genetically modified food

Students engage with **2020's Nobel Prize winners**, who created an enzyme that edits genes with disease risks.

In this lab activity, students will be thrilled to see **the usually invisible proteins** that make us up entirely.

This lesson's **focus on mathematics and computational thinking** shows the process of cell replication.

Students **research** particular types of cancer cells.

Students use **patterns and mathematics** to look at rare genetic conditions.

Students will examine inheritance and **analyze dominant and recessive traits** across family ties.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performanceexpectations

This unit supports progress toward the performance expectations listed below:

MS-LS3-1

Develop and use a model to describe why structural changes to genes (mutations) located on chromosomes may affect proteins and may result in harmful, beneficial, or neutral effects to the structure and function of the organism.

MS-LS3-2

Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

Disciplinary Core Ideas

LS3.A: Inheritance of Traits
LS3.B: Variation of Traits

Students explore the location and pairing of genes, and investigate how traits are linked to these protein sequences.

At the start of the unit, students explore gene mutations in genetic code and their cause. Through modeling of meiosis and mitosis, students build an understanding of the variation between parents and their offspring. They observe the outcome of genetic crosses and find out what causes the display of dominant and recessive traits.

Science and Engineering Practice

Using Mathematics and Computational Thinking

Students look at the occurrence of genetic traits and their frequency across populations.

By analyzing patterns in DNA molecules, they learn what leads to observable traits. When looking at inheritance, they must use recognition of patterns and ratios to deduce relationships.

Crosscutting Concept

Cause and Effect

Students consider the causes of genetic conditions by exploring DNA sequences in organisms.

Students examine how changes in DNA have an effect on offspring. The occurrences of genes within a population are investigated as their effects are seen through family trees and pedigree charts.

Nature of Science

- Scientific Knowledge is Open to Revision in Light of New Evidence
- Science is a Human Endeavor

Science, Technology, Society and the Environment

- Influence of Engineering, Technology, and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

Students build on their knowledge from the Cells and Plants units in Grade 6, where they learned that all living things are made from cells, and that cells work together to form tissues and organs, which are specialized for particular body functions.

Using this foundational understanding of cells, students develop an understanding of how traits are controlled by genetic material within the cells. They also explore how traits are inherited through the division of cells in mitosis and meiosis, and how mutations arise and are inherited.

Science and Engineering Practices

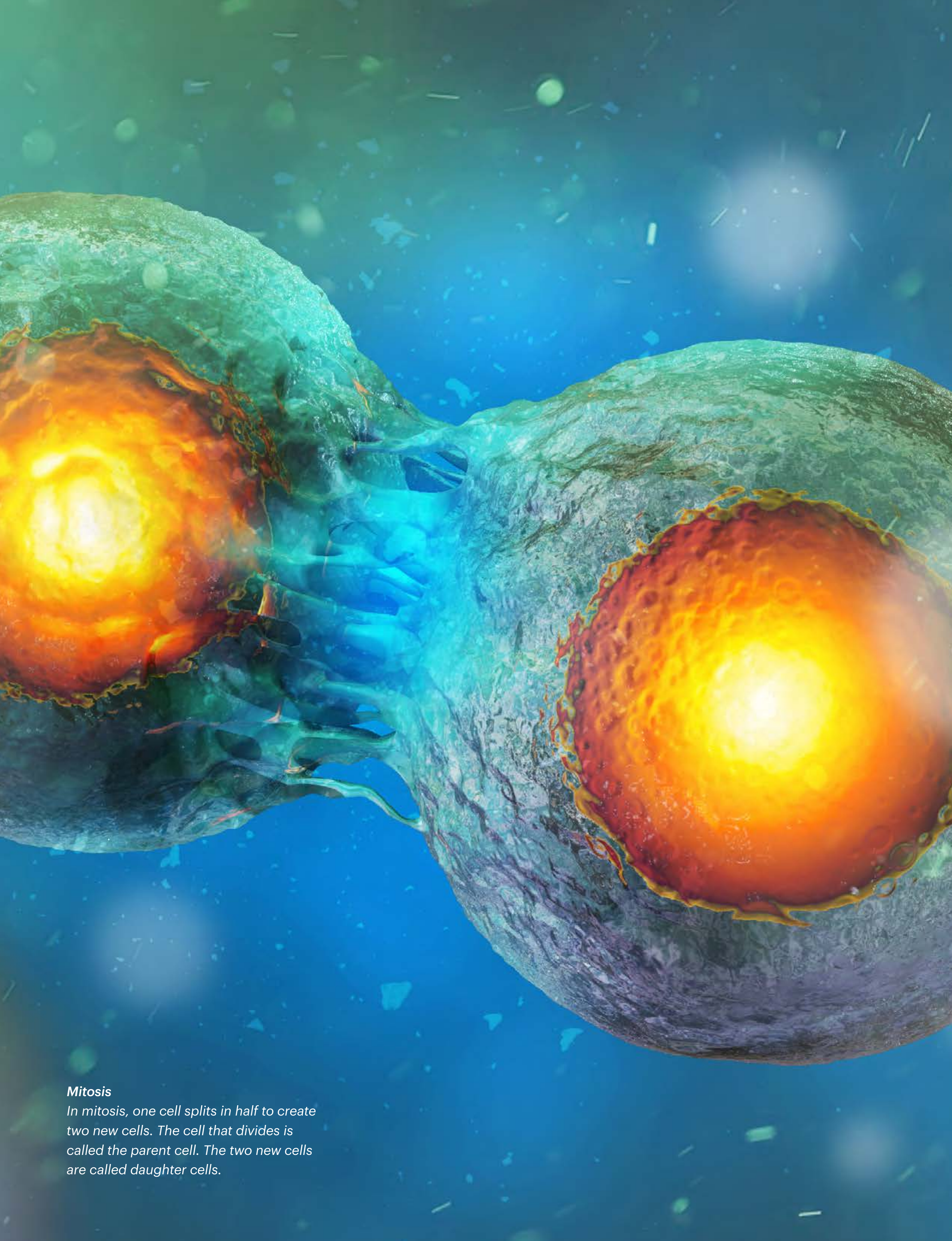
Throughout Grade 6 units, students used mathematical skills within scientific contexts, and to test proposed solutions to engineering and design problems.

In this unit, they will build an understanding of how to calculate ratios by working with the relative number of different phenotypes in Punnett squares.

Crosscutting Concepts

Students considered the concept of cause and effect in The Importance of Biodiversity unit in Grade 6. They examined data that showed a correlation between variables, and were asked to think critically about whether there could be a causal relationship between them. They recognized that in many cases, phenomena may have multiple causes and therefore we can only describe these cause and effect relationships using probability.

In Genetics, these concepts are further explored in the context of genetic material. Specifically, when considering genotype and phenotype, students describe the potential outcomes of genetic crosses using ratios to represent probabilities.



Mitosis
In mitosis, one cell splits in half to create two new cells. The cell that divides is called the parent cell. The two new cells are called daughter cells.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: How can genes increase the risk of cancer? Career Profile: Genetic counselor	How do your parents' genetics influence your traits?	Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS3.A** Inheritance of Traits	Cause and Effect	Ask students to write down what things they'd like to know if they could test their genetic sequence	Article linked in teaching notes, *Cosmos Magazine*, "Gene that doubles risk of lung cancer"
Lesson 2	Science news: The 2020 Nobel Prize for the discovery of CRISPR	What are "genetics scissors" and how can we improve the situation faced by women in STEM?	Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**LS3.B** Variation of Traits	Structure and Function	Ask students to read article linked in lesson, *Cosmos Magazine*, "10 Unusual Applications of CRISPR Gene Editing"	Poster: Celebrating Women in STEM poster set. Posters are available for purchase in the Stile Shop
Lesson 3	1.1 Lesson: DNA and genes	What are DNA, genes, and bases, and how do they help make you, you?	Review teaching notes in Prepare Mode	Developing and Using Models	**LS3.A** Inheritance of Traits	Structure and Function	Ask students to summarize what they know about DNA, genes, and bases	
Lesson 4	1.2 Lesson: The genetic code	How do proteins form?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**LS3.B** Variation of Traits	Patterns	Ask students to summarize what they know about proteins, amino acids, and codons	

Lesson Planning Guide

Week 1 · **Week 2** · Week 3 · Week 4 · Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.3 Lesson: Mutations	How can changes to a single base cause big mutations?	Review Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**LS3.B** Variation of Traits	Patterns	Ask students to summarize what they know about insertion, deletion, and substitution mutations Ask students to read 1.4 Lab activity: Extracting DNA in preparation for the next lesson	
Lesson 6	1.4 Lab activity: Extracting DNA	How can I extract DNA from strawberries?	Review the Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter (prepare the extraction buffer a day before)	Planning and Carrying Out Investigations	**LS3.A** Inheritance of Traits	Structure and Function	Ask students to complete all lab questions	Extra SEP support: 0.1 Conducting science investigations Extra SEP support: 2.1 Observing & inferring
Lesson 7	2.1 Lesson: Mitosis	How does mitosis allow my body to grow and repair?	Review the Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**LS3.A** Inheritance of Traits	Stability and Change	Ask students to summarize the stages of mitosis	
Lesson 8	2.2 Project: Cancer cells	How does cell division relate to cancer?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare materials for creating posters like paper and pencils	Obtaining, Evaluating, and Communicating Information	**LS3.B** Variation of Traits	Stability and Change	Ask students to finish their poster	Extra SEP support: 1.1 Researching

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required
Lesson 9	2.3 Lesson: Meiosis	How does meiosis produce sex cells for reproduction?	Review teaching notes in Prepare Mode
Lesson 10	3.1 Lesson: Simple inheritance	What is the difference between your genotype and your phenotype?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode
Lesson 11	3.2 Lesson: Punnett squares	How do you use Punnett squares to predict genetic traits?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode
Lesson 12	3.3 Lesson: Sex-linked inheritance	How are traits, such as color vision deficiency, determined?	Review the Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode

	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	Developing and Using Models	**LS3.B** Variation of Traits	Structure and Function	Ask students to summarize the stages of meiosis	
Lesson 10	Analyzing and Interpreting Data	**LS3.A** Inheritance of Traits	Patterns	Ask students to read article linked in lesson, *Cosmos Magazine*, "The key gene that allows bees to collect pollen"	
Lesson 11	Developing and Using Models	**LS3.A** Inheritance of Traits	Patterns	Ask students to read article linked in lesson, *All That's Interesting*, "The Fugate Family of Kentucky Has Had Blue Skin For Centuries — Here's Why"	
Lesson 12	Developing and Using Models	**LS3.A** Inheritance of Traits	Cause and Effect		

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	3.4 Lesson: Pedigrees	How are specific traits passed through generations of a family?	Review Key Questions from the previous lessonin Analyze Mode Review teaching notes in Prepare Mode You may like to print or draw an enlarged copy of the Pedigree symbols for students to refer to	Developing and Using Models	**LS3.A** Inheritance of Traits	Cause and Effect		3.6 Extension: Codominant inheritance
Lesson 14	3.5 Project: Construct a family tree	How has a trait been passed through my family?	Review the Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Decide if students will create their family tree on paper or digitally and provide the relevant materials	Developing and Using Models	**LS3.A** Inheritance of Traits	Patterns	Ask students to complete their pedigree	
Lesson 15	Unit review Glossary: Genetics	How can I be prepared for the Genetics tests?	Review Key Questions from the unit using Analyze Mode to identify areas to revisit	Using Mathematics and Computational Thinking	**LS3.A** Inheritance of Traits **LS3.B** Variation of Traits	Cause and Effect	Ask students to review teacher feedback from lessons in the unit	Glossary: Genetics
Lesson 16	Test: Genetics	How much have I learned about Genetics?	Ensure students have access to a device				Ask students to write a reflection on what they have learned about genetics	

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5

The guide below is based on three 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	Test: Simple inheritance	How much have I learned about simple inheritance?	Ensure students have access to a device	Using Mathematics and Computational Thinking	**LS3.A** Inheritance of Traits **LS3.B** Variation of Traits	Cause and Effect	Ask students to write a reflection on what they have learned about simple inheritance	
Lesson 18	Science news: Genetically modified food	How has genetically modified corn sparked a debate in Mexico?	Review teaching notes in Prepare Mode Complete grading of tests ahead of test review session	Engaging in Argument From Evidence	**LS3.B** Variation of Traits	Stability and Change	Ask students to read article linked in lesson from *Vox*, "Here's what 9,000 years of breeding has done to corn, peaches, and other crops"	Extra SEP support: 6.1 Evaluating media claims Extra SEP support: 6.2 Critical thinking *YouTube* video linked in teaching notes, "Are GMOs Good or Bad? Genetic Engineering & Our Food" by *Kurzgesagt* – In a Nutshell
Lesson 19	Test review	How successful was my revision of Genetics?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Using Mathematics and Computational Thinking	**LS3.A** Inheritance of Traits **LS3.B** Variation of Traits	Cause and Effect	Ask students to reflect on the effectiveness of their revision and identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical and literacy skills.

Students use ratios and total frequencies of genes in a population to calculate possible outcomes and apply these to the specific populations they're studying.

Common Core State Standards Connections: Math

MP.4

Model with mathematics.

7.RPA.2

Recognize and represent proportional relationships between quantities.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Students are required to determine the meaning of symbols, key terms, and ideas from scientifically specific contexts that are relevant to the middle school grade band.

Students communicate this knowledge in many forms such as posters, investigations, and diagrams of their understanding.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flow chart, diagram, model, graph, or table).

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions, and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Science news: Genetically modified food**
  Questions 4, 6, 10, 12, 15
- **Science news: The 2020 Nobel Prize for the discovery of CRISPR**
  Questions 5, 6, 8, 11, 12
- **Career profile: Genetic counselor**
  Questions 1, 3
- **1.1 Lesson: DNA and genes**
  Questions 7, 12, 14, 22, 23
- **1.2 Lesson: The genetic code**
  Question 14
- **1.3 Lesson: Mutations**
  Question 11
- **1.4 Lab activity: Extracting DNA**
  Questions 1, 3, 4, 5
- **2.1 Lesson: Mitosis**
  Questions 3, 10, 24
- **2.3 Lesson: Meiosis**
  Questions 9, 19, 22
- **3.1 Lesson: Simple inheritance**
  Questions 2, 8
- **3.2 Lesson: Punnett squares**
  Questions 15, 18, 22, 23
- **3.3 Lesson: Sex-linked inheritance**
  Questions 7, 12, 15, 16
- **3.4 Lesson: Pedigrees**
  Questions 4, 8, 10, 13, 15
- **3.6 Extension: Codominant inheritance**
  Questions 2, 9, 12, 16

Extension opportunities in this unit

Challenge Questions
Most lessons contain one or more Challenge Questions, which are an opportunity for students to show they are working above the level of the learning goal. When answering these questions, students can extend themselves by applying their knowledge to new contexts, or to solve more complex problems. These provide a great extension opportunity.

Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC
3.6 Extension: Codominant inheritance	Why is it important to know your blood type?	Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**LS3.A** Inheritance of Traits	Patterns
Science news: Genetically modified food	How does someone's tone and volume impact how persuasive they are?	Review teaching notes labeled "Differentiation opportunity" in Prepare Mode	Constructing Explanations and Designing Solutions	**LS3.A** Inheritance of Traits	Structure and Function

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
Introduction: How can genes increase the risk of cancer?	All genetic mutations are harmful.	**Use 1.3 Lesson: Mutations** Genetic mutations are sometimes harmful and sometimes harmless. 1.3 Lesson: Mutations examines the process through which mutations occur, and their impact on proteins that are produced.
	If you look more like one parent then you have inherited more of that parent's genes.	**Use 3.1 Lesson: Simple inheritance and 3.2 Lesson: Punnett squares** Each parent contributes an equal amount of genetic information. In 3.1 Lesson: Simple inheritance, students learn how genotypes translate to phenotypes, and can use this knowledge to build upon their understanding of how offspring inherit genetic information. Ask questions that link these two ideas together, such as, "How does a parent's genetic information get transferred to their offspring?" and, using Punnett squares, emphasize that in heterozygotes, a dominant trait appears despite the presence of a recessive allele. Ask questions such as, "Did the black guinea pigs in question 9 receive any genetic information from their white parent?" and, "Did the tall sunflowers in question 12 receive more genetic information from their tall parent?"

Lesson	Misconception	Addressing the misconception
(Continued) Introduction: How can genes increase the risk of cancer?	Boys get all their traits from their fathers and girls get their traits from their mothers.	**Use 2.3 Lesson: Meiosis** Apart from the genes that determine your sex, you inherit genes from both parents for every characteristic. 2.3 Lesson: Meiosis explains the process through which sex cells are produced, and allows students to recognize that each parent contributes equal amounts of genetic information. Ask questions that address this understanding, such as, "Do I get all of my genes from my mother/father?"
	Your genes determine all your characteristics.	This is a long-standing debate, but the answer seems to be that genes and environment play roughly equal roles in determining people's characteristics. At least, this was the finding of a recent review of 3000 studies of identical twins, reported in *Cosmos Magazine*.
Science news: The 2020 Nobel Prize for the discovery of CRISPR	Men are better than women at STEM.	Consider using **Women in STEM career profiles** unit. Women face huge inequality within STEM despite many of the most important scientific discoveries having been made by women. This inequality is evident when examining the number of Nobel Prizes awarded to men in comparison to women. The Women in STEM career profiles unit is a collection of lessons in the Stile Library, which show a range of women who work in STEM using their passion and expertise to make a positive impact on the world around them.
3.3 Lesson: Sex-linked inheritance	Females are more likely to have blonde hair.	Hair color is an autosomal trait so the probability of blonde hair is equal between the sexes. Hair color is determined by multiple genes, so it cannot be accurately depicted using a Punnett square. You may like to discuss possible reasons for this misconception, such as a higher proportion of females choosing to dye their hair compared to males.

ELL support

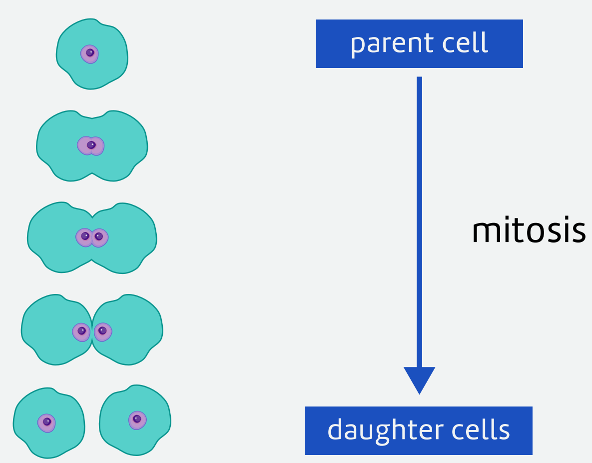
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

Genetics lessons include a number of flow charts and diagrams to help students understand the inheritance of traits from one generation to the next and the variation that can occur. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

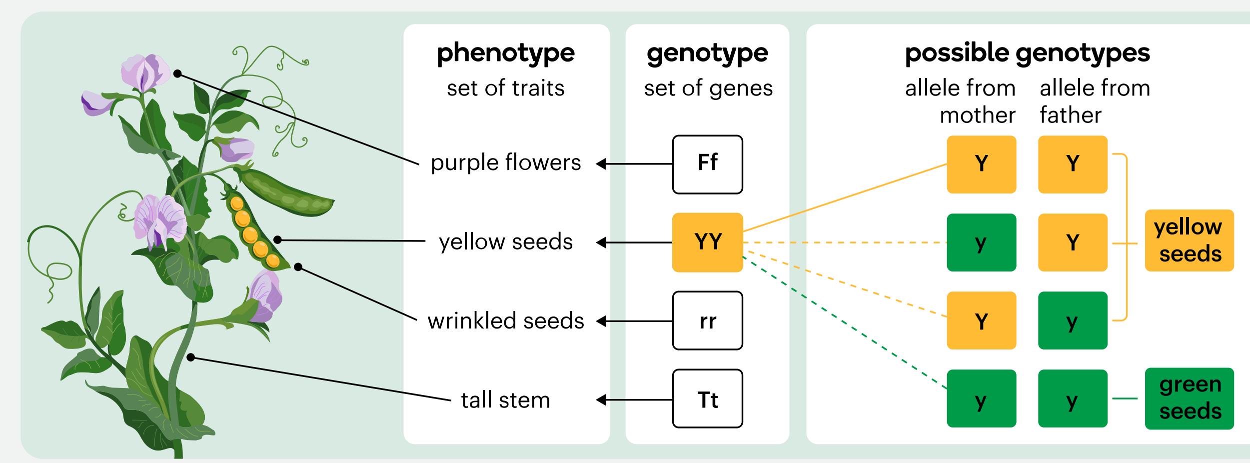
2.1 Lesson: Mitosis

Illustrating and labeling the process of mitosis allows students to be clear about what these subject specific terms mean.



3.1 Lesson: Simple inheritance

Subject-specific nomenclature can be difficult to understand and recall. This diagram helps all students, but especially English Language Learners, as color combination and letter notation are used with arrows to contextualize the information.

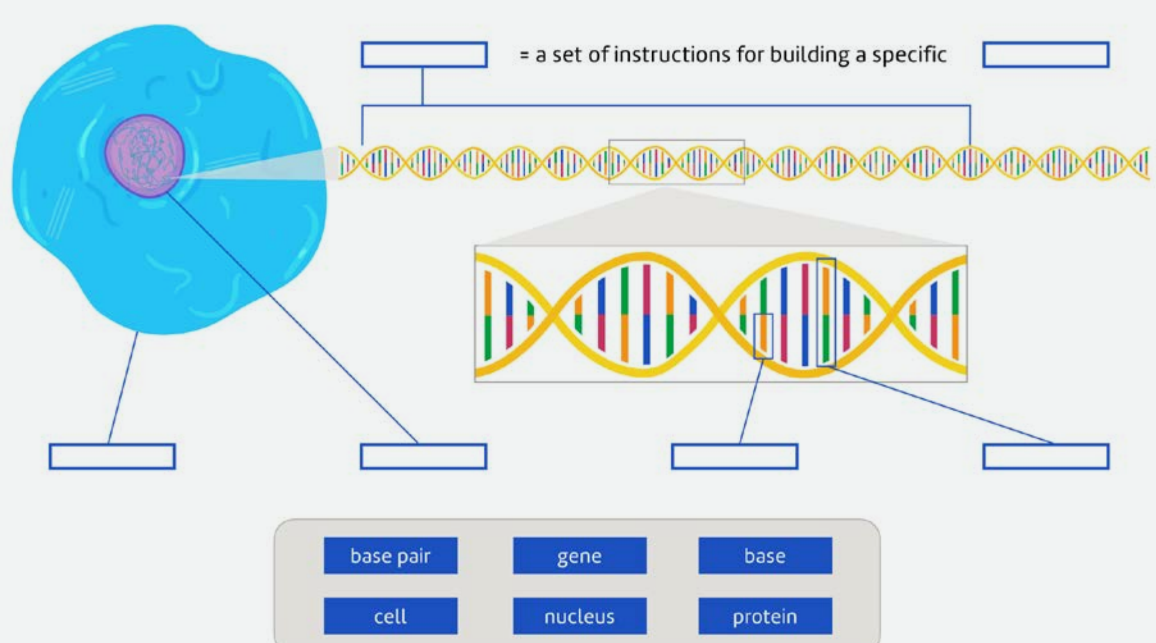


Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.1 Lesson: DNA and genes

Drag-and-drop questions allow students to gain familiarity with subject-specific vocabulary when first introduced to concepts in a new unit.
As students face multiple exposures to these terms, they will gain confidence to spell and use them in written responses.



Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Summative assessment

Test
This unit contains two tests to provide summative assessment of student learning across the whole unit.

- **Test: Genetics**
  Multiple choice, short answer, fill-in-the-blank: 45–60 minutes
- **Test: Simple inheritance**
  Multiple choice and short answer: 45–60 minutes

Science and Engineering Practices
One lab activity and two projects within the unit can be used as a summative assessment of Science and Engineering Practices.

- **1.4 Lab activity: Extracting DNA**
  Lab activity: 45–60 minutes
- **2.2 Project: Cancer cells**
  Project: 45–60 minutes
- **3.5 Project: Construct a family tree**
  Project: 30–45 minutes

Lab Activities

Lab Activity

Extracting DNA

Activity purpose: Extract DNA from strawberries.

stileapp.com/go/extractingDNA

45–60 minutes

3–4 students per group

Materials

Lab Equipment
Each group of students will need:
- ziplock bag (15 x 10 cm)
- 60 mL test tube
- 20 mL measuring cylinder
- square of fine gauze or cheesecloth (15 x 15 cm)
- small funnel
- 15 cm long skewer
- black cardboard

Chemicals
- 1 small strawberry
- 20 mL ice cold 70% ethanol or isopropyl rubbing alcohol
- 2 teaspoons (10 mL) DNA extraction buffer (see below)

DNA extraction buffer: makes 500 mL
(enough for 50 extractions)

- 50 mL shampoo or 25 mL liquid dishwashing detergent
- 7.5 g kitchen salt (about 1 teaspoon)
- 450 mL water

Combine and stir gently until mixed.

Preparation

Dilute the ethanol and refrigerate the day before, making sure you have enough ice to keep it ice cold.

Prepare the extraction buffer ahead of time.

Notes

Collect all test tubes and their contents at the conclusion of the lesson for correct disposal.

Method

Method that students will follow
1. Wash the strawberry and remove the green leaves, which are called sepals.
2. Place the strawberry in a ziplock bag, seal it and crush it with your hand.
3. Add 2 teaspoons of the DNA extraction buffer to the bag, seal it and squeeze to mix for about 1 minute.
4. Place a funnel in the test tube. Place the strip of gauze in the funnel.
5. Pour the strawberry buffer mixture into the funnel so it is filtered into the test tube.
6. Carefully pour ice cold ethanol into the test tube until it is about half full. The ethanol will form a layer on top of the liquid that came through the gauze.
   Do not shake the test tube.
7. Keep the tube still and hold it at eye level. Watch what happens and record your observations.
8. Scoop out the DNA carefully using the cocktail stick.
9. Spread the DNA out on a piece of black card to view it and record your observations.

Unit 2 – Plants

Why are some plants carnivorous?

Venus flytrap
Carnivorous plants have evolved specialized cells and structures for luring and trapping prey.

Storyline and anchoring phenomenon

Plants have special structures to absorb nutrients from the soil and air, but what if that isn't enough? Some plants live in locations where they can't get enough nutrition this way. The solution? Act like an animal.

Students engage with the phenomenon of carnivorous plants and explore how they gain nutrients. Through making comparisons to other plants, they ask questions about the differences in how they obtain nutrients and, in doing so, discover the process of photosynthesis.

Students connect with prior knowledge about plant structures by discussing the features of plants that allow them to be used for a variety of different purposes. They examine plant structures under microscope power and learn about the function of specific anatomical features, including those involved in photosynthesis. Students also consider the structures of flowering plants, and how these relate to their specific pollinators. This builds on the ecology and food web knowledge gained earlier in The Stile Curriculum.

Students must come to their own conclusions about why plants have evolved specialized cells and structures to lure and trap prey.

This unit at a glance

Plants

Introduction: Predatory plants
Science news: Why are bees disappearing?
Career profile: Botanical artist

1.1 Lesson: Plant anatomy
1.2 Lesson: Leaf structure and epidermis cells
1.3 Lab activity: Viewing leaf epidermis cells

2.1 Lesson: Flower anatomy
2.2 Lesson: Sexual reproduction in plants
2.3 Project: Asexual reproduction in plants

3.1 Extension: Carnivorous plants
3.2 Investigation: Venus flytraps

Glossary: Plants
Test: Plants

Students dissect the **structure and function** of plant organs.

News articles and career profiles underpin the unit in **real-world phenomena**.

Students develop **microscopy skills** to observe the minute structures of plants.

Students use **hands-on activities** to observe how plants reproduce when they can't move!

Students **investigate** the mechanisms of a Venus flytrap.

Tests measure student achievement and provide opportunities for **reflection** and **feedback**.

The glossary provides definitions of key terms accompanied by images. These are perfect for **supporting ELL students** to build scientific vocabulary.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-LS1-5

Construct a scientific explanation based on evidence for how environmental and genetic factors influence the growth of organisms.

MS-LS1-7

Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

MS-LS3-2

Develop and use a model to describe why asexual reproduction results in offspring with identical genetic information and sexual reproduction results in offspring with genetic variation.

Disciplinary Core Ideas

- **LS1.A:** Structure and Function
- **LS1.B:** Growth and Development of Organisms
- **LS1.C:** Organization of Matter and Energy Flow in Organisms

Students first engage with this unit by exploring predatory plants.

Students use this as a lens to consider the structure of plant systems, and explore how chemical reactions fuel plant growth and reproduction. They consider plants' reproductive strategies to find out how they overcome the barriers of being unable to move to seek nutrients or reproduce.

Science and Engineering Practices

- Planning and Carrying Out Investigations
- Constructing Explanations and Designing Solutions

Students have multiple opportunities to construct explanations for how plant systems function, and to justify these explanations.

Students create testable questions about the complexity of plant life, then plan and carry out investigations to explore these questions.

Crosscutting Concepts

- Scale, Proportion, and Quantity
- Systems and System Models
- Structure and Function

Students get to the root of plants by looking at the levels of organization within them.

Students investigate the systems that allow plants to transport nutrients and water to their cells.

Nature of Science

- Scientific Knowledge is Based on Empirical Evidence

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

The Plants unit builds on Disciplinary Core Ideas explored during Grade 6 through the Food Chains and Food Webs and Elements and Compounds units.

In Food Chains and Food Webs, students learned about interactions within ecosystems and the flow of energy between trophic levels using models of ecosystems. They examined the different types of relationship that exist between organisms, including competitive, predatory, and mutualistic.

Through Plants, students further develop their knowledge of energy flow within ecosystems by recognizing the Sun as the source of energy for plants, which are eaten by consumers, and therefore provide nutrients to them and the organisms that consume them. They also understand that competition for resources applies to a range of organisms, including plants, which are unable to move locations to reproduce or obtain nutrients.

In Elements and Compounds, students recognized that atoms combine in a variety of ways to form molecules of different sizes with different arrangements. They learned that these substances rearrange through chemical reactions, though the number of atoms remains the same. Plants helps them to build on this knowledge, as the reactions involved in photosynthesis are an example of chemical reactions where molecules are recombined and atoms conserved.

Science and Engineering Practices

Students developed and used models across units in Grade 6, including in Elements and Compounds, Cells, Food Chains and Food Webs, and Light.

They interacted with models that describe unobservable mechanisms, such as light waves and the formation of compounds, and developed models to describe phenomena, including the phases of the Moon and eclipses.

During the Plants unit, students interact with models of plant cells to describe the structure of a leaf and its role in the process of photosynthesis.

Crosscutting Concepts

Grade 6 units developed students' understanding of the concepts of systems and system models; scale, proportion, and quantity; and structure and function.

They engaged with systems and system models in Our Place in Space where they examined the scale of the Solar System.

In the Cells unit, students explored the idea of scale, proportion, and quantity, by using microscopes to observe cells. These observations required them to consider the scale of magnification and recognize cells' proportions by calculating their size in micrometers. They were also able to make connections between the structure of specialized cells and their function within the body.

In Plants, students engage with models that demonstrate the scale of plant cells in relation to the parts they make up. They also recognize the structure of plant cells is directly related to their function in the process of photosynthesis.

Tree roots
Tree roots are a plant organ involved in absorbing water and nutrients, anchoring the plant and storing energy.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Predatory plants Science news: Why are bees disappearing?	How do carnivorous plants capture their prey?	Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.C** Organization of Matter and Energy Flow in Organisms	Patterns	Ask students to complete any remaining questions	Article linked in teaching notes, *Cosmos Magazine*, "Lazy pitcher plants catch more ants"
Lesson 2	1.1 Lesson: Plant anatomy	Do plants have organs?	Review teaching notes in Prepare Mode Optional: Ask students to bring in devices to take photos for the plant hunt activity	Planning and Carrying Out Investigations	**LS1.A** Structure and Function	Structure and Function		*YouTube* video linked in teaching notes, "What's the Difference Between a Plant and a Vegetable?" by *Live Science*
Lesson 3	1.2 Lesson: Leaf structure and epidermis cells	How do the structure and function of leaves help plants survive?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**LS1.A** Structure and Function	Structure and Function		
Lesson 4	1.3 Lab activity: Viewing leaf epidermis cells	What do guard cells and stomata actually look like?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Planning and Carrying Out Investigations	**LS1.A** Structure and Function	Scale, Proportion, and Quantity		Extra SEP support: 2.1 Observing & inferring

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.3 Lab activity: Viewing leaf epidermis cells	What do guard cells and stomata actually look like?	Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Planning and Carrying Out Investigations	**LS1.A** Structure and Function	Structure and Function Scale, Proportion, and Quantity		Extra SEP support: 5.3 Creative thinking
Lesson 6	2.1 Lesson: Flower anatomy	What are the main parts of a flower?	Review the Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Planning and Carrying Out Investigations	**LS1.B** Growth and Development of Organisms	Structure and Function	Students who are proficient at the first dissection can be given 2–4 additional flowers of different species to dissect. They can then identify similarities and differences between the species based on their observations	
Lesson 7	2.2 Lesson: Sexual reproduction in plants	How do flowers help plants reproduce sexually?	Review the Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**LS1.B** Growth and Development of Organisms	Structure and Function	Ask students to familiarize themselves with the project before the next lesson	Website linked in teaching notes, *Center for Plant Conservation*
Lesson 8	2.3 Project: Asexual reproduction in plants	Can I create the right conditions for a plant to reproduce asexually?	Review the Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Planning and Carrying Out Investigations	**LS1.B** Growth and Development of Organisms	Patterns		Extra SEP support: 1.1 Researching

Lesson Planning Guide

Week 1 Week 2 Week 3

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	3.2 Investigation: Venus flytraps	How do Venus flytraps shut?	Review the Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the investigation. See the relevant pages at the end of this chapter	Planning and Carrying Out Investigations	**LS1.A** Structure and Function	Cause and Effect: Mechanism and Prediction	Ask students to continue working on 2.3 Project: Asexual reproduction in plants	3.1 Extension: Carnivorous plants Extra SEP support: 0.1 Conducting science investigations
Lesson 10	Unit review Glossary: Plants	How can I be prepared for the Plants test?	Review Key Questions from the unit using Analyze Mode to identify areas to revisit	Planning and Carrying Out Investigations Constructing Explanations and Designing Solutions	**LS1.A** Structure and Function **LS1.B** Growth and Development of Organisms **LS1.C** Organization of Matter and Energy Flow in Organisms	Scale, Proportion, and Quantity Systems and System Models Structure and Function	Ask students to review Key Questions and teacher feedback from lessons in the unit	Glossary: Plants Poster: Cell Organielles Music Festival poster. Posters are available for puchase in the Stile Shop
Lesson 11	Test: Plants	How much have I learned about Plants?	Ensure every student has access to a device Complete grading of test ahead of test review session				Ask students to write a reflection on what they have learned from the unit	
Lesson 12	Career profile: Botanical artist Test review	How successful was my revision of Plants?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these				Ask students to reflect on the effectiveness of their revision and identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical skills.

Throughout the unit, students can communicate their knowledge and understanding in many ways. They undertake investigations that allow them to collect and present data and summarize this in a display of the investigation.

Common Core State Standards Connections: Math

7.SP.A

Use random sampling to make inferences about a population.

7.SP.B

Draw informal comparative inferences about two populations.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Students learn new vocabulary and content throughout this unit with sense-making and visual displays of new information.

Students integrate written content with graphical displays to show their understanding of technical texts by presenting information in new ways. They write summaries of findings from hands-on investigations, applying their knowledge to real-world and observable contexts.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.2

Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6-8 texts and topics.

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flow chart, diagram, model, graph, or table).

WHST.6-8.2

Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

WHST.6-8.9

Draw evidence from informational texts to support

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Science news: Why are bees disappearing?**
  Questions 5, 6, 7, 9
- **1.1 Lesson: Plant anatomy**
  Questions 3, 6, 7, 11, 17, 18, 19, 20, 21
- **1.2 Lesson: Leaf structure and epidermis cells**
  Questions 9, 12, 13
- **1.3 Lab activity: Viewing leaf epidermis cells**
  Questions 2, 3
- **2.1 Lesson: Flower anatomy**
  Questions 7, 10, 14
- **2.2 Lesson: Sexual reproduction in plants**
  Questions 7, 8, 11, 12, 13, 17, 18, 20, 21
- **3.1 Extension: Carnivorous plants**
  Questions 2, 4, 7, 8
- **3.2 Investigation: Venus flytraps**
  Questions 1, 4, 7, 8

Extension opportunities in this unit

Challenge Questions
Most lessons contain one or more Challenge Questions, which are an opportunity for students to show they are working above the level of the learning goal.

When answering these questions, students can extend themselves by applying their knowledge to new contexts, or to solve more complex problems. These provide a great extension opportunity.

Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC
3.1 Extension: Carnivorous plants	How do carnivorous plants capture their prey?	Review teaching notes in Prepare Mode	Engaging in Argument From Evidence	**LS1.A** Structure and Function	Structure and Function

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
1.1 Plant anatomy	Only animals and humans have organs.	**Use 1.1 Lesson: Plant anatomy** Plants have organs just like animals do. The main plant organs include roots, stems, leaves, flowers, and fruit. Discuss the definition of an organ as a part of the body that performs a specific function. Apply this definition to different plant structures and ask questions to support the connection between plant organs and their definition, such as "Does this part of the plant perform a specific function? What is the function?" before asking "Can we consider this part of the plant to be an organ?"

New shoots growing from old potatoes
Potato tubers store energy so that the plant can reproduce asexually. Both roots and shoots will sprout from the tuber.

ELL support

To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

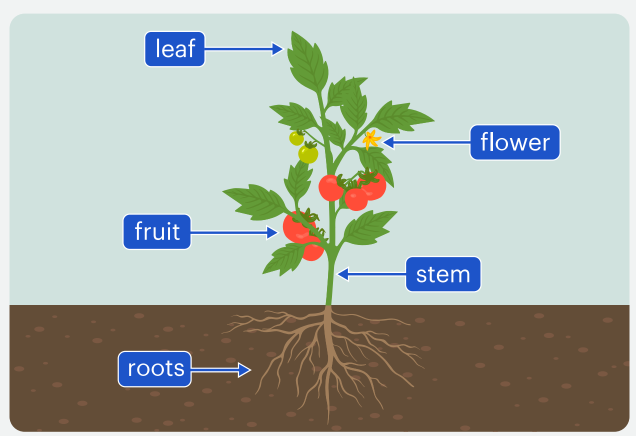
Plants lessons include a number of flow charts and diagrams to help students understand the subject-specific vocabulary of the Plants unit as well as the specific structures found in plants. Encourage students to draw on these visual representations, and to actively interpret the information they contain.

Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

1.1 Lesson: Plant anatomy

Diagrams of familiar plants with labels to point out subject-specific language will allow ELL students to access information through multiple media exposures.

By visually associating these words with the illustrated example, students make connections between the plant structures and the words that describe them.



2.1 Lesson: Flower anatomy

Microscopic images show topic-specific language throughout the lesson that is revisited through the unit. These clearly illustrate a connection between specific plant parts, and the terminology used to describe them.

Customization

Teachers can integrate locally relevant phenomena by including images and examples of plants that are native or significant to their region. This could be crops that are abundant in the area or wildflowers and tree species that students will recognize from parks and reserves nearby.

2.2 Lesson: Sexual reproduction in plants

Titan arum, the flowering plant that smells like rotting flesh, is native to Indonesia. However, it can be seen in many botanic gardens across the USA. It blooms every 3–5 years. Students might like to visit one nearby, or even take a field trip to see this plant and many others at a botanic garden in their area.

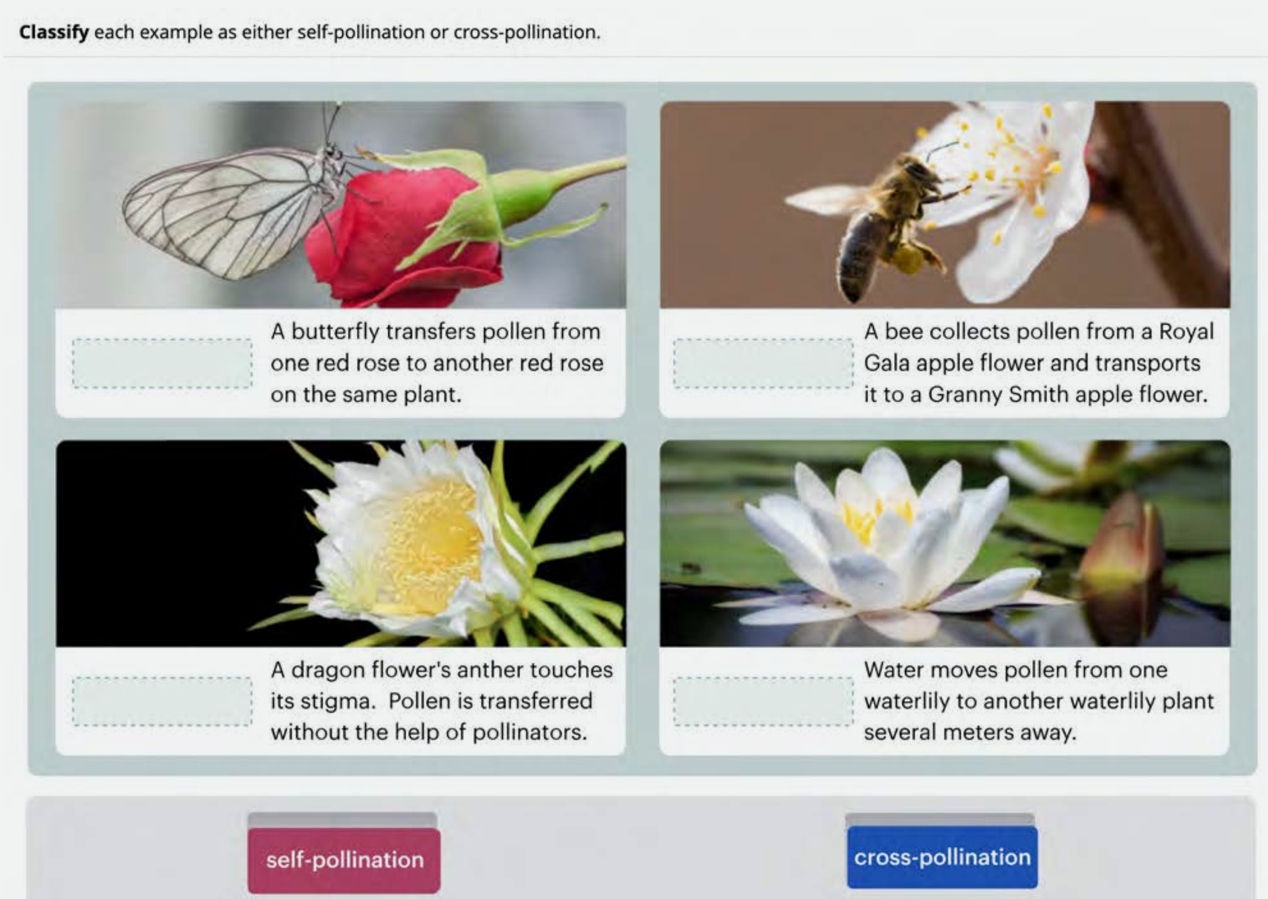
Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills.

These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

2.2 Lesson: Sexual reproduction in plants

Drag-and-drop questions allow English Language Learners to match terminology with images and definitions. This question supports students to show their understanding of key differences between self-pollination and cross-pollination. By matching the terms to multiple examples, they gain familiarity with these words and can also connect phrases with familiar objects in the image, such as "red rose."



Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Summative assessment

Test
This unit contains a test to provide summative assessment of student learning across the whole unit.

- **Test: Plants**
  Multiple choice and short answer: 45–60 minutes

Science and Engineering Practices
A lab activity, project, and investigation within the unit can be used as summative assessments of Science and Engineering Practices.

- **1.3 Lab activity: Viewing leaf epidermis cells**
  Lab activity: 100–120 minutes
- **2.3 Project: Asexual reproduction**
  Project: 45–60 minutes
- **3.2 Investigation: Venus flytraps**
  Investigation: 45–60 minutes

Lab Activities

Lab Activity

Viewing leaf epidermis cells

Activity purpose: Use a light microscope to observe leaf epidermis cells.

stileapp.com/go/plantcellsexp

100–120 minutes

3–4 students per group

Materials

Lab Equipment
Each group of students will need:
- suitable leaf – examples include common ivy, ribbon grass, spider plant, geranium, hibiscus, sweet pea, broad bean, or most succulents, such as "Mother-in-law's Tongue"
- 1 mL artist's colorless water-based varnish or colorless nail polish
- compound light microscope
- microscope slide
- forceps
- 1 cm^2 of wax or grease-proof paper
- 10 cm colorless sticky tape
- small scissors

Chemicals
None required

Preparation

We highly recommend that you test this lab activity before doing it in class. Depending on the types of leaves and varnish that you use, you may need to adjust the method in order to get optimal results. For example, some varnishes will work best if they are pressed onto the leaf while still not fully set.

Prepare leaves by placing branches in water somewhere with good light.

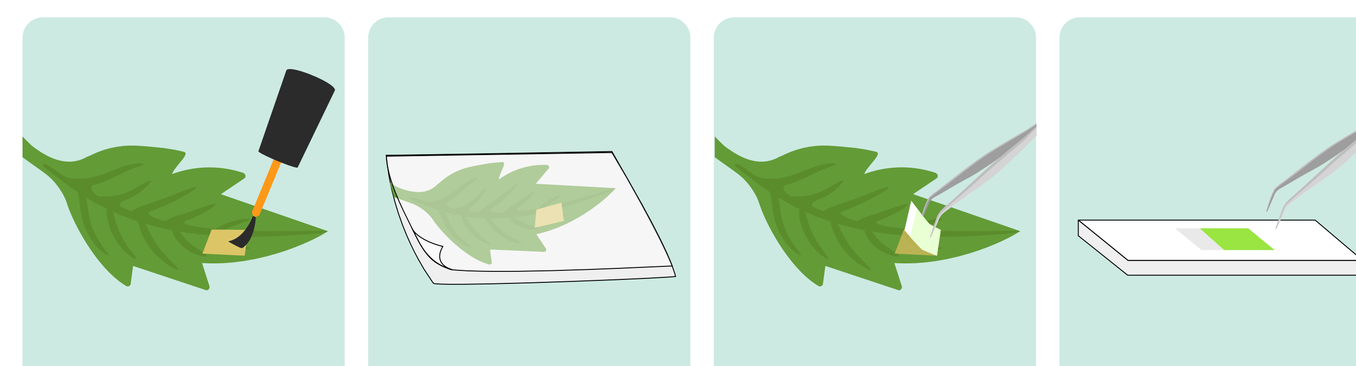
Notes

Artist's colorless water-based varnish usually yields better results than nail polish.

Most stomata are located on the lower epidermis of leaves. The dry leaf impress should reveal the stomata, guard cells and pavement cells. Students should be able to see the cell wall but are not likely to see the cell membrane.

Method

Method that students will follow
1. Paint a thin patch of varnish approximately 1 cm^2 on the lower surface of your leaf and leave until the varnish is tacky but not completely dry. Avoid painting over major veins.
2. Place a sheet of wax paper over the varnish patch and press down on it for about 45 seconds. Note: Depending on the varnish and leaves you may be able to skip this step; ask your teacher.
3. Wait for the varnish to fully harden.
4. Optionally create a small handle to lift the dried varnish off the leaf:
   - cut a piece of sticky tape about 2 cm long. Fold the tape over on itself leaving a narrow sticky strip 2 or 3 millimeters wide
   - place the sticky part of the tape along one edge of the varnish patch
5. Use the forceps (and sticky tape handle if you made one) to carefully peel the varnish from the leaf surface. If you need to, use the scissors to cut off the sticky tape handle.
6. Place the varnish patch on the microscope slide.
7. Examine the impression under low, medium, and high magnification.



Lab Activity

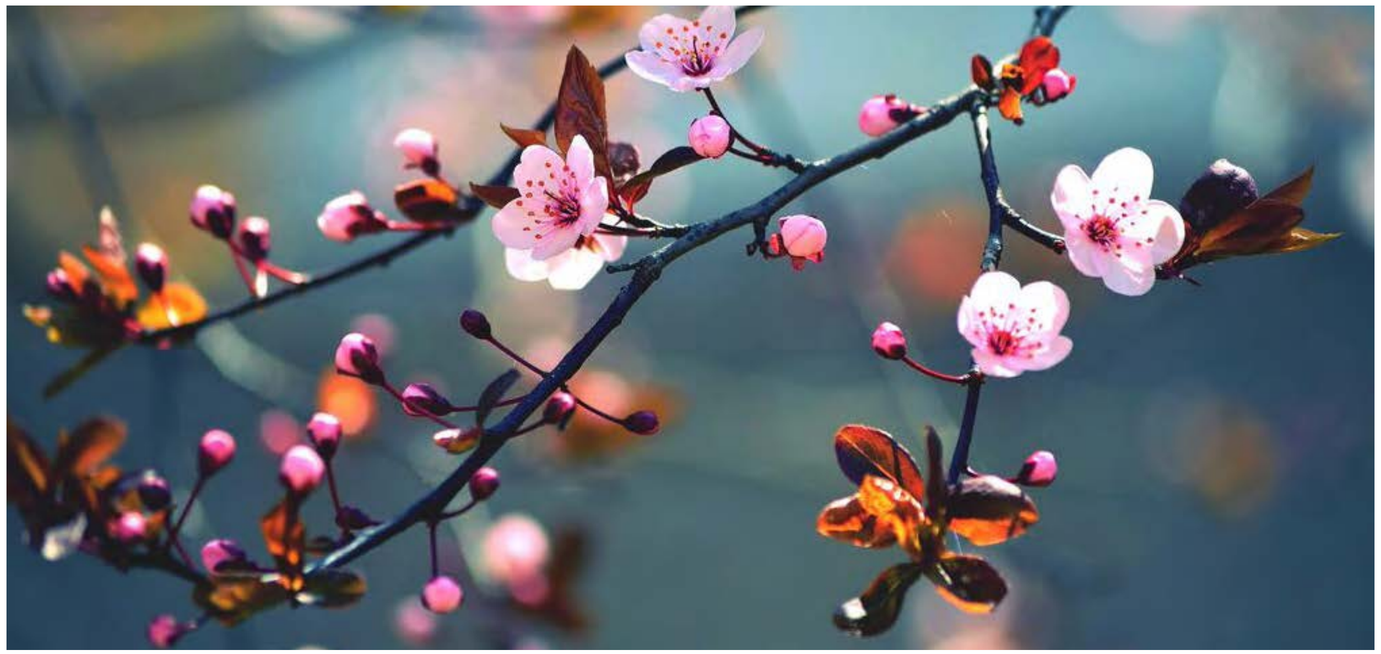
Flower dissection

Activity purpose: Examine the main parts of a flower and their roles in plant reproduction.

stileapp.com/go/plants-flower-anatomy

100–120 minutes

2 students per group



Materials

Lab Equipment
Each group of students will need:
- 1 flower species
- scalpel
- tweezers
- magnifying glass or hand lens
- cutting boards
- optional: poster board, markers, and tape for poster activity

Chemicals
- glass of water

Preparation

We recommend that all students in the class use the same flower species for their first dissection. Not all flowers work well for this activity. The best flowers are Alstroemeria lilies, tulips, daffodils, carnations, petunias, and gladioli. Flowers that should be avoided include daisies, asters, calla lilies, roses, and irises, as their parts are more challenging to identify.

Notes

A video of a flower dissection has been included to guide students. You will need to run through how to safely use a scalpel before students begin the dissection. Some main points to discuss include:

1. Students should never touch the blade.
2. Highlight that there is a sharp edge to the blade that will do the cutting.
3. All cutting needs to be done on a cutting board.
4. Cuts should be made in a slow, dragging back motion.

Extension: Students who are proficient at the first dissection can be given 2–4 additional flowers of different species to dissect. They can then identify similarities and differences between the species based on their observations.

Optional poster activity: Students can produce a poster of their dissections by taping their dissected flowers to it and labeling each part.

Method

Method that students will follow
1. Gently remove the sepal and petals by pulling them away from the stem of the flower.
2. Use the tweezers to remove the male parts (anther and filaments) of the flower.
3. Closely observe the anther with the magnifying glass – you may see some pollen grains.
4. The female part should now be exposed. Carefully use the scalpel and cutting board to cut the ovary open.
5. Closely observe the ovary with the magnifying glass – you may be able to see the eggs.

Lab Activity

Asexual reproduction in plants

Activity purpose: Research asexual reproduction in plants and propagate a plant.

stileapp.com/go/plants-asexual

30 minutes to set up the project

2 students per group

Materials

Lab Equipment
Each group of students will need:
- beaker or glass jar
- knife
- chopping board
- 1 bunch of spring onions

Chemicals
- water

Preparation

Gather equipment and chemicals.

Notes

Spring onions are some of the quickest growers so are a good option if you are short on time. Small shoots can start to grow in just 1–2 days. This could be easily done at home or in the classroom.

If you have more time, alternative plants your students could grow (with the approximate time before they start sprouting) include:
- spider plants (7–10 days)
- Devil's ivy (1–2 weeks)
- succulents (3 weeks)
- lavender (2–4 weeks)
- basil (2–4 weeks)
- African violets (3–4 weeks)
- strawberries (4–6 weeks)

Method

Method that students will follow

1. Using a knife and chopping board, cut 2–3 cm cuttings of the spring onion bulbs. Make sure to keep all the roots on the cuttings.
2. Place cuttings in a glass beaker and pour in enough water to submerge the roots. Make sure at least 1 cm of the stem is above the water.
3. Place the glass beaker in sunlight and leave for several days. Top up the water if it starts to evaporate quickly.
4. When shoots start to grow out of the top of the cuttings, they are ready to plant in soil.

Lab Activity

Venus flytraps

Activity purpose: A guided inquiry to plan and conduct a scientific investigation that models what causes Venus flytraps to shut.

stileapp.com/go/plants-venus-flytraps

45–60 minutes

2 students per group

Materials

Lab Equipment
Each group of students will need:
- a Venus flytrap with at least 6 open traps
- stopwatch
- teaspoon
- thin paintbrush
- toothpick
- human hair
- thick cotton thread
- drinking straw
- sand

Chemicals
- tap water
- salt water
- sugar solution
- flour
- salt

Preparation

None required

Notes

None

Method

Students write their own method for this investigation.

Further scaffolding for students to plan, conduct, and communicate a science investigation is provided in the Stile lesson.

How can we prevent plastic from harming marine life?

Oceanic garbage patches
Plastic collects in the open ocean, trapped in large circular currents, which form giant "garbage patches."

Storyline and anchoring phenomenon

Plastic is an incredibly useful material that is all around us – literally. But now, plastic waste is swamping our oceans and harming the creatures that live there. It's also making its way into our bodies through the food chain!

In Ecosystems, students are introduced to beautiful oceanic landscapes in a 360° video. They are then confronted with footage of a diver swimming in densely polluted waters and are driven to ask questions about the damage this is causing to wildlife who depend on the ocean for survival. Their questions lead students to explore how ecosystems work and what happens when they are disturbed by human impacts like plastic pollution. They unpack the concepts of photosynthesis and cellular respiration through hands-on lab activities and learn how energy is transferred and matter is cycled within these systems.

Students are forced to consider their own plastic waste and available plastic alternatives. They apply Science and Engineering Practices to create casein plastic from milk and evaluate its effectiveness as a replacement for plastic in different situations.

Entrepreneur Pete Ceglinski introduces students to the Seabin Project, a group that designs solutions to help remove plastic pollution from the ocean. This inspires them to design and construct their own solutions in an engineering challenge where they work collaboratively with their peers.

The unit builds toward a Socratic seminar, where students debate the question "Should we ban single-use plastics?" from the perspective of different stakeholders. Finally, they work in groups to apply their knowledge in creating a campaign that communicates an important message about the problem of plastic pollution.

This unit at a glance

Ecosystems

Students engage in the **real-world phenomenon** of plastic pollution.

Introduction: The problem of plastic pollution
Career profile: Entrepreneur
What do you already know?

1.1 Lesson: What are plastics?
1.1 Quiz: What are plastics?
1.2 Lab activity: Properties of plastics
1.3 Lab activity: Sorting plastics by density
1.4 Extension: The chemistry of plastics
1.4 Quiz: The chemistry of plastics
1.5 Lesson: My plastic impact
1.6 Lesson: Reducing your plastic impact
1.7 Engineering challenge: Cleaning our oceans

Students use a multidisciplinary approach to **explore the composition of plastic**.

Students **reflect** on their own plastic use.

Students **design a solution** to remove plastic from the ocean.

2.1 Lesson: What are ecosystems?
2.1 Quiz: What are ecosystems?
2.2 Lab activity: Make an ecosystem model
2.3 Investigation: Abiotic factors and plant growth
2.4 Lesson: Predator–prey relationships
2.5 Lesson: Competition
2.6 Lesson: Symbiosis
2.6 Quiz: Relationships in ecosystems

Students **create a model of an ecosystem** and engage with this model throughout the unit.

Quizzes are included throughout the unit as **formative assessment** of student learning.

3.1 Lesson: Sources of energy
3.1 Quiz: Sources of energy
3.2 Lesson: Energy transfer and cycling of matter
3.2 Quiz: Energy transfer and cycling of matter
3.3 Investigation: Photosynthesis

Students explore photosynthesis through a **collaborative investigation**.

Students **reflect** on the impacts of human activity on ecosystems.

Students **explore multiple perspectives** on plastic use and pollution.

Students **engage in argument from evidence** to communicate with others about how to reduce their plastic impact.

The properties of plastic
Because plastic is light, it floats in the ocean and is easily mistaken for food by marine animals.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-LS1-6

Construct a scientific explanation based on evidence for the role of photosynthesis in the cycling of matter and flow of energy into and out of organisms.

MS-ESS3-3

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.

MS-ESS3-4

Construct an argument supported by evidence for how increases in human population and per-capita consumption of natural resources impact Earth's systems.

MS-LS2-5

Evaluate competing design solutions for maintaining biodiversity and ecosystem services.

MS-LS1-7

Develop a model to describe how food is rearranged through chemical reactions forming new molecules that support growth and/or release energy as this matter moves through an organism.

Disciplinary Core Ideas

- **LS1.C**: Organization for Matter and Energy Flow in Organisms
- **LS2.C**: Ecosystem Dynamics, Functioning, and Resilience
- **ESS3.C**: Human Impacts on Earth Systems
- **PS3.D**: Energy in Chemical Processes and Everyday Life
- **ESS2.C:** The Roles of Water in Earth's Surface Processes

Students learn about the way in which energy is cycled through ecosystems, and the role of photosynthesis within these cycles.

They build an understanding of the delicate balance between an ecosystem's components, and the importance of biodiversity. Students recognize the impact of plastic waste upon the environment, and the need to reduce our plastic consumption.

Science and Engineering Practices

- Asking Questions and Defining Problems
- Engaging in Argument From Evidence
- Obtaining, Evaluating, and Communicating Information
- Using Mathematics and Computational Thinking

Students ask questions about the impact of plastic consumption on the environment and define the problem of ocean pollution in order to design a solution.

They use mathematical concepts to recognize the scale of the plastic waste problem and the need for a solution. Students compare and critique arguments from different stakeholder perspectives, and present oral arguments supported by scientific reasoning as part of a Socratic seminar. They communicate scientific information through a campaign about the problem of plastic pollution.

Crosscutting Concepts

- Scale, Proportion, and Quantity
- Cause and Effect
- Energy and Matter
- Systems and System Models
- Structure and Function
- Stability and Change

Students engage with the idea of scale as they consider the way in which plastic waste has a cumulative effect on the global environment.

They recognize the way in which changes to one part of an ecosystem impact its other components, and how damage to the natural world affects living creatures. When considering the cycling of energy within an ecosystem, students learn about how a plant's structure is related to its function in the process of photosynthesis.

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

In the Grade 6 Cells unit, students learned about cell organelles, including chloroplasts. They learned that chloroplasts were involved in the process of photosynthesis, through which plants make their own food.

In Ecosystems, students build on this idea as they gain an understanding of the role that plants play as a source of energy within food chains and unpack the chemical reactions that take place during photosynthesis. They also learn the role that the Sun plays in this reaction.

In Food Chains and Food Webs, students gained an understanding of the interdependence of organisms within ecosystems. In The Importance of Biodiversity, they were able to recognize the role of a single organism within an ecosystem and how a reduction in biodiversity in bees threatens global food security.

In Ecosystems, students extend this knowledge by exploring marine ecosystems and explicitly learning about what makes an ecosystem healthy and why this is of benefit to humans. A number of units in Grade 6 of The Stile Curriculum address the impact that humans have on the planet. Cells, for instance, discusses how agricultural practices release huge amounts of greenhouse gases and that this negatively impacts the environment. Ecosystems digs deeper into the human impacts on ecosystems by examining the effects of fishing, agricultural runoff, and plastic pollution on marine organisms.

Science and Engineering Practices

Science and Engineering Practices are embedded across units in Grade 6. Students ask questions in order to conduct investigations and define problems so that they can design solutions through engineering challenges in The Importance of Biodiversity, Our Place in Space, and Heat. Ecosystems has students extending their knowledge of these practices in an engineering challenge to design an instrument that removes plastic from the ocean.

In Cells, they obtained and evaluated information on the issue of cultured meat, the unit's anchoring phenomenon. They then used this information to engage in argument from evidence by participating in a Socratic seminar where the perspectives of various stakeholders were represented.Ecosystems requires students to build on their experience with these practices in a Science and society lesson that asks, "Should we ban single-use plastics?"

Mathematics and computational thinking are incorporated into a lesson on human impacts on marine ecosystems, where they must consider the proportions of fish populations that survive after sustained periods of commercial fishing activity. Students have experience with using these skills in a science context from last year's Heat unit, where they made a range of calculations using temperature.

Crosscutting Concepts

Ecosystems has students considering human impacts on the environment as they evaluate data and calculate the proportion of a species' population that is lost through activities such as fishing. They are familiar with this concept from last year's unit, The Importance of Biodiversity, where students also looked at population levels and the proportions of one species compared to another. Both of these units also explore cause and effect relationships, where reduction in the population of a species has a measurable impact on other species within the same ecosystem. The concept of stability and change also applies to these population changes.

Students have learned about energy and matter in Heat, Light, and Food Chains and Food Webs, which all involve the transferral of energy within systems. They have modeled these systems in a number of ways and will learn more about energy transfer between trophic levels of an ecosystem and modeling the systems where this transfer takes place in this unit.

Structure and function is considered as students examine the composition of plastic and its properties, as well as during the engineering challenge. Students have thought about this concept in Cells, where they examined cell specialization, and in previous engineering challenges during the engineering design process.

Biomagnification happens in bigger animals
Small amounts of plastic eaten by small fish can be biomagnified up the food chain as bigger animals, such as seals, eat the smaller fish.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5 Week 6 Week 7 Week 8 Week 9 Week 10

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: The problem of plastic pollution	How does plastic pollution affect the planet?	Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**ESS3.C** Human Impacts on Earth Systems	Energy and Matter	Ask students to read article linked in lesson, *Cosmos Magazine*, "Pacific island the most plastic-polluted place on Earth"	*YouTube* video linked in teaching notes, "Turtles and plastic pollution" by *Australian Academy of Science* *YouTube* video linked in teaching notes, "Beached whale had 30 plastic bags in stomach" by *Euronews*
Lesson 2	What do you already know? Career profile: Entrepreneur	How can developments in STEM help reduce plastic pollution?	Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.C** Organization for Matter and Energy Flow in Organisms	Energy and Matter	Ask students to familiarize themselves with terminology from Glossary: Ecosystems	Ecosystems poster set. Posters are available for purchase in the Stile Shop
Lesson 3	1.1 Lesson: What are plastics?	Why is plastic not so fantastic?	Review What do you already know? lesson in Analyze Mode Review teaching notes in Prepare Mode Bring in various plastic objects with different properties for students to examine	Asking Questions and Defining Problems	**ESS3.C** Human Impacts on Earth Systems	Structure and Function	Ask students to keep a plastic diary for the next week to be used in a later lesson (1.5 Lesson: My plastic impact) Assign 1.1 Quiz: What are plastics?	
Lesson 4	1.2 Lab activity: Properties of plastics	What are the properties of different types of plastic?	Review Quiz and Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Asking Questions and Defining Problems	**ESS3.C** Human Impacts on Earth Systems	Structure and Function	Ask students to search for the recycling codes on their hard plastics at home and observe which numbers are the most common	

Lesson Planning Guide

Week 1 · **Week 2** · Week 3 · Week 4 · Week 5 · Week 6 · Week 7 · Week 8 · Week 9 · Week 10

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.3 Lab activity: Sorting plastics by density	How are different types of plastic recycled?	Review Key Questions from the previous lesson in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**ESS3.C** Human Impacts on Earth Systems	Structure and Function	Remind students to bring plastic diaries from the last week to the next lesson	1.4 Extension: The chemistry of plastics 1.4 Quiz: The chemistry of plastics
Lesson 6	1.5 Lesson: My plastic impact	How much plastic waste do I produce?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**ESS3.C** Human Impacts on Earth Systems	Structure and Function	Question 12 can be started in class and completed as a homework task	
Lesson 7	1.6 Lesson: Reducing your plastic impact	What can I do to reduce my individual plastic impact?	Review Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**ESS3.C** Human Impacts on Earth Systems	Energy and Matter		Article linked in lesson, *Cosmos Magazine,* "Technique upcycles single-use plastics"
Lesson 8	1.7 Engineering challenge: Cleaning our oceans Form a team, Define and Explore sections	Can we design and create a product that removes plastic from the ocean?	Review Key Questions from the previous lesson in Analyze Mode Prepare the materials for the engineering challenge. See the relevant pages at the end of this chapter Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**ESS3.C** Human Impacts on Earth Systems	Structure and Function	Ask students to complete questions 1–3 as homework if not completed in class	Extra SEP support: 0.3 The engineering process Extra SEP support: 1.1 Researching

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	1.7 Engineering challenge: Cleaning our oceans Design and Create sections	Can we design and create a product that removes plastic from the ocean?	Prepare the materials for the engineering challenge. See the relevant pages at the end of this chapter Review student progress in Analyze Mode	Asking Questions and Defining Problems	**ESS3.C** Human Impacts on Earth Systems	Structure and Function	Ask students to complete questions 4–5 as homework if not completed in class	Extra SEP support: 2.1 Observing and inferring
Lesson 10	1.7 Engineering challenge: Cleaning our oceans Test, Evaluate and Improve sections		Review student progress in Analyze Mode	Engaging in Argument From Evidence			Ask students to complete questions 6–7 as homework if not completed in class	Extra SEP support: 2.2 Measuring Extra SEP support: 2.7 Results Extra SEP support: 3.8 Analyzing data to test a hypothesis
Lesson 11	1.7 Engineering challenge: Cleaning our oceans		Review student progress in Analyze Mode				Ask students to complete questions 8–11 as homework if not completed in class	Website linked in lesson, *Seabin Project*
Lesson 12	2.1 Lesson: What are ecosystems?	How do living and non-living things interact in ecosystems?	Review Key Questions from engineering challenge Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**LS2.C** Ecosystem Dynamics, Functioning, and Resilience	Systems and System Models	Assign 2.1 Quiz: What are ecosystems? Ask students to bring a glass jar (such as those used for jam, peanut butter, or pickles) or large soft drink bottle for the next lesson	

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7 · Week 8 · Week 9 · Week 10

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	2.2 Lab activity: Make an ecosystem model	Can we make a model of an ecosystem?	Review Quiz and Key Questions from the previous lesson in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.C** Organization for Matter and Energy Flow in Organisms	Systems and System Models		Extra SEP support: 2.1 Observing and inferring
Lesson 14	2.3 Investigation: Abiotic factors and plant growth Form a team, Aim, Background and Variables sections	Does changing the biotic factors in an ecosystem affect plant growth?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.C** Organization for Matter and Energy Flow in Organisms	Systems and System Models	Ask students to complete questions 1–6 as homework if not completed in class	Inquiry scaffold tool linked in teaching notes
Lesson 15	2.3 Investigation: Abiotic factors and plant growth Hypothesis, Method, Materials and Safety		Review student progress in Analyze Mode	Asking Questions and Defining Problems	**LS1.C** Organization for Matter and Energy Flow in Organisms	Systems and System Models	Ask students to complete questions 7–11 as homework if not completed in class	Extra SEP support: 2.2 Measuring Extra SEP support: 2.7 Results Extra SEP support: 3.8 Analyzing data to test a hypothesis
Lesson 16	2.3 Investigation: Abiotic factors and plant growth Conducting your investigation 2.4 Lesson: Predator–prey relationships	Does changing the biotic factors in an ecosystem affect plant growth? What happens to organisms in a food web if we remove a predator?	Review Key Questions from the previous lesson in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Asking Questions and Defining Problems	**LS1.C** Organization for Matter and Energy Flow in Organisms	Systems and System Models	Explain to students that they will return to 2.3 Investigation: Abiotic factors and plant growth to enter results	Extra SEP support: 0.1 Conducting science investigations

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5 Week 6 Week 7 Week 8 Week 9 Week 10

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	2.5 Lesson: Competition	Why do species compete with each other?	Review Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.C** Organization for Matter and Energy Flow in Organisms	Cause and Effect	Ask students to observe changes in their ecosystem models from 2.2 Lab activity: Make an ecosystem model and prepare to discuss their observations in the next lesson	Extra SEP support: 2.1 Observing and inferring
Lesson 18	2.6 Lesson: Symbiosis	Can species benefit from one another?	Allow time to discuss student observations of 2.2 Lab activity: Make an ecosystem model at the beginning of class Review Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS2.C** Ecosystem Dynamics, Functioning, and Resilience	Stability and Change	Assign 2.6 Quiz: Relationships in ecosystems	
Lesson 19	3.1 Lesson: Sources of energy	How do organisms in an ecosystem obtain energy?	Review Quiz and Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**LS1.C** Organization for Matter and Energy Flow in Organisms	Systems and System Models Cause and Effect	3.1 Quiz: Sources of energy	
Lesson 20	3.2 Lesson: Energy transfer and cycling of matter	How are matter and energy lost from food chains?	Review Quiz and Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**PS3.D** Energy in Chemical Processes and Everyday Life	Scale, Proportion, and Quantity	3.2 Quiz: Energy transfer and cycling of matter	Extension section: Cycling matter and energy in an ecosystem

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5 Week 6 Week 7 Week 8 Week 9 Week 10

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 21	3.3 Investigation: Photosynthesis Introduction, Part 1: Detecting carbon dioxide	Does photosynthesis make a difference to carbon dioxide levels?	Review Quiz and Key Questions from the previous lesson in Analyze Mode Prepare the materials for Part 1 of the investigation. See the relevant pages at the end of this chapter	Asking Questions and Defining Problems	**LS1.C** Organization for Matter and Energy Flow in Organisms	Cause and Effect Systems and System Models	Ask students to complete Part 1, questions 1–6 for homework if not completed in class	Extra SEP support: 2.1 Observing and inferring
Lesson 22	3.3 Investigation: Photosynthesis Part 2: The effect of light conditions on photosynthesis. Planning your investigation section	How do different light conditions impact photosynthesis?	Prepare the materials for Part 2 of the investigation. See the relevant pages at the end of this chapter Review student progress in Analyze Mode				Ask students to complete Part 2, questions 7–14 for homework if not completed in class	Extra SEP support: 2.1 Observing and inferring Extra SEP support: 2.7 Results
Lesson 23			Review student progress in Analyze Mode	Engaging in Argument From Evidence			Ask students to complete Part 2, questions 15–22 for homework if not completed in class	Extra SEP support: 3.2 Identifying errors
Lesson 24	4.1 Lesson: Biodiversity and healthy ecosystems	How do we benefit from healthy ecosystems?	Review Key Questions from Investigation in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS2.C** Ecosystem Dynamics, Functioning, and Resilience	Systems and System Models Stability and Change	Assign 4.1 Quiz: Biodiversity and healthy ecosystems	

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 25	2.3 Investigation: Abiotic factors and plant growth Results and Communicating your findings sections	How do different light conditions impact photosynthesis?	Review Key Questions and Quiz from previous lesson in Analyze Mode Print copies of the rubric for self, peer, and teacher assessment	Engaging in Argument From Evidence	**LS1.C** Organization for Matter and Energy Flow in Organisms	Scale, Proportion, and Quantity		Extra SEP support: 2.7 Results
Lesson 26	4.2 Lesson: Population changes	Why can't populations grow indefinitely?	Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information Using Mathematics and Computational Thinking	**LS2.C** Ecosystem Dynamics, Functioning, and Resilience	Systems and System Models	Ask students to complete any unfinished questions as homework	Extra SEP support: 3.5 Reading line graphs
Lesson 27	4.3 Lesson: Human impacts Questions 1–21	How does human activity impact ecosystems?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode If you prefer to run this lesson as a jigsaw activity, it will take approximately 60 minutes. You may like to divide students into groups beforehand	Obtaining, Evaluating, and Communicating Information Using Mathematics and Computational Thinking	**ESS3.C** Human Impacts on Earth Systems	Systems and System Models Stability and Change	Ask students to complete questions 1–21 as homework if not completed in class	Extra SEP support: 3.8 Analyzing data to test a hypothesis
Lesson 28	4.3 Lesson: Human impacts Questions 22–32						Assign 4.3 Quiz: Human impacts Ask students to complete questions 22–32 as homework if not completed in class	

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7 · **Week 8** · Week 9 · Week 10

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 29	4.4 Lab activity: Make plastic from milk	Can we make plastic from milk?	Review Key Questions and Quiz from previous lesson in Analyze Mode Reading teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Asking Questions and Defining Problems	**ESS3.C** Human Impacts on Earth Systems	Scale, Proportion, and Quantity		Article linked in lesson, *Science News*, "How seafood shells could help solve the plastic waste problem"
Lesson 30	Unit review Glossary: Ecosystems	How can I be prepared for the Ecosystems test?	Review Key Questions from the unit in Analyze Mode to identify areas to revisit	Asking Questions and Defining Problems Engaging in Argument From Evidence Obtaining, Evaluating, and Communicating Information Using Mathematics and Computational Thinking	**LS1.C** Organization for Matter and Energy Flow in Organisms **LS2.C** Ecosystem Dynamics, Functioning, and Resilience **ESS3.C** Human Impacts on Earth Systems **PS3.D** Energy in Chemical Processes and Everyday Life	Scale, Proportion, and Quantity Cause and Effect Energy and Matter Systems and System Models Structure and Function Stability and Change	Ask students to review teacher feedback from lessons in the unit	Glossary: Ecosystems
Lesson 31	Test: Ecosystems	How much have I learned about Ecosystems?	Ensure every student has access to a device				Prompt students to write a reflection on what they have learned from the unit	
Lesson 32	4.4 Lab activity: Make plastic from milk Results, Discussion, and Reflection sections	Can we make plastic from milk?	Prepare the materials for the lab activity. See the relevant lab activi-ty pages at the end of this chapter Review teaching notes in Prepare Mode	Planning and Carrying Out Investigations	**PS3.D** Energy in Chemical Processes and Everyday Life	Structure and Function		

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5 Week 6 Week 7 Week 8 Week 9 Week 10

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 33	5.1 Science and society: Should we ban single-use plastics?	Should single-use plastics be banned?	Print stakeholder nametags and information cards from the link in the top teaching note Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**ESS3.C** Human Impacts on Earth Systems	Structure and Function Systems and System Models Cause and Effect Stability and Change Scale, Proportion, and Quantity	Ask students to complete questions 1–2	Extra SEP support: 1.1 Researching
Lesson 34			Watch Socratic seminar video linked teaching note				Ask students to complete questions 3–7 and prepare for seminar in the next lesson	
Lesson 35			Optional: Print the Coach's checklist from the top teaching note Complete grading of test ahead of test review session	Engaging in Argument From Evidence				
Lesson 36	Test review	How successful was my revision of Ecosystems?	Use Analyze Mode to identify questions that the class found challenging in the test and prepare to discuss these	Asking Questions and Defining Problems Engaging in Argument From Evidence Obtaining, Evaluating, and Communicating Information	**LS1.C** Organization for Matter and Energy Flow in Organisms **LS2.C** Ecosystem Dynamics, Functioning, and Resilience **ESS3.C** Human Impacts on Earth Systems	Structure and Function Systems and System Models Cause and Effect Stability and Change	Ask students to reflect on the effectiveness of their revision and identify areas for improvement	

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 37	Optional Extra 5.2 Project: Communicate the issue	How can we encourage others to reduce their plastic impact?	Review teaching notes in Prepare Mode	Engaging in Argument From Evidence	**ESS3.C** Human Impacts on Earth Systems	Scale, Proportion, and Quantity	Ask students to complete questions 1–4 as homework if not completed in class	Extra SEP support: 1.1 Researching
Lesson 38			Students will need different materials depending on their groups' decision. Things such as construction paper, markers, and scissors should be available	Asking Questions and Defining Problems			Ask students to complete questions 5–6 as homework if not completed in class	Websites linked in teaching notes, *Plastic Free July* and *Sustainability in Schools*
Lesson 39				Engaging in Argument From Evidence			Ask students to complete question 7 as homework if not completed in class	
Lesson 40			Optional: Assessment rubrics can be printed				Ask students to complete the Reflection section as homework if not completed in class	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical skills.

Students examine data about plastic use and analyze changes in the data over time. They recognize how the ratio of chemical compounds that make up a plastic determine its properties.

Students observe energy flow through ecosystems and discuss the loss of energy in food chains and webs. They plan investigations and gather data to analyze changes in population levels, and communicate numerical results.

Common Core State Standards Connections: Math

7.RP.A.2

Recognize and represent proportional relationships between quantities.

7.EE.B.4

Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.

MP.4

Model with mathematics.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Lessons within this unit incorporate many opportunities for students to develop and use their reading, writing, listening, and speaking skills.

Students engage with explanatory texts about ecosystems, and the creation and consumption of plastic. They use evidence from these texts to analyze relevant information and build their understanding.

Students use data gathered through experimentation to engage in argument. They identify central ideas from key lessons that will interest different stakeholders and present their perspectives on single-use plastic and its impact on ecosystems.

Common Core State Standards Connections: English Language Arts

WHST.6-8.1

Write arguments focused on discipline content.

WHST.6-8.2

Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

WHST.6-8.7

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

WHST.6-8.8

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

WHST.6-8.9

Draw evidence from informational texts to support analysis, instinct reflection, and research.

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.2

Determine the central ideas or conclusions of a text; provide an accurate summary of the text from prior knowledge or opinions.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Introduction: The problem of plastic pollution**
  Questions 4, 5
- **Career profile: Entrepreneur**
  Question 4
- **What do you already know?**
  Questions 2, 7, 9, 13, 14
- **1.1 Lesson: What are plastics?**
  Questions 5, 13, 16, 17, 22
- **1.2 Lab activity: Properties of plastics**
  Questions 2, 3, 4
- **1.3 Lab activity: Sorting plastics by density**
  Questions 3, 4, 5, 6
- **1.4 Extension: The chemistry of plastics**
  Question 13
- **1.5 Lesson: My plastic impact**
  Questions 4, 6, 7, 9, 11
- **1.6 Lesson: Reducing your plastic impact**
  Question 8
- **1.7 Engineering challenge: Cleaning our oceans**
  Question 10
- **2.1 Lesson: What are ecosystems?**
  Questions 4, 5, 6, 7, 10, 12, 18, 19
- **2.2 Lab activity: Make an ecosystem model**
  Questions 6, 8
- **2.3 Investigation: Abiotic factors and plant growth**
  Questions 14, 15, 16, 17, 19, 20, 22
- **2.4 Lesson: Predator–prey relationships**
  Questions 5, 6
- **2.5 Lesson: Competition**
  Questions 6, 8
- **2.6 Lesson: Symbiosis**
  Questions 6, 7, 10, 12, 14, 16, 17, 18
- **3.1 Lesson: Sources of energy**
  Questions 3, 6, 7, 8, 9, 13, 14, 15
- **3.2 Lesson: Energy transfer and cycling of matter**
  Questions 3, 7, 11, 12, 15, 16, 17, 18, 19, 20
- **3.3 Investigation: Photosynthesis**
  Questions 4, 6, 10, 18, 19, 20, 22
- **4.1 Lesson: Biodiversity and healthy ecosystems**
  Questions 9, 10, 13, 14, 15, 16, 18
- **4.2 Lesson: Population changes**
  Questions 4, 5, 7, 9, 11, 13, 14, 16
- **4.3 Lesson: Human impacts**
  Questions 8, 16, 17, 26, 27, 29, 30
- **4.4 Lab activity: Make plastic from milk**
  Questions 5, 6, 9, 10, 11
- **5.1 Science and society: Should we ban single-use plastics?**
  Questions 3, 4, 6, 11
- **5.2 Project: Communicate the issue**
  Questions 3, 4, 5

Extension opportunities in this unit

Challenge Questions

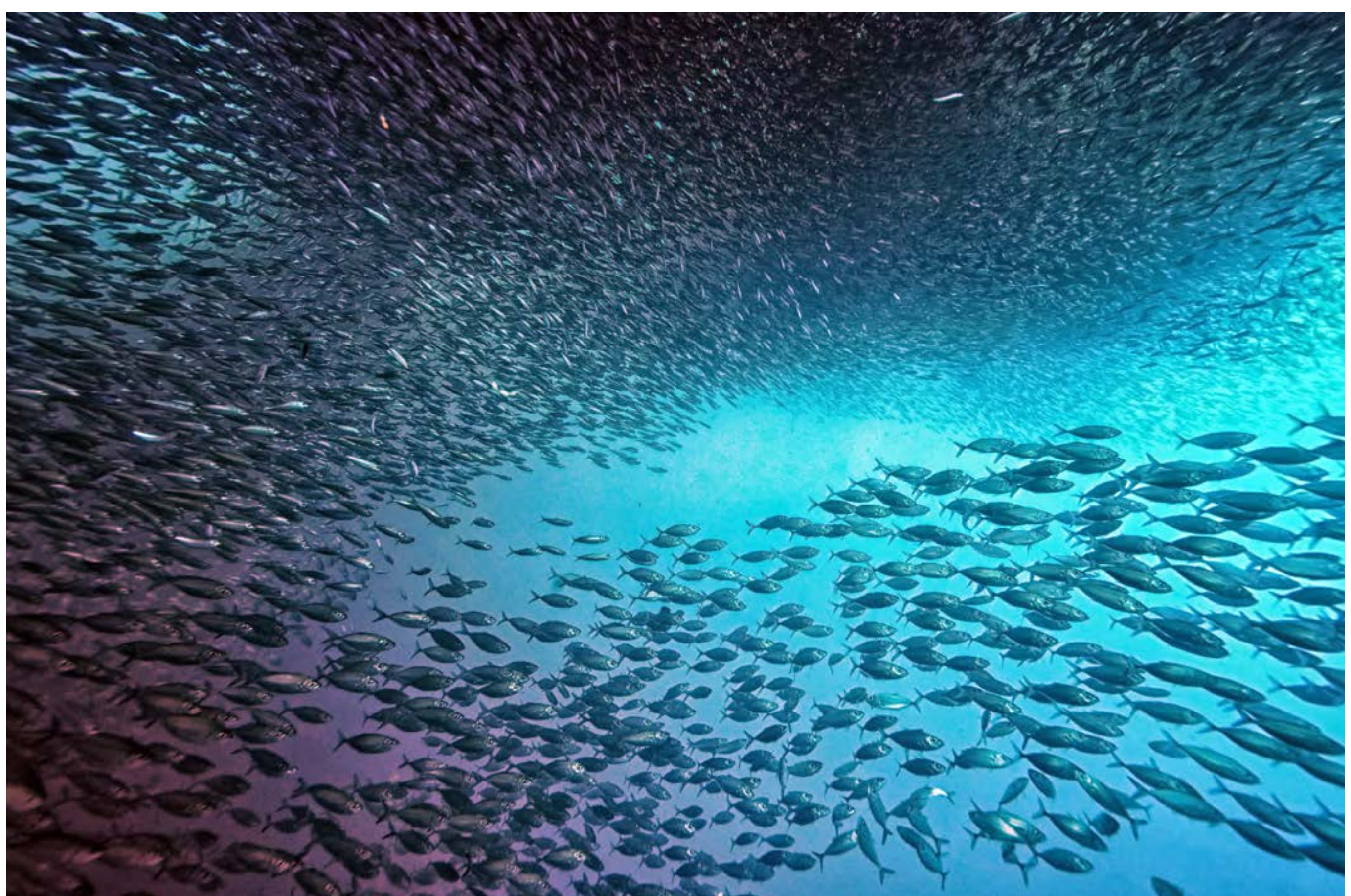
Most lessons contain one or more Challenge Questions, which are an opportunity for students to show they are working above the level of the learning goal. When answering these questions, students can extend themselves by applying their knowledge to new contexts, or to solve more complex problems. These provide a great extension opportunity.

Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC
1.4 Extension: The chemistry of plastics	How are plastics made?	Optional: molecule-building kits Optional: craft items, such as pipe cleaners, paper clips, paper straws, toothpicks, popsicle sticks, pom poms, etc.	Developing and Using Models	**PS1.A** Structure and Properties of Matter	Structure and Function
1.7 Engineering challenge: Cleaning our oceans	Can we design and create a product that removes plastic from the ocean?	Consider giving students a budget and assigning dollar values to each of the materials provided. This simulates real-world engineering constraints	Asking Questions and Defining Problems	**ESS3.C** Human Impacts on Earth Systems	Structure and Function
3.2 Lesson: Energy transfer and cycling of matter Extension: Cycling matter and energy in an ecosystem	How can a plant survive for 50 years without water?	Review teaching notes in Prepare Mode	Developing and Using Models	**LS1.C** Organization for Matter and Energy Flow in Organisms **LS2.C** Ecosystem Dynamics, Functioning, and Resilience	Structure and Function
4.2 Lesson: Population changes	Why can't populations grow indefinitely?	Prepare an example of an exponential model of growth to contrast with the logistic function shown in the Adak Island otter population	Obtaining, Evaluating, and Communicating Information Using Mathematics and Computational Thinking	**LS2.C** Ecosystem Dynamics, Functioning, and Resilience	Systems and System Models
5.1 Science and society: Should we ban single-use plastics?	Should we ban single-use plastics?	Provide students with examples of single-use plastics which are hard to avoid, such as those used in a medical setting. See the article in the teaching note for more detail.	Engaging in Argument From Evidence	**ESS3.C** Human Impacts on Earth Systems	Structure and Function Systems and System Models Cause and Effect Stability and Change Scale, Proportion, and Quantity

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize them within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.



Lesson	Misconception	Addressing the misconception
What do you already know?	The Sun doesn't play a role in food chains and food webs.	Sunlight is the main source of energy for life on Earth. Sunlight energy is captured by producers via photosynthesis. Use Chapter 3 lessons to explore photosynthesis. Discuss the flow of energy from plant producers to animal consumers in this process. Ask questions about where each trophic level obtains its energy, all the way down to plant producers, and then ask where they obtain their energy from. Using diagrams to illustrate this flow of energy will be helpful to demonstrate the Sun's role.
	Energy flows in all directions in food webs and food chains.	**Use 3.2 Lesson: Energy transfer and cycling of matter** to discuss the way in which energy flows within food webs and food chains. The video "Energy transfer through a food chain" explains the process with helpful visuals. Ask students questions about where each organism obtains its energy to help them clarify this.
	Organisms can only occupy one trophic level.	Organisms can be primary, secondary, or tertiary consumers simultaneously. This is because they can be a part of several different food chains within a food web. See the Food Chains and Food Webs unit for examples and resources related to this idea.
	The arrows in food chains represent that one organism eats another organism. The direction of each arrow is often described as pointing from one organism to the organism that eats it.	Strictly speaking, the arrows represent the transfer of energy from one trophic level to another. This distinction is made by explaining the arrows as illustrating the flow of energy rather than showing which organism consumes another.

Lesson	Misconception	Addressing the misconception
2.5 Lesson: Competition	Competition between organisms always involves direct, aggressive interaction.	In fact, competition does not require aggression or direct interaction, such as fighting over food. Predators that share the same feeding ground are in competition even if they never cross each other's paths. Corals compete for space and sunlight simply by growing on the same area of rock. **Refer to the examples in Question 4 of 2.5 Lesson: Competition** All but one of these are examples of competition, however only one involves direct, aggressive interaction. Emphasize that whenever a resource in an ecosystem is limited, organisms are competing for it (question 3 addresses this). For each example, ask students, "What is the resource? Is there more than one organism trying to access it? Is this resource limited or infinite?" These questions could be written into a flow chart, where students can follow the path to identify if an example is competition.
	Plants do not compete for resources.	In fact, plants can compete for many resources, including sunlight, water, and nutrients. As with the above misconception, emphasize that whenever a resource in an ecosystem is limited, organisms are competing for it (question 3 addresses this). For each example, ask students, "What is the resource? Is there more than one organism trying to access it? Is this resource limited or infinite?" These questions could be written into a flow chart, where students can follow the path to identify if an example is competition.
	Organisms of the same species do not compete with each other for resources.	Competition often occurs between organisms of the same species when there are limited resources, including food, mates, and territory. Explain that when each individual organism requires access to a limited resource, this leads to competition. Offer an example, such as a herd of elephants drinking from a watering hole. There is a limited source of water, and all of the elephants are trying to access this resource. Therefore, there is competition.

Relationships in ecosystems
Clownfish and anemones have a mutualistic relationship, where both species benefit from one another.

ELL support

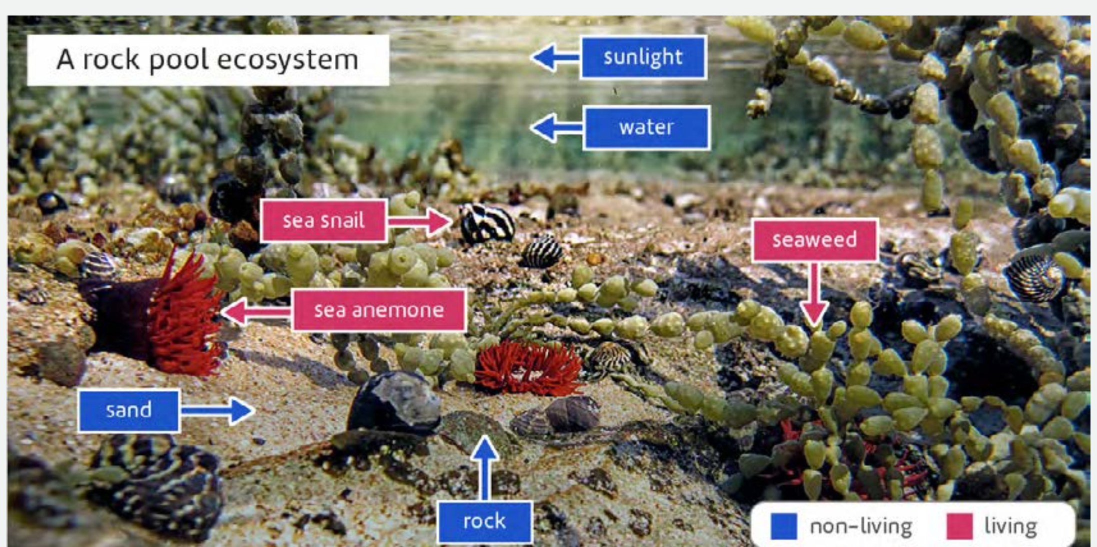
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

Ecosystems lessons include a number of flow charts and diagrams to help students understand the complexity of food chains and food webs and how human interactions can put them at risk. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

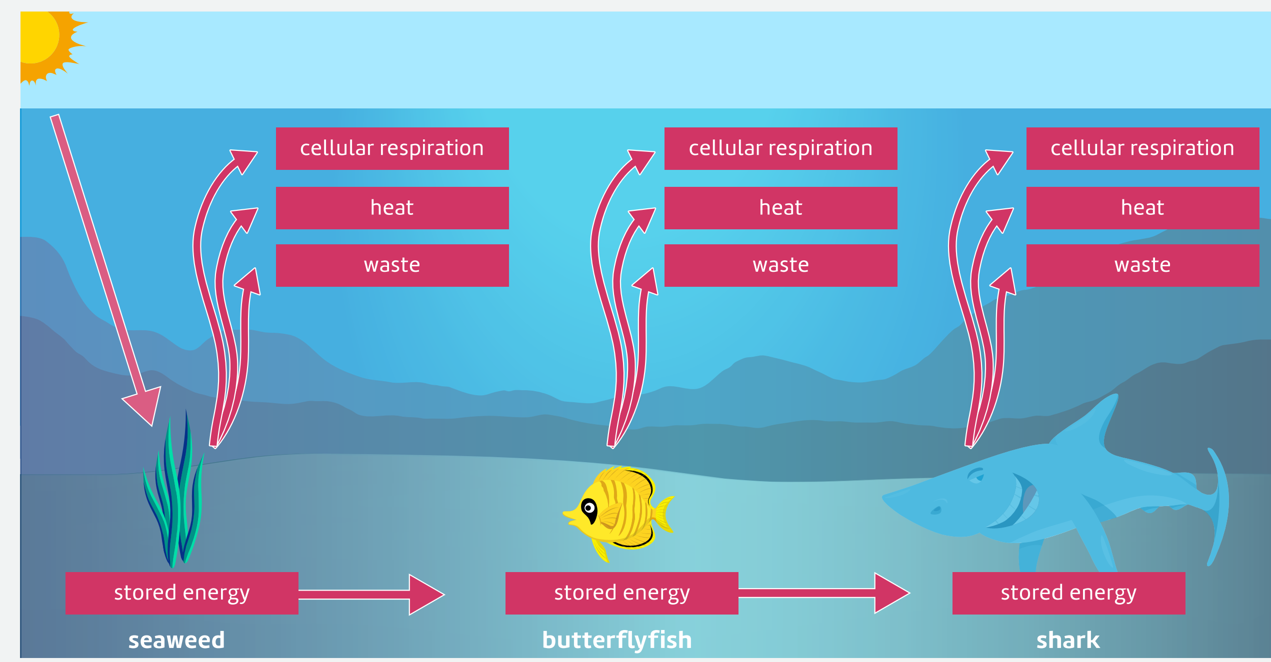
2.1 Lesson: What are ecosystems?

Some students may not be familiar with the particular ecosystems that are used as examples, especially the example species. This diagram breaks up the components of an ecosystem into living and non-living, and includes their common names. The use of labeling allows students to connect familiar visual examples with the English vocabulary.



3.2 Lesson: Energy transfers and cycling of matter

An example of a food chain is illustrated and labeled with key information from the lesson. The repetition within each step emphasizes key information in this flow chart, and simple labels support students to interpret meaning from the chart in combination with the lesson's text. Students can clearly identify the flow of energy within this ecosystem, from the Sun to the seaweed, and between organisms. The loss of energy between organisms is also evident.

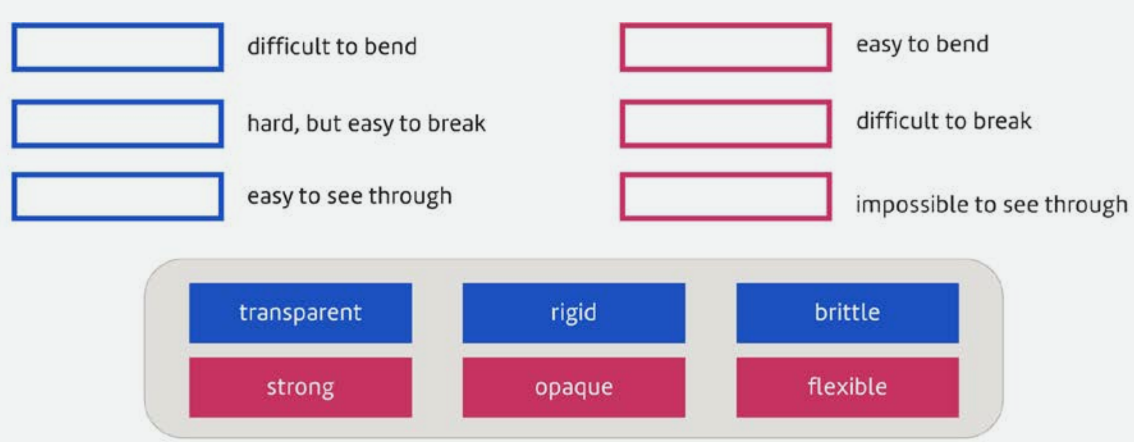


Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.1 Lesson: What are plastics?

Complex, topic-specific language is provided for students to drag-and-drop into the appropriate location. Students are able to consolidate the connection between this terminology and its definition, building a foundational understanding for students to draw upon throughout the unit.



Human impacts
Fishing is one human activity that has an impact on marine ecosystems.

Customization

There are many opportunities to create customized lessons within the Ecosystems unit. Here are a few ideas for providing local context for your learners:

2.1 Lesson: What are ecosystems?
This is an opportunity to draw on local examples of ecosystems. You can include images of flora and fauna that your students will recognize and modify text and questions to discuss their ecosystems.

2.4 Lesson: Predator–prey relationships
Familiar examples of wildlife from your region can also be added to this lesson. Images, food webs, and questions can be modified to incorporate material that will be particularly engaging for your students.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Pre-test: What do you already know?
Activate students' prior knowledge of relevant concepts including the role of the Sun in food webs, energy flows and trophic levels within food webs. Use this as a pre-test to identify misconceptions and areas where students may need additional challenge or support in subsequent lessons.

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes
Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5–10 minutes. Quizzes provide students and teachers with information about student progress toward specific learning goals.

- **1.1 Quiz: What are plastics?**
  Multiple choice: 5–10 minutes
- **1.4 Quiz: The chemistry of plastics**
  Multiple choice: 5–10 minutes
- **2.1 Quiz: What are ecosystems?**
  Multiple choice: 5–10 minutes
- **2.6 Quiz: Relationships in ecosystems**
  Multiple choice: 5–10 minutes
- **3.1 Quiz: Sources of energy**
  Multiple choice: 5–10 minutes
- **3.2 Quiz: Energy transfer and cycling of matter**
  Multiple choice: 5–10 minutes
- **4.1 Quiz: Biodiversity and healthy ecosystems**
  Multiple choice: 5–10 minutes
- **4.3 Quiz: Human impacts**
  Multiple choice: 5–10 minutes

Summative assessment

Test
This unit contains a test to provide summative assessment of student learning across the whole unit.

- **Test: Ecosystems**
  Multiple choice and short answer: 45–60 minutes

Science and Engineering Practices
Four lab activities and an engineering challenge within the unit can be used as summative assessments of Science and Engineering Practices

- **1.2 Lab activity: Properties of plastics**
  Lab activity: 30–45 minutes
- **1.3 Lab activity: Sorting plastics by density**
  Lab activity: 45–60 minutes
- **1.7 Engineering challenge: Cleaning our oceans**
  Engineering challenge: 180–240 minutes
- **2.2 Lab activity: Make an ecosystem model**
  Lab activity: 45–60 minutes
- **4.4 Lab activity: Make plastic from milk**
  Lab activity: 45–60 minutes

Lab Activities

Lab Activity

Properties of plastics

Activity purpose: Sort different types of plastic by their recycling numbers and observe their properties.

stileapp.com/go/propertiesofplastics

30–45 minutes

2–4 students per group

Materials

Lab Equipment
Each group of students will need:
- a range of plastic objects, including at least one of each type of plastic (see note on next page)

Chemicals
None required

Preparation

You might encourage your students to bring empty plastic containers with recycling numbers from home.

Notes

Examples of plastic objects include:

- PET plastic (Polyethylene terephthalate, plastic code 1), e.g., soft drink or water bottle, peanut butter jars, etc.
- HDPE plastic (High density polyethylene, plastic code 2), e.g., milk and juice containers or shampoo bottles, grocery bags
- PVC plastic (Polyvinyl chlorine, plastic code 3), e.g., vinyl tablecloth or shower curtains, cling wrap
- LDPE plastic (Low density polyethylene, plastic code 4), e.g., bread, grocery bags, or resealable sandwich bags, small trash bags
- PP plastic (Polyethylene, plastic code 5), e.g., take-out or margarine containers or polystyrene rope, bottle caps, straws
- PS plastic (Polystyrene, plastic code 6), e.g., yogurt containers, coffee cup lids, plastic cutlery, foam cups, plastic lids, packing peanuts

Each group of students will need at least one object made from each type of plastic, but preferably more than one of each type.

Method

Method that students will follow

1. Sort the plastic objects into six groups by finding their recycling numbers.
2. Transparency: Record whether the objects in each group are transparent or opaque.
3. Flexibility: Record whether you can bend the objects in each group.
4. Brittleness: Record whether the plastic objects break when they are bent.
5. Softness: Record whether you are able to scrunch each plastic object into a ball.

Lab Activity

Sorting plastics by density

Activity purpose: Test the densities of different types of plastic in order to understand how they can be separated for recycling.

stileapp.com/go/sortingplastics

45–60 minutes

2–4 students per group

Materials

Lab Equipment

Each group of students will need:

- 1 object made from each type of plastic (see note on next page)
- scissors
- 30 cm ruler
- permanent marker
- 6 x 100 mL beakers
- stirring rod
- gloves
- waste container for used plastics

Chemicals

- 50 mL isopropyl alcohol pure liquid
- 50 mL vegetable oil
- 50 mL distilled water
- 50 mL salt water (see note on next page)
- 50 mL honey

Preparation

The salt water should be prepared by dissolving 120 g of salt per 1 L of water to give it a density of approximately 1.08 g/mL.

Students are also asked to cut the plastic items into small pieces to test their densities. To save time and minimize plastic waste, you could create a class set of pre-cut plastic pieces. Each piece would need to be labeled with its recycling number (1–6) using a permanent marker. At the end of the lab activity, these could be washed and then reused by other classes.

Notes

Examples of plastic objects include:

- PET plastic (Polyethylene terephthalate, plastic code 1), e.g., soft drink or water bottle, peanut jars, etc.
- HDPE plastic (High density polyethylene, plastic code 2), e.g., milk and juice containers or shampoo bottles, grocery bags
- PVC plastic (Polyvinyl chlorine, plastic code 3), e.g., vinyl tablecloth or shower curtains, cling wrap
- LDPE plastic (Low density polyethylene, plastic code 4), e.g., bread, grocery bags or ziplock bags, small trash bags
- PP plastic (Polyethylene, plastic code 5), e.g., take-out or margarine containers, polystyrene rope, bottle caps, straws
- PS plastic (Polystyrene, plastic code 6), e.g., yogurt containers, coffee cup lids, plastic cutlery, foam cups, plastic lids, packing peanuts

Teachers could label beakers or glass jars for a class set of this activity and keep solvents to reuse for subsequent classes.

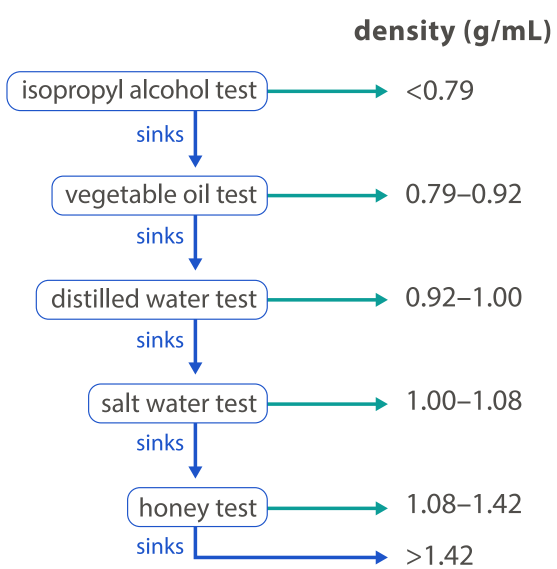
At the conclusion of the lab activity, collect the plastic pieces to be washed and reused by other classes.

Keep solvents in their containers for reuse.

Method

Method that students will follow

1. Carefully use scissors to cut out 5 small samples of each type of plastic. Each piece should measure 2 cm x 2 cm.
2. Use a permanent marker to label each sample with its recycling number.
3. Add 50 mL of each liquid to different beakers and clearly label each one: isopropyl alcohol, vegetable oil, distilled water, salt water, and honey.
4. Place the sample of Type 1 plastic into the beaker with isopropyl alcohol. Use a stirring rod to gently push down on the plastic to break the surface tension. Observe whether the plastic sinks or floats. Remove the plastic.
5. Repeat Step 4 with the other types of plastic. If a piece of plastic floats then it must be less dense than isopropyl alcohol (0.79 g/mL). Record this in the results table and stop testing this type of plastic.
6. For the types of plastic that sank in isopropyl alcohol, use new samples to test whether they sink or float in the vegetable oil. If a sample floats, use the flow chart to determine its density range. As before, record this in the results table and stop testing this type of plastic.
7. Follow the flow chart until each type of plastic floats, allowing you to determine its density range. If a sample sinks in all tests then its density must be greater than 1.42 g/mL.



The cycling of matter
All matter on Earth cycles through different processes. These processes can even be through living organisms.

Lab Activity

Cleaning our oceans

Activity purpose: Challenge students to design and test a device that removes plastic waste from the ocean.

stileapp.com/go/cleaningouroceans

180–240 minutes

3–4 students per group

Materials

Lab Equipment
Each group of students will need:
- a selection of used plastic bags, plastic containers, and cups
- rubber bands
- rope or string
- cardboard
- popsicle or craft sticks
- bamboo skewers
- wire or pipe cleaners
- corks, styrofoam, or bubble wrap
- small weighted objects, such as pebbles
- fabric or net-like cloth, such as hessian
- scissors
- sticky tape
- staples
- Blu-Tack or play dough
- ruler

For testing the devices:
- large plastic container, filled with water
- floating plastic waste items in a range of sizes, such as small straws, plastic food wrappers, and bottle caps

Chemicals
None required

Preparation

None required

Notes

To simulate an ocean environment we recommend filling a large container with water and floating plastic waste items in a range of sizes, such as small straws, plastic food wrappers, and bottle caps. The same items can be used for multiple classes to minimize waste.

We recommend that students work individually to initially define the problem, research, and brainstorm solutions before they join together in groups.

At the conclusion of the challenge, collect the plastic waste items used to test the devices for recycling.

Method

Method that students will follow
Students will follow the engineering design process to create a new and innovative product.

Instructions provided to students include:

How can we efficiently remove plastic waste from a river or ocean? Your task is to design a device to help do this. You will need to design, build, and test a small-scale model that meets the following criteria:

- has a maximum height of 30 cm and a maximum length of 30 cm
- is able to collect floating plastic from the ocean
- is constructed from the materials supplied by your teacher

Your model will be tested in the classroom by placing it in a large tub of water with floating pieces of plastic of different sizes. Your device does not need to target all sizes of plastic waste. Waves and currents may be simulated by gently shaking the tub. A river current could be simulated by gently running your hand through the water in one direction.

As an engineer, you may also like to consider the following questions in your design:

- What conditions is your device best suited to? For example, will it float in the open ocean, be tied to a pier in a sheltered bay, or be fixed to the bank of a river?
- How will you empty the plastic waste that is collected by the device?
- How will you protect wildlife from being trapped by the device?
- Can you make your device without using plastic at all? Or by using recycled plastic?
- How durable and long-lasting will your device be?

Lab Activity

Make an ecosystem model

Activity purpose: Students make a terrarium as a model of an ecosystem and identify the biotic and abiotic factors operating within it.

stileapp.com/go/ecosystemmodel

45–60 minutes

2–3 students per group

Materials

Lab Equipment
Each group of students will need:

- large glass jar (min. height 12 cm) with lid
- trowel/scoop/spoon
- approx. ½ cup gravel
- approx. ½ cup sand
- 1–2 cups soil or potting mix
- small plant or seedling such as moss, fern, or flowering lobelia
- 20 mL water
- masking tape (5 rolls per class)
- gloves
- optional: wide-mouthed funnel

Chemicals
None required

Preparation

None required

Notes

An alternative to glass jars is to use large plastic soft drink bottles. If plastic bottles are used, we recommend that they are cleaned and recycled after the activity.

Cheap flower seedlings are suitable for this activity. However for longer-lasting terrariums, we suggest plants that tolerate low light and high moisture, such as ferns, mosses, and other small tropical or "indoor" plants.

We recommend that students collect their own glass jars, such as those used for jam, peanut butter, olives, or pickles.

Assumed prior knowledge for this activity includes a basic understanding of the water cycle. You may wish to review this concept with your students in order to help them answer the discussion questions.

Method

Method that students will follow
Note: If your jar is about 12 cm tall, use the smaller measurements in the steps below. If your jar is taller, you can add more accordingly.

1. Wearing gloves, use the trowel to add 1–2 cm of gravel to the bottom of a clean, dry glass jar.
2. Add 1–2 cm of sand in a flat layer on top of the gravel.
3. Carefully add 4–6 cm of soil or potting mix. Use a funnel if possible to prevent soil sticking to the sides of the jar.
4. Use the trowel to scoop a small hole in the soil. Plant the seedling in the hole. Gently press the soil around its roots.
5. Sprinkle a small amount of water to dampen the soil. Be careful not to soak the soil with too much water. This may stop air getting to the roots and drown the plant.
6. Secure the lid on top of the jar and seal it with masking tape.
7. Place the terrarium near a window with plenty of indirect sunlight. Observe any changes over a number of days or weeks.

Lab Activity

Abiotic factors and plant growth

Activity purpose: Students conduct an open inquiry to investigate the impact of an abiotic factor on plant growth.

stileapp.com/go/abioticfactors

120–180 minutes

3–4 students per group

Materials

Lab Equipment
The materials needed will depend on the experimental design that each group of students comes up with. It is likely that each group will need:
- at least 3 seedlings or small plants
- at least 3 small pots with labels
- different types of soil or potting mix
- fertilizer
- trowel/scoop/spoon
- thermometers
- lamps or flashlights
- tape or glue
- scissors
- ruler
- marker
- gloves
- other assorted materials (see note on next page)

Chemicals
- fertilizer
- water

Preparation

None required

Notes

Abiotic factors that students may choose to investigate include temperature, the amount of sunlight, the amount of water, or the type of soil.

Depending on the abiotic factor, you may also need to provide:

- 3 cups of different types of growth medium (e.g., clay, sand, pine bark, coconut husk, soil, or potting mix)
- 1 cup fertilizer (with packet instructions for dilution for students to work with), water, spatula, measuring cup
- 3 thermometers
- 3 lamps or flashlights
- 3 pieces of different colored cellophane
- 3 cardboard boxes
- water, measuring cylinder

We recommend that you run this investigation over the course of 1–2 weeks to allow sufficient time for the plants to grow.

This template is designed to guide students through the steps of an open inquiry. It is important to consider if this type of inquiry is appropriate for your students and the type of investigation they are pursuing. You can easily modify the template by:

- varying the level of inquiry, e.g., defining a particular aim, set of materials, or method
- focusing on a particular aspect of inquiry, e.g., devising a hypothesis, identifying variables, or analyzing data
- adding extra scaffolding to support less experienced students

Method

Method that students will follow
Students will design their own method, which will require teacher approval before commencement.

Instructions provided to the student include:

Choose one abiotic factor and conduct an investigation to find out how it affects plant growth.

The design of the investigation is up to you, but here are some questions to help guide you.

- How will you vary your chosen abiotic factor from one plant to another?
- How will you measure the growth of the plants?
- How long will you run your investigation for and how frequently will you collect your results?

Further scaffolding to plan, conduct, and communicate a science investigation is provided for students in the Stile lesson.

Lab Activity

Photosynthesis

Activity purpose: Demonstrate that carbon dioxide is absorbed by plants for photosynthesis and investigate how light conditions affect the rate of photosynthesis.

stileapp.com/go/photosynthesis-investigation

90–120 minutes

2–3 students per group

Materials

Lab Equipment

Part 1
- 250 mL beaker
- 2 x test tubes
- 2 x rubber stoppers
- 10 mL measuring cylinder
- test tube rack
- stirring rod
- paper or metal straw
- 4–5 cm piece of pondweed or leaf (see note below)
- light source, such as a white light lamp or bright sunlight

Part 2
- 3 x extra test tubes and stoppers
- 3 x 4–5 pieces of pondweed or leaf
- extra white light lamps
- 10 m measuring tapes
- materials of different transparency, such as black paper, cotton gauze, muslin cloth, tissue paper, or colored cellophane
- masking tape
- stopwatch

Chemicals
- 50 mL distilled water
- 40 drops universal indicator in dropper bottle and color chart

Preparation

None required

Notes

For this activity we recommend using a variety of pondweed, such as Cabomba. Note that Cabomba may be considered an invasive weed in your country and should be disposed of responsibly. Alternative plants should have fast-growing leaves and a high photosynthetic rate, such as Paspalum, flax, corn, weeping willow, geranium, ivy, or spinach.

Keep the plant in sunlight prior to class so that the leaves can photosynthesize. This will help to give a faster color change with the indicator.

The indicator that will provide the most obvious color changes is bicarbonate indicator. Other indicators that are suitable for this activity are red cabbage indicator and phenol red. However, the activity has been written based on the use of universal indicator because this is more readily available. If a different indicator is used, you will need to provide different color charts for students to refer to.

This activity relies on a change in acidity to show that carbon dioxide is being used for photosynthesis. Prior knowledge of acids and bases is not required, but if your students have already covered this topic in chemistry then this lesson will serve as great revision and reinforcement.

Part 2 of this lesson is a template designed to guide students through the steps of an open inquiry. It is important to consider if this type of inquiry is appropriate for your students and the type of investigation they are pursuing. You can easily modify the template by:

- varying the level of inquiry, e.g., defining a particular aim, set of materials, or method
- focusing on a particular aspect of inquiry, e.g., devising a hypothesis, identifying variables, or analyzing data
- adding extra scaffolding to support less experienced students

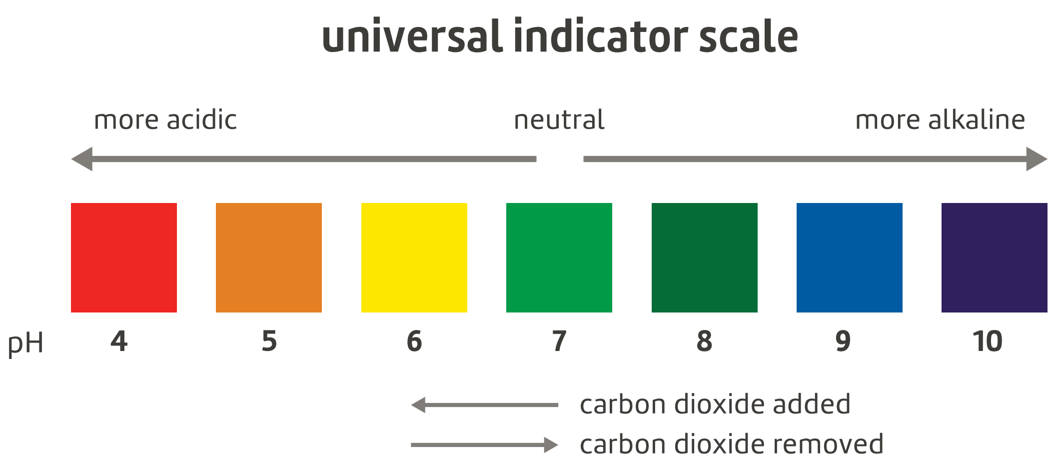
Method

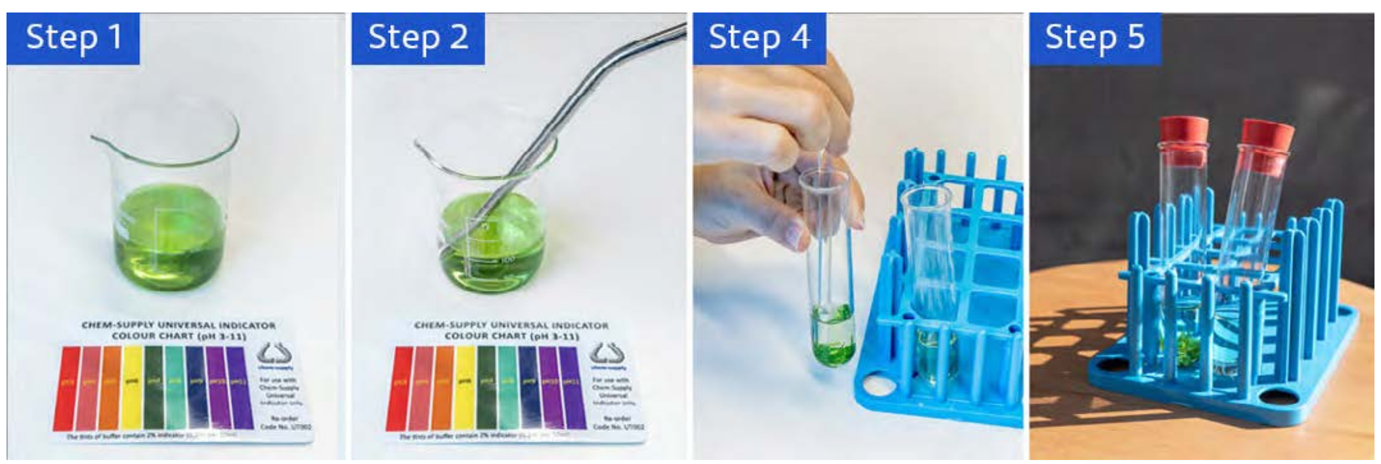
Method that students will follow

Part 1
1. Add 100 mL distilled water to the beaker. Mix in 40 drops of universal indicator to make a solution.
2. Using a straw, blow into the solution until you see a distinct color change. Do not suck through the straw or you will bring universal indicator into your mouth.
3. Rinse the test tubes with a small amount of the indicator solution. Measure 10 mL of indicator solution into each.
4. Place the small piece of pondweed in one of the test tubes. Push it gently to the bottom of the solution with a stirring rod. The test tube with no pondweed is the control.
5. Seal the test tubes with rubber stoppers and place them under a white light source or sunlight. If using a lamp, make sure the test tubes are exactly the same distance from it.
6. Wait at least 20 minutes to observe a noticeable color change in the test tube with pondweed.
7. Record the color changes in your results. Use the universal indicator scale (see next page) to determine whether carbon dioxide has been added or removed from the solution.

Note: It may help to take the pondweed out of the test tube before comparing the color to the indicator chart. This is because reflected light from the pondweed makes the solution look a bit greener than it actually is.

Method (Continued)





Method (Continued)

Part 2
Students will design their own investigation, which will require teacher approval before commencement.

Instructions provided to the student include:

Use the indicator and pondweed to conduct an investigation that tests the effect of different light conditions on photosynthesis. For example, you might choose to investigate light intensity, light color, or the number of hours of light per day.

The design of the investigation is up to you, but here are some points to help guide you.

- How will you change your independent variable? For example, will you increase distance from a lamp, cover the test tubes with different materials, or something else?
- You should have at least three different conditions for your independent variable. For example, if you were changing distance from a lamp, your conditions might be 0.5 m, 1.0 m and 1.5 m.
- Which other variables will you keep constant so that it is a fair test?

Further scaffolding to plan, conduct, and communicate a science investigation is provided for students in the Stile lesson.

Lab Activity

Make plastic from milk

Activity purpose: Students make a biodegradable plastic out of casein and evaluate its properties.

stileapp.com/go/plasticfrommilks

40–60 minutes

2 students per group

Materials

Lab Equipment
Each group of students will need:
- Bunsen burner
- tripod
- gauze mat
- heatproof mat
- matches or lighter
- 2 x 250 mL beakers
- 250 mL measuring cup
- 50 mL measuring cylinder
- stirring rod
- thermometer
- paper towels
- cloth strainer
- butcher's paper
- optional: cookie cutters

Chemicals
- 150 mL whole milk
- 10 mL white vinegar

Preparation

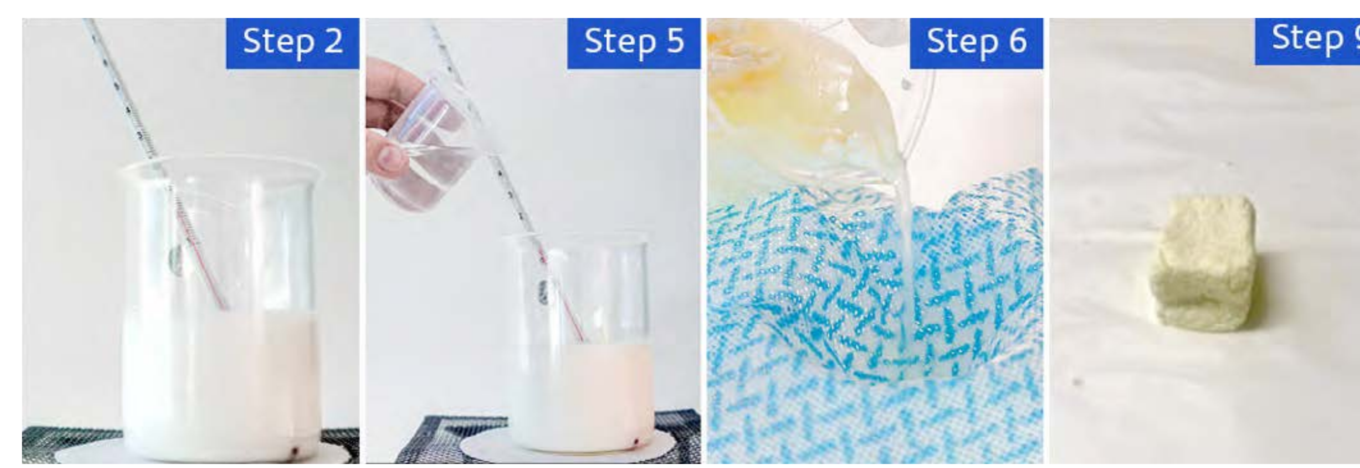
None required

Notes

Please note that the casein plastic made in this lab activity will take 3–4 days to harden enough for students to test its properties. The exact drying time depends on the size and thickness of the object made. The casein plastic will continue to dry and harden over several weeks.

Method

Method that students will follow
1. Set up the Bunsen burner and tripod on the heatproof mat. Place the gauze mat on the tripod.
2. Using the measuring cup, pour 150 mL of milk into a beaker.
3. Place the beaker of milk on the gauze mat and heat it using the safety flame. Stir the milk gently with the stirring rod.
4. When the milk reaches 122°F, turn the Bunsen burner off.
5. Using the measuring cylinder, add 10 mL of vinegar to the milk and stir. Small solid pieces will be visible floating in the mixture.
6. Carefully pour the mixture through a cloth strainer into a second beaker. Gently squeeze the cloth to remove as much of the liquid as possible.
7. Place the solids left in the strainer onto a paper towel and pat them dry.
8. Gather the solids and knead them together. Use a cookie cutter or your fingers to shape the solids into something you could use – for example, dice, jewelry, buttons, or a small trinket dish.
9. Leave the object on butcher's paper to dry. This will take about 2 to 3 days.
10. Once the object is dry, observe the material's properties. Identify whether it is transparent, flexible, brittle, or soft. Record these properties in the results table.



Unit 4 – The Nervous System

Could machines sniff out cancers better than dogs?

Dogs explore the world differently
Dogs can have up to 300 million olfactory (smell) receptors, compared to 40 million receptors in humans.

Storyline and anchoring phenomenon

Dogs have an amazing sense of smell that can detect cancers and other diseases. This ability is inspiring scientists to develop electronic detectors that could do the same. To understand how these devices would work, students learn about the basics of the nervous system.

Students first engage with the unit by drawing on their own experiences with taste and smell. They examine the structure of the nervous system and neurons and consider their function in transmitting signals that we interpret as senses. Five types of receptors are introduced as students interpret stimulus-response pathways and apply their understanding to the example of a medical detection dog.

Students communicate their understanding of synapses using their preferred medium including written text, voice recording, images, and video. Finally, they apply Science and Engineering Practices in an investigation into the relationship between taste and smell and communicate their findings in a written format.

This unit at a glance

Students **activate prior knowledge** by remembering their own experiences with smell.

The Nervous System

Introduction: Sniffing out cancer

1.1 Lesson: Parts of the nervous system
1.2 Lesson: Stimulus-response pathways
1.3 Investigation: Taste and smell

Career profile: Behavioral psychologist
Glossary: The nervous system
Test: The nervous system

Students will discover the mechanisms behind our senses.

Students investigate the connection between taste and smell in a **hands-on activity**.

Tests measure student achievement and provide opportunities for **reflection** and **feedback**.

The glossary provides definitions of key terms accompanied by images. These are perfect for **supporting ELL students** to build scientific vocabulary.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-LS1-8

Gather and synthesize information that sensory receptors respond to stimuli by sending messages to the brain for immediate behavior or storage as memories.

Disciplinary Core Idea

- **LS1.D**: Information Processing

Students explore the role of sensory receptors in human senses and learn how information is sent to the brain via the central nervous system, where it is processed to determine a response.

Science and Engineering Practices

- Constructing Explanations and Designing Solutions
- Obtaining, Evaluating, and Communicating Information
- Analyzing and Interpreting Data
- Planning and Carrying Out Investigations

Students carry out an investigation into the connection between the senses of taste and smell.

As part of this investigation, students obtain and evaluate information, analyze, and interpret data, and then use this data to construct an explanation of how human senses function. This explanation is then communicated through a written report.

Crosscutting Concepts

- Patterns
- Systems and System Models
- Structure and Function
- Stability and Change

Students consider Systems and System Models as they learn about the nervous system.

Students develop an understanding of Structure and Function as they learn about the nervous system's components, including neurons, to explain how human senses work. They observe patterns in an investigation task to establish a connection between the senses of taste and smell.

Science, Technology, Society and the Environment

– Interdependence of Science, Engineering, and Technology

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

Students build on their understanding from the Grade 6 Light unit about the way in which receptors allow us to perceive light and color.

In The Nervous System, they will learn about the way in which information is sent to the brain via the central nervous system, where it is perceived by the brain.

Science and Engineering Practices

Students have engaged in constructing explanations through all units at a Grade 6 level by applying their understanding of scientific ideas to explain examples and real-world phenomena.

They continue to apply these processes in The Nervous System. The cause and effect relationship that exists between taste and smell is explored through an investigation in the unit, where they also apply the practice of planning and carrying out investigations. From this investigation, students obtain and evaluate data and communicate their understanding through written responses.

Crosscutting Concepts

The Nervous System addresses the concepts of patterns, systems and system models, and structure and function.

They use patterns to infer a cause and effect relationship between taste and smell, providing a different context compared to previous examples from Ecosystems and The Importance of Biodiversity where students identified patterns associated with population levels.

The sense of smell
The olfactory receptor cells, responsible for our sense of smell, are the most frequently replaced neurons in the body.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 Week 2

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Sniffing out cancer Career profile: Behavioral psychologist	How can humans work with animals to detect diseases?	Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**LS1.D** Information Processing	Systems and System Models	Ask students to brainstorm other uses of detection dogs	Article linked in lesson, *Cosmos Magazine*, "Cancer detected by a sniff"
Lesson 2	1.1 Lesson: Parts of the nervous system	How do messages from our senses travel through our body to our brain?	Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**LS1.D** Information Processing	Structure and Function	Ask students to create a labeled diagram of a neuron cell from memory	Glossary: The nervous system
Lesson 3	1.2 Lesson: Stimulus-response pathways	How do we respond to different types of stimuli?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**LS1.D** Information Processing	Systems and System Models	Ask students to finish questions 1–7	Glossary: The nervous system
Lesson 4				Obtaining, Evaluating, and Communicating Information			Ask students to finish all remaining questions	Glossary: The nervous system

Lesson Planning Guide

Week 1 Week 2

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.3 Investigation: Taste and smell	Do we rely more on taste or smell for food?	Review Key Questions from the previous lesson in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter Review teaching notes in Prepare Mode	Planning and Carrying Out Investigations	**LS1.D** Information Processing	Patterns	Ask students to write a reflection on the main findings of the investigation	Extra SEP support: 2.1 Observing & inferring
Lesson 6	Unit review Glossary: The nervous system	How can I be prepared for The Nervous System test?	Review Key Questions from the unit using Analyze Mode to identify areas to revisit	Constructing Explanations and Designing Solutions Obtaining, Evaluating, and Communicating Information Analyzing and Interpreting Data Planning and Carrying Out Investigations	**LS1.D** Information Processing	Patterns Systems and System Models Structure and Function	Ask students to review teacher feedback and Key Questions from lessons in the unit	Glossary: The nervous system
Lesson 7	Test: The nervous system	How much have I learned about The Nervous System?	Ensure each student has access to a device				Ask students to write a reflection on what they have learned from the unit	
Lesson 8	Test review	How successful was my revision of The Nervous System?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these				Ask students to reflect on the effectiveness of their revision and to identify areas for improvement	

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Students draw on information provided in both written and video format to write a report that conveys their understanding of synapses.

Common Core State Standards Connections: English Language Arts

WHST.6-8.8

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions, and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **1.1 Lesson: Parts of the nervous system**
  Questions 4, 5, 9
- **1.2 Lesson: Stimulus-response pathways**
  Question 5
- **1.3 Investigation: Taste and smell**
  Questions 1, 3, 4, 5

ELL support

To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

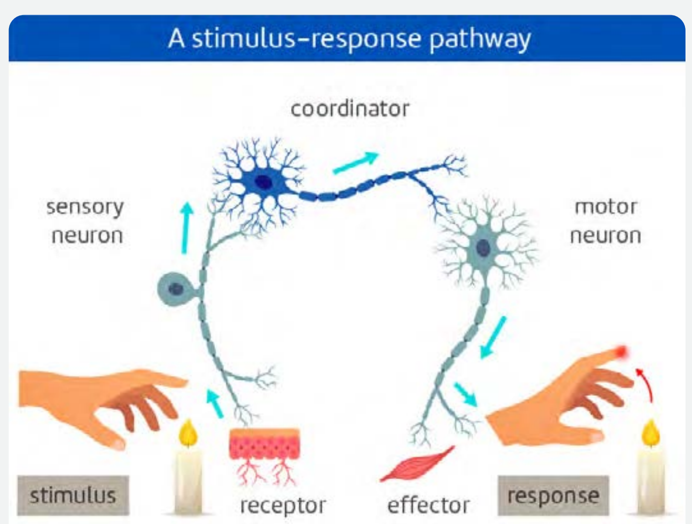
Visual representations

The lessons in this unit include a number of diagrams to help students understand the nervous system. Encourage them to draw on these visual representations and to actively interpret the information they contain.

Those with a higher level of language proficiency can use them for support in decoding written information rather than as a substitute for reading the text. Two examples of visual representations are included, though there are many more.

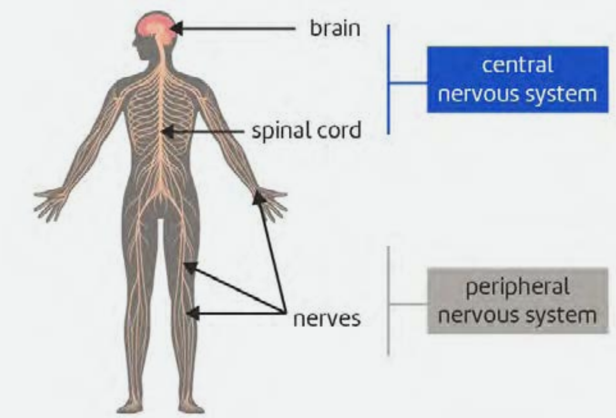
1.2 Lesson: Stimulus-response pathways

This diagram represents a stimulus-response pathway through the example of a finger touching the flame of a candle. The diagram clearly shows the three key elements of the pathway. The candle example further supports understanding. The arrows indicate the direction of the signal's transmission, and the use of labels helps connect the pathway's components to key vocabulary.



1.1 Lesson: Parts of the nervous system

This diagram illustrates the parts of the central and peripheral nervous systems. It shows the extensive network of nerves throughout the body and the connections between the brain, spinal cord, and nerves, respectively. The use of labels supports the connection of the system's parts with the appropriate English vocabulary.

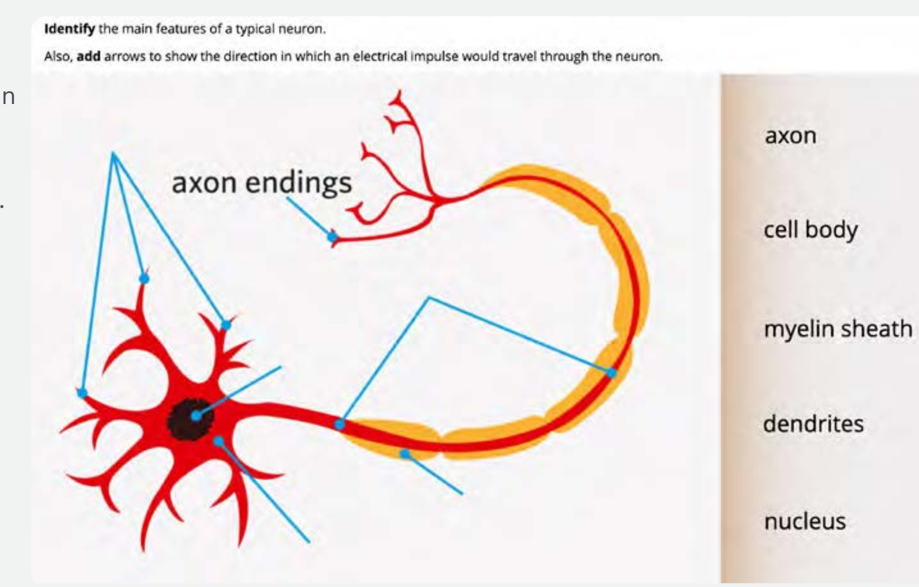


Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.1 Lesson: Parts of the nervous system

This labeling task allows students to easily position and reposition the words within the diagram as they associate the visual representation of a neuron with these key terms.



Detection dog in training
Dogs are trained from a young age to detect the scents of cancers, hormones, and illicit substances.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Summative assessment

Test
This unit contains a test to provide a summative assessment of student learning across the whole unit.

- **Test: The nervous system**
  Multiple choice and short answer: 60 minutes

Science and Engineering Practices
One investigation within the unit can be used as a summative assessment of Science and Engineering Practices.

- **1.3 Investigation: Taste and smell**
  Lab activity: 60 minutes

Lab Activities

Lab Activity

Taste and smell

Activity purpose: Investigate the difference between taste and smell.

stileapp.com/go/tastesmell

45–60 minutes

3–4 students per group

Materials

Lab Equipment
Each group of students will need:
- blindfold
- 4 x variety of foods supplied in plastic cups or plates (e.g., salt and vinegar chips, lifesavers, cooking chocolate, jellybeans, cocktail onions)
- toothpicks or popsicle sticks or spoons as required
- pen
- paper

Chemicals
None required

Preparation

Students should not be encouraged to consume food in the laboratory. It is best to arrange a room swap to a normal classroom if available.

Notes

Be aware of student allergies and intolerances when preparing for this activity.

Method

Method that students will follow
Your teacher will provide food for you to test, but you're not allowed to see it so move away from the table and apply your blindfold!

1. Put your blindfold on.
2. Hold your nostrils closed and open your mouth. Your partner will place a piece of food from plate 1 in your mouth.
3. Record what you initially taste.
4. Open your nostrils and remove your blindfold. Record what you taste.
5. Repeat for each of the remaining plates of food.

Unit 5 – Active Earth

How do we build future-ready cities?

Fuego Volcano, Guatemala
Volcanoes form when molten (melted) rock or "magma" reaches the surface.

Storyline and anchoring phenomenon

Natural hazards can be awe-inspiring and catastrophic at the same time. They represent an unstoppable force of nature that can create wide-spread disaster within seconds.

The Active Earth unit uses natural hazards, including earthquakes, volcanoes, tsunamis, and landslides as the anchoring phenomenon that motivates students to understand the processes and mechanisms that occur beneath the Earth's surface.

As students encounter examples of natural hazards and the destruction they can leave in their wake, they are compelled to understand what causes them. This leads them to explore what makes our planet vulnerable to natural hazards, and they build this knowledge by delving into the structure of the Earth, types of rock, the rock cycle, and plate tectonics.

Students are motivated by the guiding question, "How do we build future-ready cities?" which is revisited throughout the unit and promotes questioning about how humans can prepare for natural disasters.

Students engage in personal mitigation by developing a household evacuation plan and then consider solutions for disaster-prone regions such as smart land-use, early warning systems, and innovative infrastructure. The unit culminates in an engineering challenge that asks them to design an earthquake-proof building. Students apply their knowledge to develop a solution to the problem of residents being displaced after an earthquake in their hometown.

This unit at a glance

A pre-test activates students' prior knowledge.

The **real-world phenomena** of natural disasters drives the unit and motivates student learning.

Students address **Crosscutting Concepts** as they create models of the Earth's structure, the rock cycle, and tectonic plates.

Language glossary provides definitions of key terms accompanied by images. These are perfect for supporting ELL students to build scientific vocabulary.

Active Earth

What do you already know?
Introduction: Natural disasters

1.1 Lesson: Types of rock
1.1 Optional activity: Guess to Know Your Rocks
1.2 Lesson: Structure of the Earth
1.2 Quiz: Structure of the Earth
1.3 Lab activity: Model of the Earth

2.1 Lesson: The rock cycle
2.1 Quiz: The rock cycle
2.2 Lab activity: Modeling the rock cycle
2.3 Virtual field trip

3.1 Lesson: Continental drift
3.1 Quiz: Continental drift
3.2 Lab activity: Modeling tectonic plates
3.3 Lesson: Plate tectonics
3.3 Quiz: Plate tectonics
3.4 Extension: Hotspot volcanoes

4.1 Lesson: Home evacuation plan
4.2 Engineering challenge: Earthquake-resistant buildings

Glossary: Active Earth
Career profile: Earthquake geologist
Test: The rock cycle
Test: Plate tectonics

Students **design a model** to visualize the movement of tectonic plates and their boundaries.

Collaborative learning allows students to work in groups applying Science and Engineering Practices to design an earthquake-resistant building.

Career profiles showcase diverse individuals exploring fascinating careers in STEM.

Summative tests measure student achievement.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-ESS2-1

Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

MS-ESS2-2

Construct an explanation based on evidence for how geoscience processes have changed Earth's surface at varying time and spatial scales.

MS-ESS2-3

Analyze and interpret data on the distribution of fossils and rocks, continental shapes, and seafloor structures to provide evidence of the past plate motions.

MS-ESS3-2

Analyze and interpret data on natural hazards to forecast future catastrophic events and inform the development of technologies to mitigate their effects.

Disciplinary Core Ideas

- **ESS1.C**: The History of Planet Earth
- **ESS2.B**: Plate Tectonics and Large-Scale System Interactions
- **ESS3.A**: Natural Resources
- **ESS3.B**: Natural Hazards
- **ESS2.A**: Earth Materials and Systems

Students build an understanding of how geoscience processes cause natural hazards. They begin by learning about the cycling of matter through the rock cycle and the role of energy derived from the Earth's interior in creating different types of rock.

Students also explore how Earth's continents have changed over time and become familiar with the idea of continental drift. They then consider tectonic processes, including the different types of plate boundaries.

Science and Engineering Practices

- Constructing Explanations and Designing Solutions
- Developing and Using Models
- Asking questions and defining problems

Students analyze and interpret data from observation and maps showing the location of volcanoes, earthquakes, and plate boundaries.

They develop and use models that they use to construct explanations of natural hazards. The unit culminates in students designing a solution for housing in earthquake-prone regions.

Crosscutting Concepts

- Stability and Change
- Scale, Proportion, and Quantity

Students apply the concept of stability and change when considering the movement of tectonic plates, and the cycling of matter through the rock cycle. This connects to the idea of energy from the Earth's core fueling this natural system.

Students explore scale, proportion, and quantity when examining earthquake-related data, such as magnitude, frequency, and depth.

Nature of Science

- Scientific Knowledge is Open to Revision in Light of New Evidence
- Science Addresses Questions About the Natural and Material World
- Science is a Human Endeavor

Science, Technology, Society and the Environment

- Influence of Engineering, Technology and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

Our Place in Space took Grade 6 students on a journey through the Solar System and into the phenomena of gravity, seasons, lunar phases, and eclipses.

Active Earth builds on students' knowledge by taking them inside the Earth to consider its structure and internal systems.

Students will revisit their knowledge that earthquakes and volcanoes occur in patterns and consider that the history of natural hazards can help to predict future events. They learn about tectonic plates and the interactions between them, as well as continental drift.

Science and Engineering Practices

Students have analyzed and interpreted data in a number of Grade 6 units, preparing them to use this skill in Active Earth.

The unit's engineering challenge, like the ones they did in Grade 6, has them defining problems and designing solutions. Students build models of plate tectonics, and the rock cycle, furthering the skills they gained in designing and using models throughout sixth grade, such as in Our Place in Space.

Crosscutting Concepts

The concept of stability and change is prevalent in this unit in relation to the sudden changes that occur on the Earth's surface through natural disasters, and the gradual changes represented in continental drift.

Students are familiar with this concept from the Ecosystems unit earlier in the year.

Temporary shelters in Nepal after the 2015 earthquake

Many buildings were damaged during the 2015 earthquake in Nepal. Two years later, 800,00 families were still living in temporary shelters.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	What do you already know? Introduction: Natural disasters	How do natural hazards become natural disasters?	Review teaching notes in Prepare Mode Optional: Use VR headsets and smartphones for a virtual reality experience of the aftermath of the 2015 Nepal earthquake. VR headsets are available for purchase in the Stile Shop	Analyzing and Interpreting Data	**ESS2.A** Earth's Materials and Systems	Stability and Change		Poster: Career Profile poster set. Posters are available for purchase in the Stile Shop
Lesson 2	1.1 Lesson: Types of rock 1.1 Optional Activity: Guess to Know Your Rocks	Why do some rocks cause landslides and others don't?	Review results from What do you already know? in Analyze Mode to guide next areas to emphasize Review teaching notes in Prepare Mode Print a set of Guess to Know Your Rocks cards for each student. These will be re-used for 2.3 Virtual field trip	Analyzing and Interpreting Data	**ESS2.A** Earth's Materials and Systems	Stability and Change	Assign 1.1 Quiz: Types of rock	Extra SEP support: 2.1 Observing and inferring
Lesson 3	1.2 Lesson: Structure of the Earth	What does the center of the Earth look like?	Review Key Questions and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**ESS2.A** Earth's Materials and Systems	Scale, Proportion, and Quantity	Assign 1.2 Quiz: Structure of the Earth	
Lesson 4	1.3 Lab activity: Model of the Earth	How can we use a nectarine to visualize the center of the Earth?	Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Developing and Using Models	**ESS2.A** Earth's Materials and Systems	Scale, Proportion, and Quantity		Extra SEP support: 0.1 Conducting science investigations

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	2.1 Lesson: The rock cycle	How did the rock cycle cause the town of Chaitén, Chile, to split in half?	Review Key Questions from previous lesson and 1.2 Lesson: Structure of the Earth, and review 1.2 Quiz in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**ESS2.A** Earth's Materials and Systems	Energy and Matter	Assign 2.1 Quiz: The rock cycle	
Lesson 6	2.2 Lab activity: Modeling the rock cycle	What happens when magma cools quickly?	Review Key Questions and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Developing and Using Models	**ESS2.A** Earth's Materials and Systems	Systems and System Models	Ask students to complete any remaining questions	Extra SEP support: 0.1 Conducting science investigations
Lesson 7	2.3 Virtual field trip	How can I go on a geology field trip without traveling?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Print Guess to Know Your Rocks cards Optional: Use VR headsets and smartphones for a virtual reality experience of famous rock formations. VR headsets are available to purchase from the Stile Shop	Analyzing and Interpreting Data	**ESS2.A** Earth's Materials and Systems	Patterns	Ask students to complete any remaining questions	Extra SEP support: 3.8 Analyzing data to test a hypothesis Extra SEP support: 5.3 Creative thinking
Lesson 8	3.1 Lesson: Continental drift	How can continental drift help Cool find his family?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**ESS2.B** Plate Tectonics and Large-Scale System Interactions	Stability and Change	Assign 3.1 Quiz: Continental drift	Extra SEP support: 2.1 Observing and inferring

Lesson Planning Guide

Week 1 · Week 2 · **Week 3** · Week 4 · Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	3.2 Lab activity: Modeling tectonic plates	What happens when tectonic plates move?	Review Key Questions and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Developing and Using Models	**ESS1.C** The History of Planet Earth	Cause and Effect	Ask students to complete questions 1–2 and review tests 1–3 in the lab activity	Extra SEP support: 0.1 Conducting science investigations
Lesson 10							Ask students to complete any remaining questions	Glossary: Active Earth
Lesson 11	3.3 Lesson: Plate tectonics	Why is understanding plate boundaries important for future-ready cities?	Review Key Questions from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**ESS1.C** The History of Planet Earth	Patterns	Assign 3.3 Quiz: Plate tectonics	3.4 Extension: Hotspot volcanoes Extra SEP support: 3.7 Examining trends in data using spreadsheets
Lesson 12	4.1 Lesson: Home evacuation plan	How can we be ready for a natural hazard?	Review Key Questions and Quiz from the previous lesson in Analyze Mode Prepare construction paper and pens to create home evacuation plan	Constructing Explanations and Designing Solutions	**ESS3.B** Natural Hazards	Cause and Effect	Ask students to complete questions 1–7 Assign students Parts 2 and 3 to complete at home	*Great ShakeOut* earthquake drill resources linked in teaching notes

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	4.1 Lesson: Home evacuation plan	How can we be ready for a natural hazard?	Review teaching notes in Prepare Mode Prepare construction paper and pens to create home evacuation plan	Constructing Explanations and Designing Solutions	**ESS3.B** Natural Hazards	Cause and Effect	Ask students to complete any remaining questions	
Lesson 14	Glossary: Active Earth Unit review	How can I be prepared for the Active Earth tests?	Review Quizzes and Key Questions from the unit using Analyze Mode to identify areas to revisit	Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Developing and Using Models	**ESS1.C** The History of Planet Earth **ESS2.A** Earth's Materials and Systems **ESS2.B** Plate Tectonics and Large-Scale System Interactions **ESS2.C** The Roles of Water in Earth's Surface Processes **ESS3.A** Natural Resources **ESS3.B** Natural Hazards	Stability and Change Scale, Proportion, and Quantity	Ask students to review teacher feedback from lessons in the unit	Glossary: Active Earth
Lesson 15	Test: The rock cycle Career profile: Earthquake geologist	How much have I learned about the rock cycle?	Ensure each student has access to a device				Ask students to write a reflection on what they have learned about the rock cycle	Career profile: Earthquake geologist
Lesson 16	Test: Plate tectonics	How much have I learned about plate tectonics?	Ensure each student has access to a device				Ask students to write a reflection on what they have learned about plate tectonics	

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5

The guide below is based on three 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	4.2 Engineering challenge: Earthquake-resistant buildings	How can we build future-ready buildings?	Review teaching notes in Prepare Mode Prepare the materials for the engineering challenge. See the relevant pages at the end of this chapter	Developing and Using Models	**ESS1.C** The History of Planet Earth	Cause and Effect	Ask students to complete questions 1–5	Extra SEP support: 5.1 Validity and reliability
Lesson 18							Ask students to complete questions 6–9	Extra SEP support: 5.2 What is creativity? Extra SEP support: 5.3 Creative thinking
Lesson 19							Ask students to finish all remaining questions	
Lesson 20	Test review	How successful was my revision of Active Earth?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Developing and Using Models	**ESS1.C** The History of Planet Earth **ESS2.A** Earth's Materials and Systems **ESS2.B** Plate Tectonics and Large-Scale System Interactions **ESS2.C** The Roles of Water in Earth's Surface Processes **ESS3.A** Natural Resources **ESS3.B** Natural Hazards	Stability and Change Scale, Proportion, and Quantity	Ask students to reflect on the effectiveness of their revision and to identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical and literacy skills.

In considering the structure of Earth, students are explicitly taught the mathematical concept of ratios and apply this to build a scale model that illustrates the proportion of the Earth's layers. While exploring the fossil record, students gain an appreciation for the spans of time involved in Earth's history and the relative distances between different periods of time.

Common Core State Standards Connections: Math

7.RP.A.2

Recognize and represent proportional relationships between quantities.

MP.2

Reason abstractly and quantitatively.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Students build on literacy skills as they are introduced to a range of vocabulary associated with the Earth's structure, types of rock, plate boundaries, and the processes within the rock cycle.

They integrate information from text with visual information that appears in flow charts, diagrams, simulations, physical models, and tables to develop their understanding of key concepts and processes such as the rock cycle.

Lab activities require students to read carefully and closely follow procedural steps to consolidate their understanding of the Earth's structure, the rock cycle, and relative dating. Finally, the engineering challenge asks students to present their proposed earthquake-proof structure to their peers along with evidence and reasoning for its suitability.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.2

Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

RST.6-8.3

Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flow chart, diagram, model, graph, or table).

RST.6-8.9

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions, and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **What do you already know?**
  Questions 5, 6, 8
- **Introduction: Natural disasters**
  Questions 3, 9, 11
- **1.1 Lesson: Types of rock**
  Questions 20, 21
- **1.1 Optional Activity: Guess to know your rocks**
  Questions 6, 7
- **1.2 Lesson: Structure of the Earth**
  Questions 12, 15, 17, 20
- **1.2 Lab activity: Model of the Earth**
  Questions 13, 15
- **The rock cycle**
  Questions 13, 15, 16, 17, 18
- **2.2 Lab activity: Modeling the rock cycle**
  Questions 9, 10, 11, 12
- **2.5 Virtual field trip**
  Questions 5, 7, 8, 10, 12
- **3.1 Lesson: Continental drift**
  Questions 9, 12, 17
- **3.2 Lab activity: Modeling tectonic plates**
  Questions 4, 6, 8, 9
- **3.3 Lesson: Plate tectonics**
  Questions 6, 9, 14, 21, 22
- **4.1 Lesson: Family evacuation plan**
  Questions 6, 7, 8, 11
- **4.2 Engineering challenge: Earthquake-resistant buildings**
  Questions 10, 12

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
What do you already know?	All rocks are the same, and it's hard to tell how they originated.	**Use 1.1 Lesson: Types of rock** Rocks are classified into three basic types and many more subtypes. They have key features and properties that allow scientists to tell them apart.
	Rocks are classified by their appearance only.	**Use 1.1 Lesson: Types of rock** Scientists classify rocks by their appearance (color, features, minerals present, grain/crystal size, etc.), chemical composition, density, mineral properties (cleavage, luster, streak, hardness, etc.) and more!
	Rocks are always solid.	**Use 2.1 Lesson: The rock cycle and 2.2 Lab activity: Modeling the rock cycle** Rocks subjected to high temperatures and pressures are liquid or partially liquid.
	Rocks formed in the place they are currently located.	**Use 3.3 Lesson: Plate tectonics** Rocks move because of Earth's surface processes, such as plate tectonics and erosion.

Common misconceptions

Lesson	Misconception	Addressing the misconception
1.2 Lesson: Structure of the Earth	The mantle is composed of liquid rock (magma).	**Use 1.2 Lesson: Structure of the Earth, questions 12 and 13 explicitly address the composition of the Earth's layers.** The mantle is almost entirely solid – as shown by its ability to transmit both P- and S-waves from earthquakes. S-waves cannot travel through liquids, such as the outer core. Small amounts of melting do occur in certain parts of the mantle where the conditions are right, but even those parts are only about 1% liquid. However, the intense heat and pressure in the lower mantle means that the solid rock behaves as a fluid over geological timescales. This means that it can flow in giant convection cells, at a rate similar to that at which our fingernails grow.
2.3 Lesson: The fossil record	All fossils are preserved bones of dead animals.	Source real examples of resin fossils and mold fossils, or examine images of these. Preserved bones and other harder substances, such as teeth and claws, are called body fossils. These are just one type of fossil. Other types include: – Trace fossil – any trace of an organism, such as a footprint or piece of dung – Resin fossil – an organism trapped in tree sap – Mold fossil – an imprint of the shape of an organism
3.2 Lab activity: Modeling tectonic plates	Earth's continents are the tectonic plates.	**Use 3.3 Lesson: Plate tectonics** Examine the map in question 4 and emphasize the distinction between the borders of the plates and the continents. Also, refer to examples of landforms caused by convergent and divergent plate boundaries which exist within continents. Tectonic plates are composed of continental and oceanic crust. Some plates are made of a combination of both.

Lesson	Misconception	Addressing the misconception
3.3 Lesson: Plate tectonics	Plate boundaries cannot occur within a continent.	**Use 3.3 Lesson: Plate tectonics** Refer to examples of landforms caused by convergent and divergent plate boundaries which exist within continents. Plate boundaries can occur between continental and oceanic crust and in the middle of either.
	When two plates move away from each other, water or loose rock fills the empty gap.	**Use 3.3 Lesson: Plate tectonics** Refer to the interactive above question 5 and the graphic in the Divergent Boundaries section. When two oceanic plates move away from each other, magma pushes up through the gap. When two continental plates move apart, a rift forms that could fill with water or loose rock, but eventually magma pushes up through cracks in the crust.
	Continental plate material is pushed beneath oceanic plate material when two plates are pushed together.	**Use 3.3 Lesson: Plate tectonics** Refer to the Convergent Boundaries section, and questions 12 and 13 which directly address this. Oceanic material is subducted beneath continental material if the two are pushed together. This is because oceanic crust is denser than continental crust.

ELL support

To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

Active Earth lessons include a number of flow charts and diagrams to help students understand the rock cycle, the Earth's structure, and plate tectonics. Encourage students to draw on these visual representations, and to actively interpret the information they contain.

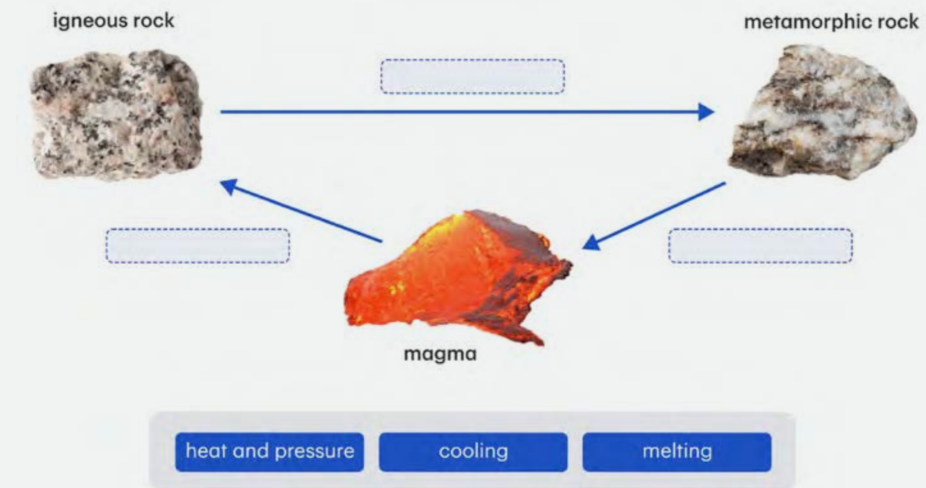
Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

1.2 Lesson: Structure of the Earth

The below diagram of the Earth's structure is a rich source of information. It demonstrates that the Earth is made up of layers, shows the number of layers, their relative thickness, and the differences in their heat and composition without using the English language.

A model of the layers of Earth

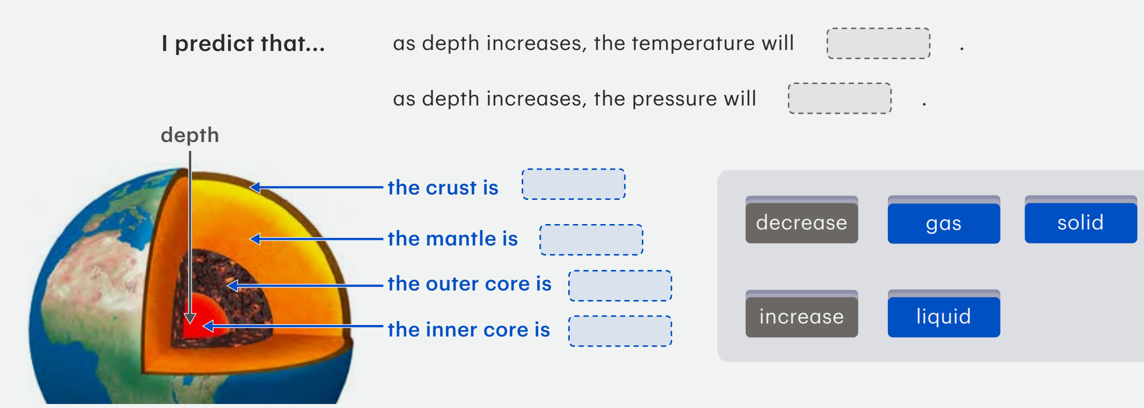
2.1 Lesson: The rock cycle
This uses only key vocabulary, images, and arrows to illustrate the rock cycle so that students can focus on decoding only these words and phrases, thus reducing the demand on language comprehension skills.



Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.1 Lesson: Structure of the Earth
This drag-and-drop task allows students to focus on identifying and positioning the key words appropriately, rather than writing sentences in English.



Antelope Canyon, Arizona
Antelope Canyon is made up of sandstone which forms when layers of loose sediment are compacted and cemented over time.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Pre-test: What do you already know?
Activate students' prior knowledge of relevant concepts including types of rock, the rock cycle, and plate tectonics. Use this as a pre-test to identify misconceptions and areas where students may need additional challenge or support in subsequent lessons.

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes
Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5–10 minutes. Quizzes provide students and teachers with information about student progress toward specific learning goals.

- **1.2 Quiz: Structure of the Earth**
  Multiple choice: 5 minutes
- **2.1 Quiz: The rock cycle**
  Multiple choice and fill-in-the-blank: 10 minutes
- **3.1 Quiz: Continental drift**
  Multiple choice: 5 minutes
- **3.3 Quiz: Plate tectonics**
  Multiple choice and fill-in-the-blank: 10 minutes

Summative assessment

Test
This unit contains two tests to provide summative assessment of student learning across the whole unit. One test assesses student understanding of the rock cycle, while the other assesses understanding of plate tectonics.

- **Test: The rock cycle**
  Multiple choice and short answer: 35 minutes
- **Test: Plate tectonics**
  Multiple choice and short answer: 35 minutes

Science and Engineering Practices
Two lab activities and an engineering challenge within the unit can be used as summative assessment of Science and Engineering Practices.

- **2.2 Lab activity: Modeling the rock cycle**
  Lab activity: 60 minutes
- **3.2 Lab activity: Modeling tectonic plates**
  Lab activity: 60 minutes
- **4.2 Engineering challenge: Earthquake-resistant buildings**
  Engineering challenge: 180 minutes

Lab Activities

Activity purpose: Represent the layers of the Earth by building a simple 3D model.

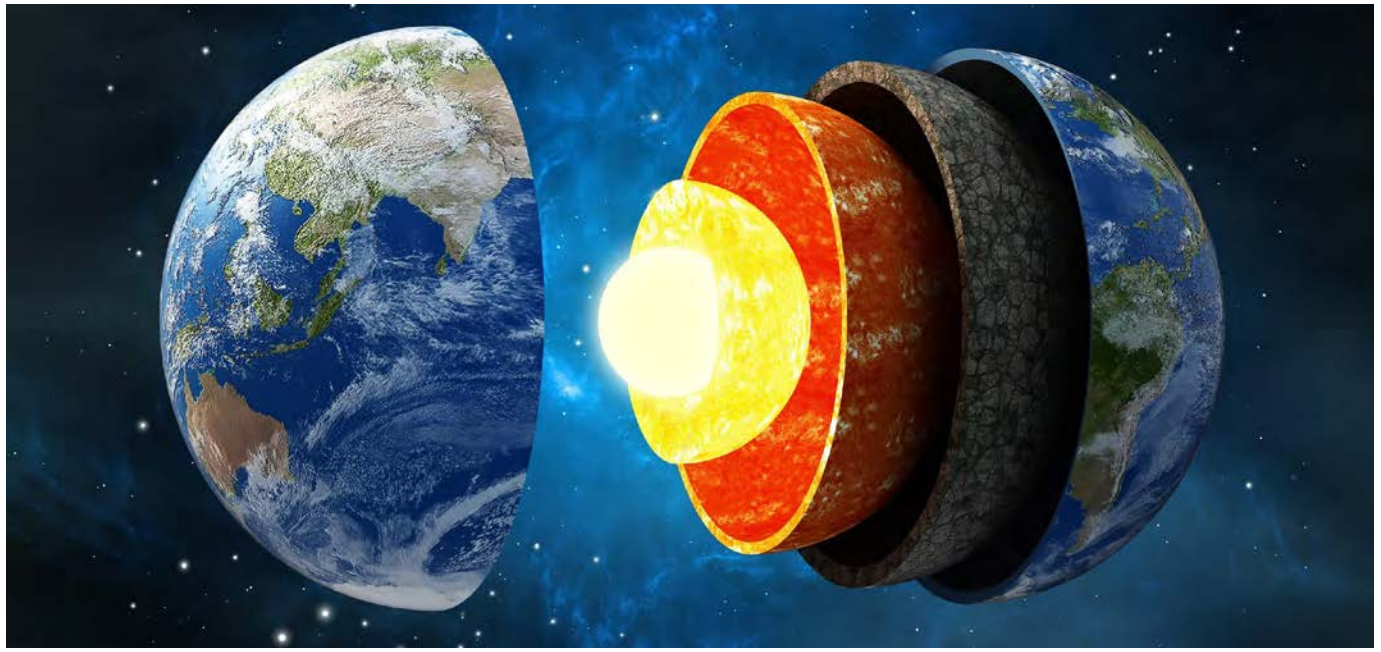
stileapp.com/go/earthmodel

45–60 minutes

3–4 students per group

Lab Activity

Model of the Earth



Materials

Lab Equipment
Each group of students will need:
- 30 cm ruler
- 4 different colored lumps of play dough, each color weighing approximately 400 g
- 4 toothpicks
- 4 small sticky notes
- scissors

Chemicals
None required

Preparation

Play dough will need to be prepared in advance.

Notes

We recommend that students work in pairs or small groups to encourage teamwork. This will also reduce the amount of materials required – each model needs about 1 kg (2 lbs.) of play dough.

Method

Method that students will follow
1. Make a ball of play dough to represent the Earth's inner core. It will need to measure 2.4 cm across. Cut the ball in half and measure this distance using the ruler.
2. Roll out three layers of play dough using the other three colors. Measure the thickness of each layer to make sure they match the values you calculated above. Note: The crust layer will be extremely thin!
3. Wrap the "outer core" layer around the "inner core" half-ball to make a hemisphere. You may need to mold the play dough to make a neat, flat surface. Take care not to change the thicknesses of the layers.
4. Wrap the "mantle" around the "outer core."
5. Wrap the "crust" around the "mantle."
6. Make labels for each of the layers by writing on the sticky notes and then wrapping the sticky end around the toothpick. Stick the toothpicks into each layer to complete your model.

Lab Activity

Modeling the rock cycle

Activity purpose: Model the processes involved in the rock cycle.

stileapp.com/go/rockcycle

45–60 minutes

2–3 students per group

Materials

Lab Equipment
Each group of students will need:
- aluminum foil (1 roll for the class)
- ziplock plastic bag approx. 16 cm x 17 cm
- 2 x 500 mL beakers
- 500 mL measuring jug
- kettle
- scissors

Chemicals
- 4 candies (we recommend Starburst because they stick together when pressed and easily melt in hot water; chocolate or crayons could also be used)
- 200 mL ice
- 250 mL hot water

Preparation

Depending on the number of groups more than one kettle will be required as each group will need 250 mL of hot water.

Notes

This lab activity assumes that students are already familiar with the rock cycle. A photo of each "rock" formed in this activity (using Starburst) can be found in the model answers on Stile.

Method

Method that students will follow

Part 1

1. Cut the "rock" material into small pieces, squeeze the air out of the bag, and seal the pieces in the ziplock bag.
2. Fold aluminum foil around the bag to form a flat parcel.
3. Press down with your hand to flatten the parcel. You could also place a heavy book on the parcel or even stand on it.
4. Remove the aluminum foil and observe the "rock" formed. Keep the ziplock bag sealed and take a photo.

Part 2

1. With the "rock" material still sealed in the ziplock bag, squeeze and knead the bag with your fingers. Your hands will also warm up the bag and its contents.
2. Stop kneading when the pieces start to merge. Keep the ziplock bag sealed and take a photo.

Part 3

1. Use the kettle to boil water and fill one of the 500 mL beakers up half way.
2. Place ice cubes into the other 500 mL beaker and half fill with cold water.
3. With the "rock" material still sealed in the ziplock bag, place the bag into the hot water.
4. Leave for about 2 minutes or until the material has melted.
5. Remove the bag and place it into the ice water for about 2 minutes or until the material has hardened.
6. Remove the "rock" material from the ziplock bag and take a photo.

Unit 6 – Newton's Laws of Motion

How can we use Newton's Laws in car crash investigations?

The Dawn spacecraft orbits Ceres
Dawn uses ion engines, which harness solar energy to eject a jet of xenon gas. In space, these engines generate speeds of over 14,000 km/h (8,699 mph).

Storyline and anchoring phenomenon

Students begin this unit in space, where the asteroid belt inspires questions about the birth of our Solar System. But how can students get there to explore it?

The Dawn spacecraft, launched in 2007, uses ion engines that create forces strong enough to move through space. While orbiting, Dawn helps us get a closer look at our Solar System.

A little closer to home, students make connections between the force needed to move through space and the forces that drive our everyday transport. To better understand these, they explore the three Newtonian laws.

Building on their knowledge of contact and non-contact forces, students apply their prior knowledge of velocity and acceleration to calculate and compare forces acting on an object. They use these calculations to make predictions about the movements of vehicles.

By engaging in engineering challenges to create rockets and balloon cars, students observe forces in action and use these observations to construct explanations of how and why the motion of vehicles will change.

This unit at a glance

Newton's Laws of Motion

Introduction: Exploring the asteroid belt
What do you already know?
Career profile: Vehicle collision investigator

Students engage with the **phenomenon of vehicle collisions** and ask how we can use Newton's laws to investigate their impact.

1.1 Lesson: What are forces?
1.1 Quiz: What are forces?
1.2 Lesson: Types of forces
1.2 Quiz: Types of forces
1.3 Lesson: Balanced and unbalanced forces
1.3 Quiz: Balanced and unbalanced forces
1.4 Investigation: Friction and braking distance

Each lesson has an accompanying quiz for **formative assessment**.

2.1 Lab activity: Demonstrating Newton's first law
2.2 Lesson: The first law of motion
2.2 Quiz: The first law of motion
2.3 Lesson: Inertia on Earth
2.3 Quiz: Inertia on Earth
2.4 Lesson: Free body diagrams
2.4 Quiz: Free body diagrams

Students begin the unit by **exploring phenomena** that demonstrate Newton's first law.

Students will **create representations of forces** acting within systems to communicate their understanding.

Students apply the third law to **multiple scales of interactions** and to **clarify misconceptions**.

Students engage in **engineering practices and make sense of cause and effect relationships** as they test variables.

Students **use engineering skills** to problem-solve and create a car that can move different masses.

Students use household items to create the most force possible by **manipulating variables**.

Launching a rocket relies on Newton's Third Law of Motion. *The rocket's engine accelerates hot gases toward the Earth, and a thrusting force is produced in the opposite direction.*

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-PS2-1

Apply Newton's third law to design a solution to a problem involving the motion of two colliding objects.

MS-PS2-2

Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.

Disciplinary Core Idea

- **PS2.A**: Forces and Motion

For any pair of objects, there are forces that act both on and between them.

This unit explores the motion of objects with unbalanced forces and different masses. Students learn about Newton's first, third, and second laws respectively and apply their knowledge to design and build vehicles that demonstrate all three laws of motion at work.

Science and Engineering Practice

- Constructing Explanations and Designing Solutions

Students engage with engineering challenges and investigations.

Students have the opportunity to build and test designs, then modify them using their knowledge of forces. They make sense of their findings to construct explanations and design solutions for problems as they explore everything from jet-propelled cans to speed limit recommendations.

Crosscutting Concepts

- Stability and Change
- Patterns
- Scale, Proportion, and Quality

Students begin this unit by thinking about the large scale phenomenon of space and how they could move through it by changing forces out of a stable state.

Students are able to identify patterns in movement and apply their understanding of the scale at which changes in force need to occur to have an effect on the way objects move.

Nature of Science

- Scientific Investigations Use a Variety of Methods
- Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena

Science, Technology, Society and the Environment

- Interdependence of Science, Engineering, and Technology

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

From Grade 6's Heat unit, students have an understanding of how energy is transferred between particles and the different ways in which this transfer can take place.

Newton's Laws of Motion introduces students to forces, and builds on the idea of energy being transferred. Students recognize that an object's motion is determined by the forces acting upon it. Through investigations and hands-on exploration, they become familiar with each of the three Newton's laws.

Science and Engineering Practices

Students have constructed explanations throughout Stile units, and continue to do so in Newton's Laws, where they must apply scientific reasoning to explain how data collected through investigations is adequate for the conclusions they reach.

Crosscutting Concepts

Stability and change is a concept that students have applied in Ecosystems, in relation to population levels, and in Active Earth, in relation to the movement of tectonic plates that causes natural hazards. They will build on their knowledge of this concept as they recognize that changes in the way an object moves are caused by the forces that are acting upon it.

Patterns are also a common theme in Newton's Laws of Motion, as each of the laws describes a pattern that is observable in the way objects behave. Students are familiar with the concept of patterns from their experience with Food Chains and Food Webs in Grade 6, where they identified patterns in data using diagrams.

Students have an understanding about scale, proportion, and quantity from their learning in Light and Ecosystems. They have an understanding that relationships can be expressed through algebraic expressions and equations, and will extend upon this as they learn about Newton's laws in this unit.

Jet ski in motion
Jet skis use a propellor to thrust them forward. When water moves backward out of the jet ski, the reactive force moves the jet ski forward.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Exploring the asteroid belt What do you already know?	What do I already know about forces?	Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Patterns	Ask students to read article linked in lesson, *Cosmos Magazine*, "Dawn arrives on Ceres"	Article linked in lesson, *Cosmos Magazine*, "Dawn probe paints picture of icy, rocky Ceres – with an ice volcano"
Lesson 2	1.1 Lesson: What are forces?	What are forces?	Review What do you already know? to identify areas to emphasize Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**PS2.A** Forces and Motion	Stability and Change	Assign 1.1 Quiz: What are forces?	
Lesson 3	1.2 Lesson: Types of forces	How can I know what type of force is acting?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Asking Questions and Defining Problems	**PS2.A** Forces and Motion	Stability and Change	Assign 1.2 Quiz: Types of forces	
Lesson 4	1.3 Lesson: Balanced and unbalanced forces	Are there always forces acting on an object?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**PS2.A** Forces and Motion	Stability and Change	Assign 1.3 Quiz: Balanced and unbalanced forces	

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.4 Investigation: Friction and braking distance	How can I decrease braking distance?	Review Key Question and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Planning and Carrying Out Investigations	**PS2.A** Forces and Motion	Stability and Change	Ask students to complete questions 1–11	Extra SEP support: 1.3 Writing a hypothesis
Lesson 6	1.4 Investigation: Friction and braking distance 2.1 Lab activity: Demonstrating Newton's first law	What do my observations tell me about Newton's first law?	Prepare to complete 1.4 Investigation in this lesson Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Stability and Change		*YouTube* video linked in teaching notes, "Newton's apple" by *Stile Education*
Lesson 7	2.2 Lesson: The first law of motion	How can Newton's first law help us improve road safety?	Review previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Stability and Change	Assign 2.2 Quiz: The first law of motion	Career profile: Vehicle collision investigator
Lesson 8	2.3 Lesson: Inertia on Earth	Why do moving objects slow down?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Patterns	Assign 2.3 Quiz: Inertia on Earth	Glossary: Newton's laws of motion

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	2.4 Lesson: Free body diagrams	How can we represent the forces acting on an object?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Stability and Change	Assign 2.4 Quiz: Free body diagrams	
Lesson 10	3.1 Lab activity: Demonstrating Newton's third law	What does Newton's third law look like?	Review Key Question and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for activities 1 and 2. See the relevant lab activity pages at the end of this chapter	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Stability and Change	Ask students to complete questions 1–7	Extra SEP support: 0.3 The engineering process
Lesson 11			Prepare the materials for activities 3 and 4. See the relevant lab activity pages at the end of this chapter				Ask students to complete questions 8–11 Students can further refine the design of their CD hovercraft if they have identified areas for improvement	
Lesson 12	3.2 Lesson: The third law of motion	How does Newton's third law make work challenging for astronauts in space?	Review previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Stability and Change	Assign 2.2 Quiz: The third law of motion Ask students to bring in soft drink cans with the tabs still attached for an activity later in this unit	Glossary: Newton's laws of motion

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · **Week 4** · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	3.3 Lesson: Gravity and the third law	How do the forces exerted by the Earth and Moon compare to one another?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Scale, Proportion, and Quantity	Assign 3.3 Quiz: Gravity and the third law	3.4 Extension: Recoil, jets, and collision 3.4 Quiz: Recoil, jets, and collision
Lesson 14	3.5 Investigation: Water rockets	How can I use Newton's laws to make my rocket travel farther?	Review Key Question and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Stability and Change	Ask students to complete questions 1–6	Extra SEP support: 0.1 Conducting science investigations
Lesson 15			If assigned, review Key Question and Quiz from 3.4 Extension: Recoil, jets, and collision Review teaching notes in Prepare Mode				Ask students to complete questions 7–11	
Lesson 16	3.6 Lesson: Comparing electrostatic and gravitational forces	How can I know for sure which force is strongest?	Review previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Scale, Proportion, and Quantity	Remind students to bring in soft drink cans with the tabs still attached for an activity later in this unit	Glossary: Newton's laws of motion

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5 Week 6 Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	4.1 Engineering challenge: Balloon cars	How can I make a car that can transport different masses?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Note that students will not begin building their prototypes until the next lesson	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Patterns	Ask students to complete questions 1–4	Extra SEP support: 0.1 Conducting science investigations
Lesson 18			Review student progress in Analyze Mode Prepare the materials for the engineering challenge. See the relevant pages at the end of this chapter				Ask students to complete questions 5–7	Extra SEP support: 0.3 The engineering process
Lesson 19			Review student progress in Analyze Mode Prepare the materials for the engineering challenge. See the relevant pages at the end of this chapter				Ask students to complete question 8	
Lesson 20			Review student progress in Analyze Mode				Ask students to complete question 9 Remind students to bring in soft drink cans with the tabs still attached for an activity later in this unit	

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 21	4.2 Lesson: The second law of motion	How do objects speed up and slow down?	Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Scale, Proportion, and Quantity	Assign 4.2 Quiz: The second law of motion	
Lesson 22	4.3 Lesson: Applying the second law	How can we use Newton's second law?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Scale, Proportion, and Quantity	Ask students to complete questions 1–12	A printed copy of the F=ma triangles could be useful for students
Lesson 23			Review teaching notes in Prepare Mode				Ask students to complete all remaining questions Assign 4.3 Quiz: Applying the second law	4.4 Extension: Flying car simulation
Lesson 24	4.5 Investigation: Jet-propelled can	How do Newton's laws apply to everyday objects?	Review Key Question and Quiz from previous lesson in Analyze Mode If assigned, review 4.4: Extension in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Scale, Proportion, and Quantity		4.6 Project: Battling misconceptions

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 25	4.5 Investigation: Jet-propelled can	How do Newton's laws apply to every day objects?	Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Scale, Proportion, and Quantity	Ask students to evaluate each other's conclusions to peer assess whether they have related their findings back to the aim of the investigation	
Lesson 26	Unit review Glossary: Newton's laws of motion	How can I be prepared for the Newton's Laws of Motion test?	Review Key Questions from the unit using Analyze Mode to identify areas to revisit	Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Stability and Change Patterns Scale, Proportion, and Quality	Ask students to review teacher feedback from lessons in the unit	
Lesson 27	Test: Newton's laws of motion	How much have I learned about Newton's Laws of Motion?	Ensure every student has access to a device Complete grading of test ahead of test review session				Prompt students to write a reflection on what they have learned from the unit	
Lesson 28	Science and society: Speed limits in built up areas Test review	What should the speed limit be in built-up areas? How successful was my revision of Newton's Laws of Motion?	Review teaching notes in Prepare Mode Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these				Ask students to reflect on the effectiveness of their revision and identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical skills.

Students apply math skills throughout the unit by engaging in numerical representations for force and its direction. They read and write equations with pronumerals and use these to solve multistep equations that can describe the overall movement of objects.

Common Core State Standards Connections: Math

MP.2

Reason abstractly and quantitatively.

7.NS.A.1

Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram.

7.EE.A.2

Understand that rewriting an expression in different forms in a problem context can shed light on the problem and how the quantities in it are related.

7.EE.B.3

Solve multistep real-life and mathematical problems posed with positive and negative rational numbers in any form, using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies.

7.EE.B.4

Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Lessons within this unit incorporate many opportunities for students to develop and use their reading, writing, listening, and speaking skills.

Students develop comprehension in this unit through interactive text questions. They use context as well as explicit teaching to learn subject-specific words and terms and the symbols that represent them. Using their content knowledge, students follow directions to conduct experiments and draw on several sources to make informed hypotheses and predictions about experiments.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST.6-8.3

Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks.

RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

WHST.6-8.7

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions, and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **What do you already know?** Questions 2, 3
- **Career profile: Vehicle collision investigator** Questions 3, 4
- **2.1 Lab activity: Demonstrating Newton's first law** Questions 4, 5, 9, 10
- **2.2 Lesson: The first law of motion** Questions 5, 9, 16, 17
- **2.3 Lesson: Inertia on Earth** Questions 1, 2, 3, 8, 10, 11
- **2.4 Lesson: Free body diagrams** Questions 1, 5, 7
- **3.1 Lab activity: Demonstrating Newton's third law** Questions 2, 5
- **3.2 Lesson: The third law of motion** Questions 6, 13
- **3.3 Lesson: Gravity and the third law** Questions 1, 5, 7, 10
- **3.4 Extension: Recoil, jets, and collisions** Questions 1, 2, 6, 8, 9
- **3.5 Investigation: Water rockets** Questions 3, 6, 7, 8, 9, 11
- **3.6 Lesson: Comparing electrostatic and gravitational forces** Questions 4, 6, 13, 14
- **4.2 Lesson: The second law of motion** Questions 1, 17
- **4.4 Extension: Flying car simulation** Questions 9, 10
- **4.5 Investigation: Jet-propelled can** Questions 2, 4, 5, 6, 7, 8, 9, 10
- **4.6 Project: Battling misconceptions** Questions 2, 3
- **Science and society: Speed limits in built-up areas** Questions 2, 3, 4, 5, 7

Extension opportunities in this unit

Challenge Questions
Most lessons contain one or more Challenge Questions, which are an opportunity for students to show they are working above the level of the learning goal.

When answering these questions, students can extend themselves by applying their knowledge to new contexts, or to solve more complex problems. These provide a great extension opportunity.

Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC
3.4 Extension: Recoil, jets, and collisions	Can Newton's laws explain how jetpacks work?		Analyzing and Interpreting Data	**PS2.A** Forces and Motion	Systems and System Models
3.6 Lesson: Comparing electrostatic and gravitational forces	Why does the equation generate negative values for attractive forces, and positive values for repulsive forces?		Constructing Explanations and Designing Solutions	**PS2.A** Forces and Motion	Scale, Proportion, and Quantity
4.4 Extension: Flying car simulation	What happens if cars collide in space?		Using Mathematics and Computational Thinking	**PS2.A** Forces and Motion	Energy and Matter: Flows, Cycles, and Conservation

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
1.3 Lesson: Balanced and unbalanced forces	If an object is at rest, there are no forces acting on it.	**Use 1.3 Lesson: Balanced and unbalanced forces** This is discussed through the balanced forces section of this lesson. Share results for the Live Poll in question 1, and discuss these together, emphasizing that all of these objects have forces acting on them. Repeat this for the multiple choice questions.
2.3 Lesson: Inertia on Earth	Moving objects naturally slow down and stop.	**Use 2.3 Lesson: Inertia on Earth** Forces that resist motion, such as friction, air resistance, and water resistance, cause moving objects to slow down. The Why do moving objects slow down? section of this lesson addresses this. Have students discuss questions 1 and 2, then review the model answers together as a class.
3.2 Lesson: The third law of motion	Objects in orbit are not acted on by gravity.	**Use 3.2 Lesson: The third law of motion** Gravity is what keeps objects in orbit. The video in this lesson refers to the fact that for objects in orbit, it's "as if" there's no gravity. Students may be confused by orbits and the idea of weightlessness. If students raise this, we suggest putting it off for the time being, while reinforcing that gravity does act on objects in orbit, it's just that if you are in orbit it doesn't *seem* as if there is any gravity.

Lesson	Misconception	Addressing the misconception
3.3 Lesson: Gravity and the third law	An object with greater mass exerts a stronger force.	**Use 3.3. Lesson: Gravity and the third law** Paired forces have equal magnitudes. People forget this part of the third law because they consider the effects of the forces, rather than the size. This misconception is explicitly addressed through the questions and videos in this lesson.
3.4 Extension: Recoil, jets, and collisions	Jet engines require some surrounding medium such as air or water to push off from.	**Use 3.3. Lesson: Gravity and the third law** The principle of equal and opposite forces explains why this isn't accurate. Work alongside students to draw a free-motion diagram that illustrates the forces on a jet to support this explanation.
4.6 Project: Battling misconceptions	An object with no unbalanced forces acting on it will naturally come to rest.	**Use 1.3 Lesson: Balanced and unbalanced forces** An object will keep moving with the same speed and direction unless acted on by a net force.
	An unbalanced force causes an object to move with a constant velocity.	**Use 4.2 Lesson: The second law of motion** The net force on an object is equal to its mass multiplied by its acceleration, or F = ma.
	Larger objects apply larger forces to smaller objects.	**Use 3.2 Lesson: The third law of motion** Every force has an equal and opposite reaction force.

ELL support

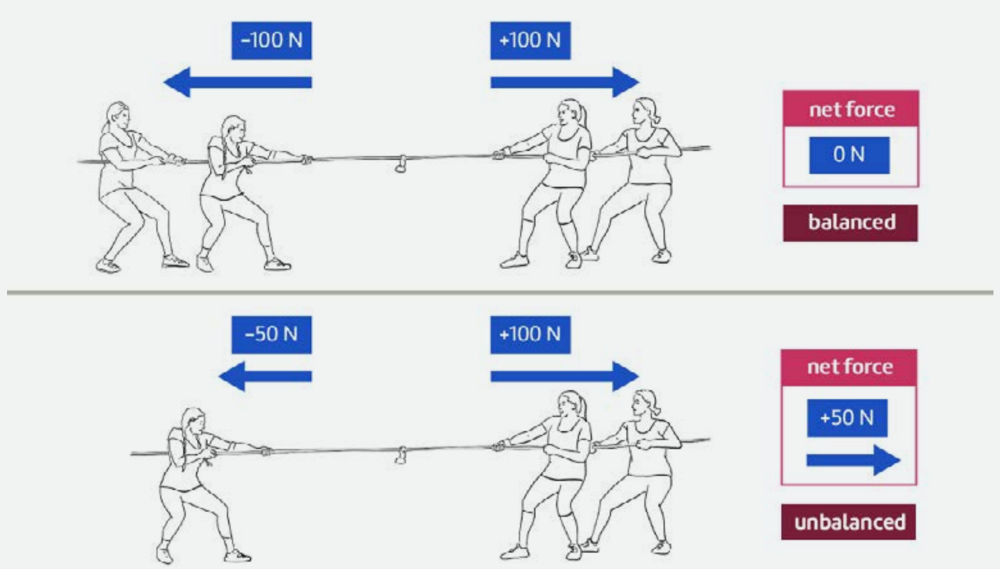
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

Newton's Laws of Motion lessons include a number of flow charts and diagrams to help students understand the laws of motion. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

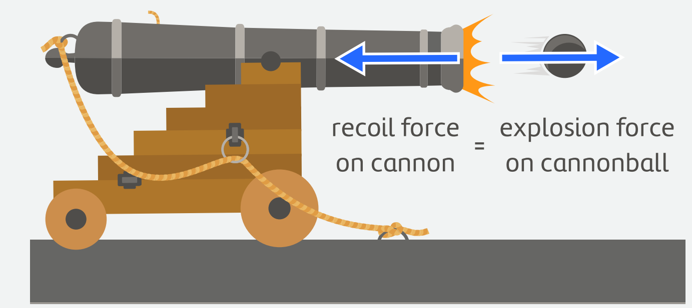
1.2 Lesson: The first law of motion

Diagrams with visual representations are supported with mathematical equations to show content that is delivered with text. This gives alternate exposures to the same key information for students to create their own definitions that make sense to them.



2.4 Extension: Recoil, jets, and collisions

Visual demonstrations with force arrows reinforce topic-specific vocabulary.

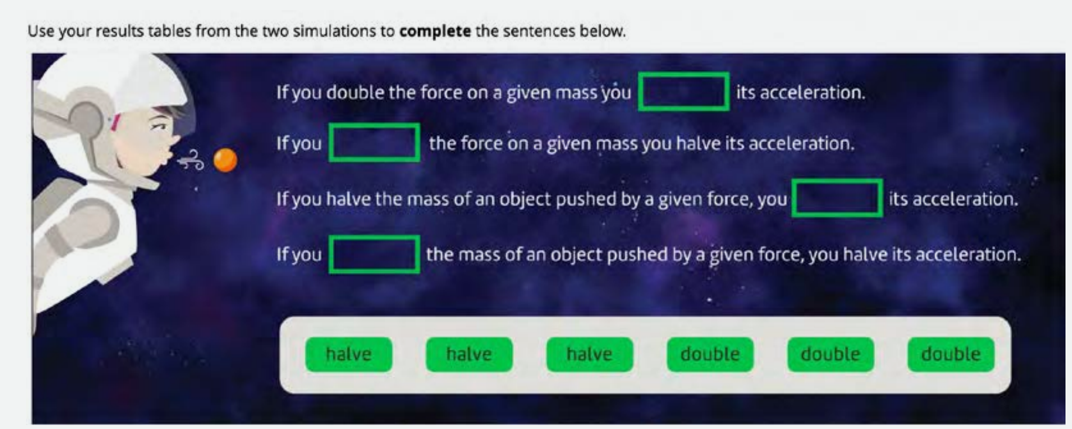


Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

3.2 Lesson: The second law of motion

ELL students experience success by finishing sentences that summarize theory taught in the lesson. Understanding is required to complete these questions successfully but the time required is decreased, allowing you to engage with students who still require support.



Customization

To customize this unit, you could look at speed limits and any publicly available data about car crashes in your area to add relevance to the lesson, Science and society: Speed limits in built-up areas.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Pre-test: What do you already know?
Activate students' prior knowledge of relevant concepts including contact and non-contact forces, vocabulary such as push and pull, and units of force. Use this as a pre-test to identify misconceptions and areas where students may need additional challenge or support in subsequent lessons.

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recomment that teachers only grade these questions.

Quizzes
Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5–10 minutes. Quizzes provide students and teachers with information about student progress toward specific learning goals.

- **1.2 Quiz: The first law of motion**
  Multiple choice: 5 minutes
- **1.3 Quiz: Inertia on Earth**
  Multiple choice: 5 minutes
- **1.4 Quiz: Free body diagrams**
  Multiple choice and constructing a diagram: 10 minutes
- **2.2 Quiz: The third law of motion**
  Multiple choice: 5 minutes
- **2.3 Quiz: Gravity and the third law**
  Multiple choice: 5 minutes
- **2.4 Quiz: Recoil, jets, and collisions**
  Multiple choice: 5 minutes
- **3.2 Quiz: The second law of motion**
  Multiple choice and short answer: 10 minutes
- **3.3 Quiz: Applying the second law**
  Multiple choice and short answer: 10 minutes

Summative assessment

Test
This unit contains a test to provide summative assessment of student learning across the whole unit.

- **Test: Newton's laws of motion**
  Multiple choice, short answer, and fill-in-the-blank: 45–60 minutes

Science and Engineering Practices
One lab activity, one engineering challenge, and two investigations within the unit can be used as summative assessment of Science and Engineering Practices.

- **2.1 Lab activity: Demonstrating Newton's third law**
  Lab activity: 60 minutes
- **2.5 Investigation: Water rockets**
  Investigation: 180 minutes
- **3.1 Engineering challenge: Balloon cars**
  Engineering challenge: 240 minutes
- **3.5 Investigation: Jet-propelled can**
  Investigation: 120 minutes

Lab Activities

Lab Activity

Demonstrating Newton's first law

Activity purpose: Complete simple demonstrations to model Newton's first law of motion.

stileapp.com/go/Newtonsfirst

45–60 minutes

2 students per group

Materials

Lab Equipment
Per group:
- 8.5 x 11 inch piece of paper
- 1 coin
- paper
- 2 x 30 cm rulers
- tape

Chemicals
None required

Preparation

In the activity keep the first ruler in place and level with a thin strip of Blu-Tack along the sides or tape across the top halfway along.

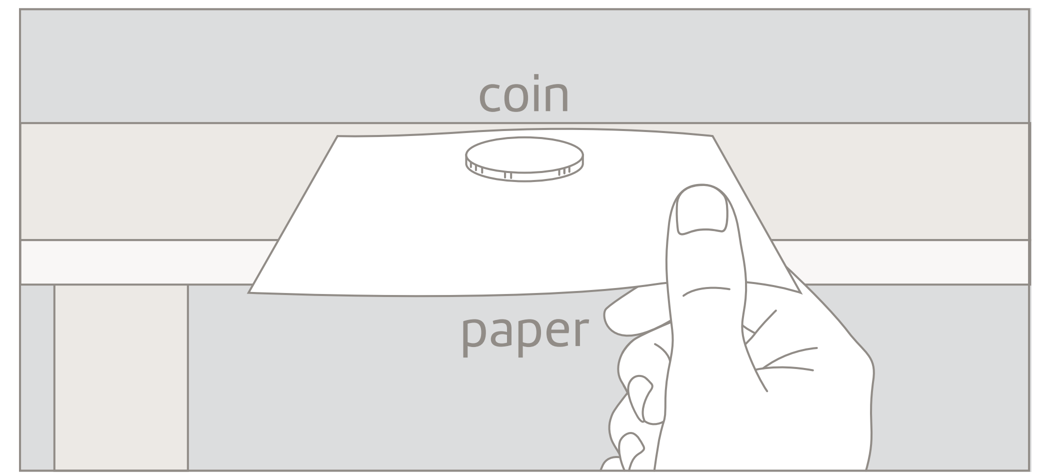
Notes

Student activities: Students demonstrate inertia for themselves with stationary and moving coins or toy cars. These activities give students hands-on experience with inertia.

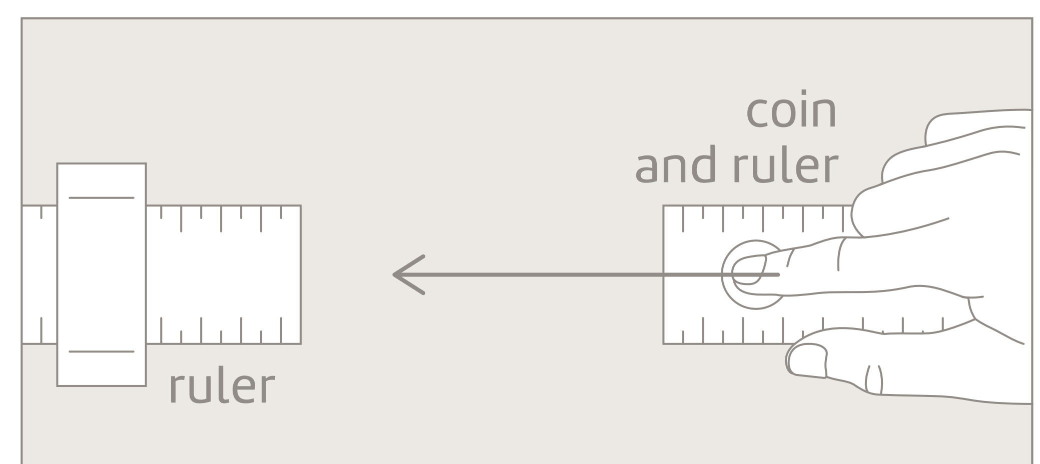
Method

Method that students will follow

Activity 1:
1. Place a coin or something a little heavier on a sheet of paper near the edge of a table, so the paper sticks out from the edge.
2. Pull the paper out as quickly as you can. How does the coin move?



Activity 2:
1. On a smooth flat tabletop fix a ruler so it won't move. Place your coin on another ruler about 3 feet away.
2. Holding the coin in place on the second ruler, push them together and then let go so they slide together toward the fixed ruler. How does the coin move when the rulers collide?



Lab Activity

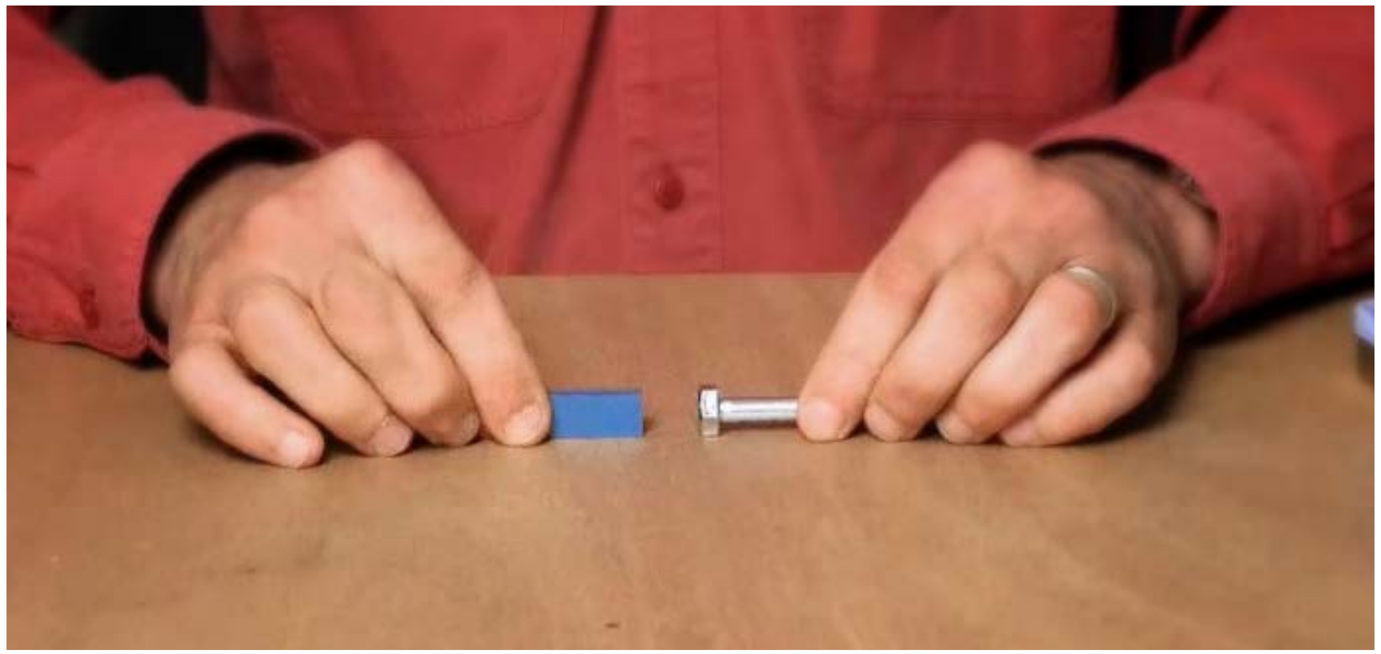
Demonstrating Newton's third law

Activity purpose: Complete simple demonstrations to model Newton's third law of motion.

stileapp.com/go/Newtonsthird

60–90 minutes

3–4 students per group



Materials

Lab Equipment
- wheeled desk chairs
- open space of smooth floor for wheeling
- bar magnet
- bolt (approx. equal mass to bar magnet)
- 2–5 kg spring balances
- old CD
- balloon
- valve type drink bottle lid
- hot glue gun

Chemicals
None required

Preparation

Students complete a series of activities to demonstrate Newton's third law. The first three require little setup and can all be done in a single class, while the fourth is a small project. Make a selection, or do them all.

You could also set up the demonstrations as a round-robin depending on the independence and behavior of your students.

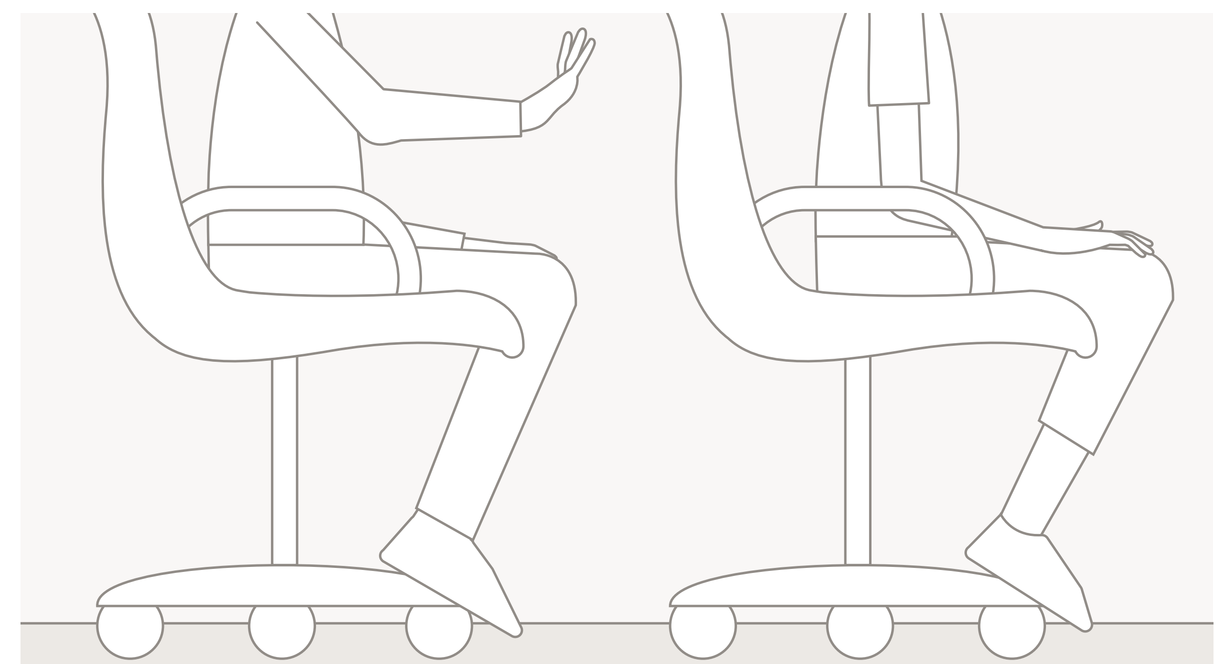
Notes

None

Method

Method that students will follow

Activity 1:
A student sits in each chair with the chairs next to each other. Feet must be off the floor. To begin with, at least, choose students of about the same mass. One student pushes the other's chair. Observe what happens.

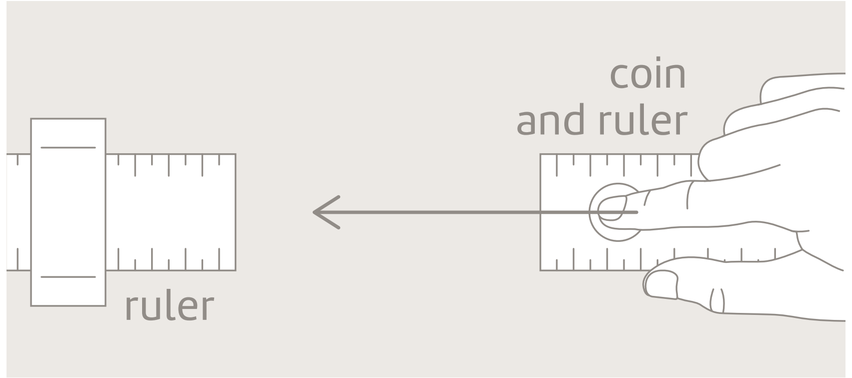


Method

Method that students will follow

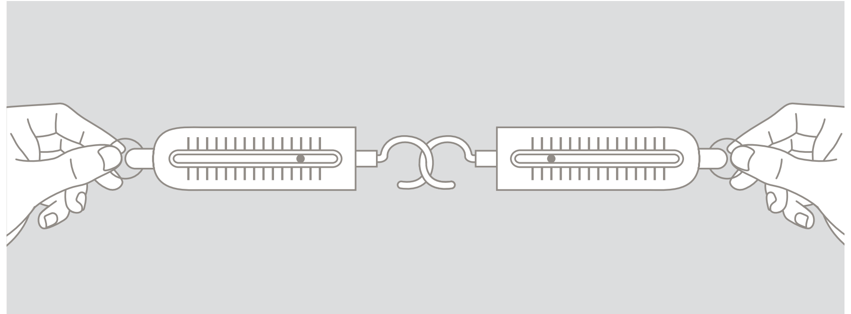
Activity 2:

1. First, make sure that the bolt is not magnetic by testing it against another piece of iron or steel, such as a paper clip.
2. Hold the magnet and the bolt down on a table, close enough that you can feel them pulling toward each other.
3. Remove your hand from the bolt. What happens?
4. Hold both objects down again the same distance apart as in step 2.
5. Remove your hand from the magnet. What happens?



Activity 3:

1. Hook two spring balances together with one student pulling or holding each end.



Skydiver
A skydiver takes advantage of gravity to pull them back to Earth.

Activity purpose: Build and test rockets powered by jets of water. Students are challenged to find the best mix of water and air in order to maximize launch distance.

stileapp.com/go/waterrockets

90–120 minutes

3–4 students per group

Lab Activity

Water rockets

Materials

Lab Equipment
- 20 fl oz. plastic drink bottle
- cork (to fit 20 fl oz. bottle)
- bicycle pump with a needle attachment
- potato chip can (needs to be 20 cm long and wide enough to fit 20 fl oz. bottle)
- heavy wire (e.g., coat hanger)
- scissors
- water
- 30 m tape measure
- safety glasses

Chemicals
None required

Preparation

This activity will need to be conducted in a large outdoor space.

Notes

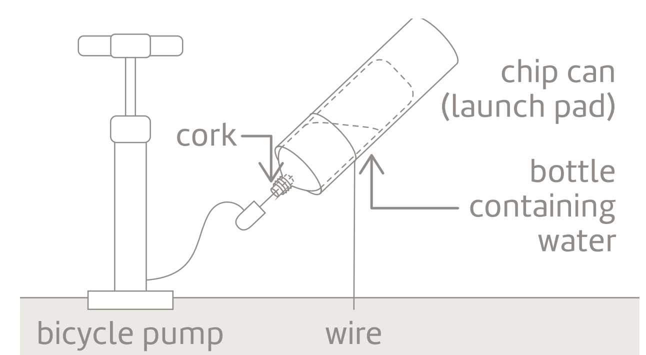
None

Method

Method that students will follow

Building your rocket:

1. Make a launch pad by cutting the lower section off the potato chip can to leave a 20 cm long open tube. Check that the bottle slides in easily.
2. Wrap the upper third of the wire securely around the chip can and extend the remaining straight section of wire past the base of the can.
3. Insert the needle attachment of the pump into the cork so that it sticks out slightly. Make sure the cork fits securely into the plastic bottle.



Launching your rocket:

1. Note: The rockets must only be launched in a large outdoor area with at least 60 feet of open space in front of the launch area. Wear safety glasses and make sure nobody is in the line of fire.
2. Set up the launch pad by pushing the wire into the ground so that the chip can sits at an angle of about 45°.
3. Begin by launching an empty bottle: insert the cork into the bottle, slide it into the launch pad, and then insert the needle attachment into the pre-made hole in the cork.
4. While one team member holds the launch pad steady, another rapidly pumps the bike pump ,and the other team members estimate and record the launch distance. A launch occurs whenever the cork comes out of the bottle, even if the bottle doesn't leave the launch pad.
5. Repeat steps 2 and 3 with the bottle full of water and record the launch distance (the launchers might get a little wet).
6. Repeat steps 2 and 3 with about 1 cup of water in the bottle and record the launch distance.

Activity purpose: Design balloon-powered cars and then vary their masses as an intuitive exploration of Newton's second law.

stileapp.com/go/ballooncars

90–120 minutes

3–4 students per group

Lab Activity

Balloon cars

Materials

Lab Equipment
To be determined by students. We suggest:
- car body: cardboard, craft sticks, boxes, styrofoam blocks
- axles: wooden skewers, drinking straws
- wheels: bottle caps, CDs
- binding materials: sticky tape, rubber bands, paper clips, Blu-Tack
- other: 3 balloons, flexible drinking straws, 4 x 100 g masses (e.g., chocolate bars), mass balance, 10 m measuring tape, scissors

Chemicals
None required

Preparation

Supply a roll of masking tape to mark where the 10 m line is.

Notes

We recommend that students work individually to initially define the problem, research, and brainstorm solutions before they join together in groups.

Method

Method that students will follow

Students will follow the engineering design process to design their own balloon-powered car.

Instructions provided to students include:

Design a scale model of a balloon-powered car.
Your scale model must:

- be built only from the materials provided
- be powered by 1–3 balloons inflated by human breath
- be able to transport up to 4 masses of 100 g each a distance of 10 m

A template outlining the engineering design process and further scaffolding is provided to students in the Stile lesson.

Lab Activity

Jet-propelled can

Activity purpose: Investigate how Newton's laws apply to jet propulsion using water streaming from a can.

stileapp.com/go/jetcan

45–60 minutes

3–4 students per group

Materials

Lab Equipment
- one or more empty drink cans with the tabs still attached
- a nail
- about 3 feet of fishing line
- fishing swivel (optional)
- bucket or tub of water to immerse can to be filled
- enough water for each group to refill can 4–5 times

Chemicals
None required

Preparation

Ensure a few weeks notice is given so that enough soft drink cans with tabs still attached can be saved to do this activity.

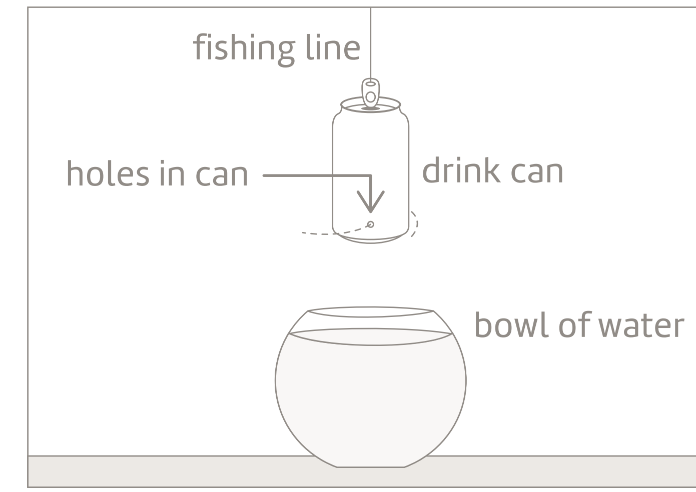
Notes

Ensure that the nail is a good size, and if it can be inserted into the can by hand or if a hammer may be needed.

Method

Method that students will follow
1. Lie a can on its side. Use a nail to carefully punch two holes on either side, just above the bottom rim. Before removing the nail from each hole, angle it to the left to slant the holes parallel to the base of the can.
2. Bend the tab straight up and tie a length of fishing line to it. If available, add a fishing swivel to allow the can to rotate freely.
3. Submerge the can in the bucket of water to fill it up.
4. Holding the fishing line, raise the can out of the water. As water streams out of the holes it should start to spin. Try to count the number of spins. Repeat two more times. Find the average number of spins over the three trials.
5. Add an extra slanted hole and repeat steps 3 and 4.
6. Add a fourth slanted hole and repeat again.

If there is time, you can experiment with more holes.



An artist's image of an astronaut on Mars
If humans are to colonize Mars, we'll need to learn how to keep water in the states we can use.

Unit 7 – States of Matter

Why is liquid water so important for humans to live on Mars?

Storyline and anchoring phenomenon

What are some of the challenges you'd face living on Mars? The key to life as we know it is water – but on Mars, it would freeze! Students engage with changes in states of matter to consider how they could overcome this challenge.

They meet astronauts Stephanie Wilson and Scott Kelly, who talk about their careers and how their work is contributing to the future of space exploration. The guiding question, "Why is liquid water so important for humans to live on Mars?" scaffolds the learning process in this unit.

Students reflect on their prior experiences and observe familiar substances to discuss their properties and how they behave in their different states. They use this knowledge when examining a new substance to reason about its state.

Students are introduced to the particle model and apply it to explain the behavior of specific substances. They find evidence in support of the accepted model from their own lab investigations, then build on their understanding using an interactive digital model.

This model allows students to visualize changes in state at the particle level and helps them develop a complete idea of changes between states of matter.

The guiding question is revisited through a project at the end of the unit, which asks students to use their knowledge of states of matter to explain the difficult nature of creating settlements on Mars. They create an application to be one of the first people to move to the red planet, which includes details about why they want to live there and what makes them a suitable candidate.

This unit at a glance

States of Matter

Introduction: Mission to Mars
Career profile: Astronaut – Stephanie Wilson
Career profile: Astronaut – Scott Kelly
What do you already know?

1.1 Lesson: States of matter
1.2 Lesson: Properties of states of matter
1.2 Quiz: Properties of the states of matter
1.3 Lab activity: Observing oobleck

2.1 Lesson: The particle model
2.1 Quiz: The particle model
2.2 Lab activity: Evidence for the particle model

3.1 Lesson: Changing states
3.1 Quiz: Changing states
3.2 Investigation: Evaporation
3.3 Lesson: Changing states and the particle model
3.3 Quiz: Changing states and the particle model
3.4 Lab activity: Observing changes of state

Project: Life on Mars
Glossary: States of matter
Test: States of matter

Students **engage with the phenomenon** that drives the unit: how could we live on Mars?

Students **activate prior knowledge** by completing a pre-test.

Students explore the **structure** and common features of different states of matter.

Students will **apply the particle model to new situations.**

Students learn how the particle **model was proposed for invisible phenomena** and apply this model to known substances.

Students will **carry out investigations** to compare and contrast how matter moves at different temperatures.

Students **observe a change in state** and infer the **particle model** for each state.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-PS1-1

Develop models to describe the atomic composition of simple molecules and extended structures.

MS-PS1-4

Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed.

Disciplinary Core Idea

- **PS1.A**: Structure and Properties of Matter

Students discover that substances are made of different atoms and that particles have different properties.

Student investigate the structures of solids and the possibility of forming lattices so that things hold shape.

Science and Engineering Practices

- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Developing and Using Models

Students investigate the difference between states of the same substance.

Students ask questions about water requirements on Mars and define problems humans would face if they were to live on Mars. They carry out investigations to define the states of matter, including exceptions to the rule. Students develop and use the particle models to explain the movement of the invisible causes for changes to states of matter.

Crosscutting Concepts

- Patterns
- Energy and Matter

Students use patterns of particle arrangement to define solids, liquids, and gases.

Students observe patterns of substances changing state and use this to predict the changes of state in other substances.

Nature of Science

– Science is a Way of Knowing

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

Students extend upon their knowledge of matter from the Grade 6 unit, Elements and Compounds, where they learned that substances are composed of different types of atoms, which form molecules.

They will build on this understanding to learn how solids, liquids, and gases are composed at the particle level, and how changes of state occur.

Science and Engineering Practices

Students have a number of opportunities to develop and use models in The Stile Curriculum, and will apply this practice to learn about the different states of matter.

The models within this unit will support students to visualize the relationships between particles, much like those that students used in Food Chains and Food Webs to visualize the relationship between organisms in an ecosystem.

By planning and carrying out investigations, students will be able to provide evidence in support of the particle model described in the unit. They have used a similar approach in Our Place in Space, where investigations were used to justify explanations of seasons, lunar phases, and eclipses.

Crosscutting Concepts

Patterns can be identified as the core concept related to States of Matter, as students associate macroscopic patterns to the arrangement of particles at a microscopic level.

This builds upon their understanding from Elements and Compounds, where students associate patterns with atomic-level structure.

Snowflake
Water can change between a liquid and a solid by changing the arrangement of its molecules.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Mission to Mars Career Profile: Astronaut – Stephanie Wilson	Why would liquid water be needed to live on Mars?	Review teaching notes in Prepare Mode Optional: Use VR headsets and smartphones for a virtual reality experience of the surface of Mars. VR headsets are available to purchase from the Stile Shop	Constructing Explanations and Designing Solutions	**PS1.A** Structure and Properties of Matter	Patterns	Ask students to imagine they live on Mars, and then to write a postcard home to Earth that describes the challenges of life on Mars	
Lesson 2	What do you already know? Career Profile: Astronaut – Scott Kelly	What is it like being an astronaut?	Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS1.A** Structure and Properties of Matter	Patterns		Students may be interested to read Scott Kelly's biography *Endurance: Young Readers Edition*
Lesson 3	1.1 Lesson: States of matter	Are inflated balloons heavier or lighter than deflated balloons?	Review results from What do you already know? Review teaching notes in Prepare Mode Optional: Electronic balance and party balloons	Developing and Using Models	**PS1.A** Structure and Properties of Matter	Systems and System Models	Ask students to familiarize themselves with Glossary: States of matter	
Lesson 4	1.2 Lesson: Properties of states of matter	What are the properties of each state of matter?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for Activity: Observing properties	Developing and Using Models	**PS1.A** Structure and Properties of Matter	Systems and System Models	Assign 1.2 Quiz: Properties of states of matter	

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.3 Lab activity: Observing oobleck	What state is oobleck in?	Review Key Questions and Quiz from previous lesson in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter Review teaching notes in Prepare Mode Optional: Preparation of Blu-Tack and play dough for non-Newtonian fluids	Planning and Carrying Out Investigations	**PS1.A** Structure and Properties of Matter	Structure and Function	Ask students to read the materials and method before the lesson	
Lesson 6	2.1 The particle model	How does the particle model explain the different properties of solids, liquids, and gases?	Review the Key Question from lab activity in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**PS1.A** Structure and Properties of Matter	Systems and System Models	Assign 2.1 Quiz: The particle model	Extra SEP support: 5.3 Creative thinking
Lesson 7	2.2 Lab activity: Evidence for the particle model	Is the particle model useful for explaining phenomena around me?	Review Key Questions and Quiz from previous lesson in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter Review teaching notes in Prepare Mode	Planning and Carrying Out Investigations	**PS1.A** Structure and Properties of Matter	Systems and System Models		Extra SEP Support: 2.1 Observing and inferring
Lesson 8	3.1 Lesson: Changing states	How can changes in state be explained through the loss or gain of energy?	Review Key Questions from the Lab activity in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**PS1.A** Structure and Properties of Matter	Energy and Matter	Assign 3.1 Quiz: Changing states	Glossary: States of Matter

Lesson Planning Guide

Week 1 · Week 2 · **Week 3** · Week 4

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	3.2 Investigation: Evaporation	How can the evaporation rates of different liquids be tested and compared?	Review Key Questions and Quiz for previous lesson in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter Review teaching notes in Prepare Mode	Planning and Carrying Out Investigations	**PS1.A** Structure and Properties of Matter	Energy and Matter	Ask students to self-assess using the rubric	Extra SEP support: 1.3 Writing a hypothesis Extra SEP support: 2.4–2.5 Controlled variables
Lesson 10	3.3 Lesson: Changing states and the particle model	How can changes of state be explained using the particle model?	Review Key Questions from Investigation in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**PS1.A** Structure and Properties of Matter	Systems and System Models	Assign 3.3 Quiz: Changing states and the particle model	Glossary: States of matter
Lesson 11	3.4 Lab activity: Observing changes of state	What happens to water particles as they change state?	Review Key Question and Quiz from previous lesson in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter Review teaching notes in Prepare Mode	Planning and Carrying Out Investigations	**PS1.A** Structure and Properties of Matter	Energy and Matter	Ask students to review teacher feedback from lessons in the unit to prepare for the test	Extra SEP support: 2.1 Observing and inferring
Lesson 12	Unit review Glossary: States of matter	How can I be prepared for the States of Matter test?	Review Key Questions from the unit using Analyze Mode to identify areas to revisit	Asking Questions and Defining Problems Planning and Carrying Out Investigations Developing and Using Models	**PS1.A**: Structure and Properties of Matter	Patterns Systems and System Models Energy and Matter	Ask students to review teacher feedback from lessons in the unit to prepare for the test	Glossary: States of matter

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · **Week 4**

The guide below is based on two 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	Test: States of matter	How much have I learned about States of Matter?	Ensure all students have access to a device Complete grading of test ahead of test review session	Asking Questions and Defining Problems Planning and Carrying Out Investigations Developing and Using Models	**PS1.A**: Structure and Properties of Matter	Patterns Systems and System Models Energy and Matter	Prompt students to write a reflection on what they have learned from the unit	
Lesson 14	Project: Life on Mars Test review	What would it take to be a candidate for a trip to Mars? How successful was my revision of States of Matter?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Engaging in Argument From Evidence	**PS1.A** Structure and Properties of Matter	Energy and Matter	Ask students to reflect on the effectiveness of their revision and to identify areas for improvement	3D virtual reality tour of Mars from Access Mars

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical skills.

Students observe the changes of states of matter and quantify the theory of the conservation of mass.
They use measurements to justify the types of changes in state. Students understand that different substances have different melting and boiling points that can be measured with positive and negative integers.

Common Core State Standards Connections: Math

MP.2

Reason abstractly and quantitatively.

MP.4

Model with mathematics.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Lessons within this unit incorporate many opportunities for students to develop and use their reading, writing, listening, and speaking skills.

Students will explain why there would be difficulties with living on Mars. They will be able to display information in multiple modes throughout the unit through the use of Open Response questions and by analyzing diagrams to summarize information.

Common Core State Standards Connections: English Language Arts

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flow chart, diagram, model, graph, or table).

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Career profile: Astronaut – Stephanie Wilson**
  Questions 4, 5
- **Career profile: Astronaut – Scott Kelly**
  Question 2
- **1.1 Lesson: States of matter**
  Questions 2, 11
- **1.2 Lesson: Properties of states of matter**
  Questions 13, 14, 15
- **1.3 Lab activity: Observing oobleck**
  Questions 6, 7
- **2.1 Lesson: The particle model**
  Questions 3, 9, 18, 20
- **2.2 Lab activity: Evidence for the particle model**
  Questions 4, 9, 10, 12, 13, 16, 17
- **3.1 Lesson: Changing states**
  Questions 9, 11, 13, 16, 17
- **3.2 Investigation: Evaporation**
  Questions 5, 12, 14, 15, 16
- **3.3 Lesson: Changing states and the particle model**
  Questions 7, 9, 10
- **Project: Life on Mars**
  Questions 1, 4

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
What do you already know?	Gases are weightless, and a filled balloon will either have the same weight or will float up off the scales.	**Use 1.1 Lesson: States of matter** Gases have mass, like all the other states of matter. Gases can be easily compressed, unlike liquids and solids. The compressed air inside the balloon is denser than the surrounding air. So the weight of the compressed air exceeds the weight of the air displaced by the balloon. This produces an additional downwards weight force on the balloon, resulting in the measured increase in mass. Use 1.1 Lesson: States of matter to allow students to see the measurements on the scales for themselves and unpack the reasoning together through questioning and discussion.

ELL support

Visual representations

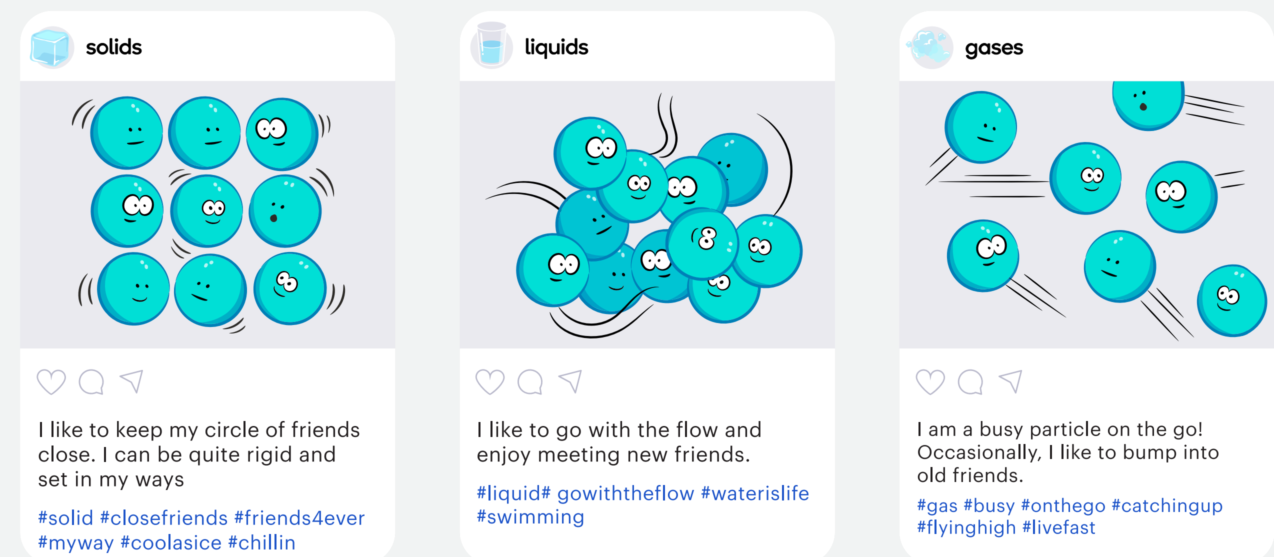
States of Matter lessons include a number of flow charts and diagrams to help students understand the changes that matter must go through to progress from one state to another. Encourage students to draw on these visual representations and actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

1.2 Lesson: Properties of states of matter

This image shows visual examples of a solid, liquid, and a gas. A written caption helps students understand the written examples and connect English language and scientific terminology to these familiar items.

2.1 Lesson: The particle model

Visual representations of invisible particles with motion lines help explain the differences in the way particles move. Visualizing the particles with annotations that use simple, familiar language will help students connect the descriptions with particle movement described in the lesson.

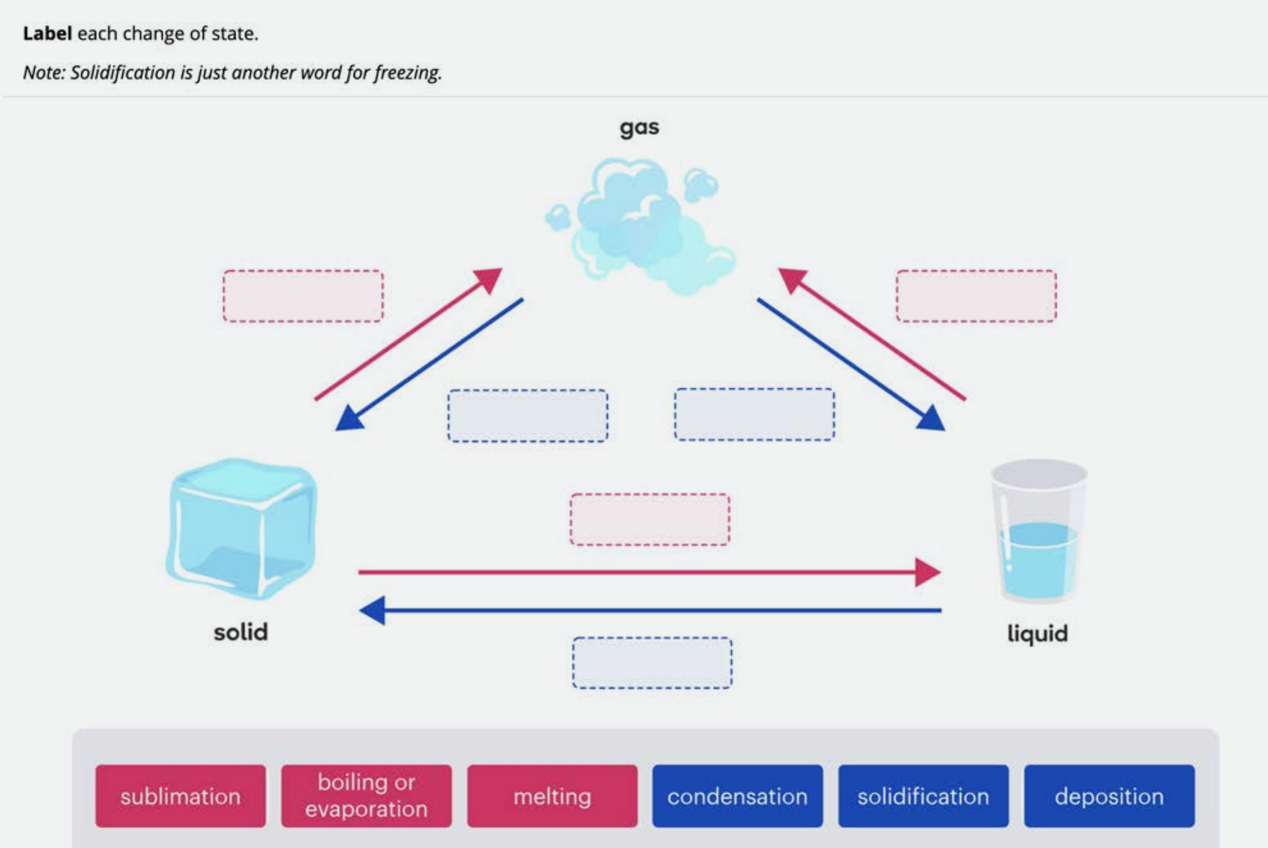


Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

3.1 Lesson: Changing states

Students consolidate their knowledge of terminology associated with the changes of states by matching the image with the topic-specific language in this summary diagram.



Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Pre-test: What do you already know?
Activate students' prior knowledge of relevant concepts, including properties of solids, liquids, and gases.
Use this as a pre-test to identify misconceptions and areas where students may need additional challenge or support in subsequent lessons.

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes

Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5–10 minutes. Quizzes provide students and teachers with information about student progress toward specific learning goals.

- **1.2 Quiz: Properties of the states of matter**
  Multiple choice: 5–10 minutes
- **2.1 Quiz: The particle model**
  Multiple choice: 5–10 minutes
- **3.1 Quiz: Changing states**
  Multiple choice: 5–10 minutes
- **3.3 Quiz: Changing states and the particle model**
  Multiple choice and fill-in-the-blank: 5–10 minutes

Summative assessment

Test
This unit contains a test to provide summative assessment of student learning across the whole unit.

Test: States of matter
Multiple choice and short answer: 45–60 minutes

Science and Engineering Practices
Three lab activities, an investigation, and a project within the unit can be used as summative assessment of Science and Engineering Practices.

- **1.3 Lab activity: Observing oobleck**
  Lab activity: 45–60 minutes
- **2.2 Lab activity: Evidence for the particle model**
  Lab activity: 30–45 minutes
- **3.2 Investigation: Evaporation**
  Lab activity: 45–60 minutes
- **3.4 Lab activity: Observing changes of state**
  Lab activity: 45–60 minutes
- **Project: Life on Mars**
  Project: 25–30 minutes

Lab Activities

Lab Activity

Observing oobleck

Activity purpose: Elicit students' prior knowledge about solids, liquids, and gases by observing oobleck – a non-Newtonian fluid.

stileapp.com/go/observingoobleck

45–60 minutes

2–3 students per group

Materials

Lab Equipment
Each group of students will need:
– mixing bowl
– spoon

Chemicals
– 1 cup of cornflour
– optional: 5 drops of food coloring
– ¼ cup of water

Preparation

Optional: Prior to the lab activity, watch a video of someone riding a bike over oobleck and explain how it is possible.

Notes

Oobleck is a non-Newtonian fluid. It displays properties of both liquids and solids under different conditions. Applying a sudden strong force to the mixture increases its viscosity. A quick tap on the surface will make it hard because the cornstarch particles are pressed together. However, if you slide your fingers through it slowly, it behaves like a liquid. This is because moving slowly gives the cornstarch particles time to move out of the way. Other non-Newtonian fluids include play dough and Blu-Tack. However, these substances behave in the opposite way to oobleck. They exhibit properties of fluids when a force is applied to them, but behave like solids when at rest.

Method

Method that students will follow

1. Measure out one cup of cornflour and place it in a bowl.
2. Slowly pour ¼ of a cup of water into the cornflour, mixing as you go.
3. Add 5 drops of food coloring to the mixture and mix until the color is even.
4. Carefully observe how the oobleck behaves when you:
   a. pour it onto your hands
   b. squeeze it in your fist
   c. roll it between your hands
   d. quickly run your fingers through it
   e. slowly run your fingers through it

Lab Activity

Evidence for the particle model

Activity purpose: Observe and explain evidence for the particle model of matter.

stileapp.com/go/particlemodel

45–60 minutes

3–4 students per group

Materials

Each group of students will need:

Lab Equipment
- 10 mL syringe
- marble (must fit in the syringe)
- 2 beakers, labeled "hot" and "cold"
- stopwatch
- flask (for ice water)

For whole class:
- 1 L conical flask (for ice water)
- kettle (for hot water)
- large plastic measuring jug (for hot water)

Chemicals
- 10 mL water (to fill the syringe)
- hot water
- cold water

For whole class:
- ice
- 2 different colored food dyes
- bottle of perfume

Preparation

The activities in this lesson could be set up as a round robin, where students rotate between activity stations around the classroom.

Notes

Part 3 is also suitable as a whole class activity.

If the students find it difficult to keep their thumb on the syringe tip, press the tip into a large rubber stopper when compressing.

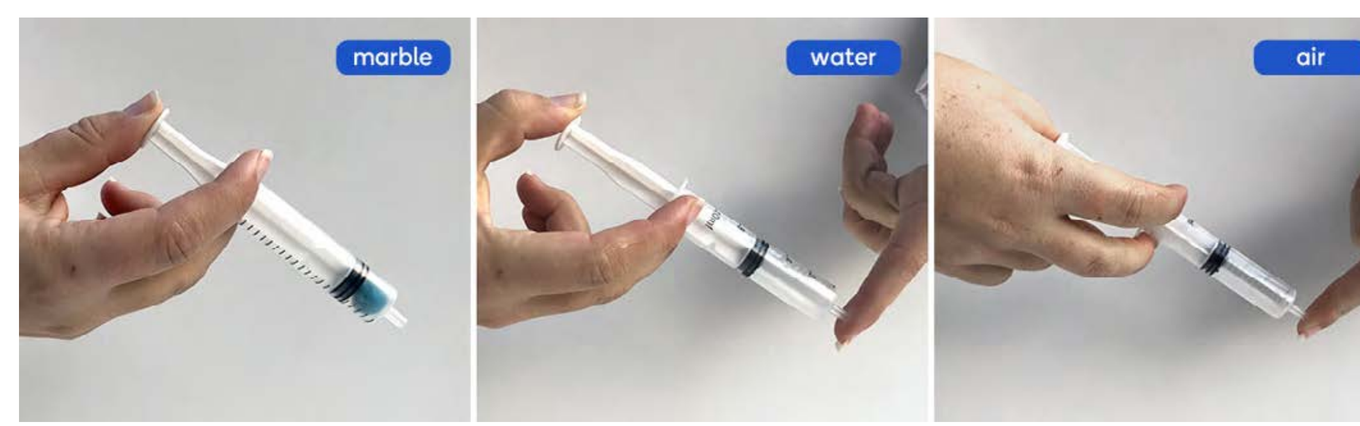
Method

Method that students will follow

Part 1
Solid
1. Place a marble in the empty syringe.
2. Press down on the stopper.
   Can you compress the marble?

Liquid
3. Fill the empty syringe with water and place your thumb over the opening.
4. Press down on the stopper. Can you compress the water?

Gas
5. Pull the stopper on an empty syringe back to fill it with air and place your thumb over the opening.
6. Press down on the stopper.
   Can you compress the air?



Method

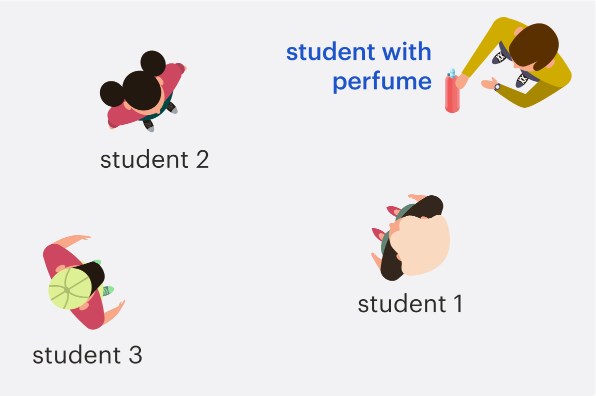
Method that students will follow

Part 2

1. Fill one beaker with hot water. Fill the other one with cold water. Rest the beakers on a bench.
2. Add a few drops of food dye to each beaker.
3. Observe what happens initially and again after 2 minutes.

Part 3

1. One student in the group takes the perfume bottle to one corner of the classroom.
2. The rest of the group spreads out, all at different distances from the person with the perfume.
3. The first student sprays the perfume toward the rest of the group.
4. As soon as a group member can smell the perfume, they should raise their hand.
5. Wait for a few minutes or until everyone can smell the perfume. Record your observations.



Monkeys in a steamy hot spring
Hot springs in Japan attract monkeys to take a bath as heat from the Earth warms up the water and slowly evaporates.

Lab Activity

Evaporation

Activity purpose: Investigate the evaporation rates of different liquids.

stileapp.com/go/evaporation

45–60 minutes

3–4 students per group

Materials

Each group of students will need:

Lab Equipment
- a ruler or measuring tape
- cups or beakers
- measuring cylinders (of the same size)
- hot plate
- thermometers
- stopwatch

Chemicals
- various liquids such as water, vinegar, milk, juice, etc.

Preparation

None required

Notes

This template is designed to guide students through the steps of an open inquiry. It is important to consider if this type of inquiry is appropriate for your students and the type of investigation they are pursuing.
You can easily modify the template by:
- varying the level of inquiry, e.g., defining a particular aim, set of materials or method
- focusing on a particular aspect of inquiry, e.g., devising a hypothesis, identifying variables, or analyzing data
- adding extra scaffolding to support less experienced students

Method

Method that students will follow
Method is to be determined by students as per question 6.

Lab Activity

Observing changes of state

Activity purpose: Observe changes of state from solid to liquid to gas when water is heated.

stileapp.com/go/observingchanges

45–60 minutes

3–4 students per group

Materials

Lab Equipment
Each group of students will need:
- 250 mL conical flask
- party balloon
- Bunsen burner
- heatproof mat
- tripod
- gauze mat
- matches or gas lighter

Chemicals
- 5 ice cubes

Preparation

Make ice cubes ahead of time; each group of students will need 5 cubes.

Notes

Make sure that the ice cubes will fit through the neck of the conical flask.

Get the students to blow into the balloon prior to inserting it over the mouth of the conical flask. This will stretch the balloon and make it easier for the balloon to expand.

It's important that the students are reminded that if cold water is run over the hot glass there is a risk of the glass cracking, so it's important to allow the glass to cool.

Method

Part 1 – Heating
1. Place 5 ice cubes into the conical flask.
2. Stretch the end of the empty balloon over the top of the conical flask. It should be sealed so that no air can flow in or out.
3. Place the conical flask above the Bunsen burner as shown in the photo. Heat the flask until the ice cubes melt.
4. When the water begins to boil rapidly, turn off the Bunsen burner. Allow the flask to stand for a few minutes while you record your observations.

Part 2 – Cooling
1. Once the flask is cool enough to touch, take it off the tripod.
2. Run cool water over the conical flask. Observe what happens to the balloon.

Hands-on labs in Stile

Units in Stile have hands-on labs integrated throughout. Listed below is each of the units in Grade 7 of The Stile Curriculum, and all of the materials required for one group of students to complete the labs within that unit.

Genetics

Extracting DNA

- ziplock bag (15 x 10 cm)
- 60 mL test tube
- 20 mL measuring cylinder
- square of fine gauze or cheesecloth (15 x 15 cm)
- small funnel
- 15 cm long skewer
- black cardboard
- 1 small strawberry (per student)
- 20 mL ice cold 70% ethanol or isopropyl rubbing alcohol
- 2 teaspoons (10 mL) DNA extraction buffer (see below)
- DNA extraction buffer: makes 500 mL (enough for 50 extractions)
- 50 mL shampoo or 25 mL liquid dishwashing detergent
- 7.5 g kitchen salt (about 1 teaspoon)
- 450 mL water

Plants

Viewing leaf epidermis cells

- suitable leaf – examples include common ivy, ribbon grass, spider plant, geranium, hibiscus, sweet pea, broad bean, or most succulents, such as “Mother-in-law’s Tongue”
- 1 mL artists’ colorless water-based varnish or colorless nail polish
- compound light microscope
- microscope slide
- forceps
- 1 cm^2 of wax or grease-proof paper
- 10 cm colorless sticky tape
- small scissors

Flower dissection

- 1 flower species
- scalpel
- tweezers
- magnifying glass or hand lens
- cutting boards
- optional: poster board, markers, and tape for poster activity
- glass of water

Plants continued

Asexual reproduction in plants

- beaker or glass jar
- knife
- chopping board
- 1 bunch of spring onions
- water

Venus flytraps

- a Venus flytrap with at least 6 open traps
- stopwatch
- teaspoon
- thin paintbrush
- toothpick
- human hair
- sugar solution
- thick cotton thread
- drinking straw
- sand
- tap water
- salt water
- sugar solution
- flour
- salt

Ecosystems

Properties of plastics

- a range of plastic objects, including at least one of each type of plastic

Sorting plastics by density

- 1 object made from each type of plastic
- scissors
- 30 cm ruler
- permanent marker
- 6 x 100 mL beakers
- stirring rod
- gloves
- waste container for used plastics
- 50 mL isopropyl alcohol pure liquid
- 50 mL vegetable oil
- 50 mL distilled water
- 50 mL salt water
- 50 mL honey

Cleaning our oceans

- a selection of used plastic bags, plastic containers, and cups
- rubber bands
- rope or string
- cardboard
- popsicle or craft sticks
- bamboo skewers
- wire or pipe cleaners
- corks, styrofoam, or bubble wrap
- small weighted objects, such as pebbles
- fabric or net-like cloth, such as hessian
- scissors
- sticky tape
- staples
- Blu-Tack or playdough
- ruler
- large plastic container, filled with water
- floating plastic waste items in a range of sizes, such as small straws, plastic food wrappers, and bottle caps

Ecosystems (continued)

Make an ecosystem model

- large glass jar (min. height 12 cm) with lid
- trowel/scoop/spoon
- approx. ½ cup gravel
- approx. ½ cup sand
- 1–2 cups soil or potting mix
- small plant or seedling such as moss, fern, or flowering lobelia
- 20 mL water
- masking tape (5 rolls per class)
- gloves
- optional: wide-mouthed funnel

Abiotic factors and plant growth

- at least 3 seedlings or small plants
- at least 3 small pots with labels
- different types of soil or potting mix
- fertilizer
- trowel/scoop/spoon
- thermometers
- lamps or flashlights
- tape or glue
- scissors
- ruler
- marker
- gloves
- fertilizer
- water
- Depending on the abiotic factor, you may also need to provide: 3 x cups of different types of growth medium (e.g., clay, sand, pine bark, coconut husk, soil, or potting mix)
- 1 x cup fertilizer (with packet instructions for dilution for students to work with), water, spatula, measuring cup
- 3 x differently colored cellophane
- 3 x cardboard boxes
- water, measuring cylinder

Photosynthesis

- 250 mL beaker
- 2 x test tubes
- 2 x rubber stoppers
- 10 mL measuring cylinder
- test tube rack
- stirring rod
- paper or metal straw
- 4–5 cm piece of pondweed or leaf
- light source, such as a white light lamp or bright sunlight
- 50 mL distilled water
- 40 drops universal indicator in dropper bottle and color chart
- 3 x extra test tubes and stoppers
- 3 x 4–5 pieces of pondweed or leaf
- extra white light lamps
- 10 m measuring tapes
- materials of different transparency, such as black paper, cotton gauze, muslin cloth, tissue paper, or colored cellophane
- masking tape
- stopwatch

Make plastic from milk

- Bunsen burner
- tripod
- gauze mat
- heatproof mat
- matches or lighter
- 2 x 250 mL beakers
- 250 mL measuring cup
- 50 mL measuring cylinder
- stirring rod
- thermometer
- paper towels
- cloth strainer
- butcher's paper
- optional: cookie cutters
- 150 mL whole milk
- 10 mL white vinegar

The Nervous System

Taste and smell

- blindfold
- 4 x variety of foods supplied in plastic cups or plates (e.g. salt and vinegar chips, lifesavers, cooking chocolate, jellybeans, cocktail onions)
- toothpicks or popsicle sticks or spoons as required
- pen
- paper

Active Earth

Model of the Earth

- 30 cm ruler
- 4 different colored lumps of play dough, each color weighing approximately 400 g
- 4 toothpicks
- 4 small sticky notes
- scissors

Modeling the rock cycle

- aluminum foil (1 roll for the class)
- ziplock plastic bag approx 16 cm x 17 cm
- 2 x 500 mL beakers
- 500 mL measuring jug
- kettle
- scissors
- 4 candies (we recommend Starburst because they stick together when pressed and easily melt in hot water; chocolate or crayons could also be used)
- 200 mL ice
- 250 mL hot water

Modeling tectonic plates

- various choices for the semi-liquid material (e.g., shaving cream, tomato sauce, melted chocolate, golden syrup, mud, etc.)
- various choices for the solid tectonic plates (e.g., cardboard, crackers, wafers, thin plastic sheets, flat shells, etc.)
- a flat, shallow bowl or tub

Earthquake-resistant buildings

- Blu-Tack or plasticine (1 stick/25 grams)
- uncooked spaghetti (30 pieces)
- scissors
- 30 cm ruler
- 2 x 1 m lengths of dowel
- 2 x 75 cm lengths of PVC
- 2 x 60 cm lengths of PVC
- 4 PVC elbows
- wooden board, 60 cm x 60 cm
- 8 nuts
- 4 eye bolts
- 4 bolts
- 8 elastic bands
- electric drill with drill bit

Newton’s Laws of Motion

Demonstrating Newton’s first law

- apple
- sharp knife
- cutting mat
- 8.5 x 11 inch piece of paper
- 1 coin
- paper
- 2 x 30 cm rulers
- tape

Demonstrating Newton’s third law

- wheeled desk chairs
- open space of smooth floor for wheeling
- bar magnet
- bolt (approx. equal mass to bar magnet)
- 2–5 kg spring balances
- old CD
- balloon
- valve type drink bottle lid
- hot glue gun

Water rockets

- 20 fl oz. plastic drink bottle
- cork (to fit 20 fl oz. bottle)
- bicycle pump with a needle attachment
- potato chip can (needs to be 20 cm long and wide enough to fit 20 fl oz. bottle)
- heavy wire (eg. coat hanger)
- scissors
- water
- 30 m tape measure
- safety glasses

Balloon cars

- car body: cardboard, craft sticks, boxes, styrofoam blocks
- axles: wooden skewers, drinking straws
- wheels: bottle caps, CDs
- binding materials: sticky tape, rubber bands, paper clips, Blu-Tack
- other: 3 balloons, flexible drinking straws, 4 x 100 g masses (e.g. chocolate bars), mass balance, 10 m measuring tape, scissors

Jet-propelled can

- one or more empty drink cans with the tabs still attached
- a nail
- about 3 feet of fishing line
- fishing swivel (optional)
- bucket or tub of water to immerse can to be filled
- enough water for each group to refill can 4–5 times

States of Matter

Observing oobleck

- mixing bowl
- spoon

Evidence for the particle model

- 10 mL syringe
- marble (must fit in the syringe)
- 2 beakers, labeled “hot” and “cold”
- stopwatch
- flask (for ice water)

For whole class:
- 1 L conical flask (for ice water)
- kettle (for hot water)
- large plastic measuring jug (for hot water)

Evaporation

- a ruler or measuring tape
- cups of beakers
- measuring cylinders (of the same size)
- hot plate
- thermometers
- stopwatch

Observing changes of state

- 250 mL conical flask
- party balloon
- Bunsen burner
- heatproof mat
- tripod
- gauze mat
- matches or gas lighter

Grade

8

Unit 1 – Earth Systems

How does our planet recycle?

The aurora borealis or northern lights
This beautiful phenomenon is caused by energetic particles from the Sun interacting with the atmosphere, which is one of Earth's four systems.

Storyline and anchoring phenomenon

Most students know it's important to look after the environment and recycle but how does our planet recycle?

This unit explores the many cycles of the Earth. Students are introduced to this unit by meeting Dr. Pia Winberg, a marine ecologist who finds creative ways to use seaweed sustainably. She and her team are looking to find ways to add seaweed nutrients to everyday foods and ways to use seaweed in medicines!

Students learn key terms, including renewable and nonrenewable resources before exploring the water cycle through learning about how water is recycled on the International Space Station. They examine the phenomenon of terrestrial radiation while applying their knowledge of Earth's four systems and how energy moves between them.

Students learn about albedo through a hands-on lab activity where they compare temperatures of different colored pieces of paper under light sources. They then take a trip a little bit closer to home, and learn about how the reintroduction of wolves to Yellowstone National Park changed the hydrosphere.

This multimodal unit culminates with students completing a research paper on another cycle of their choice to deliver a class presentation.

This unit at a glance

Earth Systems

Meet Dr. Pia Winberg a scientist who studies the uses of seaweed as a sustainable resource.

Introduction: How does our planet recycle?

Students examine the key processes in the water cycle and complete a simple **model**.

Students compare the rock cycle to the water cycle.

1.1 Lesson: The water cycle
1.1 Quiz: The water cycle
1.2 Investigation: Modeling the water cycle
1.3 Lesson: Four global systems
1.3 Quiz: Four global systems
1.4 Lesson: Movement of matter
1.4 Quiz: Movement of matter
1.5 Lesson: Movement of energy
1.5 Quiz: Movement of energy
1.6 Lab activity: Albedo and color
1.7 Investigation: Albedo and color

Students complete **formative assessment** throughout the unit.

Students examine the **phenomenon** of terrestrial radiation.

Students **explore** how the reintroduction of wolves to Yellowstone National Park changed the hydrosphere.

2.1 Lesson: Ecosystems
2.1 Quiz: Ecosystems
2.2 Lesson: The carbon cycle
2.2 Quiz: The carbon cycle
2.3 Project: Explore another cycle

Students **investigate** another cycle and prepare a presentation.

Glossary: Earth systems
Test: Earth systems

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-ESS2-1

Develop a model to describe the cycling of Earth's materials and the flow of energy that drives this process.

MS-ESS2-4

Develop a model to describe the cycling of water through Earth's systems driven by energy from the Sun and the force of gravity.

MS-ESS3-1

Construct a scientific explanation based on evidence for how the uneven distributions of Earth's mineral, energy, and groundwater resources are the result of past and current geoscience processes.

Disciplinary Core Ideas

- **ESS2.A**: Earth's Materials and Systems
- **ESS2.C**: The Roles of Water in Earth's Surface Processes
- **ESS3.A**: Natural Resources

Students explore how energy flows and matter cycles in Earth's systems. They follow the journey of water molecules through the water cycle, driven by the Sun and gravity, and learn the processes involved through a hands-on investigation.

Students recognize that humans rely on resources from the atmosphere and biosphere and that these resources are nonrenewable and limited.

Science and Engineering Practices

- Planning and Carrying Out Investigations
- Constructing Explanations and Designing Solutions
- Obtaining, Evaluating, and Communicating Information

Students plan and carry out investigations about the water cycle and albedo. They use the results of these investigations to construct explanations and as a means of obtaining information.

Students build upon the information they have collected through research from multiple sources, including websites and online articles. They synthesize and evaluate this information, then communicate it in both written answers and an oral presentation.

Crosscutting Concepts

- Systems and System Models
- Energy and Matter
- Stability and Change

Students create and engage with models of Earth's systems to learn about the flows of energy and matter within and between them. They understand stability and change in the context of these systems and how they respond to different circumstances.

Science, Technology, Society and the Environment

- Influence of Engineering, Technology, and Science on Society and the Natural World

Nature of Science

- Scientific Knowledge is Open to Revision in Light of New Evidence
- Science Addresses Questions About the Natural and Material World
- Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

In Grade 7's Active Earth unit, students developed an understanding of the cycling of matter through the rock cycle. From Ecosystems, they became familiar with the pattern of interconnected ocean currents that causes plastic to circulate and accumulate in oceanic "garbage patches."

This knowledge is extended as students learn about how energy flows and matter cycles within Earth's systems. The idea of both matter and energy cycling through systems is familiar to students from the Food Chains and Food Webs and Ecosystems units earlier in The Stile Curriculum, where students considered producers and consumers at different trophic levels. Students will be able to draw comparisons between these cycles and the water cycle as they learn about the movement of water between land, ocean, and atmosphere, and the role of sunlight in these processes.

Science and Engineering Practices

Students have planned and carried out investigations throughout middle school, and draw upon their skills in this area in this unit.

Where the investigation process in Grades 6 and 7 offered students a significant amount of scaffolding, Earth Systems' investigation about the relationship between albedo and color gives students more freedom to determine how they will structure their investigation. They will identify independent and dependent variables, the tools required to gather information, and record data to support their conclusions.

The incorporation of models also continues in this unit, with students developing and using a model to describe the phenomenon of the water cycle and evaluating the model.

Crosscutting Concepts

Students have considered the concept of energy and matter when learning about the way in which energy is transferred in Heat and Light units, and the cycling of matter through trophic levels in Food Chains and Food Webs and Ecosystems units.

In Earth Systems, they consider the flow of energy and cycling of matter between Earth's systems, making connections with their previous knowledge of energy and matter from a number of different contexts taught earlier in middle school.

The concept of systems and system models has also been carried through grade levels, where models have been used to represent the flow of energy and matter in Light, Ecosystems and Our Place in Space units. Students will apply this when they create a model that represents the system of the water cycle, and the flow of matter between its stages.

The idea of stability and change is further explored, extending students' understanding from Ecosystems where they recognized the connection that exists between parts of a system. This idea is explored through the cycles that students learn about in the unit, including the carbon cycle.

A seaweed farm in Indonesia
Seaweed is fast-growing and doesn't need fresh water or fertilizers, unlike crops grown on land. Scientists are developing new ways of using seaweed as a sustainable resource.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: How does our planet recycle?	How does our planet recycle?	Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**ESS3.A** Natural Resources	Systems and System Models	Ask students to read *Science News for Students* article, "Cool jobs: Finding foods for the future," linked in the lesson	PhycoHealth website linked in the references for this lesson
Lesson 2	1.1 Lesson: The water cycle	How thirsty would you need to be to drink your own pee?	Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**ESS3.A** Natural Resources **ESS2.C** The Roles of Water in Earth's Surface Processes	Systems and System Models Stability and Change	Assign 1.1 Quiz: The water cycle	WaterGAP model website linked in teaching notes
Lesson 3	1.2 Investigation: Modeling the water cycle	Can we purify salt water?	Review Key Questions and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare materials for investigation. See relevant pages at the end of this chapter	Planning and Carrying Out Investigations	**ESS2.C** The Roles of Water in Earth's Surface Processes	Systems and System Models Stability and Change	Optional: Ask students to complete Extra SEP support: 2.7 Results in preparation for the next lesson	Extra SEP support: 2.2 Measuring
Lesson 4	1.2 Investigation: Modeling the water cycle	Can we purify salt water?	Review student progress in Analyze Mode	Planning and Carrying Out Investigations	**ESS2.C** The Roles of Water in Earth's Surface Processes	Systems and System Models Stability and Change		Science Investigations poster set. Posters are available for purchase in the Stile Shop

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.3 Lesson: Four global systems	What are the Earth's four systems and how do they interact?	Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**ESS2.A** Earth Materials and Systems	Systems and System Models	Assign 1.3 Quiz: Four global systems as homework	
Lesson 6	1.4 Lesson: Movement of matter	How does matter move between Earth's systems?	Review Key Question and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**ESS2.A** Earth Materials and Systems	Energy and Matter	Assign 1.4 Quiz: Movement of matter as homework	
Lesson 7	1.5 Lesson: Movement of energy	How does the Earth get energy?	Review Key Question and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**ESS2.A** Earth Materials and Systems	Energy and Matter Systems and System Models	Assign 1.5 Quiz: Movement of energy as homework	*Cosmos Magazine* article linked in lesson, "Vantablack, the blackest material ever made"
Lesson 8	1.6 Lab activity: Albedo and color 1.7 Investigation: Albedo and color	What's the relationship between color and albedo?	Review Key Question and Quiz from the previous lesson in Analyze Mode Consider whether the lab activity, 1.6, or investigation, 1.7, is the best fit for your students. You may use 1.6 as an extension opportunity Review teaching notes in Prepare Mode, and determine how you will divide the activities over the three allocated lessons Prepare the materials for the investigation/lab activity. See the relevant pages at the end of this chapter	Constructing Explanations and Designing Solutions	**ESS2.A** Earth Materials and Systems	Energy and Matter	Assign Extra SEP support: 2.1 Observing and inferring	Extra SEP support: 0.1 Conducting science investigations

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	1.6 Lab activity: Albedo and color 1.7 Investigation: Albedo and color	What's the relationship between color and albedo?	Review student progress in Analyze Mode	Planning and Carrying Out Investigations	**ESS2.A** Earth Materials and Systems	Energy and Matter	Assign Extra SEP support: 2.7 Result	
Lesson 10			Review student progress in Analyze Mode					
Lesson 11	2.1 Lesson: Ecosystems	How did wolves affect the water in Yellowstone National Park?	Review Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**ESS2.A** Earth Materials and Systems	Energy and Matter Stability and Change	Assign 2.1 Quiz: Ecosystems	
Lesson 12	2.2 Lesson: The carbon cycle	Do seasons affect carbon dioxide levels in the atmosphere?	Review Key Question and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**ESS2.A** Earth Materials and Systems	Energy and Matter Stability and Change	Assign 2.2 Quiz: The carbon cycle	*The Atlantic* article, "The Wood Wide Web," linked in the lesson

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	2.3 Project: Explore another cycle Select a cycle and research it	What other cycles are there on Earth?	Review Key Questions and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**ESS2.A** Earth Materials and Systems	Systems and System Models	Assign Extra SEP support: 1.1 Researching	*Cosmos Magazine* articles linked in the lesson, "Nitrogen pollution: the forgotten element of climate change, and Phosphorus is vital for life on earth"
Lesson 14	2.3 Project: Explore another cycle Create diagram and prepare presentation	What other cycles are there on Earth?	Review student progress in Analyze Mode Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**ESS2.A** Earth Materials and Systems	Systems and System Models	Ask students to practice their presentation	
Lesson 15	2.3 Project: Explore another cycle Deliver presentations	What other cycles are there on Earth?	Review student progress in Analyze Mode Print rubrics for peer and teacher grading	Obtaining, Evaluating, and Communicating Information	**ESS2.A** Earth Materials and Systems	Systems and System Models		
Lesson 16	2.3 Project: Explore another cycle Deliver presentations	What other cycles are there on Earth?	Print rubrics for peer and teacher grading	Obtaining, Evaluating, and Communicating Information	**ESS2.A** Earth Materials and Systems	Systems and System Models		

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 **Week 5**

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	Unit review	How can I be prepared for the Earth Systems test?	Review Key Questions from the unit in Analyze Mode to identify areas to revisit	Constructing Explanations and Designing Solutions	**ESS3.A** Natural Resources **ESS2.C** The Roles of Water in Earth's Surface Processes **ESS2.A** Earth Materials and Systems	Energy and Matter Systems and System Models Stability and Change	Ask students to review teacher feedback from lessons in the unit	
Lesson 18	Test: Earth systems	How much have I learned about Earth Systems?	Ensure every student has access to a device	Constructing Explanations and Designing Solutions	**ESS3.A** Natural Resources **ESS2.C** The Roles of Water in Earth's Surface Processes **ESS2.A** Earth Materials and Systems	Energy and Matter Systems and System Models Stability and Change	Prompt students to write a reflection on what they have learned from the unit	
Lesson 19	Test review	How successful was my revision of Earth Systems?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Constructing Explanations and Designing Solutions	**ESS3.A** Natural Resources **ESS2.C** The Roles of Water in Earth's Surface Processes **ESS2.A** Earth Materials and Systems	Energy and Matter Systems and System Models Stability and Change	Ask students to reflect on how effective their revision was, and to identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical skills.

Students observe the phenomenon of cycling of matter across the Earth over both short and long time scales. Due to the complexity of these matters, students are required to reason abstractly as to where and when the cycling matter has happened. In some instances, such as the water cycle and the albedo effect, students use quantitative data to justify their understanding of the cycling of energy and matter through the Earth's systems.

Common Core State Standards Connections: Math

MP.2

Reason abstractly and quantitatively.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Lessons within this unit incorporate many opportunities for students to develop and use their reading, writing, listening, and speaking skills.

Students use multiple texts and multimedia presentations of information to compare and contrast information on the cycling of matter. They evaluate the accuracy of this resource and then create their own visual displays to demonstrate their understanding of a nutrient cycle of their choosing

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.9

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

WHST.6-8.8

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

SL.8.5

Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Introduction**
  Questions 4,6
- **1.1 Lesson: The water cycle**
  Questions 6, 7 9, 10
- **1.2 Lesson: Four global systems**
  Question 12
- **1.3 Lesson: Movement of matter**
  Questions 3, 7, 11, 12
- **1.4 Lesson: Movement of energy**
  Questions 4, 6, 9, 10, 13, 14
- **2.1 Lesson: Ecosystems**
  Questions 2, 9
- **2.2 Lesson: The carbon cycle**
  Questions 6, 11, 16

Extension opportunities in this unit

Challenge Questions
Most lessons contain one or more Challenge Questions, which are an opportunity for students to show they are working above the level of the learning goal.

When answering these questions, students can extend themselves by applying their knowledge to new contexts or to solve more complex problems. These provide a great extension opportunity.

Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC
2.3 Project: Explore another cycle	How can I pitch my ideas to the class?	None	Constructing Explanations and Designing Solutions	**ESS2.A** Earth Materials and Systems	Systems and System Models

ELL Support

To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

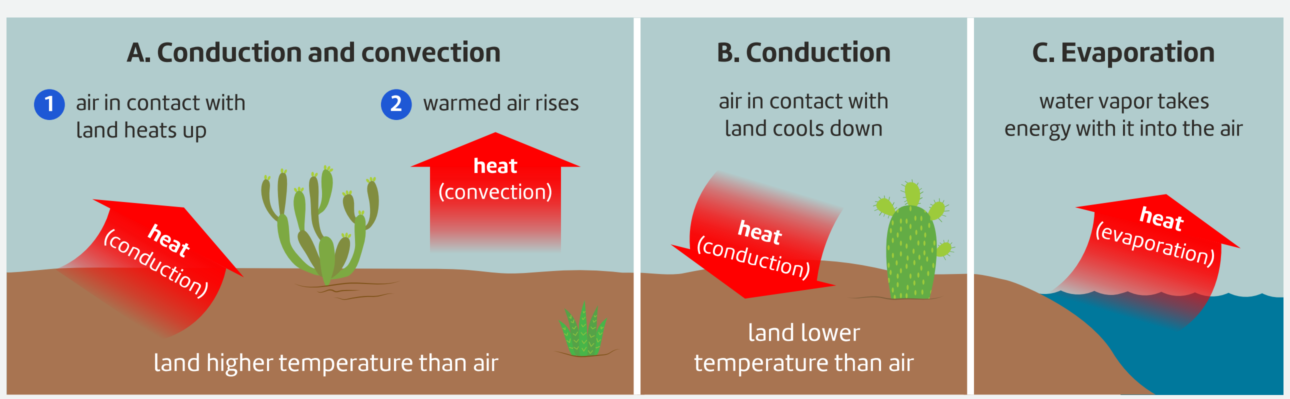
Visual representations

Earth Systems lessons include a number of flow charts and diagrams to help students understand the four global systems and how they interact. Encourage students to draw on these visual representations and actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information rather than as a substitute for reading the text.

Two examples of visual representations are included below, though there are many more.

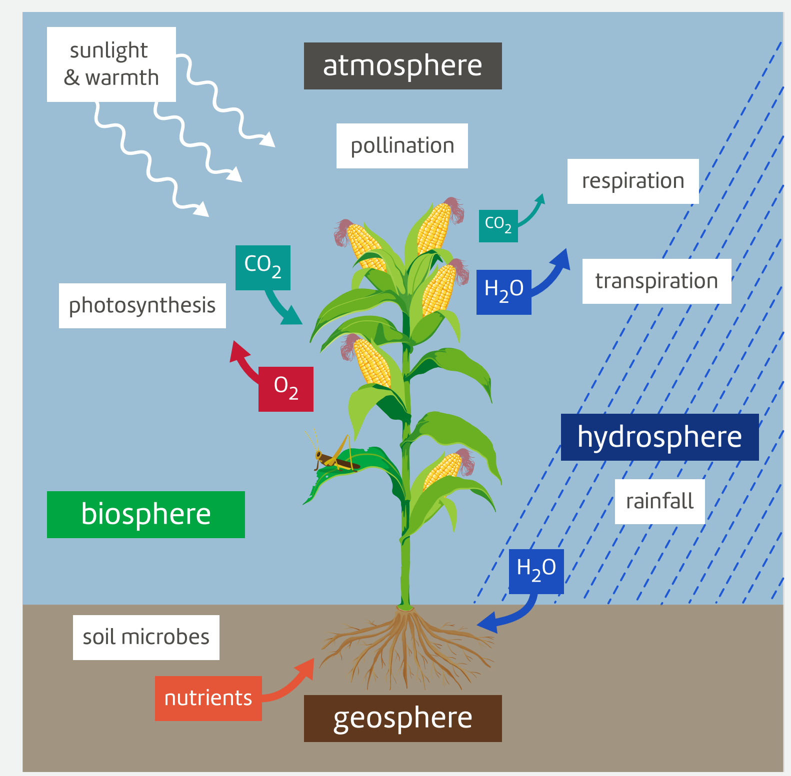
1.5 Lesson: Movement of energy

This illustration of conduction, convection, and evaporation demonstrates how heat moves around the planet. Red, the universal color for heat, is used for the arrows showing how heat moves between air, land, and water to support students to recognize what is being shown. Clear labels alongside the arrows help students to link the visual representation to the appropriate terminology.



Lesson 2.1: Ecosystems

Corn is likely a familiar plant to most students. Diagrams of familiar plants with subject-specific language will allow ELL students to access information through multiple media exposures. By visually associating these words with the illustrated example, students make connections between the corn plant, the various interactions within its ecosystem and the associated words. This helps students build their English vocabulary and supports their comprehension of text that uses this terminology.



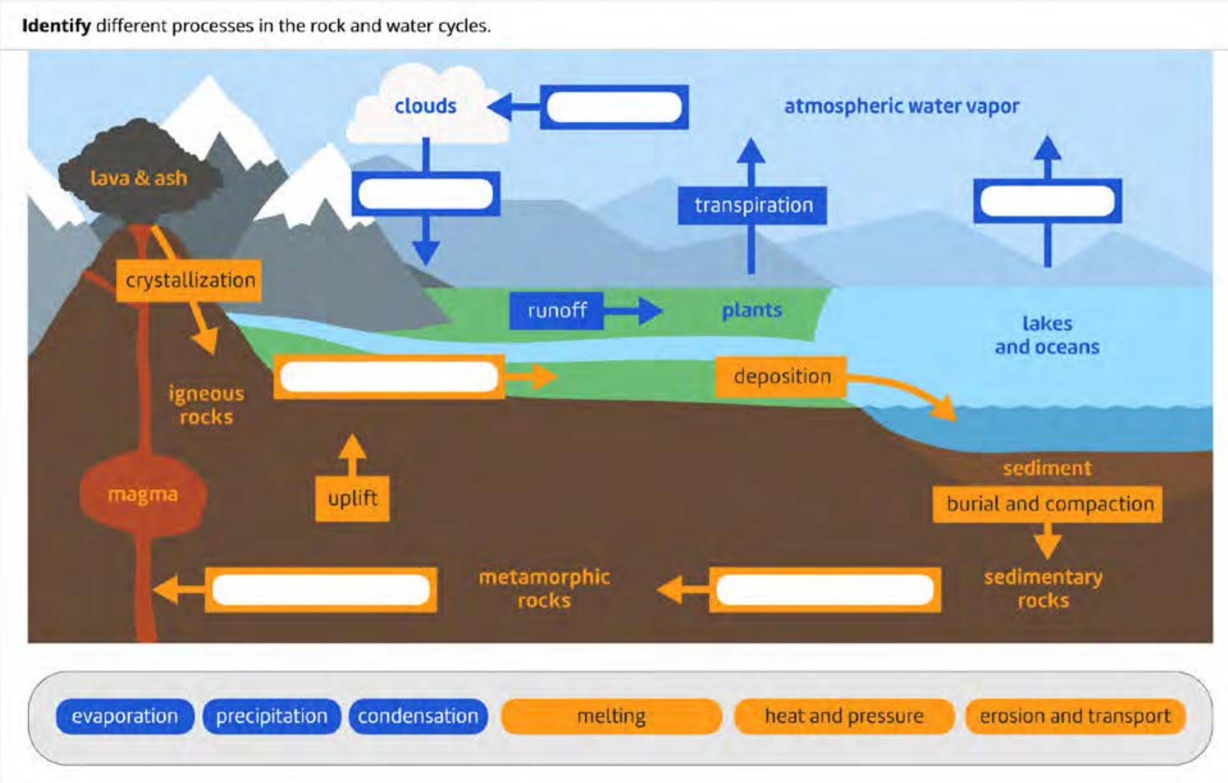
Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.3 Lesson: The four global systems

Drag-and-drop questions allow English Language Learners to match terminology with images. It focuses them on identifying and positioning the key terms appropriately, rather than writing full sentences in English.

Each process is color coordinated in relevant universal colors with the water cycle in blue and the rock cycle in orange. This question helps students demonstrate their understanding of the key processes involved in each cycle with supporting illustrations. As students are exposed to these terms multiple times throughout The Stile Curriculum, and in particular the Earth Systems unit, they will gain confidence to spell and use them in written forms.



A mountain river in Switzerland
This landscape captures the interaction of some of Earth's systems.

Customization

There are many opportunities to create customized lessons within the Earth Systems unit. Here are a few ideas for providing local context for your learners:

Introduction: How does our planet recycle?
In this lesson, you could also mention any other examples of sustainable resources in your local area, and include images or questions about these. Examples include local wind farms, solar panels on houses, or research into new sustainable materials or foods.

1.3 Lesson: Movement of matter
Volcanoes are used in this lesson as an example of matter moving around the Earth. You can replace the existing examples with active American volcanoes like those in Alaska and Hawai'i, and include images and questions about these.

1.4 Lesson: Movement of energy
This lesson includes a question about what has the highest and lowest albedo in the image of the Scottish Highlands. You can substitute the image with one from your local area and adjust the question to suit.

2.2 Lesson: The carbon cycle
An Australian ecosystem is used in this lesson to demonstrate the carbon cycle. You could use organisms from your local area instead, and modify the images and questioning to fit.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative Assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes
Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5–10 minutes. Quizzes provide students and teachers with information about student progress towards specific learning goals.

- **1.1 Quiz: Water cycle**
  Multiple choice and written response: 5–10 minutes
- **1.2 Quiz: Four global systems**
  Multiple choice and written response: 5–10 minutes
- **1.3 Quiz: Movement of matter**
  Multiple choice and written response: 5–10 minutes
- **1.4 Quiz: Movement of energy**
  Multiple choice and written response: 5–10 minutes
- **2.1 Quiz: Ecosystems**
  Multiple choice and written response: 5–10 minutes
- **2.2 Quiz: The carbon cycle**
  Multiple choice and written response: 5–10 minutes

Summative Assessment

Test
This unit contains a test to provide summative assessment of student learning across the whole unit.

- **Test: Earth systems**
  Multiple choice and short answer: 45–60 minutes

Science and Engineering Practices
One lab activity, one project, and one investigation within the unit can be used as summative assessment of Science and Engineering Practices.

- **1.5 Lab activity: Albedo and color**
  Lab activity: 45–60 minutes
- **1.6 Investigation: Albedo and color**
  Investigation: 60–90 minutes
- **2.3 Project: Explore another cycle**
  Project: 45–60 minutes

Lab Activities

Activity purpose: Build a solar still and simulate aspects of the water cycle as you purify fresh water from salty water.

stileapp.com/go/watercycle

60–90 minutes

3–4 students per group

Lab Activity

Modeling the water cycle

Materials

Lab Equipment

Each group of students will need:
- large metal or plastic flat-bottomed bowl
- 500 mL measuring jug
- small shallow glass or cup
- measuring jug or measuring cylinder
- plastic wrap (wider than the bowl)
- adhesive tape
- small stone, pebble, or marble
- teaspoon

Chemicals
- hot water
- food dye
- 1 teaspoon salt

Preparation

None required

Notes

None

Method

Method that students will follow

1. Add a measured volume of hot water (equivalent to about 1 cm depth) to the bowl.
2. Add some food coloring and about a teaspoonful of salt to the hot water in the bowl, stir to dissolve.
3. After considering the factors that influence where you should put your solar still, take all the equipment outside to a sunny, level place.
4. Place the glass or cup in the middle of the bowl making sure no water splashes into it.
5. Cover the bowl loosely with plastic wrap, then tightly seal it around the rim of the bowl using the adhesive tape.
6. Place the stone in the middle of the plastic wrap above the cup. It should cause the film to angle down into the cup, but must not touch the cup.
7. Record the “initial time” in your results table. Also note the color of the salty water.
8. Leave the solar still for at least an hour (the longer the better) and then check that there is some water in the cup. Record the “final time” in your results table.
9. Take the solar still back indoors, carefully remove the plastic wrap, and take out the cup.
10. Measure the amount of purified water in the cup and note the color of this water. Record these details in the results table.

Activity purpose: Investigate how color influences albedo, measured by recording temperature.

stileapp.com/go/albedocolor-G (guided)
stileapp.com/go/albedocolor-O (open)

30–45 minutes

3–4 students per group

Lab Activity

Albedo and color

Materials

Lab Equipment
Each group of students will need:
- 3 thermometers or an infrared temperature probe
- 1 piece of black paper
- 1 piece of white paper
- 1 piece of paper of a third color
- a tray (optional)
- high intensity lamp or sunlight
- stopwatch

Note: Make sure that the pieces of paper are all of the same type, size, and thickness. Paper napkins are a good option.

Preparation

Two options are provided for this activity in Stile – a guided or open investigation.

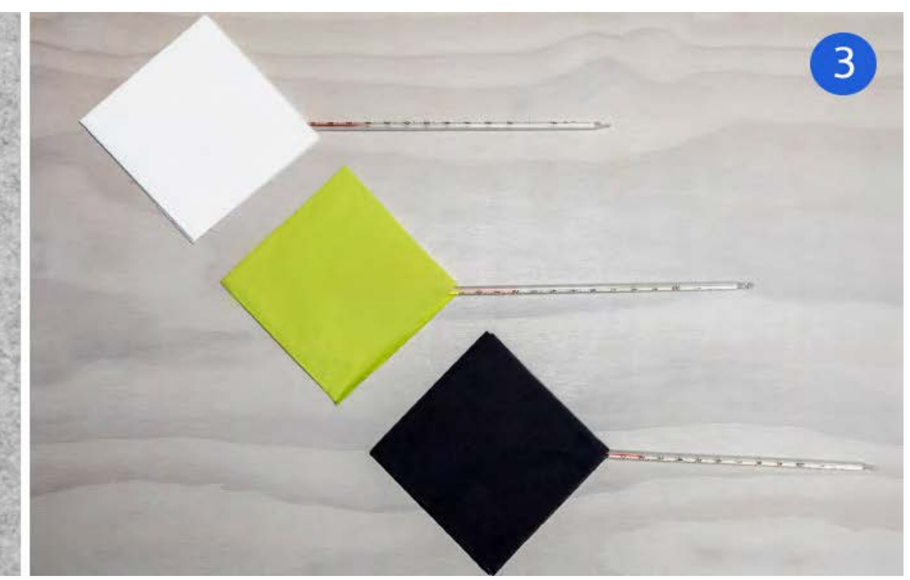
Consider which is the most appropriate for your students.

Notes

None

Method

Method that students will follow
1. Fold each piece of paper the same way to make pockets as shown.
2. Place a thermometer with the bulb in the center of each pocket, under 1 layer of paper.
3. Lay the the paper pieces and thermometers together on the tray or a surface where they are not under the light source. Make sure that each pocket has the single paper layer facing up.
4. Read the temperatures and record in the table below.
5. Move the paper and thermometers under the lamp or in the Sun.
6. Record the temperatures every 2 minutes for 10 minutes.



Unit 2 – Climate Change

Climate change... is there even a debate?

Struggling to grow crops in a changing world
Human-induced climate change is having a wide range of impacts around the world, including the increased risk of drought and extreme weather events.

Storyline and anchoring phenomenon

The effects of climate change can be seen all around us. So what can we do about it? And does our contribution even make a difference?

Students begin this unit by engaging in the phenomenon of the California wildfires, and ask how climate change is making wildfires worse, and what can we do to help? They are motivated to unpack the greenhouse effect, and to discover how the climate system works. Students use models to explore how a number of systems influence weather patterns, and examine patterns from data that reveal Earth's climate history. They even contribute to a citizen science project by identifying cells in images of fossilized leaf samples!

Having explored the mechanisms behind weather and climate, students are able to connect human activities with rising levels of atmospheric carbon dioxide, and develop an understanding that humans are responsible for climate change. By examining evidence from a range of sources, students can see the wide-spread impacts of climate change on the Earth and those who occupy it, from plants to people and everything in between.

Having recognized the consequences of increased temperatures and rising sea levels, students embark on an engineering challenge where they define the problem of flooding for agricultural communities and design a solution in the form of a floating garden.

Students create their own models of sea-level rise, and use these models to draw conclusions about the causes of increased water levels. Finally, they consider the role of the media in communicating about climate change, and consider opposing perspectives regarding their responsibility to share different viewpoints.

This unit at a glance

Students express their **prior knowledge** of climate change and identify common misconceptions.

Students **engage in the real-world phenomenon** of wildfires and ask what climate change has to do with these events.

Climate change

Introduction: Climate change
Science news: California wildfires
Career profile: Climate scientist
1.1 Lesson: The greenhouse effect
1.1 Quiz: The greenhouse effect
1.2 Lesson: Weather and climate
1.2 Quiz: Weather and climate
1.3 Lesson: Ocean currents
1.3 Quiz: Ocean currents
1.4 Lesson: Earth's climate history
1.4 Quiz: Earth's climate history
1.5 Citizen science: Tracking CO_2 levels
1.6 Simulation: Terraforming an exoplanet

2.1 Lesson: Human activity and global warming
2.1 Quiz: Human activity and global warming
2.2 Lesson: Effects of global warming
2.2 Quiz: Effects of global warming
2.3 Engineering challenge: Floating gardens
2.4 Investigation: Modeling sea-level rise (guided)
2.5 Investigation: Modeling sea-level rise (open)
2.6 Extension: Predicting the future
2.6 Quiz: Predicting the future
2.7 Project: Other questions

Science and society: Responding to climate change
Glossary: Climate change
Test: Climate change

Students **discover** the role of human activity on atmospheric carbon dioxide.

Students **create and explore** models to represent the causes of rising sea levels.

Students **design solutions** to help communities in Bangladesh who are impacted by flooding as a result of climate change.

Students **complete an inquiry project** to address their unanswered questions about climate change.

NGSS alignment overview

The elements listed are assessed at grade-band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-ESS2-6

Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

MS-ESS2-5

Collect data to provide evidence for how the motions and complex interactions of air masses result in changes in weather conditions.

MS-ESS3-5

Ask questions to clarify evidence of the factors that have caused the rise in global temperatures over the past century.

Disciplinary Core Ideas

- **ESS2.C**: The Roles of Water in Earth's Surface Processes
- **ESS2.D**: Weather and Climate
- **ESS3.D:** Global Climate Change

Students examine the way in which water moves and changes within the Earth's atmosphere, and consider the factors that influence this.

They learn about the greenhouse effect, and recognize that patterns in the movement of water are involved in determining weather patterns. Students discover the influence of the ocean on climate and weather, as well as sunlight, ice, landforms, and living organisms.

Students engage with data that allows them to discover the role of human activities in climate change. They explore the various ways in which science can help us to reduce our impact and slow climate change, or to drive the development of technology through engineering that will allow us to overcome its effects.

Science and Engineering Practices

- Analyzing and Interpreting Data
- Obtaining, Evaluating, and Communicating Information

Students analyze and interpret data representing carbon dioxide emissions, temperature, and sea levels over time and make causal connections between these factors.

They engage with a variety of sources of information, including websites, magazine articles, videos, and Stile lessons, from which they obtain scientific information. They synthesize the information and then communicate it through written responses and oral presentation.

Crosscutting Concepts

- Patterns
- Cause and Effect: Mechanism and Prediction
- Systems and System Models

Students identify patterns in the Earth's climate history, and identify cause and effect relationships between human activity, atmospheric carbon dioxide levels, temperature increases, and sea-level rises.

They recognize that the Earth's systems, such as weather systems and ocean currents, play a crucial role in climate and therefore in climate change.

Nature of Science

- Scientific Knowledge is Open to Revision in Light of New Evidence
- Science Addresses Questions About the Natural and Material World
- Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Science, Technology, Society and the Environment

- Influence of Engineering, Technology, and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

Having been introduced to Earth's systems and the cycling of matter and energy between them in the previous unit, students build upon this to recognize the influence of these systems on weather patterns and climate. This is supported by their foundational understanding of the way in which matter cycles through the rock cycle from Active Earth in Grade 6.

Students' recognition of the impacts that humans have on the environment from Ecosystems also contributes to their understanding of the role that human activity has on the climate. They are able to identify that greenhouse gases are contributing to global warming, and explain that our understanding of climate science can reduce the impact to Earth.

Science and Engineering Practices

Students will analyze and interpret data through graphical displays of carbon dioxide emissions, and will consider the relationship between this data and increases in temperature over a 150-year time period. Their experience with analysis and interpretation of data from Heat and The Nervous System will support them in doing this.

Students will also obtain, evaluate and communicate information as they have done previously in Light, The Importance of Biodiversity, and Ecosystems units. They will begin to obtain scientific information to describe evidence of climate change, and will synthesize information from research to answer their own questions about climate change.

Crosscutting Concepts

Students will engage with the concepts of systems and system models, energy and matter, and stability and change in this unit. They will build on their understanding from Earth Systems as they explore the way in which models are used to represent the flow of energy through natural systems, and the way in which change in natural systems is examined through changes in carbon emissions and temperature over time.

Controlled burning
Controlled burning can be used to prevent catastrophic wildfires. First Nations Peoples have used this technique in North America and other parts of the world for thousands of years.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Climate change Science news: California wildfires	What does climate change have to do with the California wildfires?	Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**ESS3.D** Global Climate Change	Cause and Effect	Ask students to read the *NPR* article linked in the lesson “To Manage Wildfire, California Looks to What Tribes Have Known All Along”	*FireWorks* Educational Program website, linked in teaching notes *California Department of Fish and Wildlife Science* article, “Wildfire Impacts,” link in teaching notes
Lesson 2	1.1 Lesson: The greenhouse effect	Are greenhouse gases bad?	Review teaching notes in Prepare Mode Review student answers to Introduction: Climate change in Analyze Mode to gauge prior knowledge	Constructing Explanations and Designing Solutions	**ESS3.D** Global Climate Change	Systems and System Models	Assign 1.1 Quiz: The greenhouse effect	
Lesson 3	1.2 Lesson: Weather and climate	What’s the difference between weather and climate?	Review Key Question and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**ESS2.D** Weather and Climate **ESS3.D** Global Climate Change	Patterns Systems and System Models	Assign 1.2 Quiz: Weather and climate	
Lesson 4	1.3 Lesson: Ocean currents	What drives the ocean’s currents?	Review Key Question and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**ESS2.C** The Roles of Water in Earth’s Surface Processes **ESS2.D** Weather and Climate	Systems and System Models	Assign 1.3 Quiz: Ocean currents	*National Centers for Environmental Information* website, linked in reference information for this lesson

Lesson Planning Guide

Week 1 · **Week 2** · Week 3 · Week 4 · Week 5 · Week 6

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.4 Lesson: Earth's climate history	What was Earth like thousands of years ago?	Review Key Question and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**ESS2.D** Weather and Climate	Patterns	Assign 1.4 Quiz: Earth's climate history	Poster: Earth's Changing Climate. Posters are available for purchase in the Stile Shop
Lesson 6	1.5 Citizen science: Tracking CO_2 levels	How can I help scientists understand Earth's history?	Review Key Questions and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Attempt the activity yourself to familiarize yourself with what students are required to do	Analyzing and Interpreting Data	**ESS2.D** Weather and Climate	Patterns	Ask students to contribute further observations to this citizen science project	*Zooniverse* website, linked in the lesson, is a hub of citizen science projects
Lesson 7	1.6 Simulation: Terraforming an exoplanet	Can we make another planet inhabitable?	Review teaching notes in Prepare Mode Experiment with the simulation to familiarize yourself with what students are expected to do	Developing and Using Models	**ESS2.D** Weather and Climate	Systems and System Models	Ask students to read *Science Magazine* article linked in the lesson, "Closest alien world to our solar system could be ripe for life, models suggest"	*Nautilus* article linked in teaching notes, "The Argument Against Terraforming Mars"
Lesson 8	2.1 Lesson: Human activity and global warming	Are humans causing global warming?	Review Key Question from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare to work through questions 1–12 in this lesson	Analyzing and Interpreting Data	**ESS3.D** Global Climate Change	Cause and Effect		Interactive video linked in lesson showing how human CO_2 emissions interact with the natural carbon cycle

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5 Week 6

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	2.1 Lesson: Human activity and global warming	Are humans causing global warming?	Check student progress in Analyze Mode Prepare to complete remaining questions during this lesson	Analyzing and Interpreting Data	**ESS3.D** Global Climate Change	Cause and Effect	Assign 2.1 Quiz: Human activity and global warming	*Cosmos Magazine* article linked in lesson, "Trees and plants reached "peak carbon" 10 years ago" *NASA*, *NOAA* and *Carbon Map* websites linked in lesson
Lesson 10	2.2 Lesson: Effects of global warming	What's so bad about global warming?	Review Key Questions and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare to work through questions 1–9 during this lesson	Constructing Explanations and Designing Solutions	**ESS3.D** Global Climate Change	Cause and Effect		*Cosmos Magazine* article linked in lesson, "What happens if the permafrost disappears?"
Lesson 11			Review teaching notes in Prepare Mode Review student progress in Analyze Mode	Constructing Explanations and Designing Solutions	**ESS3.D** Global Climate Change	Cause and Effect	Assign 2.2 Quiz: Effects of global warming	*Cosmos Magazine* article linked in lesson, "Human activity prods major weather events"
Lesson 12	2.3 Engineering challenge: Floating gardens Define, Brainstorm, and Investigate sections	Can we design a solution to help communities cope with the impacts of climate change?	Review Key Questions and Quiz from the previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare to work through questions 1–3 during this lesson	Constructing Explanations and Designing Solutions	**ESS2.C** The Roles of Water in Earth's Surface Processes **ESS3.D** Global Climate Change	Structure and Function	Ask students to read about Practical Action at their website, linked in the lesson	Extra SEP support: 0.3 The engineering process

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	2.3 Engineering challenge: Floating gardens Design section	Can we design a solution to help communities cope with the impacts of climate change?	Review student progress in Analyze Mode Prepare to work on question 4 during this lesson	Asking Questions and Defining Problems	**ESS2.C** The Roles of Water in Earth's Surface Processes **ESS3.D** Global Climate Change	Structure and Function	Assign Career profile: Climate scientist	Extra SEP support: 5.2 What is creativity?
Lesson 14	2.3 Engineering challenge: Floating gardens Build and Test sections	Can we design a solution to help communities cope with the impacts of climate change?	Review student progress in Analyze Mode Prepare the materials for the engineering challenge. See the relevant pages at the end of this chapter Prepare to work through questions 5–8 during this lesson	Constructing Explanations and Designing Solutions	**ESS2.C** The Roles of Water in Earth's Surface Processes **ESS3.D** Global Climate Change	Structure and Function	Ask students to complete questions 5–8 as homework if not completed during class	Extra SEP support: 5.3 Creative thinking
Lesson 15	2.3 Engineering challenge: Floating gardens Real-world solutions and Reflection sections	Can we design a solution to help communities cope with the impacts of climate change?	Review student progress in Analyze Mode Prepare to complete remaining questions in the lesson	Constructing Explanations and Designing Solutions	**ESS2.C** The Roles of Water in Earth's Surface Processes **ESS3.D** Global Climate Change	Structure and Function	Ask students to prepare to present their work to the class in the next lesson	
Lesson 16	2.3 Engineering challenge: Floating gardens Sharing session	Can we design a solution to help communities cope with the impacts of climate change?	Prepare for students to present their work during this lesson Print rubrics for peer and teacher marking during student presentations	Constructing Explanations and Designing Solutions	**ESS2.C** The Roles of Water in Earth's Surface Processes **ESS3.D** Global Climate Change	Structure and Function	Ask students to complete the reflection section of this lesson	

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5 Week 6

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	2.4/2.5 Investigation: Modeling sea-level rise	What makes the biggest impact on sea levels?	Consider whether the guided investigation, 2.4, or the open investigation, 2.5, is the best fit for your students. You may use 2.5 as an extension opportunity Review teaching notes in Prepare Mode and determine how you will divide the activities over the three allocated lessons Prepare the materials for the investigation. See the relevant pages at the end of this chapter	Planning and Carrying Out Investigations Developing and Using Models	**ESS2.D** Weather and Climate **ESS2.C** The Roles of Water in Earth's Surface Processes	Cause and Effect		Extra SEP support: 0.1 Conducting science investigations
Lesson 18			Review student progress in Analyze Mode Prepare the materials for the investigation. See the relevant pages at the end of this chapter	Planning and Carrying Out Investigations Developing and Using Models	**ESS2.D** Weather and Climate **ESS2.C** The Roles of Water in Earth's Surface Processes	Cause and Effect		Extra SEP support: 2.1 Observing and inferring
Lesson 19			Review student progress in Analyze Mode Prepare the materials for the investigation. See the relevant pages at the end of this chapter	Planning and Carrying Out Investigations Developing and Using Models	**ESS2.D** Weather and Climate **ESS2.C** The Roles of Water in Earth's Surface Processes	Cause and Effect	Ask students to complete the reflection section of this lesson Assign Extension: Computer modeling of sea-level change, question 5, to appropriate students	2.6 Extension: Predicting the future 2.6 Quiz: Predicting the future
Lesson 20	2.7 Project: Other questions	What questions do I still have about Climate Change?	Review Key Questions from the previous lesson in Analyze Mode If assigned, review Key Questions and Quiz from 2.6 Extension Review teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**ESS2.D** Weather and Climate **ESS2.C** The Roles of Water in Earth's Surface Processes **ESS3.D** Global Climate Change	Cause and Effect Patterns Systems and System Models	Ask students to complete the remainder of this task	Extra SEP support: 6.1 Evaluating media claims

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · **Week 6**

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 21	Science and society: Responding to climate change	How should the media communicate about climate change?	Review teaching notes in Prepare Mode	Engaging in Argument from Evidence	**ESS3.D** Global Climate Change	Cause and Effect Patterns Systems and System Models	Ask students to review Glossary: Climate Change in preparation for the test	
Lesson 22	Unit review	How can I be prepared for the Climate Change test?	Review Key Questions from the unit in Analyze Mode to identify areas to revisit	Analyzing and Interpreting Data Developing and Using Models Constructing Explanations and Designing Solutions	**ESS2.D** Weather and Climate **ESS2.C** The Roles of Water in Earth's Surface Processes **ESS3.D** Global Climate Change	Cause and Effect Patterns Systems and System Models	Ask students to review teacher feedback from lessons in the unit	
Lesson 23	Test: Climate CHange	How much have I learned about Climate Change?	Ensure every student has access to a device	Analyzing and Interpreting Data Developing and Using Models Constructing Explanations and Designing Solutions	**ESS2.D** Weather and Climate **ESS2.C** The Roles of Water in Earth's Surface Processes **ESS3.D** Global Climate Change	Cause and Effect Patterns Systems and System Models	Prompt students to write a reflection on what they have learned from the unit	
Lesson 24	Test review	How successful was my revision of Climate Change?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Analyzing and Interpreting Data Developing and Using Models Constructing Explanations and Designing Solutions	**ESS2.D** Weather and Climate **ESS2.C** The Roles of Water in Earth's Surface Processes **ESS3.D** Global Climate Change	Cause and Effect Patterns Systems and System Models	Ask students to reflect on how effective their revision was, and to identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical skills.

Students engage with data about carbon dioxide emissions, temperature, and sea level throughout the unit, and make comparative judgments about the quantities that these data represent.

Common Core State Standards Connections: Math

MP.2

Reason abstractly and quantitatively.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Lessons within this unit incorporate many opportunities for students to develop and use their reading, writing, listening, and speaking skills.

Students engage with information about climate change from various sources, including magazines, websites, and Stile lessons. They use these texts as evidence to support their reasoning, and paraphrase relevant information when writing explanations. Students create a video to share their work in the engineering challenge, which they present to the class.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.9

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

WHST.6-8.8

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

SL.8.5

Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Science news: California wildfires**
  Questions 4, 9, 12, 13, 15
- **1.1 Lesson: The greenhouse effect**
  Question 11
- **1.2 Lesson: Weather and climate**
  Questions 8, 9, 14, 16
- **1.3 Lesson: Ocean currents**
  Questions 9, 10, 11, 15
- **1.4 Lesson: Earth's climate history**
  Questions 7, 9, 10, 12, 13
- **1.6 Lesson: Terraforming an exoplanet**
  Questions 2, 3, 4, 5, 6
- **2.1 Lesson: Human activity and global warming**
  Questions 4, 9, 10, 11, 12, 15, 16, 17, 18
- **2.2 Lesson: Effects of global warming**
  Questions 5, 8, 13, 14, 16, 17
- **2.3 Engineering challenge: Floating gardens**
  Questions 1, 9
- **2.4 Investigation: Modeling sea-level rise (guided)**
  Questions 1, 2, 3, 4, 5, 6, 7, 8, 12, 13, 14, 15, 16
- **2.5 Investigation: Modeling sea-level rise (open)**
  Questions 4, 5, 6
- **2.6 Extension: Predicting the future**
  Questions 7, 8, 11, 12, 14, 15
- **Science and society: Responding to climate change**
  Questions 1, 2, 3
- **Test: Climate change**
  Questions 3, 6, 11, 12, 15, 18, 21, 24, 27, 30, 35, 36, 41, 42, 45

Extension opportunities in this unit

Challenge Questions
Most lessons contain one or more Challenge Questions, which are an opportunity for students to show they are working above the level of the learning goal.

When answering these questions, students can extend themselves by applying their knowledge to new contexts, or to solve more complex problems. These provide a great extension opportunity.

Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC
2.4/ 2.5 Investigation: Modeling sea-level rise Extension section: Computer modeling of sea-level change	Can computers predict future sea levels?	None	Developing and Using Models	**ESS2.D** Weather and Climate **ESS2.C** The Roles of Water in Earth's Surface Processes	Patterns
2.5 Investigation: Modeling sea-level rise (open)	Can I plan my own investigation into sea-level rise?	See relevant pages at the end of this chapter	Planning and Carrying Out Investigations Developing and Using Models	**ESS2.D** Weather and Climate **ESS2.C** The Roles of Water in Earth's Surface Processes	Cause and Effect
2.6 Extension: Predicting the future	Can we predict future effects of global warming?	None	Planning and Carrying Out Investigations Developing and Using Models	**ESS3.D** Global Climate Change	Patterns

ELL Support

To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

Climate Change lessons include a number of flow charts and diagrams to help students understand the systems and mechanisms involved with global warming. Encourage students to draw on these visual representations and actively interpret the information
they contain. Those with a higher level of language proficiency can use them for support in decoding written information rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

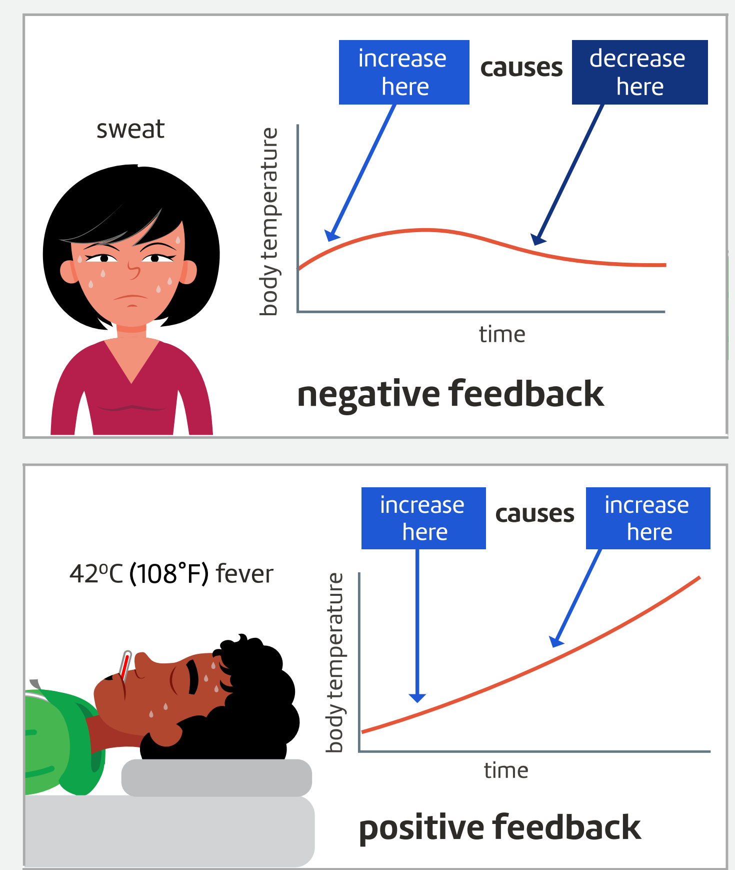
Science news: California wildfires

This infographic is included in the lesson about California wildfires, in the section that addresses what students can do to make a difference. By combining short phrases with simple structure, symbols to represent the key ideas within each phrase, and the use of color to distinguish between two categories, this visual representation supports student comprehension of English language.

Students are able to associate the symbols beside each phrase with the words used to communicate the message. These images help students to make connections between the written English words, and the actions they represent.

2.2 Lesson: Effects of global warming

These images illustrate the meaning of two specific phrases: positive feedback and negative feedback. The graphical representation uses simple labels to describe the function shown, and the characters demonstrating sweat and fever provide a familiar example to which students can relate. The combination of the graph, the character illustration, and the labels used combine to help students to unpack the meaning of positive and negative feedback.



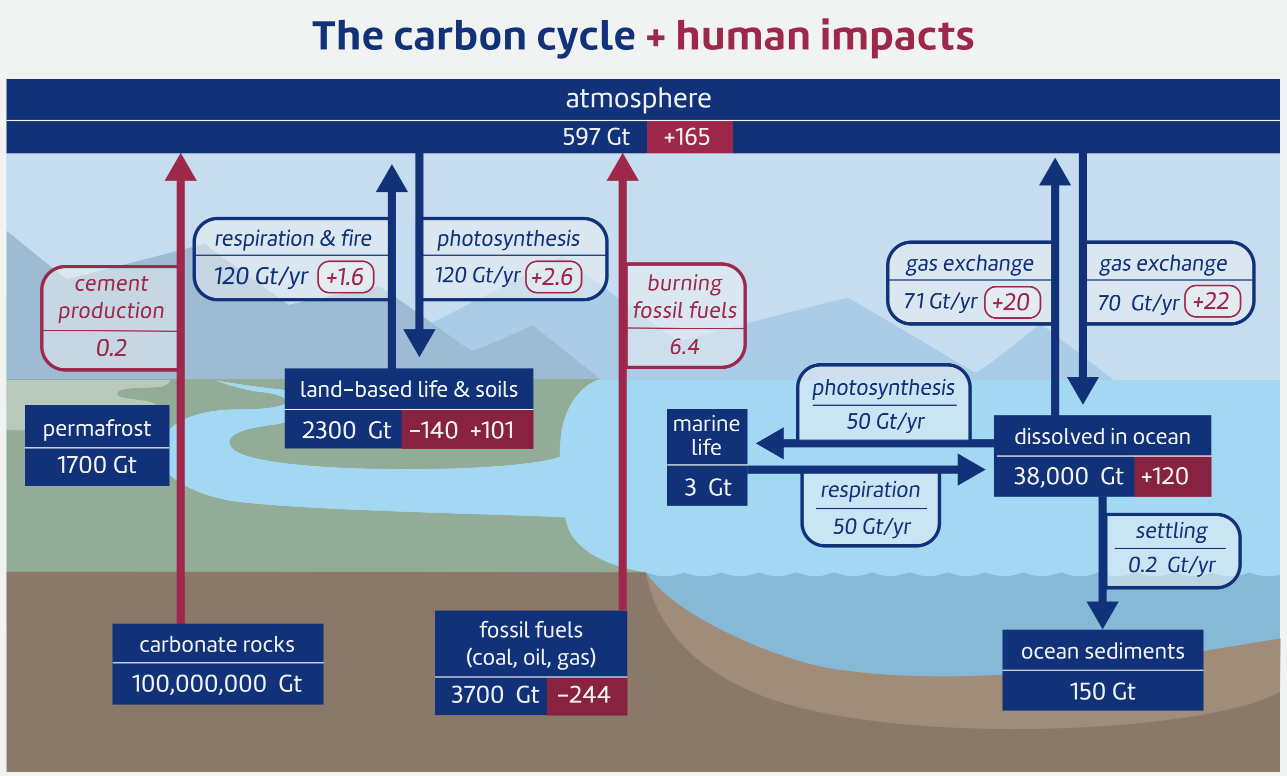
Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

2.1 Lesson: Human activity and global warming

This diagram represents the carbon cycle. It shows the quantities of carbon that were held in reservoirs and movement between these reservoirs prior to human impacts, compared with the quantities in the mid-1990s. The clear red and blue color coding supports students to distinguish between the two sets of data.

The use of arrows and numbers provide a universal language that students can interpret easily, while the use of simple labels allows students to build familiarity with subject-specific terminology. Overall, this diagram helps students to unpack the impact of human activity on carbon quantities throughout the carbon cycle and supports comprehension of text within the lesson.



An oil refinery
The burning of fossil fuels is a major source of the carbon dioxide emissions that are intensifying the greenhouse effect.

Customization

There are many opportunities to create customized lessons within the Climate Change unit. Here are a few ideas for providing local context for your learners:

Science news: California wildfires
This lesson uses images of landscapes and animals within California to describe the impact of wildfires. You could incorporate images and news articles about extreme weather events in your region, such as hurricanes or floods, to support the idea that climate change is having an impact on climate in a variety of ways.

2.1 Lesson: Human activity and global warming
This lesson discusses human activities that contribute to carbon dioxide emissions. You may like to include images that represent examples of high carbon emission in your region, such as power plants and factories.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts and Science and Engineering Practices together to explain phenomena and solve problems.

Formative Assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes
Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5-–0 minutes. Quizzes provide students and teachers with information about student progress towards specific learning goals.

- **1.1 Quiz: The greenhouse effect**
  Multiple choice: 5 minutes
- **1.2 Quiz: Weather and climate**
  Multiple choice: 5 minutes
- **1.3 Quiz: Ocean currents**
  Multiple choice: 5 minutes
- **1.4 Quiz: Earth's climate history**
  Multiple choice: 5 minutes
- **2.1 Quiz: Human activity and global warming**
  Multiple choice: 5 minutes
- **2.2 Quiz: Effects of global warming**
  Multiple choice: 5 minutes
- **2.6 Quiz: Predicting the future**
  Multiple choice: 5 minutes

Summative Assessment

Test
This unit contains a test to provide summative assessment of student learning across the whole unit.

- **Test: Climate change**
  Multiple choice and short answer: 45–60 minutes

Science and Engineering Practices
An investigation that can be either guided or open and an engineering challenge can be used as summative assessments of Science and Engineering Practices.

- **2.4 Investigation: Modeling sea-level rise (guided) OR**
  2.5 Investigation: Modeling sea-level rise (open)
  Investigation: 130–180 minutes
- **2.3 Engineering challenge: Floating gardens**
  Engineering challenge: 220–300 minutes

Lab Activities

Activity purpose: Experimentally model the effects on sea level of melting sea and land ice, and thermal expansion.

stileapp.com/go/floatinggardens

90–120 minutes

3–4 students per group

Lab Activity

Floating gardens

Materials

Lab Equipment
Each group of 3–4 students will need a range of materials that give them a range of options for each element of their design:

- to help the model float, e.g., 2 x 250 mL plastic drink bottles, 2 small plastic food trays, 15 straws, 10 corks, bubble wrap (23 cm wide x 30 cm long), 2 balloons
- to bind the model together, e.g., 2 m of string, 1 stick of Blu-Tack, 1 glue stick, 1 roll of adhesive tape, rubber bands
- to provide padding or support, e.g., cardboard, craft sticks, 1 egg carton, cotton wool, straw, paper towel
- extra challenge: potting mix and seeds (e.g., lettuce or alfalfa) to actually grow some vegetables
- scissors

Chemicals
None required

Preparation

To test the models you will need a large tub or sink half-filled with water, card cut to 23 cm x 30 cm, and 5 one-kilogram weights.

Notes

This engineering challenge was originally developed by Practical Action, an organization that uses technology to challenge poverty in developing countries.

Teacher notes, student worksheets, and more background information can be found at their website: https://practicalaction.org/floatinggardenchallenge

We recommend that students work individually to initially define the problem, research, and brainstorm solutions before they join together in groups.

Method

Method that students will follow
Students will follow the engineering design process to create a floating garden.

Instructions provided to students include:

We need your help to design a floating garden for communities in Bangladesh.

You will need to build and test a small-scale model that meets the following criteria:

- floats on water while supporting a weight of 5 kg
- has a fairly flat top for soil to support crops
- is less than 23 cm wide and 30 cm long
- is built out of any materials provided to you by your teacher

A template outlining the engineering design process and further scaffolding is provided to students in the Stile lesson.

Activity purpose: Experimentally model the effects on sea level of melting sea and land ice, and thermal expansion.

stileapp.com/go/sealevel-G (guided)
stileapp.com/lsSealevel-O (open)

60–90 minutes

3–4 students per group

Lab Activity

Modeling sea-level rise

Materials

Lab Equipment

Part 1
- 2 600 mL beakers
- 250mL beaker
- permanent marker

Part 2
- 250 mL conical flask
- retort stand and clamp
- long thermometer
- Bunsen burner
- tripod
- heatproof mat
- gauze mat
- tongs
- permanent marker
- plasticine
- 30 cm ruler
- masking tape

Chemicals

Part 1
- approx. 600 mL water
- 2 ice cubes, the same size

Part 2
- approx. 10 drops food coloring
- approx. 300 mL water

Preparation

Prepare ice cubes ahead of time.

Two options are provided for this activity in Stile – a guided or open investigation. Consider which is the most appropriate for your students.

Notes

None

Method

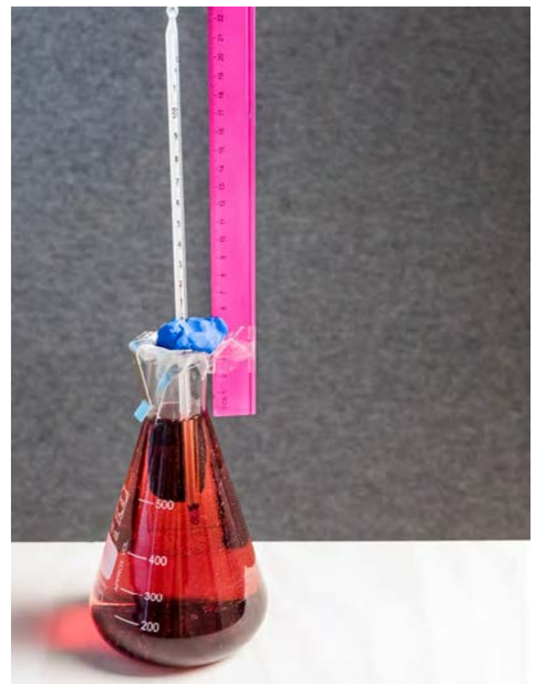
Part 1

1. Place the smaller beaker upside down in one of the beakers. This represents a land mass.
2. Half fill each large beaker with water.
3. Place one ice cube into the water of the first beaker to represent sea ice and the other ice cube on top of the small beaker in the second beaker to represent land ice, as shown in the photo below.
4. Mark the water level on each beaker.
5. Place the beakers in the Sun or somewhere warm and wait for them to melt.
6. After all of the ice has melted, observe the water level in each beaker.

Method

Part 2

1. Fill the flask with very cold water up to the bottom of the neck, as shown at right.
2. Add food coloring to improve visibility.
3. Place the thermometer in the flask and secure it in place using the retort stand and clamp. Ensure that the bulb doesn't sit on the bottom of the flask.
4. Use sticky tape to attach a ruler to the side of the flask. Ensure that the ruler is vertical and positioned so that zero aligns with the current water level.
5. Note down the starting temperature of the water and the water level on the ruler (0 mm).
6. Slowly heat the water.
7. Complete the table, recording the temperature and water level for every 5°C increase in temperature.



Method that students will follow (for open investigation)

Students will design their own method, which will require teacher approval before commencement.

Instructions provided to students include:

Design a scientific experiment to test the relative importance of the three factors above for rising sea levels. You will need to design a small-scale model that represents the important features of the real-world situation while controlling certain variables.

Your experimental design should include the following sections:

- Aim: State the purpose of the experiment
- Hypothesis: Frame a scientific hypothesis that outlines what you predict will happen and why
- Variables: Identify the independent, dependent, and controlled variables
- Materials: Make a list of the materials you'll need, including a drawing of the experimental setup
- Procedure: Write a numbered list of the steps of the experiment that is clear enough for anyone to follow

High tide on an island in Kiribati
Many people around the world are already experiencing the impact of rising sea levels.

Unit 3 – Evolution

Are we responsible for the rise of superbugs?

Antibiotic-resistant bacteria
Our use of antibiotics has saved countless lives but is also influencing the evolution of bacteria.

Storyline and anchoring phenomenon

This unit begins with the facts – antibiotics are becoming less effective. Students observe the timeline of the development of antibiotics and how these life-saving medications became commonplace.

The phenomenon of the giant petri dish experiment, conducted at Harvard University, is used to demonstrate bacteria's ability to evolve and overcome the stresses of antibiotics that aren't 100% effective. Students dive into the complex question: "Are we responsible for the rise of antibiotic-resistant superbugs?"

Students use hands-on activities to model evolution, complete case studies of natural selection, and explore adaptations that allow populations to evolve to become the fittest for their environment. These concepts are applied to bacteria in a Stile-created simulation where students manipulate the factors that cause bacteria to either thrive or die off. By observing stability and change as a Crosscutting Concept across the unit, learners will see cause and effect of environmental pressures and the resulting changes in population. Using data, students analyze these changes and communicate this information in context.

By modeling the formation of new species, students ask questions, define problems, and conduct investigations to understand this concept in detail. The unit culminates in a Socratic seminar where students take their knowledge of evolution and apply it to the storyline of the rise in antibiotic-resistant superbugs. By taking on viewpoints of multiple stakeholders, students use data and evidence gathered through the unit to discuss the key concerns of people who use antibiotics and consider how to avoid the evolution of superbugs.

This unit at a glance

Evolution

Introduction: The rise of superbugs
Lesson: The evolution of antibiotic resistance
Career profile: Infectious diseases doctor
What do you already know?

1.1 Lab activity: Modeling evolution
1.2 Lesson: Variation
1.2 Case study: Variation
1.2 Quiz: Variation
1.3 Lesson: Natural selection
1.3 Case study: Natural selection
1.3 Quiz: Natural selection
1.4 Simulation: Modeling natural selection
1.5 Lesson: Adaptations
1.5 Case study: Adaptations
1.5 Quiz: Adaptations
1.6 Simulation: Modeling antibiotic resistance

2.1 Lesson: The tree of life
2.2 Lab activity: Modeling the formation of species
2.3 Lesson: The formation of species
2.3 Case study: Speciation of chimpanzees and bonobos
2.3 Quiz: The formation of the species
2.4 Project: Extinction

Socratic seminar: How should we use antibiotics?
Glossary: Evolution
Test: Evolution

This lesson engages students with the **phenomenon of real-time evolution** by observing the filming of bacteria populations over two weeks.

A hands-on activity where **students model the case study** by representing populations and observe how chance plays a large role in evolution.

Students learn that **all species are connected to common ancestors** and selection pressures and inheritance of traits change the diversity of life on Earth over time.

A Stile-created simulation that allows students to **manipulate environmental variables and collect data**.

Using a simulation, students view **stability and change** within populations when different conditions are applied.

Students **observe changes in populations and present solutions** for saving current populations at risk of extinction.

Using the knowledge students have gathered through the unit, they **engage in argument from evidence** to consider multiple avenues for the use of antibiotics in the future.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-LS1-4

Animals engage in characteristic behaviors that increase the odds of reproduction.

MS-LS3-2

Variations of inherited traits between parent and offspring arise from genetic differences that result from the subset of chromosomes (and therefore genes) inherited.

MS-LS4-2

Anatomical similarities and differences between various organisms living today and between them and organisms in the fossil record enable the reconstruction of evolutionary history and the inference of lines of evolutionary descent.

MS-LS4-4

Natural selection leads to the predominance of certain traits in a population, and the suppression of others.

MS-LS4-5

Gather and synthesize information about technologies that have changed the way humans influence the inheritance of desired traits in organisms.

MS-LS4-6

Use mathematical representations to support explanations of how natural selection may lead to increases and decreases of specific traits in populations over time.

Disciplinary Core Ideas

- **LS3.A**: Inheritance of Traits
- **LS4.A**: Evidence of Common Ancestry and Diversity
- **LS4.B**: Natural Selection
- **LS4.C**: Adaptation

Students explore the possibilities for how the increase in presence of antibiotics in the environment has occurred.

Through the lens of the quick growth and development of bacterial colonies, students observe how traits of resistance to antibiotics are passed to the next generations.

Science and Engineering Practices

- Obtaining, Evaluating, and Communicating Information
- Engaging in Argument From Evidence
- Asking Questions and Defining Problems

Through the unit, students observe information gathered by scientists over time.

Students are exposed to information that requires understanding of complex knowledge. To decipher this, students need to ask questions and define problems to solve. They engage in activities that will demonstrate natural selection in real-world situations. The final lesson in this unit, the Socratic seminar, requires students to take different viewpoints and construct argument from evidence and communicate this information.

Crosscutting Concept

- Stability and Change

Engaging in evolution allows learners to observe the stability in systems and the changes that occur as a result of changing demands within the ecosystem.

Nature of Science

- Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena
- Scientific Investigations Use a Variety of Methods

Science, Technology, Society and the Environment

- Interdependence of Science, Engineering, and Technology
- Influence of Engineering, Technology, and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

Students are introduced to the idea of heredity, inheritance, and variation of traits in this unit. They will be able to make connections to prior knowledge from the Cells unit, where they learned about the parts of a cell, and the Genetics unit, where they were introduced to DNA as the genetic material that cells carry and how the process of meiosis creates sex cells.

Students will learn about the role of mutation in introducing variation to a population, and how mutations impact an individual's traits.

Science and Engineering Practices

Students apply a range of Science and Engineering Practices through a Socratic seminar as part of this unit. They have experiences with these same practices from previous Socratic seminars in Cells and Ecosystems units earlier in The Stile Curriculum.

Much like they have in previous discussions, students will obtain information about the social impacts of antibiotic use from the perspective of a specific stakeholder, and will communicate this through oral presentation. They must critique perspectives presented by other students, ask questions to gain further elaboration, and receive feedback on their own explanations.

Crosscutting Concepts

The idea of stability and change is apparent throughout the unit, as evolution represents a change in genetic traits of a population over time. Students are familiar with this idea from Ecosystems, where it is also used to describe changes to a population.

This prior knowledge will be extended as students examine changes to bacterial populations over time and the impact these changes have on their resistance to antibiotics.

The tree of life
Humans and sharks seem very different at first glance, but if we investigate further we discover many shared genetic traits.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.**Focus SEP**

The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: The rise of superbugs Lesson: The evolution of antibiotic resistance	How do superbugs evolve and why are they a problem?	Review the teaching notes in Prepare Mode	Asking Questions and Defining Problems Constructing Explanations	**LS1.B** Growth and Development of Organisms	Stability and Change Cause and Effect	Ask students to read *The Conversation* article linked in the lesson, "What should you eat after you've been on antibiotics? And can probiotics and prebiotics get your gut back to normal?"	Extra SEP support: 2.1 Observing and inferring
Lesson 2	What do you already know? Career Profile: Infectious diseases doctor	What do I already know about Evolution?	Review Key Questions from the previous lessons in Analyze Mode Review the teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS1.B** Growth and Development of Organisms	Stability and Change		*Science News for Students* article linked in teaching notes, "Explainer: What you can do to fight antibiotic resistance"
Lesson 3	1.1 Lab activity: Modeling evolution	Can you model evolution by natural selection in the classroom?	Review What do you already know? in Analyze Mode to determine areas to focus on Review the teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Obtaining, Evaluating, and Communicating Information	**LS4.B** Natural Selection	Stability and Change Cause and Effect Patterns		Extra SEP support: 6.2 Critical thinking
Lesson 4							Ask students to complete any remaining questions	

Lesson Planning Guide

Week 1 · **Week 2** · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.2 Lesson: Variation	How do new variations in genetic traits arise in a population?	Review Key Questions from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode	Asking Questions and Defining Problems	**LS3.A** Inheritance of Traits	Stability and Change		Genetics unit: 1.1 Lesson: DNA and genes Genetics unit: 3.1 Lesson: Simple inheritance
Lesson 6	1.2 Case study: Variation	Why is variation within a species important for evolution?	Review Key Questions from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**LS4.A** Evidence of Common Ancestry and Diversity	Stability and Change	Assign 1.2 Quiz: Variation	
Lesson 7	1.3 Lesson: Natural selection	Can we create conditions that drive natural selection?	Review Key Question and Quiz from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode	Analyzing and Interpreting Data Using Mathematics and Computational Thinking	**LS4.B** Natural Selection	Stability and Change Cause and Effect Patterns		Evolution Simulator by *MinuteLabs* linked in teaching notes Video by Primer on *YouTube* linked in teaching notes, “Simulating Natural Selection”
Lesson 8	1.3 Case study: Natural selection	What causes a population to evolve?	Review Key Question from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information Analyzing and Interpreting Data Using Mathematics and Computational Thinking	**LS4.B** Natural Selection	Stability and Change	Assign 1.3 Quiz: Natural selection	Video by Kishony Lab, Harvard Medical School and Technion linked in teaching notes, “The Evolution of Bacteria on a “Mega-Plate” Petri Dish”

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required
Lesson 9	1.4 Simulation: Modeling natural selection	Can you manipulate the evolution of a species?	Review Key Question and Quiz from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode Experiment with the simulation to familiarize yourself with what students are expected to do
Lesson 10			Review student progress in Analyze Mode
Lesson 11	1.5 Lesson: Adaptations	What kinds of adaptations can be passed on through generations?	Review Key Questions from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode
Lesson 12	1.5 Case study: Adaptations	How do adaptations evolve?	Review Key Questions from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode

	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	Obtaining, Evaluating, and Communicating Information Analyzing and Interpreting Data Using Mathematics and Computational Thinking	**LS4.B** Natural Selection	Stability and Change Cause and Effect Patterns		Extra SEP support: 3.5 Reading line graphs
Lesson 10					
Lesson 11	Asking Questions and Defining Problems Constructing Explanations	**LS4.B** Natural Selection	Stability and Change Cause and Effect		
Lesson 12	Asking Questions and Defining Problems	**LS4.B** Natural Selection	Stability and Change	Assign 1.5 Quiz: Adaptations	Extra SEP support: 2.1 Observing and inferring *National Park Service* webpage on the environment and wildlife of Saguaro National Park, linked in teaching notes

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · **Week 4** · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	1.6 Simulation: Modeling antibiotic resistance	How can our use of antibiotics create superbugs?	Review Key Questions and Quiz from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode Experiment with the simulation to familiarize yourself with what students are expected to do	Engaging in Argument From Evidence Analyzing and Interpreting Data Using Mathematics and Computational Thinking	**LS1.B** Growth and Development of Organisms	Stability and Change Cause and Effect Patterns		Extra SEP support: 2.4 Controlled variables (Part 1)
Lesson 14			Review the teaching notes in Prepare Mode				Ask students to complete any remaining questions	Extra SEP support: 2.5 Controlled variables (Part 2)
Lesson 15	2.1 Lesson: The tree of life	Which animal is most closely related to T. rex?	Review Key Questions from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode	Asking Questions and Defining Problems Engaging in Argument From Evidence	**LS4.A** Evidence of Common Ancestry and Diversity	Cause and Effect	Ask students to read 2.2 Lab activity: Modeling the formation of species in preparation for the next lesson	Evogeneao: Interactive tree of life explorer
Lesson 16	2.2 Lab activity: Modeling the formation of species	How can one population give rise to multiple species?	Review Key Questions from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Asking Questions and Defining Problems Developing and Using Models Constructing Explanations	**LS4.A** Evidence of Common Ancestry and Diversity	Stability and Change		Extra SEP support: 0.1 Conducting science investigations

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · **Week 5** · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	2.3 Lesson: The formation of species	How are new species formed?	Review Key Questions from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode	Asking Questions and Defining Problems Engaging in Argument From Evidence	**LS4.A** Evidence of Common Ancestry and Diversity	Cause and Effect	Ask students to research another example of speciation	
Lesson 18	2.3 Case study: Speciation of chimpanzees and bonobos	How does DNA evidence show how closely species are related?	Review Key Questions from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**LS4.A** Evidence of Common Ancestry and Diversity	Stability and Change	Assign 2.3 Quiz: The formation of species	*The Conversation* article, linked in teaching notes "Revealed: the ancient genetic link between chimpanzees and bonobos" *Popular Science* article, linked in lesson "A new species of superbug is emerging – and it loves when you eat sugar"
Lesson 19	2.4 Project: Extinction Research	How can we save species from the brink of extinction?	Review Key Question and Quiz from the previous lesson in Analyze Mode Review the teaching notes in Prepare Mode	Obtaining, Evaluating, and Communicating Information	**LS4.B** Natural Selection	Cause and Effect	Ask students to continue working on their project	*Smithsonian Magazine* article linked in lesson "Modern Humans Emerged As Ancient 'Siberian Unicorns' Died Out – But Their Demise Wasn't Our Fault"
Lesson 20							Ask students to prepare for their presentation	

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 21	2.4 Project: Extinction Presentation and peer assessment	How can we save species from the brink of extinction?	Review the teaching notes in Prepare Mode	Engaging in Argument From Evidence	**LS4.B** Natural Selection	Cause and Effect	Ask students to complete any remaining questions and assess their project against the rubric	*WWF* article linked in lesson, "WWF is saving black rhinos by moving them"
Lesson 22	Unit review Glossary: Evolution	How can I be prepared for the Evolution test?	Review Key Questions from the unit in Analyze Mode to identify areas to revisit	Asking Questions and Defining Problems Engaging in Argument From Evidence Obtaining, Evaluating, and Communicating Information	**LS1.B** Growth and Development of Organisms **LS3.A** Inheritance of Traits **LS4.A** Evidence of Common Ancestry and Diversity **LS4.B** Natural Selection **LS4.C** Adaptation	Stability and Change Cause and Effect	Ask students to review teacher feedback and Key Questions from lessons in the unit	Glossary: Evolution
Lesson 23	Test: Evolution	How much have I learned about Evolution?	Ensure every student has access to a device				Ask students to write a reflection on what they have learned from the unit	
Lesson 24	Socratic seminar: How should we use antibiotics?	How should we use antibiotics?	Review teaching notes in Prepare Mode Prepare to work on Questions 1-4 during this lesson	Asking Questions and Defining Problems	**LS1.B** Growth and Development of Organisms	Stability and Change Cause and Effect	Ask students to continue preparing for Socratic seminar	Articles linked in teaching notes, *Science News for Students*, "A silent health emergency" *The Conversation*, "Scientists alone can't solve the antibiotic resistance crisis – we need economists too"

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 25	Socratic seminar: How should we use antibiotics?	How should we use antibiotics?	Review student progress in Analyze Mode Prepare to work on Questions 5 and 6 during this lesson	Engaging in Argument From Evidence	**LS1.B** Growth and Development of Organisms	Stability and Change Cause and Effect	Ask students to continue preparing for Socratic seminar as homework	Extra SEP support: 6.1 Evaluating media claims Extra SEP support: 6.2 Critical thinking
Lesson 26			Review student progress in Analyze Mode Prepare to work on Questions 7 to 9 during this lesson				Ask students to continue preparing for Socratic seminar	*YouTube* video by Jennifer Madland: AVID Socratic Seminar
Lesson 27			Print materials required for Socratic seminar Prepare to work on Questions 10 to 15 during this lesson Complete grading of test ahead of Test review	Obtaining, Evaluating, and Communicating Information			Ask students to complete any remaining questions	
Lesson 28	Test review	How successful was my revision of Evolution?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Asking Questions and Defining Problems Engaging in Argument From Evidence Obtaining, Evaluating, and Communicating Information	**LS1.B** Growth and Development of Organisms **LS3.A** Inheritance of Traits **LS4.A** Evidence of Common Ancestry and Diversity **LS4.B** Natural Selection **LS4.C** Adaptation	Stability and Change	Ask students to reflect on the effectiveness of their revision, and to identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Students gather observations and data from live bacterial population simulations that are used to answer statistical questions.

This data is summarized and used in real-world contexts that are then modeled with different populations and environmental factors over time.

Common Core State Standards Connections: Math

MP.4

Model with mathematics.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Students use comprehension strategies to analyze scientific and technical texts and evaluate arguments in text.

Students learn technical terms and understand what claims are made that are based on scientific studies, experiments, simulations and multimedia sources. They convey this knowledge in many modes, including a collaborative discussion with peers with researched differing viewpoints as stakeholders to surmise their learning over the unit.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flow chart, diagram, model, graph, or table).

RST.6-8.9

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

SL.8.5

Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

WHST.6-8.2

Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

WHST.6-8.9

Draw evidence from informational texts to support analysis, reflection, and research.

SL.8.1

Engage effectively in a range of collaborative discussions (one-on-one, in groups, teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

SL.8.4

Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

Poison dart frogs are brightly colored and highly toxic. These traits help them survive because the bright colors signal danger to predators.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Introduction: The rise of superbugs**
  Questions 5, 7, 8
- **Lesson: The evolution of antibiotic resistance**
  Question 3
- **Career profile: Infectious diseases doctor**
  Questions 3, 4, 5
- **What do you already know?**
  Questions 6, 7, 9
- **1.1 Lab activity: Modeling evolution**
  Questions 10, 12
- **1.2 Lesson: Variation**
  Questions 6, 9, 10
- **1.2 Case study: Variation**
  Questions 5, 6, 7, 8
- **1.3 Lesson: Natural selection**
  Questions 8, 11
- **1.3 Case study: Natural selection**
  Questions 4, 7
- **1.4 Simulation: Modeling natural selection**
  Questions 10, 14, 18
- **1.5 Lesson: Adaptations**
  Question 5
- **1.5 Case study: Adaptations**
  Questions 2, 4, 5, 7, 9, 11
- **1.6 Simulation: Modeling antibiotic resistance**
  Questions 5, 8, 9, 12
- **2.1 Lesson: The tree of life**
  Questions 10, 15
- **2.2 Lab activity: Modeling the formation of species**
  Questions 5, 10
- **2.3 Lesson: The formation of species**
  Question 7
- **2.3 Case study: Speciation of chimpanzees and bonobos**
  Questions 4, 9, 10, 11
- **2.4 Project: Extinction**
  Questions 9, 11, 12, 14
- **Socratic seminar: How should we use antibiotics?**
  Questions 8, 9, 14, 15

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize them within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
What do you already know?	All bees of the same species are genetically identical.	**Use 1.2 Case study: Variation** There is always genetic variation in a population and this is essential for evolution. The Importance of variation section explicitly addresses this.
	Humans do not share a common ancestor with other species.	**Use 2.1 Lesson: The tree of life** Humans share a common ancestor with other species. This lesson shows how species have evolved over time, and explicitly addresses common ancestry between humans and other species.
	Only species with obvious similarities share a common ancestor.	**Use 2.1 Lesson: The tree of life** All species on Earth are related to each other in a single "tree of life." This lesson shows how species have evolved over time, and explicitly addresses common ancestry between humans and other species.
	Humans cannot influence the evolution of other species.	**Use Lesson: What do you already know?** Humans can influence evolution through artificial selection, such as selectively breeding dogs or crops to have favorable traits. We can also influence evolution through selection pressures, including hunting, pollution, and climate change.

Lesson	Misconception	Addressing the misconception
What do you already know?	An organism can evolve in its lifetime.	**Use 1.1 Lab activity: Modeling evolution** An individual organism can't evolve at all, only a population can. Also, traits acquired during an organism's lifetime can't become more common through evolution, as this only applies to genetic traits. Modeling evolution through the lab activity shows the role of reproduction and inheritance in evolution. The Evolving Adaptations section in 1.5 Lesson: Adaptations also illustrates this concept.
	Most of the species that ever existed are still living today.	**Use 2.4 Project: Extinction** Most of the species that have evolved through the history of Earth have gone extinct. Extinction is an ordinary part of the struggle for survival and competition for resources. 2.4 Project: Extinction will allow students to recognize the number of species that have become extinct.
Introduction: The rise of superbugs	All bacteria are bad.	**Use Introduction: The rise of superbugs** In the gut, helpful bacteria work to keep us healthy. These bacteria play an important role in helping the body process nutrients. They even protect the gut from being colonized by harmful bacteria. This misconception is explicitly addressed through a Did you know? section.
1.2 Lesson: Variation	Giraffes evolved long necks because they spent their lives reaching for higher branches.	**Use Lesson 1.2: Variation** Only genetic traits are heritable. Giraffes didn't evolve long necks from reaching for high branches. Instead, random genetic mutations gave longer-necked giraffe ancestors an advantage in obtaining food. So, over many generations, this trait became more common. This misconception is explicitly addressed through a Common misconception section.

Lesson	Misconception	Addressing the misconception
1.3 Lesson: Natural selection	Evolution doesn't "progress" in any particular direction.	**Use Lesson 1.3: Natural selection** Evolution doesn't have a goal. A population evolves because of natural selection. This process just depends on how well different variations are adapted to the environment. This misconception is explicitly addressed through a Common misconception section
1.5 Lesson: Adaptations	Species try to adapt to their environment.	**Use 1.5 Lesson: Adaptations** Species don't become adapted to their environment by choice. Adaptations are a result of random variations. Some variations are good, others are bad. Variations that help organisms survive are adaptations and these are passed on to the next generation. This misconception is explicitly addressed through a Common misconception section.
	Natural selection gives organisms what they need to survive.	**Use 1.5 Lesson: Adaptations** Natural selection doesn't give organisms what they need. Selection pressures can only select between the variations that are present in the population. Selection pressures don't give species the traits they need to survive – those traits need to appear by chance. This misconception is explicitly addressed through a Common misconception section.

A Vietnamese mossy frog
The evolution of adaptations like this frog's camouflage is a product of genetic variation and natural selection.

ELL support

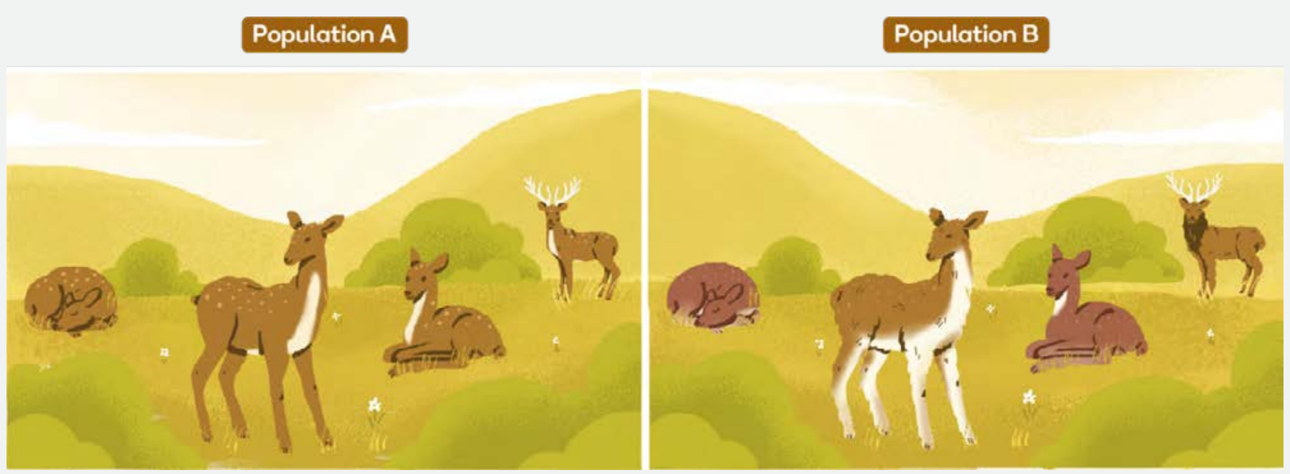
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

Lessons in the Evolution unit include a number of flow charts and diagrams to help students understand the many factors that contribute to the changes in species over time.Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

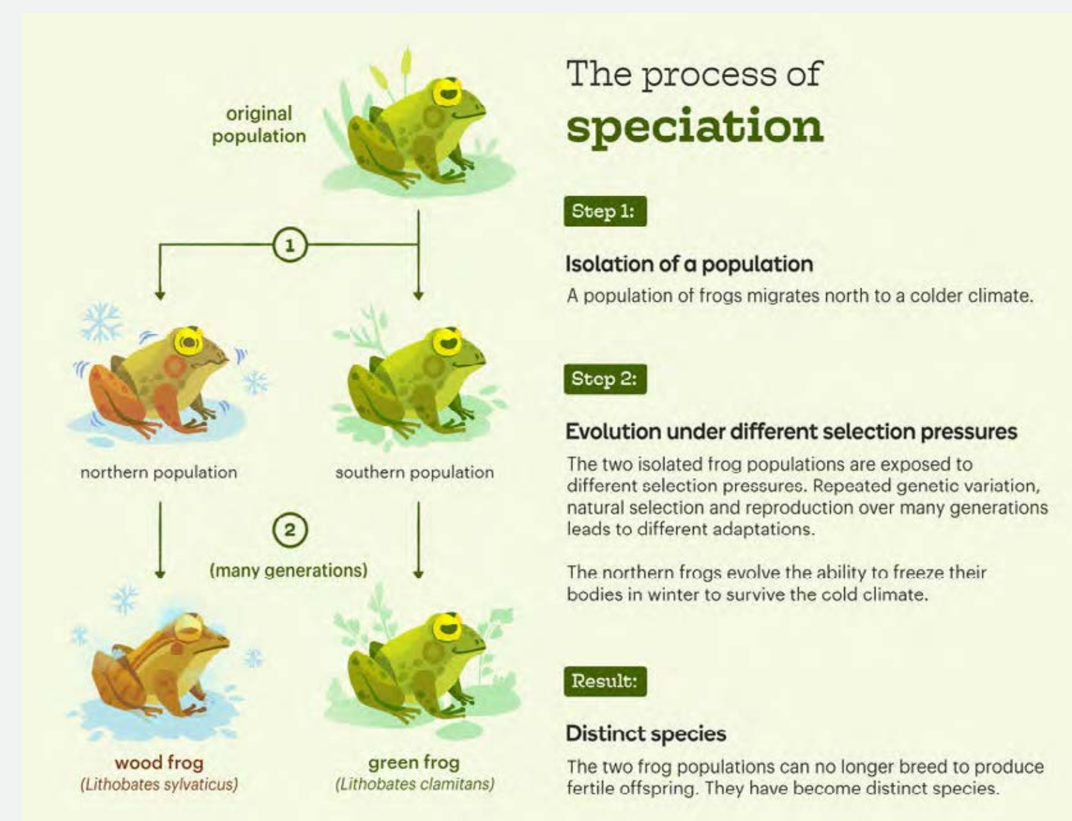
1.2 Case study: Variation

This image represents the concept of variation within a population by contrasting two populations of deer. By using an illustration, students are able to interpret the meaning of the *phrases* variation and *population* and can use these interpretations to support their comprehension of text within the lesson.



2.3 Lesson: The formation of species

This infographic pairs simple phrases containing scientific terminology with illustrations that represent the key processes of speciation. This combination supports students to comprehend the written elements, as they can follow the visual representation shown. Students can gain familiarity with the terminology in this context, and gain confidence with specific vocabulary as they progress through the unit.

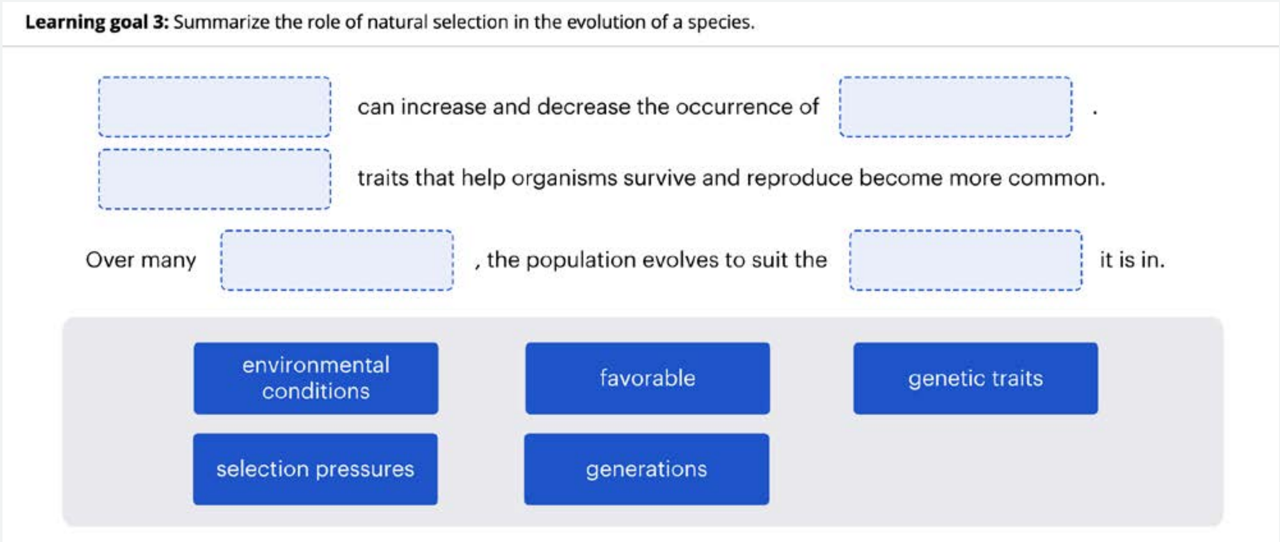


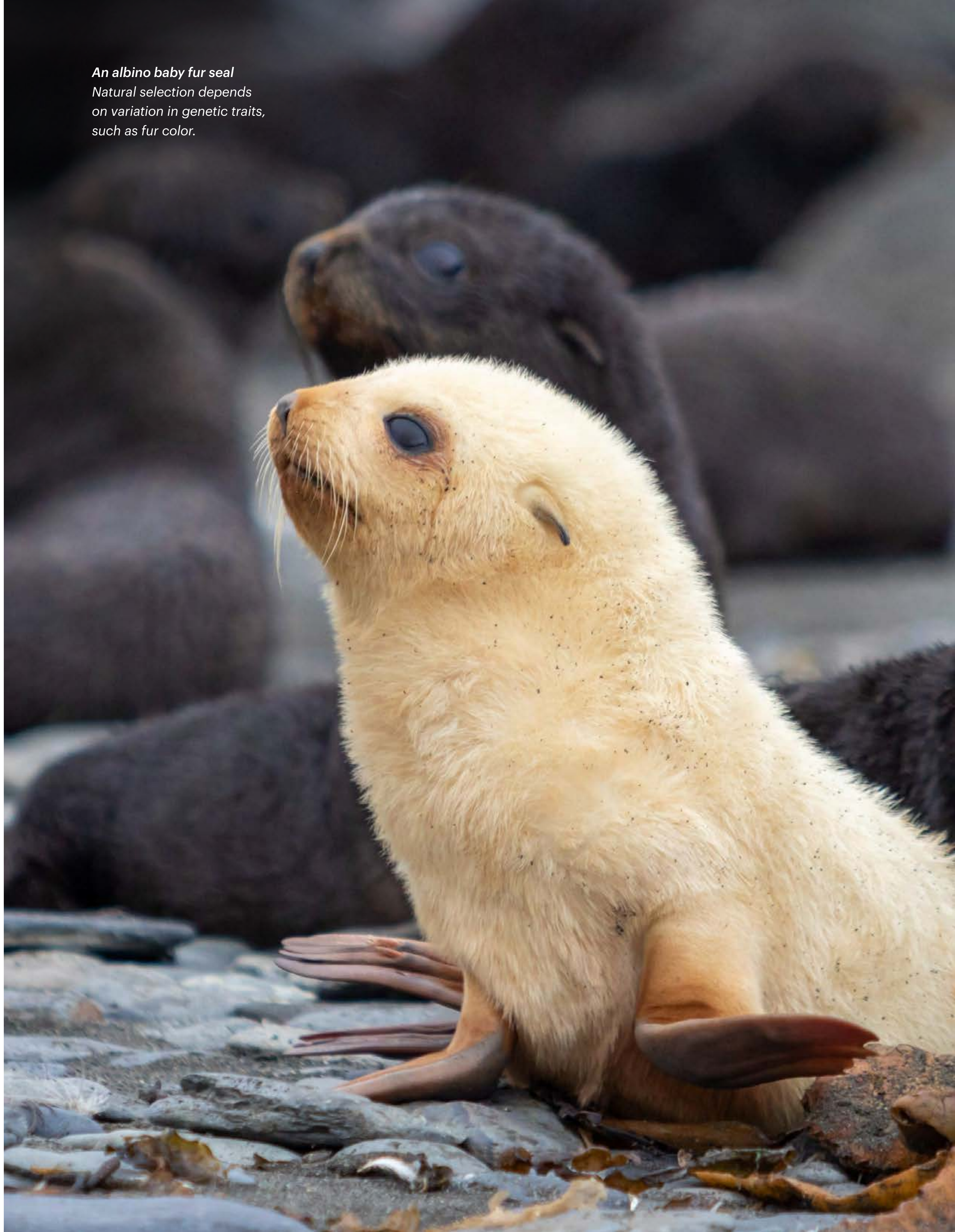
Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.3 Quiz: Natural selection

This question asks students to demonstrate their knowledge with a fill-in-the-blank question. This means that writing full sentences isn't required to communicate student understanding, making the question more accessible to ELL students. By isolating the scientific terminology and asking students to place it correctly into the provided sentences, students are able to use contextual clues from within the text to support them in answering the question.



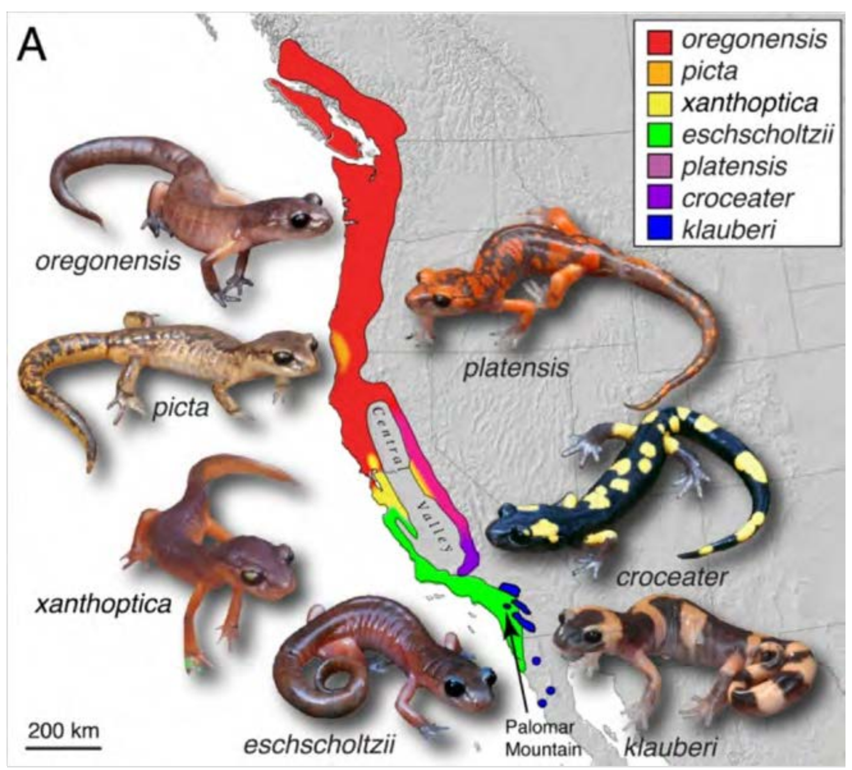


An albino baby fur seal
Natural selection depends on variation in genetic traits, such as fur color.

Customization

There are many opportunities to create customized lessons within the Evolution unit. Here are a few ideas for providing local context for your learners:

2.3 Lesson: The formation of species
Teachers can use the ring species of salamanders in Southern California – *Ensatina eschscholtzii* and *Ensatina klauberi* – as local examples of speciation. Two species are naturally geographically separating (sympatrically), but the two species still overlap in the "hybrid zone."
In the middle of the hybrid zone, a high proportion of hybrids are present. The genetic disequilibrium is concentrated on the *E. escholtzii* side of the zone where nearly all hybrids possess the *E. klauberi* mitochondrial DNA, indicating that the hybrids are formed when a female *E. klauberi* mates with a male *E. escholtziii*, but not the other way around. This is called "asymmetric hybridization."



Range of the Ensatina eschscholtzii complex in Western North America. Names refer to subspecies.

Devitt, T.J., Baird, S.J. & Moritz, C. Asymmetric reproductive isolation between terminal forms of the salamander ring species *Ensatina eschscholtzii* revealed by fine-scale genetic analysis of a hybrid zone. *BMC Evol Biol* 11, 245 (2011). https://doi.org/10.1186/1471-2148-11-245)

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative Assessment

Pre-test: What do you already know?
Activate students' prior knowledge of relevant concepts including inheritance, variation, and the theory of evolution. Use this as a pre-test to identify misconceptions and areas where students may need additional challenge or support in subsequent lessons.

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes

- **1.2 Quiz: Variation**
  Multiple choice and written response: 5–10 minutes
- **1.3 Quiz: Natural Selection**
  Multiple choice and written response: 5–10 minutes
- **1.5 Quiz: Adaptations**
  Multiple choice and written response: 5–10 minutes
- **2.3 Quiz: The formation of species**
  Multiple choice and written response: 5–10 minutes

Summative Assessment

Tests
This unit contains a test to provide summative assessment of student learning across the whole unit.

- **Test: Evolution**
  Multiple choice and short answer: 30–45 minutes

Science and Engineering Practices
Two lab activities within the unit can be used as summative assessment of Science and Engineering Practices.

- **1.1 Lab activity: Modeling evolution**
  Group task and discussion: 80–90 minutes
- **2.2 Lab activity: Modeling the formation of species**
  Lab modeling activity: 45–60 minutes

Lab Activities

Lab Activity

Modeling evolution

Activity purpose: Model the process of evolution by natural selection through a hands-on competition.

stileapp.com/go/EvolutionExp

80–90 minutes

5 groups

Materials

Lab Equipment
To set up the traits:
- blindfolds or eye patches for ⅓ of the class
- slings (optional) for ⅓ of the class

For the final challenge, each group will need:
- newspaper or waste paper
- tape
- glue

Chemicals
None required

Preparation

Blindfolds and slings should be distributed by the teacher. The remaining materials should be provided in stations or in groups for student collection.

Detailed instruction is required for this lab activity. Reading the activity in its entirety before commencing is recommended.

The Round 2 task will need to have letters assigned to each column. To avoid students jumping ahead, it is recommended that the letters are written on the whiteboard.

Notes

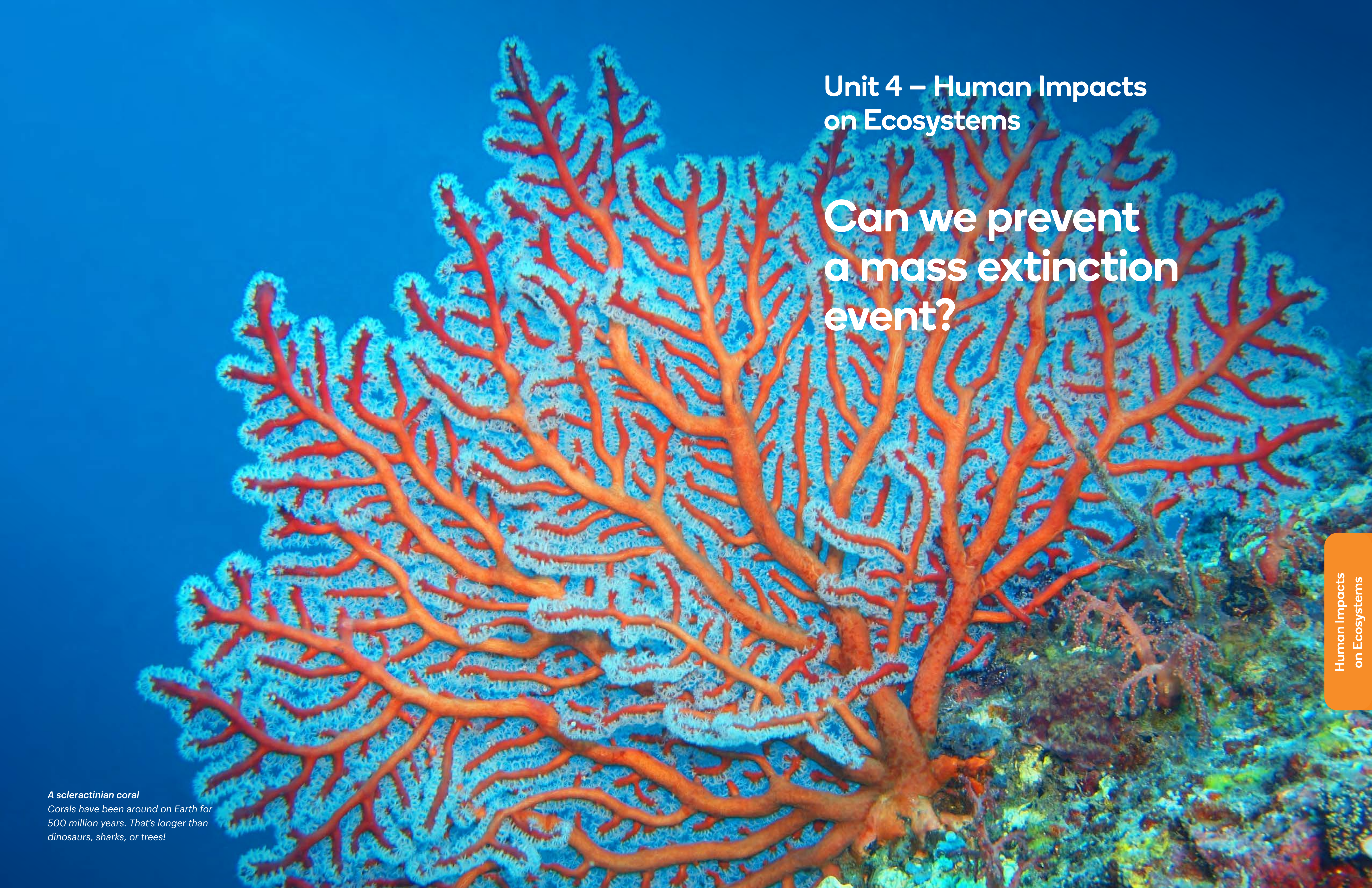
None

Method

Method that students will follow
1. Students are randomly divided into five groups by the teacher.
2. Read the special instructions related to the defining trait for each group before taking part in the activities.
3. At the end of each round, the members of the eliminated group are reassigned randomly to the surviving groups. They represent the offspring from reproduction and take on the trait of the group to which they're assigned.
4. Complete the puzzle in Round 1 on each individual device. The shapes cannot overlap and every shape must be used. The last group to have all team members complete the puzzle is eliminated.
5. Complete the table in Round 2 on one device for each group. The last team to complete this task is eliminated.
6. Create a free-standing tower in Round 3 using only the materials provided. The tower must be able to stand unassisted for at least ten seconds. The tallest tower is the winner!

Unit 4 – Human Impacts on Ecosystems

Can we prevent a mass extinction event?



A scleractinian coral
Corals have been around on Earth for 500 million years. That's longer than dinosaurs, sharks, or trees!

Storyline and anchoring phenomenon

Most people haven't seen coral reefs up close, and if you're one of the lucky few who has, you'll know they're beautiful structures that house a wide variety of marine life. But did you know these wonderlands also support the survival of roughly half a billion people worldwide?

Coral reefs provide humans with food, medicine, income, and protection from storms and erosion. They also absorb huge amounts of carbon from the atmosphere, helping reduce the effects of climate change.

Unfortunately, coral reefs are in danger of becoming extinct. In the last 70 years, over 50% of corals have disappeared and more than 90% are expected to die by 2050! A combination of natural and human-induced causes is driving large-scale damage and massive bleaching events. So, what does this mean for us? What does it mean for the organisms that rely on the reefs to survive? And can we do anything to stop it?

Students are motivated to answer these questions throughout this unit. They are immersed in a coral reef through a virtual reality experience, build a model of a healthy coral reef using a simulation, and learn about the complex interdependence of organisms in a coral reef ecosystem. Students take a trip through time to learn about the fossil record and relative dating, then apply this knowledge to discover that coral reefs have experienced extinction before! They question how coral reefs have come back from extinction so many times and why these complex ecosystems are so important. Students explore evidence for evolution and uncover how all life forms are related to a common ancestor. This drives them to consider how the corals of the past may help the corals of today survive.

This unit culminates with students flexing their argumentation and oral presentation skills as they work on a campaign to save the coral reefs and prevent the sixth mass extinction.

This unit at a glance

Human Impacts on Ecosystems

Pre-test: Human Impacts on Ecosystems

1. Beauty and the bleached: Are corals going extinct?
2. How do coral reefs protect us?
3. How do scientists know the history of corals?
4. How were corals impacted by past mass extinctions?
5. Are all animals related?
6. What makes a coral reef healthy?
7. Why do populations in an ecosystem change?
8. How are humans impacting current coral reefs?
9. How does the chemistry of our oceans affect corals?
10. What's really killing our corals?
11. Are we heading for another mass extinction?
12. How are scientists trying to save corals?
13. How can you protect corals?
14. Creating a campaign plan

Test: Human Impacts on Ecosystems

Students **engage with the phenomena** of coral bleaching using a 360° virtual reality experience.

Students use a **hands-on activity** to **model** the sedimentary layers and how scientists understand the relative ages of fossils.

Students **discover patterns** of evolution through observing embryos, bone structure, and common ancestors.

Students **observe patterns** in the changes in populations and identify **causes and effects** of changes over time.

Students use **explicit teaching** to **problem-solve** how the changing atmospheric CO_2 could cause the next mass extinction event.

Students observe how scientists are **problem-solving** and **discovering** ways in which they can help corals recover.

Students use their knowledge to **collaborate and problem-solve** ways they can spark enthusiasm in the wider population to save the reefs.

NGSS alignment overview

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-ESS1-4

Construct a scientific explanation based on evidence from rock strata for how the geologic time scale is used to organize Earth's 4.6-billion-year-old history.

MS-ESS3-3

Apply scientific principles to design a method for monitoring and minimizing a human impact on the environment.*

MS-LS2-1

Analyze and interpret data to provide evidence for the effects of resource availability on organisms and populations of organisms in an ecosystem.

MS-LS4-1

Analyze and interpret data for patterns in the fossil record that document the existence, diversity, extinction, and change of life forms throughout the history of life on Earth under the assumption that natural laws operate today as in the past.

MS-LS4-2

Apply scientific ideas to construct an explanation for the anatomical similarities and differences among modern organisms and between modern and fossil organisms to infer evolutionary relationships.

MS-LS4-3

Analyze displays of pictorial data to compare patterns of similarities in the embryological development across multiple species to identify relationships not evident in the fully formed anatomy.

The elements listed are assessed at grade band level within this unit.

Disciplinary Core Ideas

- **LS2.A:** Interdependent Relationships in Ecosystems
- **LS4.A:** Evidence of Common Ancestry and Diversity
- **ESS1.C:** The History of Planet Earth
- **ESS3.C:** Human Impacts on Earth Systems

Students explore coral reefs and their many wonders throughout this unit.

They observe current biodiversity and the many forms of life that the reef systems support. Through this rich biodiversity, corals have been a hub for evolution and extinction events through millions of years of life on Earth. Students explore the evidence for evolution by looking at embryos and common morphology among today's living creatures. They broach the question, "Are we on the cusp of the next mass extinction? And if so, how can we prevent it?"

Science and Engineering Practices

- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Argument From Evidence
- Obtaining, Evaluating and Communicating Information

Students analyze data that demonstrates how important corals are to humans and to ecosystems.

They observe tropical storms and their effects on the coastal communities that are destroyed by them. Students look at how we can use reef systems to protect our towns and, most importantly, conserve biodiversity to prevent the next mass extinction. They design solutions to minimize impacts on reef systems and culminate their knowledge to engage in argument from evidence gathered through the unit to create a campaign plan.

Crosscutting Concepts

- Patterns
- Cause and Effect: Mechanism and Prediction
- Stability and Change

Exploring life on Earth, students are shown the profound impact that corals have on our livelihoods and ecosystems by observing data that demonstrates the buffer effect of coral reefs on coastal systems and possible effects of removing them.

They observe patterns in the way species change over time and postulate cause and effect relationships for previous mass extinction events. Students discover the scale at which extinctions need to be observed to be considered "mass" and the proportion of life on Earth that's become extinct. Students use their observations of cause and effect and patterns to create a campaign plan to save the reefs from the next mass extinction event.

Nature of Science

- Scientific Knowledge Assumes an Order and Consistency in Natural Systems

Science, Technology, Society and the Environment

- Influence of Science, Engineering, and Technology on Society and the Natural World

*The performance expectations marked with an asterisk integrate traditional science content with engineering through a Practice or Disciplinary Core Idea.

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

In Ecosystems, students learned that changes to the Earth's environments impact living things by exploring the effect of plastic on marine ecosystems. As they examine the relationship between the height of coral reefs and the height of waves, students are able to build on their previous understanding by identifying the impact that a decrease in coral reef heights has on human populations due to flooding in coastal communities.

Expanding on their learning about the rock cycle from Active Earth, students use models to demonstrate the way in which coral fossils within rock strata provide evidence of their history on Earth, and engage with the fossil record as proof of mass extinction events in the past. Students analyze images of embryology and physiology to identify similarities between species, and refer to evidence from the fossil record to infer evolutionary relationships.

Seeing the changes in coral life forms represented in the fossil record allows for students to make links with the way in which populations change through mutation and the inheritance of variation. The Ecosystems, Plants, and Food Chains and Food Webs units covered the way in which organisms compete for limited resources. Students will now recognize that access to these resources determines the success of growth and reproduction, and therefore the passing of genes between generations.

Science and Engineering Practices

Students have applied skills in analyzing and interpreting data across grade levels. For example, they used data from maps in Active Earth to understand the connection between the location of tectonic plates, earthquakes, and volcanoes.

In Human Impacts on Ecosystems, they continue to develop this practice as they analyze data from maps and from an investigation to provide evidence of the role of coral reefs in protecting coastal communities from storms. As they did in Ecosystems and Food Chains and Food Webs, students identify relationships in data, which show that mass extinction events align with decreases in coral diversity, and represent similarities in comparative anatomy and embryology that suggest species are related. Students have previously designed solutions through engineering challenges in The Importance of Biodiversity, Heat, and Ecosystems. They apply their experience with designing solutions to design a replacement for plastic water bottles, sunscreen, or an anchor that will protect coral reef ecosystems.

Socratic seminars in units such as Cells have given students experience with engaging in oral argumentation from evidence. By creating a campaign to raise awareness about the issues facing corals, students will build on this experience to present a written argument supported by scientific information.

Crosscutting Concepts

Students have examined cause and effect relationships through The Importance of Biodiversity, Food Chains and Food Webs, Genetics, Ecosystems, and more units in The Stile Curriculum. In Human Impacts on Ecosystems, students explore cause and effect relationships by examining data that shows the impact coral reefs have on wave height, and by using a simulation to model the impacts of coral extinctions on other organisms.

Having identified patterns in the location of earthquakes and volcanoes in Active Earth, students are primed to recognize patterns in fossil data that represent the presence of coral species throughout time, and the absence of coral species following mass extinction events. They also identify patterns in the development of different species by comparing images of their embryos, and use this as evidence of the relationship between living things. Students transfer their understanding of stability and change in the context of population changes from Ecosystems and Genetics.

A hawksbill turtle
Hawksbill turtles play an important role in coral reef ecosystems. By feeding on sponges, they provide corals with more space to grow.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Pre-test: The History of ife on Earth	How much do I already know about Human Impacts on Ecosystems?	Ensure each student has access to a device					Extra SEP support: 3.5 Reading line graphs can be used to discuss the line graph after students have submitted
Lesson 2	Beauty and the bleached: Are corals going extinct?	What's the big deal with coral bleaching?	Review Pre-test in Analyze Mode Review teaching notes in Prepare Mode Optional: Use VR headsets and smartphones for a virtual reality experience of coral reefs. VR headsets are available to purchase from the Stile Shop	Analyzing and Interpreting Data		Stability and Change	Discuss with students how they could communicate the issues they have observed	
Lesson 3	How do coral reefs protect us?	How do coral reefs protect humans?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**ESS3.C** Human Impacts on Ecosystems	Cause and Effect	Ask students to complete question 7, using data to justify their answer	*NCA* article, "Changes in Hurricanes" linked in teaching notes
Lesson 4	What can rocks tell us about the history of corals?	How do we know how old things are in Earth's history?	Review Key Question from previous lesson in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions Developing and Using Models	**ESS1.C** The History of Planet Earth	Scale, Proportion, and Quantity	Ask students to complete any remaining questions	

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	How were corals impacted by past mass extinctions?	How do we know what has gone extinct in a mass extinction?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**LS4.A** Evidence of Common Ancestry and Diversity **ESS1.C** The History of The Planet	Patterns	Ask students to brainstorm similarities with extinct organisms and organisms that they see today	Extra SEP support: 2.1 Observing and inferring
Lesson 6	Are all animals related?	Am I related to dinosaurs?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Print a class set of the paper puzzle before class	Analyzing and Interpreting Data	**LS4.A** Evidence of Common Ancestry and Diversity	Patterns	Assign *Evogeneao* "Tree of Life Explorer" interactive from teaching notes to students	Extra SEP support: 2.1 Observing and inferring
Lesson 7	What makes a coral reef healthy?	How do living and non-living things interact in a coral reef?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**LS2.A** Interdependent Relationships in Ecosystems	Cause and Effect	A discussion about whether populations can grow exponentially can front load learning for the following lesson	
Lesson 8	Why do populations in an ecosystem change?	Why can't a population keep growing in a healthy ecosystem?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**LS2.A** Interdependent Relationships in Ecosystems	Patterns		

Lesson Planning Guide

Week 1 · Week 2 · **Week 3** · Week 4 · Week 5

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	How are humans impacting current coral reefs?	How are humans having an impact on reef ecosystems?	Review Key Question from previous lesson in Analyze Mode Experiment with the simulation to familiarize yourself with what students are expected to do Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**ESS3.C** Human Impacts on Earth Systems	Cause and Effect	Optional: Discuss what ocean acidity is and how it impacts oceanic organisms.	Extra SEP support: 2.1 Observing and inferring
Lesson 10	How does the chemistry of our oceans affect corals?	How does atmospheric CO_2 affect coral reefs?	Review Key Question from previous lesson in Analyze Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**PS1.B** Chemical Reactions	Cause and Effect	Students can use PhET simulation linked in teaching notes to learn more about the pH of different solutions	*Our World in Data* link in the teaching notes
Lesson 11	What's really killing our corals?	How often do bleaching events happen?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**ESS3.C** Human Impacts on Earth Systems	Patterns		Extra SEP support: 3.1 Types of data
Lesson 12	Are we heading for another mass extinction?	Will we see another mass extinction event?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Constructing Explanations and Designing Solutions	**ESS3.C** Human Impacts on Earth Systems	Patterns		

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	How are scientists trying to save corals?	How are humans helping the coral reefs?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Optional: Use VR headsets and smartphones for a virtual reality experience of coral reefs. VR headsets are available to purchase from the Stile Shop	Constructing Explanations and Designing Solutions	**ESS3.C** Human Impacts on Earth Systems	Stability and Change	Ask students to complete reflections for this lesson	
Lesson 14	How can you protect corals?	Can I help save coral reefs?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Optional: Use VR headsets and smartphones for a virtual reality experience of coral reefs. VR headsets are available to purchase from the Stile Shop	Constructing Explanations and Designing Solutions	**ESS3.C** Human Impacts on Earth Systems	Cause and Effect	Ask students to upload their design solution	
Lesson 15	Creating a campaign plan	How can I create a campaign to help decrease the risk of coral mass extinction?	Review Key Question from previous lesson in Analyze Mode Ensure the poster model and brief are available for students to refer to Review teaching notes in Prepare Mode	Engaging in Argument From Evidence Obtaining, Evaluating, and Communicating Information	**ESS3.C** Human Impacts on Earth Systems	Cause and Effect	Ask students to complete questions 1–4	Extra SEP support: 5.2 What is creativity?
Lesson 16			Review student progress in Analyze Mode				Ask students to complete any remaining questions	Extra SEP support: 5.2 What is creativity?

Lesson Planning Guide

The guide below is based on three 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	Unit review: Human Impacts on Ecosystems	How can I be prepared for the Human Impacts on Ecosystems test?	Review Key Questions from the unit in Analyze Mode to identify areas to revisit	Analyzing and Interpreting Data Constructing Explanations and Designing Solutions Engaging in Argument From Evidence	**ESS1.C** The History of Planet Earth **ESS3.C** Human Impacts on Earth Systems **LS2.A** Interdependent Relationships in Ecosystems **LS4.A** Evidence of Common Ancestry and Diversity	Patterns Cause and Effect Scale, Proportion, and Quantity	Ask students to review teacher feedback from lessons in the unit	
Lesson 18	Test: Human Impacts on Ecosystems	How much have I learned about Human Impacts on Ecosystems?	Ensure every student has access to a device				Prompt students to write a reflection on what they have learned from the unit	
Lesson 19	Test review: Human Impacts on Ecosystems	How successful was my revision of Human Impacts on Ecosystems?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these				Ask students to reflect on the effectiveness of their revision, and to identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Students use data throughout this unit to justify the impact that coral reefs have on human livelihoods.

They use models of mathematical data to justify why corals are important to protect in coastal systems. Students also use data about species disappearance and population changes to justify ecological concepts and reason abstractly.

Common Core State Standards Connections: Math

MP.2

Reason abstractly and quantitatively.

MP.4

Model with mathematics.

Dissolving shells
With increasing acidity in the ocean, corals, sea shells, and the animals in them, are threatened with their skeletons dissolving.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the Math standards listed.

Throughout this unit, students develop an understanding of the role that humans have to play in saving corals.

They engage with many forms of media to justify claims and conduct research projects about how their scientific knowledge can help coral reefs maintain their biodiversity. Students integrate technical information into arguments and cite specific textual references to create a campaign to communicate to others how to save the reefs.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flow chart, diagram, model, graph, or table).

WHST.6-8.8

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

WHST.6-8.7

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

WHST.6-8.1

Write arguments focused on discipline content.

SL.8.5

Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

RST.6-8.2

Determine the central ideas or conclusions of a text; provide an accurate summary of the text distinct from prior knowledge or opinions.

RST.6-8.9

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

WHST.6-8.9

Draw evidence from informational texts to support analysis, reflection, and research.

WHST.6-8.1

Write arguments to support claims with clear reasons and relevant evidence.

WHST.6-8.2

Write informative/explanatory texts to examine a topic and convey ideas, concepts, and information through the selection, organization, and analysis of relevant content.

RST.6-8.8

Distinguish among facts, reasoned judgment based on research findings, and speculation in a text.

SL.8.1

Engage effectively in a range of collaborative discussions (one-on-one, in groups, and teacher-led) with diverse partners on grade 8 topics, texts, and issues, building on others' ideas and expressing their own clearly.

SL.8.4

Present claims and findings, emphasizing salient points in a focused, coherent manner with relevant evidence, sound valid reasoning, and well-chosen details; use appropriate eye contact, adequate volume, and clear pronunciation.

RST.6-8.4

Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 6–8 texts and topics.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **2. How do scientists know the history of corals?**
  Question 3
- **5. How can we connect current species to extinct ones?**
  Question 5
- **7. What limits the living things in an ecosystem?**
  Question 3
- **10. What's really killing our corals?**
  Question 6
- **12. How are scientists trying to save corals?**
  Question 6

Extension opportunities in this unit

Challenge Questions
Most lessons contain one or more Challenge Questions, which are an opportunity for students to show they are working above the level of the learning goal. When answering these questions, students can extend themselves by applying their knowledge to new contexts, or solving more complex problems. These provide a great extension opportunity.

Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC
5. How can we connect current species to extinct ones?	How closely related am I to coral?	Interactive link posted in teaching note at the end of lesson	Analyzing and Interpreting Data	**LS4.A** Evidence of Common Ancestry and Diversity **ESS1.C** The History of Planet Earth	Patterns

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize them within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
Pre-test	All fossils are preserved bones of dead animals.	Bones can become fossils but there are other types of fossils too: – Trace fossil: any trace of an organism, such as a footprint or piece of dung – Resin fossil: an organism trapped in tree sap – Mold fossil: an imprint of the shape of an organism
4. How were corals impacted by past mass extinctions?	Climate change is only caused by human impacts.	Changes to Earth's climate have occurred cyclically throughout Earth's geological history. These create a pattern of ice age and greenhouse periods and are caused by natural events. However, the current changes to Earth's climate are linked to human activities and the rate of change is faster than from natural causes.

Lesson	Misconception	Addressing the misconception
6. What makes a coral reef healthy?	A coral is both a plant and an animal.	A coral is an animal, but it has a symbiotic relationship with microscopic algae that live inside of it.
7. What limits the living things in an ecosystem?	Competition between organisms always involves direct, aggressive interaction.	In fact, competition does not require aggression or direct interaction, such as fighting over food.
8. How are humans impacting current coral reef systems?	Climate change is causing the ocean to become acidic.	Climate change is increasing the acidity of the ocean, but the water is not becoming acidic. Sea water remains alkaline, despite the increase in acidity.
9. How does the chemistry of our oceans affect corals?	When a solid dissolves, it ceases to exist.	When a solid dissolves, the particles that made it up are still present. But they have spread through the solution and are too small to see.
	Ocean acidification means that water is acidic.	In fact, the average pH of ocean water is about 8, which makes it alkaline. Its pH is gradually decreasing toward neutral (pH 7) due to the absorption of carbon dioxide from the atmosphere.

ELL support

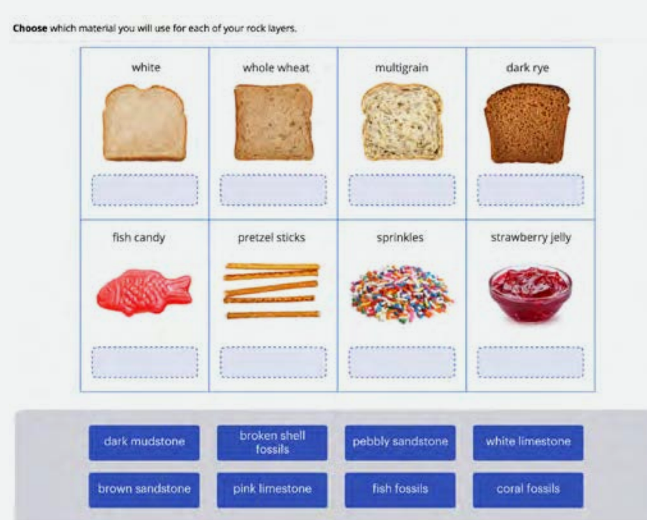
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview.

Visual representations

The Human Impacts on Ecosystems lessons include a number of flow charts and diagrams to help students understand the role that coral reefs play in many different ecosystems and how they have supported biodiversity on Earth since life began. Encourage students to draw on these visual representations and actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

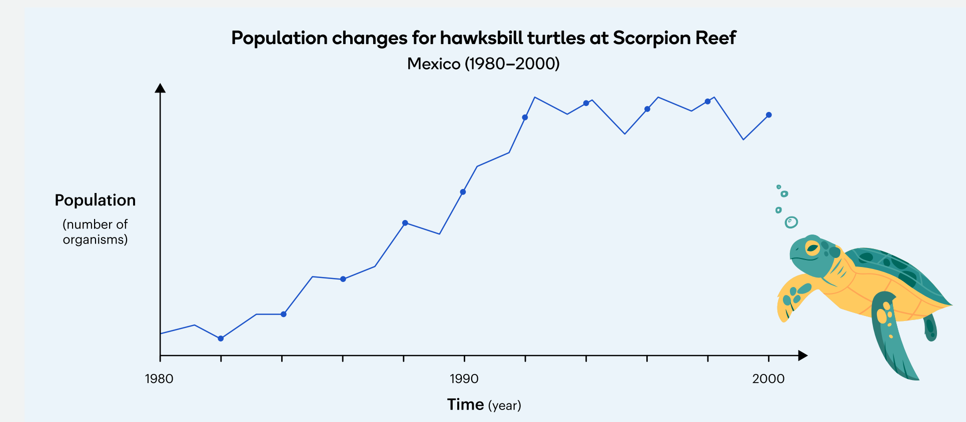
Lesson 3: How do scientists know the history of coral?

This model allows students to understand key parts of coral reefs and the processes that are discussed in the lesson by using labels for key parts and a visualization of the key content knowledge required to progress in the lesson.



Lesson 7: What limits the living things in an ecosystem?

Graphical representations of data with the assistance of imagery allow students to recognize patterns in the data that have been explained within text in the lesson. This provides a secondary exposure to the same information that can then be used to support comprehension of written information.



Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

Lesson 6: What makes a coral reef so healthy?

Students employ their knowledge of the coral reef system to create their own complex food web of organisms that they have observed throughout the interactive. They use this self-created food web to answer the following questions in the unit.

A healthy coral reef
Healthy coral reefs have supported changing ecosystems since they first appeared on Earth.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative assessment

Pre-test: What do you already know?
Activate students' prior knowledge of relevant concepts including the definition of an ecosystem, how food chains and food webs can interact within an ecosystem, predator–prey interactions, and orders of consumers. Use this as a pre-test to identify misconceptions and areas where students may need additional challenge or support in subsequent lessons.

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Summative assessment

Test
This unit contains a test to provide summative assessment of student learning across the whole unit.

- **Test: Human Impacts on Ecosystems**
  Multiple choice and short answer: 45 minutes

Science and Engineering Practices
A lesson and the culminating campaign project within the unit can be used as summative assessment of Science and Engineering Practices.

- **What's really killing our corals?**
  Lesson: 45 minutes
- **Creating a campaign plan**
  Project: 90–120 minutes

Lab Activities

Lab Activity

What can rocks tell us about the history of corals?

Activity purpose: Model relative dating using sandwiches.

stileapp.com/go/us-history-rocks

20 minutes

2 students

Materials

Lab Equipment
Each group of students will need:
- 1 slice of each type of bread: multigrain, whole wheat, white, dark rye
- bread knife
- 1 teaspoon of sprinkles
- 6 pretzel sticks
- 6 fish candies (Swedish Fish)
- 1 tablespoon of strawberry jelly

Chemicals
None required

Preparation

Materials and ingredients can be set up so that each station has the whole variety of ingredients rather than accessing each individually to save time.

Notes

The ingredients are easily swapped out for ones your students would prefer – as long as there are four types of bread and two different types of gummy candy.

Be aware of gluten intolerances or allergies of your students.

If you are working in a non-food lab: The ingredients below can easily be swapped out for different sands and soils, sticks, pebbles, and even plastic toys, to represent the fossils. Students can pour these materials into a clear container so they can visualize the different layers.

Method

Method that students will follow
1. Determine which ingredients will be used for the different types of rock layers and label these in question 1.
2. Using the below materials, create a sandwich model of rock layers. Layers can be in any order.
3. Slice your sandwich so that you have a cross section observable.
4. Upload your cross section to question 2.
5. Create a modification to your sandwich model to show the extinction of an organism and upload it to question 7.

Lab Activity

How does the chemistry of our oceans affect corals?

Activity purpose: Students investigate the impact of increasing carbon dioxide in the atmosphere and ocean acidification on corals.

stileapp.com/go/us-history-chem-oceans

10–15 minutes

Individual activity

Materials

Lab Equipment
Each student will need:
- 250 mL beaker
- universal indicator color chart
- straw

Chemicals
- universal indicator
- distilled water

Preparation

None required

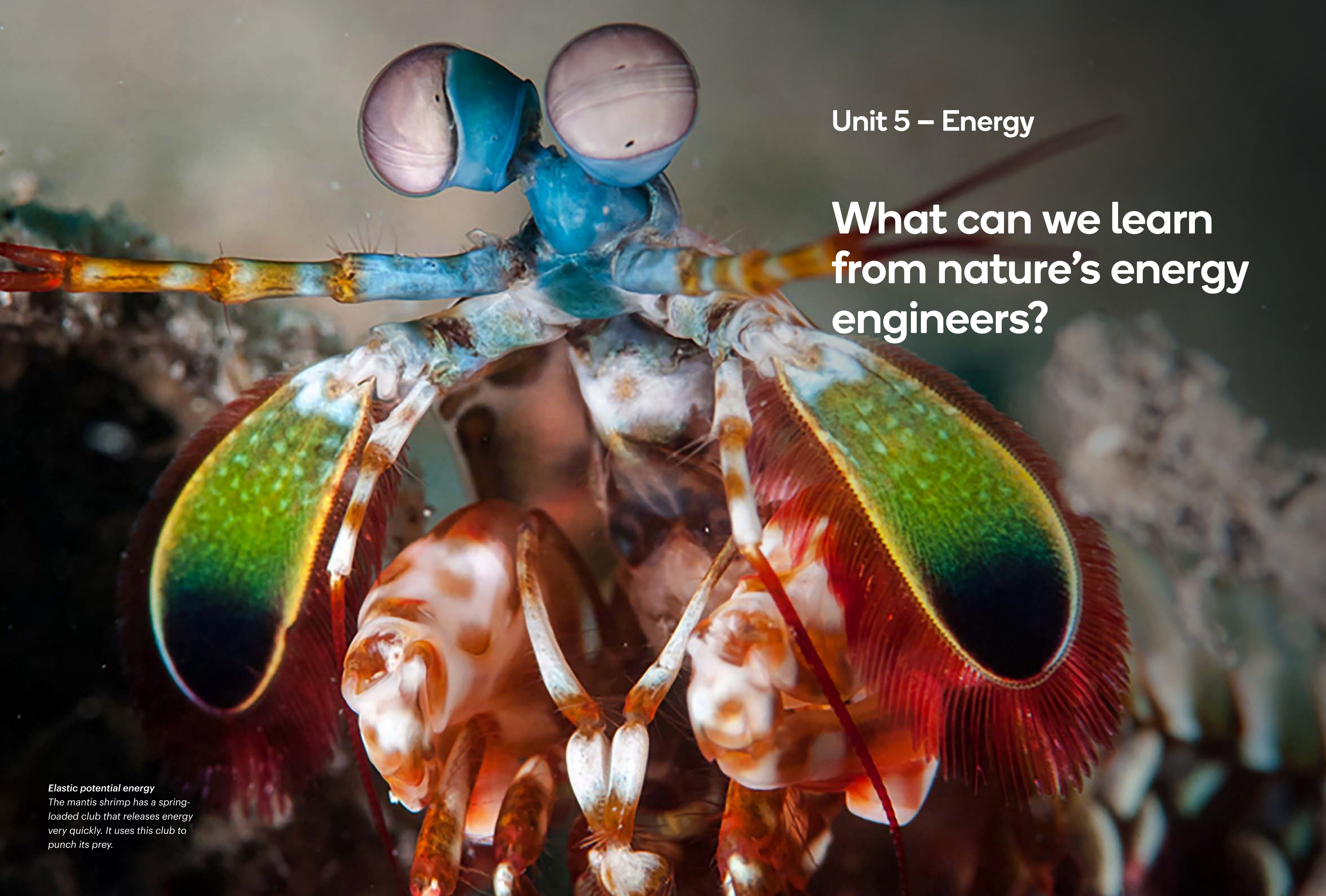
Notes

None

Method

Method that students will follow

1. Add 100 mL distilled water to the beaker. Mix in 20 drops of universal indicator to make a solution.
2. Record the color of the solution.
3. Determine the pH of the solution by comparing the color you observe to the universal indicator chart.
4. Using a straw, blow gently into the solution until you see a change. Do not suck through the straw – the universal indicator is poisonous.
5. Record the color of the solution after blowing through the straw.
6. Determine the pH of the solution by comparing the color you observe to the universal indicator chart.



Unit 5 – Energy

What can we learn from nature's energy engineers?

Elastic potential energy
The mantis shrimp has a spring-loaded club that releases energy very quickly. It uses this club to punch its prey.

Storyline and anchoring phenomenon

Energy is needed to make anything happen, from riding a bike or burning a candle, to lighting up our cities after dark. As climate change continues to cause long-lasting damage to our environment, scientists are looking for solutions.

Renewable energy technologies are cleaner and more sustainable ways of powering our homes. But these technologies are far from perfect!

Engineers are looking to nature to inspire energy-efficient designs. Given that living things also rely on using and saving energy to survive, by studying them, we can often learn how to improve our technology. Nature has already inspired new designs for trains, surfboards, robots, and wind turbines!

Set in the rich context of biomimicry, this unit provides an opportunity to bridge the gap between biology and physics. Students will be inspired to think about creative solutions to these complex problems. This unit covers types of energy, energy transfers, and energy transformations, and challenges students to explore how energy is used in nature as inspiration to help improve sustainable energy technologies.

This unit at a glance

Energy

Introduction: Nature's energy engineers
Career profile and activity: Bioengineer
What do you already know?
1.1 Lab activity: Energy mystery box
1.2 Lesson: Forms of energy
1.2 Quiz: Forms of energy
1.3 Lesson: Defining energy and its units
1.3 Quiz: Defining energy and its units

2.1 Lab activity: Asteroid marble drop
2.1 Lesson: Kinetic energy
2.2 Quiz: Kinetic energy
2.3 Investigation: Kinetic energy
2.4 Lesson: Potential energy
2.4 Quiz: Potential energy
2.5 Lab activity: Rubber band racers

3.1 Lesson: Energy transfer and transformation
3.1 Quiz: Energy transfer and transformation
3.2 Lab activity: Water wheels
3.3 Simulation: Pedal power
3.4 Extension: Energy efficiency
3.4 Quiz: Energy efficiency
3.5 Lab activity: Bouncing balls
3.6 Lab activity: Create a light bulb
3.7 Engineering challenge: Biomimicry design

Glossary: Energy
Test: Energy

Students **meet their guide** for the unit – Professor John Dabiri, a **bioengineer** who has improved the energy efficiency of wind turbines.

Students **explore** how solar panels can be improved by observing sunflowers.

Students learn about kinetic energy by using marbles to **model changes in the speed and mass** of asteroids.

Using the **real-world examples** of energy changes at hydropower plants, students examine energy transfer and transformation.

Students **model energy transfers and transformations** using an interactive simulation.

By completing an **engineering challenge around biomimicry design**, students are introduced to the United Nations Sustainability Goals and are asked to put on their engineer's caps to improve renewable energy technology.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-ETS1-1

Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-4

Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

MS-PS3-1

Construct and interpret graphical displays of data to describe the relationships of kinetic energy to the mass of an object and to the speed of an object.

MS-PS3-2

Develop a model to describe that when the arrangement of objects interacting at a distance changes, different amounts of potential energy are stored in the system.

Disciplinary Core Ideas

- **ETS1.A**: Defining and Delimiting an Engineering Problem
- **ETS1.B**: Developing Possible Solutions
- **PS3.A**: Definitions of Energy
- **PS3.B**: Conservation of Energy and Energy Transfer
- **PS3.C**: Relationship Between Energy and Forces
- **ETS1.C**: Optimizing the Design Solution

In this unit, students use models to examine types of energy.

They plan and carry out an investigation looking at energy efficiency and they analyze and interpret data to inform their design solution. Students apply math skills throughout to make calculations and represent information in the form of a graph.

Science and Engineering Practices

- Analyzing and Interpreting Data
- Engaging in Argument From Evidence
- Planning and Carrying Out Investigations
- Developing and Using Models

Students learn about types of energy and the engineering process.

They recognize that energy cannot be lost or created, and that it is transferred or transformed within a system. Students use data from their own investigations to construct and interpret graphs that represent the relationship between kinetic energy and mass or speed. Using the context of biomimicry, students use their understanding of the engineering process and types of energy to define the problem, and create and iterate on a water wheel or turbine that takes inspiration from an animal or plant.

Crosscutting Concepts

- Energy and Matter
- Scale, Proportion, and Quantity
- Systems and System Models

Students explore different types of energy and focus on developing an understanding of types of energy.

They recognize the proportional relationship between variables, such as kinetic energy and speed. Students understand that energy exists within a system with inputs and outputs, from which energy is never lost or created.

Nature of Science

- Scientific Knowledge is Based on Empirical Evidence

Science, Technology, Society, and the Environment

- Interdependence of Science, Engineering, and Technology
- Influence of Engineering, Technology and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

Students are familiar with the concept of energy from Heat and Light units, and with the cycling of matter from Food Chains and Food Webs, Ecosystems, Active Earth and Earth Systems.

In Energy they learn about specific types of energy, including kinetic energy, and make connections to their knowledge of Newton's Laws of Motion when they examine the forces exerted between two objects and the way in which potential energy is stored within systems. They are introduced to the idea of transferral and transformation of energy.

Through engineering challenges in various units in The Stile Curriculum, students are familiar with defining problems, developing solutions, testing and then modifying these. In Energy they use the context of biomimicry to apply their previous knowledge in developing solutions, and design a water wheel that is more efficient, affordable, reliable, or sustainable.

Science and Engineering Practices

Building on their previous experience with engineering challenges, students evaluate competing designs against specific criteria, and engage in argument by evaluating and comparing designs to determine which one best meets these criteria.

Students plan an investigation about kinetic energy and use a simulation to carry this out, expanding their knowledge of using models, and analyzing and interpreting data. They are familiar with these practices from other units where digital models have been used to represent specific situations, including Food Chains and Food Webs' Feed the Dingo simulation and the Terraforming an Exoplanet lesson in Climate Change.

Crosscutting Concepts

Students build upon their knowledge of the transfer of energy through systems from Food Chains, Ecosystems, Active Earth, and Earth Systems by comparing energy transfer and energy transformation and naming specific examples of this.

The use of models, such as food web diagrams, to represent the way in which energy flows within systems, provides a foundation for students to use digital models that also demonstrate this.

Students have experience with proportional relationships in the context of energy from Newton's Laws of Motion, and use this as a basis for understanding proportional relationships in calculations such as energy efficiency.

Energy efficiency
Solar panels are a great source of renewable energy, but how can we make them more efficient?

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Nature's energy engineers What do you already know?	How is the humpback whale an engineer?	Review teaching notes in Prepare Mode Review common misconceptions from What do you already know? in Prepare Mode	Analyzing and Interpreting Data	**PS3.A** Definitions of Energy	Energy and Matter	Ask students to read the *AskNature* article, "Flippers provide life, reduce drag"	Links to examples of bio-inspiration and biomimicry in teaching notes
Lesson 2	Career profile and activity: Bioengineer	How can I use nature to improve the design of a human-made object?	Review What do you already know? in Analyze Mode to guide areas to emphasize Review teaching notes in Prepare Mode Print and cut out a class set of cards for the biomimicry design activity	Developing and Using Models	**ETS1.B** Developing Possible Solutions	Energy and Matter	Ask students to summarize and provide examples of biomimicry	Extra SEP support: 5.3 Creative thinking
Lesson 3	1.1 Lab activity: Energy mystery box	How is Velcro inspired by nature?	Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Analyzing and Interpreting Data	**PS3.A** Definitions of Energy	Energy and Matter	Ask students to complete any remaining questions	Extra SEP support: 2.1 Observing and inferring
Lesson 4	1.2 Lesson: Forms of energy	What forms of energy are involved in eating breakfast?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**PS3.A** Definitions of Energy	Energy and Matter	Assign 1.2 Quiz: Forms of energy	*Legends of Learning* "Conservation of Energy" virtual game

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	1.3 Lesson: Defining energy and its units	How much energy does a grizzly bear use?	Review Key Question and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data	**PS3.A** Definitions of Energy	Energy and Matter	Assign 1.3 Quiz: Defining energy and its units	
Lesson 6	2.1 Lab activity: Asteroid marble drop Part 1: The effect of speed	If an asteroid hits Earth, how big would the crater be?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Planning and Carrying Out Investigations	**ETS1.B** Developing Possible Solutions	Energy and Matter	Ask students to complete Part 1: The effect of speed	*NASA* article linked in lesson, "Asteroids, Comets & Meteors"
Lesson 7	2.1 Lab activity: Asteroid marble drop Part 2: The effect of mass		Review Part 1: The effect of speed in Analyze Mode				Ask students to complete any remaining questions	*Down2Earth*, "Impact calculator" simulation, linked in teaching notes Extra SEP support: 0.1 Conducting science investigations
Lesson 8	2.2 Lesson: Kinetic energy	Who has more kinetic energy – an Olympic athlete or a cheetah?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data Using Mathematics and Computational Thinking	**PS3.A** Definitions of Energy	Energy and Matter Scale, Proportion, and Quantity Systems and System Models	Assign 2.2 Quiz: Kinetic energy	

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	2.3 Investigation: Kinetic energy	How fast can a car go?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models Using Mathematics and Computational Thinking	**ETS1.B** Developing Possible Solutions	Energy and Matter Scale, Proportion, and Quantity Systems and System Models	Ask students to complete questions 1–5	Extra SEP support: 0.1 Conducting science investigations
Lesson 10							Ask students to complete any remaining questions	Extra SEP support: 2.4 Controlled variables (Part 1) Extra SEP support: 2.5 Controlled variables (Part 2)
Lesson 11	2.4 Lesson: Potential energy	Who is the best hunter – the mantis shrimp or the herring gull?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Analyzing and Interpreting Data Using Mathematics and Computational Thinking	**PS3.A** Definitions of Energy	Energy and Matter Scale, Proportion, and Quantity Systems and System Models	Assign 2.4 Quiz: Potential energy	Poster: Elastic vs. gravitational potential energy. Posters are available for purchase in the Stile Shop
Lesson 12	2.5 Lab activity: Rubber band racers	How can a rubber band power a car?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Planning and Carrying Out Investigations	**ETS1.B** Developing Possible Solutions	Energy and Matter	Ask students to complete any remaining questions	Extra SEP support: 0.3 The engineering process

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · **Week 4** · Week 5 · Week 6 · Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	3.1 Lesson: Energy transfer and transformation	How does moving water turn into electricity?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Developing and Using Models	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter Systems and System Models	Assign 3.1 Quiz: Energy transfer and transformation	
Lesson 14	3.2 Lab activity: Water wheels	How can a simple water wheel generate electricity?	Review Key Questions and Quiz from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Developing and Using Models Engaging in Argument From Evidence	**PS3.C** Relationship Between Energy and Forces	Energy and Matter Systems and System Models	Ask students to complete any remaining questions in Parts 1 and 2	Extra SEP support: 2.1 Observing and inferring
Lesson 15							Ask students to complete any remaining questions	
Lesson 16	3.3 Simulation: Pedal power	How much cycling do I need to do to power my home?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Experiment with the simulation to familiarize yourself with what students are expected to do	Developing and Using Models Using Mathematics and Computational Thinking	**PS3.C** Relationship Between Energy and Forces	Energy and Matter Systems and System Models	Ask students to begin reviewing Glossary: Energy in preparation for the test	3.4 Extension: Energy efficiency 3.4 Quiz: Energy efficiency

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4 Week 5 Week 6 Week 7

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 17	3.5 Lab activity: Bouncing balls	Which ball bounces the highest?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Planning and Carrying Out Investigations Using Mathematics and Computational Thinking	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter Scale, Proportion, and Quantity Systems and System Models	Ask students to complete any remaining questions	Extra SEP support: 4.1 Mean, median, and mode (Part 1)
Lesson 18	3.6 Lab activity: Create a light bulb	How are light bulbs made?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Planning and Carrying Out Investigations Using Mathematics and Computational Thinking	**ETS1.B** Developing Possible Solutions	Energy and Matter Scale, Proportion, and Quantity Systems and System Models	Ask students to complete any remaining questions	
Lesson 19	Unit review	How can I be prepared for the Energy test?	Review Key Questions from the unit in Analyze Mode to identify areas to revisit	Using Mathematics and Computational Thinking Developing and Using Models Analyzing and Interpreting Data	**PS3.A** Definitions of Energy **PS3.B** Conservation of Energy and Energy Transfer **PS3.C** Relationship Between Energy and Forces	Energy and Matter Scale, Proportion, and Quantity Systems and System Models	Ask students to review teacher feedback and Key Questions from lessons in the unit	Glossary: Energy
Lesson 20	Test: Energy	How much have I learned about Energy?	Ensure every student has access to a device				Ask students to write a reflection on what they've learned about energy	

Lesson Planning Guide

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 21	Test review	How successful was my revision of Energy?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Analyzing and Interpreting Data Using Mathematics and Computational Thinking Developing and Using Models	**PS3.A** Definitions of Energy **PS3.C** Relationship Between Energy and Forces	Energy and Matter Scale, Proportion, and Quantity Systems and System Models	Ask students to reflect on the effectiveness of their revision, and to identify areas for improvement	
Lesson 22	**Optional Extra** 3.7 Engineering challenge: Biomimicry design The planning phase	How can nature improve the design of a water wheel?	Review teaching notes in Prepare Mode You may wish to organize groups for students to work in ahead of time	Planning and Carrying Out Investigations Developing and Using Models	**ETS1.B** Defining and Delimiting an Engineering Problem	Energy and Matter Systems and System Models	Ask students to continue working on their engineering challenge	*United Nations* article linked in lesson, "Sustainable Development Goal 7: Affordable and clean energy" *Biomimicry Institute* website linked in teaching notes "Youth Design Challenge"
Lesson 23	**Optional Extra** 3.7 Engineering challenge: Biomimicry design The planning phase		Review student progress in Analyze Mode				Ask students complete the Research section	Extra SEP support: 0.3 The engineering process
Lesson 24	**Optional Extra** 3.7 Engineering challenge: Biomimicry design The design phase		Review student progress in Analyze Mode					Extra SEP support: 0.3 The engineering process

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · **Week 7**

The guide below is based on four 45-minute lessons per week.

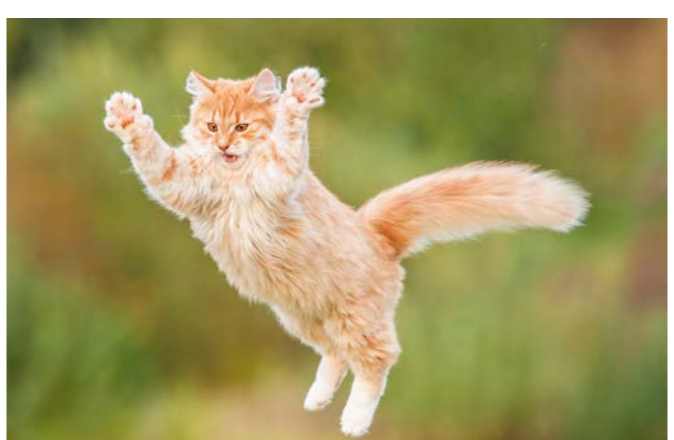
	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 25	Optional Extra 3.7 Engineering challenge: Biomimicry design The design phase	How can nature improve the design of a water wheel?	Review student progress in Analyze Mode	Engaging in Argument From Evidence Planning and Carrying Out Investigations Developing and Using Models	**ETS1.A** Defining and Delimiting an Engineering Problem	Energy and Matter Systems and System Models	Ask students to complete the Design phase	Extra SEP support: 0.3 The engineering process
Lesson 26	Optional Extra 3.7 Engineering challenge: Biomimicry design The testing phase		Review student progress in Analyze Mode				Ask student to complete the Testing phase	Extra SEP support: 0.3 The engineering process
Lesson 27	Optional Extra 3.7 Engineering challenge: Biomimicry design The sharing and reflection phase		Print copies of the rubric for peer, self, and teacher assessment					Extra SEP support: 0.3 The engineering process
Lesson 28	Optional Extra 3.7 Engineering challenge: Biomimicry design The sharing and reflection phase							

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical skills.

Students apply mathematical skills throughout the unit to make calculations, and analyze and interpret data. They solve equations to find quantities that are proportionally related to one another, and interpret the meaning of lines represented in graphs.



Common Core State Standards Connections: Math

MP.2

Reason abstractly and quantitatively.

8.EE.A.1

Know and apply the properties of integer exponents to generate equivalent numerical expressions.

8.EE.A.2

Use square root and cube root symbols to represent solutions to equations of the form x2 = p and x3 = p, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes. Know that √2 is irrational.

8.F.A.3

Interpret the equation y = mx + b as defining a linear function, whose graph is a straight line; give examples of functions that are not linear.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Lessons within this unit incorporate many opportunities for students to develop and use their reading, writing, listening, and speaking skills.

Students engage with information in written text and in videos to learn about energy. They express their understanding in writing, and use oral language to engage in group work and class discussion. Students deliver a presentation of their work to classmates as part of the engineering process.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts.

WHST.6-8.8

Gather relevant information from multiple print and digital sources, using search terms effectively; assess the credibility and accuracy of each source; and quote or paraphrase the data and conclusions of others while avoiding plagiarism and following a standard format for citation.

SL.8.5

Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flow chart, diagram, model, graph, or table).

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Career profile and activity: Bioengineer**
  Questions 1, 3, 5
- **What do you already know?**
  Questions 2, 7
- **1.1 Lab activity: Energy mystery box**
  Question 5
- **1.2 Lesson: Forms of energy**
  Questions 6, 13, 15, 17, 18
- **2.1 Lab activity: Asteroid marble drop**
  Questions 6, 10, 11, 12
- **2.2 Lesson: Kinetic energy**
  Questions 2, 7, 13, 21
- **2.3 Investigation: Kinetic energy**
  Questions 10, 11, 12
- **2.4 Lesson: Potential energy**
  Questions 7, 10, 12
- **2.5 Lab activity: Rubber band racers**
  Questions 6, 7
- **3.1 Lesson: Energy transfer and transformation**
  Questions 5, 6, 11, 13, 14, 16, 17
- **3.2 Lab activity: Water wheels**
  Questions 3, 8
- **3.3 Simulation: Pedal power**
  Questions 4, 6, 7, 8, 9, 11
- **3.4 Extension: Energy efficiency**
  Question 13
- **3.5 Lab activity: Bouncing balls**
  Questions 2, 5, 6, 7, 8, 9
- **3.6 Lab activity: Create a light bulb**
  Questions 3, 4, 6
- **3.7 Engineering challenge: Biomimicry design**
  Questions 9, 12

Extension opportunities in this unit

Challenge Questions
Most lessons contain one or more Challenge Questions, which are an opportunity for students to show they are working above the level of the learning goal. When answering these questions, students can extend themselves by applying their knowledge to new contexts, or to solve more complex problems. These provide a great extension opportunity.

Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC
2.2 Lesson: Kinetic energy Questions 14–22	How does mass affect kinetic energy?	Review teaching notes in Prepare Mode	Analyzing and Interpreting Data Using Mathematics and Computational Thinking	**PS3.A** Definitions of Energy	Energy and Matter Scale, Proportion, and Quantity
2.4 Lesson: Potential energy Questions 14–18	How can we calculate potential energy?	Review teaching notes in Prepare Mode	Analyzing and Interpreting Data Using Mathematics and Computational Thinking	**PS3.A** Definitions of Energy	Energy and Matter Scale, Proportion, and Quantity
3.1 Lesson: Energy transfer and transformation Questions 12–16	How do we use energy to make electricity?	Review teaching notes in Prepare Mode	Developing and Using Models	**PS3.C** Relationship Between Energy and Forces	Energy and Matter
3.4 Extension: Energy efficiency	Do butterfly wings really improve the energy efficiency of solar panels?	Review teaching notes in Prepare Mode	Analyzing and Interpreting Data Using Mathematics and Computational Thinking	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter Scale, Proportion, and Quantity

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

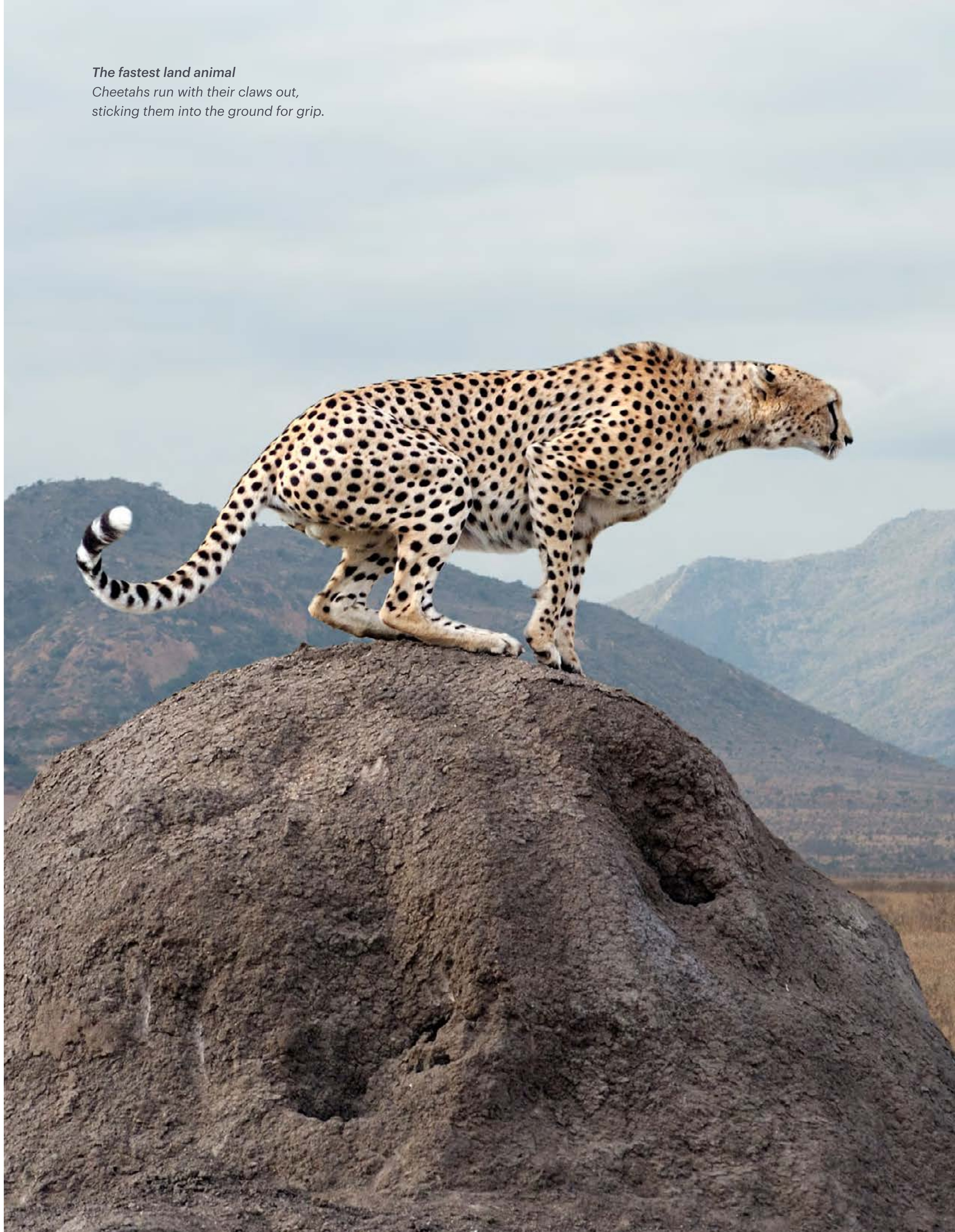
Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
1.2 Lesson: Forms of energy	Energy is stored inside objects.	**Use 2.4 Lesson: Potential energy** Energy is stored in a system because of the way objects are related to each other. One way to talk about potential energy is to describe objects as "having" it. For example, we can say that an object has more gravitational potential energy when it is higher above the ground. There are limitations in this model but they will be addressed in senior physics. The explanation in 2.4 Lesson: Potential energy is suitable for this grade level and can be used as a guide to address this misconception.
	Energy is confined to some particular origin, such as what we get from food or what the electric company sells.	**Use 1.2 Lesson: Forms of energy** Actually, energy is everywhere, has many different forms and is required for any work to happen. Students often conflate energy with electricity or "power," perhaps because so many modern devices and appliances need electricity to work. The variety of examples in this lesson counter this idea.
	Living things give inanimate objects energy by carrying or pushing them.	**Use 1.2 Lesson: Forms of energy** This is only half the story. Inanimate objects usually have many forms of energy on their own. They can also have energy transferred to them from other inanimate objects.

Lesson	Misconception	Addressing the misconception
1.2 Lesson: Forms of energy	An object at rest has no energy.	Students commonly associate the energy of an object with its movement, but objects at rest have thermal energy, chemical energy, and gravitational potential energy due to being in a gravitational field. Discuss examples of objects at rest when identifying energy. These are throughout the lesson, and throughout the unit. Examples can be unpacked in class, group, or one-on-one discussions as necessary. Ask "What types of energy does this object have?" and work through examples together. Students could refer to a checklist of possible types of energy as they consider each example.
	Only very hot objects have thermal or heat energy.	Students commonly associate hot objects with radiating thermal or heat energy but fail to recognize that all objects, even very cold ones, have some thermal energy.
1.3 Lesson: Defining energy and its units	Energy is a "thing," like a substance or object.	**Use 1.3 Lesson: Defining energy and its units** Energy is an abstract mathematical concept. It is something we calculate to describe how objects change and interact, or have the potential to do so. The introduction to this lesson unpacks the definition of energy.
	The terms "energy" and "force" are interchangeable.	**Use 1.3 Lesson: Defining energy and its units** Energy and force are related but are not the same thing. Energy is required for a force to act over a distance (to do work). For example, for a truck to push over a garbage can, it needs energy. In this case, the force is the push. The truck's engine transforms chemical energy in the fuel into the energy of motion (kinetic energy) needed to apply the force. This lesson explains the relationship between energy and force.
2.4 Lesson: Potential energy	Potential energy is stored in an object.	**Use 2.4 Lesson: Potential energy** Energy is stored in a system that may include many interacting objects. For example, a football kicked into the air has gravitational potential energy because it is part of a system that includes the Earth with its gravitational field. Comparing the amount of energy the same object has in different situations may help students to recognize that energy is stored in a system as a result of interactions, rather than in the object itself. For instance, a football on the ground compared to a football kicked into the air has different amounts of potential energy.

Lesson	Misconception	Addressing the misconception
2.4 Lesson: Potential energy	Gravitational potential energy is only related to the change in the height of an object.	**Use 2.4 Lesson: Potential energy** Gravitational potential energy also depends on the object's mass and the gravitational field strength in that location, but these are often overlooked. The section of the lesson titled "Mass also affects gravitational potential energy" addresses this idea. Ask students questions like the one stated in the lesson: "Would you rather a light piece of clothing or a heavy book fall on you from a shelf above?" Unpack the reasoning behind this, that items with more mass cause more damage on impact.
3.1 Lesson: Energy transfer and transformation	Energy is transferred mechanically whenever one object pushes or pulls on another, even if the objects do not move.	**Use 3.1 Lesson: Energy transfer and transformation** Energy transfer requires movement of some kind, even if this movement is sometimes microscopic. This lesson covers energy transfer in detail.
	Energy can be created.	**Use 3.1 Lesson: Energy transfer and transformation** The amount of energy in the universe remains constant, so energy is always transformed or transferred from somewhere else. It hasn't been "created." For example, a solar panel converts light energy into electrical energy we can use. Challenge students to come up with examples where energy is created, and talk through the transfer or transformation that has taken place.
	When energy is transferred, some energy can be lost or "disappears."	**Use 3.1 Lesson: Energy transfer and transformation** The total amount of energy in a closed system always stays the same. It is neither created nor destroyed but may be transformed from one form to another. A "closed system" means that the chosen system does not have any transfers of matter in or out of it. This lesson includes examples, which can be discussed in detail. Challenge students to come up with examples where energy is lost, and talk through the transfer or transformation that has taken place.

The fastest land animal
Cheetahs run with their claws out, sticking them into the ground for grip.



ELL Support

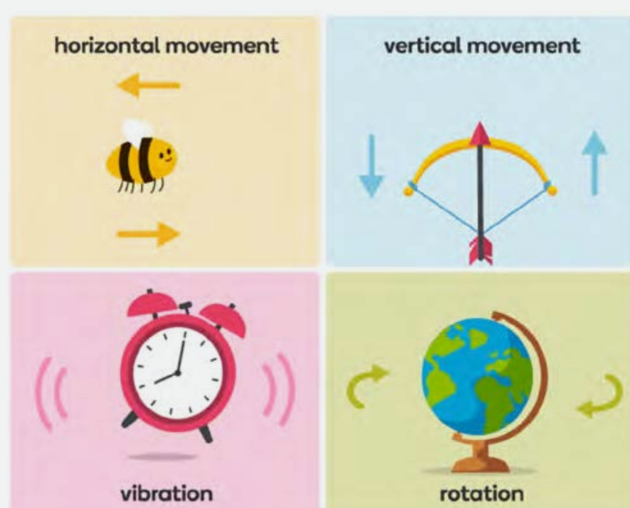
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

The lessons in Energy include a number of flow charts and diagrams to help students understand forces and sources of energy, such as sunlight, wind, and fossil fuels. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

2.2 Lesson: Kinetic energy

These diagrams show clear lines to indicate movement and direction, and are accompanied by the appropriate scientific vocabulary from this unit. Within the lesson, the diagrams are animated to further reinforce the type of movement being described. The visual representation of this information supports students in decoding the meaning of these terms.

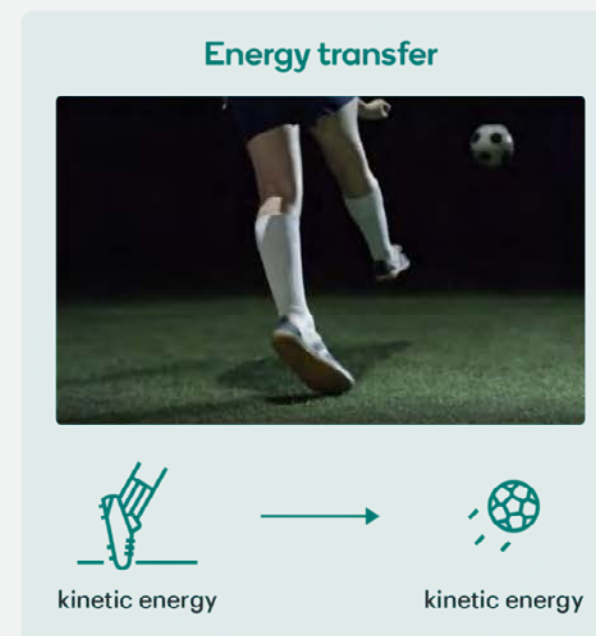


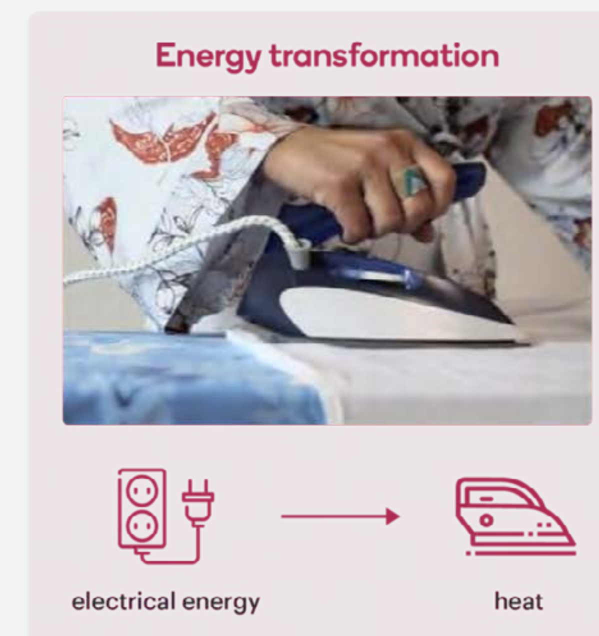
Different types of motion.

3.1 Lesson: Energy transfer and transformation

These images, and the flow diagrams that accompany them, support students to understand the scientific language being used within the lesson. The photographs show familiar examples, which students will recognize from their own lives and will likely be able to describe in their dominant language.

These examples are then translated into flow diagrams using clear illustrations and symbols, which represent the flow of energy. By referring to these diagrams, students will be able to associate the English terminology with the examples shown. This will support their comprehension of the text in the lesson.





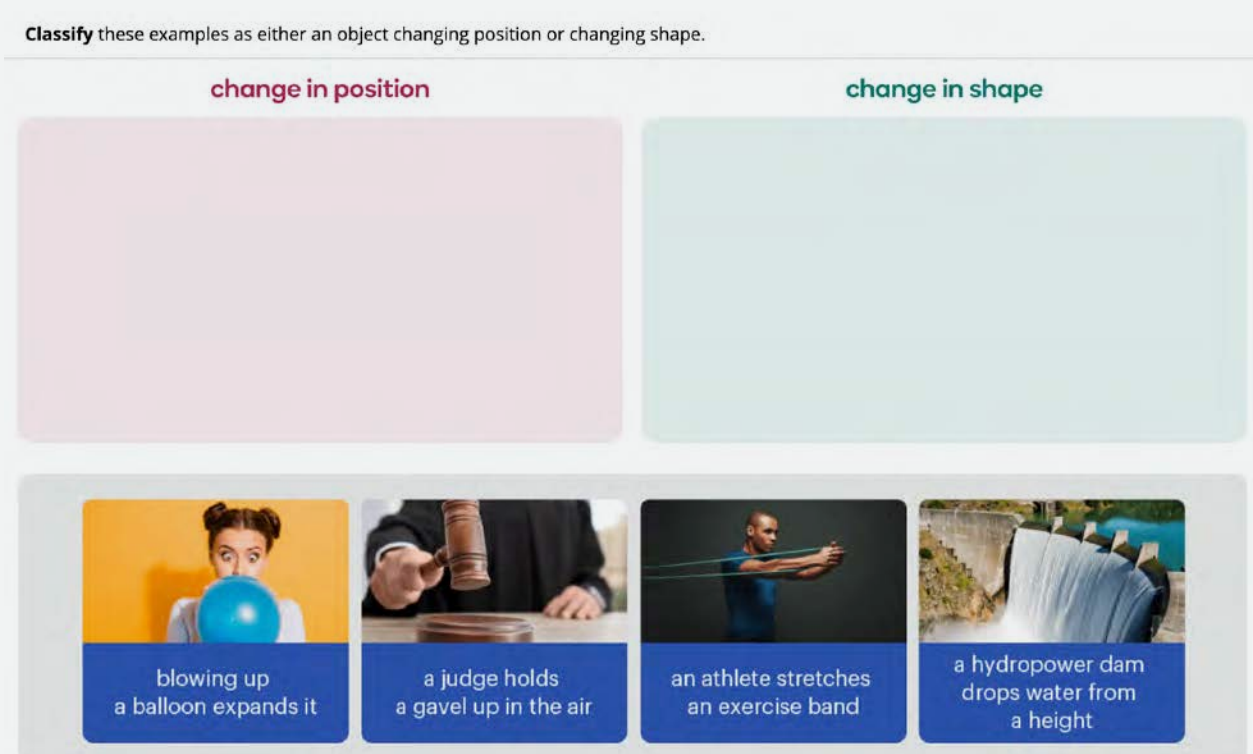
Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

2.4 Lesson: Potential energy

This question requires students to sort examples into two categories: Change in position or change in shape. Each example includes a photograph that represents what is written in the description.

This visual support helps students to recognize which category the example belongs to, and helps them to decode the short, simple phrases paired with each photograph. The repeated engagement with the terms "change," "shape," and "position," as they complete the activity builds familiarity with these words and their meaning.




City lights
We rely on electrical energy to light our roads, buildings, and vehicles.

Customization

There are many opportunities to create customized lessons within the Energy unit. Here are a few ideas for providing local context for your learners:

Introduction: Nature's energy engineers
In this lesson, there are references to school strikes for climate protests. You may be able to find images or articles about strikes that happened in your local area to include in the lesson.

There are several links to further information about examples of biomimicry in the teaching notes. Some of these examples may have particular relevance for your students. If, for instance, you live in a particularly warm environment, the self-cooling building would be an interesting example to explore further as a class.

3.1 Lesson: Energy transfer and transformation
Defining energy and its units includes opportunities to calculate the energy contained in food items. You could substitute one of the examples for a drink or snack offered in your school cafeteria.

3.1 Lesson: Energy transfer and transformation
If there are hydropower plants in your local area, or if your town's electricity is generated by hydropower, you could include information about this within the lesson. Images of dams, facts about the amount of electricity they generate, and which regions they power would be interesting for students to examine.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative Assessment

Pre-test: What do you already know?
Activate students' prior knowledge of relevant concepts including a basic understanding of forces and of sources of energy, such as sunlight, wind, and fossil fuels. Use this as a pre-test to identify misconceptions and areas where students may need additional challenge or support in subsequent lessons.

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Quizzes
Some lessons have an associated quiz, designed to be used for formative assessment of material covered in the core lesson. A quiz is made up of a small number of automatically graded questions and can be completed in 5–10 minutes. Quizzes provide students and teachers with information about student progress towards specific learning goals.

- **1.2 Quiz: Forms of energy**
  Multiple choice and fill-in-the-blank: 5–10 minutes
- **1.3 Quiz: Defining energy and its units**
  Multiple choice: 5–10 minutes
- **2.2 Quiz: Kinetic energy**
  Multiple choice: 5–10 minutes
- **2.4 Quiz: Potential energy**
  Multiple choice: 5–10 minutes
- **3.1 Quiz: Energy transfer and transformation**
  Multiple choice and fill-in-the-blank: 5–10 minutes
- **3.4 Quiz: Energy efficiency**
  Multiple choice and fill-in-the-blank: 5–10 minutes

Summative Assessment

Test
This unit contains a test to provide a summative assessment of student learning across the whole unit.

- **Test: Energy**
  Multiple choice, short answer, and fill-in-the-blank: 45–60 minutes

Science and Engineering Practices
Six lab activities, an investigation, and an engineering challenge can be used as summative assessment of Science and Engineering Practices.

- **1.1 Lab activity: Energy mystery box**
  Lab activity: 30–40 minutes
- **2.1 Lab activity: Asteroid marble drop**
  Lab activity: 30–45 minutes
- **2.3 Investigation: Kinetic energy**
  Investigation: 45–90 minutes
- **2.5 Lab activity: Rubber band racers**
  Lab activity: 45–60 minutes
- **3.2 Lab activity: Water wheels**
  Lab activity: 40–50 minutes
- **3.5 Lab activity: Bouncing balls**
  Lab activity: 30–40 minutes
- **3.6 Lab activity: Create a light bulb**
  Lab activity: 30–40 minutes
- **3.7 Engineering challenge: Biomimicry design**
  Engineering challenge: 240–330 minutes

Lab Activities

Lab Activity

Energy mystery box

Activity purpose: Explore everyday items that exemplify different forms of energy.

stileapp.com/go/energy-mystery-box

30–40 minutes

2–3 students per group

Materials

Lab Equipment
One mystery box that contains:
- apple
- leaf
- sparkler and lighter
- flashlight and batteries (the required number of batteries for the flashlight to run)
- rubber band
- 2 ping pong balls
- squeaky toy (rubber duck)
- piece of Velcro

Chemicals
None required

Preparation

None required

Notes

The items in the mystery box can be swapped out depending on what is available at your school.
It would be good to have at least one item for each of the main forms of energy (sound, light, heat, electrical, gravitational, elastic, kinetic, chemical). You could also include a magnet if you wish to introduce magnetic potential energy. Velcro is included as an example of biomimicry and is the subject of a class poll later in the activity.

Alternative setups include having just one mystery box for the whole class or stations set up around the class with a few of each item.

Method

Method that students will follow
1. Use your senses to examine each item as you interact with it in different ways.
   Caution: Do not use the senses of taste or smell.
2. Record your observations.
3. Propose a form of energy that may be associated with each item.

Lab Activity

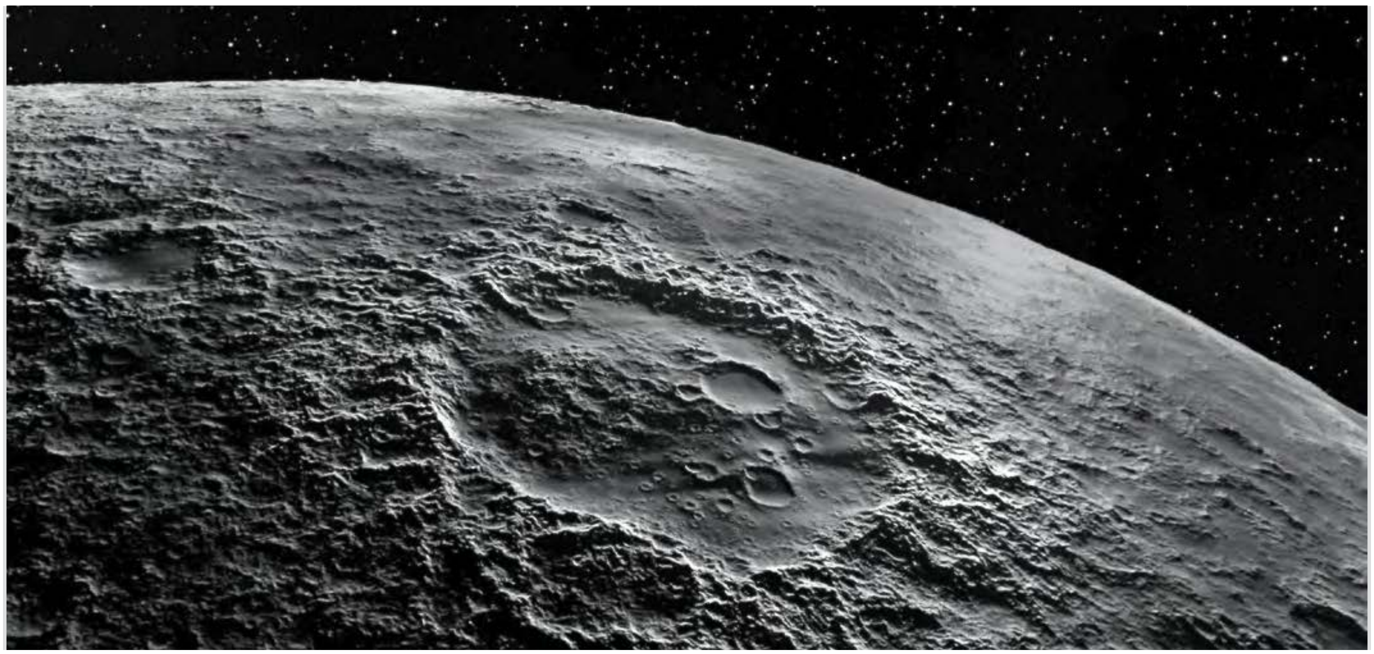
Asteroid marble drop

Activity purpose: Explore how kinetic energy depends on the mass and speed on an object.

stileapp.com/go/asteroid-marble-drop

30–45 minutes

2–3 students per group



Materials

Lab Equipment
Each group of students will need:
- 1 small marble or pebble
- 1 large marble or pebble
- shallow tray or box, such as a baking tray
- 2 lb. bag of flour
- cocoa powder or hot chocolate powder
- spoon
- 30 cm ruler
- sieve
- electronic balance or kitchen scale

Chemicals
None required

Preparation

None required

Notes

To save time, you may like to ask half of the groups in the class to investigate the effect of mass and the other half to investigate the effect of speed.
After plotting their results, you could bring them back for a class discussion where they present and compare their results.

Method

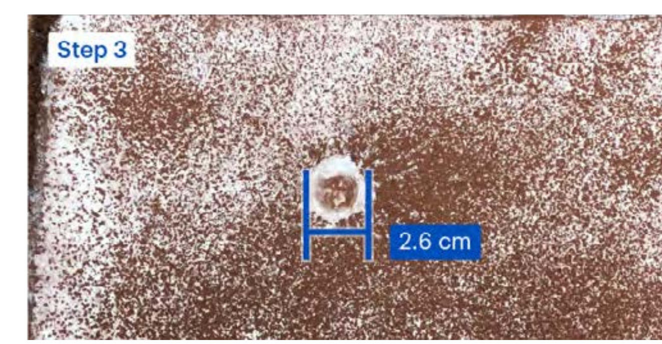
Method that students will follow

Part 1 – The effect of speed
Low speed

1. Pour flour into the tray to make a layer about 1 cm thick. Use the back of the spoon to gently even out the surface of the flour. Dust the top of the flour with cocoa powder using the sieve.
2. Measure 30 cm above the surface of the flour. Take a small marble and drop it into the box from that height.
3. Measure the width of the crater across the widest part, from the outer edges. Record the measurement in the results table in centimeters (cm).
4. Repeat the same test two more times. Then calculate the average of the three tests.

High speed

5. Smooth the surface of the flour again and dust with cocoa powder.
6. Repeat the method above but this time throw the marble downwards instead of dropping it.



Method

Part 2 – The effect of mass

Reset the flour in the tray from Part 1. Dust again with cocoa powder if necessary.
Use the electronic balance to measure the mass of the small marble and the large marble individually.
Record both measurements in the results table.

Small mass

1. Measure 30 cm above the surface of the flour. Take the small marble and drop it into the box from that height.
2. Measure the crater width and record it in the results table.
3. Repeat the same test two more times. Then calculate the average of the three tests.

Large mass

1. Smooth the surface of the flour again and dust with cocoa powder.
2. Repeat the method above, but dropping a large marble instead of a small one.

Energy in the ocean
Aquatic animals have inspired the development of renewable energy technology.

Lab Activity

Rubber band racers

Activity purpose: Explore elastic potential energy by building toy cars powered by rubber bands.

stileapp.com/go/rubber-band-racers

45–60 minutes

3–4 students per group

Materials

Lab Equipment

Each group of students will need:
- rubber band
- 2 skewers
- 4 plastic lids of the same size (e.g., milk bottle lids)
- measuring tape
- cardboard tube (e.g., toilet paper roll)
- toothpick
- scissors
- ½ lb. of modeling clay or other small weight
- optional: ruler

Chemicals

None required

Preparation

None required

Notes

Optional activity: When students have collected and interpreted their results, you might organize a race to see whose rubber band racer is the fastest.
This might help students consider how they could improve their designs.

Method

Method that students will follow

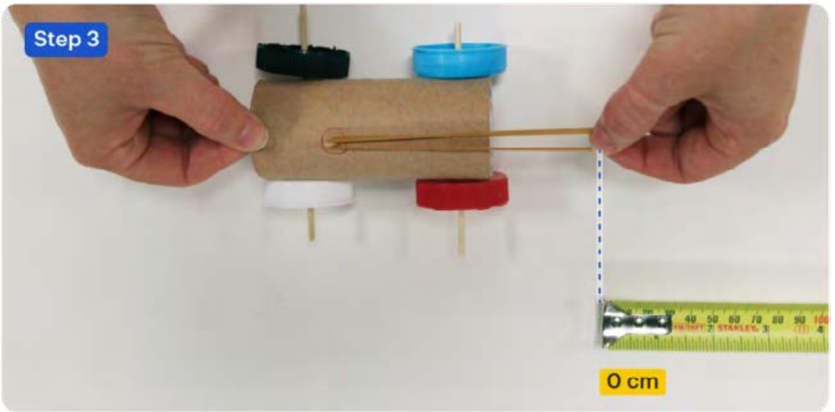
Part 1 – Making the rubber band racer

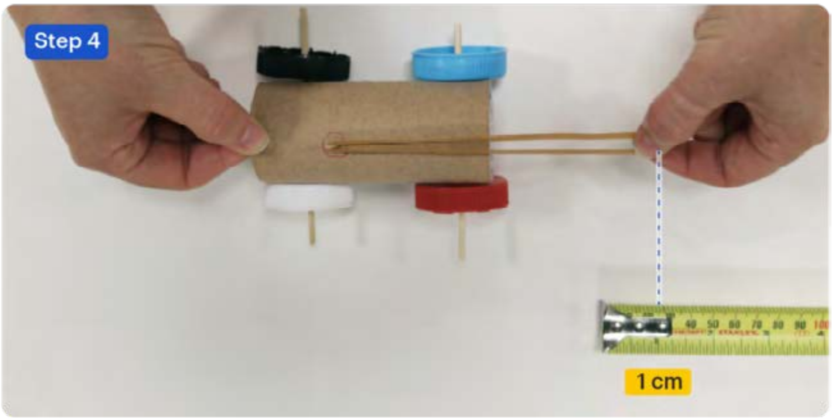
1. Using scissors, carefully make small holes in the center of each plastic lid. Make sure the holes are just big enough for the skewers to push through, but not move around.
2. Using scissors, carefully make four small holes in the cardboard tube, as shown in the diagram. Make sure they are 1 cm from each end of the tube and 3 cm apart. This will ensure the racer moves in a straight line.
3. Push the skewers through the holes in the cardboard tube and make sure they can rotate easily.
4. Place the lids on either end of the skewers to make the wheels. Use the scissors to shorten the skewers for a more compact car. Check that the wheels move freely by rolling the car on the ground.
5. Make a hole in the top of the cardboard tube and push the toothpick in at a 45° angle. The toothpick should reach the bottom of the tube, to hold it in place.
6. Place the modeling clay or other small weight inside the tube. This will help the racer travel in a straight line.

Method

Part 2 – Testing the racer

1. Find a clear area with a hard, smooth floor. Lay out the tape measure to a length of about 10 feet. You will use this to measure the distance traveled by the racer.
2. Hook the rubber band over the toothpick and extend it out in front of the car, so it is straight but not stretched.
3. Line up the end of the rubber band with the 0 mark on the tape measure, as shown in the diagram.
4. Hold the back of the racer with your other hand. Stretch the rubber band to 1 cm. This is the stretch distance. Release the car and measure how far it travels, to the nearest centimeter. This is the travel distance. Record this data in the results table.
5. Run two more trials with the same stretch distance. Then calculate the average of the three trials.
6. Repeat Steps 4 and 5 with stretch distances of 2 cm, 3 cm, 4 cm, and 5 cm.





Gravitational potential energy
A skydiver's gravitational potential energy decreases as they get closer to the ground.

Lab Activity

Water wheels

Activity purpose: Students make a simple model of a water wheel to collect evidence about energy transfer.

stileapp.com/go/water-wheels

40–50 minutes

2–4 students per group

Materials

Lab Equipment
Each group of students will need:
– 2 pieces of thick cardboard or thin plastic
– approx. 9 paper or plastic cups
– bamboo skewer
– scissors
– stapler
– pen
– 1 m ruler or tape measure
– water jug or another pouring vessel
– large container or bucket
– 2 chairs

Chemicals
– water

Preparation

None required

Notes

This activity prepares students for completing the engineering challenge about biomimicry design, which involves designing a water wheel or turbine using biomimicry.

We recommend saving the student's water wheels so they can look at them during the design phase of the engineering challenge. If you want students to have the choice to reuse and modify their water wheels, we suggest providing water-resistant materials such as wood, plastic, or laminated cardboard.

Method

Method that students will follow

Part 1 – Making the water wheel
1. Follow the video to construct a simple water wheel. Refer to Stile lesson for video.
2. Hold the water jug above the water wheel. Use the ruler to record its height.
3. Pour the water in a steady stream to test the water wheel.

Part 2 – Making observations
1. Pour the water in a steady stream to make the water wheel spin again.
This time, make observations of the water wheel at the following points:
a) before pouring the water over it
b) while water is being poured over it
c) after the water stops being poured
4. Record detailed observations in the results table. Things you should pay attention to include:
– the motion of the water wheel
– the motion of the water
– any other observations, such as sounds that are made

Lab Activity

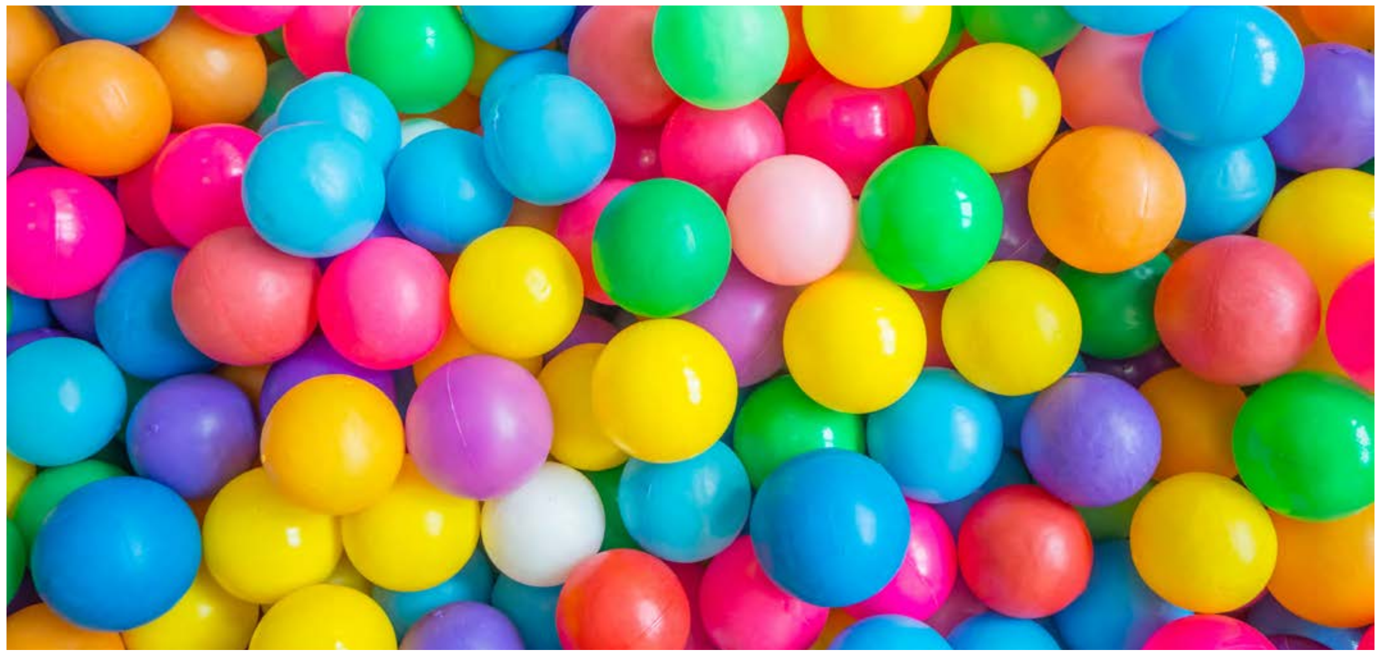
Bouncing balls

Activity purpose: Compare the energy efficiency of the bouncing of various balls.

stileapp.com/go/bouncingballs

30–40 minutes

3–4 students per group



Materials

Lab Equipment
Each group of students will need:
- 3 spherical balls of different kinds (e.g., tennis ball, baseball, golf ball, table tennis ball)
- meter ruler or tape measure
- 160 cm x 30 cm sheet of paper
- tape
- marking pen

Chemicals
None required

Preparation

None required

Notes

None

Method

Method that students will follow
1. Find an area of flat, hard floor next to a wall. Attach the sheet of paper to the wall with sticky tape, with one of the narrow ends touching the floor. Measure exactly 150 cm from the floor and draw a line on the paper, labeled "150 cm."
2. Hold the first ball so that the top is exactly 150 cm above the ground. Release the ball without applying any force. Record how high it bounces by drawing a line on the paper where the top of the ball reaches. Label this line (e.g. ,"tennis 1" if it's the first trial with a tennis ball) and measure its height in centimeters.
3. Repeat Step 2 two more times with the same ball.
4. Repeat Steps 2 and 3 for the other two balls.

Lab Activity

Create a light bulb

Activity purpose: Build a filament light bulb and explain why it isn't energy efficient.

stileapp.com/go/create-lightbulb

30–40 minutes

2–4 students per group

Materials

Lab Equipment
Each group of students will need:
- power pack that supplies up to 12 V
- 2 alligator clips and wires
- 10 cm long piece of nichrome wire
- 2 large metal nails (approx. 3–4 cm long)
- piece of modeling clay or play dough (approx. 3 cm x 3 cm)
- glass jar with a wide opening

Chemicals
None required

Preparation

None required

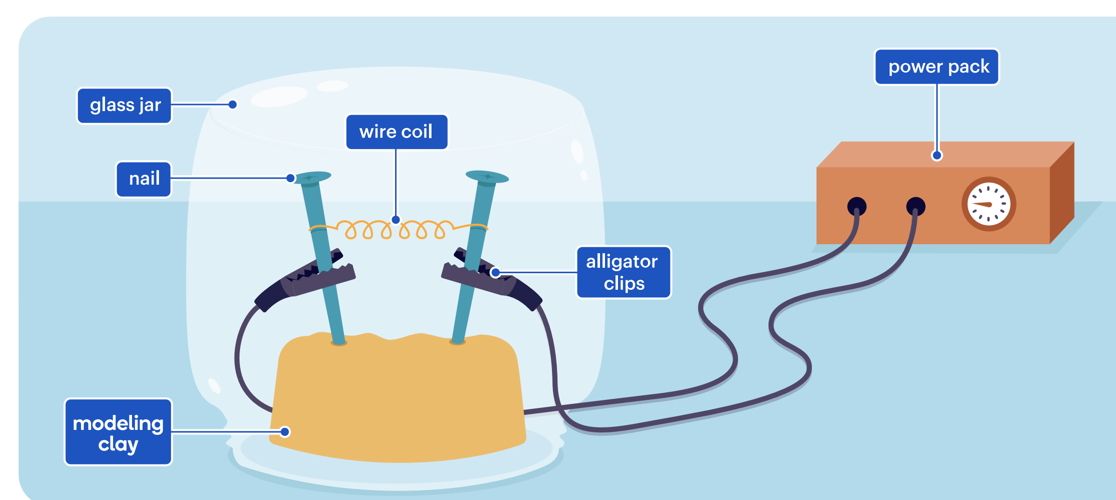
Notes

Safety:
- Students to wear safety glasses at all times.
- The filament will heat up quickly. Make sure students know not to touch it. If the voltage or current is too high, the nichrome wire will get too hot and may break down. This will break the circuit.
- Ensure the experimental setup is not taken apart until the nichrome wire has been allowed to cool for at least a few minutes.

Method

Method that students will follow
1. Tightly wrap the nichrome wire around a nail or pencil to form a coil, leaving the ends straight. Remove the wire from the nail. The wire coil should be only 1–2 cm long. This will be the filament.
2. Roll the modeling clay into a spherical shape. Then firmly press it onto a lab bench. Stick the two nails vertically out of the modeling clay, about 2–3 cm apart.
3. Wrap the ends of the wire coil around the top of each nail. The nails act as the connecting wires.
4. Connect an alligator clip to each of the nails below the wire coil.
5. Plug in the power pack. Ensure that it is turned down to 0 volts (V).
6. Attach the other end of each alligator clip to the power pack. This will complete the circuit between the power pack, wires, nails, and wire coil.
7. Turn on the power pack. This is the electrical source.
8. Slowly increase the voltage until the nichrome wire starts to glow.

   Note: The glowing filament is easier to observe if the classroom is dark.
9. Carefully place the glass jar over the entire modeling clay and nail setup. This is the glass bulb.



Activity purpose: Challenge students to design and test a water wheel or turbine that takes inspiration from an animal or plant.

stileapp.com/go//biomimicry-design

240–330 minutes

3–4 students per group

Lab Activity

Biomimicry design

Materials

Lab Equipment
The materials for this activity may vary. We suggest providing the following:
- optional: water wheels that students created in the water wheel lab activity
- selection of used plastic bags and plastic containers
- selection of cardboard or thin plastic sheets
- paper or plastic cups
- water jugs, buckets, or other vessels
- thin-spouted watering cans
- paddles, such as ping pong paddles or spatulas
- pipe or hose offcuts
- small weighted objects, such as washers or paper clips
- bamboo skewers
- cotton thread
- rope or string
- scissors
- masking tape
- staplers
- stopwatches or video recording devices
- tally counters
- rulers

Chemicals
None required

Preparation

We recommend giving students advance notice about this engineering challenge so that they can begin developing their ideas. You may like to introduce the challenge at the start of the unit as the major project that students will be working towards.

Notes

We suggest running this challenge in four phases:
1. The planning phase (45–90 minutes): Introduce the background and the design brief, have students form a team, define the problem, and brainstorm possible solutions. This phase can be completed at the start of the unit. Students can research the topic outside of class time.
2. The design phase (90–120 minutes): Teams gather together to design their devices and create prototypes.
3. The testing phase (45–60 minutes): Teams test and evaluate their prototypes and attempt to improve their designs, time permitting.
4. The sharing and reflection phase (45–60 minutes): Teams share the inspiration for their designs, how well their prototypes performed, and how they could be improved. Finally, they reflect on their learning by relating it back to the essential question and self-assess using a rubric.

Method

Method that students will follow
Students will follow the engineering design process to create a new and innovative product.

Instructions provided to students include:
- Your task is to redesign a water wheel or turbine by taking inspiration from nature.
- The new design should be more efficient, affordable, reliable, or sustainable.

You will need to design, build, and test a small-scale model that meets the following criteria:
- takes up a maximum space of 30 cm height x 30 cm length x 30 cm width
- is able to turn on an axle using the kinetic energy of flowing water
- takes inspiration from how an animal or plant functions
- is constructed with materials supplied by your teacher or that you can easily get from home

Further scaffolding to plan and conduct this engineering challenge is provided in the lesson.

Unit 6 – Energy Conservation

Can we use ocean waves to produce electricity?

Hang ten
Energy transformation creates waves in the ocean for surfers to ride.

Storyline and anchoring phenomenon

The ocean is an incredible playground for surfers, who harness the power of the ocean on their boards, turning and doing tricks while riding in to shore. What if we could also use that energy to power our cities and homes?

This unit provides an opportunity for students to use the ideas and engineering practices they learned in the Energy unit to delve deeper into how nature can inspire us to create a greener future.

It explores how energy is transferred through systems with examples of roller coasters and skate parks. Students also examine how hydropower, friction, and resistance play a role.

This unit at a glance

Students **engage in the real-world phenomenon** of using the ocean's waves to generate energy.

Students explore energy transformation with **mathematical equations**.

Energy Conservation

Introduction: Harnessing the power of the ocean

Career profile: Renewable energy engineer

1.1 Lesson: The law of conservation of energy

1.2 Lesson: Hydropower energy transformations

1.3 Simulation: Energy changes in a skate park

Test: Energy conservation

Students discover how hydropower works, they **research its impact on the environment**, and present their knowledge.

Students **explore an interactive digital model** to discover the energy transformations that happen in a skate park.

NGSS alignment overview

The elements listed are assessed at grade band level within this unit.

Three-dimensional elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and, when taught as part of The Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance expectations

This unit supports progress toward the performance expectations listed below:

MS-PS3-5

Construct, use, and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Disciplinary Core Idea

- **PS3.B**: Conservation of Energy and Energy Transfer

Students explore the motion of objects and how a change in motion can result in a change in a type of energy.

Science and Engineering Practices

- Analyzing and Interpreting Data
- Using Mathematics and Computational Thinking
- Constructing Explanations and Designing Solutions

Students gather data from simulations and analyze how this data provides evidence for the changes in both the type and amount of energy within a system.

Crosscutting Concepts

- Stability and Change

Students investigate how underwater movement can be transformed into energy in a different form that can be used to power cities.

They observe that small changes in one part of a system can cause large changes in another system as energy is transformed.

Nature of Science

- Scientific Investigations Use a Variety of Methods

Science, Technology, Society and the Environment

- Interdependence of Science, Engineering and Technology
- Influence of Engineering, Technology and Science on Society and the Natural World

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

Newton's Laws of Motion and Energy units have developed students' understanding of the connection between energy and motion.

Energy Conservation introduces students to the way in which changes in motion result in a change in energy, and explores instances where these energy transferrals and transformations can be harnessed, in the production of electricity, for instance.

Science and Engineering Practices

Students have applied their understanding of proportional thinking in a number of units, and most recently in the Energy unit when calculating energy efficiency. In this unit, students analyze data that represents transferral and transformation of energy, and apply mathematical thinking to calculate quantities of energy.

They have constructed explanations based on scientific theories most recently in Evolution, and Human Impacts on Ecosystems, and will further develop this skill by explaining the law of energy conservation.

Crosscutting Concepts

The concept of stability and change relates to the changes in energy through transferral and transformation. Students have knowledge of this concept through Newton's Laws of Motion, which they build upon in this unit.

Three Gorges Dam, China
Three Gorges Dam's 18,000 megawatt production capacity is three times greater than that of the Hoover Dam in Nevada.

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 Week 2

The guide below is based on four 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Introduction: Harnessing the power of the ocean 1.1 Lesson: The law of conservation of energy	Can we use the ocean's waves to produce energy? How does conservation of energy apply to roller coasters?	Review teaching notes in Prepare Mode	Using Mathematics and Computational Thinking	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Ask students to read the *Cosmos Magazine* article linked within the lesson	Career profile: Renewable energy engineer
Lesson 2	1.2 Lesson: Hydropower energy transformations	Do we need waves to make energy from water?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode	Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter		Extra SEP support: 1.1 Researching
Lesson 3	1.3 Simulation: Energy changes in a skate park	What energy transformations take place when a skater rides a ramp?	Review Key Question from previous lesson in Analyze Mode Review teaching notes in Prepare Modew Experiment with the simulation to familiarize yourself with what students are expected to do	Developing and Using Models Constructing Explanations and Designing Solutions	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Ask students to experiment further with the simulation	
Lesson 4	Unit review	How can I be prepared for the Energy Conservation test?	Review Key Questions from the unit in Analyze Mode to identify areas to revisit	Developing and Using Models Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Ask students to review teacher feedback and model answers from the unit to prepare for the test	

Lesson Planning Guide

Week 1 Week 2

The guide below is based on two 45-minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	Test: Energy conservation	How much have I learned about Energy Conservation?	Ensure every student has access to a device	Analyzing and Interpreting Data Using Mathematics and Computational Thinking Constructing Explanations and Designing Solutions	**PS3.B** Conservation of Energy and Energy Transfer	Energy and Matter	Prompt students to write a reflection on what they have learned from the unit	
Lesson 6	Test review	How successful was my revision of Energy Conservation?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these				Ask students to reflect on the effectiveness of their revision and to identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Lessons within this unit are carefully constructed to ensure multiple opportunities for students to build and apply mathematical skills.

Students begin this unit by quantifying different forms of energy efficiency in different processes. They create equations that explain relationships between gravitational potential energy and kinetic energy within systems and contextualize these relationships.

Common Core State Standards Connections: Math

MP.2

Reason abstractly and quantitatively.

MP.4

Model with mathematics.

8.EE.A.1

Know and apply the properties of integer exponents to generate equivalent numerical expressions.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Lessons within this unit incorporate many opportunities for students to develop and use their reading, writing, listening, and speaking skills.

Students use understanding of energy types to analyze new situations in which these apply. They interpret diagrams and create descriptions and equations to convey the changes in energy types that they observe.

Common Core State Standards Connections: English Language Arts

RST.6-8.1

Cite specific textual evidence to support analysis of science and technical texts, attending to the precise details of explanations or descriptions.

WHST.6-8.1

Write arguments focused on discipline content.

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flow chart, diagram, model, graph, or table).

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace Written Response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions, and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Career profile: Renewable energy engineer**
  Question 1
- **1.1 Lesson: The law of conservation of energy**
  Questions 10, 12
- **1.2 Lesson: Hydropower energy transformations**
  Questions 5, 6, 7, 8, 10, 11
- **1.3 Simulation: Energy changes in a skate park**
  Questions 2, 3, 6

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
1.1 Lesson: The law of conservation of energy	Energy can disappear.	The fundamental law of conservation of energy states that energy can never be created or destroyed but only transformed from one type to another.

ELL Support

To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

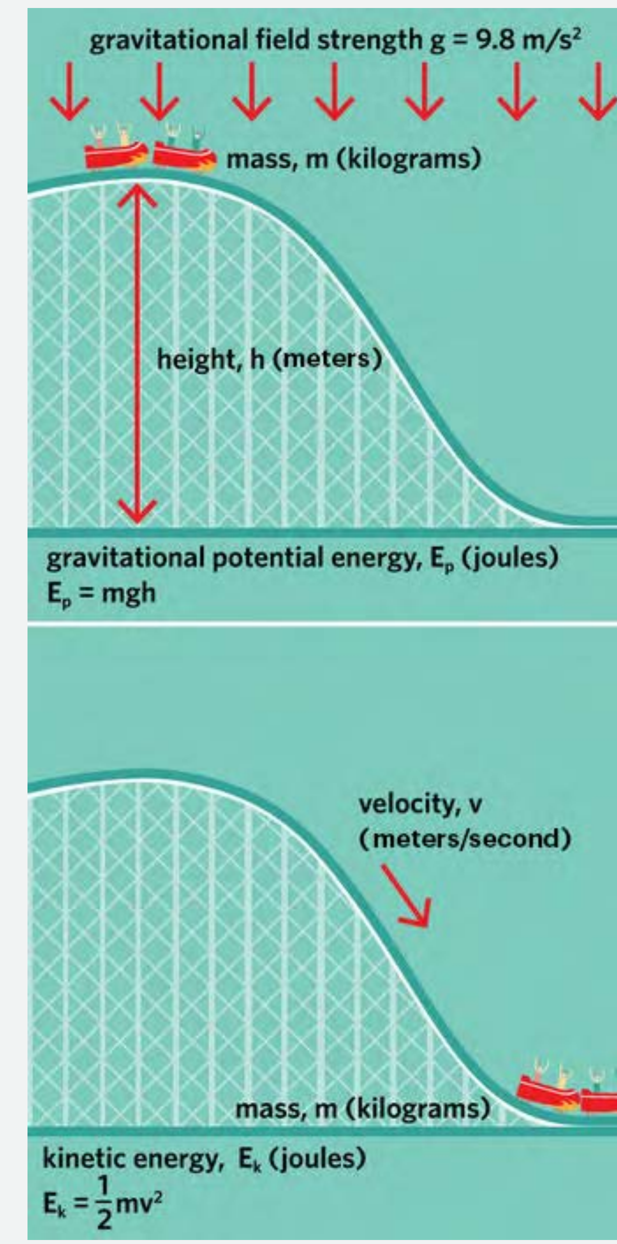
Energy Conservation lessons include a number of flow charts and diagrams to help students understand how energy is conserved when transferred or transformed. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

Introduction: Harnessing the power of the ocean

Different types of energy are displayed with examples that show where this type of energy is most often observed.

1.1 Lesson: The laws of the conservation of energy

This infographic incorporates the situation of a roller coaster, as well as numerical values that students will need to add to their general formula for calculating the potential and kinetic energy.

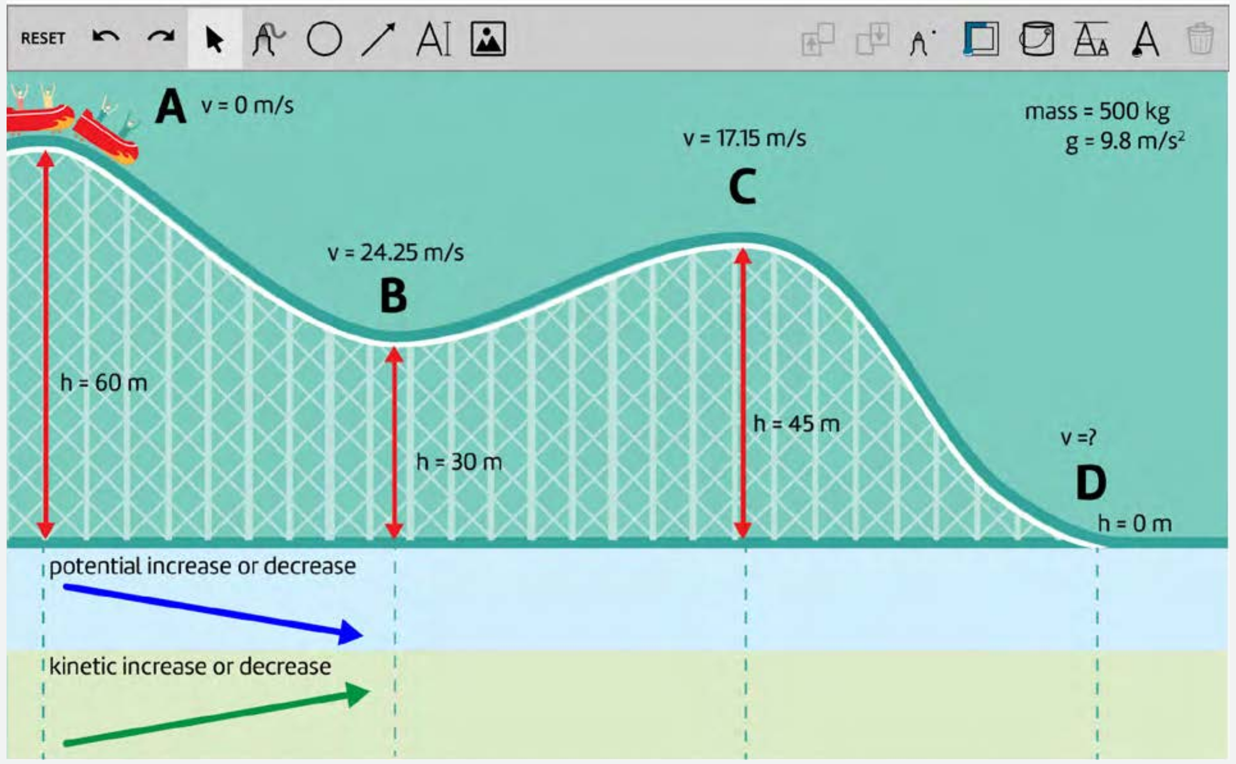


Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

1.1 Lesson: The law of conservation of energy

Students use visual representations of arrows to show how the relationships of kinetic and potential energy change throughout an example roller coaster.



Boulder City, Nevada
Hoover Dam is a major tourist attraction, receiving an estimated seven million visitors per year.

Customization

There are many opportunities to create customized lessons within the Energy Conservation unit. Here is an idea for providing local context for your learners:

California Energy Commission has information available on the use of hydroelectric power throughout the state.

Interpretation of data for the impact that the use of hydropower could have on renewable energy could be extracted from the California Energy Commission website, included in the teaching notes.

Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts, and Science and Engineering Practices together to explain phenomena and solve problems.

Formative Assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Summative Assessment

Test
This unit contains one test to provide summative assessment of student learning across the whole unit.

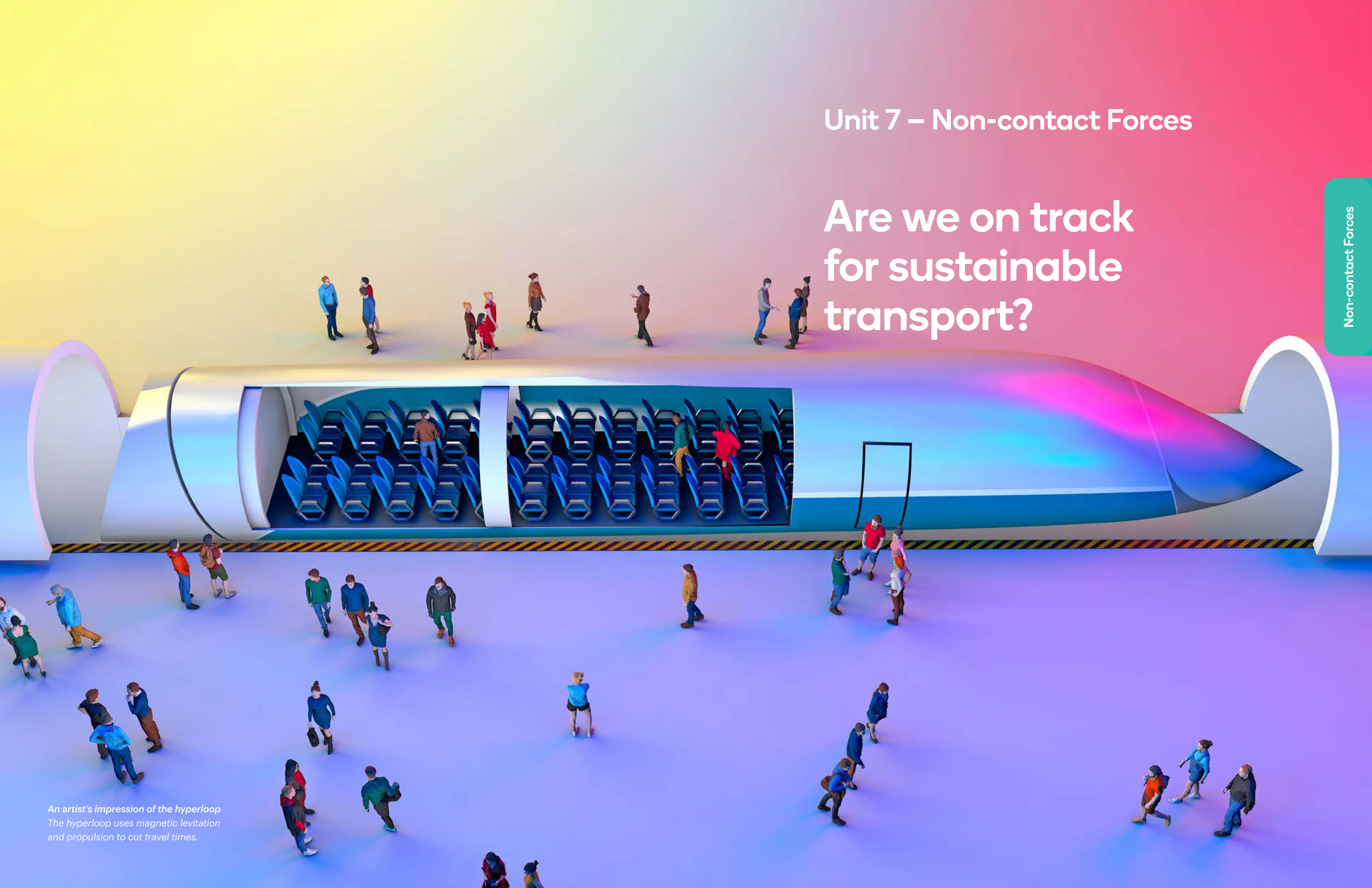
- **Test: Energy Conservation**
  Multiple choice and short answer: 45–60 minutes

Science and Engineering Practices
The simulation lesson within the unit can be used as a summative assessment of Science and Engineering Practices.

- **1.3 Energy changes in a skate park**
  Simulation: 60 minutes

Unit 7 – Non-contact Forces

Are we on track for sustainable transport?



An artist's impression of the hyperloop
The hyperloop uses magnetic levitation and propulsion to cut travel times.

Storyline and anchoring phenomenon

How did you get to school or work today? Each day billions of humans around the world take a trip somewhere in a car, bus, train, or plane. All of these contribute to over 7 billion tons of carbon dioxide emissions each year and over a billion used tires! Is this the transport of the future?

When we think of futuristic, clean methods of transport, we need to think big! How can we create sustainable and usable transportation for a variety of commuters?

The future of high-speed travel that could replace planes and trains looks increasingly like the bullet trains of now and the upcoming Hyperloop in San Francisco. Throughout this unit, students take on the role of engineers, toying with the principles of all non-contact forces to see if they can create their own masterpiece of civil engineering.

Throughout the lessons, 3-dimensional assessment questions scaffold the ability to think about transport solutions holistically through multiple lenses to progress towards the next piece of the transport puzzle.

Students' creations have a set of geographical parameters that must be negotiated with critical thinking and relational knowledge of forces. Students will need to understand the most appropriate non-contact force to use within multiple scenarios and annotate their blueprint to demonstrate their thought processes. Students show their understanding by presenting their design solution, demonstrating the engineering process, and justifying the decisions they've made. They have the opportunity to self-assess before a peer assessment of their entire engineering journey.

This unit at a glance

Students engage in a **real-world issue** of **sustainability and engineering**.

Students **formulate testable questions** that can be explored using magnetic slime.

Students **observe phenomena** through playing games to make sense of non-contact forces.

Non-contact Forces

1. Is there a problem with how we travel?
2. Engineering challenge: Defining the problem
3. Can you lift slime without touching it?
4. Are magnets the only solution?
5. How can you boost your transport system?
6. How do magnets interact?
7. Can magnetism keep our train moving?
8. How can we make an electromagnet?
9. Engineering challenge: Designing a solution
10. Engineering challenge: Optimizing your design
11. Engineering challenge: Communicating your design

Glossary: Non-contact Forces

Test

Students use **models to observe invisible forces** and discuss the limitations of modeling.

Students **create and problem-solve** to discover the relationships between the strength of electromagnets and design factors.

Students **engage in the engineering process** to improve their own ideas and designs for a sustainable travel future.

NGSS alignment overview

Three-Dimensional Elements

All Stile units incorporate a three-dimensional approach, with Crosscutting Concepts and Science and Engineering Practices integrated throughout. This unit contributes a particular focus on the elements listed below and when taught as part of the Stile Curriculum, ensures full coverage of grade-level expectations by the end of middle school.

Performance Expectations

This unit supports progress toward the performance expectations listed below:

MS-PS2-3

Ask questions about data to determine the factors that affect the strength of electric and magnetic forces.

MS-PS2-5

Conduct an investigation and evaluate the experimental design to provide evidence that fields exist between objects exerting forces on each other even though the objects are not in contact.

MS-ETS1-2

Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.

MS-ETS1-3

Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

Science, Technology, Society and the Environment

- Influence of Science, Engineering, and Technology on Society and the Natural World

The elements listed are assessed at grade-band level within this unit.

Disciplinary Core Ideas

- **PS2.B**: Types of Interactions
- **ETS1.B**: Developing Possible Solutions
- **ETS1.C**: Optimizing the Design Solution

Students explore interactions between objects at a distance through electric and magnetic forces.

They investigate the magnitude of the charges, the currents, magnetic strength, and proximity of objects to one another. Students map these fields and forces and use them to overcome the obstacles outlined in the engineering design brief.

They then systematically assess engineering solutions and modify them based on test results. The best parts of these solutions are added to their designs and modeled in the final design solution.

Science and Engineering Practices

- Asking Questions and Defining Problems
- Developing and Using Models
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in Argument From Evidence
- Obtaining, Evaluating, and Communicating Information

Students begin the unit by observing data on emissions from types of transport.

This prompts them to ask questions about today's transport solutions and define a problem that needs to be solved. Students develop models to visualize invisible phenomena and plan and carry out investigations to refine them. Using their models of non-contact forces, they design a transport solution and use external evidence to refine, optimize, and justify the transport solution they have created.

By refining and optimizing solutions for a track, students create a model that engages in argument from external evidence and evidence that they have gathered to justify the transport solution they have created.

Crosscutting Concepts

- Structure and Function
- Systems and System Models
- Cause and Effect

Students observe how systems have smaller parts that allow them to function as a whole.

They use models to represent these systems and interactions and analyze these models for limitations. Using the models, students analyze how structures within systems have specific functions related to the material from which they are made. They create a transport solution to address climate issues that is informed by societal desires, needs, and values. It also addresses climate issues and uses of natural resources while considering economic conditions.

Prior knowledge

In this unit, students will build on their prior knowledge across the three dimensions of the NGSS. A summary of expected prior knowledge in each dimension is included on this page, along with information about how students will use this knowledge.

Disciplinary Core Ideas

As they did in Energy, and earlier in The Stile Curriculum through engineering challenges, students engage in the engineering design process to develop possible solutions to a defined problem.

In this instance, they are encouraged to optimize their final product by evaluating parts of different solutions and combining them into a new design. Their exploration of energy through Newton's Laws of Motion, and earlier in Grade 8 in both Energy and Energy Conservation units, provides students with a foundation from which to build an understanding of electric and magnetic forces.

Science and Engineering Practices

Almost all Science and Engineering practices are applied by students in this unit. They have previously defined problems and designed solutions in a number of different contexts, most recently in the Energy unit. Students also used simulations to conduct investigations and generate data that supports a claim.

Students will use these skills to plan and carry out investigations with models. Non-contact Forces require students to use their scientific knowledge of electromagnetism to determine possible sustainable transport solutions through the engineering design process. They test and revise their design based on predefined criteria, and engage in argumentation to justify the decisions they have made along the way.

Crosscutting Concepts

As with previous engineering challenges and tasks, students consider the structure and function of specific materials when designing and building a solution. As they use models to examine electric and magnetic forces, they recognise that, like the nervous system and ecosystems, interactions take place within smaller subsystems.

The cause and effect relationships that allowed students to predict phenomena in the Human Impacts on Ecosystems unit are applied when students link our current forms of transport with climate change and air pollution.

Smog-free skies in Los Angeles
In March 2020, when 40 million residents were ordered to stay home due to the COVID-19 pandemic, the city experienced the longest stretch of good air quality since 1995!

How to use the Lesson Planning Guide

The lesson planning guides provided represent our recommendation for how you can teach each unit in the suggested time frame according to the sequence of learning in the Overview section.

Lesson name
The lesson name is listed here as it appears in the Stile Library.

What students will ponder
These questions are inspired by real-world phenomena and drive students' learning within the lesson.

Preparation required
This section outlines some key tips to ensure you are prepared to teach the lesson. They can include a reminder to review key questions, prepare lab materials or review student work or teacher notes.

Focus SEP
The Science and Engineering Practice that is the focus of the lesson. Use this as a guide to determine which practices to emphasize as you teach. Some focus SEPs are partially developed as they are not assessed at grade band level within the unit. Fully developed SEPs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus DCI
The Disciplinary Core Idea that is the focus of the lesson. Use this as a guide to determine which ideas to emphasize as you teach. Some focus DCIs are partially developed as they are not assessed at grade band level within the unit. Fully developed DCIs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Focus CCC
The Cross Cutting Concept that is the focus of the lesson. Use this as a guide to determine which concepts to emphasize in your teaching. Some focus CCCs are partially developed as they are not assessed at grade band level within the unit. Fully developed CCCs, which are assessed at grade band level in the unit, are listed in the NGSS alignment overview.

Consolidation and preparation
Consolidation and preparation resources include ideas for homework, extra activities for in class or opportunities for mastery and consolidation.

Extra resources
This lists resources that can be used as differentiation opportunities to support or extend students.

Week toggle

This refers to the week in the sequence of learning as recommended in the sequence of learning in the Overview section.

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4

The guide below is based on four 60 minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 1	Is there a problem with how we travel?	Should we change the way we travel?	Review teaching notes in Prepare mode	Engaging in Argument From Evidence Analyzing and Interpreting Data	**ETS1** A Defining and Delimiting an Engineering Problem	Cause and Effect	Provide students with article linked in teaching notes and ask them to read it. *CNN*, "Los Angeles has notoriously polluted air, but right now it has some of the cleanest of any major city"	
Lesson 2	Engineering challenge: Defining the problem	How can we solve today's transport problems?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare mode Prepare the materials for the engineering challenge. See the relevant pages at the end of this chapter.	Asking Questions and Defining Problems	**ETS1.B** Developing Possible Solutions	Systems and System Models	Ask students to review the Glossary lesson	Extra SEP support: 0.3 The engineering process
Lesson 3	Can you lift slime without touching it?	How can magnetic pull be increased?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter.	Asking Questions and Defining Problems Planning and Conducting an Investigation Analyzing and Interpreting Data	**PS2.B** Types of Interactions	Cause and Effect		Extra SEP support: 1.2 Identifying testable questions
Lesson 4	Are magnets the only solution?	What are some other non-contact forces?	Review teaching notes in Prepare mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Constructing Explanations and Designing Solutions	**PS2.B** Types of Interactions	Structure and Function Cause and Effect		

Lesson Planning Guide

Week 1 Week 2 Week 3 Week 4

The guide below is based on four 60 minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 5	How can you boost your transport system?	What is a magnetic accelerator?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Planning and Carrying Out Investigations	**PS2.B** Types of Interactions	Systems and System Models Structure and Function	Ask students to revisit the Glossary lesson	Extra SEP support: 3.1 Types of data
Lesson 6	How do magnets interact?	How can we create patterns with magnets?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Developing and Using Models Analyzing and Interpreting Data	**PS2.B** Types of Interactions	Systems and System Models		Extra SEP support: 2.1 Observing and inferring
Lesson 7	Can magnetism keep our train moving?	Can we create a magnetic field without magnets?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Developing and Using Models	**PS2.B** Types of Interactions	Structure and Function		
Lesson 8	How can we make an electromagnet?	Can we control and use electromagnetic forces?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare Mode Prepare the materials for the lab activity. See the relevant lab activity pages at the end of this chapter	Planning and Carrying Out Investigations Analyzing and Interpreting Data	**PS2.B** Types of Interactions	Patterns		*PHET* simulation linked in teaching notes, "Magnets and electromagnets"

Lesson Planning Guide

Week 1 Week 2 **Week 3** Week 4

The guide below is based on four 60 minute lessons per week.

	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 9	Engineering challenge: Designing a solution	What might a sustainable transport solution look like?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare mode Prepare paper and markers	Constructing Explanations and Designing Solutions	**ETS1.B** Developing Possible Solutions	Systems and System Models	Ask each student to commit to a component they will create, and list the materials they will need.	Extra SEP support: 0.3 The engineering process
Lesson 10	Engineering challenge: Optimising your design	Can our design be improved?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare mode	Constructing Explanations and Designing Solutions	**ETS1.B** Developing Possible Solutions **ETS1.C** Optimizing the Design Solution	Structure and Function		Extra SEP support: 0.3 The engineering process
Lesson 11	Engineering challenge: Communicating your design	How can we share our learning?	Review Key Questions from previous lesson in Analyze Mode Review teaching notes in Prepare mode Prepare poster paper Optional: print rubrics for assessment	Constructing Explanations and Designing Solutions Engaging in Argument From Evidence	**ETS1.B** Developing Possible Solutions	Structure and Function		Extra SEP support: 0.3 The engineering process
Lesson 12	Unit review Glossary	How can I be prepared for the Non-contact Forces test?	Review Key Questions from the unit in Analyze Mode to identify areas to revisit				Ask students to review teacher feedback from lessons in the unit	

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · **Week 4**

The guide below is based on four 60 minute lessons per week.

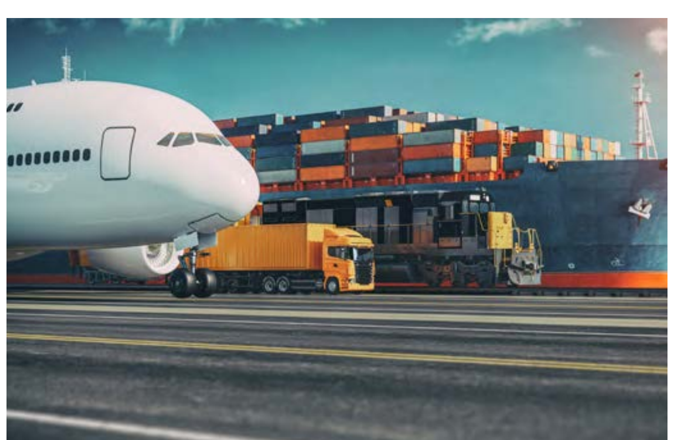
	Lesson name	What students will ponder	Preparation required	Focus SEP	Focus DCI	Focus CCC	Consolidation and preparation	Extra resources
Lesson 13	Test	How much have I learned about non-contact forces?	Ensure every student has access to a device	Asking Questions and Defining Problems Analyzing and Interpreting Data Engaging in argument from evidence Constructing Explanations and Designing Solutions	**PS2.B** Types of Interactions **ETS1.B** Developing Possible Solutions **ETS1.C** Optimizing the Design Solution	Structure and Function Cause and Effect	Prompt students to write a reflection on what they have learned from the unit	
Lesson 14	Test review	How successful was my revision of Non-contact Forces?	Use Analyze Mode to identify questions that the class found challenging and prepare to discuss these	Asking Questions and Defining Problems Analyzing and Interpreting Data Engaging in argument from evidence Constructing Explanations and Designing Solutions	**PS2.B** Types of Interactions **ETS1.B** Developing Possible Solutions **ETS1.C** Optimizing the Design Solution	Structure and Function Cause and Effect	Ask students to reflect on the effectiveness of their revision, and to identify areas for improvement	

Common Core Standards Integration: Math

This unit supports progress towards the Math standards listed.

Students analyze data that informs the need for a sustainable transport solution.

They use data to support claims that require computation of averages as well as comparisons between multiple sets of data to justify claims that the solution is the best fit.



Common Core State Standards Connections: Math

MP.2

Reason abstractly and quantitatively.

Common Core Standards Integration: English Language Arts

This unit supports progress towards the English Language Arts standards listed.

Students engage with multiple exposures to data and reasoning for a transport solution.

They then use their understanding to create questions that can be investigated and a final question that will guide their design solution. The presentation allows students to demonstrate their ideas for design in multiple ways that include presentation of data in charts and drawings and annotated diagrams to strengthen their claims.

Common Core State Standards Connections: English Language Arts

RST.6-8.7

Integrate quantitative or technical information expressed in words in a text with a version of that information expressed visually (e.g., in a flowchart, diagram, model, graph, or table).

RST.6-8.9

Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

WHST.6-8.7

Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration.

SL.8.5

Integrate multimedia and visual displays into presentations to clarify information, strengthen claims and evidence, and add interest.

Differentiation

You can read about our approach to differentiation for specific student needs in the Overview section.

Providing alternative means of expression

The questions listed for each lesson below are opportunities to replace written response questions with Open Response questions that allow students to select how they will communicate their knowledge. You can read more about Open Response questions and how to replace question types in The Stile Guide.

Note that not *all* Written Response questions within a lesson are suggested, as students should still be given the opportunity to practice and develop their written language skills.

- **Is there a problem with the way we travel?**
  Question 4
- **Engineering challenge: Defining the problem**
  Questions 4, 6
- **Can you lift slime without touching it?**
  Questions 3, 6
- **Are magnets the only solution?**
  Questions 4, 5
- **How can you boost your transport system?**
  Question 8
- **How do magnets interact?**
  Question 7
- **Can magnets keep our train moving?**
  Questions 7, 8
- **Engineering challenge: Optimizing your design**
  Question 2

Common misconceptions

Common misconceptions related to the key ideas within the unit have been identified and listed below. These can be found as teaching notes within lessons where students encounter these ideas.

Highlighting possible misconceptions allows teachers to anticipate and recognize within students' responses, and address them in a timely manner. Addressing these misconceptions may require one-on-one coaching or small group work to emphasize specific points.

Lesson	Misconception	Addressing the misconception
1. Is there a problem with how we travel?	While there may be data that shows a correlation, there is not always a direct link between measurements or data and the cause for the data.	This lesson asks students to dissect data on total emissions produced by looking at data "per vehicle." There are scaffolded questions that allow students to examine how emissions can be attributed to individual vehicles.
4. Are magnets the only solution?	Students could classify magnetism as a contact force because magnets, when attracted to each other, make contact.	Explicit teaching on magnets is given, and how interactions begin in proximity to one another results in a non-contact force. The remainder of the lesson reinforces this before using magnets without contact in the next lesson.

ELL Support

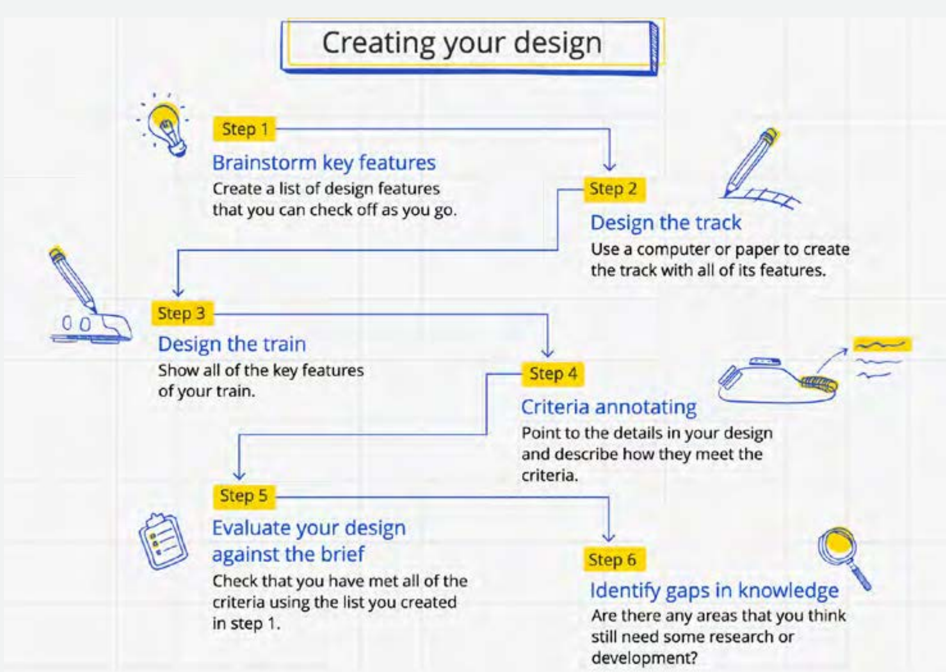
To read about our overall approach to supporting ELL students, including specific features in Stile, see the Overview section.

Visual representations

Sustainable Travel lessons include a number of flow charts and diagrams to help students understand forces that act at a distance, as well as the engineering process. Encourage students to draw on these visual representations, and to actively interpret the information they contain. Those with a higher level of language proficiency can use them for support in decoding written information, rather than as a substitute for reading the text. Two examples of visual representations are included below, though there are many more.

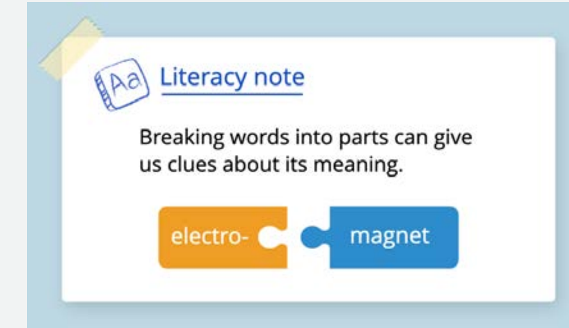
9. Engineering challenge: Designing a solution

This flowchart summarizes a complex process articulated in the lesson's text. The descriptive images that accompany each step support interpretation of the short section of text provided.



7. Lesson: Can magnetism keep our train moving?

This literacy note provides a strategy that is useful for comprehension of subject-specific words.

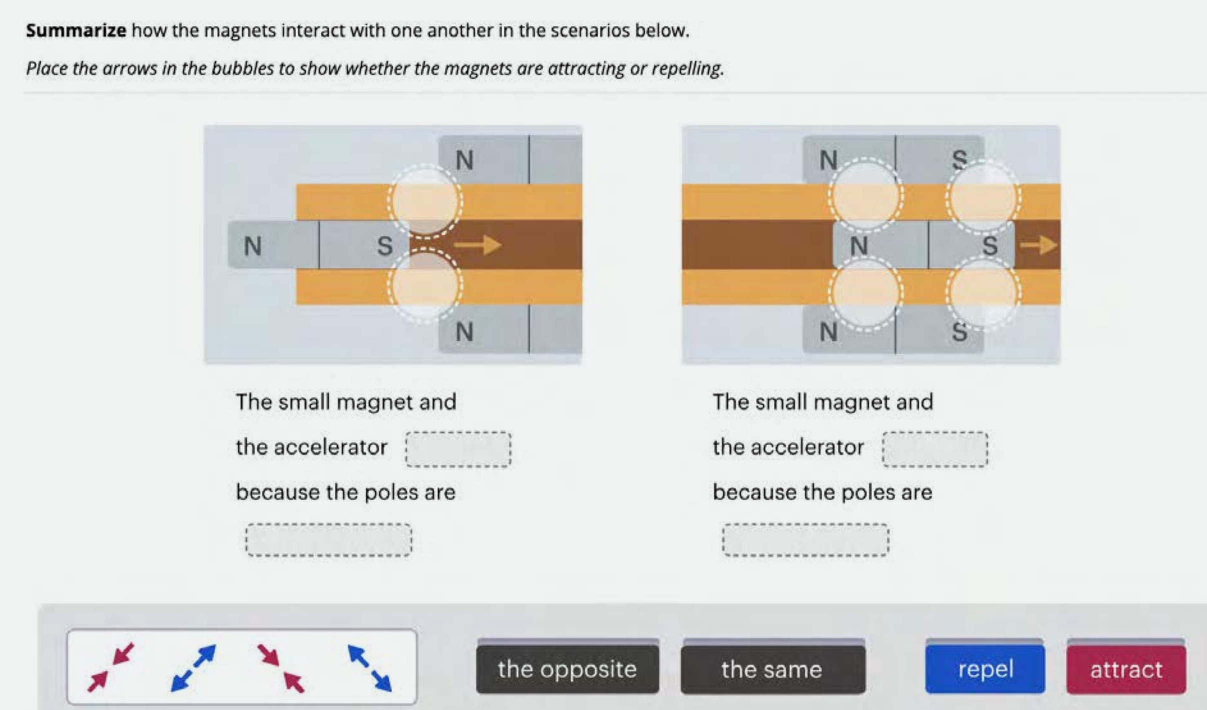


Interactive question types

Allowing students to manipulate and position items in interactive questions means they can complete labeling and fill-in-the-blank questions without using written language. This means that their ability to access learning material and communicate their understanding doesn't rely upon their literacy skills. These activities also support the development of scientific vocabulary, as visual representations are often matched with labels or words matched with their definitions.

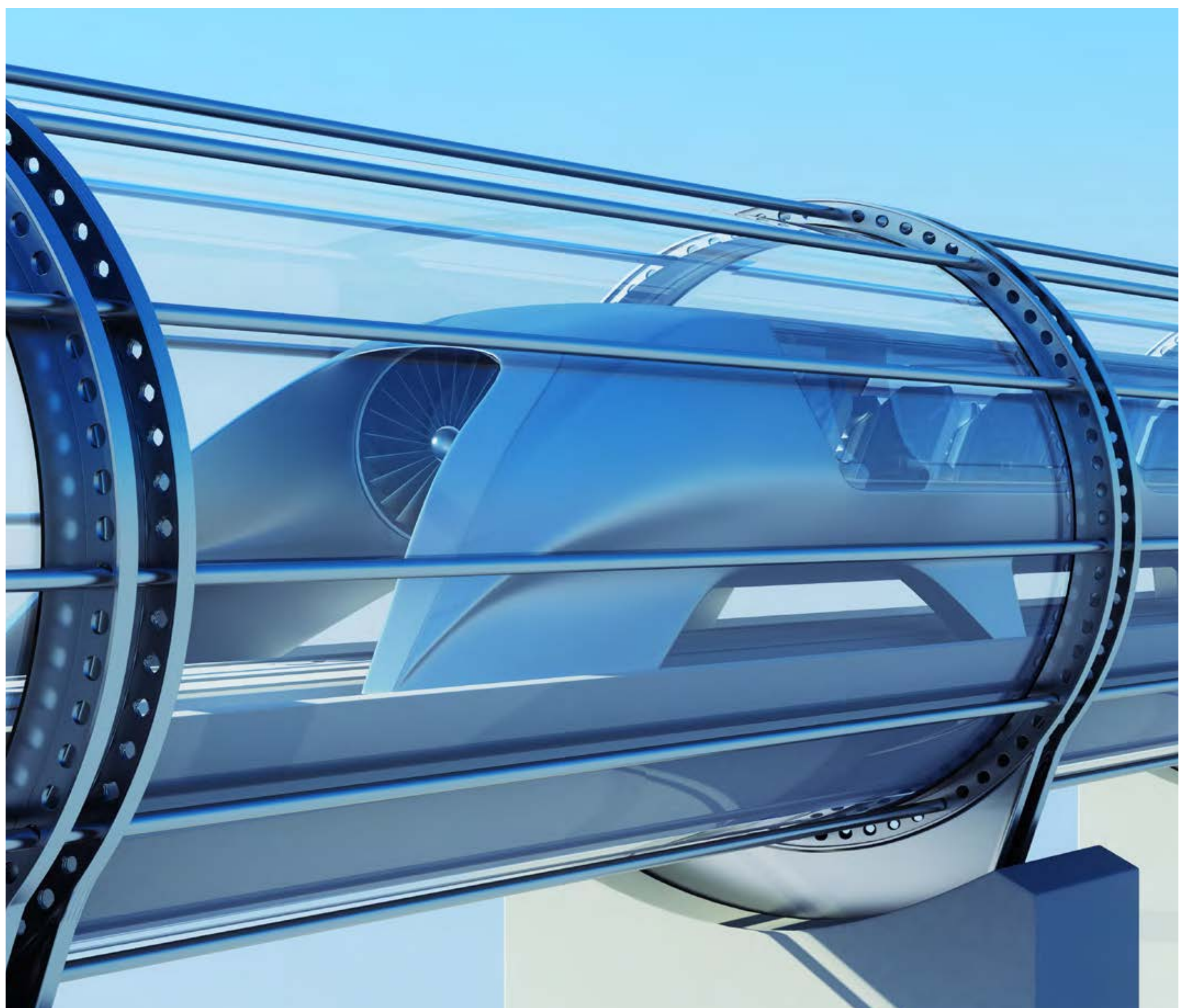
5. Lesson: How can you boost your transport system?

This question allows students to place arrows as visual cues that represent what they observed within the lab. By completing sentences below using drag-and-drop, students are supported to match "attract" and "repel" vocabulary with the visual cue and create their own step-by-step explanation of how the accelerator in the lesson works.



Customization

Learning in this unit is contextualized with the Californian Hyperloop train idea at the beginning of the unit. Using examples of travel times across your own state, and perhaps even to Mexico and further to South America, will create relevance for students.



Assessment

Stile's assessment tasks require students to apply their understanding of Disciplinary Core Ideas, Crosscutting Concepts and Science and Engineering Practices together to explain phenomena and solve problems.

Formative Assessment

Key Questions
Rather than developing multiple tasks specifically for the purpose of formative assessment, Stile provides tools for teachers to make quick, frequent judgments about student progress within every lesson. Each lesson contains one or more Key Questions where students demonstrate their achievement against the learning goal. Using the in-class analytics available in Teach Mode, teachers can use Key Questions as assessments for learning and make timely decisions to respond to students' needs. We strongly recommend that teachers only grade these questions.

Summative Assessment

Tests
This unit contains a test to provide a summative assessment of student learning across the whole unit.

- **Test**
  Multiple choice and short answer: 45 minutes

Science and Engineering Practices
The final practical activity for the Engineering Challenge within the unit can be used as a summative assessment of Science and Engineering Practices.

- **Engineering challenge: Communicating your design**
  Presentation of the design solution they have created with peer and self-assessment: 40–60 minutes

Lab Activities

Lab Activity

Can you lift slime without touching it?

Activity purpose: Allow students to explore the basics of magnetism through a scaffolded investigation.

stileapp.com/go/US-NCF-slime

45–60 minutes

2–3 students per group

Materials

Lab Equipment

Part 1:
- 100 mL Elmer's School Glue
- mixing bowl
- spoon for mixing
- 50 mL water
- 1 tablespoon borax solution
- 1 tablespoon of iron filings
- neodymium magnet
- optional: 1 tablespoon of conditioner

Part 2:
- additional neodymium magnet(s)
- additional iron filings (2-3 tablespoons)
- rulers
- timers

Chemicals
None required

Preparation

Preparation required by teacher
This activity is run in two parts. Keep the materials required for challenge 1 and challenge 2 separate. Do not give students all materials for both challenges at the start of the lesson.

Prepare the borax solution in advance. The borax solution can be made with one tablespoon of borax (or washing powder with borax in the ingredients) mixed into 100 mL of water.

Optional: A tablespoon of conditioner can be mixed into the slime to make it less sticky.

Notes

Notes for the teacher
The magnetic slime doesn't store well after being made. The top layer oxidizes, and the viscosity increases, making it challenging to work with.

The slime that each group makes in challenge 1 can be divided into smaller portions once it is made. This allows for students to conduct investigations in smaller groups.

Safety
Disposing of materials - ensure slime is disposed in a trash can and not down the sink.

Method

Method that students will follow:
1. Pour 100 mL of glue into a mixing bowl.
2. Mix in 50 mL of water.
3. Slowly drizzle the borax solution into your mixture. Stir as you go. The mixture should start to thicken.
4. Use your hands to grab the slime out of the bowl. The slime should feel like a runny jelly.
5. Add the iron filings using a new dry tablespoon. Knead the slime with your hands to ensure an even distribution of iron filings.
6. Move a magnet close to your slime and see if part of the slime lifts towards the magnet.

Lab Activity

Are magnets the only solution?

Activity purpose: Compare and contrast electrostatic and magnetic forces.

stileapp.com/go/US-NCF-magnetSolution

20 minutes

2 students per group

Materials

Lab Equipment
Per group:
- 1 aluminium can with label removed
- 2 x 30 cm long PVC pipe
- two cloths
- Flat and clear table to roll can along

Preparation

Preparation required by teacher
Tables should be arranged lengthways so that students can roll their can down the table.

Notes

It is advised that students aren't given materials until you are ready for the activity to begin.

A few attempts should be allowed so that students can refine their practices to figure out the best way to increase the electrostatic charge. You may like to have one student defending and one attacking, starting the can at one end of the desk and having to move it the entire length.

A time limit of 5-7 minutes of exploration is encouraged to explore this phenomenon.

Method

Method that students will follow:
1. Clear a desk completely.
2. Take a PVC pipe and cloth.
3. Rub the PVC pipe vigorously on the cloth 5x before you start.
4. Place the aluminium can in the middle of the desk and stand at either of the long ends of the table.
5. When the teacher says "GO!" begin to try to move the can off of your end of the desk.
6. Reset the game and try again - continue to play as many games as possible and keep score of who has won each round.

Rules:
- You cannot touch the can (if either person touches the can, you will need to restart).
- The first person to move the can off of their end of the desk is the winner.

Lab Activity

How can you boost your transport system?

Activity purpose: Students use data to support the best design of an accelerator that could be used in their future transport solution.

stileapp.com/go/US-NCF-transportSystem

40–60 minutes

2–3 students

Materials

Lab Equipment
Each group of students will need:
- 2 large neodymium magnets
- 1 small magnet
- 2 square wood pieces (30 cm long)
- A clear plastic ruler
- Blu-tack
- A pencil

Chemicals
None required

Preparation

None required

Notes

The space in between the wooden dowel must be large enough for the small magnet to pass through, but not wide enough for it to turn.

Press down on the ruler on top of the accelerator when pushing the small magnet through. If the ruler isn't held down, the small magnet will flip. A second set of hands can be helpful here.

In the video, the two large magnets both have their north poles facing toward the entry point of the small magnet. Similarly, the small magnet has its north pole facing forward as it enters the chute.

Keep the magnets away from phones and computers. It's best to set up the magnetic accelerators on long tables or on the floor.

Method

Method that students will follow

1. Keep track of the poles of the magnets you are using. Using a compass is a good way to identify the north and south pole.
2. Make sure the chute that the small magnet moves through is large enough for it to pass through, but not so wide that it can turn around while inside.
3. Set up the magnetic accelerator on a long table or on the floor.
4. Determine the four different arrangements that will be tested.
5. Create a table that will record the data that will be gathered.
6. Test each design and record the data.

Lab Activity

How do magnets interact?

Activity purpose: Investigate magnetic fields in order to visualize the forces at play in magnetic interactions.

stileapp.com/go/US-NCF-magnetsInteract

30 minutes

2 students

Materials

Lab Equipment
Each group of students will need:
- 1 bar magnet
- 1 8.5 x 11 in. piece of blank paper per student
- 1 8.5 x 11 in. transparent plastic sheet
- iron filings
- compass
- pencil
- colored marker

Chemicals
None required

Preparation

Dividing materials into quantities needed for each group will save time when setting up this activity.

Notes

Students will need to reuse the iron filings, so care should be taken when using them and putting them back in their containers.

Through open-ended investigation, students create their own model of a magnetic field, including direction.

Students will then use this model of one magnetic field to predict how two magnetic fields will interact.

Method

Method that students will follow

Part 1a:
1. Take a white sheet of paper and place a bar magnet on it.
2. Take the clear sheet and hold it over the magnet, about 10cm above the table.
3. Sprinkle some iron filings onto the plastic sheet to cover a square 15 x 15 cm.
4. Place the sheet over the top of the magnet so that it is touching. Gently tap the sides of the sheet and the magnetic filings will begin to move.
5. To reset the iron filings, take the clear sheet away from the magnet and tap the sides gently.
6. Once you have created this pattern, lift the clear sheet straight up and move it to the side to observe the pattern.
7. Draw the magnet's position and which pole is which. Draw the pattern you see onto the sheet of paper using single lines.
8. Do the same for the other person's paper.
9. Place your iron filings back into the container.

Part 1b:
1. Place the magnet over the diagram. Make sure to match the magnet's poles with the poles that you have labeled on the diagram.
2. Place the compass on five spots on your diagram.
3. Using your marker, draw an arrow in the direction the red needle of your compass points at each spot.

Part 2:
1. Sprinkle your iron filings on the plastic sheet and lift the sheet gently over two magnets.
2. Use the two magnets to investigate what happens to the magnetic fields as you put like poles and opposite poles together.
3. Create a pattern of your magnets attracting and repelling.
4. Take an image of both.
5. Gently bend the plastic sheet to gather the iron filings and put them back in their container.

Lab Activity

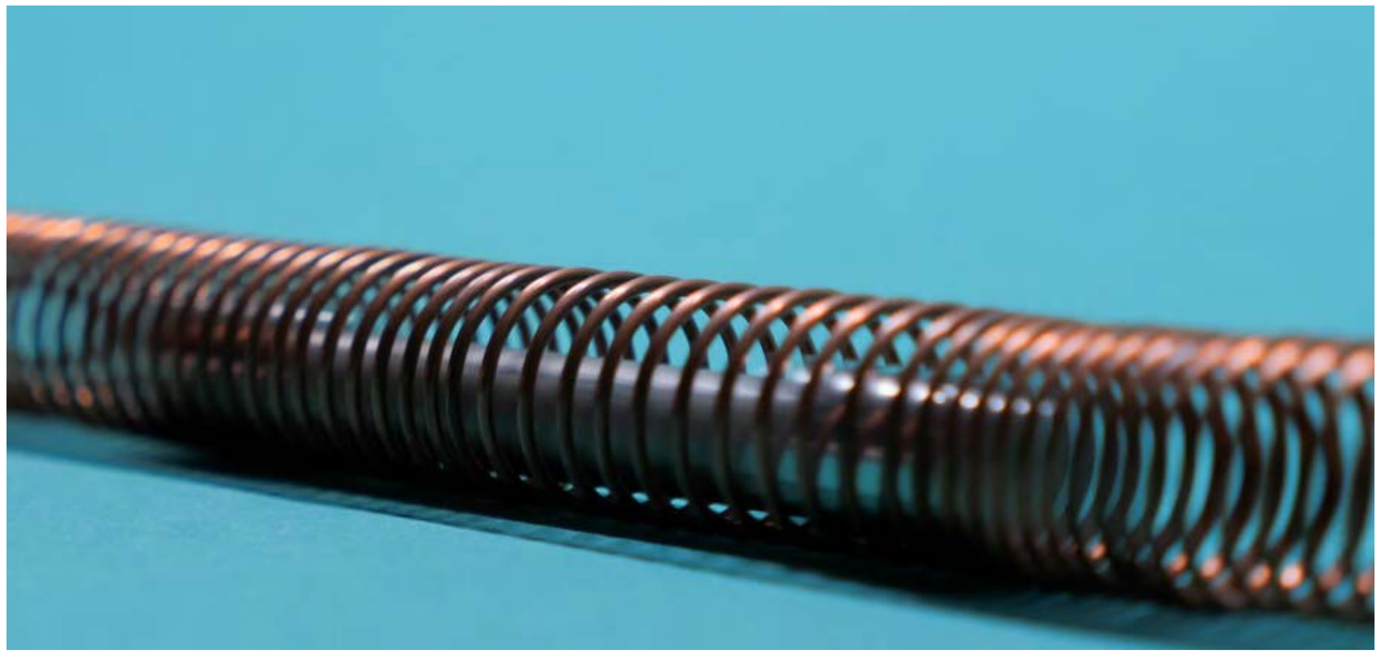
Can magnets keep our train moving?

Activity purpose: Allow students to explore the basics of magnetism through a scaffolded investigation.

stileapp.com/go/US-NCF-train

15–20 minutes

2–3 students



Materials

Lab Equipment
Each group of students will need:
- AAA battery
- copper coil
- two cylindrical neodymium magnets
- (if necessary) a small piece of Blu-Tack

Chemicals
None required

Preparation

Before class:
- Check that the batteries are charged
- Check that the copper coils are mostly shiny and tightly coiled

Notes

Avoid stretching the coils like springs or deforming their shape. If the copper coil becomes loose, tighten it around the wooden dowel in the kit.

Do not leave the train to run through the coil in a loop or for long periods, as the battery will overheat.

Handle magnets with care. Strong magnets can cause pinching and may shatter if they collide from a distance.

On rare occasions, pushing the train backwards through the coil can cause the battery to spark. This should not pose a safety risk.

Store the coils in a dry, air tight container to slow the oxidation of the bare copper wire. If a green patina forms that interferes with their function, boil the coils in a solution of 1 cup of vinegar, 1 tablespoon of salt, and 3 cups of water to help remove the copper oxide layer.

Method

Method that students will follow
1. Create a train by placing a magnet on each end of a battery.
2. Use a compass to ensure that both ends of the train have the same polarity. If not, flip a magnet. Note: The north end of a compass points to a magnet's south pole.
3. Investigate how the train moves through the coil. *Note: Student results depend on the train entering a "clockwise coil" as shown in the diagram below.*

Lab Activity

How can we make an electromagnet?

Activity purpose: Students design and investigate factors that affect the strength of an electromagnet.

stileapp.com/go/US-NCF-electromagnet

25 minutes

2–3 students

Materials

Lab Equipment
Each group of students will need:
- 80 cm of insulated bell wire (exposed ends)
- AAA battery
- iron nail
- two pieces of electrical tape
- small, light, uniform pieces of iron to measure the strength of the electromagnet, such as small staples or iron filings. Note: Use a stapler to separate the staples.

Chemicals
None required

Preparation

Before class:
- Check that the batteries are charged
- Check that the copper coils are mostly shiny and tightly coiled

Notes

Disconnect the wires when the electromagnet isn't being tested to stop the battery from overheating.

Use electrical tape to stop any live wires from being touched.

Guiding student investigation:
This lesson and the suggested materials assume that students have experimented with the number of coils on their electromagnet. Alternative activities may vary with the materials available to students but could include:
- changing the current in the circuit by connecting multiple batteries in parallel (requires additional wire, batteries, and electrical tape)
- changing the size or material of the electromagnet's nail core by wrapping the wire around different numbers of nails (requires additional nails or nails of different types and sizes)

Method

Method that students will follow
1. Create a train by placing a magnet on each end of a battery.
2. Use a compass to ensure that both ends of the train have the same polarity. If not, flip a magnet. Note: The north end of a compass points to a magnet's south pole.
3. Investigate how the train moves through the coil. Note: Student results depend on the train entering a "clockwise coil" as shown in the diagram below.

Test and change your electromagnet (15 min):
Turn on your electromagnet:

4. Touch the battery's negative terminal to the wire on the electrical tape.
5. Stick the electrical tape onto the battery. Make sure to cover any exposed parts of the wire.

Turn off your electromagnet:

6. Disconnect the wire from the negative terminal of your battery when you have finished testing.

Hands-on labs in Stile

Units in Stile have hands-on labs integrated throughout. Listed below is each of the units in Grade 8 of The Stile Curriculum, and all of the materials required for one group of students to complete the labs within that unit.

Earth Systems

Albedo and color

- 3 thermometers or an infrared temperature probe
- 1 piece of black paper
- 1 piece of white paper
- 1 piece of paper of a third color
- a tray (optional)
- high intensity lamp or sunlight
- stopwatch

Floating gardens

- 2 x 250 mL plastic drink bottles
- 2 x small plastic food trays
- 15 x straws
- 10 x corks
- bubble wrap
- 2 x balloons
- 2 m of string
- 1 stick of Blu-Tack
- 1 glue stick
- 1 roll of adhesive tape
- elastic bands
- cardboard
- craft sticks
- 1 egg carton
- cotton wool
- straw
- paper towel
- potting mix
- seeds (e.g. lettuce or alfalfa)
- scissors

Modeling sea level rise

- 2 x 600 mL beakers
- 1 x 250 mL beaker
- permanent marker
- approx. 600 mL water
- 2 ice cubes, the same size
- 250 mL conical flask
- retort stand and clamp
- long thermometer
- Bunsen burner
- tripod
- heatproof mat
- gauze mat
- tongs
- plasticine
- 30 cm ruler
- masking tape
- approx. 10 drops food coloring
- approx. 300 mL water

Evolution

Modeling evolution

- blindfolds or eye patches for ⅓ of the class
- slings (optional) for ⅓ of the class
- newspaper or waste paper
- tape
- glue

Modeling the formation of species

- a coin per student or a coin toss website
- paper
- pencils for drawing

Mass Extinctions

How do scientists know the history of corals?

- 1 slice of each type of bread: whole wheat, multigrain, white, and dark rye
- bread knife
- 1 teaspoon of sprinkles
- 6 pretzel sticks
- 6 fish candies (Swedish Fish)
- 1 tablespoon of strawberry jelly

How does the chemistry of our oceans affect corals?

- 1 250 mL beaker
- 100 mL distilled water
- universal indicator in a dropper bottle
- universal indicator chart
- 1 straw

Energy

Energy mystery box

- apple
- leaf
- sparkler and lighter
- flashlight and batteries (the required number of batteries for the flashlight to run)
- rubber band
- 2 ping pong balls
- squeaky toy (rubber duck)
- piece of Velcro

Rubber band racers

- rubber band
- 2 skewers
- 4 plastic lids of the same size (e.g. milk bottle lids)
- measuring tape
- cardboard tube (e.g. toilet paper roll)
- toothpick
- scissors
- ½ lb. of modeling clay or other small weight
- optional: ruler

Asteroid marble drop

- 1 small marble or pebble
- 1 large marble or pebble
- shallow tray or box, such as a baking tray
- 2 lb. bag of flour
- cocoa powder or hot chocolate powder
- spoon
- 30 cm ruler
- sieve
- electronic balance or kitchen scale

Water wheels

- 2 pieces of thick cardboard or thin plastic
- approx. 9 paper or plastic cups
- bamboo skewer
- scissors
- stapler
- pen
- 1 m ruler or tape measure
- water jug or another pouring vessel
- large container or bucket
- 2 chairs
- water

Energy continued

Bouncing balls

- 3 spherical balls of different kinds
- (e.g., tennis ball, baseball, golf ball, table tennis ball)
- meter ruler or tape measure
- 160 cm x 30 cm sheet of paper
- tape
- marking pen

Create a light bulb

- power pack that supplies up to 12 V
- 2 alligator clips and wires
- 10 cm long piece of nichrome wire
- 2 large metal nails (approx. 3–4 cm long)
- piece of modeling clay or play dough (approx 3 cm x 3 cm)
- glass jar with a wide opening

Biomimicry design

- optional: water wheels that students created in the water wheel practical activity
- selection of used plastic bags and plastic containers
- selection of cardboard or thin plastic sheets
- paper or plastic cups
- water jugs, buckets, or other vessels
- thin-spouted watering cans
- paddles, such as ping pong paddles or spatulas
- pipe or hose offcuts
- small weighted objects, such as washers or paper clips
- bamboo skewers
- cotton thread
- rope or string
- scissors
- masking tape
- staplers
- stopwatches or video recording devices
- tally counters
- rulers
- water

Non-contact Forces

Can you lift slime without touching it?

- 100 mL Elmer's School Glue
- mixing bowl
- spoon for mixing
- 50 mL water
- 1 tablespoon borax solution
- 1 tablespoon iron filings
- neodymium magnet
- optional: 1 tablespoon of conditioner
- additional neodymium magnet(s)
- additional iron filings (2–3 tablespoons)
- rulers
- timers

Are magnets the only solution?

- 1 aluminium can with label removed
- 2 x 30 cm long PVC pipe
- two cloths
- Flat and clear table to roll can along

How can you boost your transport system?

- 2 large neodymium magnets
- 1 small magnet
- 2 square wood pieces (30cm long)
- A clear plastic ruler
- Blu-Tack
- a pencil

How do magnets interact?

- 1 bar magnet
- 1 8.5 x 11 in. piece of blank paper per student
- 1 8.5 x 11 in. transparent plastic sheet
- iron filings
- compass
- pencil
- colored marker

Non-contact Forces (continued)

Can magnets keep our train moving?

- AAA battery
- copper coil
- Two cylindrical neodymium magnets
- (if necessary) a small piece of Blu-Tack

How can we make an electromagnet?

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