# The force of friction



<table>
<tr><th>Assessment description</th><th>Category</th></tr>
<tr><td rowspan="2">Students conduct a fair test to establish how friction affects the distance travelled by a toy car.</td><td>Written</td></tr>
<tr><td>Technique</td></tr>
<tr><td></td><td>Experimental investigation</td></tr>
<tr><td>Context for assessment</td><td>Alignment</td></tr>
<tr><td rowspan="4">This assessment requires students to explore the force of friction.<br>In Section 1 they investigate how far a toy car will travel across different surfaces and explain their observations using their knowledge of friction.<br>In Section 2 students apply their knowledge of friction to a real-life scenario.</td><td>• Australian Curriculum 5.0, Year 4 Science Australian Curriculum content and achievement standard ACARA — Australian Curriculum, Assessment and Reporting Authority www.australiancurriculum.edu.au<br>• Year 4 Science standard elaborations www.qsa.qld.edu.au/downloads/p_10/ac_sci_yr4_se.pdf</td></tr>
<tr><td>Connections</td></tr>
<tr><td>This assessment can be used with the QSA Australian Curriculum resource titled Year 4 plan — Science exemplar www.qsa.qld.edu.au/downloads/p_10/ac_science_yr4_plan.doc</td></tr>
<tr><td>Definitions</td></tr>
<tr><td>In this assessment</td><td>Assessment materials</td></tr>
<tr><td>Teacher guidelines<br>Student booklet<br>Task-specific standards — continua<br>Task-specific standards — matrix<br>Sample response<br>Assessment resource — Scientific concepts and student's prior understandings<br>Assessment resource — Scientific inquiry process</td><td>Per group:<br>• access to three different surfaces, e.g. concrete, carpet, linoleum, tiles<br>• one metre measuring tape or ruler<br>• toy car<br>• ramp</td></tr>
</table>

# Teacher guidelines

## Identify curriculum

| Content descriptions to be taught | | |
|---|---|---|
| **Science Understanding** | **Science as a Human Endeavour** | **Science Inquiry Skills** |
| **Physical sciences**<br>• Forces can be exerted by one object on another through direct contact or from a distance ACSSU076 | **Nature and development of science**<br>• Science involves making predictions and describing patterns and relationships ACSHE061 | **Questioning and predicting**<br>• With guidance, identify questions in familiar contexts that can be investigated scientifically and predict what might happen based on prior knowledge ACSIS064<br>**Planning and conducting**<br>• Safely use appropriate materials, tools or equipment to make and record observations, using formal measurements and digital technologies as appropriate ACSIS066<br>**Processing and analysing data and information**<br>• Use a range of methods including tables and simple column graphs to represent data and to identify patterns and trends ACSIS068<br>• Compare results with predictions, suggesting possible reasons for findings ACSIS216<br>**Evaluating**<br>• Reflect on the investigation; including whether a test was fair or not ACSIS069<br>**Communicating**<br>• Represent and communicate ideas and findings in a variety of ways such as diagrams, physical representations and simple reports ACSIS071 |

**General capabilities (GCs) and cross-curriculum priorities (CCPs)**
This assessment may provide opportunities to engage with the following GCs and CCPs. Refer also to the Resources tab on the P-10 Science Curriculum and Assessment page: www.qsa.qld.edu.au/yr4-science-resources.html

- **Literacy**
- **Numeracy**
- **ICT capability**
- **Critical and creative thinking**
- **Personal and social capability**

**Achievement standard**
This assessment provides opportunities for students to demonstrate the following highlighted aspects.

By the end of Year 4, students apply the observable properties of materials to explain how objects and materials can be used. They use contact and non-contact forces to describe interactions between objects. They discuss how natural and human processes cause changes to the Earth's surface. They describe relationships that assist the survival of living things and sequence key stages in the life cycle of a plant or animal. They identify when science is used to ask questions and make predictions. They describe situations where science understanding can influence their own and others' actions.

Students follow instructions to identify investigable questions about familiar contexts and predict likely outcomes from investigations. They discuss ways to conduct investigations and safely use equipment to make and record observations. They use provided tables and simple column graphs to organise their data and identify patterns in data. Students suggest explanations for observations and compare their findings with their predictions. They suggest reasons why their methods were fair or not. They complete simple reports to communicate their methods and findings.

Source: ACARA, The Australian Curriculum v5.0, www.australiancurriculum.edu.au

# Sequence learning

## Suggested learning experiences

This assessment leads on from the learning experiences outlined in the QSA's Year 4 Science Year level plan. The knowledge, understanding and skills in the Year level plan will prepare students to engage in this assessment.

See Year 4 plan — Science exemplar
www.qsa.qld.edu.au/downloads/p_10/ac_science_yr4_plan.doc

## Adjustments for needs of learners

To make adjustments, teachers refer to learning area content aligned to the student's chronological age, personalise learning by emphasising alternate levels of content, general capabilities or cross-curriculum priorities in relation to the chronological age learning area content. The emphasis placed on each area is informed by the student's current level of learning and their strengths, goals and interests. Advice on the process of curriculum adjustment for all students and in particular for those with disability, gifted and talented or for whom English is an additional language or dialect are addressed in *Australian Curriculum — Student Diversity* materials.

For information to support students with diverse learning needs, see:

- Queensland Studies Authority materials for supporting students with diverse learning needs
  www.qsa.qld.edu.au/10188.html
- Australian Curriculum Student Diversity
  www.australiancurriculum.edu.au/StudentDiversity/Overview
- The *Melbourne Declaration on Educational Goals for Young Australians*
  www.mceecdya.edu.au/mceecdya/melbourne_declaration,25979.html
- *Disability Standards for Education* http://deewr.gov.au/disability-standards-education.

# Develop assessment

## Preparing for the assessment

Learning experiences in preparation for the assessment could include:

**Revising key concepts**

- Revise from Year 2 how pushes and pulls change the speed, direction or shape of an object.

**Exploring forces**

- Investigate questions about forces, for example:
  - What is a force?
  - What is a contact force?
  - What is a non-contact force?
  - What is friction?
  - Where are forces acting in my everyday life?
- Explore different contact and non-contact forces and the effects of these forces on the movement of objects.
- Consider how non-contact forces are similar to contact forces in terms of objects pushes and pulls.
- Draw labelled and force-arrow diagrams to show the forces that are acting on an object.
  - Arrows pointing away indicate that a pull is being applied while an arrow pointing into the object indicates a push.
  - The size of the arrows can also represent the size of the force that is applied.
- Explore friction (forces working against each other) through pushing an object across different surfaces This would be demonstrated in a force diagram as an arrow pointing in the opposite direction from the movement.
- Experience how the application of additional forces to objects upset balance and cause motion. For example, kicking a ball, knocking down dominoes.
- Explore everyday situations where friction is an advantage and where it is a disadvantage.
- Explore the concept of measuring forces and that they have unit of measurement (Newton: N) just as distance can be measured and has a unit of measurement (metres: m; centimetres: cm).

**Conducting investigations to explore forces**

- Identify questions in familiar contexts that can be investigated scientifically and predict what might happen.
- Guide students to suggest ways to plan and conduct safe and fair investigations about the characteristics of liquids and solids and their change in state.
- Support students to carry out simple investigations in small groups.
- Support students to record and represent data using tables, column graphs and labelled scientific diagrams and model the appropriate features of these.
- Practise using and reading a spring balance to measure force.
- Support students to calculate averages when multiple trials are conducted.
- Discuss any data collected as a class in order to identify and explain patterns in the data, justify findings and compare with predictions.
- Support students to communicate ideas using a simple report format.

## Implementing

### Section 1: Question and prediction

| Student role | Teacher role |
|---|---|
| • Participate in a discussion about the purpose of the assessment.<br>• Clarify your understanding of the investigation question (if necessary).<br>• Write your prediction and explain why you think it will happen. | • Introduce the assessment and relate to students' prior understandings of forces.<br>• Present the investigation question, clarifying student understanding of this where necessary.<br>• Monitor students as they complete their predictions. Explain the importance of providing an explanation (justification) for their answers. |

### Section 1: Keeping the investigation fair

| Student role | Teacher role |
|---|---|
| • Participate in a discussion about the factors that have to be considered to ensure the investigation is a fair test.<br>• Complete the table, i.e. what will change, what will be measured and what will be kept the same. | • Lead the discussion about the factors that have to be considered to ensure the investigation is a fair test, i.e. what will change, what will be measured and what will be kept the same. |

### Section 1: Method

| Student role | Teacher role |
|---|---|
| • Clarify your understanding of how the equipment is to be assembled (if necessary).<br>• Clarify your understanding of the method (if necessary).<br>• Assemble the equipment and conduct the investigation in a small group, following the teacher instructions. | • Ensure all students understand how the equipment is to be assembled.<br>• Read the method and explain each step in the process clearly to students. Clarify student understanding where necessary.<br>• Using your knowledge of the students' personalities and abilities, place students in groups of three.<br>• Discuss behavioural and safety expectations for the investigation (e.g. working safely, cooperating and sharing, listening to each other).<br>• Provide each group with the necessary materials and equipment.<br>• Support and guide students to assemble the equipment and conduct the investigation. |

### Section 1: Results

| Student role | Teacher role |
|---|---|
| • Measure the friction or distance. Record the data in the table provided in the *Student booklet*.<br>• Identify the middle value from the multiple trials for each surface. Record in the *Student booklet*.<br>• Use coloured pencils to create a column graph on the grid provided in the *Student booklet*. | • Support and guide students as they collect their measurements. Ensure that all students are recording their data in the table provided.<br>• Read, explain and discuss with students why the middle value will be the best to use when drawing the column graph.<br>• Provide students with coloured pencils to complete their column graphs. |

| Implementing | |
|---|---|
| **Section 1: Discussion and conclusion** | |
| **Student role**<br>• Clarify your understanding of the discussion questions in the *Student booklet* (if necessary).<br>• Answer the discussion questions in the *Student booklet* and use the evidence from the results summary table and column graph to explain your decisions.<br>• Clarify your understanding of the conclusion questions in the *Student booklet* (if necessary).<br>• Complete the conclusion in the *Student booklet*. | **Teacher role**<br>• Read the discussion questions to students, clarifying understanding of these where necessary.<br>• Monitor students as they complete the discussion questions. Reiterate the importance of using the evidence collected and recorded in the results summary table and column graph to provide an explanation (justification) for their answers.<br>• Read the conclusion questions to the students.<br>• Monitor students as they complete the conclusion. |
| **Section 2: Applying your science knowledge** | |
| **Student role**<br>• Clarify your understanding of the information and question in the 'Applying your science knowledge' section of the *Student booklet* (if necessary).<br>• Select one of the photos and apply your science knowledge to complete the questions in the *Student booklet*. | **Teacher role**<br>• Read the information and questions to the students, clarifying understanding of these where necessary.<br>• Monitor students as they complete the questions. Reiterate the importance of providing an explanation (justification) for their answers. |

# Make judgments

When making judgments about the evidence in student responses to this assessment, teachers are advised to use the task-specific standards provided. The development of these task-specific standards has been informed by the Queensland Year 4 standard elaborations. See www.qsa.qld.edu.au/downloads/p_10/ac_sci_yr4_se.doc.

## *The Queensland standard elaborations for Science*

The Queensland Year 4 standard elaborations for Science is a resource to assist teachers to make consistent and comparable evidence-based A to E (or equivalent) judgments. It should be used in conjunction with the Australian Curriculum achievement standard and content descriptions for the relevant year level.

The Queensland Science standard elaborations provide a basis for judging *how well* students have demonstrated what they know, understand and can do using the Australian Curriculum achievement standard.

The Australian Curriculum achievement standards dimensions of Understanding and Skills are used to organise the Queensland Science standard elaborations. Understanding and Skills in Science are organised as Understanding dimension and Skills dimension.

The valued features of Science drawn from the achievement standard and the content descriptions for Understanding dimension and Skills dimension are organised as:

- Science Understanding
- Science as a Human Endeavour
- Questioning and predicting

- Planning and conducting
- Processing and analysing data and information
- Evaluating
- Communicating.

## *Task-specific standards*

Task-specific standards give teachers:

- a tool for directly matching the evidence of learning in the student response to the standards
- a focal point for discussing student responses
- a tool to help provide feedback to students.

Task-specific standards are not a checklist; rather they are a guide that:

- highlights the valued features that are being targeted in the assessment and the qualities that will inform the overall judgment
- specifies particular *targeted aspects* of the curriculum content and achievement standard
- aligns the valued feature, task-specific descriptor and assessment
- allows teachers to make consistent and comparable on-balance judgments about student work by matching the qualities of student responses with the descriptors
- clarifies the curriculum expectations for learning at each of the five grades (A–E or the early years equivalent)
- shows the connections between what students are expected to know and do, and how their responses will be judged and the qualities that will inform the overall judgment
- supports evidence-based discussions to help students gain a better understanding of how they can critique their own responses and achievements, and identify the qualities needed to improve
- encourages and provides the basis for conversations among teachers, students and parents/carers about the quality of student work and curriculum expectations and related standards.

## *Task-specific valued features*

Task-specific valued features are the discrete aspects of the valued features of Science targeted in a particular assessment and incorporated into the task-specific standards for that assessment. They are selected from the Queensland Science standard elaborations valued features drawn from the Australian Curriculum achievement standard and content descriptions.

| **Task-specific valued features for this assessment** |
| --- |
| The following identifies the valued features for this assessment and makes explicit the understandings and skills that students will have the opportunity to demonstrate. This ensures that the alignment between what is taught, what is assessed and what is reported is clear. |

| Australian Curriculum achievement standard dimensions | Queensland standard elaborations valued features | Task-specific valued features |
|---|---|---|
| Understanding dimension | Science understanding | Application of knowledge about forces and friction to an everyday scenario<br>**Section 2: Applying your science knowledge** |
| Skills dimension | Questioning and predicting | Makes a prediction about the effect of friction<br>**Section 1: Prediction** |
| | Planning and conducting | Collection and recording of data in the results tables and use of data to draw a column graph<br>**Section 1: Results** |
| | Processing and analysing data and information | Use of data in the results tables and column graph to explain findings<br>**Section 1: Discussion** |
| | Evaluating | Identification of factors that need to be considered to make the investigation fair<br>**Section 1: Keeping the investigation fair** |
| | Communicating | Communication of ideas and findings in a variety of ways (short responses, tables, column graph)<br>**Sections 1 and 2** |

The task-specific standards for this assessment are provided in two models using the same task-specific valued features:

- a matrix
- a continua.

## *Matrix and Continua*

Task-specific standards can be prepared as a matrix or continua. Both the matrix and continua:

- use the Queensland standard elaborations to develop task-specific descriptors to convey expected qualities in student work — A to E or equivalent
- highlight the same valued features from the Queensland standard elaborations that are being targeted in the assessment and the qualities that will inform the overall judgment
- incorporate the same task-specific valued features i.e. make explicit the particular understanding / skills students have the opportunity to demonstrate for each selected valued feature
- provide a tool for directly matching the evidence of learning in the student response to the standards to make an on-balance judgment about student achievement
- assist teachers to make consistent and comparable evidence-based A to E or equivalent judgments.

***Continua***

The continua model of task-specific standards uses the dimensions of the Australian Curriculum achievement standard to organise task-specific valued features and standards as a number of reference points represented progressively along an A–E continuum. The task-specific valued features at each point are described holistically. The task-specific descriptors of the standard use the relevant degrees of quality described in the Queensland standard elaborations.

Teachers determine a position along each continuum that best matches the evidence in the students' responses to make an on-balance judgment about student achievement on the task.

The continua model is a tool for making an overall on-balance judgment about the assessment and for providing feedback on task specific valued features.

***Matrix***

The matrix model of task-specific standards uses the structure of the Queensland standard elaborations to organise the task-specific valued features and standards A to E. The task-specific descriptors of the standard described in the matrix model use the same degrees of quality described in the Queensland standard elaborations.

Teachers make a judgment about the task-specific descriptor in the A to E (or equivalent) cell of the matrix that best matches the evidence in the students' responses in order to make an on-balance judgment about how well the pattern of evidence meets the standard.

The matrix is a tool for making both overall on-balance judgments and analytic judgments about the assessment. Achievement in each valued feature of the Queensland standard elaboration targeted in the assessment can be recorded and feedback can be provided on the task-specific valued features.

# Use feedback

| | |
|---|---|
| **Feedback to students** | Evaluate the information gathered from the assessment to inform teaching and learning strategies. Focus feedback on the student's personal progress and the next steps in the learning journey.<br>The task-specific standards for this assessment can be used as a basis for providing feedback to students.<br>Offer feedback that:<br>• maximises the students' opportunities to succeed in the assessment by providing feedback on investigations carried out during the term, specifically about:<br>– making reasoned predictions<br>– accurately collecting and recording data in tables and column graphs<br>– using the data in tables and column graphs as evidence to give reasoned explanations for investigation findings<br>• involves students in the process by providing opportunities to ask follow-up questions<br>• focuses on each student's personal progress relative to their previous achievements<br>• identifies the characteristics of a high quality response that aligns with the descriptors in the task-specific standards. |
| **Resources** | For guidance on providing feedback, see the professional development packages titled:<br>• *About feedback* www.qsa.qld.edu.au/downloads/p_10/as_feedback_about.doc<br>• *Seeking and providing feedback* www.qsa.qld.edu.au/downloads/p_10/as_feedback_provide.doc. |

# The force of friction



Image: *Speed (84/365)* by, John Liu, Creative Commons Attribution 2.0, http://flic.kr/p/9tndJN

**Students conduct a fair test to establish how friction affects the distance travelled by a toy car.**

**You will:**

- make predictions
- discuss how to make an investigation fair
- conduct an investigation
- record results
- identify patterns in your results
- draw a conclusion
- apply your science knowledge to a real-life situation.

# Section 1. Investigating friction

Friction is a force. If something is moving, friction opposes it. Friction is a force that exists whenever two things rub against each other.

You will conduct an investigation about how friction affects the distance a toy car travels.

In your investigation you will roll a toy car down a ramp and on to different surfaces. You will measure how far the car travels along the different surfaces.

## *Question*

***What you are trying to find out by doing the investigation?***

**How does friction affect the distance a toy car will travel?**

## *Prediction*

***What you think is going to happen in the investigation:***

I think the toy car will travel the greatest distance on the ..... surface.

I think this because .....

.....

## *Materials and equipment*

***Things you will need to conduct your investigation:***

- a toy car
- a ramp from which to launch the toy car
- books (to raise the ramp)
- 3 different surfaces, e.g. concrete, carpet, linoleum, tiles, bench top
- a one-metre measuring tape or ruler

## *Keeping the investigation fair*

***Getting the best results you can:***

It is important to make sure that this investigation is a fair test.

Have a class discussion with your teacher and class members to complete the table below.

| One thing that we will change each trial | What we will measure | Things that we will keep the same each trial |
|---|---|---|
| | | |

## *Method*

***Follow these steps to conduct your investigation:***

**Step 1:**

- Set up the equipment using one surface, as shown in the photo below.
- Make sure that there is plenty of room at the end of the ramp for the toy car to roll on to the test surface as it leaves the ramp.

**Step 2:**

- Place the toy car at the top of the ramp so its back wheels are on the edge of the ramp.
- Hold it in position.

**Step 3:**

Repeat three times:

- Release the toy car and wait until it stops moving.
- Measure the distance from the end of the ramp to the back wheels of the car.
- Record the distance in centimetres in the results table.

**Step 4:**

- Repeat steps 1, 2 and 3 for the other two surfaces.

## *Results*

***A record of the data you collect during the investigation***

1. Describe the appearance of each surface, e.g. rough, smooth, bumpy.
2. Record the distance the toy car travelled for each trial and each surface.

**Table 1: Results data**

| Surface | Appearance | Distance travelled (cm) | | |
|---|---|---|---|---|
| | | Test 1 | Test 2 | Test 3 |
| **Surface 1:** | | | | |
| **Surface 2:** | | | | |
| **Surface 3:** | | | | |

3. Repeating an experiment more than once helps you to be sure that the data you collect is as accurate as possible. No experiment method is perfect so by repeating it a number of times you can recognise any results that may be inaccurate and don't fit the pattern of the other measurements taken.

   In this experiment you repeated the method for each surface three times, but when drawing a column graph from the data you collected you will use only one of the measurements for each surface.

   We will assume that the most **accurate** measurement is the value that sits in the middle of the three measurements you took for each surface.

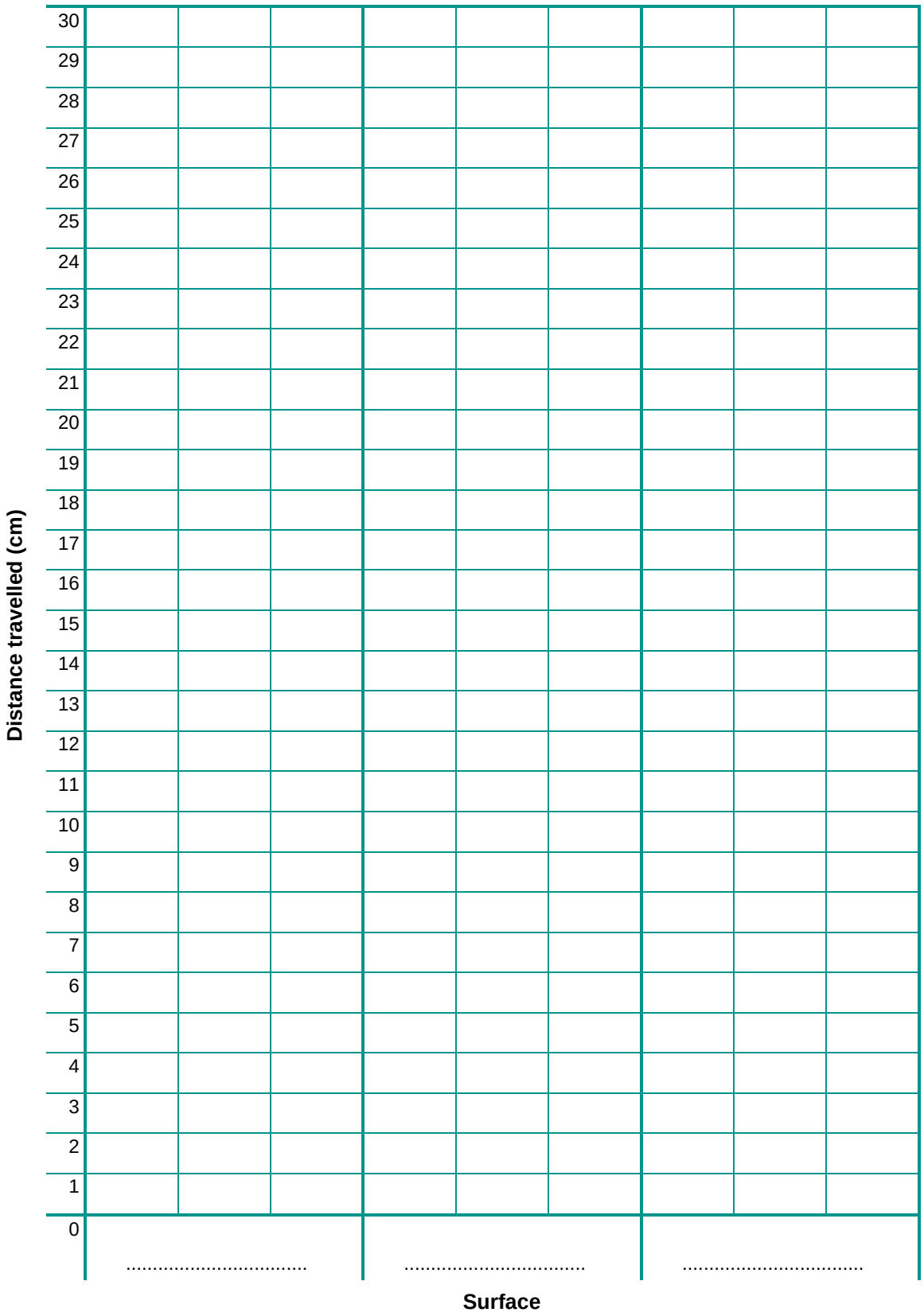
   Complete the table below, using the middle value for each surface from your table of results.

**Table 2: Results summary**

| Surface | Distance travelled (cm) |
|---|---|
| **Surface 1:** | |
| **Surface 2:** | |
| **Surface 3:** | |

4. Use the values from Table 2 in Question 3 to draw a column graph showing the distance the toy car travelled for each of the three surfaces.

**Distance travelled over different surfaces**



## Discussion

***Describe and explain your results using evidence from the investigation and your science knowledge.***

5. Over which surface did the toy car travel the greatest distance? .....

   Was friction high or low between this surface and the wheels of the toy car? .....

   Use the evidence from the results table and the column graph and your observation of the surface to explain how you know this.

   .....

   .....

   .....

   .....

6. Over which surface did the toy car to travel the smallest distance? .....

   Was friction high or low between this surface and the wheels of the toy car? .....

   Use the evidence from the results table and the column graph and your observation of the surface to explain how you know this.

   .....

   .....

   .....

   .....

## Conclusion

***What did you find out?***

7. Was the investigation question answered? (circle one) Yes / No
8. Was your prediction correct? (circle one) Yes / No
9. How does friction affect the distance a toy car will travel?

.....

.....

## Section 2. Applying your science knowledge

In Section 1, we investigated how friction affects the movement of objects. Sometimes friction can be an advantage, and sometimes it is a disadvantage. It depends on the situation.

Choose **one** of the photos below.

**Slippery slide**

Image: *Space savings,* kimubert, Creative Commons Attribution 2.0, www.flickr.com/photos/treevillage/8591237012/in/photostream

**Running shoes**

Image: *26 miles of rock and roll,* George Ruiz, Creative Commons Attribution 2.0, www.flickr.com/photos/29946035@N08/4735345767/in/photolist-8drTjx-cJMR5y-8EehNW

10. Is friction an advantage or disadvantage in this situation? advantage / disadvantage (circle one)

11. Explain why friction is an advantage or disadvantage in this situation.

.....

.....

.....

.....

.....

.....

# The force of friction

Name .....



**Purpose of assessment**: To conduct a fair test to establish how friction affects the distance travelled by a toy car.

| Understanding and Skills | | | | |
|---|---|---|---|---|
| **Science Understanding** | **Science Inquiry Skills** | | | |
| **Section 2: Applying your science knowledge**<br>Application of knowledge about forces and friction to an everyday scenario. | **Section 1: Prediction and discussion**<br>Prediction about friction and the effect of friction.<br>Use of data in the results table and column graph to explain findings. | **Section 1: Keeping the investigation fair and results**<br>Identification of factors that need to be considered to make the investigation fair.<br>Collection and recording of data in the results table and use of this data to draw a column graph. | **Sections 1 and 2**<br>Communication of ideas and findings in a variety of ways (short responses, tables, column graph). | |
| Application of science knowledge to provide a reasoned explanation of why friction is an advantage or a disadvantage in the chosen situation. | Reasoned prediction about the distance travelled by the toy car. Use of data in the results table and patterns in the column graph to explain with justification why the toy car travelled different distances over different surfaces. | Accurate collection and recording of reliable data in the table and use of this data to accurately draw a column graph to compare friction of different surfaces and the distance travelled over different surfaces. | Clear and purposeful communication of ideas and findings about the force of friction. | **A** |
| | | | | **B** |
| Application of science knowledge to provide an explanation of why friction is an advantage or a disadvantage in the chosen situation. | Plausible prediction about the distance travelled by the toy car. Use of data in the results table and patterns in the column graph to describe the distances travelled by the toy car over different surfaces. | Identification of factors that make the investigation fair. Collection and recording of data in the table and use of this data to draw a column graph to compare friction of different surfaces and the distance travelled over different surfaces. | Communication of ideas and findings about the force of friction. | **C** |
| | | | | **D** |
| Statement of isolated science facts about friction. | Restatement of the investigation question and completion of the results table. | Listing of given factors that make the investigation fair. Listing of observations about friction and distance travelled. | Use of given representations to communicate ideas and findings about the force of friction. | **E** |

# The force of friction

Name .....



**Purpose of assessment:** To conduct fair tests about friction.

| | | | A | B | C | D | E |
|---|---|---|---|---|---|---|---|
| Understanding dimension | Science Understanding | **Section 2: Applying your science knowledge** Application of knowledge about forces and friction to an everyday scenario. | Application of science knowledge to provide a reasoned explanation of why friction is an advantage or a disadvantage in the chosen situation. | Application of science knowledge to provide an informed explanation of why friction is an advantage or a disadvantage in the chosen situation. | Application of science knowledge to provide an explanation of why friction is an advantage or a disadvantage in the chosen situation. | Application of science knowledge to provide a partial explanation of why friction is an advantage or a disadvantage in the chosen situation. | Statement of isolated science facts about friction. |
| Skills dimension | Questioning and predicting | **Section 1: Prediction** Prediction about the effect of friction. | Reasoned prediction about the distance travelled by the toy car. | Informed prediction about the distance travelled by the toy car. | Plausible prediction about the distance travelled by the toy car. | Prediction about the distance travelled by the toy car. | Restatement of the investigation question. |
| | Planning and conducting | **Section 1: Results** Collection and recording of data in the results table and use of this data to draw a column graph. | Accurate collection and recording of reliable data in the table and use of this data to accurately draw a column graph to compare the distance travelled over different surfaces | Collection and recording of relevant data in the table and use of this data to draw a column graph to compare the distance travelled over different surfaces. | Collection and recording of data in the table and use of this data to draw a column graph to compare the distance travelled over different surfaces. | Collection and partial recording of data in the table and use of this data to draw a column graph to compare the distance travelled over different surfaces. | Listing of observations about friction and distance travelled. |
| | Processing and analysing data and information | **Section 1: Discussion** Use of the data in the results table and column graph to explain findings. | Use of the data in the results table and patterns in the column graph to explain with justification why the toy car travelled different distances over different surfaces. | Use of the data in the results table and patterns in the column graph to explain why the toy car travelled different distances over different surfaces. | Use of the data in the results table and patterns in the column graph to describe the distances travelled by the toy car over different surfaces. | Use of given data to identify obvious patterns about the distance travelled by the toy car over different surfaces. | Completion of the results tables. |

| | | | A | B | C | D | E |
|---|---|---|---|---|---|---|---|
| Skills dimension | Evaluating | **Section 1 : Keeping the investigation fair**<br>Identification of factors that need to be considered to make the investigation fair. | No opportunity in this assessment for students to demonstrate an A or B standard. | | Identification of factors that make the investigation fair. | Identification of obvious factors that make the investigation fair. | Listing of given factors that make the investigation fair. |
| | Communicating | **Sections 1 and 2**<br>Communication of ideas and findings in a variety of ways (short responses, tables, column graph). | Clear and purposeful communication of ideas and findings about the force of friction. | Clear communication of ideas and findings about the force of friction. | Communication of ideas and findings about the force of friction. | Narrow communication of ideas and findings about the force of friction. | Use of given representations to communicate ideas and findings about the force of friction. |

# The force of friction



# Scientific concepts and student's prior understandings

## Scientific concepts

### *Force*

A force is an influence that produces, or tends to produce, a change in the motion of an object. When there is a push, a pull, a bend, a twist, a turn, a squeeze, a tear, a lift, a stretch, friction or resistance, at least one force is being exerted.

A force can move something, make it go faster or slower, change its direction, stop it, or change its shape. Often an object will be affected by a number of forces at once. If these forces are balanced, the object will be held in place and will keep its shape.

When a force is applied, energy can be transferred or transformed. Transfer of energy refers to the shifting of energy from one object to another. For example, a bowling ball with kinetic energy (energy of movement) hits the tenpins and gives them kinetic energy.

### *Gravity*

According to the Newtonian model, gravity is a force of attraction that any body with mass has towards any other body with mass. The effect of gravity increases with increased mass. For example, the effect of gravity is greater on the Earth than it is on the moon because the Earth has a larger mass than the moon. The effect of gravity is also greater over shorter distances. For example, the sun has a greater gravitational pull on the Earth than other more distant stars do. Gravity contributes towards keeping the planets in orbit around the sun and is the reason that objects fall towards the Earth when they are dropped.

### *Friction*

Friction occurs when two objects slide across each other. It results from contact between the objects' surfaces.

An object will move across a surface if the force applied to move it is greater than the force due to friction. The effect of friction can be reduced by streamlining, and by minimising the amount of contact between surfaces through the use of wheels, ball bearings, lubricants and flat surfaces — for example, snow skis. The presence of friction in many everyday situations is helpful — in fact, movement without friction is difficult, if not impossible. The use of bitumen on roads and treads on tyres and shoes helps to increase the effect of friction.

Air resistance is the friction that occurs when an object makes contact with particles in the air.

## Students' prior understandings

Students' prior understandings may differ from scientific concepts in a range of ways. Some students may:

- believe that the force of an object resides within the object rather than being an external effect. A common misconception is that if an object *is not* moving there are *no* forces acting on it, and if an object *is* moving there *is* force acting on it in the direction it is moving. This is incorrect, as demonstrated by these examples:
  - if an object is stationary on the ground, gravity is acting downwards and a reaction force from the ground is acting upwards
  - if an object such as a toy car is given a push across a flat surface, there is initially forward force acting on it, but once it is allowed to move freely, there is *no* forward force. Friction exerts a force in the opposite direction to the object's motion and is the reason it eventually stops moving
- believe that forces can be applied only by living things, i.e. they may realise that a human can apply a force but may not consider the effects of gravity or friction
- be aware of one or several forces being exerted on an object, but may not consider *all* forces, e.g. students may realise that gravity is acting on a ball rolling down a hill, but may not consider the effect of friction acting in the direction opposite to the motion of the ball.

### *Resource*

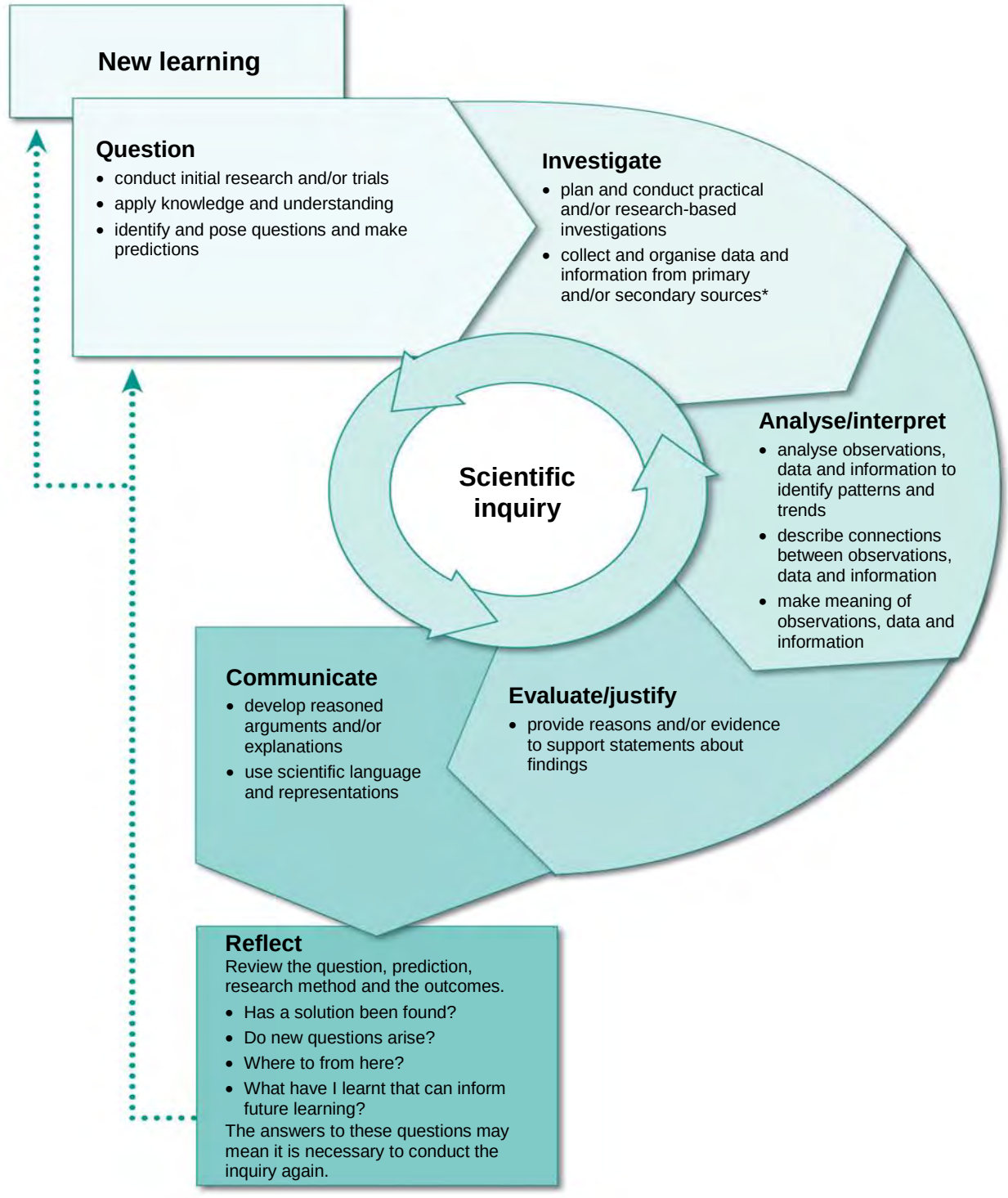
Sourcebook modules provide teachers with a range of learning and teaching ideas. Teachers are encouraged to modify modules to meet the specific needs and interests of particular groups of students and individual students, their own needs and the learning environment.

QSA, Science (1999) sourcebook module > Energy and change > Force and motion, www.qsa.qld.edu.au/992.html.

# The force of friction



## Scientific inquiry process in Years 3–4




* In Science, a *primary source* is information created by the person or persons directly involved in a study or observing an event. A *secondary source* is information that has been compiled from primary sources by a person or persons not directly involved in the original study or event, e.g. texts found on websites, magazines or textbooks.