Stile

Energy

# How can we learn from nature to improve energy technology?

Teaching Plan and Lab Guide

***Elastic potential energy***
*The mantis shrimp has a spring-loaded club that releases energy very quickly. It uses this club to punch its prey.*

Version 2.2

# Contents

## Teaching Plan



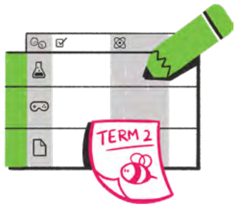
## Lab Guide

# 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.

## Before class

### Teacher resources




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

### Student resources

**Stile X phone app**

- Front-load the unit's scientific terminology through flashcards and quizzes

## During class

### Teacher resources

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

### Student resources

**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

### Teacher resources

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

### Student resources

**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

***The fastest land animal***
*Cheetahs run with their claws out, sticking them into the ground for grip.*

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# Teaching Plan

# Storyline and real-world phenomenon

## How can we learn from nature to improve energy technology?

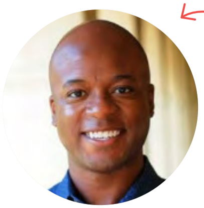
Climate change continues to cause long-lasting damage to our environment and scientists are looking for solutions. Renewable energy technologies are cleaner and more sustainable ways of powering our homes but these technologies are far from perfect. For example, most solar panels can only transform 20% of sunlight into usable electrical energy.

Engineers are now looking to nature for ways of improving the designs of our renewable energy technologies. Organisms have evolved adaptations that have been tried and tested over millions of years in their struggle for survival. Incorporating these adaptations into engineering designs is called biomimicry.

In this unit, students discover how biomimicry can provide a new lens to engineering as they design better renewable energy technologies. Students explore real-world examples like solar panels inspired by sunflowers and wind turbines inspired by humpback whales. This biology-inspired physics unit covers forms of energy, as well as energy transfer and energy transformation; and challenges students to engineer an improved water wheel design by taking inspiration from a plant or animal. Throughout the unit, students work towards answering the question, “How can we learn from the natural world to design more sustainable energy technology?”

**Big ideas**

- What forms of energy are there?
- What role do kinetic energy and potential energy play in our daily lives?
- What’s the difference between energy transfer and energy transformation?
- How can we improve renewable energy technology using biomimicry?



*In this unit students meet Professor **John Dabiri**, a bioengineer who studies the energy efficiency of living things to design better technology*

**Highlights**

- Explore real examples of technologies inspired by living things
- Build a range of devices, including a water wheel and a light bulb
- Use interactive simulations to investigate kinetic energy and explore energy transformations
- Complete an engineering challenge where students design a solution aligned to the UN Sustainable Development Goals
- End of unit test

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# This unit at a glance

**This unit is designed to take six 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 have additional revision and consolidation material available in **Stile X**, our hard-copy study booklet and accompanying app.

## Energy

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

Students **meet their guide** for the unit – Professor John Dabiri, a **bioengineer** who has improved the energy efficiency of wind turbines.

- Introduction: Nature's energy engineers
- Career profile and activity: Bioengineer
- Pre-test: Energy

Students **explore** how solar panels can be improved by observing sunflowers.

- 1.1 Energy mystery box
- 1.2 Forms of energy
- 1.2 Check-in: Forms of energy
- 1.3 Defining energy and its units
- 1.3 Check-in: Defining energy and its units

Students learn about kinetic energy by using marbles to **model changes in the speed and mass** of asteroids.

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

- 2.1 Asteroid marble drop
- 2.2 Kinetic energy
- 2.2 Check-in: Kinetic energy
- Skill builder: Planning – Question
- 2.3 Kinetic energy
- 2.4 Potential energy
- 2.4 Check-in: Potential energy
- 2.5 Rubber band racers

Students **model energy transfers and transformations** using an interactive simulation.

Using a **real-world example** of energy changes at a hydropower plant, students examine energy transfer and transformation.

- 3.1 Energy transfer and transformation
- 3.1 Check-in: Energy transfer and transformation
- 3.2 Water wheels
- 3.3 Pedal power
- 3.4 Energy efficiency
- 3.4 Check-in: Energy efficiency
- 3.5 Bouncing balls
- 3.6 Create a light bulb

In the **engineering challenge**, students use the United Nations Sustainable Development Goals to improve renewable energy technology using **biomimicry**.

- 3.7 Designing a solution
- 3.8 Testing and improving a solution
- 3.9 Communicating a solution

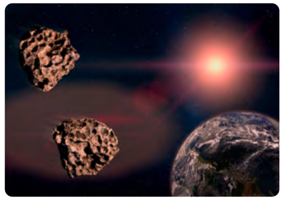
This **summative assessment** assesses students' curriculum-aligned knowledge.

- Glossary: Energy
- Test: Energy

# Unit storyline

Throughout this unit, students explore how engineers solve problems in creative ways, taking inspiration from nature. With lots of examples of interesting inventions, they are then motivated to design a solution aligned with the UN sustainability goals. The use of multiple phenomena supports students in developing scientific skills and understanding. The progression of these phenomena, and how they are observed within lessons, is detailed below.

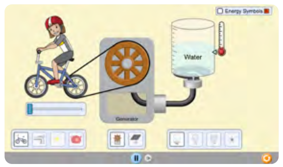
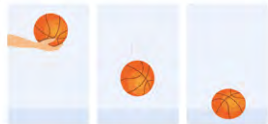
| Phenomenon | Lesson |
|---|---|
| **Humpback whale fins can be used to improve wind turbine designs**   | **Introduction: Nature's energy engineers**<br>– Students learn about how the problem of climate change relates to our use of energy<br>– They explore examples of biomimicry including the humpback whale adaptation of decreasing drag and how this could be applied to create energy efficient wind turbines |
| **Velcro was inspired by grass seeds**   | **1.1 Energy mystery box**<br>– Students explore types of energy in everyday objects and group them based on similarities and differences<br>– They discover the mystery box item inspired by nature is Velcro – inspired by grass seeds |

| Phenomenon | Lesson |
|---|---|
| **Sunflowers can be used to improve solar panels**  | **1.2 Forms of energy**<br>– Students examine how solar panels can be improved by observing sunflowers<br>– They learn about various forms of energy, including kinetic energy and potential energy |
| **Modelling asteroid impacts**  | **2.1 Asteroid marble drop**<br>– Students model an asteroid impact using marbles and flour to determine whether mass or speed affects the kinetic energy of an object<br>– They explore the limitations of scientific models |

# Unit storyline

| Phenomenon | Lesson |
|---|---|
| **The speed of an Olympic gold medalist vs a cheetah**  | **2.2 Kinetic energy**<br>– Students consider how speed impacts kinetic energy by exploring the difference between cheetahs and humans<br>– They discover Olympic sprinter shoe spikes are inspired by cheetahs' claws<br>– They calculate kinetic energy and explore how it relates to mass |
| **Braking distance in a car**  | **2.3 Kinetic energy**<br>– Students explore how braking distance is affected by mass and speed by planning an investigation and collecting data using a simulation |
| **The potential energy of a mantis shrimp and herring gull**   | **2.4 Potential energy**<br>– Using the context of the mantis shrimp, students examine how elastic potential energy depends on changes in shape<br>– Taking inspiration from the herring gull, students examine how gravitational potential energy depends on height and mass<br>– Students discover the mantis shrimp uses more potential energy than the herring gull to break open a clam's shell |
| **The energy of elastic bands**  | **2.5 Rubber band racers**<br>– Students discover the elastic potential energy of elastic bands by watching them explode a watermelon<br>– They use this knowledge to build a toy car powered by rubber bands<br>– They collect and use data to determine the relationship between stretch distance and distance travelled to learn about elastic potential energy |

# Unit storyline

| Phenomenon | Lesson |
|---|---|
| **Hydropower plants are inspired by waterfalls**  | **3.1 Energy transfer and transformation**<br>– Students learn about energy transfers and transformations through the context of waterfalls and how these have inspired hydropower plants<br>– They build energy flow diagrams to help understand how one form of energy can transform into another form |
| **Water wheels**  | **3.2 Water wheels**<br>– Students discover water wheels move from falling water<br>– They build a water wheel and apply their understanding of energy transfers and transformations |
| **Pedalling can create electricity**  | **3.3 Pedal power**<br>– Students use a simulation to explore how pedalling can create electricity by applying their understanding of energy transformations |
| **Laptops heat up while running**  | **3.4 Energy efficiency**<br>– Students explore how energy transformations work in a laptop<br>– They calculate energy efficiency of everyday objects and are introduced to waste energy, such as heat in a laptop |
| **Bouncing balls decrease their bounce over time**  | **3.5 Bouncing balls**<br>– Students test energy efficiency in a number of different bouncing balls |
| **LED bulbs are more efficient than filament bulbs**  | **3.6 Creating a light bulb**<br>– Students build a filament light bulb and explore the waste energy of these bulbs |

# Curriculum alignment

This unit focuses on forms of energy, energy transfers and energy transformations, and then challenges students by exploring how biomimicry can help improve renewable energy technologies.

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:

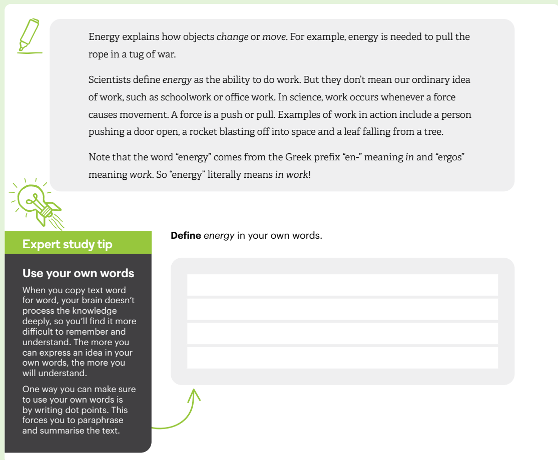
- The concepts of renewable energy, sustainability and energy use at home (**Resources** unit)
- The general flow of matter (**Food Chains and Food Webs** unit)
- The forces that act upon objects and relating the changes of an object's motion to its mass (**Forces** unit)

# Stile X: Energy

## 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:
- Forms of energy
- Defining energy and its units
- Kinetic energy
- Potential energy
- Energy transfer and transformation


Energy explains how objects *change* or *move*. For example, energy is needed to pull the rope in a tug of war.

Scientists define *energy* as the ability to do work. But they don't mean our ordinary idea of work, such as schoolwork or office work. In science, work occurs whenever a force causes movement. A force is a push or pull. Examples of work in action include a person pushing a door open, a rocket blasting off into space and a leaf falling from a tree.

Note that the word "energy" comes from the Greek prefix "en-" meaning *in* and "ergos" meaning *work*. So "energy" literally means *in work*!

**Expert study tip**

**Use your own words**

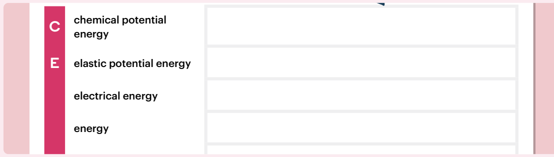
When you copy text word for word, your brain doesn't process the knowledge deeply, so you'll find it more difficult to remember and understand. The more you can express an idea in your own words, the more you will understand.

One way you can make sure to use your own words is by writing dot points. This forces you to paraphrase and summarise the text.

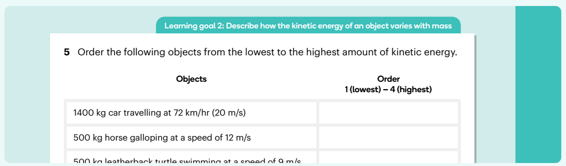
**Define** *energy* in your own words.

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.


| | |
|---|---|
| C | chemical potential energy |
| E | elastic potential energy |
| | electrical energy |
| | energy |

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.
- Classify different forms of energy encountered in everyday life
- Recognise the definition of energy
- Make simple calculations of energy using appropriate units
- Describe how the kinetic energy of an object varies with speed
- Describe how the kinetic energy of an object varies with mass
- Describe how elastic potential energy depends on an object's shape
- Analyse how gravitational potential energy depends on an object's mass and height
- Describe the difference between energy transfer and energy transformation
- Model energy transfers and transformation using simple flow diagrams


Learning goal 2: Describe how the kinetic energy of an object varies with mass

5 Order the following objects from the lowest to the highest amount of kinetic energy.

| Objects | Order 1 (lowest) – 4 (highest) |
|---|---|
| 1400 kg car travelling at 72 km/hr (20 m/s) | |
| 500 kg horse galloping at a speed of 12 m/s | |

# 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.


### Check-ins

Six check-in lessons have been included as a formative assessment opportunity in 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 | 1.2 Check-in: Forms of energy | Multiple choice, drag and drop | 5–10 minutes |
| Check-in | 1.3 Check-in: Defining energy and its units | Multiple choice | 5–10 minutes |
| Check-in | 2.2 Check-in: Kinetic energy | Multiple choice | 5–10 minutes |
| Check-in | 2.4 Check-in: Potential energy | Multiple choice | 5–10 minutes |
| Check-in | 3.1 Check-in: Energy transfer and transformation | Multiple choice, drag and drop | 5–10 minutes |
| Check-in | 3.4 Check-in: Energy efficiency | Multiple choice, drag and drop | 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: Energy | Multiple choice, drag and drop, written response | 45–60 minutes |

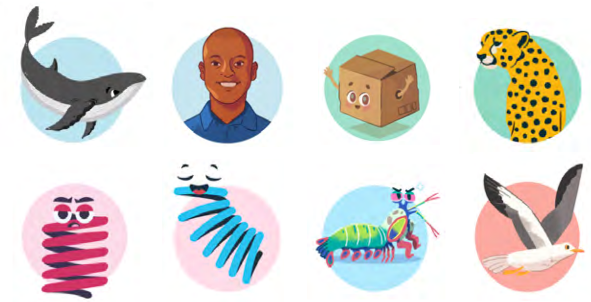
### Scientific skills

One project within this unit can be used as a summative assessment of science inquiry skills.

| Lesson type | Lesson name | Question types | Time |
|---|---|---|---|
| Engineering challenge | 3.7 Designing a solution | Written response | 45 minutes |
| Engineering challenge | 3.8 Testing and improving a solution | Written response | 45 minutes |
| Engineering challenge | 3.9 Communicating a solution | Written response | 45 minutes |

# Important things to know about this unit

## Character conversations

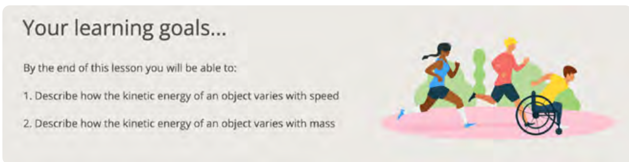


Whale, Professor John Dabiri, Penguin, Kingfisher, Kangaroo, Box, Toaster, Blue Spring, Pink Spring, Cheetah, Car, Clam, Mantis Shrimp and Herring Gull are included as animated characters throughout the unit, and speech bubbles are used as a bridge between sections of the lesson and to provide light 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. Students frequently contribute their questions to live brainstorms, and these questions are drawn upon to drive the learning from the students' perspectives. The guiding question, "How can we learn from nature to improve energy technology?" is introduced in the Introduction: Nature's energy engineers. It 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 a solution to the problem. 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).

## 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/parentemailenergy**

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.

# Important things to know about this unit

## Elastic vs gravitational potential energy poster

This unit has an accompanying poster that summarises elastic and gravitational potential energy through a quirky cartoon that showcases how mantis shrimp and clams use potential energy to their advantage. Purchase this poster from the Stile Shop **here**.


## 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

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 | **Introduction: Nature's energy engineers** | 1. Identify examples of energy technology that are inspired by nature | Review teaching notes in Prepare Mode<br>Collect Stile X booklets for this unit<br>Find out more about using Stile X in **The Stile Guide**<br>**Send parent email template**<br>10 minutes | As a class, use the live brainstorm to briefly discuss climate change and draw out students' prior knowledge | Students explore examples of "engineering" in nature through the process of evolution, they will then be introduced to a new field of science and engineering called biomimicry | Students complete the live brainstorm to consider any questions they have around energy or biomimicry<br>Hand out the Stile X booklets and activate Stile X app | Stile X app: Flashcards |
| Sesion 2 | **Career profile and activity: Bioengineer**<br>MATERIALS REQUIRED | | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>Printed class set of **cards for the biomimicry design activity**<br>30 minutes | As a class, read and watch a video introducing Professor John Dabiri, a bioengineer, who will be the guide for the unit | Students analyse an example of John's biomimicry and then use this inspiration to design their own using two randomly assigned cards (one natural, one man-made) | Introduce the engineering challenge at the end of the unit and, as a class, discuss how learnings from this lesson could prepare them for the final engineering challenge | Stile X app: Flashcards |
| Session 3 | **Pre-test: Energy** | | Provide feedback on the design task in the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>30 minutes | Explain that students will complete a pre-test to help you find out what they already know | Students complete a pre-test to show what they already know about energy | Review student designs from the previous class | Stile X app: Flashcards |
| Session 4 | **1.1 Energy mystery box**<br>MATERIALS REQUIRED | 1. Classify everyday objects based on observed similarities relating to energy | Review student answers to **Pre-test: Energy** in Analyse Mode to gauge students' prior knowledge<br>Review teaching notes in Prepare Mode<br>Collect the required materials listed in the **Lab Guide**<br>Complete the **Risk Assessment Template**<br>25 minutes | As a class, briefly review how observations are made and their importance for scientists | Students use their senses to investigate what they can find in their mystery box and then associate it to similarities relating to energy | As a class, discuss any hard to place items and then look back at the poll (before the mystery box) where students guessed which item was an example of biomimicry and review why the answer was Velcro | Stile X app: Flashcards |

| | Lesson name | Learning goals | Preparation required | Ice breaker | Core of lesson | To close | Revision and mastery |
|---|---|---|---|---|---|---|---|
| Session 5 | **1.2 Forms of energy** | 1. Classify different forms of energy encountered in daily life | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>20 minutes | As a class, watch a video on sunflower movement and then ask students to complete a *See, Think, Wonder* thinking routine | Students explore forms of energy and then make connections to examples from everyday life<br>Direct students to the corresponding Stile X revision notes to complete the question: In your own words, define energy | Ask students to reflect on forms of Energy using the *I used to think, but now I think* thinking routine<br>Assign **1.2 Check-in: Forms of energy** as homework to be completed before the next lesson | Stile X app: Flashcards<br>Stile X app: Forms of energy video<br>Stile X Revision notes: Forms of energy<br>Glossary terms: sound, light, heat, electrical energy, thermal energy, kinetic energy, potential energy |
| Session 6 | **1.3 Defining energy and its units** | 1. Recognise the definition of energy<br>2. Make simple calculations of energy using appropriate units | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>20 minutes | As a class, review answers to **1.2 Check-in: Forms of energy** | Students define energy and then learn about the standard unit for measuring energy: the joule<br>Direct students to the corresponding Stile X revision notes to complete the question: Define energy in your own words | Ask students to reflect on this lesson by using the *Very Important Points* reflection strategy<br>Assign **1.3 Check-in: Defining energy and its units** as homework to be completed before the next lesson | Stile X app: Flashcards<br>Stile X app: Defining energy and its units video<br>Stile X Revision notes: Defining energy and its units<br>Glossary terms: energy, joule, kilojoule |
| Session 7 | **2.1 Asteroid marble drop**<br>MATERIALS REQUIRED | 1. Conduct simple tests to collect data about kinetic energy<br>2. Interpret the results to describe how mass and speed relate to kinetic energy | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>Collect the required materials listed in the **Lab Guide**<br>Complete the **Risk Assessment Template**<br>30 minutes | As a class, review answers to **1.3 Check-in: Defining energy** | Students investigate kinetic energy through looking at speed and mass | Ask students to reflect on this lesson by using a *Plus, Minus, Interesting (PMI) chart* | Stile X app: Flashcards<br>Glossary terms: model |
| Session 8 | **2.2 Kinetic energy** | 1. Describe how the kinetic energy of an object varies with speed<br>2. Describe how the kinetic energy of an object varies with mass | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>20 minutes | As a class, discuss using biomimicry of a cheetah's foot in sport and whether it is a form of cheating | Students will consider how mass and speed relate to kinetic energy and explain the relationship between the three | Ask students to reflect on this lesson by using the *Very Important Points* reflection strategy<br>Direct students to the corresponding Stile X revision notes to complete the question: Use the outline note-taking method to summarise kinetic energy | Stile X app: Flash quiz 1, Kinetic energy video<br>Stile X Revision notes: Kinetic energy<br>Glossary terms: speed, mass, linear relationship, non-linear relationship |

| | Lesson name | Learning goals | Preparation required | Ice breaker | Core of lesson | To close | Revision and mastery |
|---|---|---|---|---|---|---|---|
| Session 9 | **Skill builder: Planning – Question**<br>*This lesson is optional and can be skipped* | 1. Identify the independent and dependent variables in a testable question<br>2. Determine a testable question for an investigation | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>20 minutes | As a class, talk through the Conducting a Science Investigation poster in the lesson | Students practise writing testable questions and identifying independent and dependent variables | Ask students to reflect on how their learning has changed since the start of the lesson<br>Assign **2.2 Check-in: Kinetic energy** as homework to be completed before the next lesson | Stile X app: Flashcards |
| Session 10 | **2.3 Kinetic energy** | 1. Identify independent, dependent and controlled variables to ensure a fair test | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>20 minutes | As a class, review answers to **2.2 Check-in: Kinetic energy** | Students conduct an investigation on the effect of mass and speed on kinetic energy in vehicles using a simulation<br>**Questions 1–6** | Ask students to ensure they have all their results recorded and a photo of these uploaded in question 6 | Stile X app: Flashcards |
| Session 11 | **2.3 Kinetic energy**<br>*You may choose to teach this lesson at a faster pace in only one session.* | 2. Interpret the results to describe how mass and speed relate to kinetic energy | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review rubric in preparation<br>10 minutes | As a class, discuss students' observations from their individual tests last lesson | Students analyse and interpret their results from their investigation in the previous lesson<br>**Questions 7–14** | Ask students to reflect on their investigation by listing what worked well and what they could improve<br>Direct students to the corresponding Stile X revision notes to complete the question: Identify an example of each type of potential energy | Stile X app: Flashcards |
| Session 12 | **2.4 Potential energy** | 1. Describe how elastic potential energy depends on an object's shape<br>2. Analyse how gravitational potential energy depends on an object's mass and height | Provide feedback on the Key Question, review the questions students still have about energy and provide feedback on their individual evaluations using the rubric from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>30 minutes | As a class, watch two videos of predators using energy to obtain food and get students to predict which animal can supply more energy | Students explore potential energy, focusing on how elastic potential energy depends on shape and how gravitational potential energy depends on height and mass<br>*Extension task: Students can calculate gravitational potential energy* | Ask students to reflect on this lesson by using the *3-2-1 Bridge* thinking routine<br>Assign **2.4 Check-in: Potential energy** as homework to be completed before the next lesson | Stile X app: Flashcards<br>Stile X app: Potential energy video<br>Stile X Revision notes: Potential energy<br>Glossary terms: elastic potential energy, gravitational potential energy |

| | Lesson name | Learning goals | Preparation required | Ice breaker | Core of lesson | To close | Revision and mastery |
|---|---|---|---|---|---|---|---|
| Session 13 | **2.5 Rubber band racers**<br>MATERIALS REQUIRED | 1. Test a prediction about the effect of elastic potential energy on a toy car | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>Collect the required materials listed in the **Lab Guide**<br>Complete the **Risk Assessment Template**<br>30 minutes | As a class, review answers to **2.4 Check-in: Potential energy** | Students investigate elastic potential energy by building cars powered by rubber bands to test the relationship between the stretch distance of the rubber band and the distance travelled | Ask students to reflect on this activity by using the *Connect, Extend, Challenge* thinking routine | Stile X app: Flashcards |
| Session 14 | **3.1 Energy transfer and transformation** | 1. Describe the difference between energy transfer and energy transformation<br>2. Model energy transfers and transformations using simple flow diagrams | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>20 minutes | As a class, watch a video on hydropower and then complete a See, Think, Wonder thinking routine | Students examine the difference between energy transfer and energy transformation and then model the energy changes using flow diagrams<br>Direct students to the corresponding Stile X revision notes to complete the question: Complete the table below to compare energy transfer and energy transformation | Ask students to reflect on the essential question of the unit in preparation for their upcoming engineering challenge<br>Assign **3.1 Check-in: Energy transfer and transformation** as homework to be completed before the next lesson | Stile X app: Energy transfer and transformation video<br>Stile X Revision notes: Energy transfer and transformation<br>Glossary terms: energy transfer, energy transformation, flow diagram, total energy |
| Session 15 | **3.2 Water wheels**<br>MATERIALS REQUIRED | 1. Describe changes in the kinetic energy of a water wheel | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>Collect the required materials listed in the **Lab Guide**<br>Complete the **Risk Assessment Template**<br>35 minutes | As a class, review answers to **3.1 Check-in: Energy transfer and transformation** | Students build a simple water wheel and then create a flow diagram to show the energy changes | Ask students to reflect on what they did well and what they think they could improve on next time | Stile X app: Flash quiz 2<br>Stile X app: Flashcards |
| Session 16 | **3.3 Pedal power** | 1. Model the energy transfers and transformations for a pedal-powered light bulb | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>20 minutes | As a class, complete the poll on whether it is possible to power a house by peddling a bike and then watch the video explanation | Students model energy transfers and transformations using simulations looking at pedal power and solar power | Ask students to reflect on this lesson by using a *Plus, Minus, Interesting (PMI)* chart | Stile X app: Flashcards |

| | Lesson name | Learning goals | Preparation required | Ice breaker | Core of lesson | To close | Revision and mastery |
|---|---|---|---|---|---|---|---|
| Session 17 | **3.4 Energy efficiency** | 1. Distinguish between useful and waste energy<br>2. Calculate the energy efficiency of a device | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>20 minutes | As a class, have a brief discussion and complete the poll on whether all energy is converted into useful energy when used | Students identify energy inputs and outputs and distinguish between useful and waste energy in simple scenarios, they then calculate energy efficiency | Ask students to reflect on this lesson by using the *Think, Puzzle, Explore* thinking routine<br>Assign **3.4 Check-in: Energy efficiency** as homework to be completed before the next lesson | Stile X app: Flash quiz 3<br>Glossary: input energy, output energy, waste energy, useful energy, energy efficiency |
| Session 18 | **3.5 Bouncing balls**<br>MATERIALS REQUIRED | 1. Compare the energy efficiency of bouncing various balls<br>2. Analyse the energy transformations involved | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>Collect the required materials listed in the **Lab Guide**<br>Complete the **Risk Assessment Template**<br>30 minutes | As a class, review answers to **3.4 Check-in: Energy efficiency** | Students investigate energy efficiency by measuring the height of bouncing different balls and then calculating the efficiency | Ask students to reflect on what they did well and what they think they could improve on next time | Stile X app: Flashcards |
| Session 19 | **3.6 Creating a light bulb**<br>MATERIALS REQUIRED<br>*This lesson is optional and can be skipped if you don't have access to nichrome wire* | 1. Create a filament light bulb<br>2. Explain why a filament light bulb isn't energy efficient | Provide feedback on the Key Question from the previous lesson in Analyse Mode<br>Review teaching notes in Prepare Mode<br>Collect the required materials listed in the **Lab Guide**<br>Complete the **Risk Assessment Template**<br>35 minutes | As a class, discuss why LED light bulbs are more energy efficient than filament light bulbs | Students create a filament light bulb and evaluate its energy efficiency | Ask students to reflect on how changing technology can save energy using the *Three Whys* thinking routine | Stile X app: Flashcards |
| Session 20 | **Designing a solution (Part 1)**<br>MATERIALS REQUIRED | 1. Create a new design for a water wheel using biomimicry | Review teaching notes in Prepare Mode<br>Collect the required materials listed in the **Lab Guide**<br>Complete the **Risk Assessment Template**<br>15 minutes | As a class, read about the 17 Sustainable Development Goals and discuss *Goal 7 – Affordable and clean energy* | Students read to the design brief, form teams, brainstorm biomimicry designs and create an improved design for a water wheel that's inspired by nature | Begin building the water wheel prototype based off of their new design | Stile X app: Flashcards |

| | Lesson name | Learning goals | Preparation required | Ice breaker | Core of lesson | To close | Revision and mastery |
|---|---|---|---|---|---|---|---|
| Session 21 | **Designing a solution (Part 2)**<br>MATERIALS REQUIRED | 1. Create a new design for a water wheel using biomimicry | Review teaching notes in Prepare Mode<br>Collect the required materials listed in the **Lab Guide**<br>Complete the **Risk Assessment Template**<br>15 minutes | Review the designs that students drew in the last lesson | Create the new water wheel prototype, ready to be tested in the next lesson | Fast finishers can complete mindful colouring activities in Stile X | Stile X app: Flashcards |
| Session 22 | **Testing and improving a solution**<br>MATERIALS REQUIRED | 1. Judge the effectiveness of the new water wheel design<br>2. Reflect on how the testing process improved the design | Review teaching notes in Prepare Mode<br>Collect the required materials listed in the **Lab Guide**<br>Complete the **Risk Assessment Template**<br>10 minutes | As a class, review the design brief again, and then each group can collect materials for their prototypes | Students create, test and improve their nature-inspired water wheel designs | Students can begin thinking about how they will present their final design to the class | Stile X app: Flashcards |
| Session 23 | **Communicating a solution** | 1. Create a presentation for your improved water wheel design | Review teaching notes in Prepare Mode<br>Collect the required materials listed in the **Lab Guide**<br>10 minutes | As a class, review the design brief one last time and discuss modes for presenting to the class | Students create a presentation that shows their final design and how it addresses each of the design criteria | Encourage students to review feedback and model answers from the unit for revision<br>Assign Stile X: Practice test in preparation for the unit test | Stile X app: Flash quiz 1–3<br>Study Stile X Revision notes in preparation for **Test: Energy** |
| Session 24 | **Test: Energy** | | Ensure each student has access to a device | Seat students appropriately for the test | Supervise students as they complete 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.

| Equipment | Supplier | Purchase link | Preparation required | Quantity required per group |
|---|---|---|---|---|
| alligator clip leads | Haines Educational | **Aligator clip leads – 2 pack** | | 2 leads |
| baking tray | Coles | **Coles baking tray** | | 1 tray |
| bamboo skewers | Coles | **Bamboo skewers** | | 2 skewers |
| battery | Officeworks | **Energizer rechargeable AAA batteries – 4 pack** | | *The battery type and number depends on the type of torch being used. |
| beaker | Modern Teaching Aids | **500 mL glass beaker** | | 1 beaker |
| bowl | Coles | **Stainless steel mixing bowl** | | 1 bowl |
| cocoa powder | Coles | **Nestle baking cocoa** | | 2 tablespoons |
| electronic balance | Haines Educational | **Electronic balance, accurate to 0.01 g** | | 1 balance |
| flour | Coles | **White plain flour** | | 1 kg |
| matches | Coles | **Safety matches** | | 1 match |
| measuring tape | Haines Educational | **Tape measure, 5 m** | | 1 tape measure |

# Complete unit material list (cont.)

| Equipment | Supplier | Purchase link | Preparation required | Quantity required per group |
|---|---|---|---|---|
| modelling clay | Haines Educational | **Plasticine, 500 g** | | 100 g |
| nail | Bunnings Warehouse | **500 g bullet head nails** | | 2 nails |
| nichrome wire | Haines Educational | **Nichrome wire, 32 SWG – 50 g reel** | Refer to the *Before class preparation* section of the **Creating a light bulb** lesson | 10 cm |
| power pack | Haines Educational | **Power supply, 2–12 V, AC/DC, 5A** | | 1 power pack |
| rubber bands | Officeworks | **Rubber bands, 500 g** | | 1 rubber band |
| scalpel | Haines Educational | **Scalpel handles, No.4**<br>**Scalpel blades, 100 pack** | | 1 scalpel |
| spoons (disposable) | Officeworks | **Wooden spoons, 100 pack** | | 6 spoons |
| velcro | Officeworks | **VELCRO mini dots** | | 1 piece |

ACTIVITY

# Energy mystery box

Watch the demo video

stileapp.com/go/energymysteryboxvideo

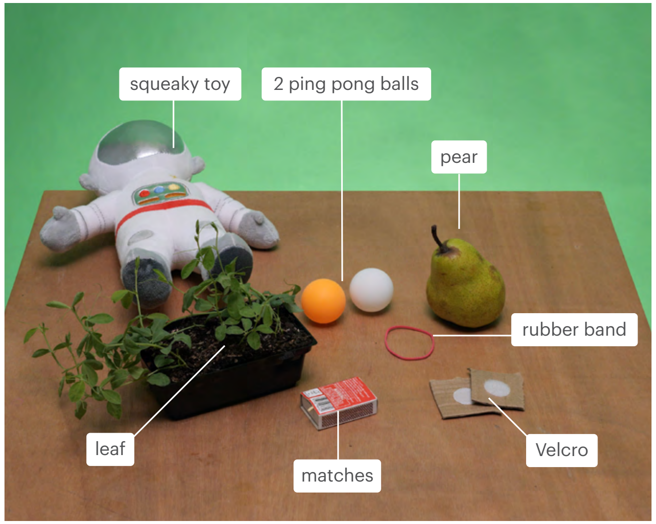
**Activity purpose:** Explore everyday items that exemplify different forms of energy.

| | |
|---|---|
| 45 minutes | Lesson: **stileapp.com/go/energy-mystery-box** |
| 2–3 students per group | RiskAssess: **stileapp.com/go/raenergymysterybox** |

## Materials

Each group of students will need:
- 1 apple or pear
- 1 leaf
- 1 matches
- 1 rubber band
- 2–3 ping pong balls
- 1 rubber duck or other similar squeaky toy
- 1 piece of Velcro

*Alternative materials:*
- *If you're short on materials, you can set up just one mystery box for the whole class or set up stations around the class with a few of each item.*
- *Other materials that work well in this activity include batteries, a torch, a sparkler and a spoon.*




## Before class preparation

30 minutes: Gather the materials required for this lab and set up 1 mystery box per group of 2–3.

*Note: This practical activity can be run remotely. Just ask students to create their own energy mystery boxes using items they have around their homes.*

## Tips and tricks

**Things we learned from testing the lab ourselves**
The items in the mystery box can be swapped out depending on what is available at your school. It is good to have items that represent a number of different forms of energy (sound, light, heat, electrical, elastic, chemical). You could also include a magnet if you wish to introduce magnetic potential energy. *Note that any object can be used to represent gravitational and kinetic energy.* Velcro is included as an example of biomimicry and is the subject of a class poll later in the activity.

Most items can have more than one type of energy assigned to them. For example, the squeaky toy can be held up, dropped or thrown to show gravitational and kinetic energy. It also illustrates sound energy and elastic energy when squeezed.

Encourage students to combine the batteries and torch to create a new form of energy.

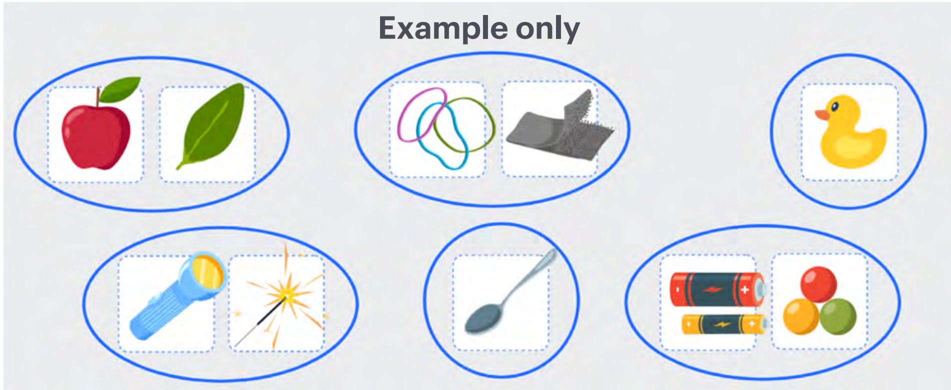
## Method

1. Use your senses to examine each item as you interact with it in different ways.
2. Record your observations.
3. Propose a form of energy that may be associated with each item.


## Final outcome

**What you can expect to see at the end**
The outcome of this practical activity will vary depending on what categories the students choose. Students who have prior knowledge of forms of energy will be able to group the items into different forms of energy.

Students just need to justify their chosen groups. An example grouping could include the following:




Example justification:
- The leaf and apple were grouped together because they are things from the natural world. They can be eaten to provide energy.
- The sparkler and torch were grouped together because they both provide light.
- The rubber band and Velcro were grouped together because they can stretch and change shape.
- The batteries and balls were grouped together because they both move by rolling.
- The spoon was placed in its own group because it did not fit with any of the others.
- The rubber duck is placed in its own group because it produces a sound.

PRACTICAL ACTIVITY

# Asteroid marble drop

Watch the demo video

stileapp.com/go/energyasteroidvideo

**Activity purpose:** Explore how kinetic energy depends on the mass and speed of an object.

| | |
|---|---|
| 45 minutes | Lesson: **stileapp.com/go/asteroid-marble-drop** |
| 2–3 students per group | RiskAssess: **stileapp.com/go/ramarbledrop** |

## Materials

Each group of students will need:
- 1 small marble or pebble
- 1 large marble or pebble
- 1 shallow baking tray
- 1 kg packet of flour
- 2 tablespoons of cocoa powder
- 1 tablespoon
- 30 cm ruler
- 1 medium sieve
- 1 electronic balance, accurate to 0.01 g

*Alternative materials:*
- *Flour and cocoa powder can be replaced with sand and soil.*


## Before class preparation

5 minutes: Make sure you've got all of the materials you need before class. After explaining the task to the class, encourage groups to gather their own materials from the provided resources.

## Tips and tricks

**Things we learned from testing the lab ourselves**
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.

For more advanced students, you may also encourage them to notice and record observations of how far debris flies away from the crater with each impact. This could be interpreted as additional evidence of the kinetic energy of the marble or pebble. Students could then have the option of graphing either or both sets of data to compare and add to their discussion. Note that the difference in flying debris is usually more prominent when testing mass compared to testing speed in this investigation.

We provide instructions for testing only two pebbles with different masses. However, you might encourage students to test more pebbles with different masses if they have the time and materials. This would better model good scientific practice, since two data points are generally not sufficient for drawing conclusions, even with multiple trials for each one.

## Method

**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 or pebble 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 centimetres (cm).
4. Repeat the same test two more times. Then calculate the average of the three tests.

*High speed*

1. Smooth the surface of the flour again and dust with cocoa powder.
2. Repeat the method above but this time throw the marble or pebble downwards instead of dropping it.

*Note: When throwing the marble or pebble, try to release it at the 30 cm mark. This will make it as similar as possible to the low speed condition.*



**PART 2: The effect of mass**

1. Reset the flour in the tray from Part 1. Dust again with cocoa powder if necessary.
2. Use the electronic balance to measure the mass of the small marble or pebble and the large marble or pebble individually. Record both measurements in the results table.

*Small mass*

1. Measure 30 cm above the surface of the flour. Take the small marble or pebble 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*

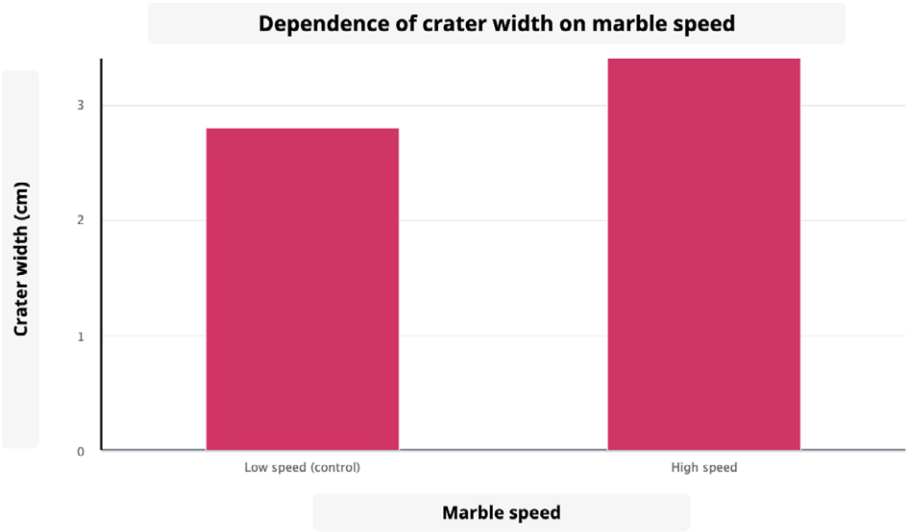
1. Smooth the surface of the flour again and dust with cocoa powder.
2. Repeat the method above, but dropping a large marble or pebble instead of a small one.

## Final outcome

### What you can expect to see at the end

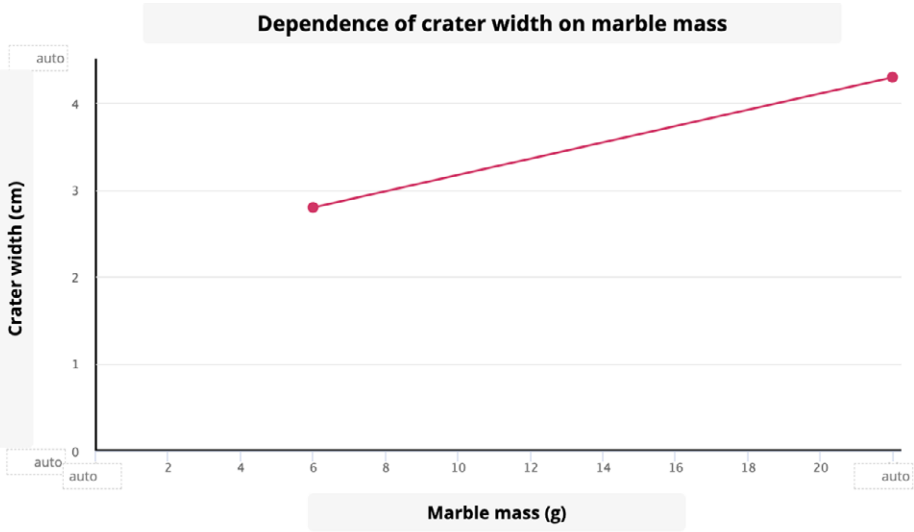
**PART 1**

– Students should see the average crater width increases as speed increases. Their graphs should look something like this:




**PART 2**

– Students should see the average crater width increases as mass increases. Their graphs should look something like this:



PRACTICAL ACTIVITY

# Rubber band racers

Watch the demo video

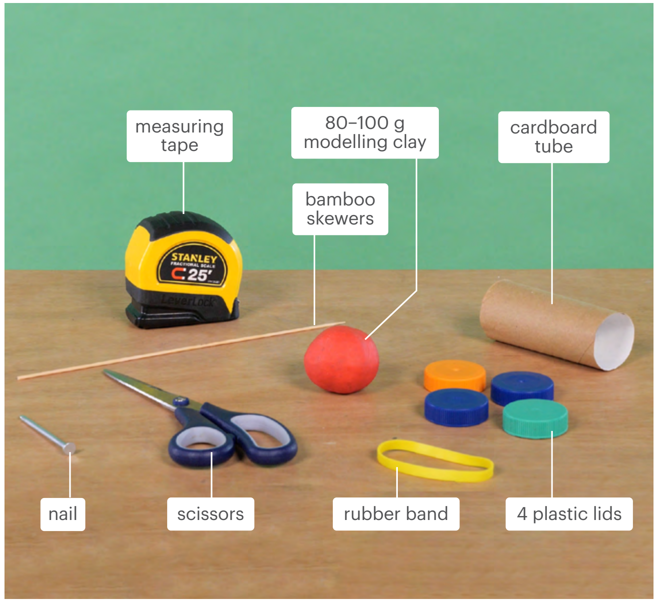
stileapp.com/go/energyracervideo

**Activity purpose:** Explore elastic potential energy by building toy cars powered by rubber bands.

| | |
|---|---|
| 45 minutes | Lesson: **stileapp.com/go/rubber-band-racers** |
| 2–4 students per group | RiskAssess: **stileapp.com/go/rarubberbandracers** |

## Materials

Each group of students will need:
- 1 rubber band
- 1–2 bamboo skewers
- 4 plastic lids of the same size (e.g. milk bottle lids)
- measuring tape
- cardboard tube (e.g. toilet paper roll)
- scissors
- 80–100 g modelling clay or other small weight
- 1 nail (for making holes in the cardboard and plastic lids)
- *optional: ruler, toothpick*




## Before class preparation

5 minutes: Make sure you've got all of the materials you need before class. After explaining the task to the class, encourage groups to gather their own materials from the provided resources.

*Note: To decrease waste and promote sustainability, ask students to collect toilet rolls and milk caps from home.*

## Tips and tricks

**Things we learned from testing the lab ourselves**
Rubber bands vary in their elasticity. We recommend using a rubber band that is 0.5 cm wide and 10 cm long when flattened. If you're using a smaller rubber band, it may not need to be stretched up to 5 cm as described in the method. Similarly, a larger rubber band may need to be stretched more than 5 cm. If you choose a different range of stretch distances, the results table and graph in the lesson will need to be adjusted.

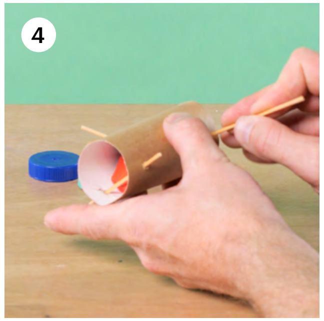
Every rubber band has an elastic limit, where it snaps. The racers are even more limited because they can't support large amounts of elastic potential energy. If the rubber band is stretched too much, the car no longer rolls on the floor. Adding more weight to the car can help it withstand more elastic potential energy.

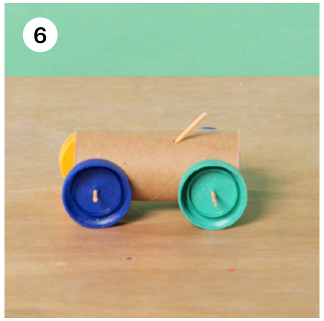
## Method

**PART 1: Making the rubber band racer**

1. Using a nail, carefully punch small holes in the centre of each plastic lid. Make sure the holes are just big enough for the skewers to push through, but not move around.
2. Place the modelling clay inside the tube. This will help the racer travel in a straight line.
3. Using a nail, carefully make four small holes in the cardboard tube. 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.
4. Make a hole in the top of the cardboard tube at a 45° angle. The nail should penetrate through the modelling clay and reach the bottom of the tube.
5. Push the skewers through the holes in the cardboard tube.
6. 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.

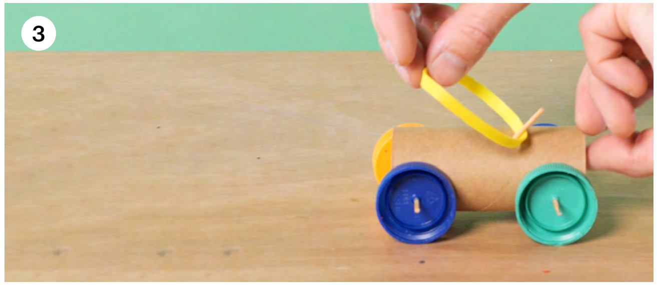


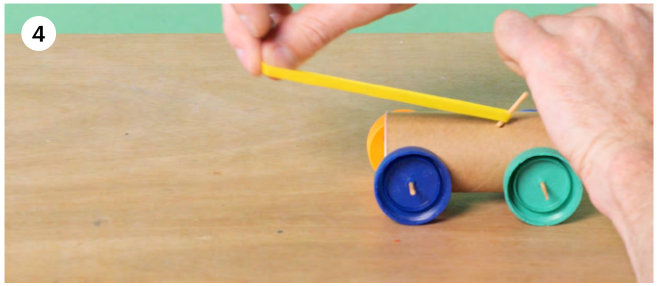



**PART 2: Testing the racer**

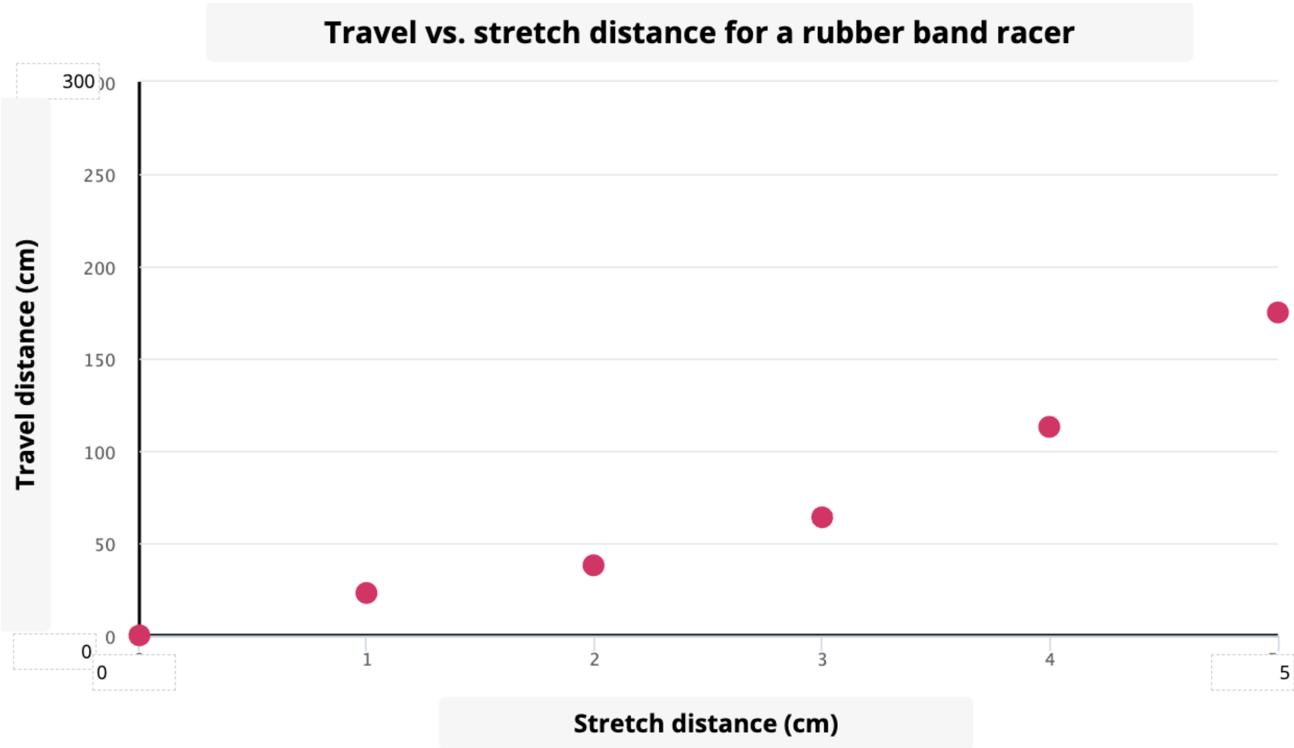
1. Find a clear area with a hard, smooth floor. Lay out the tape measure to a length of 200–300 cm. You will use this to measure the distance travelled by the racer.
2. Hook the rubber band over the toothpick and extend it out in front of the car, so it is straight but not stretched.
3. Line up the end of the rubber band with the 0 cm 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 centimetre. 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.



## Final outcome

**What you can expect to see at the end**
Students should see their rubber band racer travels further with more stretch of the rubber band. This is because as the rubber band is stretched further, it stores more elastic potential energy. When the rubber band is released, this elastic potential energy is converted into kinetic energy. An example result can look like this:



PRACTICAL ACTIVITY

# Water wheels

Watch the demo video

stileapp.com/go/energywaterwheelvideo

**Activity purpose:** Students make a simple model of a water wheel to collect evidence about energy transfer.

| | |
|---|---|
| 45 minutes | Lesson: **stileapp.com/go/water-wheels** |
| 2–4 students per group | RiskAssess: **stileapp.com/go/rawaterwheels** |

## Materials

Each group of students will need:
- 1 cork
- 1 scalpel
- 1 pen
- 2 bamboo skewers
- 6–8 disposable, preferable recyclable, spoons
- 1 L water
- water jug
- 1 large bowl or bucket
- 2 chairs or stools


## Before class preparation

5 minutes: Make sure you've got all of the materials you need before class. After explaining the task to the class, encourage groups to gather their own materials from the provided resources.

Later in this unit, students will be improving upon their water wheel using the principles of biomimicry. At the end of this lesson, pack students' water wheels and any supporting materials into a box so that they can be reused in the engineering challenge.

## Tips and tricks

**Things we learned from testing the lab ourselves**
We recommend saving the students' water wheels so students can look at them during the redesign 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.

If some students finish early, you might encourage them to try pouring the water from different heights to see if this has an effect on how the water wheel spins.

## Method

### PART 1: Making the water wheel

1. Using a scalpel, cut 6–8 marks lengthways into the cork. The lines should be the same as the width of the spoon handles. They only need to be 5 mm deep.
2. Push one spoon handle gently into each of your cork cuts. All the spoons will need to face the same direction.
3. Stick a bamboo skewer into each end of the cork.
4. Balance each bamboo skewer on a chair or stool.
5. Place a water bowl underneath the water wheel between the two chairs or stools.
6. Hold the water jug above the water wheel.
7. 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:
   – before pouring the water over it
   – while water is being poured over it
   – after the water stops being poured
2. 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




## Final outcome

**What you can expect to see at the end**

This activity is a great opportunity for students to explore energy transformation. In this case, students should pay particular attention to the transformation of gravitational potential energy into kinetic energy.

Students can use this activity to discuss how the kinetic energy of the wheel changes before, during and after the water is poured. An example of a student response from this discussion could be:
*The water wheel has no kinetic energy before the water is poured. When the water hits the water wheel, a force is applied. The water wheel begins to rotate, and there is an increase in kinetic energy. After the water stops pouring, the kinetic energy decreases until the water wheel stops rotating.*

PRACTICAL ACTIVITY

# Bouncing balls

Watch the demo video

stileapp.com/go/energybouncingballsvideo

**Activity purpose:** Compare the energy efficiency of the bouncing of various balls.

| | |
|---|---|
| 45 minutes | Lesson: **stileapp.com/go/bouncingballs** |
| 3–4 students per group | RiskAssess: **stileapp.com/go/rabouncingballs** |

## Materials

Each group of students will need:
- 3 spherical balls of different kinds – e.g. tennis ball, baseball, cricket ball, golf ball, ping pong ball, squash ball, bouncy ball
- 1 m ruler or measuring tape
- 1 roll of masking tape
- 1 pen
- butchers paper


## Before class preparation

5 minutes: Make sure you've got all of the materials you need before class. After explaining the task to the class, encourage groups to gather their own materials from the provided resources.

## Tips and tricks

**Things we learned from testing the lab ourselves**

To reduce waste, this activity can also be completed without the use of butchers paper. Simply attach pieces of masking tape directly to the wall to indicate the required heights. Be sure to still add a labelled piece of tape for 150 cm before beginning the activity. Then, add labelled pieces of tape for each ball drop.

Ensure students only drop each ball, applying any additional force will change the results.

Students will need to use the energy efficiency equation to calculate each ball's efficiency. We recommend introducing this equation at the start of class to check everyone is comfortable with it.

$$\text{efficiency} = \frac{\text{useful output energy}}{\text{total input energy}} \times 100\%$$

$$\text{efficiency} = \frac{\text{bounce height}}{\text{drop height}} \times 100\%$$

## Method

1. Find an area of flat, hard floor next to a wall. Attach sheets of butchers paper to the wall so that one narrow end touches the floor. Attach enough sheets so that the other narrow end reaches a height of at least 150 cm.
2. Measure exactly 150 cm from the floor and draw a line on the paper. Label this line “150 cm”.
3. 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 centimetres.
4. Repeat Step 3 two more times with the same ball.
5. Repeat Steps 3 and 4 for the other two balls.


## Final outcome

**What you can expect to see at the end:**
The results will vary depending on which balls students use. An example outcome has been provided below.

| Type of ball | Bounce height (cm) Trial 1 | Bounce height (cm) Trial 2 | Bounce height (cm) Trial 3 | Bounce height (cm) Average | Energy efficiency (%) |
|---|---|---|---|---|---|
| *Example: bouncy ball* | 125 | 118 | 128 | 371 ÷ 3 = 124 | 124 ÷ 150 × 100 = 83% |
| Examples only: golf ball | 120 | 117 | 115 | 117 | 78% |
| tennis ball | 68 | 79 | 67 | 71 | 47% |
| exercise ball | 107 | 111 | 105 | 108 | 72% |

The golf ball was the most energy efficient, with an efficiency of 78%.

The exercise ball also had a relatively high energy efficiency of 72%.

The tennis ball was the least energy efficient at 47%. It bounced back to less than half the height it was dropped from and was the least bouncy.

PRACTICAL ACTIVITY

# Creating a light bulb

Watch the demo video

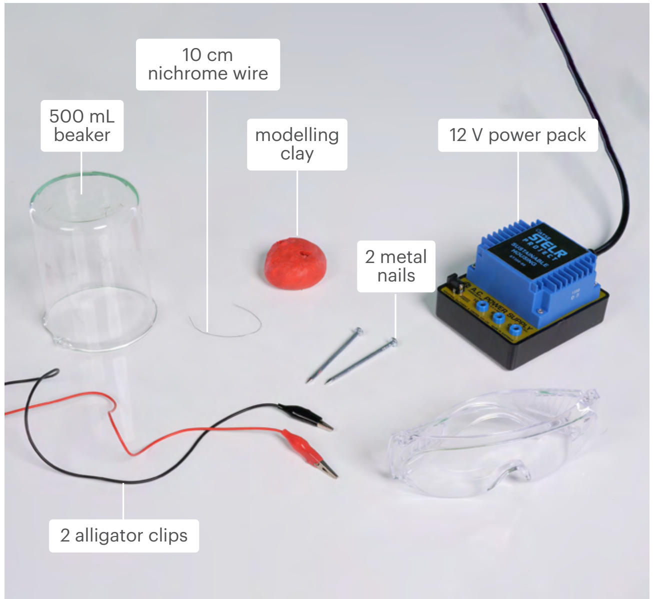
stileapp.com/go/energylightbulbvideo

**Activity purpose:** Build a filament light bulb and explain why it isn't energy efficient.

| | |
|---|---|
| 45 minutes | Lesson: stileapp.com/go/create-lightbulb |
| 2–4 students per group | RiskAssess: stileapp.com/go/ralightbulb |

## Materials

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 metal nails (approx. 3–4 cm long)
- piece of modelling clay (approx. 3 cm x 3 cm)
- 500 mL beaker
- *optional: pencil*




## Before class preparation

5 min: To help the activity run quickly in the classroom, we recommend pre-cutting lengths of nichrome wire before class.

## Tips and tricks

**Things we learned from testing the lab ourselves**
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. This will break the circuit and turn off the light bulb.

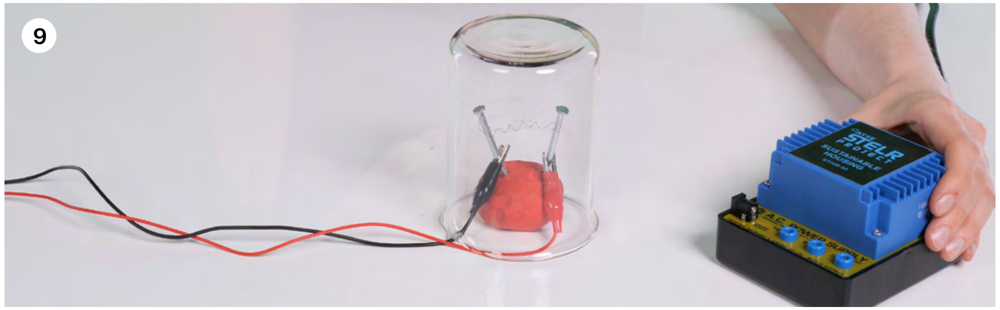
Ensure the experimental setup is not taken apart until the nichrome wire has been allowed to cool for at least a few minutes.

The glowing filament is easier to observe if the classroom is dark.

## Method

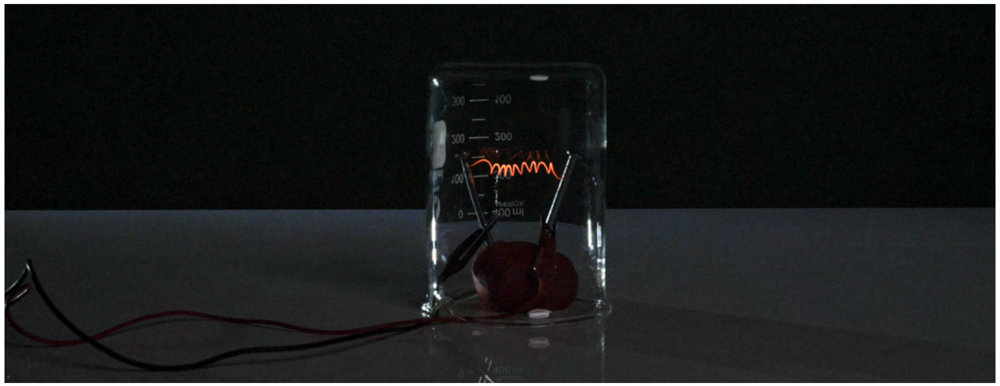
1. Tightly wrap the nichrome wire around a nail or pencil to form a coil, leaving the ends straight. Remove the wire from the nail. The wire coil should be only 1–2 cm long. This will be the *filament*.
2. Wrap the ends of the wire coil around the top of each nail. The nails act as the *connecting wires*.
3. Roll the modelling clay into a spherical shape. Then firmly press it onto a lab bench. Stick the two nails vertically out of the modelling clay, about 2–3 cm apart.
4. Connect an alligator clip to each of the nails below the wire coil.
5. Carefully place the beaker over the entire modelling clay and nail setup. This is the *glass bulb*.
6. Plug in the power pack. Ensure that it is turned down to 0 volts (V).
7. 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.
8. Turn on the power pack. This is the *electrical source*.
9. Slowly increase the voltage until the nichrome wire starts to glow.






## Final outcome

**What you can expect to see at the end**
Students should have a setup that looks similar to the following:



Students can conclude the following from this practical activity:

The filament light bulb showed the transformation of electrical energy into useful light energy and waste heat. It loses a lot of energy to the surroundings as heat. This large amount of waste energy results in a very low energy efficiency of 10%. An LED light bulb is much more energy efficient, at about 90%.

ENGINEERING CHALLENGE

# Engineering challenge

Watch the demo video

[stileapp.com/go/energyengchallengevideo]

**Activity purpose:** Students follow the engineering process to design, test and improve the water wheel using inspiration from an animal or plant.

| | |
|---|---|
| 4 x 45 minutes | Lesson: **stileapp.com/go/biomimicry-design** |
| 3–4 students per group | RiskAssess: **stileapp.com/go/rabiomimicrydesign** |

## Materials

Each group of students will need:
– 1 water wheel created in the water wheel practical activity
Students may use any combination of other materials.
We suggest some options below:
– 1 used plastic bag or plastic container
– 2 sheets of cardboard
– 6 paper or plastic cups
– 1 water jug
– 1 pipe or hose offcuts
– 6 small weighted objects, such as washers or paper clips
– 2 bamboo skewers
– 1 stopwatch
– 20 cm of string
– 1 scissors
– 1 roll of masking tape
– 1 stapler
– 1 ruler
– 1 L water


## Before class preparation

5 minutes: We suggest students reuse their water wheels from the water wheel practical activity. These will need to be available to students at the beginning of the engineering challenge.

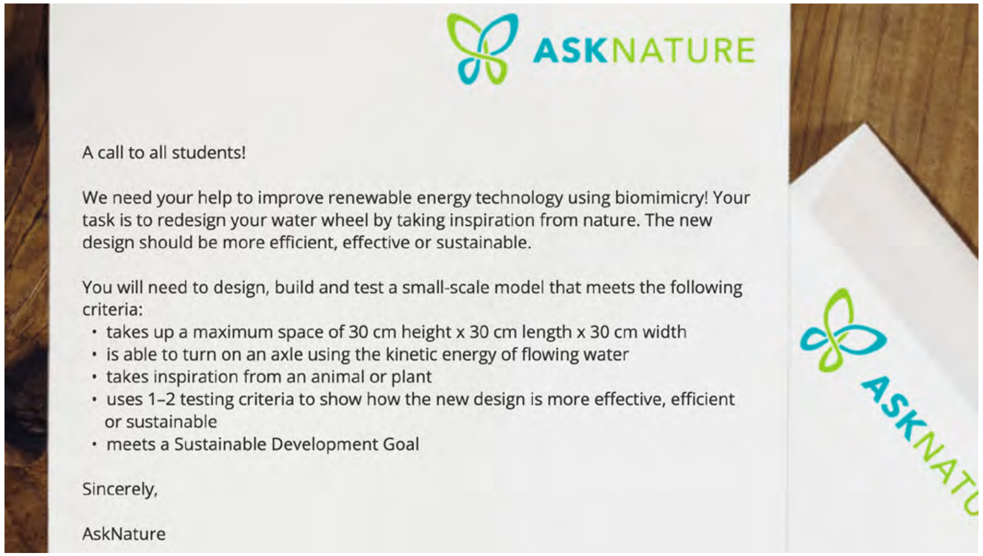
## Tips and tricks

**Things we learned from testing the lab ourselves**
Water wheels with water-resistant materials last longer and can undergo multiple rounds of testing and iterating.

The design activity included in the career profile is good preparation for the creative thinking needed in this engineering challenge. Feel free to refer back to this when students are brainstorming their biomimicry solutions.

Consider giving students a budget for their engineering project. You can assign values to each of the materials provided, and have students maintain a budget journal to track their expenditure. Providing students with a budget simulates real-world engineering constraints and challenges students to carefully consider their choice of materials, particularly in the design phase.

## The design brief


ASKNATURE

A call to all students!

We need your help to improve renewable energy technology using biomimicry! Your task is to redesign your water wheel by taking inspiration from nature. The new design should be more efficient, effective 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 an animal or plant
- uses 1–2 testing criteria to show how the new design is more effective, efficient or sustainable
- meets a Sustainable Development Goal

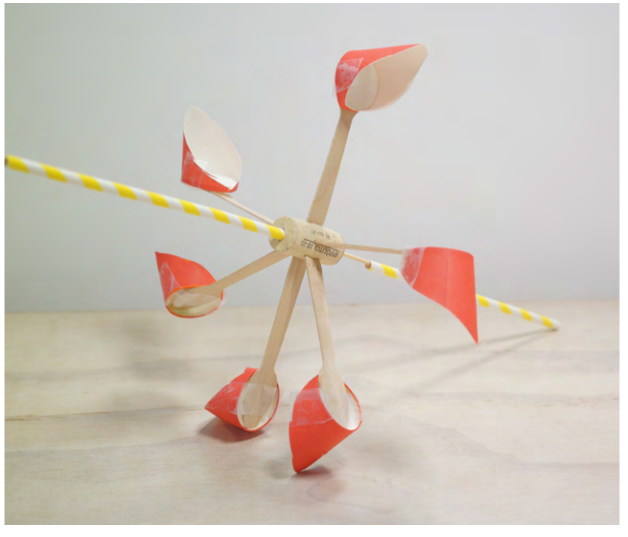
Sincerely,

AskNature

## 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 modified water wheel that a student might develop. In this case, the shape of the scoops on the water wheel is inspired by the shape of a pelican's bill and throat pouch.



A student could be expected to justify the improved performance of this design based on a number of factors. These might include the number of times the wheel rotates in a set time or the amount of water that is lost from the water wheel as it turns.

## Troubleshooting

**Some tricky areas in the engineering challenge that may require additional support**
Before students begin working on their redesigns, ensure they have a strong understanding of the criteria listed in the design brief.

Students will need to determine how they'll measure the improvements of their new designs. This should be part of their brainstorming phase in the first engineering challenge lesson.

Possible ways to test improvements include:
- counting the number of times the wheel rotates in a set time
- using the wheel to lift a small object tied to the axle by a string
- measuring how much water can flow through the water wheel before it fails
- recording the number of sustainable or recyclable materials used
- assigning a budget to their materials

Students will need to run these tests on both the original water wheel and the redesigned water wheel.

Students may first try to make their water wheel look like a plant or animal. Remind students that a biomimicry design takes learnings from how a plant or animal functions instead of how they look.

Students will need to justify their design. Here's an example using a pelican as inspiration:

| Animal or plant | How it interacts with water | What it achieves by doing this (its function) | Would a similar function be useful to a water wheel? |
|---|---|---|---|
| Example only: Pelican | Its mouth has a large pouch that expands to scoop up water. | The pouch allows a pelican to scoop up more water, increasing its chances of catching fish. | Yes. Expandable pouches could help a water wheel hold more water. This could make it spin faster and also prevent water from flowing over and being wasted. |

Call us on 1300 918 292

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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.