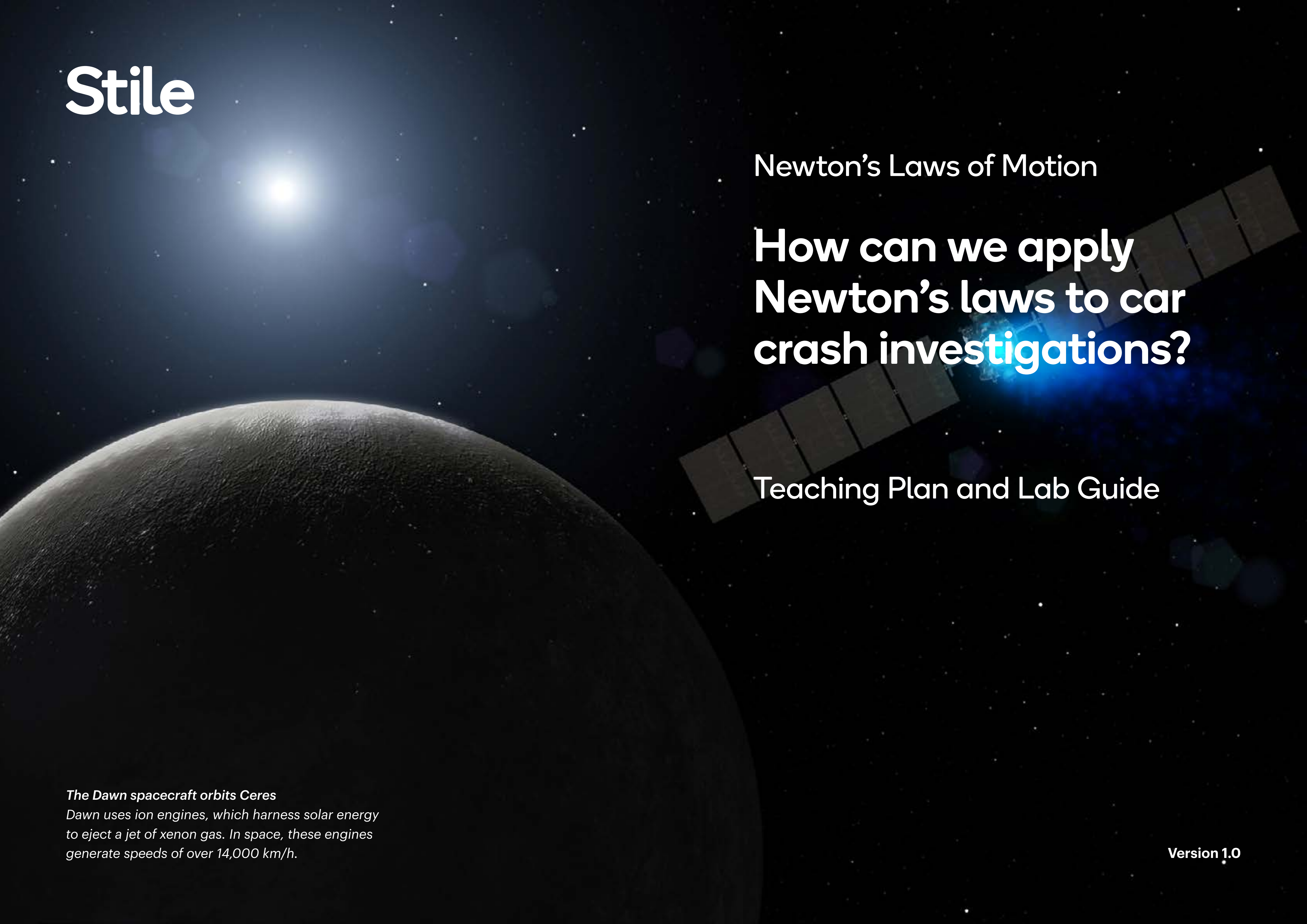
Stile

Newton’s Laws of Motion

How can we apply Newton’s laws to car crash investigations?

Teaching Plan and Lab Guide



The Dawn spacecraft orbits Ceres
Dawn uses ion engines, which harness solar energy to eject a jet of xenon gas. In space, these engines generate speeds of over 14,000 km/h.

Version 1.0

Contents

Teaching Plan

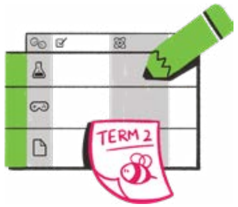
Lab Guide

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

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Inertia on Earth
As a skydiver falls, gravity pulls them down and air resistance pushes them up.

Teaching Plan

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Storyline and real-world phenomenon

How can we apply Newton’s laws to car crash investigations?

The forces in car crashes can be intense. Vehicle collision investigators use Newton’s three laws of motion to help understand what happened, revealing if any drivers were at fault. In this unit, students investigate these fundamental laws through hands-on demonstrations and fun interactives.

Big ideas

- What are Newton’s three laws of motion?
- How do they apply, both on Earth and in space?
- How do free body diagrams help us understand the effects of forces?

Highlights

- Build and test water rockets and use Newton’s laws to improve their flight
- Investigate how Newton’s laws apply to jet propulsion
- Design a clean-energy car powered only by human breath
- Use an interactive involving flying cars to discover the relationship between force, mass and velocity

In this unit, students meet Detective Sergeant ***Dr Jenelle Mehegan****, who works in the Major Collision Investigation Unit using evidence at crash sites to reconstruct vehicle movements.*

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This unit at a glance

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

Eight additional lessons are indicated in the lesson planning guide for teachers using Victorian Curriculum or New South Wales Syllabus. This unit will take six weeks if these lessons are included, with four 45-minute class sessions per week.

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

Newton's Laws of Motion

Students engage in the **real-world phenomenon** of how forces act on spacecraft and asteroids in space.

- Introduction: Exploring the asteroid belt
- What do you already know?
- Career profile: Vehicle collision investigator

Students activate **prior knowledge** about forces, speed and velocity.

- 1.1 Demonstrating Newton's first law
- 1.2 The first law of motion
- 1.2 Check-in: The first law of motion
- 1.3 Inertia on Earth
- 1.3 Check-in: Inertia on Earth
- 1.4 Free body diagrams
- 1.4 Check-in: Free body diagrams

Formative assessment provides a quick check of student progress at a pivotal point in the unit.

- 2.1 Demonstrating Newton's third law
- 2.2 The third law of motion
- 2.2 Check-in: The third law of motion
- 2.3 Gravity and the third law
- 2.3 Check-in: Gravity and the third law
- 2.4 Recoil, jets and collisions
- 2.4 Check-in: Recoil, jets and collisions
- 2.5 Water rockets

Students **build and test** water-powered rockets to apply Newton's third law in this hands-on activity.

- 3.1 Designing a balloon car
- 3.2 Improving a balloon car
- 3.3 The second law of motion
- 3.3 Check-in: The second law of motion
- 3.4 Applying the second law
- 3.4 Check-in: Applying the second law
- 3.5 Flying car simulation
- 3.6 Jet-propelled can
- 3.7 Battling misconceptions

Students **design, build, test and evaluate** prototypes of balloon-powered cars.

Students **create** a water jet-propelled can in this hands-on activity.

Students **conduct and film interviews** that address misconceptions of Newton's laws.

- Science and society: Speed limits in built-up areas
- Glossary: Newton's laws of motion
- Test: Newton's laws of motion

Students **discuss and debate** speed limits that could minimise fatalities in crashes.

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

Unit storyline

Throughout this unit, students engage with what happens in car collisions to explore Newton’s laws. They learn about the effect of inertia, forces and gravity in different scenarios, including everyday life on Earth and objects in space. 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.

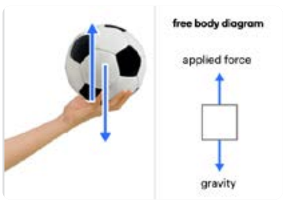
Phenomenon	Lesson
The laws of motion apply in space and on Earth 	**Introduction: Exploring the asteroid belt** – Students read about the Dawn spacecraft that visited Ceres, the largest object in the asteroid belt – They watch enhanced imagery captured by the Dawn spacecraft of Ceres and are introduced to how the laws of motion apply to both objects in space and vehicles on Earth
Evidence at vehicle collision sites can be used to reconstruct vehicle movements 	**Career profile: Vehicle collision investigator** – Students meet their career profile guide for the unit, Dr Jenelle Mehegan, a detective sergeant in the Major Collision Investigation Unit with Victoria Police – Jenelle explains her work and how she uses evidence at vehicle collision sites to reconstruct vehicle movements

Phenomenon	Lesson
Inertia on Earth 	**1.1 Demonstrating Newton’s first law** – Students observe a demonstration that illustrates inertia with an apple, a knife and a wooden spoon – They explore this concept through a hands-on activity using coins
Newton’s first law can help us to understand car crashes 	**1.2 The first law of motion** – Students watch a video about how cars are tested for safety – They apply the concept of inertia to car crashes by learning about Newton’s first law

Unit storyline

Phenomenon	Lesson
Inertia in different scenarios on Earth	**1.3 Inertia on Earth** – Students consider why moving objects on Earth slow down – They apply their knowledge to different scenarios and explore the effect of forces and inertia

Phenomenon	Lesson
Forces can be represented with diagrams	**1.4 Free body diagrams** – Students read text and examine a diagram that introduces free body diagrams – They then apply their learning to draw free body diagrams of the forces acting in different scenarios

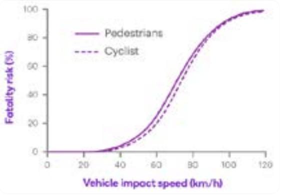


Phenomenon	Lesson
Newton's third law	**2.1 Demonstrating Newton's third law** – Students explore Newton's third law in a series of practical activities, including pushing each other on wheeled chairs, drawing a magnet and metal bolt together and pulling spring balances apart

Phenomenon	Lesson
Applying Newton's laws to build balloon-powered cars	**3.1 Designing a balloon car** – Students apply their understanding of Newton's laws to create balloon-powered cars in an engineering challenge

Unit storyline

Phenomenon	Lesson
Higher speed is linked with higher fatality for pedestrians and cyclists hit by cars	**Science and society: Speed limits in built-up areas** – Students examine a graph depicting increased fatality risk with increased speed for pedestrians and cyclists hit by cars – They apply their knowledge of Newton's laws to discuss what speed limits should be in areas with high cyclist and pedestrian traffic



Curriculum alignment

This unit focuses on Newton's laws of motion. Students investigate the laws of motion and analyse the relationship between force, mass and acceleration of objects.

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:

- Forces and non-contact forces (**Forces** and **Non-contact Forces and Electricity** units)
- The movement of objects in space and the effect of gravity (**Our Place in Space** unit)
- Different forms of energy (**Energy** unit)

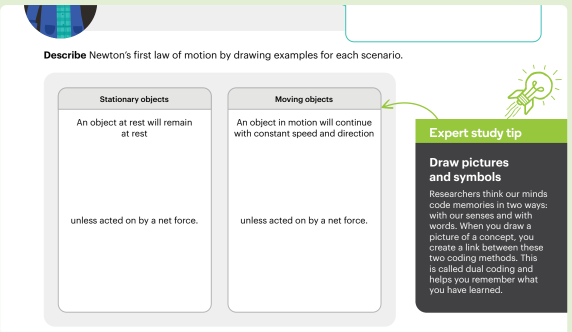
Stile X: Newton's Laws of Motion

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:

- The first law of motion
- Inertia on Earth
- Free body diagrams
- The third law of motion
- Gravity and the third law
- The second law of motion
- Applying the second law

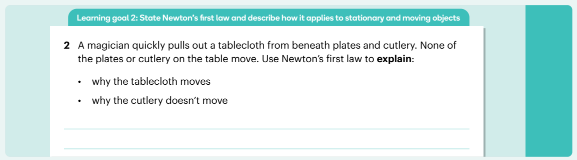


Read **expert study tips** aloud and discuss them in class to help students build important study skills.

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.

- Explain what inertia is
- State Newton's first law and describe how it applies to stationary and moving objects
- Describe how gravity, friction and air resistance disguise some of the effects of inertia on Earth
- Explain how net forces cause objects to change their velocities
- Draw and interpret free body diagrams
- State Newton's third law of motion
- Explain how the third law of motion applies to forces acting between objects
- Apply Newton's third law to the gravitational attraction between two objects
- State Newton's second law of motion
- Describe how an object's acceleration depends on its mass and the force applied
- Use the second law to calculate force, mass and acceleration



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

Eight check-in lessons have been included as formative assessment opportunities 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: The first law of motion	Multiple choice	10 minutes
Check-in	1.3 Check-in: Inertia on Earth	Multiple choice	10 minutes
Check-in	1.4 Check-in: Free body diagrams	Multiple choice, canvas	10 minutes
Check-in	2.2 Check-in: The third law of motion	Multiple choice	5 minutes
Check-in	2.3 Check-in: Gravity and the third law	Multiple choice	5 minutes
Check-in	2.4 Check-in: Recoil, jets and collisions	Multiple choice	10 minutes
Check-in	3.3 Check-in: The second law of motion	Multiple choice, written response	10 minutes
Check-in	3.4 Check-in: Applying the second law	Multiple choice, written response	15 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: Newton's laws of motion	Multiple choice, drag and drop, written response	45 minutes

Scientific skills

A project and an engineering challenge can be used as a summative assessment of science inquiry skills in this unit.

Lesson type	Lesson name	Question types	Time
Engineering challenge	3.1 Designing a balloon car	Open response	45 minutes
Research project	3.6 Battling misconceptions	Table, written response, open response	90 minutes or assigned as homework

Important things to know about this unit

Engineering challenge

This unit includes an engineering challenge where students design a balloon-powered car to carry varying masses. The engineering challenge focuses on students' ability to test, evaluate and improve upon a design. By exploring how variation in mass affects the car's performance, students will be able to demonstrate an understanding of the engineering process and apply their knowledge of Newton's laws.

Detailed advice on how to run the engineering challenge, as well as possible student outcomes, alternative approaches to reduce materials and how to emphasise the engineering process, can be found in the **Lab Guide**.

Character conversations

Dr Jenelle's character is included throughout the unit, and her 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 the character within the lesson.

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). These goals are introduced at the start of the lesson so students clearly understand the intended learning outcomes for the lesson.

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/parentemailnewtonslaws**

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

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: Exploring the asteroid belt** *and* **Pre-test: Newton's laws of motion** *and* **Career profile: Vehicle collision investigator**		Review teaching notes in Prepare Mode Collect Stile X booklets for this unit Find out more about Stile X in **The Stile Guide** Send **parent email template** 30 minutes	As a class, read about the Dawn spacecraft and complete a brainstorm	Students activate prior knowledge by completing **Pre-test: Newton's laws of motion**	Students meet Dr Jenelle Mehegan, in **Career profile: Vehicle collision investigator**	Stile X app: Flashcards Glossary terms: applied force, contact force, force, mass, net force, newton, speed, velocity, weight
Session 2	**1.1 Demonstrating Newton's first law** MATERIALS REQUIRED	1. Predict the outcome of a demonstration of Newton's first law 2. Summarise the results of a demonstration of Newton's first law	Review student answers to the previous lesson in Analyse Mode to gauge prior knowledge Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** Review teaching notes in Prepare Mode 30 minutes	As a class, watch a video demonstration of inertia and predict what will happen	Students explore inertia in a practical activity	Students use their knowledge about inertia to explain the demonstration from the beginning of the lesson	Stile X app: Flashcards
Session 3	**1.2 The first law of motion**	1. Explain what inertia is 2. State Newton's first law and describe how it applies to stationary and moving objects	Provide feedback on the Key Questions from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 30 minutes	As a class, watch a video about how cars are tested for safety measures in collisions in vehicle research centres	Students apply their understanding of inertia and Newton's first law to a series of real-world scenarios Direct students to the corresponding Stile X revision notes to complete the question: Describe Newton's first law of motion by drawing examples for each scenario	Students explain how Newton's first law applies to specific scenarios Assign **1.2 Check-in: The first law of motion** as homework to be completed before the next session	Stile X app: The first law of motion video Stile X Revision notes: The first law of motion Glossary terms: balanced force, first law of motion, inertia, tension
Session 4	**1.3 Inertia on Earth**	1. Describe how gravity, friction and air resistance disguise some of the effects of inertia on Earth 2. Explain how net forces cause objects to change their velocities	Provide feedback on the Key Questions from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 30 minutes	As a class, review answers to **1.2 Check-in: The first law of motion**	Students explore inertia on Earth and apply their understanding to a range of real-world scenarios Direct students to the corresponding Stile X revision notes to complete the question: Identify the two forces in each example that cause the object to slow down	Students answer questions about whether inertia applies in space Assign **1.3 Check-in: Inertia on Earth** as homework to be completed before the next session	Stile X app: Inertia on Earth video Stile X Revision notes: Inertia on Earth Glossary terms: air resistance, friction, gravity, unbalanced force, water resistance

Lesson Planning Guide

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 5	**1.4 Free body diagrams**	1. Draw and interpret free body diagrams	Provide feedback on the Key Questions from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 30 minutes	As a class, review answers to **1.3 Check-in: Inertia on Earth**	Students draw and interpret free body diagrams Direct students to the corresponding Stile X revision notes to complete the question: A class of students created free body diagrams for someone holding a cup of coffee Complete the table to compare each response to the model answer	Students use free body diagrams to calculate net force Assign **1.4 Check-in: Free body diagrams** as homework to be completed before the next session	Stile X app: Free body diagrams video Stile X Revision notes: Free body diagrams Glossary terms: free body diagram, support force
Session 6	**2.1 Demonstrating Newton's third law** MATERIALS REQUIRED *Note: This lesson is allocated two class sessions, but could be run in one session with less time allocated to reviewing and discussing results*	1. Predict the outcomes of a demonstration of Newton's third law	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** Review teaching notes in Prepare Mode 30 minutes	As a class, review answers to **1.4 Check-in: Free body diagrams**	Students complete two activities to demonstrate Newton's third law	Students describe what happened in the second activity through an open response question	Stile X app: Flash Quiz 1
Session 7	**2.1 Demonstrating Newton's third law** *continued* *This session is optional if you choose to complete this lesson in one session only*	2. Model a demonstration of Newton's third law to explain how it works	Provide feedback on the results from the first part of the lesson in Analyse Mode Collect the required materials listed in the **Lab Guide**. Complete the **Risk Assessment Template** Review teaching notes in Prepare Mode 30 minutes	As a class, discuss learning and results from the activities in the last session	Students observe examples of Newton's third law in a practical activity and by watching a video.	Ask students to reflect on this lesson using a *Think, Pair, Share* thinking routine	Stile X app: Flash Quiz 1
Session 8	**2.2 The third law of motion**	1. State Newton's third law of motion 2. Explain how the third law of motion applies to forces acting between objects	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 30 minutes	As a class, watch a video of astronauts Christina Koch and Jessica Meir reflecting on the first all-female spacewalk and brainstorm why a spacewalk would be challenging	Students apply Newton's third law to a series of scenarios Direct students to the corresponding Stile X revision notes to complete the question: Explain why the third law of motion applies to Cernan as he pushes his bookshelf	Students use a free body diagram to explain why a ball accelerates away from your foot when kicked Assign **2.2 Check-in: The third law of motion** as homework to be completed before the next session	Stile X app: The third law of motion video Stile X Revision notes: The third law of motion Glossary terms: reaction force, third law of motion

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 9	**2.3 Gravity and the third law**	1. Apply Newton's third law to the gravitational attraction between two objects	Provide feedback on the Key Questions from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 30 minutes	As a class, review answers to **2.2 Check-in: The third law of motion**	Students explore a common misconception concerning the third law: that paired forces have equal magnitudes Direct students to the corresponding Stile X revision notes to complete the question: Construct a free body diagram to show the paired gravitational forces for the Sun and the Earth	Students analyse the forces acting on a skydiver using a free body diagram Assign **2.3 Check-in: Gravity and the third law** as homework to be completed before the next session	Stile X app: Gravity and the third law video Stile X Revision notes: Gravity and the third law Glossary term: non-contact force
Session 10	**2.4 Recoil, jets and collisions** *This lesson is not required for curriculum coverage and can be skipped*	1. Apply Newton's third law of motion to explain jet propulsion	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 20 minutes	As a class, review answers to **2.3 Check-in: Gravity and the third law**	Students explore the concepts of Newton's third law in a small range of examples, all involving applied forces pushing things apart	Assign **2.4 Check-in: Recoil, jets and collisions** as homework to be completed before the next session	Glossary terms: collision force, thrust
Session 11	**2.5 Water rockets** MATERIALS REQUIRED *Note: This lesson is allocated two class sessions, but could be run in one session with less time allocated to reviewing and discussing results*	1. Investigate how varying the amount of water loaded into water rockets affects their launch distance	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** Review teaching notes in Prepare Mode 30 minutes	If assigned, review answers to **2.4 Check-in: Recoil, jets and collisions**	Students build and test rockets powered by jets of water	Students complete the test results table	Stile X app: Flash Quiz 2
Session 12	**2.5 Water rockets** *continued* *This session is optional if you choose to complete this lesson in one class session only*	2. Explain how Newton's laws apply to the motion of rockets	Provide feedback on the results from the first part of the lesson in Analyse Mode Review teaching notes in Prepare Mode 20 minutes	As a class, review the method and results from the first part of the lesson	Students construct a graph of their results and complete the discussion section	Students present their results to the class and complete their conclusion	Stile X app: Flash Quiz 2

Lesson Planning Guide

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

Session	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 13	**3.1 Designing a balloon car** MATERIALS REQUIRED *Note: This lesson is allocated two class sessions, but could be run in one session with less time allocated to reviewing and discussing results*	1. Create a design for a balloon-powered car 2. Investigate the performance of a balloon-powered car	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** Review teaching notes in Prepare Mode 30 minutes	As a class, read the design brief for the engineering challenge and review the engineering design process	Students design, build and test their balloon-powered car prototype	Students investigate the performance of their balloon-powered car, recording their results and observations from testing	Stile X app: Flashcards
Session 14	**3.2 Improving a balloon car** MATERIALS REQUIRED *This session is optional if you choose to complete this lesson in one class session only*	1. Explain how the design of a balloon-powered car could be improved	Provide feedback on the results from the previous lesson in Analyse Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** Review teaching notes in Prepare Mode 30 minutes	As a class, review the designs and results from the previous lesson	Students improve their initial design and rebuild, test and evaluate their improved design	Students record and share their balloon car's design and performance with the class	Stile X app: Flashcards
Session 15	**3.3 The second law of motion**	1. State Newton's second law of motion 2. Describe how an object's acceleration depends on its mass and the force applied	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 30 minutes	As a class, observe the video of an experiment performed by an astronaut on the International Space Station	Students explore Newton's second law in an interactive simulation Direct students to the corresponding Stile X revision notes to complete the question: Use the Cornell note-taking template to outline and summarise how Newton's second law of motion describes the relationship between force, mass and acceleration	Students complete the final challenge question Assign **3.3 Check-in: The second law of motion** as homework to be completed before the next session	Stile X app: The second law of motion video Stile X Revision notes: The second law of motion Glossary terms: second law of motion
Session 16	**3.4 Applying the second law**	1. Use the second law to calculate force, mass and acceleration	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 20 minutes	As a class, review answers to **3.3 Check-in: The second law of motion**	Students calculate force, mass and acceleration by re-arranging the equation F = ma Direct students to the corresponding Stile X revision notes to complete the question: Complete the blanks to demonstrate how to re-arrange Newton's second law to calculate acceleration or mass	Students calculate the acceleration of a boat using a free body diagram Assign **3.4 Check-in: Applying the second law** as homework to be completed before the next session	Stile X app: Applying the second law video Stile X Revision notes: Applying the second law

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	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 17	**3.5 Flying car simulation**	1. Calculate the acceleration of a car from its final and initial velocities 2. Calculate the forces acting on cars in collisions using F = ma	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 30 minutes	As a class, review answers to **3.4 Check-in: Applying the second law** Introduce students to the simulation and allow them to explore how it works	Students use an interactive simulation to unpack how Newton's laws apply to flying-car collisions in space	Students write an explanation of how the simulation demonstrates Newton's third law	Glossary terms: acceleration
Session 18	**3.6 Jet-propelled can** MATERIALS REQUIRED *Note: This lesson is allocated two class sessions, but could be run in one session with less time allocated to reviewing and discussing results*	1. Explain how Newton's laws apply to a spinning can propelled by a jet of water	Provide feedback on the Key Questions from the previous lesson in Analyse Mode Collect the required materials listed in the **Lab Guide** Complete the **Risk Assessment Template** Review teaching notes in Prepare Mode 30 minutes	As a class, read the background text and discuss the aim, method and materials for this activity	Students conduct a hands-on activity using water jets to spin a can	Students record the results of their experiment	Stile X app: Flash Quiz 3
Session 19	**3.6 Jet-propelled can** *continued* *This session is optional if you choose to complete this lesson in one class session only*	1. Explain how Newton's laws apply to a spinning can propelled by a jet of water	Provide feedback on the results from the first part of the lesson in Analyse Mode Review teaching notes in Prepare Mode 30 minutes	As a class, discuss the results from the first part of the lesson	Students complete their discussion and explore whether increasing the number of holes in the can increases the speed at which it rotates	Students write a conclusion for the activity	Stile X app: Flash Quiz 3
Session 20	**3.7 Battling misconceptions** *This session is optional for teachers using Version 9 of the Australian Curriculum and the Western Australian Curriculum*	1. Create a video to communicate one of Newton's laws of motion	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 30 minutes	As a class, watch the video about people's misconceptions around Newton's laws	Students plan to create an interview video	Students share their plan with the class Assign **filming and uploading their video to the lesson** as homework to be completed before the next session	Stile X app: Flash Quiz 3

	Lesson name	Learning goals	Preparation required	Ice breaker	Core of lesson	To close	Revision and mastery
Session 21	**3.7 Battling misconceptions** *continued* *This session is optional for teachers using Version 9 of the Australian Curriculum and the Western Australian Curriculum*	1. Create a video to communicate one of Newton's laws of motion	Provide feedback on the videos from the first part of the lesson in Analyse Mode Review teaching notes in Prepare Mode 45 minutes	As a class, discuss the interviews students recorded and their findings	Students brainstorm and film ways to address the misconceptions	Students share their videos with the class	Stile X app: Flashcards
Session 22	**Science and society: Speed limits in built-up areas** *This session optional for teachers using Version 9 of the Australian Curriculum and the Western Australian Curriculum*	1. Summarise arguments for and against lower speed limits in built-up areas	Provide feedback on the Key Question from the previous lesson in Analyse Mode Review teaching notes in Prepare Mode 30 minutes	As a class, examine the graph depicting increased risk of fatality with increased speed for pedestrians and cyclists hit by cars and complete a poll	Students discuss and debate what the speed limit should be in built-up areas based on scientific and statistical data	Students reflect on whether the debate changed their minds about speed limits	Stile X app: Flashcards
Session 23	**Unit review** *This session is optional for teachers using Version 9 of the Australian Curriculum and the Western Australian Curriculum, and revision can be assigned for homework*		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 60 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	Stile X app: Flash Quiz 1–3 Study Stile X Revision notes in preparation for **Test: Newton's laws of motion**
Session 24	**Test: Newton's laws of motion**		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

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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	Quantity required per group	Labs this equipment is used in
bamboo skewers	1 packet for the class	3.1 Designing a balloon car
balloon	1 balloon	3.1 Designing a balloon car
bicycle pump with needle attachment	1 pump with needle attachment	2.5 Water rockets
bolt	1 bolt	2.1 Demonstrating Newton's third law
bucket	1 bucket	3.6 Jet-propelled can
cork	1 packet for the class	3.1 Designing a balloon car
drinking straw	1 packet for the class	3.1 Designing a balloon car
fishing line	30 cm length	3.6 Jet-propelled can
measuring tape, 30 m	1 measuring tape	2.5 Water rockets 3.1 Designing a balloon car
modelling clay	1 packet for the class	3.1 Designing a balloon car

Complete unit material list (cont.)

Equipment	Quantity required per group	Labs this equipment is used in
nail	1 nail	2.5 Water rockets 3.6 Jet-propelled can
paper, A4	1 sheet of paper	1.1 Demonstrating Newton's first law
paper cup	1 packet for the class	3.1 Designing a balloon car
permanent marker	1 marker	2.5 Water rockets
ruler, 30 cm	2 rulers	1.1 Demonstrating Newton's first law
scissors	1 pair	3.1 Designing a balloon car
sticky tape	1 roll per class	1.1 Demonstrating Newton's first law 3.1 Designing a balloon car
string	1 ball for the class	3.1 Designing a balloon car

Complete unit material list (cont.)

Specialised items

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	Quantity required per group	Labs this equipment is used in
100 mL measuring cylinder	1 measuring cylinder	2.5 Water rockets
bar magnet	1 magnet	2.1 Demonstrating Newton’s third law
retort stand with bosshead and clamp	1 retort stand with bosshead and clamp	2.5 Water rockets
rubber stopper	1 rubber stopper	2.5 Water rockets
spring balance	2 spring balances	2.1 Demonstrating Newton’s third law

PRACTICAL ACTIVITY

Demonstrating Newton's first law

Watch the demo video

stileapp.com/go/firstlawvideo

Activity purpose: Students demonstrate inertia for themselves with stationary and moving coins.

45 minutes	Lesson: **stileapp.com/go/NewtonsFirst**
2 students per group	RiskAssess: **stileapp.com/go/raNewtonsfirst**

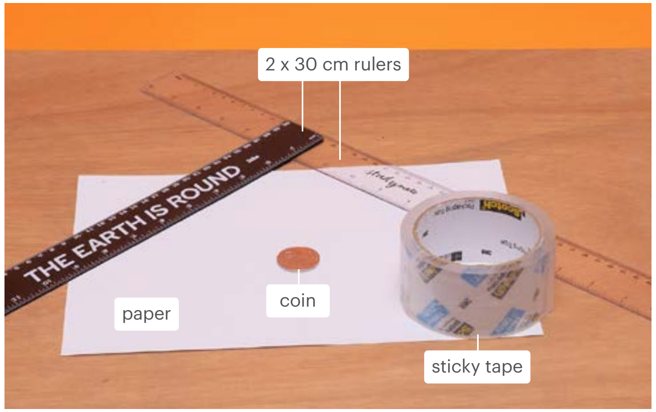
Materials

Each group of 2 students will need:

- coin
- paper
- 2 x 30 cm rulers
- sticky tape

Alternative materials:

- *The coin can be replaced by any small object with a flat bottom, such as a pebble.*



Before class preparation

Other than collecting materials, no additional preparation is required.

Tips and tricks

Things we learned from testing the lab ourselves

Both of the demonstrations are great representations of Newton's first law. The materials in them can be easily substituted based upon what you have available. Note that changing the materials may change the amount of friction between the different objects, changing the outcome of the demonstrations.

In DEMONSTRATION 1, if the friction between the coin, or coin replacement, and paper is too high, the coin will move forward as the paper is removed. Similarly, in DEMONSTRATION 2, if the friction between the coin, or the coin replacement, and the ruler is too high, the ruler won't move forward when the two rulers collide.

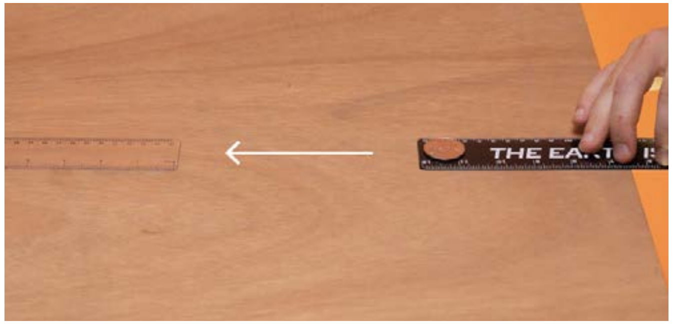
Method

DEMONSTRATION 1: Coin at rest

1. Place a coin on a sheet of paper near the edge of a table so the paper sticks out from the edge.
2. Pull the paper out as quickly as you can.

DEMONSTRATION 2: Coin in motion

1. Tape a ruler on to a tabletop so it won't move. Place your coin on another ruler about 15 cm away.
2. Push the ruler with the coin toward the ruler that is taped to the table. Let go when the two rulers hit each other.



Final outcome

What you can expect to see at the end

In DEMONSTRATION 1, when students pull the paper, the coin should move slightly in the same direction as the paper but only a few millimetres. It basically should stay where it was.

	Before: while the coin is sitting on the paper	After: as the paper is pulled away
coin	at rest	at rest
paper	at rest	moving

In DEMONSTRATION 2, when the rulers collide, students should observe the coin keeps moving in the same direction. The ruler the coin is on should come to a sudden stop when it hits the fixed ruler.

	Before: while the coin and ruler are sliding together	After: after the rulers collide
coin	moving	moving
ruler	moving	at rest

PRACTICAL ACTIVITY

Demonstrating Newton's third law

Watch the demo video

stileapp.com/go/thirdlawvideo

Activity purpose: Students complete a series of activities to demonstrate Newton's third law.

45 minutes	Lesson: **stileapp.com/go/NewtonsThird**
3–4 students per group	RiskAssess: **stileapp.com/go/raNewtonsthird**

Materials

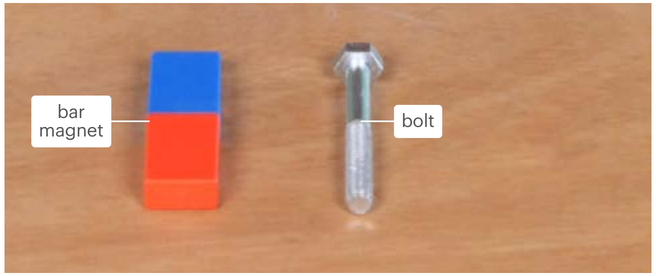
Each group of students will need:

ACTIVITY 1

- 2 wheeled desk chairs
- open space of smooth floor for wheeling

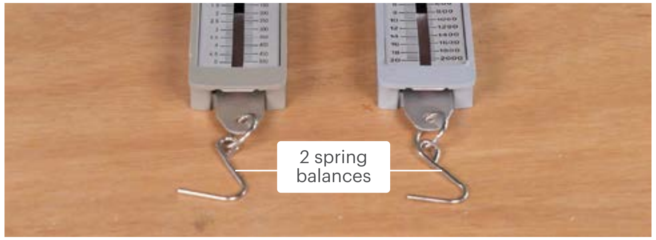
ACTIVITY 2

- bar magnet
- bolt (approx. equal mass to bar magnet)



ACTIVITY 3

- 2 spring balances



Before class preparation

Other than collecting materials, no additional preparation is required.

Tips and tricks

Things we learned from testing the lab ourselves

You may wish to run these activities as a round robin, with students moving between stations to complete each activity. If so, set up a number of stations around the classroom for each activity. Students can complete each in turn, before moving to the next activity. Each activity should take around the same amount of time to complete.

In ACTIVITY 1, students should swivel the wheels on each chair so that they are in line with the direction they will be pushed. This will ensure the chairs roll easily, making for a clearer demonstration of Newton's third law.

In ACTIVITY 2, depending on the strength of the magnet, students may find they need to bring the magnet and bolt quite close to each other before they're pulled together. If they're too far apart, the magnetic force will not be strong enough to pull them together.

In ACTIVITY 3, students may observe the spring balances showing different readings if one or both are stuck. In these cases, explain that the spring balances aren't working properly and the results should be ignored.

The lesson also contains a fourth example of Newton's third law, a CD hovercraft. This example can be run as an activity, if you wish. If you run this activity, each group of students will need:

- CD
- balloon
- valve-type drink bottle lid
- thumbtack
- piece of card
- scissors

Note that a hot glue gun is required for this activity. Students can follow the method in the video in the lesson to create their CD hovercrafts.

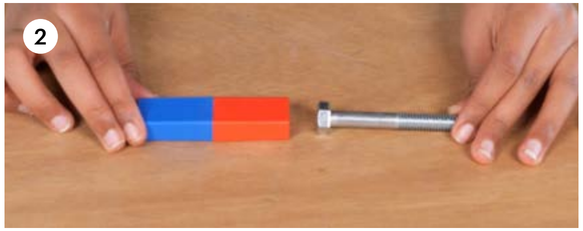
Method

ACTIVITY 1: Wheeled chairs

1. A student sits in each chair with the chairs next to each other. Feet must be off the floor. To begin with, choose students of about the same mass.
2. One student pushes the other's chair. Record your observations.

ACTIVITY 2: Magnet and bolt

1. First, make sure that the bolt is not magnetised by testing it against another piece of iron or steel, such as a paper clip.
2. Hold the magnet and the bolt down on a table, close enough that you can feel them pulling towards each other.
3. Remove your hand from the bolt. What happens?
4. Hold both objects down again, the same distance apart as in step 2.
5. Remove your hand from the magnet. What happens?



ACTIVITY 3: Spring balance pull

1. Hook two spring balances together with one student pulling or holding each end.
2. Gently pull the spring balances. Try to make the spring balances give different readings. This would mean the forces applied by the two balances on each other were not equal.

Final outcome

What you can expect to see at the end

ACTIVITY 1: Wheeled chairs

Students will observe that both chairs will roll away from each other, regardless of which student pushes. Increasing the force of the push causes the chairs to move faster and further apart before coming to a stop.

ACTIVITY 2: Magnet and bolt

Students will observe that when they hold the magnet and let go of the bolt, the bolt slides across the table towards the magnet. When it hits the magnet, the bolt stops and remains stuck to it.

When students hold the bolt and let go of the magnet, the magnet slides across the table towards the bolt. When it hits the bolt, the magnet stops and remains stuck to it.

The two cases are perfectly symmetrical.

ACTIVITY 3: Spring balance pull

Students will observe that the spring balances always show the same reading as each other. It doesn't matter how gently they pull the spring balances, or whether one is pulled while the other is kept fixed. They always show the same reading as each other.

PRACTICAL ACTIVITY

Water rockets

Watch the demo video

stileapp.com/go/waterrocketsvideo

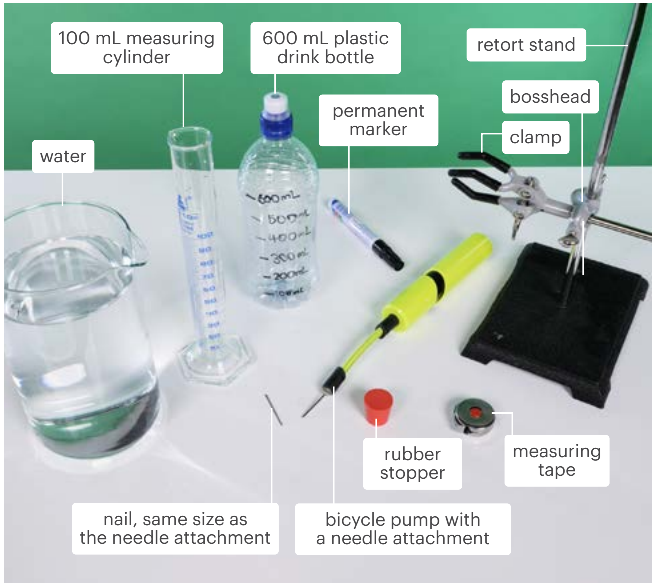
Activity purpose: Students build and test rockets powered by jets of water. They are challenged to find the best mix of water and air in order to maximise launch distance.

2 x 45 minutes	Lesson: **stileapp.com/go/WaterRockets**
3–4 students per group	RiskAssess: **stileapp.com/go/rawaterrockets**

Materials

Each group of students will need:
- 600 mL plastic drink bottle
- permanent marker
- 100 mL measuring cylinder
- rubber stopper
- bicycle pump with a needle attachment
- nail, the same size as the needle attachment
- water
- measuring tape
- retort stand
- clamp
- bosshead

Alternative materials:
- *The measuring tape can be replaced with a trundle wheel and flags to measure out the distances for the rocket launch.*



Before class preparation

Other than collecting materials, no additional preparation is required.

Tips and tricks

Things we learned from testing the lab ourselves

PART 1: Building your rocket
It's important to check in advance that the rubber stopper is a good fit for the plastic bottle. At least a third of the rubber stopper needs to be able to fit inside the lip of the bottle to form a good seal.

PART 2: Launching your rocket
The rockets should only be launched in a large outdoor open space, such as a sports field, with at least 30 m of open space in front of the launch area. Mark a launching area with a line along which the teams can set up their launch pads with suitable distances between them. Instruct all students to remain behind the line while the rockets are being launched and make sure appropriate safety measures are enforced.

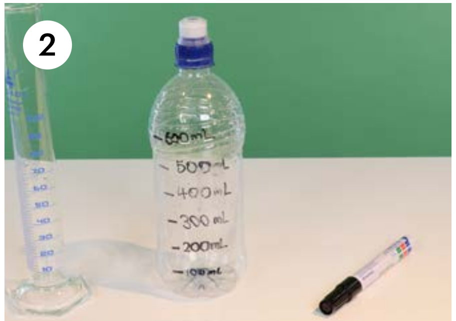
If possible, measure and mark out the testing area before students begin launching their rockets. Setting up a series of measuring tapes, or using flags with distance markers, can help students quickly measure out the distance their rockets travel. Make sure all students set up their launch pads at the same angle so that they can easily compare their results.

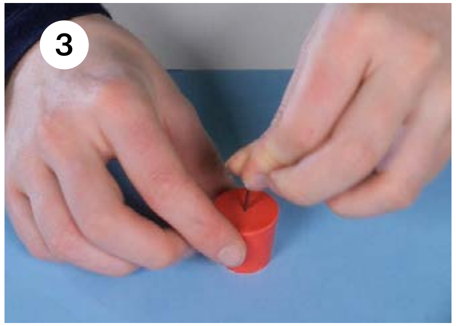
The launchers may get wet in the splash zone during the launch.

Method

PART 1: Building your rocket

1. Using the measuring cylinder, measure 100 mL of water. Pour this into the plastic bottle. Mark and label the height of the water level using the permanent marker.
2. Repeat step 1 until you've made labels for 100 mL, 200 mL, 300 mL, 400 mL, 500 mL and 600 mL. Then tip out the water.
3. Use the nail to puncture a hole through your rubber stopper. The nail should travel the whole way through the rubber and come out the other side.
4. Insert the needle attachment of the pump into the hole in the rubber stopper. The needle should stick slightly out the other end. Make sure the rubber stopper fits securely into the plastic bottle.





PART 2: Launching your rocket

1. Set up the launch pad by placing the retort stand on the ground. Secure the bosshead and clamp so that the rocket will be able to sit at an angle of about 45°.
2. Insert the rubber stopper and needle attachment into the empty bottle. Secure the clamp around the stopper only so that the bottle can launch off it.
3. While one team member holds the launch pad and bottle steady, another rapidly pumps the bike pump. Ensure you hold the bottle lightly so that it can launch easily.
4. When the rocket is launched, record the launch distance the bottle travels. *Note: A launch occurs whenever the bottle comes off the rubber stopper, even if the bottle doesn't leave the launch pad.*
5. Repeat steps 2, 3 and 4 with the bottle full of water. Record the launch distance.
6. Repeat steps 2, 3 and 4 with 200 mL of water in the bottle. Record the launch distance.

Note: The launchers may get wet in the splash zone during the launch.

Final outcome

What you can expect to see at the end
Students will observe that the amount of water inside the bottle represents a trade-off. When the water inside the pressurised bottle is released, it produces a thrust. If there's no water, there is very little thrust. However, adding water also adds mass to the bottle. Adding too much water makes the bottle too heavy, and it isn't able to travel very far.

An example set of results a group of students might collect is shown below:

Test	Water volume (mL)	Launch distance (m)	Reason for performance
1	0	2	Examples only: Without any water, there was just a rapid release of the pressurised air. This was enough to launch the bottle a small distance but there wasn't enough mass ejected to produce a strong thrust.
2	600	0.5	The bottle barely got out of the tube, probably because the mass of all the water made it too heavy to pick up much speed. There was also only a small amount of air that could be pressurised so the outward force was quite weak.
3	200	9	The greater launch distance seems to be a combination of two factors. The large amount of compressed air is able to generate a fairly strong force. The small amount of water is not too heavy to get moving and as it streams out of the rocket its mass provides greater thrust than a stream of the same volume of air.

ENGINEERNG CHALLENGE

Designing a balloon car

Watch the demo video

stileapp.com/go/balloncarsvideo

Activity purpose: Students follow the engineering process to design, create and test a prototype of a balloon car.

2 x 45 minutes	Lesson: **stileapp.com/go/BalloonCars**
2–4 students per group	RiskAssess: **stileapp.com/go/raballooncars**

Materials

Each group of students will need:
- cardboard
- corks
- bamboo skewers
- drinking straws
- plastic bottle caps
- sticky tape
- string
- balloon
- modelling clay
- paper cups
- scissors – for cutting only
- measuring tape – for measuring only

Alternative materials:
- *Other craft and recycling materials can also be used as appropriate materials. These include plastic bottles, food containers and pipe cleaners.*

Before class preparation

Other than collecting materials, no additional preparation is required.

Tips and tricks

Things we learned from testing the lab ourselves

It's important students test their designs as they build them. To help with testing, measure out a 3 m course for students to use as a testing area. Encourage students to take notes of different design aspects they change during the engineering challenge as a result of their tests.

The design brief

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.

One of the most challenging parts of the engineering challenge is working out how to securely attach the balloon to the car. In particular, accounting for the expansion of the balloon when it is inflated can be hard.

Encourage students to spend some time focusing on just this aspect of their car. Ideally, the balloon can be easily inflated while it is attached to the car, rather than needing to be inflated separately and then attached afterwards. If students are stuck, you might suggest poking a hole through a piece of cardboard or similar material, and threading the balloon nozzle through the hole. The end of the balloon can then be secured with tape, if necessary.

Final outcome

There are lots of possible solutions to the engineering challenge; here is an example we came up with during testing

The example below uses a paper cup as the core of the balloon car. The balloon is threaded through a small hole in the cup in order to secure it. The axis of the car are bamboo skewers within drinking straws, with plastic bottle caps secured to the end to act as wheels.

PRACTICAL ACTIVITY

Jet-propelled can

Watch the demo video

stileapp.com/go/jetcanvideo

Activity purpose: Students conduct an experiment using water jets to spin a can, demonstrating all three of Newton's laws. Students explore if increasing the number of holes increases the speed that the can rotates.

45 minutes	Lesson: **stileapp.com/go/JetCan**
3–4 students per group	RiskAssess: **stileapp.com/go/rajetcan**

Materials

Each group of students will need:

- empty drink can with the ring-pull opener still attached
- nail
- 30 cm length of fishing line
- bucket or large tub
- water

Before class preparation

One week prior: You can ask students to bring in cans for this activity from home. Ensure at least one week's notice is given so that enough soft drink cans with ring-pull openers still attached can be saved to do this activity.

Tips and tricks

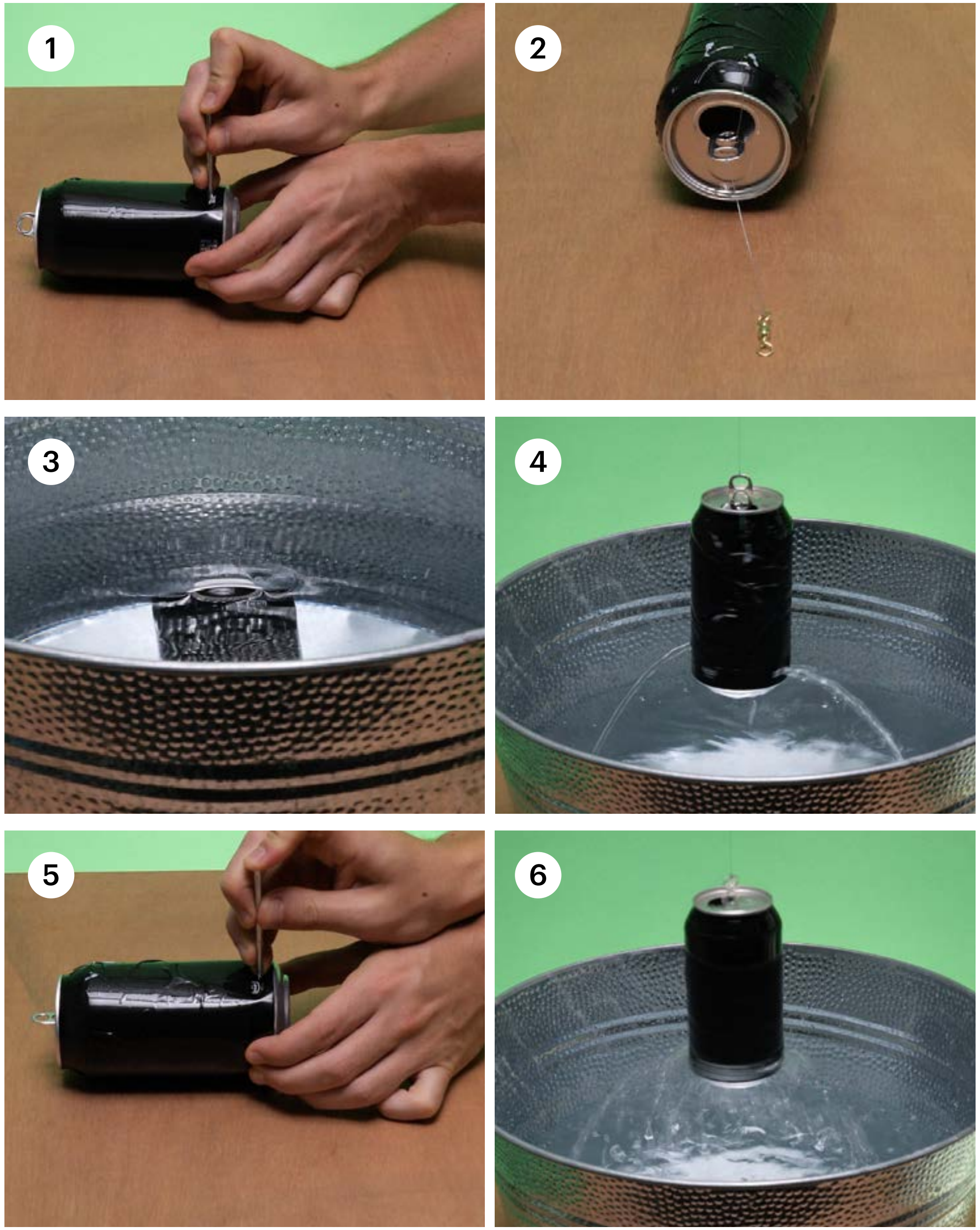
Things we learned from testing the lab ourselves

The ring-pull openers on the drink cans may fall off during testing. If this occurs, punch a hole through the top of the can using a nail. Thread a piece of fishing line through the nail hole and the drinking hole and tie it off. This will create a central point from which the can will be able to hang.

Method

1. Lie a can on its side. Use a nail to carefully punch one hole on either side, just above the bottom rim. Before removing the nail from each hole, angle it to the left to slant the holes parallel to the base of the can.
2. Bend the ring-pull straight up and tie a length of fishing line to it.
3. Fill the bucket with water. Submerge the can in the bucket of water to fill it up.
4. Holding the fishing line, raise the can out of the water.
   As water streams out of the holes, it should start to spin.
   Try to count the number of spins. Repeat two more times. Calculate the average number of spins over the three trials.
5. Add an extra slanted hole and repeat steps 3 and 4.
6. Add a fourth slanted hole and repeat again.

If there is time, you can experiment with more holes.



Final outcome

What you can expect to see at the end

Students will observe the can spinning, with the water coming out of the slanted holes, propelling this movement. The more holes are added to the can, the faster it will spin.

An example set of results a student might gather is shown below:

Number of holes in the can	Number of spins counted	Observations
2	14	The can spun slowly at first. It picked up speed over time.
3	16	The can spun much faster than when it only had two holes, but also came to a stop sooner.
4	17	The can spun the fastest out of all tests. It also stopped the soonest.

Call us on 1300 918 292

Email us at community@stileeducation.com

Swing by the office to say hi!
Level 5, 128 Exhibition Street, Melbourne, Victoria

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.