Stile

Forces

How have people used forces for thousands of years?

Teaching Plan and Lab Guide

Very early use of a lever
Spear throwers have been used by First Nations Australians to manipulate forces for millennia.

Version 1.1

Contents

Teaching Plan

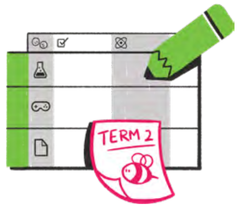
Lab Guide

Everything in one place

Stile is a complete science curriculum. Our digital lessons and hard-copy booklets are designed to help students be the best learners they can be and to give you the tools to do what you do best: teach.

Teacher resources	Student resources

Before class



Find out everything you need to know from the unit's **Teaching Plan** and **Lab Guide**.

In **Prepare Mode** for each lesson, you can:
- Read the detailed teaching notes
- Print a copy to refer to in class
- Customise resources for the needs of your students

Stile X phone app
- Front-load the unit's scientific terminology through flashcards and quizzes

During class

Within **Teach Mode** you can:
- Implement explicit teaching with learning goals and Key Questions
- Use videos, images and text to guide your instruction
- Facilitate discussion with live brainstorms and polls
- View student data instantly to inform your teaching

Stile Digital
- Engage in real-world phenomena through:
  - Practical activities
  - Research projects
  - Classroom lessons
  - Hands-on activities
  - Breaking news
  - Extension lessons
  - Engineering challenges
  - Open-ended investigations

After class

To **Analyse** student work:
- View data in Analyse Mode to determine your next teaching steps
- See a bird's-eye view of student progress in the Markbook
- Release model answers to students
- Provide written feedback where it matters most

Stile X booklets
- Consolidate and revise material learned in class by:
  - Creating structured revision notes
  - Recording definitions in the glossary
  - Completing practice test questions

Stile X phone app
- 60-second summary videos recap key ideas from the Stile lesson

Scan here to view **The Stile Guide**, the essential guide to supercharging your teaching with Stile

Teaching Plan

Incorporating Aboriginal and Torres Strait Islander Histories and Cultures

Addressing the cross-curriculum priority

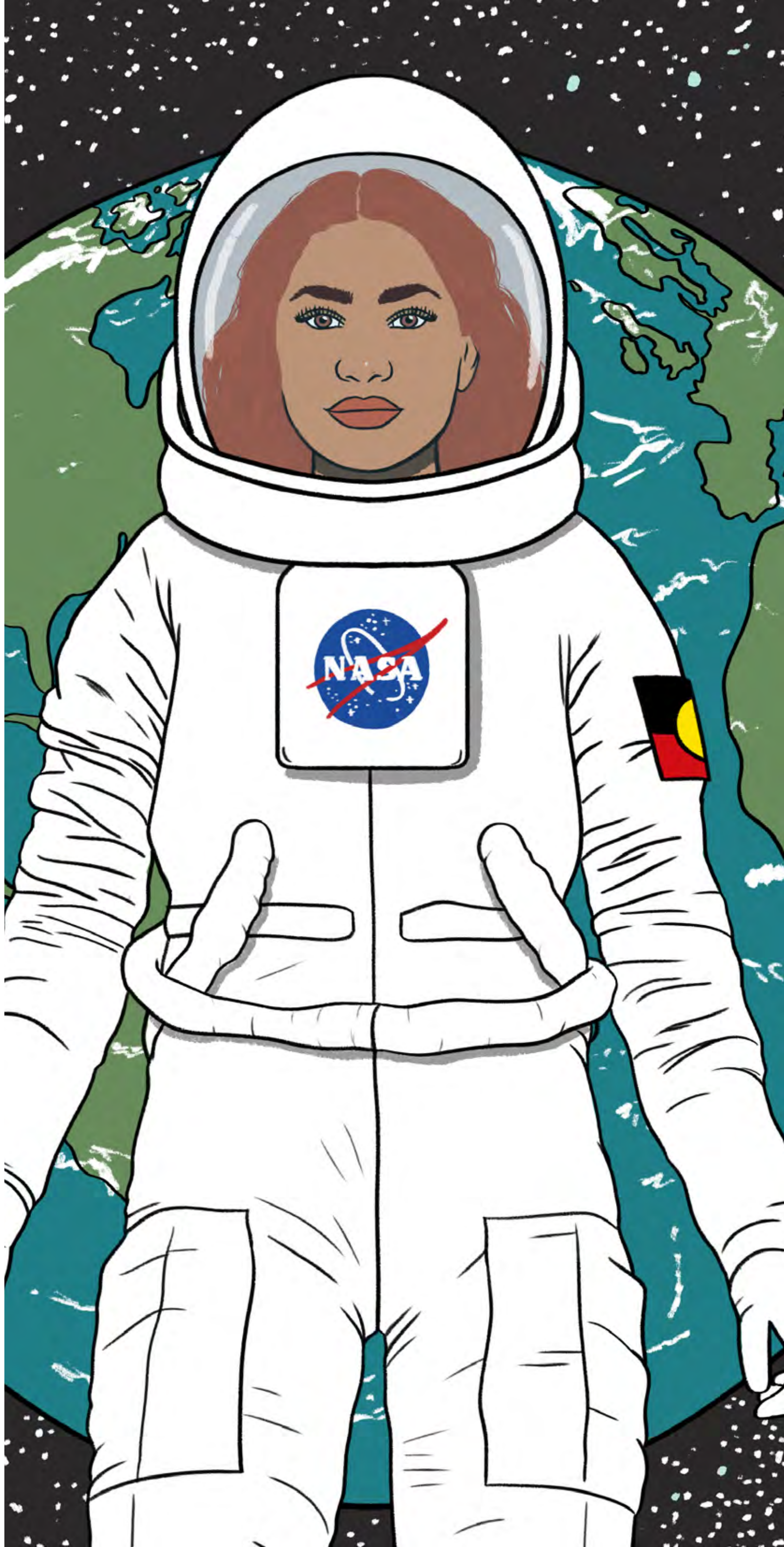
The Australian Curriculum requires Aboriginal and Torres Strait Islander Histories and Cultures to be incorporated into all learning areas as a cross-curriculum priority. In Version 9 of the Australian Curriculum particular emphasis is placed on recognising Australia's First Peoples. ACARA's national monitoring reports show that there is strong support for this cross-curriculum priority amongst educators and many teachers want to do it justice. These reports also show that teachers are unsure about how to do so in a respectful and appropriate manner, which can prevent them from trying. "The reality of this for many educators is that fear freezes them into inaction." (Sambono, 2021)

Forces is the first unit that has come from a process of collaboration between Stile's science team and First Nations scientists, artists and educators. In creating this unit, we endeavour to support you to include Aboriginal and Torres Strait Islander Histories and Cultures into your science teaching and to offer reassurance that we have done everything possible to help you do so safely and sensitively. Stile aims to meet the two goals ACARA has set for this cross-curriculum priority. These are:

1. To provide Aboriginal and Torres Strait Islander students with the ability to see themselves, their identities and cultures reflected in the curriculum
2. To allow all students to engage in reconciliation, respect and recognition of the world's oldest continuous living cultures

References:

Sambono, J. (2021). The Aboriginal and Torres Strait Islander Histories and Cultures Cross-curriculum Priority: Cultural responsiveness in science education. *SASTA Journal* 2021a, 4–13.



Aboriginal astronaut
The National Indigenous Space Program aims to have the first Aboriginal female astronaut travel into space.

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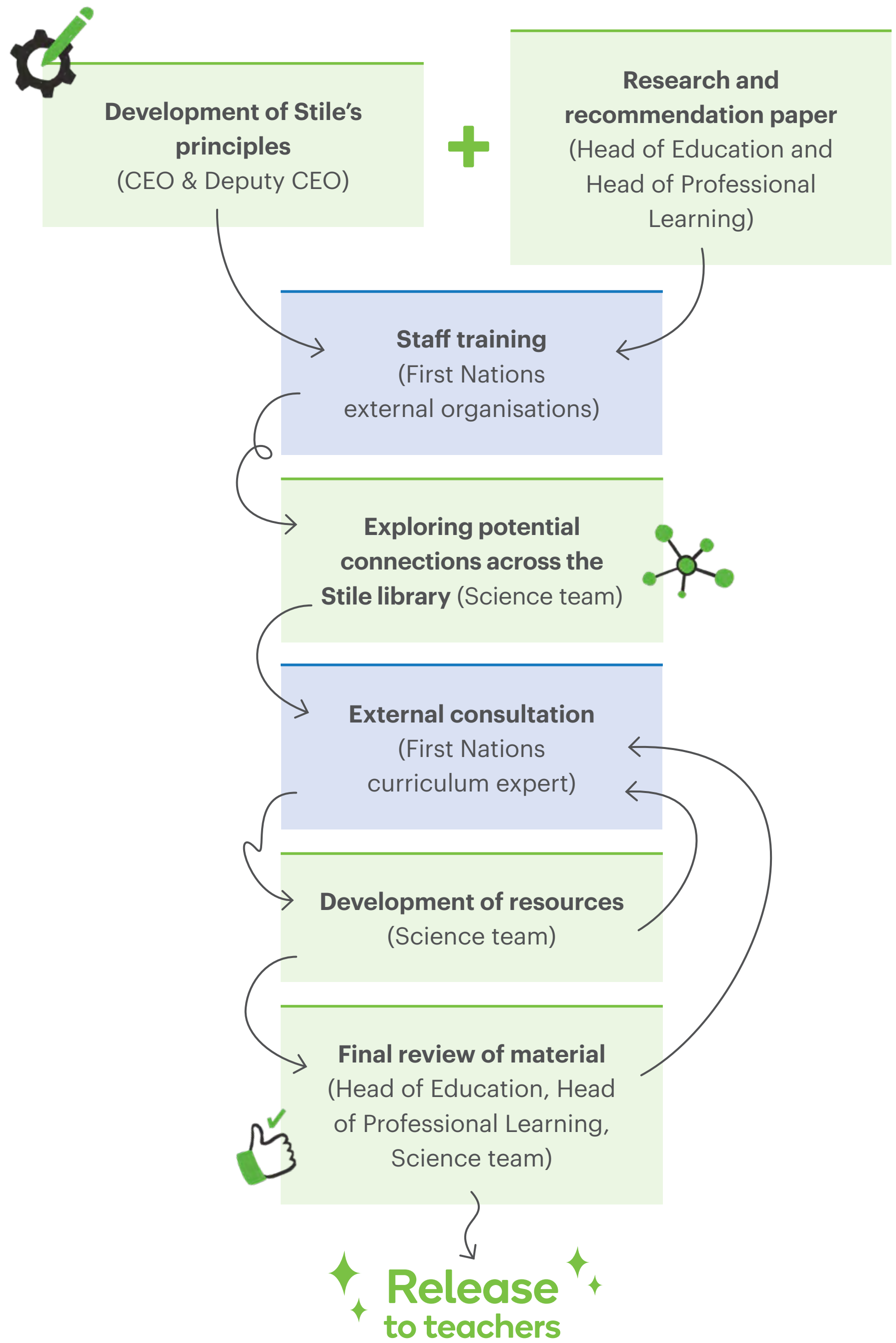
Incorporating Aboriginal and Torres Strait Islander Histories and Cultures

Our process

The science team at Stile has undertaken considerable professional development, research and training, with a focus on protecting Indigenous Cultural and Intellectual Property. We have been guided by the Australian Curriculum's extensive elaborations for Aboriginal and Torres Strait Islander Histories and Cultures, all of which were meticulously researched and developed by a team of curriculum specialists.

All lessons that incorporate Aboriginal and Torres Strait Islander Histories and Cultures in this unit are marked with a boomerang icon in the "Unit at a glance" and "Lesson planning guide" sections of this document. These resources have been researched, reviewed and developed by the team at Stile, in collaboration with First Nations experts.

As with all of our units we have provided comprehensive teacher notes within each Stile lesson. These are designed to support you to teach this content in a respectful and appropriate manner.

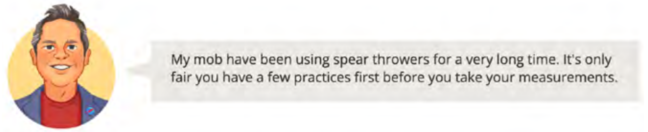


Incorporating Aboriginal and Torres Strait Islander Histories and Cultures

Our collaborators

This unit has been developed in collaboration with:

Professor Chris Lawrence (Noongar), founder of the National Indigenous Space Program
Professor Chris is seen throughout the unit as the career profile. His inspiring journey from high-school dropout to professor allows teachers and students to discuss big issues such as disadvantage and systemic racism faced by First Nations Australians. Professor Chris has provided his voice to guide students in developing their understanding of forces throughout the unit. He has also collaborated with us by presenting videos and reviewing content and copy.



Joe Sambono (Jingili), curriculum expert and team leader of ACARA's First Nations elaborations in Science
Joe has guided the development of the unit and carefully considered all cultural aspects, providing ongoing guidance and advice. He has assisted in instances of traditional languages, facilitated meetings with relevant community members and sourced archival and photographic materials. Joe has also provided extensive feedback and guidance as our primary content reviewer.

Janelle Burger (Noongar), illustrator
Janelle is a freelance illustrator who has contributed her wonderful artwork to the unit, from her pattern work seen in the unit's guiding question banner to her fabulous illustration of Gloria, the First Nations astronaut. More information about Janelle's work can be found at **janelleburger.net**

Spear thrower illustration by Janelle Burger.

Storyline and real-world phenomenon

How have people used forces for thousands of years?

Forces are acting all around us. Our understanding of forces allows us to achieve incredible things, from constructing the pyramids to landing spacecraft on distant planets. And while we often consider the pyramids to be an incredible feat of ancient ingenuity, we tend to overlook much older knowledge held by First Nations Australians.

Evidence shows First Nations Australians have been using levers for well over 7000 years. In fact, there's evidence to suggest they've been used for at least 40,000 years! The oldest human remains ever found in Australia show a pattern of wear on the elbow very similar to a condition known as "spear-thrower elbow". This condition can be caused by regular use of a spear thrower, a type of lever. Fast forward to the present day and First Nations Australians are using their understanding of forces to reach great heights. Professor Chris Lawrence, the career profile for this unit, has developed the National Indigenous Space Program to take students to NASA's Jet Propulsion Laboratory in Pasadena, California.

In this unit students explore examples of ancient technology and their modern counterparts through the guiding question "How have people used forces for thousands of years?" They learn about Professor Chris's experiences of overcoming challenges to achieve his goals. Students journey to space and back as they apply their knowledge of forces to engineer a space parachute to safely land cargo on the surface of another planet.

Big ideas
- What do forces do?
- When are forces balanced and unbalanced?
- What are net forces?
- How do we measure forces?

Highlights
- Build and test catapults and ball throwers
- Design a speed multiplier based on spear-thrower technology in an engineering challenge
- Use a simulation to explore friction and braking distances in an open investigation
- Create a parachute for an astronaut in an extended engineering challenge

Career Profile
*In this unit students meet **Professor Chris Lawrence**, the founder of the National Indigenous Space Program. They hear his personal story and learn about his work to highlight the struggle for First Nations students to overcome disadvantage.*

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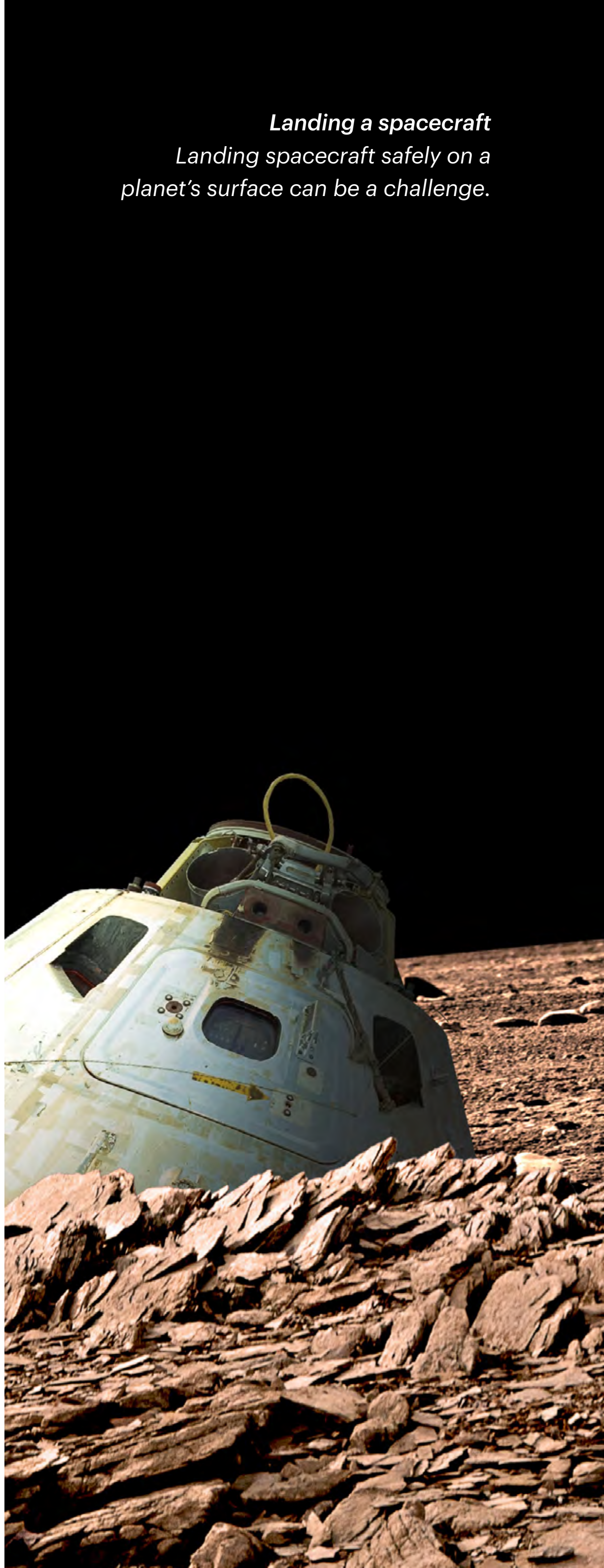


Landing a spacecraft
Landing spacecraft safely on a planet's surface can be a challenge.

This unit at a glance

This unit is designed to take nine weeks for teachers using Version 9 of the Australian Curriculum, with four 45-minute class sessions per week.

For teachers using the NSW Syllabus or the Victorian Curriculum, optional lessons are indicated in the lesson planning guide. If optional lessons are omitted, this unit will take 7.5 weeks with four 45-minute class sessions per week.

Classroom lesson	Breaking news
Extension lesson	Practical activity
Pre-test	Research project
Check-in	Hands-on activity
Glossary	Engineering challenge
Test	Open-ended investigation

This icon indicates lessons that incorporate Aboriginal and Torres Strait Islander Histories and Cultures

This icon indicates lessons that have additional revision and consolidation material available in **Stile X**, our hard-copy study booklet and accompanying app.

Forces

- Career profile: Indigenous Space Program Founder
- Pre-test: Forces

- 1.1 What are forces?
- 1.1 Check-in: What are forces?
- 1.2 Using ramps
- 1.3 Types of forces
- 1.3 Check-in: Types of forces
- 1.4 Friction and braking distance
- 1.5 Effect of forces

- 2.1 Balanced and unbalanced forces
- 2.1 Check-in: Balanced and unbalanced forces
- 2.2 Speed and force multipliers
- 2.3 Testing a speed multiplier
- 2.4 Building a catapult
- 2.5 Designing an improved speed multiplier
- 2.6 Testing and evaluating a speed multiplier
- 2.7 Net force

- 3.1 Gravity
- 3.1 Check-in: Gravity
- 3.2 Are astronauts weightless?
- 3.3 The effect of gravity
- 3.4 Designing a space parachute
- 3.5 Building a space parachute
- 3.6 Testing a space parachute
- 3.7 Improving a space parachute
- 3.8 Sharing your space parachute design

- Glossary: Forces
- Test: Forces

Students **activate prior knowledge** about forces through this formative assessment.

Regular **formative assessment** provides a quick check of student progress throughout the unit.

Students **investigate** how levers, such as spear throwers, are used by First Nations Australians to change the magnitude of a force.

Using their understanding of spear-thrower technology, students **design a solution** to improve a speed multiplier.

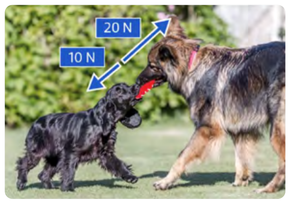
Students **design a solution** to return a space capsule back to the Earth using the engineering design process.

This **summative assessment** assesses students' curriculum-aligned knowledge.

Unit storyline

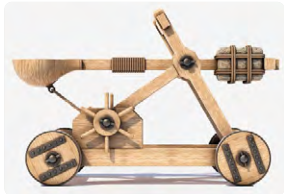
Throughout this unit, students investigate how people, including First Nations Australians, have utilised forces for thousands of years. They explore how cultural perspectives can influence people's world views and the development of science. The use of multiple phenomena supports students to develop scientific skills and understanding. The progression of these phenomena, and how they are observed within lessons, is detailed below.

Phenomenon	Lesson
Forces are applied in everyday life 	**1.1 What are forces?** – Students explore what forces are by looking at how they are applied in real-world examples
Ramps can help lift heavy objects 	**1.2 Using ramps** – Students explore how ramps were used to lift 2.5 tonne blocks over 100 m to help build the pyramids – They test this by creating their own ramps to lift heavy objects

Phenomenon	Lesson
A vehicle's braking distance depends on friction 	**1.4 Friction and braking distance** – Students use a simulation to investigate how friction affects the braking distance of a vehicle
Balanced and unbalanced forces are in action in everyday life 	**2.1 Balanced and unbalanced forces** – Students explore balanced and unbalanced forces by looking at real-world examples

Unit storyline

Phenomenon	Lesson
Ball throwers can change the amount of force acting on a ball 	**2.2 Speed and force multipliers** – Students discover how ball throwers are an adaptation of spear-thrower technology developed by First Nations Australians – Students explore how a lever such as a ball thrower can change the magnitude of a force – They investigate this by creating a force and speed multiplier
Spear throwers come in many different shapes and sizes 	**2.3 Testing a speed multiplier** – Students explore different spear throwers used by many First Nations people across Australia – They investigate how the length of the resistance arm affects the distance an object can be thrown

Phenomenon	Lesson
Catapults can launch heavy objects long distances 	**2.4 Building a catapult** – Students explore how a catapult functions as both a speed and force multiplier
How to win tug-of-war 	**2.7 Net force** – Students explore and calculate net forces in a game of tug-of-war by manipulating variables in a simulation

Unit storyline

Phenomenon	Lesson
Gravity keeps us on the ground 	**3.1 Gravity** – Students examine how gravity keeps us on the ground – They use their understanding to calculate the weight and mass of objects on different planets
Astronauts float at the International Space Station 	**3.2 Are astronauts weightless?** – Students learn how gravity works in space to help explain why astronauts float at the International Space Station
Balls of different masses fall at the same speed 	**3.3 The effect of gravity** – Students investigate whether balls of different masses fall at the same speed
Parachutes can be used to counter the force of gravity 	**3.4–3.8 Engineering challenge** – Students use the engineering design process to develop a space parachute

Curriculum alignment

This unit focuses on types of forces and whether they are balanced or unbalanced. Detailed alignment information can be found at the links below.

Click here to view curriculum alignment for Version 8.4 of the Australian Curriculum

Click here to view curriculum alignment for Version 9 of the Australian Curriculum

Click here to view alignment for the NSW Syllabus for the Australian Curriculum

Click here to view curriculum alignment for the Victorian Curriculum

Click here to view curriculum alignment for the Western Australian Curriculum

Prior knowledge

This unit is written with the assumption that students have some existing subject knowledge.

Before beginning this unit, students should be familiar with:

- How forces can be exerted by one object on another through direct contact or from a distance
- How friction, gravity and magnets exert forces that can affect the motion of objects

Stile X: Forces

What's in the Stile X booklet?

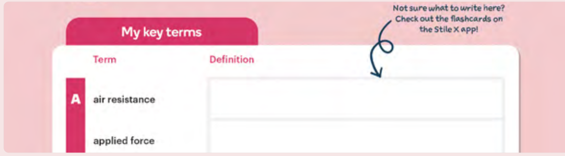
Model how to complete the structured **revision notes** as students fill in sections of these pages in class. Any remaining sections can be done at home before the next lesson. As students become more familiar with Stile X, increase independent use both at home and in class.

This unit includes **revision notes** for:

- What are forces?
- Types of forces
- Balanced and unbalanced forces
- Gravity

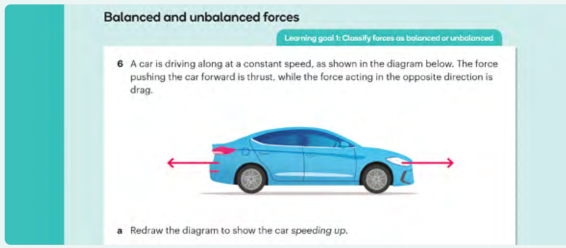
Read **expert study tips** aloud and discuss them in class to help students build important study skills.

When you see a bolded word in Stile, ask students to turn to the **glossary** pages to record the definition in their own words.



The **practice test** is perfect for revision. Fast finishers can even complete questions as an extension activity during class time. Each question addresses a learning goal from the unit's core lessons.

- Define what forces are
- Analyse forces using force arrow diagrams
- Measure forces
- Identify different types of forces in the world around you
- Distinguish between contact and non-contact forces
- Classify forces as balanced or unbalanced
- Explain scenarios using the concepts of gravity and gravitational fields
- Apply mass and weight to scenarios on different planets



Assessment

Stile's assessment tasks require students to apply general capabilities, skills and knowledge to explain phenomena and solve problems. We recommend using the formative assessment opportunities listed to gauge student progress, which will guide your next teaching steps. Self-assessment opportunities are also included in both Stile and Stile X to encourage metacognitive monitoring. Summative assessment tasks are designed to show what a student has learned throughout the unit and can be used to inform your reporting.

Formative assessment

Key Questions
A Key Question is an opportunity for students to demonstrate their progress against a learning goal. Stile lessons include one Key Question for each learning goal. Using the in-class analytics available in Teach Mode, you can use Key Questions to make quick, frequent judgements about student progress. We strongly recommend that you focus on these questions when providing written feedback.

★ Key Question

Check-ins
Four check-in lessons have been included as formative assessment opportunities throughout the unit. Check-ins contain self-marking multiple choice and drag and drop questions that will give you a quick snapshot of student learning at pivotal points in the unit. Student results in a check-in assessment will help you determine whether students are ready to progress to the next phase in the learning cycle, or whether further teaching is required.

Lesson type	Lesson name	Question types	Time
Check-in	What are forces?	Multiple choice, drag and drop	5–10 minutes
Check-in	Types of forces	Multiple choice	5–10 minutes
Check-in	Balanced and unbalanced forces	Multiple choice	5–10 minutes
Check-in	Gravity	Multiple choice	5–10 minutes

Summative assessment

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

Lesson type	Lesson name	Question types	Time
Test	Test: Forces	Multiple choice, drag and drop, written response	45 minutes

Scientific skills
The final engineering challenge within this unit can be used as a summative assessment of science inquiry skills.

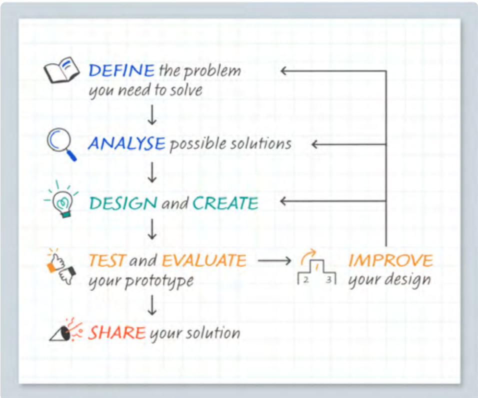
Lesson type	Lesson name	Question types	Time
Engineering challenge	Designing a space parachute	Written response, open response, table, student upload, drag and drop, brainstorm	45 minutes
Engineering challenge	Building a space parachute	Written response, open response, table, student upload, drag and drop, brainstorm	45 minutes
Engineering challenge	Testing a space parachute	Written response, open response, table, student upload, drag and drop, brainstorm	45 minutes
Engineering challenge	Improving a space parachute	Written response, open response, table, student upload, drag and drop, brainstorm	45 minutes
Engineering challenge	Sharing your space parachute design	Written response, open response, table, student upload, drag and drop, brainstorm	45 minutes

Important things to know about this unit

Engineering challenges

This unit contains two engineering challenges. In the first, the engineering design process is scaffolded for students as they create an improved speed multiplier. In the second engineering challenge, students design a parachute for a space capsule to land safely on the surface of a planet. The engineering challenges focus on testing, evaluating and improving upon a design. By exploring different designs for their speed multipliers and parachutes, students will be able to demonstrate an understanding of the engineering process and apply their knowledge of forces.

Detailed advice on how to facilitate the engineering challenges in this unit can be found in the Lab Guide at the end of this document. This advice includes possible student outcomes, alternative approaches to reduce materials and guidance around emphasising the engineering process.



Character conversations

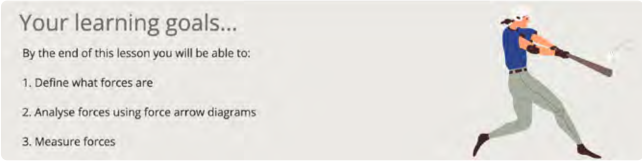
Hawesy, Levi and Professor Chris Lawrence are included as characters throughout the unit, and speech bubbles are used as a bridge between sections of the lesson and to provide light humour. Where character conversations appear, they should be read in the same way as other sections of text. You might read the conversations aloud, or ask students to "play" the role of a specific character within the lesson.

The role of the guiding question

Student curiosity and questioning drive the learning in this unit. The guiding question, "How have people used forces for thousands of years?", acts as a support around which you can facilitate discussion and support students to connect their own questions to the targeted materials.

Learning goals

While student curiosity and questioning drive the learning, the design of the unit as a whole supports students to make sense of phenomena and design solutions. The use of learning goals guides them toward specific outcomes in each lesson, so that their learning builds toward understanding the phenomenon and designing solutions to problems. Evidence shows that students who know what is expected of them are more likely to engage in the learning process and achieve better learning outcomes (Hattie, 2012).



Important things to know about this unit

Skill builders

The lesson planning guide for this unit allocates four class sessions to **Skill builder: Conducting science investigations**. This lesson scaffolds the processes of planning and conducting an investigation that is a fair test. It guides students through recording, analysing and communicating the results of their investigation as well as evaluating the quality of the data collected. This skill builder is included before students conduct investigations about forces and will help them to complete these with confidence. A focus on developing science inquiry skills and practices is especially well-suited to year 7 and will set students on the path to success as they continue to learn science.

Parent email template

This unit includes a pre-written email template that you can use to inform parents about what students are learning in class. You'll find a link to this template in the teacher notes at the bottom of the unit's folder in your Stile subject or you can go to stileapp.com/go/parentemailforces

Copy the text, paste it into an email, and modify it to suit. This is a great way to bridge the gap between school and home, and engage parents in their child's learning.

Resources

Lab Guide
The end of this document contains a Lab Guide that includes the materials and methods for this unit's hands-on and practical activities. Pages from the Lab Guide are also linked in the teaching notes of the relevant Stile lesson.

For each practical activity, hands-on activity, engineering challenge or open-ended investigation you'll find:

- Demo videos, which can be viewed before class to help with preparation, or shown to students during class for extra scaffolding
- Handy tips and tricks for making the activity a success
- A RiskAssess template
- An expected final outcome

Student supplies
Each student will need:

- A device to access Stile lessons
- A Stile X booklet for this unit
- A pen or pencil to complete answers in Stile X
- Coloured pencils to complete mindful colouring activities in Stile X

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · Week 4 · Week 5 · Week 6 · Week 7 · Week 8 · Week 9

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

Click here to download an editable version of this planning guide.

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 1	**Career Profile: Indigenous Space Program Founder** *and* **Pre-test: Forces**		Review teaching notes in Prepare Mode Collect Stile X booklets for this unit Find out more about using Stile X in **The Stile Guide** Send **parent email template** 25 minutes	As a class, watch the video about Professor Chris Lawrence and discuss some of the significant aspects of his life	Students explore the life story of Professor Chris Lawrence and discuss the challenges he's faced and overcome Students encounter the unit's guiding question for the first time and propose ways people have used forces to solve problems	Ask students to complete **Pre-test: Forces** and submit their work Hand out Stile X booklets and activate Stile X app	Stile X app: Flashcards
Session 2	**1.1 What are forces?** *Questions 1–12*	1. Define what forces are 2. Analyse forces using force arrow diagrams	Review student answers to **Pre-test: Forces** in Analyse Mode to gauge prior knowledge Review teaching notes in Prepare Mode 45 minutes	As a class, read about forces and classify examples as a push or a pull	Students explore the definition of a force and identify examples	Students summarise their learning about force arrow diagrams with a Key Question Direct students to the corresponding Stile X revision notes to complete the question: Describe the force interaction that you have drawn	Stile X app: What are forces? video Stile X Revision notes: What are forces? Glossary terms: newtons, spring balance
Session 3	**1.1 What are forces?** *continued* *and* **1.1 Check-in: What are forces?** MATERIALS REQUIRED	3. Measure forces	Provide feedback on the Key Questions from the first part of the lesson in Analyse Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** 30 minutes	Introduce the activity to the class using the information in the lesson	Students measure the amount of force it takes to complete simple tasks	Ask students to reflect on their learning using the *Think, Puzzle, Explore* thinking routine Students complete **1.1 Check-in: What are forces?** independently at the end of the lesson	Stile X app: What are forces? video Stile X Revision notes: What are forces? Glossary terms: force, gravity
Session 4	**1.2 Using ramps** MATERIALS REQUIRED	1. Describe the relationship between angle of inclination and effort force	Provide feedback on the Key Question from the previous lesson in Analyse Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** 30 minutes	As a class, review answers to **1.1 Check-in: What are forces?** Discuss how ramps were used in the construction of the pyramids	Students investigate how ramps can be used to reduce the force required to pull an object	Ask students to consider how they would improve their designs as part of their conclusion	Stile X app: Flashcards

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 5	**1.3 Types of forces** *Questions 1–14*	1. Identify different types of forces in the world around you	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, watch the videos about forces around us	Students identify different types of forces from real-life situations	Students match each type of force to its definition in the Key Question Direct students to the corresponding Stile X revision notes to complete the question: Create a visual summary of the different types of forces using the image	Stile X app: Types of forces video Stile X Revision notes: Types of forces Glossary terms: tension, applied force, friction, magnetism, air resistance, water resistance, elastic force
Session 6	**1.3 Types of forces** *Questions 15–25*	2. Distinguish between contact and non-contact forces	Provide feedback on the Key Question from the first part of the lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, watch the video of people playing "bubble soccer" and identify different types of forces	Students classify examples of contact and non-contact forces Direct students to the corresponding Stile X revision notes to complete the question: Compare contact forces and non-contact forces by completing the graphic organiser	Ask students to reflect on their learning using the *Connect, Extend, Challenge* thinking routine Assign **1.3 Check-in: Types of forces** as homework to be completed before the next lesson	Stile X app: Types of forces video Stile X Revision notes: Types of forces Glossary terms: contact force, non-contact force
Session 7	**Skill builder: Conducting science investigations** *Questions 1–5* *This session is optional for teachers using the NSW Syllabus or Victorian Curriculum*	1. Plan and conduct a science investigation that is a fair test	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode You may wish to print the **scientific investigation posters** to display in your classroom. These are also available for purchase from the **Stile Shop** 35 minutes	As a class, review answers to **1.3 Check-in: Types of forces** Watch the video of astronauts on the International Space Station and brainstorm about growing plants in space	Find out about Project Tomatosphere by watching a video Students consider why astronauts are trying to grow fruit and vegetables in space	Introduce students to the scientific investigation process Students explore the growth chamber simulation and brainstorm investigation questions as a class	Stile X app: Flash quiz 1
Session 8	**Skill builder: Conducting science investigations** *Questions 6–9* *This session is optional for teachers using the NSW Syllabus or Victorian Curriculum*	1. Plan and conduct a science investigation that is a fair test	Review student work from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, revisit the brainstorm of investigation questions from the last session	Using the information in the lesson, guide students through the process of writing an aim, identifying variables, writing a hypothesis, identifying materials and recording a method	Ask students to share and discuss their planned investigation with a partner	Stile X app: Flash quiz 1

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 9	**Skill builder: Conducting science investigations** *Questions 10–13* *This session is optional for teachers using the NSW Syllabus or Victorian Curriculum*	1. Plan and conduct a science investigation that is a fair test 2. Record, analyse and communicate the results	Review student work from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	Explain the importance of safety when conducting an investigation. As a class, identify the safety hazards shown in the image	Students use the simulation to conduct their investigations and record results in the table provided	Students use the graphing tool to plot the data from their investigation	Stile X app: Flash quiz 1
Session 10	**Skill builder: Conducting science investigations** *Questions 14–18* *This session is optional for teachers using the NSW Syllabus or Victorian Curriculum*	2. Record, analyse and communicate the results 3. Evaluate the quality of the data collected and identify improvements	Review student work from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode Print copies of the investigation rubric for students to self-assess 25 minutes	Introduce the analysis task and sentence starters to help students analyse their results	Students evaluate their investigation and write a conclusion	Students complete a self-assessment using the investigation rubric	Stile X app: Flash quiz 1
Session 11	**1.4 Friction and braking distance (Part A)**	1. Identify the independent, dependent and controlled variables	Review teaching notes in Prepare Mode Review student investigations and rubrics from **Skill builder: Conducting science investigations** 60 minutes	As a class, read the background information and allow students to explore the simulation	Students use the simulation to investigate how weather conditions affect braking distance	As a class, review and discuss student conclusions in Teach Mode	Stile X app: Flash quiz 1
Session 12	**1.4 Friction and braking distance (Part B)**	2. Explain whether the results of an investigation support the hypothesis	Provide feedback on the Key Question from the first part of the lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	Introduce the investigation task and walk students through the template	Students begin conducting their own investigation using the simulation by identifying variables, writing a hypothesis and collecting results	Ask students to share their planned investigations and hypotheses with a partner	Stile X app: Flashcards

Lesson Planning Guide

Week 1 · Week 2 · Week 3 · **Week 4** · Week 5 · Week 6 · Week 7 · Week 8 · Week 9

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 13	**1.4 Friction and braking distance (Part B continued)**	2. Explain whether the results of an investigation support the hypothesis	Review teaching notes in Prepare Mode 10 minutes	As a class, discuss students' progress with their investigations	Students complete their investigation, evaluate their results and write a conclusion	Ask students to reflect on the investigation process using the investigation rubric	Stile X app: Flashcards
Session 14	**1.5 Effect of forces** *Questions 1–7* MATERIALS REQUIRED	1. Determine a hypothesis for an investigation	Review student conclusions from the previous session in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	Help students to form pairs or small groups to complete their investigation	Students plan an investigation into the effect of forces	Ask each group of students to share their planned investigations and hypotheses with the class	Stile X app: Flashcards
Session 15	**1.5 Effect of forces** *Questions 8–9* MATERIALS REQUIRED	2. Construct a graph of the results	Provide feedback on the Key Question from the first part of the lesson in Analyse Mode Review teaching notes in Prepare Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** 45 minutes	Students review the methods they wrote during the last session	Students conduct their investigation into the effects of forces	Ask students to discuss their graph choice within their groups	Stile X app: Flashcards
Session 16	**1.5 Effect of forces** *Questions 10–17*	3. Explain the relationship between two variables using evidence	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, discuss the benefits of different types of graph and ask students to justify their choices	Students analyse the results from their investigation into the effects of forces	Ask students to reflect on the investigation process using the investigation rubric	Stile X app: Flashcards

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 17	**2.1 Balanced and unbalanced forces** *Questions 1–11*	1. Classify forces as balanced or unbalanced	Provide feedback on the Key Questions from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, complete a live poll about objects that have forces acting upon them	Students use a simulation to investigate how balanced forces affect the motion of an object	As a class, discuss examples of unbalanced forces and have students answer the written response question	Stile X app: Balanced and unbalanced forces video Stile X Revision notes: Balanced and unbalanced forces Glossary terms: balanced force
Session 18	**2.1 Balanced and unbalanced forces** *Questions 12–19*	1. Classify forces as balanced or unbalanced	Provide feedback on the Key Question from the first part of the lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, read about unbalanced forces and discuss examples	Students use a simulation to investigate how unbalanced forces affect the motion of an object	Direct students to the corresponding Stile X revision notes to complete the question: Determine whether the forces shown in each image are balanced or unbalanced Assign **2.1 Check-in: Balanced and unbalanced forces** as homework to be completed before the next lesson	Stile X app: Balanced and unbalanced forces video Stile X Revision notes: Balanced and unbalanced forces Glossary terms: unbalanced force
Session 19	**2.2 Speed and force multipliers** MATERIALS REQUIRED	1. Justify what type of lever a spear thrower is	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** 45 minutes	As a class, review answers to **2.1 Check-in: Balanced and unbalanced forces**	Students investigate how a lever can be used to change the magnitude of a force	Review student answers to the Key Question as a class and discuss misconceptions	Stile X app: Flashcards
Session 20	**2.3 Testing a speed multiplier** MATERIALS REQUIRED	1. Explain how a speed multiplier can improve the distance an object is thrown	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** 30 minutes	As a class, discuss the spear throwers of Australia infographic and propose reasons for the different styles of spear thrower	Students investigate the effect of speed multipliers on the distance a projectile travels when thrown	Ask students to reflect on their ball-thrower design by identifying advantages and limitations	Stile X app: Flashcards

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 21	**2.4 Building a catapult** MATERIALS REQUIRED	1. Explain the types of levers involved in loading and firing a catapult	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** 45 minutes	As a class, discuss the history of catapults and complete a poll about levers	Students investigate how a catapult functions as both a force and speed multiplier	Ask students to reflect on their learning by completing three questions about their catapult designs	Stile X app: Flashcards
Session 22	**2.5 Designing an improved speed multiplier** MATERIALS REQUIRED	1. Create a design for an improved speed multiplier	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode Print a copy of the **Key Question template** and checklist for each group 45 minutes	As a class, watch the biomimicry video and discuss how nature can be an inspiration for engineering	Students follow the engineering design process to improve the design of a speed multiplier	Ask students to assess their group's work using the rubric provided	Stile X app: Flashcards
Session 23	**2.6 Testing and evaluating a speed multiplier** MATERIALS REQUIRED	1. Evaluate the effectiveness of an improved speed multiplier	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** 45 minutes	As a class, discuss the design differences between a spear thrower and ball thrower	Students follow the engineering design process to create, test and evaluate a speed multiplier	Ask students to assess their group's improved design using the rubric provided	Stile X app: Flashcards
Session 24	**2.7 Net force** *This session is not required for curriculum coverage and is optional*	1. Calculate the net force acting on an object	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, define the term net force and describe how to calculate it	Students use a simulation to help calculate net force	Assign any incomplete questions in the lesson for homework and have students complete the *Very Important Points* reflection activity	Stile X app: Flashcards

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 25	**3.1 Gravity** *Questions 1–13*	1. Explain scenarios using the concepts of gravity and gravitational fields	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, watch the video about gravity	Students examine the force of gravity and the strength of gravitational fields	Direct students to the corresponding Stile X revision notes to complete the question: Summarise the key concepts related to gravity, gravitational fields and mass and weight using the outline note-taking method	Stile X app: Gravity video Stile X Revision notes: Gravity Glossary terms: gravitational field, gravitational field strength
Session 26	**3.1 Gravity** *Questions 14–19* *and* **3.1 Check-in: Gravity**	2. Apply mass and weight to scenarios on different planets	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, read about the difference between weight and mass	Students explain the difference between weight and mass	Ask students to complete the reflection activity *Think, Puzzle, Explore* Ask students to complete **3.1 Check-in: Gravity** independently in class	Stile X app: Gravity video Stile X Revision notes: Gravity Glossary terms: mass, weight
Session 27	**3.2 Are astronauts weightless?** *This session is not required for curriculum coverage and is optional*	1. Explain whether it's accurate to say that astronauts in space are weightless	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, review answers to **3.1 Check-in: Gravity** Watch the video on the National Indigenous Space Program	Students examine why astronauts on the International Space Station appear to be weightless	Fast finishers can complete mindful colouring activities in Stile X	Stile X app: Flash quiz 2
Session 28	**3.3 The effect of gravity** MATERIALS REQUIRED	1. Determine whether balls of different mass fall at the same speed	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** 45 minutes	As a class, watch the video about how objects with different mass are affected by gravity	Students investigate the effect of gravity on objects of different mass	Ask students to complete the *Connect, Extend, Challenge* thinking routine	Stile X app: Flash quiz 1–2

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 29	**3.4 Designing a space parachute**	1. Create a design for a spacecraft's parachute	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, watch the video about engineering at the Jet Propulsion Laboratory	Develop a plan for a space parachute	Ask students to share design plans within their group	Stile X app: Flash quiz 1–2
Session 30	**3.5 Building a space parachute**	1. Construct a prototype of a space parachute	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** 45 minutes	As a class, discuss the differences seen in the two Mars rovers	Students construct their prototype parachutes	Students use a rubric to self-assess their design	Stile X app: Flash quiz 1–2
Session 31	**3.6 Testing a space parachute**	1. Evaluate the effectiveness of your parachute design	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** 45 minutes	As a class watch the "We brake for Mars" video	Students test and evaluate their parachutes	Students propose ways to improve their parachute design	Stile X app: Flash quiz 1–2
Session 32	**3.7 Improving a space parachute**	1. Construct an improved prototype for a space parachute 2. Compare the performance of the improved parachute to the original design	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** 45 minutes	As a class, discuss the results of the parachute testing	Improve on the parachute designs	Students reflect on the engineering design process by completing a self-assessment rubric and thinking routine	Stile X app: Flash quiz 1–2

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 33	**3.8 Sharing your parachute design**	1. Create an advertisement to showcase your parachute design	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 25 minutes	As a class, discuss the elements of a good advertisement	Students create advertisements for their parachute design	Reflect on the whole unit using a thinking routine	Stile X app: Flash quiz 1–2
Session 34	**Unit review**		Provide feedback on the Key Question from the previous lesson in Analyse Mode Review Key and Challenge Questions from the unit in Analyse Mode to identify areas to revisit with students during the lesson 90 minutes	Introduce students to the practice test section of Stile X and explain how it will help them prepare for the test	Revisit any areas of difficulty as a class or with groups of students	Encourage students to review feedback and model answers from the unit for revision	Study Stile X Revision notes in preparation for **Test: Forces**
Session 35	**Test: Forces**		Ensure each student has access to a device	Seat students appropriately for the test	Supervise students during the test	Fast finishers can complete mindful colouring activities in Stile X	Stile X: Reflection

Lab Guide

Complete unit material list

Sourcing all of the materials you need can be hard. To make it easier, we've compiled the list below to show you where we purchased the materials we used in our development and testing of the unit.

Easily accessible items

These items can be bought at your local grocery, stationery and hardware stores. They can typically be purchased with 1–2 days notice.

Equipment purchase link	Quantity required per group	Labs this equipment is used in
Blu Tack	1 stick	1.2 Using ramps 2.2 Speed and force multipliers 2.3 Testing a speed multiplier 2.5 Designing an improved speed multiplier 3.4 Designing a space parachute
craft stick	8 sticks	2.4 Building a catapult 2.5 Designing an improved speed multiplier
egg	1 egg	3.4 Designing a space parachute
Elmer's School Glue	10 mL	2.5 Designing an improved speed multiplier
garbage bag	The amount required will vary. Refer to 3.4 Designing a space parachute for more detail.	3.4 Designing a space parachute
marshmallow	2 marshmallows	2.2 Speed and force multipliers 2.4 Building a catapult
ping pong ball	1 ball	2.3 Testing a speed multiplier 2.5 Designing an improved speed multiplier

Complete unit material list (cont.)

Equipment purchase link	Quantity required per group	Labs this equipment is used in
protractor	1 protractor	1.2 Using ramps 1.5 Effect of forces 2.4 Building a catapult
rice	200 g	1.2 Using ramps
rubber band	4 rubber bands	2.4 Building a catapult 2.5 Designing an improved speed multiplier
ruler, 1 m	1 ruler	3.3 The effect of gravity
ruler, 30 cm	1 ruler	1.2 Using ramps 2.2 Speed and force multipliers 2.3 Testing a speed multiplier 2.5 Designing an improved speed multiplier
scissors	1 pair	1.1 What are forces 2.5 Designing an improved speed multiplier 3.4 Designing a space parachute
string	The amount required will vary. Refer to 3.4 Designing a space parachute for more detail.	1.2 Using ramps 2.5 Designing an improved speed multiplier 3.4 Designing a space parachute
tape, masking	1 roll for the class	3.4 Designing a space parachute
ziplock bag	1 bag	1.2 Using ramps 3.4 Designing a space parachute

Complete unit material list (cont.)

Specialised materials

These items can be bought at educational retailers or more specialised locations. We suggest ordering these in advance as they may take longer to arrive.

Equipment purchase link	Quantity required per group	Labs this equipment is used in
dynamic trolley	1 trolley	1.5 Effect of forces
electronic balance, accurate to 0.01 g	1 balance	3.3 The effect of gravity
mass, 50 g	1 mass	2.2 Speed and force multipliers
measuring tape	1 measuring tape	1.5 Effect of forces 2.3 Testing a speed multiplier 2.5 Designing an improved speed multiplier
spring balance	1 spring balance	1.1 What are forces 1.2 Using ramps
stopwatch	1 stopwatch	1.5 Effect of forces

PRACTICAL ACTIVITY

What are forces?

Watch the demo video

stileapp.com/go/whatareforcesvideo

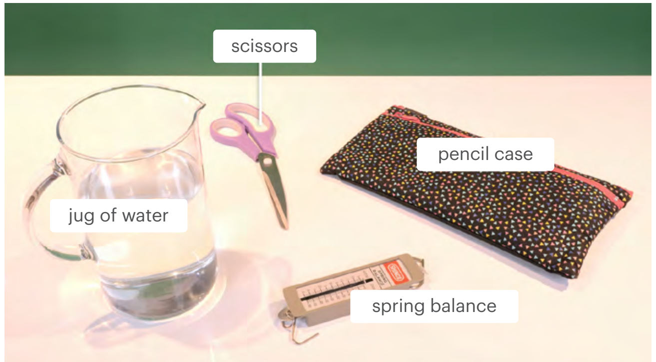
Activity purpose: Introduce what forces are and what they do.

45 minutes	Lesson: stileapp.com/go/what-are-forces
2–4 students per group	RiskAssess: stileapp.com/go/rawhatareforces

Materials

Each group of students will need:
- pencil case
- scissors
- jug of water
- spring balance

Alternative materials:
- *Students can use any other materials they have at hand for this activity. Materials with hooks that the spring balance can be attached to are preferred.*



Before class preparation

Other than collecting materials, no additional preparation is required.

Tips and tricks

Things we learned from testing the lab ourselves
To measure results accurately on the spring balance, encourage students to move steadily and slowly. This is particularly important when using the spring balance to drag an object across a table. Moving slowly at the same rate will make it easiest to get an accurate reading.

Note that depending on the mass of the objects being lifted or moved, spring balances of different capacities may be required. Ensure students never exceed the capacity of the spring balance, as this is likely to damage it.

Method

1. Carefully place the item on the hook at the bottom of the spring balance.
2. Pull gently until you are lifting, dragging or opening the item of your choice. Read the amount of force in newtons (N).
3. Aim to keep the spring balance as steady as possible.
4. Record your results in the table below.
5. You may also like to measure other forces – be sure to check with your teacher first.

Final outcome

What you can expect to see at the end
The results students produce will depend on the items they use. Encourage students to try to record their measurements to one decimal place.

Below is an example set of results, based on the items we used during testing.

Action	Force in newtons (N)
lift a pencil case	2.5 N
drag a jug of water across a desk	6.7 N
lift a pair of scissors	1.4 N
open a cupboard door	3.0 N

PRACTICAL ACTIVITY

Using ramps

Watch the demo video

stileapp.com/go/usingrampsvideo

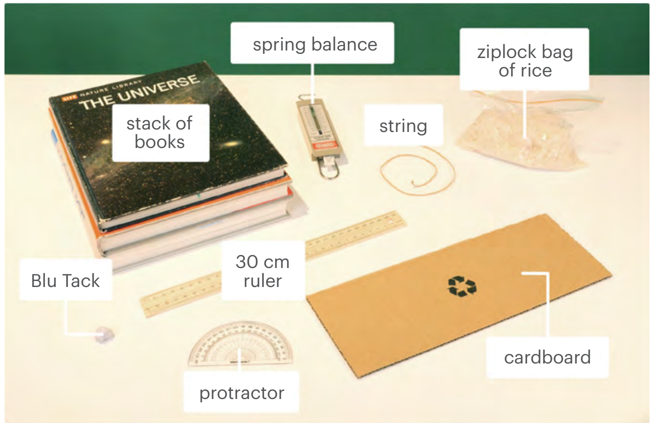
Activity purpose: Investigate how ramps can be used to reduce the force required to pull an object.

45 minutes	Lesson: stileapp.com/go/ramps
3–4 students per group	RiskAssess: stileapp.com/go/raramps

Materials

Each group of students will need:
- piece of cardboard
- stack of books
- spring balance
- small ziplock bag of rice
- string
- Blu Tack
- 30 cm ruler
- protractor

Alternative materials:
- *The rice can be replaced with any other suitable material, such as sand, soil, or gravel.*



Before class preparation

Other than collecting materials, no additional preparation is required.

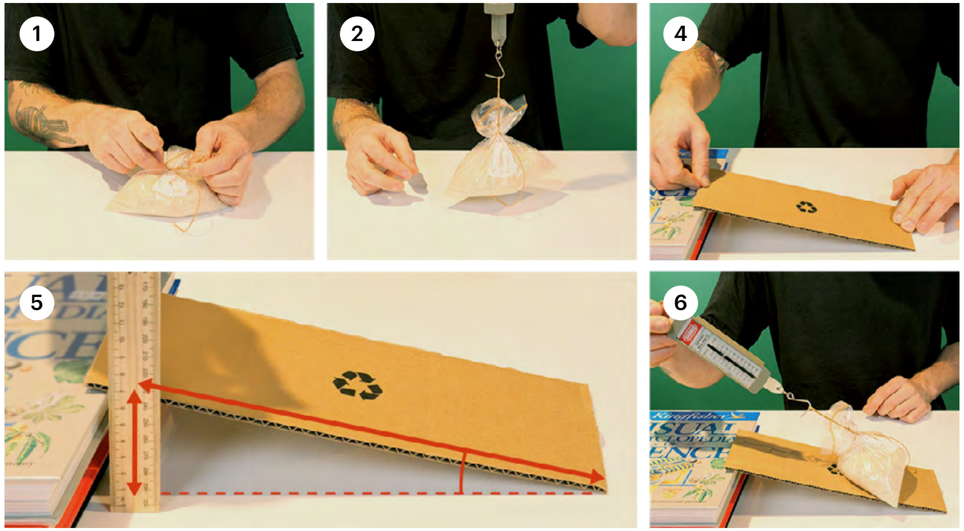
Tips and tricks

Things we learned from testing the lab ourselves
If pieces of cardboard are unavailable, other ramp materials can be substituted. Materials will vary in their coefficients of friction. If there's time, consider encouraging students to test different materials and compare the results. The ramp material should be as thin as possible while remaining rigid, as this will make it easier to accurately measure the length and height of slope.

Depending on the material that students' ramps are constructed from, some students might find that the effort force measured in some ramps is greater than the force due to gravity. This appears counter-intuitive, as the purpose of the ramp is to reduce the effort force. However, this may occur when the friction between the surface of the ramp and the ziplock bag is too great.

Method

1. Use a piece of string to tie a knot around the top of the ziplock bag of rice. Create a small loop that the spring balance can be attached to.
2. Using the spring balance, measure the force of gravity acting on the bag of rice.
3. Set up a stack of books
4. Use the piece of cardboard to create a ramp from the table to the top of the book stack. To start, place the piece of cardboard as far from the books as possible. Secure the piece of cardboard to the table and to the top of the stack of books using Blu Tack.
5. Measure the height of the ramp, the length of the ramp and the angle of inclination. *Note: Both the height and length of the ramp should be measured from the table to the top of the pile of books.*
6. Set up the ziplock bag of rice at the bottom of the ramp. Attach the spring balance and slowly drag the bag of rice up the ramp. Note the force measured on your spring balance. This is your effort force. *Note: Make sure you keep the spring balance parallel to the ramp.*
7. Repeat steps 4–6. Each time, gradually move the start of the ramp closer to the stack of books. Record at least five different ramp angles.



Final outcome

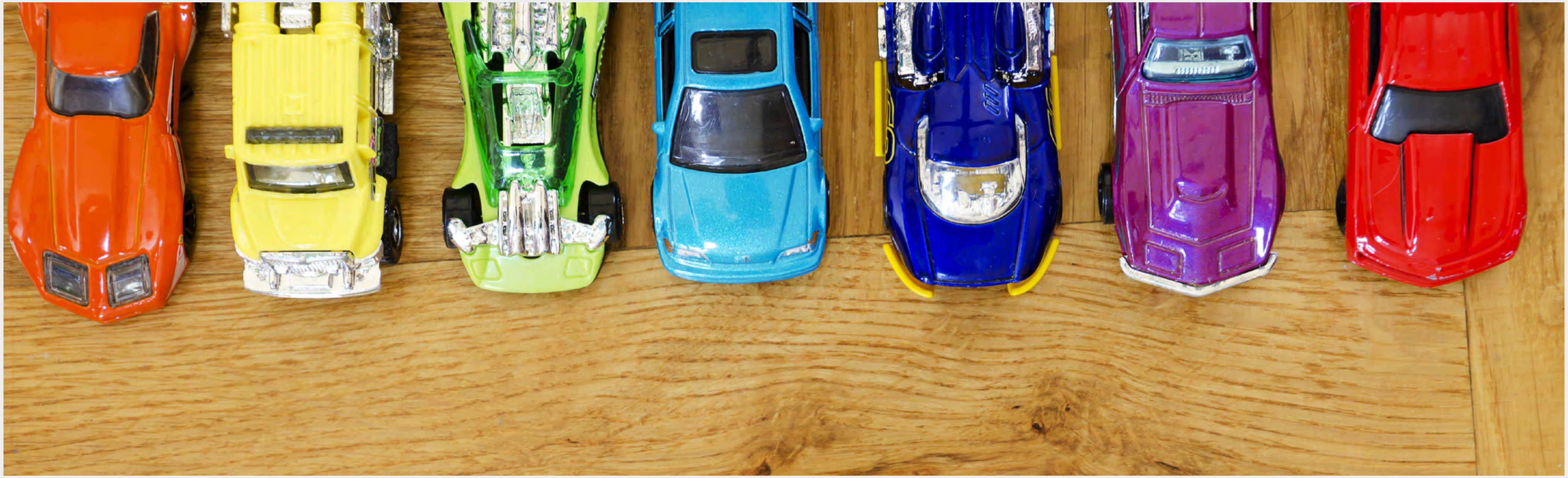
What you can expect to see at the end

This table is an example of the data students might collect during this practical activity. The results are for a bag of rice that weighed around 265 g.

Angle of inclination (°)	Length of slope (cm)	Height of slope (cm)	Effort force (N)
10	40	7	0.9
15	27	7	1.4
20	20	7	1.8
25	17	7	2.1
30	14	7	2.5

OPEN-ENDED INVESTIGATION

Effect of forces



Watch the demo video

stileapp.com/go/effectofforcesvideo

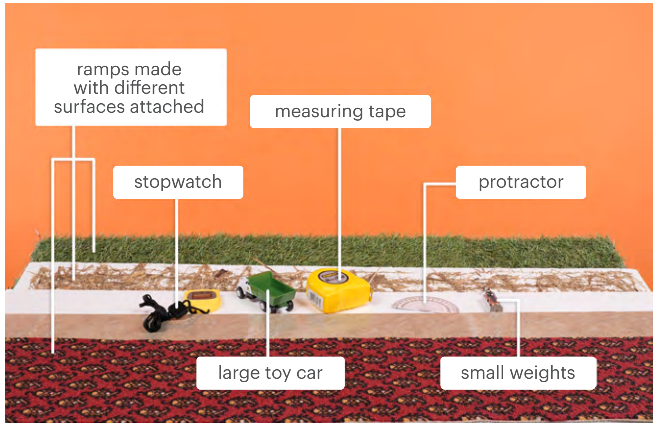
Activity purpose: Students will plan, conduct and communicate a scientific investigation into the effect of forces on moving objects.

45 minutes	Lesson: stileapp.com/go/EffectofForces
2–4 students per group	RiskAssess: stileapp.com/go/raeffectofforces

Materials

Each group of students will need:
- dynamic trolley or large toy car
- ramps with different surfaces attached:
  - smooth timber
  - carpet
  - linoleum
  - mulch
  - synthetic grass
- measuring tape
- protractor
- stopwatch
- small weights

Alternative materials:
- *Ramps can be constructed of any suitable materials. Both wooden and cardboard ramps are suitable.*



Before class preparation

60 min: The ramps for this activity need to be organised ahead of time. Consider purchasing pieces of timber to construct durable wooden ramps. To build the ramps, simply glue appropriate materials to one face of the timber board. These can be stored and reused in future years.

The ramps we used during testing were 1 m in length. This ramp length is effective, but not required. Shorter ramps can be used, provided all ramps are the same length.

Tips and tricks

Things we learned from testing the lab ourselves
Remind students to change only one variable and keep all of the others the same. We recommend either measuring the time it takes for the car to travel down the ramp, or how far the car travels after reaching the ground.

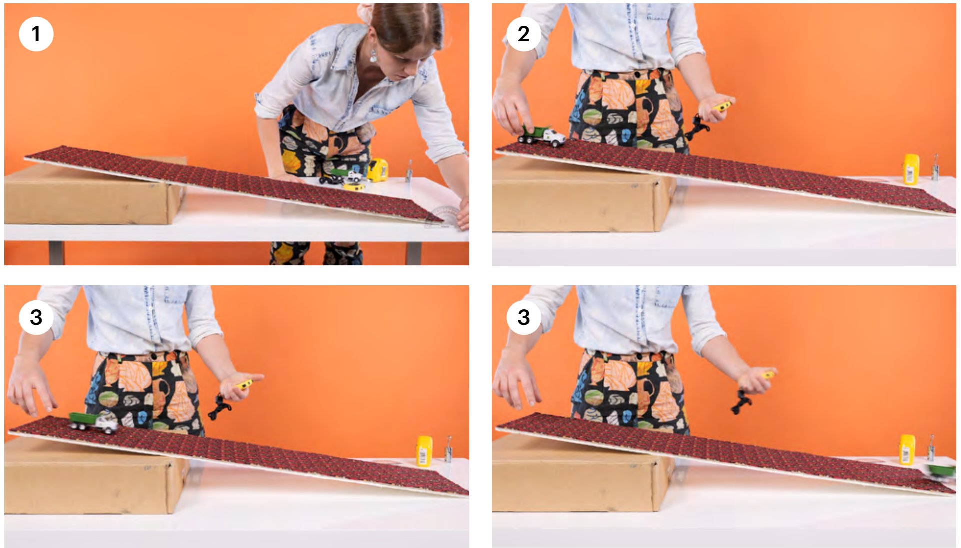
For students who are interested in extension, they can also measure the average speed of the car as it travels down the ramp. This can be done by measuring the time it takes for the car to go down the ramp and dividing the length of the ramp by this value.

Method

Students will write their own method for this open-ended investigation. An example of the steps a student might follow is listed below:

Example only:

1. *Raise one end of the carpet ramp to create an angle of inclination of 25 degrees.*
2. *Place the car at the top of the ramp.*
3. *Let go of the car and start the timer. Stop the timer when the car reaches the bottom of the ramp.*
4. *Record the time in the table. Repeat twice more and calculate an average.*
5. *Repeat steps 1–4 for the synthetic grass and smooth timber ramps.*

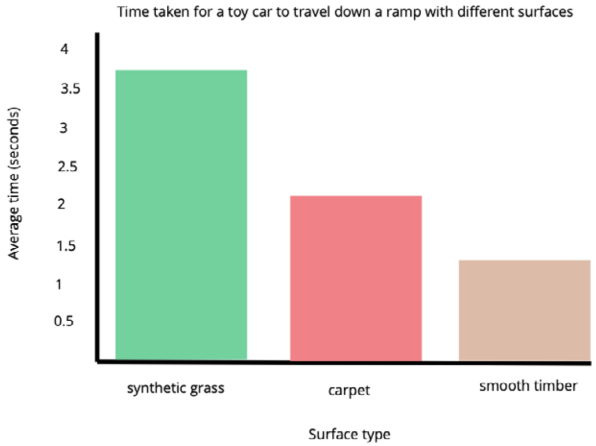


Final outcome

What you can expect to see at the end

Student results will vary depending on the variable they change and the variable they measure.

An example set of results is provided below. In this set of results, the time measured for the car to travel down the ramp was measured. The surface of the ramp was the variable that was changed.



PRACTICAL ACTIVITY

Speed and force multipliers

Watch the demo video

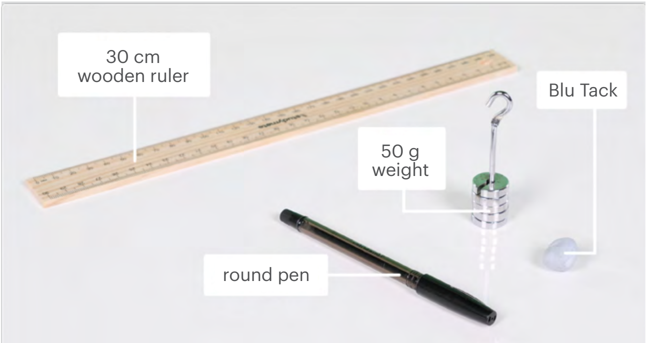
stileapp.com/go/speedforcemultipliervideo

Activity purpose: Investigate how a lever can be used to change the magnitude of a force.

45 minutes	Lesson: **stileapp.com/go/speedandforce**
2–4 students per group	RiskAssess: **stileapp.com/go/raspeedandforce**

Materials

Part 1: Testing a force multiplier
Each group of students will need:
- 30 cm wooden ruler
- 50 g weight
- round pen
- Blu Tack



Part 2: Testing a speed multiplier
Each group of students will need:
- 30 cm wooden ruler
- round pen
- Blu Tack
- marshmallow

Before class preparation

Other than collecting materials, no additional preparation is required.

Tips and tricks

Things we learned from testing the lab ourselves
The force and speed multipliers used in this lesson are designed to limit the possibility of objects flying across a classroom. Nevertheless, if you have the opportunity to do so, you may wish to test the force and speed multipliers outside of the science classroom.

In both parts of this investigation, encourage students to repeat their tests multiple times. This will help them identify small differences between the different levers. This is particularly important for part 1, where it can be difficult at first to notice the difference in force required to lift the mass.

Method

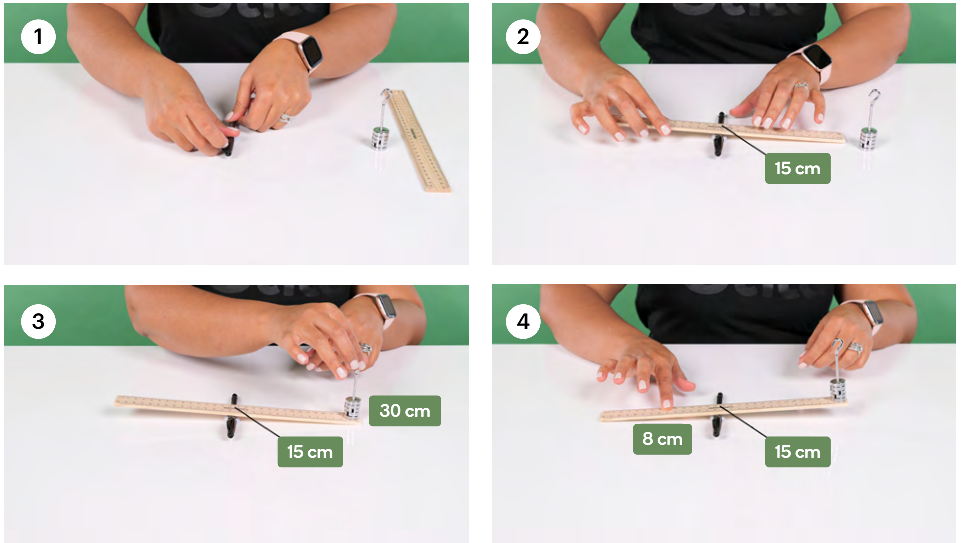
Part 1: Testing a force multiplier

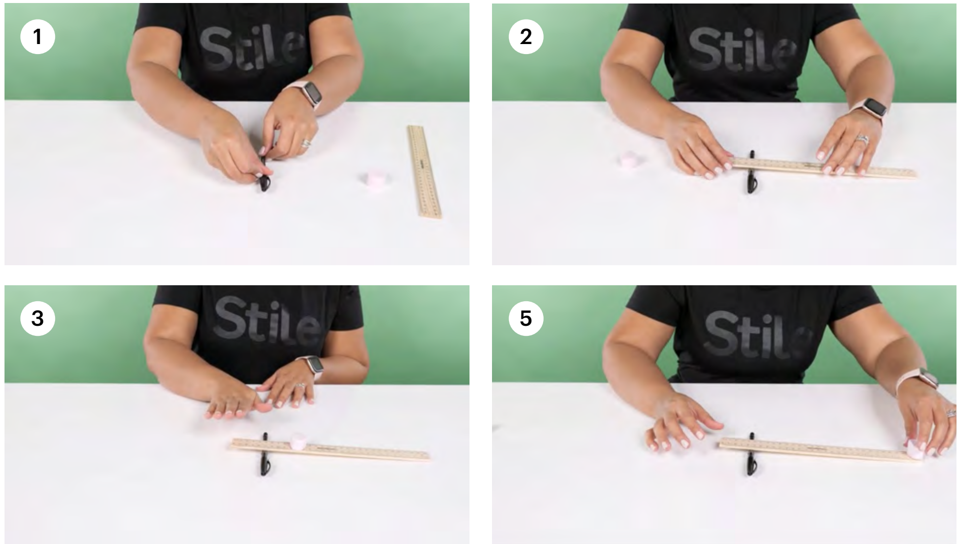
1. Stick the pen to the table with the Blu Tack. The pen will work as the fulcrum for your lever.
2. Place the ruler so that the 15 cm mark of the ruler is on top of the pen.
3. Position the weight at the 30 cm end of the ruler. Secure the weight to the ruler using Blu Tack. This is now your resistance arm.
4. Lift the weight by pushing down on the effort arm of the ruler with one finger. Press down where the ruler says 0 cm, 4 cm, 8 cm and 12 cm.

Tip: Test pressing down the effort arm at each position several times. Compare the amount of force that's required to lift the weight at each location.

Part 2: Testing a speed multiplier

1. Stick the pen to the table using Blu Tack.
2. Place the 5 cm mark of the ruler on the pen. This will create one long arm and one short arm. The long arm will be the resistance arm. The short arm will be the effort arm.
3. Place the marshmallow at the 10 cm mark of the ruler. Hit down with your hand onto the effort arm to propel the marshmallow into the air.
4. Measure the height that the marshmallow reached. This is the vertical distance it travelled.
5. Repeat steps 3 and 4 with the marshmallow at the 20 cm and then the 30 cm mark of the ruler.



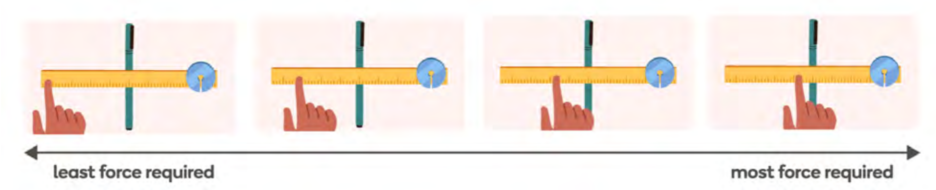


Final outcome

What you can expect to see at the end

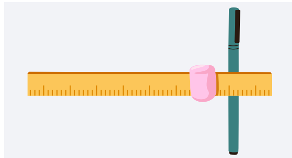
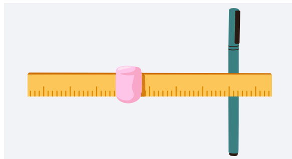
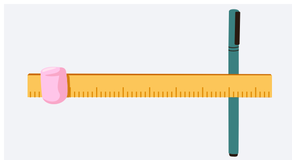
Part 1: Testing a force multiplier

Students will get a range of answers testing their force multipliers, but they should observe the following pattern of force required.



Part 2: Testing a speed multiplier

Students will get a range of answers testing their speed multipliers, but they should see similar observations to what's listed in the table below. The key observation they should note is that the marshmallow travelled a greater vertical distance the further the marshmallow was from the fulcrum.

	Position of the marshmallow	Observations
	5 cm from fulcrum	The marshmallow travelled only a small distance into the air. It reached a maximum height of around 10 cm.
	15 cm from fulcrum	The marshmallow flew much higher into the air than in the previous test. It reached a maximum height of around 40 cm.
	25 cm from fulcrum	The marshmallow flew so high it nearly hit the roof! It reached a maximum height of around 1.5 m.

PRACTICAL ACTIVITY

Testing a speed multiplier

Watch the demo video

stileapp.com/go/testingspeedmultipliervideo

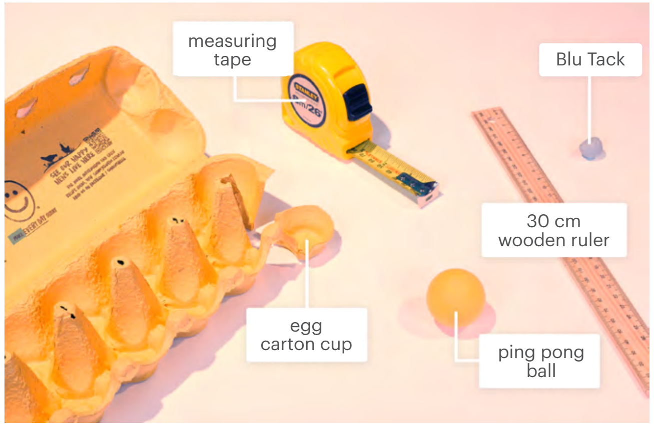
Activity purpose: Investigate the effect of speed multipliers on the distance an object is thrown.

45 minutes	Lesson: **stileapp.com/go/speedmultiplier**
2–4 students per group	RiskAssess: **stileapp.com/go/raspeedmultiplier**

Materials

Each group of students will need:
- 30 cm wooden ruler
- ping pong ball
- egg carton cup
- Blu Tack
- measuring tape

Alternative materials:
- *If you don't have an egg carton, other small receptacles, such as a paper cup or milk bottle lid, can be used to hold the ball.*



Before class preparation

Other than collecting materials, no additional preparation is required.

Tips and tricks

Things we learned from testing the lab ourselves
Even though the speed multipliers in this activity are simple, they can throw projectiles a considerable distance if used well. If possible, find a large space outside of the classroom for students to test their speed multipliers.

If you are conducting the investigation outside, consider setting out a number of measuring tapes before students begin testing. Students can then use these pre-set measuring tapes to more quickly measure the distance their ball is thrown in each test.

Encourage students to consider how they will measure the distance the ball travels in each throw. They can either measure distance based on where the ball first hits the ground or how far it travels before it stops. Either method is acceptable, so long as they are consistent between tests.

An important variable to control is the throwing technique across each test. Encourage students to consider the position from which they should release the ball so that it is a fair test. It may be best to halt the throwing motion once the throwing arm is perpendicular to the table.

Method

1. Place your elbow on a table or bench.
2. Throw the ping pong ball as far as you can without letting your elbow leave the table.
3. Measure the distance of your throw.
4. Record this in the results table below.
5. Repeat 5 times and calculate the average.
6. Place the cup on the ball thrower halfway along the ruler. This is ball thrower A. Repeat steps 1–5, recording all results in the table below.
7. Place the cup on the ball thrower at the very end of the ruler. This is ball thrower B. Repeat steps 1–5, recording all results in the table below.

Final outcome

What you can expect to see at the end
Students will have variations in their measurements. Students should demonstrate that the ball travels the furthest when using ball thrower B. The ball should travel the shortest distance when no ball thrower is used.

The answers below use the distance a ping pong ball travelled before it first hits the ground.

	Distance thrown (cm)					
Experimental set-up	Throw 1	Throw 2	Throw 3	Throw 4	Throw 5	Average
Arm only	301	295	320	279	288	297
Ball thrower A	489	515	512	499	507	504
Ball thrower B	931	902	914	926	897	914

PRACTICAL ACTIVITY

Building a catapult

Watch the demo video

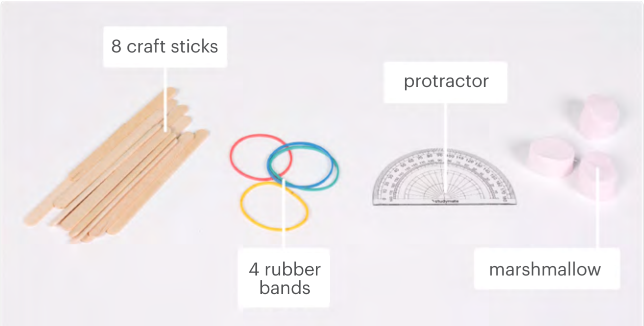
stileapp.com/go/catapultvideo

Activity purpose: Investigate how a catapult functions as both a force and a speed multiplier.

45 minutes	Lesson: **stileapp.com/go/catapult**
2–4 students per group	RiskAssess: **stileapp.com/go/racatapult**

Materials

Each group of students will need:
- 8 craft sticks
- 4 rubber bands
- marshmallow
- protractor



Before class preparation

Other than collecting materials, no other preparation is required.

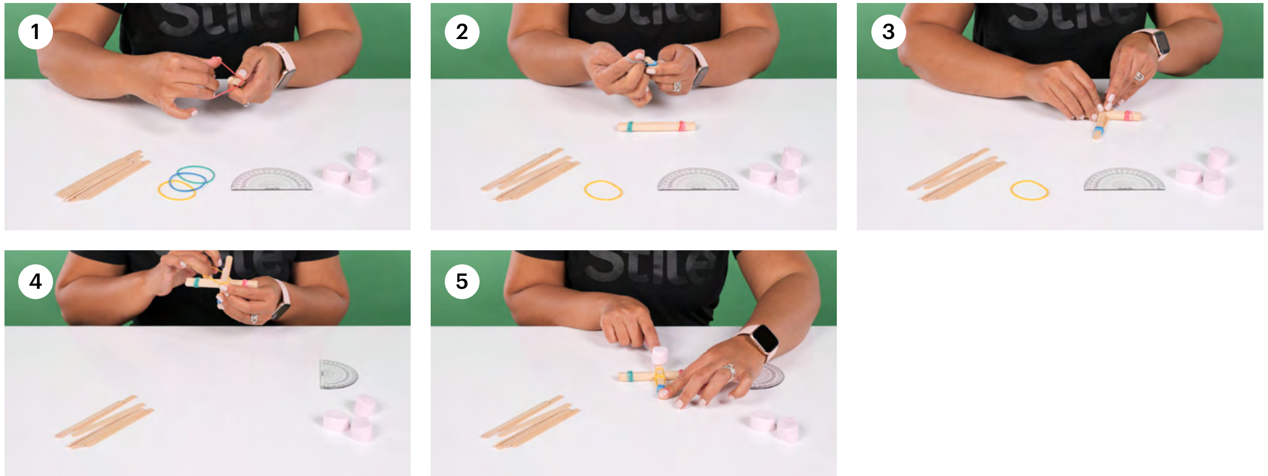
Tips and tricks

Things we learned from testing the lab ourselves
The catapults in this lesson are designed to provide an effective demonstration of the effect of levers, without launching objects with too much velocity around the room. Regardless, if you have the opportunity to do so, it might be worthwhile testing the catapults outside or in a gymnasium.

The catapults are easy to move once constructed, so building them in the classroom first and then moving location is easiest. When testing the catapults, students need a hard surface to rest their catapult on. This means that if you are intending to test the catapults in a grassed area, ask students to bring a hard cover book to rest their catapults on during testing.

Method

1. Form a stack of six craft sticks and wrap a rubber band around each end to hold them together.
2. Stack the other two craft sticks and bind them together at one end using another rubber band.
3. Separate the two craft sticks at the other end and slide the stack of six in between. The upper stick should make an angle of about 25 degrees with the horizontal.
4. Wrap the final rubber band around the centre of the structure to hold it all together.
5. Place a marshmallow on the raised end of the sloping stick. Launch the marshmallow by pressing down and releasing the stick.

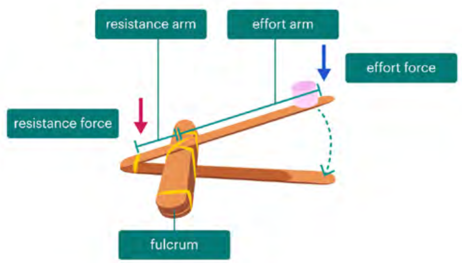


Final outcome

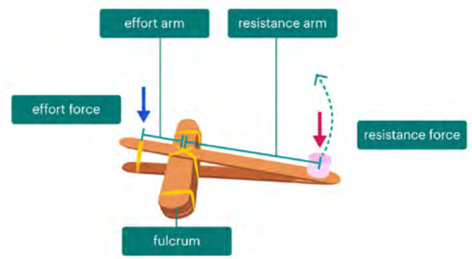
What you can expect to see at the end
The catapults students create mostly launch the marshmallow upward, rather than forward. You can expect to see a vertical height of around 75 to 90 cm from a successful launch. The marshmallow will likely move around half that distance forwards over the same time.

Using their observations from the catapult, students will then label the parts of the catapult in the *loading* phase and the *launching* phase.

Loading phase:



Launching phase:



ENGINEERING CHALLENGE

Designing an improved speed multiplier

Watch the demo video

stileapp.com/go/forcesengchallengespeedvideo

Activity purpose: Follow the engineering process to improve the design of a speed multiplier.

45 minutes	Lesson: stileapp.com/go/improvingspeedmultiplier
3–4 students per group	RiskAssess: stileapp.com/go/raimprovingspeedmultiplier

Materials

The quantity of materials will vary depending on the design of the the improved speed multiplier. The materials each group of students can choose from includes:

- Blu Tack
- 30 cm ruler
- rubber bands
- craft sticks
- glue
- egg carton cup
- cardboard
- string
- scissors
- ping pong ball
- masking tape

Before class preparation

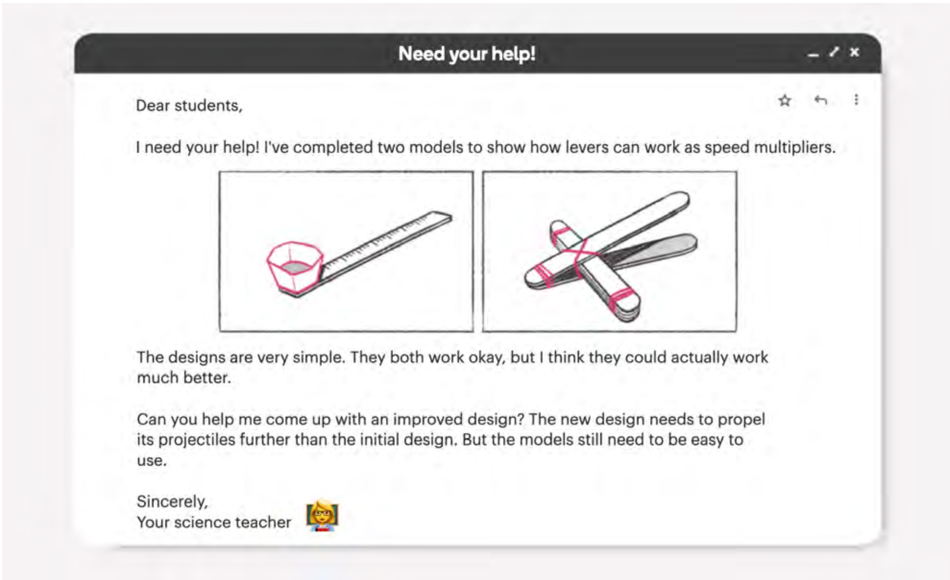
Other than collecting materials, no additional preparation is required.

Tips and tricks

Things we learned from testing the lab ourselves
When students are deciding which speed multiplier to improve, encourage some groups to choose the ball thrower and for others to choose the catapult. This will allow for fruitful discussion on how different improvements went at the end of the engineering challenge.

You may wish to run the second lesson of the engineering challenge outdoors, where there is plenty of space to practice and measure throws. To reduce the time spent measuring throws, consider setting up a testing area in a wide, open space. To do so, set up a series of parallel measuring tapes running out from a starting line.

The design brief



Final outcome

There are lots of possible solutions to the engineering challenge; here is an example we came up with during testing
This is an example of a speed multiplier based off of the ball thrower. The effectiveness of the speed multiplier has been improved by extending the length of the resistance arm. It has also been improved by changing the orientation of the ruler, so that the thin edge is facing forward, in order to reduce air resistance.

Troubleshooting

Some tricky areas in the engineering challenge that may require additional support
Creating a design that meets all of the criteria in the design brief can be tricky. To help students keep on track, keep the design brief projected on a screen during the design and build phases of the engineering challenge.

Explain that during the testing phase, students should be collecting data on the two criteria in the design brief they are trying to meet. These criteria are:

- The new design needs to propel projectiles further than the initial design.
- The new design must be easy to use.

If students are struggling to find inspiration for how to improve their designs, encourage them to look at examples of engineering in nature or the various designs of spear throwers. Some key principles students could consider when developing their designs are listed below.

Aerodynamics: Students can look to create a more streamlined design that travels through the air more easily.

Resistance arm length: Increasing the length of the resistance arm will increase the speed the projectile travels.

Ball holder: Improving the design of the ball holder will help maximise the amount of force transferred to the projectile.

Students will need to reflect on their process at the end of each lesson using a rubric. Walk students through the rubric at the end of each class and discuss how it can be used as a self-assessment tool.

PRACTICAL ACTIVITY

The effect of gravity

Watch the demo video

stileapp.com/go/effectgravityvideo

Activity purpose: Investigate the effect of gravity on objects of different mass.

45 minutes	Lesson: **stileapp.com/go/EffectofGravity**
2–4 students per group	RiskAssess: **stileapp.com/go/raeffectofgravity**

Materials

Each group of students will need:
- 4 balls of different mass
- electronic balance, accurate to 0.01 g
- video recording device (with the ability to film in slow motion, if possible)
- 1 m ruler

Before class preparation

Other than collecting materials, no other preparation is required.

Tips and tricks

Things we learned from testing the lab ourselves
If students don't have a video recording device with slow motion, there are a number of slow-motion video recording apps that students could download to assist them in viewing and analysing their results.

Method

1. Use the electronic balance to measure the mass of each ball and record the results in the table below.
2. Select a height to drop the balls from.
3. Set up the video recording device so that it is focused where the balls will hit the ground.
4. Drop all four balls at exactly the same time from exactly the same height.
5. Review the video and record your observations below.

Final outcome

What you can expect to see at the end
Students should observe that the four balls hit the ground at approximately the same time. There is likely to be some variation, and this can provide rich discussion for students who are interested.

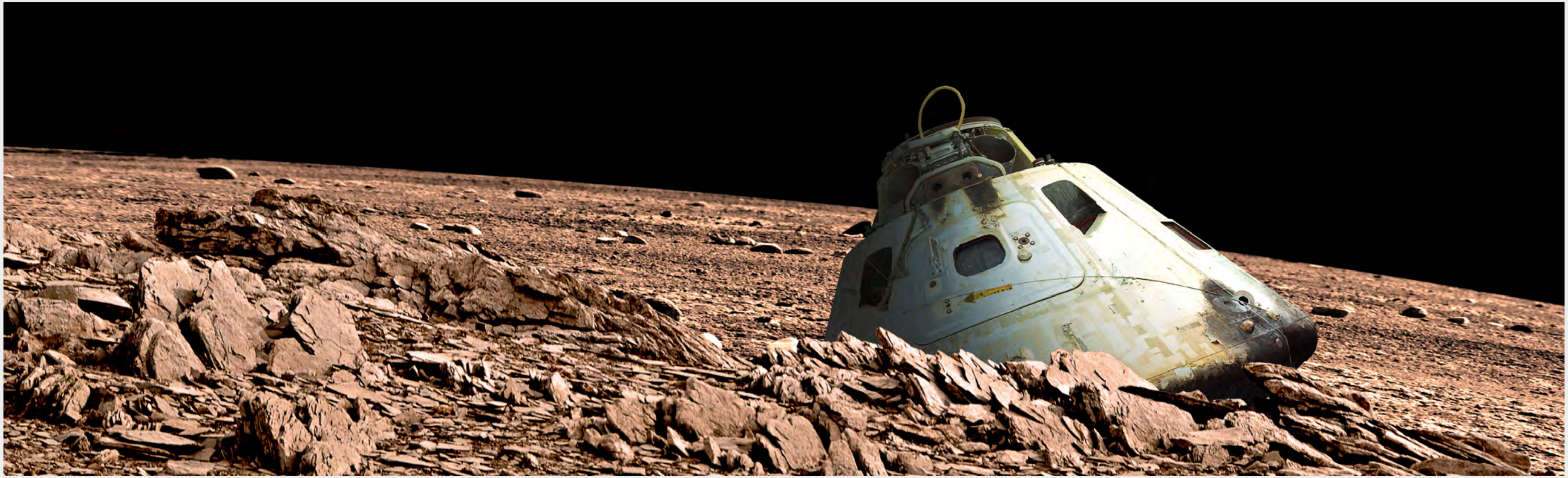
Two reasons why the balls might not hit the ground at the same time are human error and density.

Human error: It's hard to drop the four balls at the exact same time. Any differences in when balls are dropped will be reflected in the timing of when they hit the ground.

Density: Denser objects will fall slightly faster than less dense objects. To explain this to students, picture two balls of the exact same size, but different mass. As they are the same size, both balls have the same air resistance acting against them. However, the heavier ball has a greater force due to gravity acting upon it.

ENGINEERING CHALLENGE

Designing a space parachute



Watch the demo video

stileapp.com/go/forcesengchallengeparachutevideo

Activity purpose: Follow the engineering process to design a parachute for a spacecraft.

45 minutes	Lesson: stileapp.com/go/spaceparachute
2–4 students per group	RiskAssess: stileapp.com/go/raspaceparachute

Materials

The quantity of materials will vary depending on the design of the parachute. The materials each group of students can choose from includes:

- garbage bags, $10 per bag
- sheets of newspaper, $5 per sheet
- masking tape, $1 per 10 cm
- string, $2 per 30 cm
- Blu Tack, $10 per stick

Each group of students will also require:

- egg, for the cargo
- ziplock bag, for the cargo
- scissors, only for cutting
- 8 m measuring tape, only for measuring

Before class preparation

Other than collecting materials, no other preparation is required.

Tips and tricks

Things we learned from testing the lab ourselves

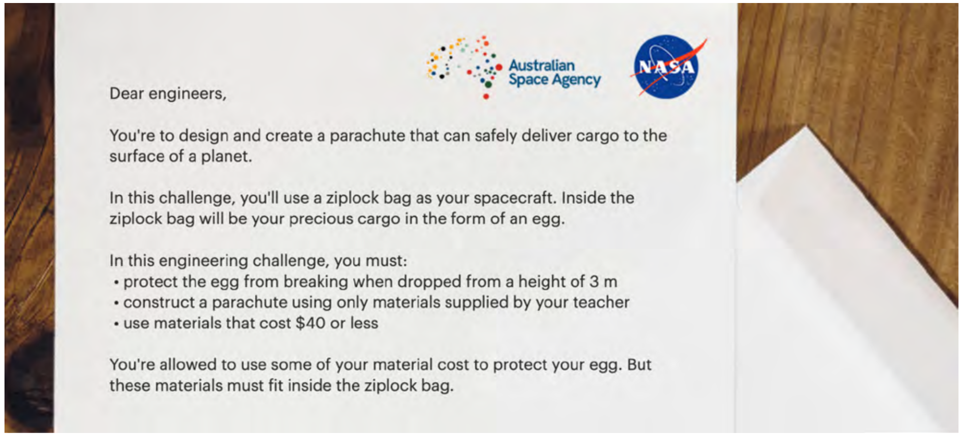
Finding the right location to test the parachutes can be tricky. If possible, a location that is protected from wind works best. External stairwells often work as great testing locations as it's easy to adjust the height at which objects are dropped from. Note that a 3 m height is not essential for this test, provided all parachutes are dropped from the same height.

The ziplock bag is included to help provide a seal for the egg. This helps contain any breakages that might occur during testing. If possible, encourage students to take pictures of the egg in the ziplock bag after each round of testing, this will provide great evidence for the impact of their improvements on the effectiveness of their designs.

When reviewing the budget of each group before testing, encourage groups to provide a labelled diagram to demonstrate where they are spending their budget. As a fun addition, you can even provide students with tokens of fake currency. Students can then exchange these with you for materials. This can be a great way to ensure students carefully track their budget and don't accidentally spend too much.

To improve the effectiveness of the parachutes during testing, consider moving the parachute back and forth to inflate it before it is dropped.

The design brief



Dear engineers,

You're to design and create a parachute that can safely deliver cargo to the surface of a planet.

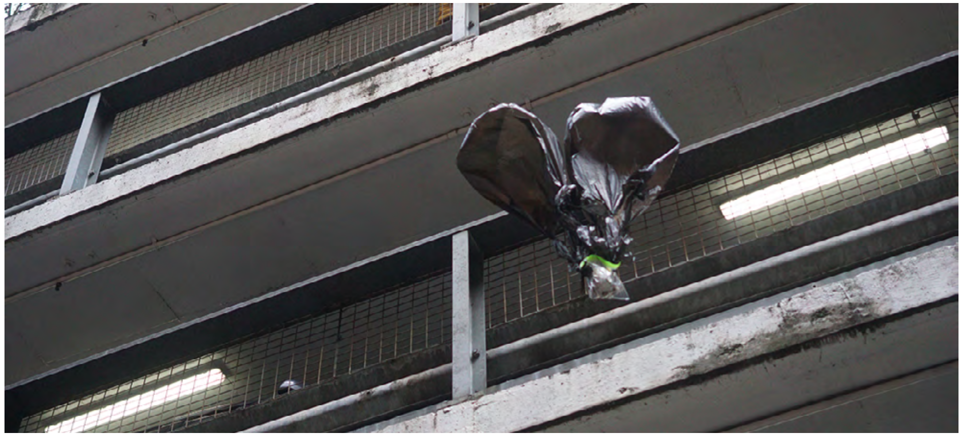
In this challenge, you'll use a ziplock bag as your spacecraft. Inside the ziplock bag will be your precious cargo in the form of an egg.

In this engineering challenge, you must:
- protect the egg from breaking when dropped from a height of 3 m
- construct a parachute using only materials supplied by your teacher
- use materials that cost $40 or less

You're allowed to use some of your material cost to protect your egg. But these materials must fit inside the ziplock bag.

Final outcome

There are lots of possible solutions to the engineering challenge; here is an example we came up with during testing
Student designs will vary depending on the materials they use and budget they have. Below is an example design students created during testing.



Troubleshooting

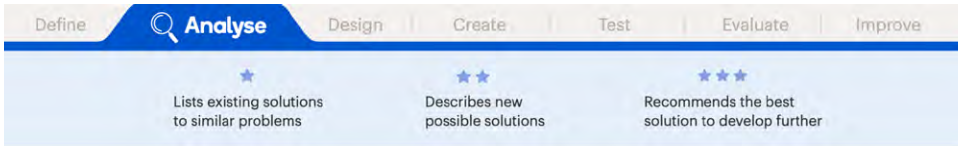
Some tricky areas in the engineering challenge that may require additional support
Creating a design that meets all of the criteria in the design brief can be tricky. To help students stay on track, keep the design brief projected on a screen during the design and build phases of the engineering challenge.

Walk around the class and prompt students when you notice they're straying from their initial drawings. Encourage them to recalculate their budgets as they adjust their designs.

Students will need to reflect on their process at the end of lesson two and four by using a rubric. Walk students through the rubric in lesson one and discuss how it can be used as a self-assessment tool.

	★	★★	★★★
Define	Identifies the problem to be solved	Describes the success criteria for the solution	Explains the constraints of the problem
Analyse	Lists existing solutions to similar problems	Describes new possible solutions	Recommends the best solution to develop further
Design	Lists design features of the proposed solution	Draws a prototype that includes the specific design features	Explains how the design features will work to solve the problem
Create	Creates a prototype for testing	Creates a prototype that matches the drawn design	Justifies design elements that were modified during construction
Test and Evaluate	Records the results of testing	Describes the results of testing	Evaluates the effectiveness of the prototype against the design criteria
Improve	States which parts of the design should be improved	Describes the changes that could be made to improve the function of the design	Justifies how the improvements lead to an optimal solution

The banners within units also help breakdown the stages of each rubric. Explain that the banners also show the stage in the engineering process students are about to begin.



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Swing by the office to say hi!
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Stile HQ is located on the traditional lands of the Boon Wurrung and Woiwurrung (Wurundjeri) peoples of the Kulin Nation. We acknowledge that sovereignty was never ceded and pay our respects to Elders past, present and future.