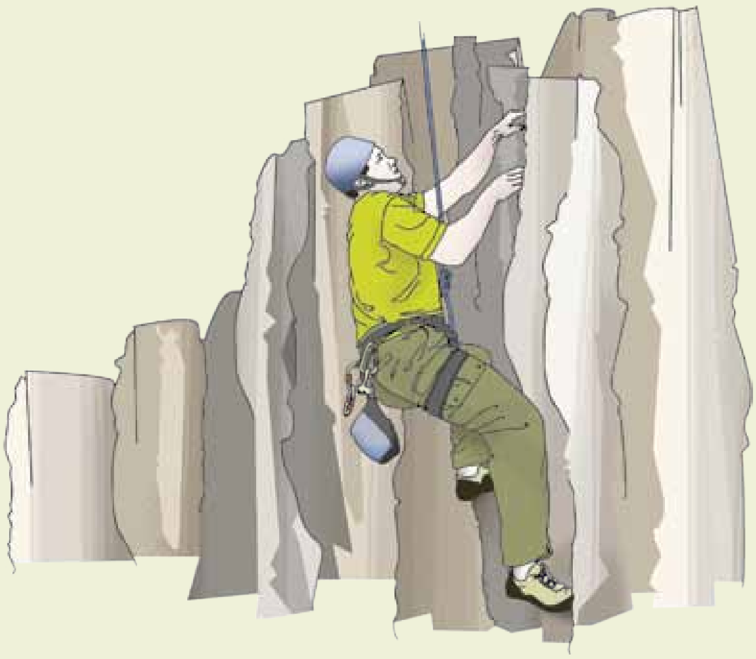
Get a grip

Teacher guidelines



6

Science

Queensland Comparable Assessment Tasks (QCATs)
2010

Queensland Government

Queensland Studies Authority

Queensland Studies Authority

Contact information

Direct questions about the implementation of QCATs or receipt of materials to:

Project Officer, Operations
Phone: (07) 3864 0299
email: qcats.administrator@qsa.qld.edu.au

Queensland Studies Authority PO Box 307 Spring Hill Qld 4004
Phone: (07) 3864 0299 Fax: (07) 3221 2553 Email: office@qsa.qld.edu.au Website: www.qsa.qld.edu.au

Contents

The 2010 QCATs

What are QCATs?

Queensland Comparable Assessment Tasks (QCATs) are designed to provide evidence of what students know, understand and can do in relation to a selection of Essential Learnings for English, mathematics and science in Years 4, 6 and 9, and to the Standards.

QCATs are authentic, performance-based assessments that:

- engage students in solving meaningful problems
- emphasise critical thinking and reasoning
- provide teachers, students and parents/carers with information about student progress and a focus for future teaching and learning.

Consistency of teacher judgments

QCATs support teachers in making consistent judgments about the quality of student work. Improved consistency of teacher judgments is achieved when teachers:

- engage in professional conversations about the quality of evidence in student responses
- reach consensus about the quality of student work
- adopt a consistent approach when using the Guide to making judgments (page 36).

Information gathered may be used by teachers to promote, assist and improve key learning area programs and help students achieve the highest standards they can.

Additional resources

QCATs Information Statement
www.qsa.qld.edu.au › Prep–Year 9 › QCATs (Years 4, 6 & 9)

Essential Learnings and Standards
www.qsa.qld.edu.au › Prep–Year 9 › Essential Learnings & Standards (Years 1–9)

Important dates

Friday 25 June	QCATs packages have arrived in schools
Tuesday 13 July ↓ Friday 17 September	Schools: • administer QCATs at any time during the school weeks of this period • grade QCATs • select five student samples that are representative of grades awarded
Monday 4 October	Schools are notified if selected to submit student samples for QSA's random sampling process
Monday 1 November	Final day for schools to submit student data to QSA
Friday 10 December*	Schools must retain all Student booklets until the end of the school year

*This date may vary from school to school

Getting ready

Student preparation

Students should have the opportunity to do their best work. For this to occur, student preparation should include:

- opportunities to engage with the Selected Essential Learnings (page 25) well in advance of participating in QCATs. If students have not engaged with the Selected Essential Learnings recently, review and consolidation may be necessary. Preparation activities should not involve rehearsal of the actual or a similar assessment
- experience with the types of questions used within the QCAT.

The quality of information provided by the QCATs will depend on the level of interaction teachers have with their students before, during and after implementation.

Additional resources Centrally-devised design brief
www.qsa.qld.edu.au › Prep–Year 9 › QCATs (Years 4, 6 & 9)

Catering for diversity — special provisions

All students should have the opportunity to participate in school-based assessment. Schools are responsible for determining which students require special provisions.

The QCATs are designed to be part of a classroom assessment program, and principles of participation and equity apply. The QSA offers this general advice:

- Students who have been identified as having specific educational requirements may be assisted using those adjustments and supports usually available in the classroom. To make participation possible in all or part of the assessment task, such help may be in the form of inclusive learning technologies, reading support or the use of support personnel.
- Students for whom English is not their first language, and who are assessed as not achieving a reading level appropriate to complete the task, may be assisted by an interpreter or educational devices (e.g. pictures, electronic whiteboards, interactive devices) to allow participation in all or part of the task.
- In exceptional circumstances, where a student's learning difficulties have precluded them from engaging with the Selected Essential Learnings, the principal (in consultation with specialist and support staff and parents/carers) may make a decision about the participation of that student in the task. Some students may be given an opportunity to complete some aspects of the assessment.

Additional resources Inclusive strategies for implementing QCATs
www.qsa.qld.edu.au › Prep–Year 9 › QCATs (Years 4, 6 & 9)

Equity
www.qsa.qld.edu.au › P–12 approach › Equity

Teacher preparation

Check contents of QCAT packages as soon as they arrive at your school

- Check that you have the appropriate number of Student booklets (one per student) and Teacher guidelines (one per implementing teacher).
- Check for any defective Student booklets.
- Contact the QSA if any additional copies are required.

Familiarise yourself with the assessment

- Read all the documents provided.
- Review the Selected Essential Learnings (page 25).
- Complete a Student booklet yourself, and then refer to the Model response (page 27) so that you understand what students are required to do.
- Download and view Sample responses from the QSA Assessment Bank (see Additional resources below).

Plan implementation

- Discuss the assessment with your colleagues, and plan any teaching or revision that may be required.
- Set the times and dates for the implementation:
  - teachers have flexibility to implement the QCATs at any time during the designated period
  - the QCATs may be completed in one, two or more sessions over one or more days
  - implementation times may differ for verified students, students with specific educational requirements or students who have English as a second language.
- Plan:
  - any support required to enable students to do their best work (e.g. teacher aides or other support personnel)
  - any materials or equipment needed to implement the assessment.
- Decide:
  - how you will implement this task for all classes at this year level
  - the processes you will use to achieve consistency of teacher judgment
  - how you will select student samples for the QSA's random sampling process
  - when, how and who will submit your school's data.

Additional resources

Sample responses
QSA Assessment Bank <https://qcar.qsa.qld.edu.au/assessmentbank>

Using Queensland Comparable Assessment Tasks (QCATs) to support learning
www.qsa.qld.edu.au › Prep–Year 9 › QCATs (Years 4, 6 & 9)

Implementation

Setting up

See page 26 in the Resources section for:

- a detailed materials list for the investigations: Materials for student investigations
- resources to support relevant learning experiences: Teacher resources.

Working with the Student booklet

Use the Annotated Student booklet (page 8) to set the conditions that ensure all students have the opportunity to do their best work.

Students should be encouraged to interact with teachers to seek clarification when required, and with other students if appropriate to the task.

Suggested implementation timeline

Preparation

Setting the scene: Group discussion	15 minutes

The assessment task

Measuring	30 minutes
Reducing friction	20 minutes
How useful is friction?	10 minutes
Which shoes grip best?	30 minutes

Annotated Student booklet

Suggested time: 15 minutes

Read the text with the class.

Engage students in a scientific discussion about the pictures and their responses to these key questions.

Setting the scene: Group discussion

Friction in sport and recreation — useful or not?

The force of friction is very useful in some sports. You need friction to catch a ball or grip a bat. In other sports it can be a problem — friction slows down swimmers and makes balls roll to a stop.

Talk about the pictures below:

- What forces are at work?
- What direction is each force working in?
- Where do these people want more friction, and where do they want less?

Queensland Studies Authority PO Box 307 Spring Hill Qld 4004
Phone: (07) 3864 0299 Fax: (07) 3221 2553 Email: office@qsa.qld.edu.au Website: www.qsa.qld.edu.au

Explain the suggested activities to students.

Allow students to test and compare different surfaces around the room.

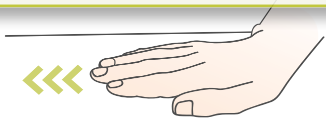
Compile a list on the board of all the surfaces students tried.

Facilitate discussion about ranking the relative friction of different surfaces, ordering the list from least to most friction.

Lead discussion to the idea that such arbitrary ranking is imprecise and that a scientific investigation could support more accurate findings.

Feel the friction

Place your hand flat on your desktop and push it across the surface.



Discuss these questions:

- Why does it grip the surface?
- If you press down harder, does that change the amount of grip?

Now try sliding your hand on different surfaces, such as wood, concrete, carpet, plastic.

- What differences do you notice?
- Which surfaces have the most grip, or make the most heat?

Make a class list of all the surface materials that were tested.

- Talk about which materials you think caused the most friction.
- Number the materials in order of the amount of friction you could feel.
  - Was it easy to agree on that order?
  - What could be a more scientific way to measure the force of friction?

Think about these questions and add some of your own, then discuss with the class.

Forces

- What are some different types of force?
- Can there be more than one force acting on an object at the same time?
-

Motion

- What makes things move?
- Why do they stop?
-

Science investigations

- When we measured friction with our hands, was it a fair test?
- How could we measure friction more accurately?
-

Stop here: Wait for your teacher's directions.

Encourage students to pose their own questions around the topic.

The activities on this page are not assessed.

Introduce the assessment.

Explain to students that in this assessment they will have opportunities to demonstrate scientific ways of investigating, communicating and reflecting in the context of forces and motion.

Work through the Guide to making judgments (page 36) with students to highlight the assessable elements for this QCAT. Explain, in student-friendly terms, the task-specific assessable elements. These identify what is being valued in the student responses.

Suggested time: 30 minutes

Read and discuss this section with the whole class.

Show the materials for the investigation (but do not distribute them yet) and demonstrate the procedure, including how to set up the measuring apparatus and record the stretch of the rubber band.

It is important to practise this yourself beforehand.

See Materials for student investigations (page 26) for guidance on preparing materials.

There is no need for each student to have identical materials or to use the same surfaces, as their data is simply comparative.

Literacy is not being assessed, so provide appropriate support for students to understand procedures and questions as well as to record responses.

Ensure students complete Question 1 before setting up their equipment.

Measuring

Let's try a more scientific way to measure friction.

Investigation

Question for investigation:

How will changing the surface change the amount of force needed to slide an object?

Materials

3 x surface materials: desktop, carpet, and one other (e.g. concrete, plastic), heavy book, ruler, rubber band, bulldog clip, pencil

Method

This method uses a rubber band to measure different amounts of force. The more the rubber band stretches, the greater the force pulling on it.

1. Place the book on your desktop, then attach a clip to the book and loop a rubber band onto the clip.
2. Use a pencil to pull the rubber band out straight, but not stretched. Using the ruler on the next page, line up the "0" of the ruler with the end of the rubber band (see photo below).
3. Slowly stretch the rubber band until the heavy load *just* starts to move.
4. Write how many millimetres the rubber band stretched in Table 1. Do this three times.
5. Using the same load, repeat Steps 2 to 4 for each surface material.

Predict

1. **Before you start, make a prediction about what will happen.**

   a) **I think that when the load is on** .... **it will need the most force**
   (surface material)

   to move it because ....

   ....

   b) **I think that when the load is on** .... **it will need the least force**
   (surface material)

   to move it because ....

   ....

4 | QCATs 2010 Student booklet Year 6 Science

Question 1 gathers evidence of:

- making predictions and linking them to scientific concepts
- use of scientific terminology.

Distribute materials for investigation. Show students how to initially adjust the mass of their load (e.g. by adding or removing books) so that the stretch required to move it on the desktop is about 100–150 mm. Once calibrated, they should keep the mass constant for all tests.

After some trial measurements and initial adjustment of loads, ask students to work individually to collect data. Provide help with understanding the procedure where necessary.

Observe

2. Carry out the investigation and record your data in the table below.

Table 1: Comparing friction of different surface materials

		Variable changed: Surface material		
		desktop	carpet	other ....
Distance rubber band stretched (mm)	Test 1			
	Test 2			
	Test 3			
	Total			
	Average (Total ÷ 3)			

Students may use calculators to work out totals and averages.

Mathematical accuracy is not being assessed.

Explain

3. a) Order the surfaces from least to most friction on the line below.

The actual order will depend on local variables. The question provides an opportunity for students to interpret their own data appropriately.

least .... most

b) Tick (✓) the boxes below to show whether each variable was changed, measured, or kept the same in the investigation.

Variables	change	measure	keep the same
rubber band	☐	☐	☐
surface material	☐	☐	☐
mass of book	☐	☐	☐
distance rubber band stretched	☐	☐	☐
direction of pull	☐	☐	☐

c) Use your data to explain your answer to the question:
How will changing the surface change the amount of force needed to slide an object?

Use these words in your answer: **force**, **friction**, **surface**.

....

....

....

d) Why was each surface tested three times?

....

....

....

Note that the investigation equipment will be used again in Question 4c, so do not collect it yet.

Question 2 gathers evidence of collecting data and recording it in a table.

Question 3 gathers evidence of interpreting data and explaining the design of a fair test.

Suggested time: 20 minutes

Read the section together with the class and discuss requirements for Question 4.

Reducing friction

When the ancient Egyptians were building the pyramids, one of their methods for moving the massive blocks of stone was a sled pulled by oxen.

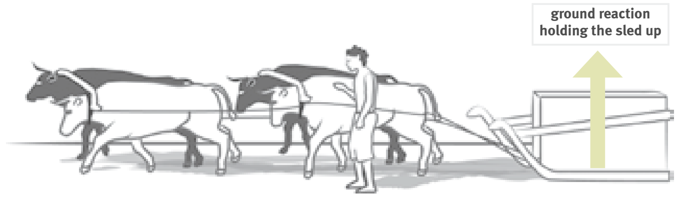
In the diagram below, one of the forces at work has been shown.

4. a) Add arrows and labels to the drawing to show:

- **the other forces at work**
- **the direction they are acting in.**

Include the forces due to: **gravity**, **friction** and **pull of rope**.

Encourage students to show as many forces as possible.



b) Use the words "force", "motion" and "friction" to explain what is happening in the diagram above.

....

....

....

....

....

Questions 4a–b gather evidence of understanding of opposing and supporting forces.

In 4a, students use the convention of force arrows to communicate ideas. They may vary the length or thickness of arrows to indicate relative size of forces.

Students independently carry out a follow-up investigation by adding rollers to the equipment they used earlier.

The Egyptians reduced friction by sprinkling water or sand under the sled, or by using wooden rollers.

c) **Repeat the investigation from page 4 using your desktop as the surface, but this time put some round pencils or pens under the load. Record your data in the table.**

Table 2: Moving a load on rollers

How far will the rubber band stretch?		Load resting on rollers
Distance rubber band stretched (mm)	**Test 1**	
	Test 2	
	Test 3	
	Total	
	Average (Total ÷ 3)	

Students record their findings. Calculators are allowed.

d) **When the load was on rollers, there was** more / less (circle one) **friction.**

I think this was because ....

....

....

....

....

Students explain their findings.

Question 4c again gathers evidence of collecting and recording data.

Question 4d gathers evidence of interpreting data to draw conclusions.

Suggested time: 10 minutes

Explain the hand-rubbing activity and facilitate a brief class discussion about the two questions (these are not assessed).

Read together the description of traditional fire-making.

For additional resources to support this learning experience, see Teacher resources on page 26.

How useful is friction?

Rub your hands together hard for 10 seconds.

Discuss these questions:

- Why do they feel warmer?
- Where do you think the heat comes from?

You have felt how friction can make things hot.

Indigenous Australians can use friction to make fire.

Making fire

Read about the traditional way to make fire using two sticks.

- Twirl a straight stick between the hands, with the end in a hollow in a piece of soft wood.
- Spin it fast and push down hard at the same time.
- Lay a bunch of very dry grass around the hollow.
- When a glowing ember forms in the hollow, tip it onto the dry grass and blow on it until flames appear.

8 | QCATs 2010 Student booklet Year 6 Science

Explain the requirements of Question 5.

Support students with literacy where necessary.

There are many variables that affect the heat from rubbing two sticks. Two are written below.

5. a) Add some more questions about variables that would affect the amount of heat from friction.

Is the end of the stick rough or smooth?

How much downward force is on the stick?

amount of heat from friction

b) Select one variable from Question 5a and explain how it changes the amount of heat.

I think .... **affects the amount of heat**

because ....

....

Stop here: Wait for your teacher's directions.

Question 5a gathers evidence of identifying the variables in a phenomenon.

Question 5b gathers evidence of understanding of the action of forces and energy.

Take a break

This is a good time to take a break in the QCAT.

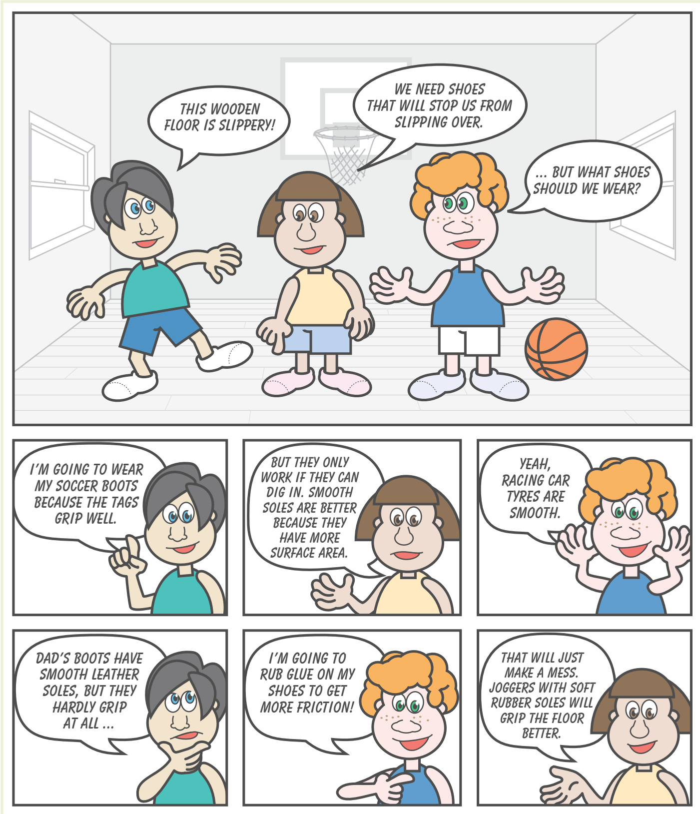
Suggested time: 30 minutes

Read the comic strip together (perhaps with roleplay).

Encourage students to identify scientific concepts that relate to this scenario.

Which shoes grip best?

In this section, you will use your knowledge of force, motion and of scientific investigation to solve a problem about friction.



6. Think about how science could help these children decide which shoes are best.

- Circle one idea in the comic strip that you agree or disagree with.
- Use scientific ideas to explain why you think it is right or wrong.

I **agree** / **don't agree** **that**...
(circle one)

because ....

....

....

Question 6 gathers evidence of reflecting on learning of scientific concepts, and applying new understandings to a new context.

Think about what you know about forces and about investigating.

7. What scientific ideas could help solve the problem "Which shoes grip the floor best?"

Look back over the earlier pages of this booklet.

a) Ideas about force and motion	b) Ideas about planning an investigation
•	•

Students reflect on ideas that may support solving a problem. Encourage them to look back through the Student booklet for relevant ideas.

Choose your shoes

In the next section, you will design a fair test to compare the grip of two shoes.

8. Decide on two different types of shoe you could test.
- Draw the soles of the shoes.
- Label your drawings to show how they are different.

Shoe 1	Shoe 2

Encourage students to draw quick, simple diagrams explaining details relevant to the investigation — and not to get bogged down with detail or colouring.

Question 7 gathers evidence of reflecting on learning, and applying new understandings to other contexts.

Question 8 gathers evidence of using labelled diagrams to communicate key ideas.

Read and discuss Question 9 with the class.

Provide explanations and support with literacy where needed.

Investigation

9. **Plan an investigation to test the friction of shoes.**

Design an investigation comparing two types of shoe to find which one grips the floor best.

If necessary, explain that a hypothesis is a reasonable prediction, linking cause and effect ("if ... then ...")

A valid fair test will identify:

- one variable to be changed
- one that can be measured or observed
- a range of other variables that will remain constant.

Investigation plan		
a) Complete the question for investigation. **Question for investigation:** **How will changing the type of shoe change** .... ?		
b) Hypothesis:		
c) What scientific ideas can you use to justify your hypothesis? (Your notes in Question 7 may help.) •		
d) What will you **change** in your investigation?	e) What will you **measure** or **observe**?	f) What things will you keep the **same**?

Question 9 gathers evidence of investigation skills through the design of a fair test.

g) List the materials and equipment you will need.

h) Draw a labelled diagram to show how you will set up the investigation.

i) List the steps for carrying out the investigation.

1.

j) Explain how you will ensure that this is a fair test.

A practical investigation plan will explain a strategy for gathering reliable data that answers the question for investigation.

Going further

Students will plan a fair test to solve a given problem, but do not implement it in this assessment.

You may choose to implement the students' investigations in follow-up activities.

Read Question 10 together and discuss the requirements.

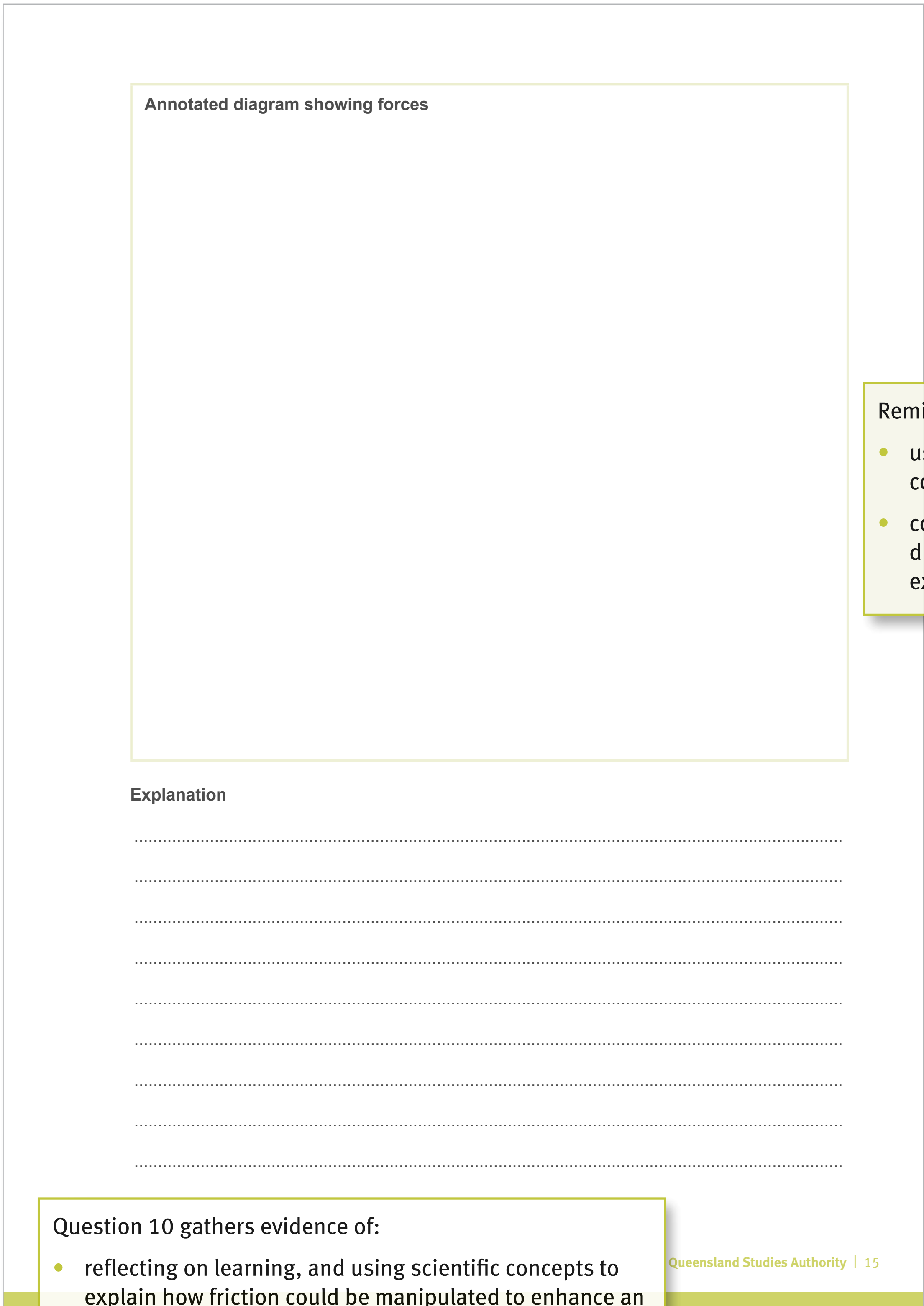
Think about how friction affects performance in the activities shown below.

10. Tick one of the pictures. Explain how friction could be increased or decreased to improve performance in that activity.

- Use scientific words and ideas.
- Present your ideas in the spaces on the opposite page.







Annotated diagram showing forces

Explanation

Queensland Studies Authority | 15

Remind students to:

- use scientific concepts
- complete both the diagram and the explanation.

Question 10 gathers evidence of:

- reflecting on learning, and using scientific concepts to explain how friction could be manipulated to enhance an activity
- communication skills — students use an annotated diagram and scientific terminology to explain their ideas.

Making judgments

Use the Guide to making judgments (GTMJ) on page 36 to grade student responses.

The Model response (page 27) and Sample responses are provided for reference purposes only. They each demonstrate possible responses and should be used to support the GTMJ.

Making judgments is not about determining whether one student's work is better than that of another. Rather, you should make standards-based judgments by matching evidence in student responses to descriptors in the GTMJ.

Read and consider all of the evidence in the student's responses before making and recording a judgment about the quality of the performance for each assessable element.

Additional resources Sample responses
QSA Assessment Bank ‹https://qcar.qsa.qld.edu.au/assessmentbank›

Using the GTMJ

This QCAT uses a continua-style GTMJ, where descriptors are placed along a continuum within each column. The diagrams below show the different parts of the GTMJ continua model, and how to use the GTMJ when grading student responses.

Record a nil award of "N" only when there is insufficient evidence to make a judgment for an overall grade.

In the following diagrams:

- Diagram 1: Understanding the GTMJ points out the different parts of the GTMJ
- Diagram 2: Using the GTMJ — the judgment process gives steps to follow when grading student responses.

Diagram 1: Understanding the GTMJ

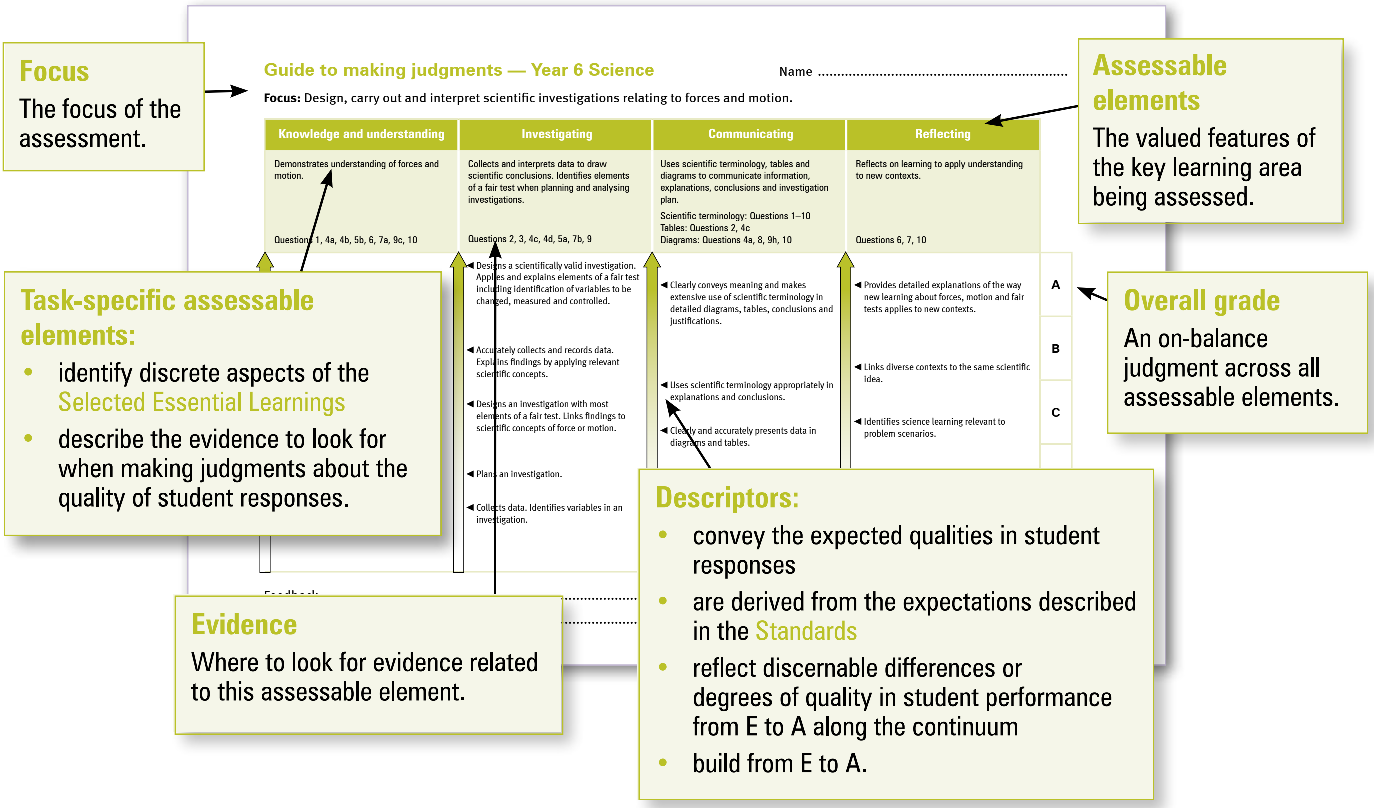
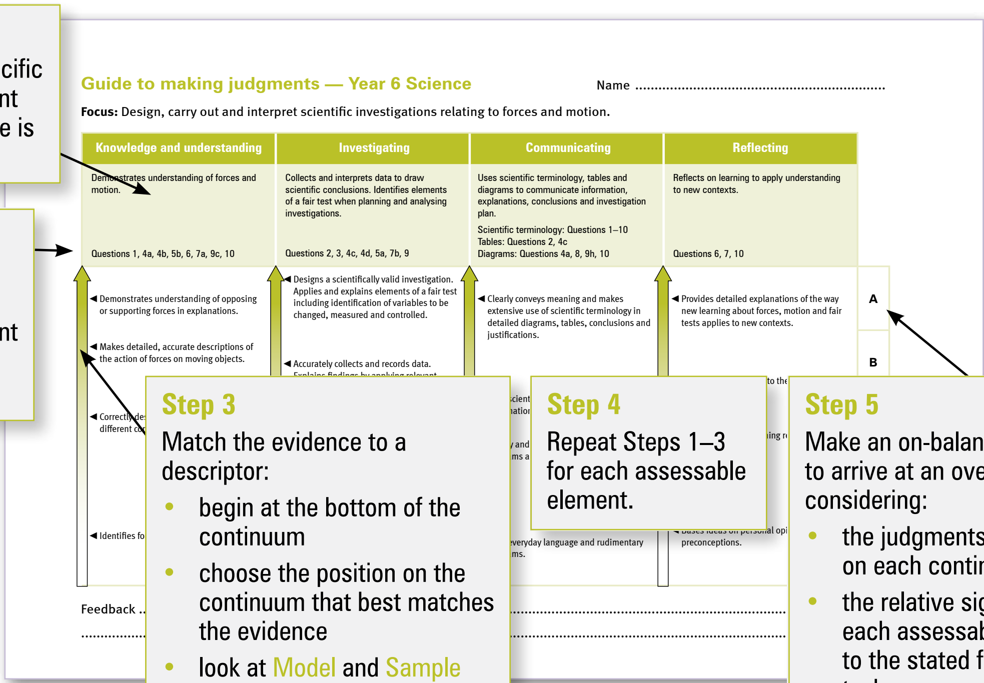


Diagram 2: Using the GTMJ — the judgment process



Step 1

Read the task-specific assessable element for which evidence is being considered.

Step 2

Locate all the evidence for an assessable element in the completed Student booklet.

Step 3

Match the evidence to a descriptor:

- begin at the bottom of the continuum
- choose the position on the continuum that best matches the evidence
- look at Model and Sample responses for clarification if necessary.

Step 4

Repeat Steps 1–3 for each assessable element.

Step 5

Make an on-balance judgment to arrive at an overall grade by considering:

- the judgments recorded on each continuum
- the relative significance of each assessable element to the stated focus of the task.

Using feedback

Assessment alone will not contribute significantly to improved learning — it is what teachers and students do with the information gathered that makes the difference. Providing quality and useful feedback is a crucial step in using assessment information to support future learning.

Assessment feedback goes beyond a simple mark or grade. Comments on the strengths of students' achievements, and on areas for improvement, provide quality feedback that can be used to inform future teaching and learning. Assessment feedback is most helpful if the specific elements of the knowledge and skills are identified and specific suggestions are provided.

The information gathered from the implementation, marking and moderation of QCATs should feed back into future planning of teaching and learning.

Feedback to help students learn

Quality feedback to a student:

- focuses on their achievement in relation to either the assessable elements with their task-specific descriptors or the Selected Essential Learnings (page 25) and their associated questions
- includes strengths of achievements
- identifies areas for improvement and strategies for future learning
- is communicated in student-friendly language
- is appropriate (e.g. in quantity and detail) to the student's age and their capacity to respond
- includes the use of Sample responses to provide examples of the quality of work corresponding to each standard.

Feedback to help teacher planning

Individual and collective student performance on QCATs, along with other school-based assessment, can be used to inform teaching and learning.

Additional resources

Using feedback to inform teaching and learning
www.qsa.qld.edu.au › Prep–Year 9 › QCATs (Years 4, 6 & 9)

Sample responses
QSA Assessment Bank ‹https://qcar.qsa.qld.edu.au/assessmentbank›

Resources

Selected Essential Learnings

The 2010 QCATs will assess what students know, understand and can do in relation to the following selection of Essential Learnings.

Science Essential Learnings by the end of Year 7	
Assessable elements The valued features of the key learning area about which evidence of learning is collected and assessed.	**Ways of working** The processes students use to develop and demonstrate their knowledge and understanding. Students are able to:
Investigating	• plan investigations, including identifying conditions for a fair comparison, variables to be changed and variables to be measured • collect and analyse first- and second-hand data, information and evidence • select and use scientific tools and technologies suited to the investigation • draw conclusions that summarise and explain patterns in data and are supported by experimental evidence and scientific concepts
Communicating	• communicate scientific ideas, data and evidence, using scientific terminology suited to the context and purpose
Reflecting	• reflect on learning, apply new understandings and identify future applications.
	Knowledge and understanding The essential concepts, facts and procedures.
Knowledge and understanding	***Energy and change*** **Forces and energy can be identified and analysed to provide explanations that benefit community lifestyles and decision making.** • The motion of an object changes as a result of the application of opposing or supporting forces.
Source: www.qsa.qld.edu.au > Prep–Year 9 > Essential Learnings & Standards (Years 1–9)	

Literacy and Numeracy Indicators

The Literacy and Numeracy Indicators are a resource that can be used when planning for teaching, learning, assessment and monitoring in all key learning areas.

This QCAT may provide opportunities to monitor and assess student progress in a selection of the Literacy and Numeracy Indicators, and may provide further focus for feedback for teachers and students to support improved learning.

Additional resources Literacy and Numeracy Indicators Information Statement
www.qsa.qld.edu.au › Prep–Year 9 › Literacy & Numeracy Indicators (P–Year 9)

Materials for student investigations

Prepare materials for the student investigations. Each student will need:

- access to surface materials: desktop, carpet, and one other (e.g. concrete, plastic, wood, glass, brick, fabric, metals)
- heavy book (e.g. student dictionary)
- ruler
- rubber band
- bulldog clip (large)
- pencil
- 3 x round pens or pencils, to use as rollers (Question 4c)

Note that there is no need for students to have identical materials or surfaces.

Teacher resources

The following resources support relevant learning experiences:

Indigenous fire-making

Use resources such as these to support How useful is friction?

- Instructions for fire-making
  Aboriginal culture n.d., Making Fire, accessed 19 May 2010,
  ‹burarra.questacon.edu.au/pages/technologies.html#makingfire› (scroll down the page)
- Illustrated explanation of fire-making,
  ‹www.aboriginalculture.com.au/pub_making_fire.shtml›

Guidelines for planning open investigations

- Queensland Studies Authority 2010, "Science sourcebook (1999) guidelines", pp. 34–36,
  ‹www.qsa.qld.edu.au/p-9/834.html›

Models for investigations

- Australian Academy of Science 2010, Curriculum resources, accessed 19 May 2010,
  ‹www.science.org.au/primaryconnections/curriculum-resources›
- The unit "Stage 2 | Energy and change | Smooth moves", in particular, provides background information on forces and examples of related student investigations,
  ‹www.science.org.au/primaryconnections/curriculum-resources/smooth-moves.htm›

Model response

This Model response gives one example of a very high quality response for each question. The Sample responses, available for download from the QSA Assessment Bank, demonstrate the quality of student responses for each standard, A to E.

Setting the scene: Group discussion

Friction in sport and recreation — useful or not?

The force of friction is very useful in some sports. You need friction to catch a ball or grip a bat. In other sports it can be a problem — friction slows down swimmers and makes balls roll to a stop.

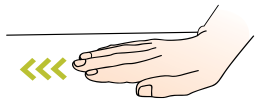
Talk about the pictures below:

- What forces are at work?
- What direction is each force working in?
- Where do these people want more friction, and where do they want less?

Images (left to right, top to bottom) shown here and on page 14 are Creative Commons: Attribution 2.0 Generic licensed photos <http://creativecommons.org/licenses/by/2.0> accessed 31 Mar 2010. **Skateboarding**: mikebaird's photostream, "5 of 6 national slalom skateboarding", <www.flickr.com/photos/mikebaird/2659707104>; **Rockclimber**: indywriter's photostream, "rock-climber", <www.flickr.com/photos/indywriter/339896763>; **Cyclist**: sillygwailo's photostream, "Racer Turns the Corner at Giro di Burnaby 2007", <www.flickr.com/photos/sillygwailo/8566591>; **Runner**: Lochnagarth's photostream, "David Miller", <www.flickr.com/photos/87464242@N00/2380499669>; **Waterslide**: dichohecho's photostream, "The biggest, scariest slide", <www.flickr.com/photos/dichohecho/2677136998>; **Tug-of-war**: Steve Weaver's photostream, "Pull!", <www.flickr.com/photos/steveweaver/2915792034>.

Queensland Studies Authority PO Box 307 Spring Hill Qld 4004
Phone: (07) 3864 0299 Fax: (07) 3221 2553 Email: office@qsa.qld.edu.au Website: www.qsa.qld.edu.au

Feel the friction



Place your hand flat on your desktop and push it across the surface.

Discuss these questions:

- Why does it grip the surface?
- If you press down harder, does that change the amount of grip?

Now try sliding your hand on different surfaces, such as wood, concrete, carpet, plastic.

- What differences do you notice?
- Which surfaces have the most grip, or make the most heat?

Make a class list of all the surface materials that were tested.

- Talk about which materials you think caused the most friction.
- Number the materials in order of the amount of friction you could feel.
  - Was it easy to agree on that order?
  - What could be a more scientific way to measure the force of friction?

Think about these questions and add some of your own, then discuss with the class.

Forces

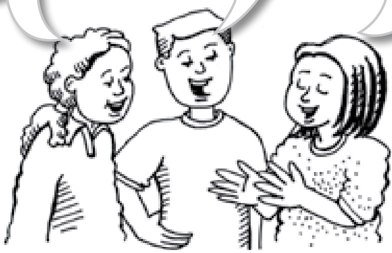
- What are some different types of force?
- Can there be more than one force acting on an object at the same time?
-

Motion

- What makes things move?
- Why do they stop?
-

Science investigations

- When we measured friction with our hands, was it a fair test?
- How could we measure friction more accurately?
-



Stop here: Wait for your teacher's directions.

Model response

Measuring

Let's try a more scientific way to measure friction.

Investigation

Question for investigation:

How will changing the surface change the amount of force needed to slide an object?

Materials

3 x surface materials: desktop, carpet, and one other (e.g. concrete, plastic), heavy book, ruler, rubber band, bulldog clip, pencil

Method

This method uses a rubber band to measure different amounts of force. The more the rubber band stretches, the greater the force pulling on it.

1. Place the book on your desktop, then attach a clip to the book and loop a rubber band onto the clip.
2. Use a pencil to pull the rubber band out straight, but not stretched. Using the ruler on the next page, line up the "0" of the ruler with the end of the rubber band (see photo below).
3. Slowly stretch the rubber band until the heavy load *just* starts to move.
4. Write how many millimetres the rubber band stretched in Table 1. Do this three times.
5. Using the same load, repeat Steps 2 to 4 for each surface material.

Predict

1. **Before you start, make a prediction about what will happen.**

a) **I think that when the load is on** carpet (surface material) **it will need the most force**

to move it because the surface is rough so it will grip.

b) **I think that when the load is on** tiles (surface material) **it will need the least force**

to move it because it is the smoothest so it has less friction.

Observe

2. **Carry out the investigation and record your data in the table below.**

Table 1: Comparing friction of different surface materials

		Variable changed: Surface material		
		desktop	carpet	other tiles
Distance rubber band stretched (mm)	Test 1	155 mm	135 mm	120 mm
	Test 2	150 mm	125 mm	135 mm
	Test 3	135 mm	130 mm	140 mm
	Total	440 mm	390 mm	395 mm
	Average (Total ÷ 3)	146.7 mm	130 mm	131.7 mm

This response depends on the data recorded in Table 1. The actual order will depend on local variables.

Explain

3. a) **Order the surfaces from least to most friction on the line below.**

least carpet → tiles → desktop most

b) **Tick (✓) the boxes below to show whether each variable was changed, measured, or kept the same in the investigation.**

Variables	change	measure	keep the same
rubber band	☐	☐	☑
surface material	☑	☐	☐
mass of book	☐	☐	☑
distance rubber band stretched	☐	☑	☐
direction of pull	☐	☐	☑

c) **Use your data to explain your answer to the question:**
How will changing the surface change the amount of force needed to slide an object?

Use these words in your answer: **force**, **friction**, **surface**.

The desktop needed the most force to slide the load, so it has the most friction. Carpet and tile surfaces needed similar amounts of force, but carpet had the least friction.

d) **Why was each surface tested three times?**

The measuring method was not very accurate, so repeated measuring gave a more accurate result.

Model response

Reducing friction

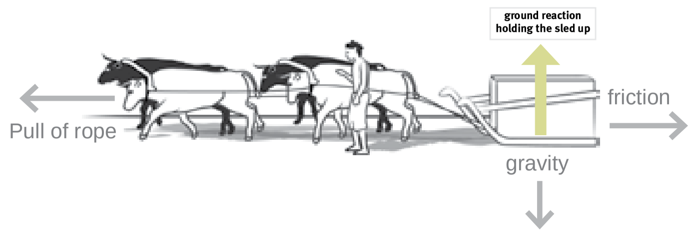
When the ancient Egyptians were building the pyramids, one of their methods for moving the massive blocks of stone was a sled pulled by oxen.

In the diagram below, one of the forces at work has been shown.

4. a) Add arrows and labels to the drawing to show:

- **the other forces at work**
- **the direction they are acting in.**

Include the forces due to: **gravity**, **friction** and **pull of rope**.



b) Use the words "force", "motion" and "friction" to explain what is happening in the diagram above.

Gravity is pushing the sled onto the ground, which is supporting it with equal force. If the oxen can pull with enough force to overcome the friction, there will be forward motion of the sled. The "pull of rope" force arrow is longer to show that it is a stronger force than friction, so the sled is moving.

The Egyptians reduced friction by sprinkling water or sand under the sled, or by using wooden rollers.

c) Repeat the investigation from page 4 using your desktop as the surface, but this time put some round pencils or pens under the load. Record your data in the table.

Table 2: Moving a load on rollers

How far will the rubber band stretch?		Load resting on rollers
Distance rubber band stretched (mm)	Test 1	0 mm
	Test 2	1 mm
	Test 3	5 mm
	Total	6 mm
	Average (Total ÷ 3)	2 mm

d) When the load was on rollers, there was more / less (circle one) **friction.**

I think this was because with rollers, there is hardly any surface contact and the load doesn't have to slide over the surface because the rollers can turn.

Model response

How useful is friction?

Rub your hands together hard for 10 seconds.

Discuss these questions:

- Why do they feel warmer?
- Where do you think the heat comes from?

You have felt how friction can make things hot.

Indigenous Australians can use friction to make fire.

Making fire

Read about the traditional way to make fire using two sticks.

- Twirl a straight stick between the hands, with the end in a hollow in a piece of soft wood.
- Spin it fast and push down hard at the same time.
- Lay a bunch of very dry grass around the hollow.
- When a glowing ember forms in the hollow, tip it onto the dry grass and blow on it until flames appear.

There are many variables that affect the heat from rubbing two sticks. Two are written below.

5. a) **Add some more questions about variables that would affect the amount of heat from friction.**

amount of heat from friction

- Is the end of the stick rough or smooth?
- How much downward force is on the stick?
- Is the end of the stick thick or thin?
- How fast is the stick spinning?
- Does the stick fit into the hollow tightly or loosely?
- Is there moisture or sap in the wood?

b) **Select one variable from Question 5a and explain how it changes the amount of heat.**

I think the thickness of the stick **affects the amount of heat**

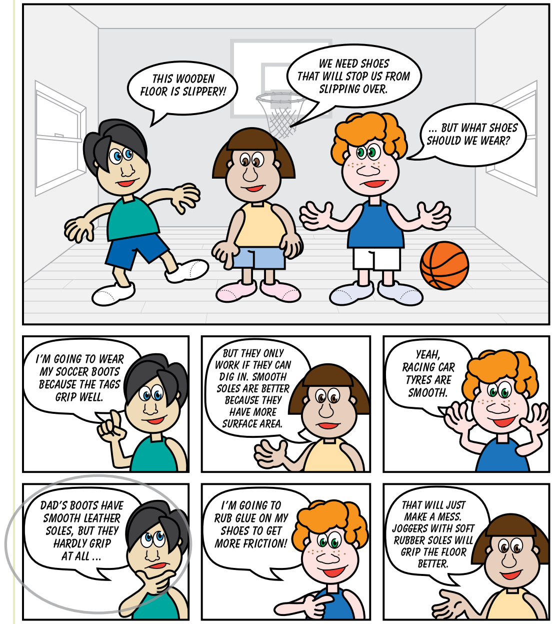
because a thicker stick will have more surface contact so there will be more friction.

Stop here: Wait for your teacher's directions.

Model response

Which shoes grip best?

In this section, you will use your knowledge of force, motion and of scientific investigation to solve a problem about friction.



6. Think about how science could help these children decide which shoes are best.

- Circle one idea in the comic strip that you agree or disagree with.
- Use scientific ideas to explain why you think it is right or wrong.

I agree / don't agree (circle one) **that** leather boots don't have much grip

because even though there's lots of surface area, the leather is hard and slippery. It doesn't grip like rubber because it doesn't mould to the surface.

Think about what you know about forces and about investigating.

7. What scientific ideas could help solve the problem "Which shoes grip the floor best?"

Look back over the earlier pages of this booklet.

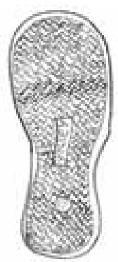
a) Ideas about force and motion	b) Ideas about planning an investigation
• Surfaces have friction which resists objects sliding over them. • If a force pushing an object is greater than the friction, the object moves. • Some materials grip more than others.	• Make a prediction first. • Change one thing. • Measure or observe something. • Don't change anything else. • Write down the results.

Choose your shoes

In the next section, you will design a fair test to compare the grip of two shoes.

8. Decide on two different types of shoe you could test.

- Draw the soles of the shoes.
- Label your drawings to show how they are different.

Shoe 1	Shoe 2
 Tennis shoe. Flat sole with lots of fine grooves. Soft rubber that bends to fits the surface.	 Jogger. Shaped sole with deep ridges. Rubber is harder and not as flexible as other shoe.

Investigation

9. Plan an investigation to test the friction of shoes.

Design an investigation comparing two types of shoe to find which one grips the floor best.

Investigation plan

a) Complete the question for investigation.

Question for investigation:

How will changing the type of shoe change the amount of force needed to slide it on the floor **?**

b) Hypothesis:

Shoe 1 will need more force to slide it than Shoe 2.

c) What scientific ideas can you use to justify your hypothesis? (Your notes in Question 7 may help.)

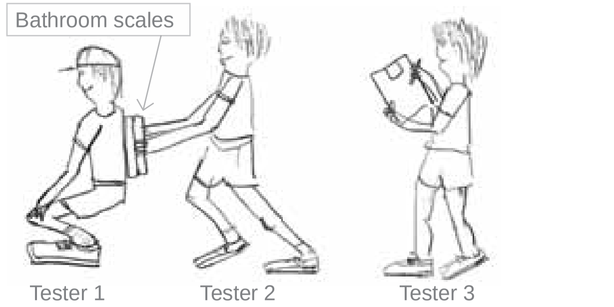
- Shoe 1 will have more grip because the sole has greater surface area and is made of softer material that moulds to the surface.

d) What will you **change** in your investigation?	e) What will you **measure** or **observe**?	f) What things will you keep the **same**?
the shoe	How hard I have to push the person to move them	• person wearing the shoe • size of shoe • the type of floor • the way I push

g) List the materials and equipment you will need.

Two pairs of shoes (tennis shoes, joggers); bathroom scales; notebook

h) Draw a labelled diagram to show how you will set up the investigation.



i) List the steps for carrying out the investigation.

1. Tester 1 puts on Shoes 1 and crouches down.
2. Tester 2 pushes Tester 1 on the back with the bathroom scales until the shoes slide. Observer records the reading on the scales when sliding starts.
3. Repeat Step 2 several times.
4. Tester 1 changes to Shoes 2.
5. Repeat Step 2 several more times.

j) Explain how you will ensure that this is a fair test.

Same people will do each test exactly the same way.

Tests will be repeated to gather more data which will be averaged. Use the same floor; measure results the same way. The only thing changed is the shoes.

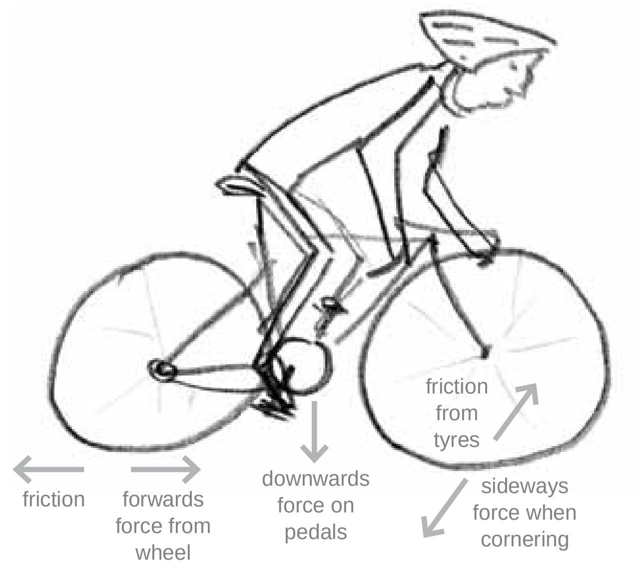
Model response

Think about how friction affects performance in the activities shown below.

10. Tick one of the pictures. Explain how friction could be increased or decreased to improve performance in that activity.

- Use scientific words and ideas.
- Present your ideas in the spaces on the opposite page.

Annotated diagram showing forces



Explanation

On a bike there is friction between the road and the wheels. To reduce friction, racing bikes use very narrow tyres. They could have even less friction if the wheels were made of a hard, smooth material.

However the bike needs friction to accelerate, brake and to go around corners. Tyres made of rubber grip because they mould to the shape of the road. The friction stops the bike slipping when the rider puts force on the pedals to accelerate, or if there is sideways force when cornering.

Notes

Notes

Guide to making judgments — Year 6 Science

Name ....

Focus: Design, carry out and interpret scientific investigations relating to forces and motion.

Knowledge and understanding	Investigating	Communicating	Reflecting	
Demonstrates understanding of forces and motion. Questions 1, 4a, 4b, 5b, 6, 7a, 9c, 10	Collects and interprets data to draw scientific conclusions. Identifies elements of a fair test when planning and analysing investigations. Questions 2, 3, 4c, 4d, 5a, 7b, 9	Uses scientific terminology, tables and diagrams to communicate information, explanations, conclusions and investigation plan. Scientific terminology: Questions 1–10 Tables: Questions 2, 4c Diagrams: Questions 4a, 8, 9h, 10	Reflects on learning to apply understanding to new contexts. Questions 6, 7, 10	
◀ Demonstrates understanding of opposing or supporting forces in explanations.	◀ Designs a scientifically valid investigation. Applies and explains elements of a fair test including identification of variables to be changed, measured and controlled.	◀ Clearly conveys meaning and makes extensive use of scientific terminology in detailed diagrams, tables, conclusions and justifications.	◀ Provides detailed explanations of the way new learning about forces, motion and fair tests applies to new contexts.	**A**
◀ Makes detailed, accurate descriptions of the action of forces on moving objects.	◀ Accurately collects and records data. Explains findings by applying relevant scientific concepts.		◀ Links diverse contexts to the same scientific idea.	**B**
◀ Correctly describes action of forces in different contexts.	◀ Designs an investigation with most elements of a fair test. Links findings to scientific concepts of force or motion.	◀ Uses scientific terminology appropriately in explanations and conclusions. ◀ Clearly and accurately presents data in diagrams and tables.	◀ Identifies science learning relevant to problem scenarios.	**C**
	◀ Plans an investigation.			**D**
◀ Identifies forces in a given context.	◀ Collects data. Identifies variables in an investigation.	◀ Uses everyday language and rudimentary diagrams.	◀ Bases ideas on personal opinion or preconceptions.	**E**

Feedback ....

....