1 Science at work

Planning page

Getting started

1.1 What is science? page 2
- Skillbuilder page 3 Writing reports
- Experiment Paper bridges

1.2 Experimenting page 6
- Activity page 6
- Experiment Which filter?
- Skillbuilder pages 9–10 Drawing graphs
- Activity page 10
- Investigate 1 Dissolving time
- Assessment task 1 Types of scientists

1.3 Solving problems page 14
- Investigate 2 Stopping distance
- Experiment Working scientifically

Main ideas
- Chapter 1 crossword

Review and Lab review
- Chapter 1 test

Essential Learnings for Chapter 1

Essential Learnings	References		
	Student book (page number)	**Workbook (page number)**	**Teacher Edition CD (Assessment task)**
Ways of working Identify problems and issues, formulate scientific questions and design investigations	pp. 2–16	Exercise 7 p. 9	
Communicate scientific ideas, explanations, conclusions, decisions and data, using scientific argument and terminology, in appropriate formats	pp. 3–4 pp. 9–13, 16	Exercise 10 p. 11	Assessment task 1 Types of scientists
Draw conclusions that summarise and explain patterns, and that are consistent with the data and respond to the question	pp. 2, 6–7, 11–16		
Plan investigations guided by scientific concepts and design and carry out fair tests	Investigate 2 p. 15 Experiment p. 16	Exercise 1 p. 6 Exercise 6 pp. 8–9	
Knowledge and understanding ***Science as a human endeavour*** People from different cultures contribute to and shape the development of science	Science in action pp. 17–19		Assessment task 1 Types of scientists

QSA Science Essential Learnings by the end of Year 9

Vocabulary

controlled
dependent
experiment
generalisation
hypothesis/hypotheses
independent
inferring
interpret
investigation
observing
qualitative
quantitative
temperature
variable

Focus for learning

Use problem-solving to work out what is wrong with a DVD player (page 1).

Equipment and chemicals (per group)

Experiment page 4* A4 paper, 2 blocks of wood (or suitable supports), plastic takeaway container, small weights (eg stones)

Activity page 6 retort stand, bosshead and clamp, paperclip, cotton thread, steel nuts (or similar weights), A4 paper, stopwatch

Experiment page 8* muddy water, filter paper, filter funnel, filter stand (or stand and clamp), 2 beakers, stopwatch (or digital watch)

Investigate 1 page 11 beaker (eg 250 mL), thermometer, stopwatch or digital watch, 4 antacid tablets (eg Alka-Seltzer), hot water (from hot tap), ice water, sheet of graph paper

Investigate 2 page 15* ramp, wooden blocks (or suitable supports), toy car or truck, metre rule, various floor surfaces (eg lino, carpet, wood), small weights

Experiment page 16* **Problem A:** thistle funnel, stopwatch, various liquids (eg glycerine, cooking oil, sugary water)

Problem B: balsa wood to make boats, sharp knife for cutting balsa wood, small cup for weights, stand and clamp, pulley, cord, stopwatch, screw hooks

Problem C: small pieces of black and white cloth, 3 thermometers

Problem D: flowers, 2 containers for flowers, sugar

* Students to list equipment they will need, which may be different from what is listed here.

1 Science at work

Getting Started

You and your friends sit down to watch a movie on DVD. You slide the DVD into the machine and nothing happens.

Work in a small group to complete the following tasks.

- Make a list of all the possible reasons why your DVD doesn't play.
- For each reason, discuss how you could test whether it is right or wrong, and suggest how the problem could be fixed.

Starting point

1 Have a general discussion, asking the students to think about the science at work in their homes. They will probably talk about electricity and light, but encourage them to think beyond appliances or technologies that use electricity, and explain how the electricity is used. For example, although microwaves need electricity to function, the science involves electromagnetic radiation. Similarly, refrigerators use electricity to apply refrigeration principles (heating and cooling), CD players use lasers, and so on. Ask the students to consider what happens when they turn a water tap on (water pressure). If it is stuffy inside a room they can open a window, but how does this help (air circulation/convection)? Or how does a washing machine with soap powder clean clothes?

2 Science is about asking questions and trying to solve them. Solving problems often involves experimenting. When something appears to go wrong or does not work, what do you do? Giving the students a scenario and asking them to work out what may be the problem—like the DVD player example given here—not only initiates problem solving but also encourages the thinker to identify all the possible problems. If there are a number of problems then there must also be a number of solutions, and it is important for students to recognise this.

3 You might find it constructive to ask the students how they fix a problem on their computers: more than likely, they will use the built-in troubleshooting options. Most installation manuals have a troubleshooting section, often in the form of schematic or flow diagrams.

4 Ask the students to design a troubleshooting page in the form of a schematic diagram, flow diagram or a series of *If then—go to* sentences for identifying what may be the problem with the DVD player. You might like to have a malfunctioning piece of science room equipment (even a DVD player) set up in the room so that students can problem solve using a hands-on approach.

5 Students could make a set of flash cards for this chapter, or for all chapters in the book. Each card includes a term/word, its meaning, and an example of how the term/word is used. Using coloured paper, the cards can be colour-coded or numbered according to the chapter number. This way the cards can be used for revision and whenever any new chapter/topic is introduced which relates to or links with a previous area of study.

Hints and tips

- Help foster students' interest in science and develop the idea that science is all around us, whether in the natural environment or created by humans. For example, you could ask the class to compile lists of everyday science, new technologies, medical breakthroughs and current topical issues in the media, such as the energy crisis or gene therapy.
- To further enhance students' appreciation of science, they could create a science journal, either for this chapter or the entire year. Each week students add a journal entry—either a current printed article (eg from a newspaper or magazine) or electronic media article (eg from a TV/radio news, current affairs or science program or podcast). Each entry should include the date of the entry, the article date, its source, a summary of the article in point form, the area of science it is about, its effect on society now and in the future, and the student's opinion or view of the article. You could make this a very simple ongoing homework activity as it promotes science literacy and can be used to initiate class discussions.

1.1 What is science?

Finding out why your DVD doesn't play involves asking questions like *Is the DVD player plugged into the TV?*, testing the question, asking more questions if the DVD still doesn't work and doing more tests.

Science is all about asking questions, testing, asking more questions and doing more tests. Science is a way of finding out how or why things happen.

You learnt previously that an experiment is a well thought out test. The test has a series of steps involving several different skills as shown below.

Observing

Observing is when you use your senses to find out as much as you can about an object or event. Observations can lead to two different types of description. One is recorded in words, and is called *qualitative* (QUAL-i-tate-ive) observation. Other observations involve taking measurements. These are called *quantitative* (QUANT-i-tate-ive) observations. Both observations are called *data*.

Generalising

Generalising is where you write a statement that seems true in most cases after you have made many observations. Since there may be exceptions to a generalisation, words like 'most' and 'many' are often used.

Often a generalisation links two different factors. For example, when a painter generalises that 'the warmer the day the faster the paint dries', he is linking drying time to temperature.

Recording

Recording is where you write down your data. You often record this in a *data table*.

Inferring

Inferring is trying to explain your observations. For example, to explain why the DVD doesn't load, you might say that there is a faulty connection between the DVD player and the TV. This inference may not be correct, but it could be tested by making further observations.

Predicting

Predicting is the process of making a forecast of what a future observation will be. Predictions are based on your observations and what you already know.

Learning experience

A useful activity is to take some specifically chosen items into the class and ask the students to write down as many observations as they can about each item within a given time limit.

1 *Observing*: Observational skills involve using senses: smell, touch, taste, sight and sound. Some chosen items could be: jelly snakes, scented leaves (gum, basil, geranium), a lit candle, a beaker of water being boiled.

2 *Recording*: When the students are writing down their observations, they are recording data. It is important to make sure the students differentiate between *qualitative* and *quantitative* data. Ask the students to describe the type of data they have been recording (probably qualitative) then ask them how they could modify their observations to collect quantitative data. For example, measure the elasticity of a jelly snake, measure how much a candle melts in five-minute intervals, record the temperature of water every minute until it reaches boiling point. Qualitative data is concerned with 'qualities' while quantitative is 'quantities' (numerical data).

3 *Inferring*: Students can then make inferences about what has been observed. *Why* might the jelly snake be stretchy, *why* does the candle melt, *why* is the leaf scented? Inferring is trying to answer 'why' questions scientifically. Making an inference about the initial question often generates more questions which need to be investigated. These questions can then be tested, generating further observations.

4 *Predicting*: This means forecasting a future event, like the Bureau of Meteorology predicting possible weather conditions. (Are they always correct?) For example: *I predict* jelly snakes with greater gelatine content

Investigations and experiments

In *ScienceWorld 1* you did many laboratory investigations. In this chapter you will be doing experiments where you have to design tests to answer questions or solve problems.

What's the difference between an investigation and an experiment? The terms mean much the same thing. Both involve carefully planned laboratory or field work. However, an experiment is based on solving a problem or answering a question.

Experiments involve designing tests, observing and recording data, then writing full reports. The Skillbuilder below shows you how to write up a report.

Skillbuilder

Writing reports

A report is organised using seven headings.

TITLE	A very brief description of the investigation, your name and the date.
AIM	You say why you did the investigation—sometimes this is a question.
MATERIALS	A list of the equipment and chemicals you used in the investigation
METHOD	You say what you did in the investigation in numbered steps. Whenever possible include a large, neat diagram of the apparatus.
RESULTS	You record the data. Data includes qualitative observations (words) and measurements (numbers). Usually these are recorded in a data table. This makes the data easier to read.
DISCUSSION	You try to explain your results, and list any problems that you experienced. You might also explain how you could improve the investigation.
CONCLUSION	You answer the question posed in the aim. Often your conclusion will contain a **generalisation**—one that seems true in most cases. For example, a student investigating paper bridges concluded: *The more folds the paper bridge has, the more weight it can support.*

will be stretchier; *I predict* smaller volumes of water will reach boiling point more quickly, and so on.

5 *Generalising*: This involves making a statement or conclusion, based on many observations, that holds true in most cases. Generalisations are often hypotheses. For example, the more gelatine a jelly snake has, the stretchier it is. (A yummy exercise would be to have the students test it using different brands of jelly snakes with differing amounts of gelatine.) Another hypothesis to test is: *the smaller the volume of water in the beaker, the quicker the temperature rises, because* … Make sure the students understand how the two variables are related.

Note: students often use the words 'This proves …' rather than 'This shows …' or 'This may be explained by …' Discourage the use of the word *prove* in science. The word is usually supported with mathematics and involves theorems.

Skillbuilder notes

- The way students present their scientific reports is important. Main headings should be clearly identifiable (different coloured ink, bold or underlined), scientific diagrams need to be appropriately drawn in pencil, on ruled paper, in 2D format and correctly labelled (see *ScienceWorld 1* page 4, 'Drawing science equipment'), and graphs should be labelled and correctly scaled. If the students are hand-writing their report, they should be encouraged to write neatly.
- An analogy for writing a report is that of a recipe in cooking, especially the method. If steps are missed out in the cooking procedure you have to make assumptions about what to do next and things are likely to go wrong. Similarly, students should not leave out any steps in their method. (It cannot be assumed the reader has done the prac before, so the method needs to be written assuming no prior experience.)
- It might be beneficial for the students to have a worksheet to put into the front of their prac book with the practical report headings and descriptions. The worksheet could be designed so that the students have to 'fill in the gaps' and write summarised descriptions of what each heading means. It can then be a quick reference aid for students who are unsure of the correct report-writing sequence, and what needs to be included under each heading.
- The following section headings may be helpful to include:
  - Title
  - Date
  - Partners
  - Aim—statement(s) of what you are going to investigate or question(s) to investigate
  - Materials—equipment or apparatus
  - Method—labelled diagram(s) and procedure steps
  - Results—data tables, graphs, observations (qualitative and/or quantitative)
  - Discussion—answers to any questions posed (inferences), error statements, possible improvements
  - Conclusion—answers to the question(s) in the aim.

Hints and tips

Separate practical notebooks are a good idea for investigations and experiments as it allows you more correction time when collected. The prac books could be clearly numbered on the front cover. Numbered prac books are great because, when submitted, any missing number is easily checked against the class roll and the student is immediately identified! You may find numbering student theory notebooks just as helpful because you could collect, say, numbers 1–10 for marking, then 11–20 and so on. It takes the pressure off collecting a whole class set at once and makes for easy record-keeping.

Research

Investigations do not always mean performing hands-on tasks but often include research. To reinforce this, the students could briefly investigate how some relatively new technologies work, such as DVD or CD players, microwaves, iPods, digital video recorders or mobile phones. These technologies can be complex so drawing diagrams to illustrate or writing how they work in point form may be easier. If the students have access to the internet, fact sheets can be downloaded. It might be appropriate to ask the students to present their investigation on poster paper or as a coloured brochure—this really depends on the degree of depth you want.

Experiment
PAPER BRIDGES

Suppose you suspend a piece of A4 photocopy paper between two blocks. How much weight will the paper support? None, you say! Well look at the paper bridge in the photo.

The paper has been folded many times. It is a paper bridge, and it can support a container with stones in it.

The problem to be solved

If we increase the number of folds in a piece of paper, will it support more weight?

Your task is to work in a small group to design an experiment that will answer this question.

Designing your experiment

1 Discuss what tests you will do to answer the question.
2 Make a list of the equipment you will need.
3 Discuss how you are going to record your observations. Will you take quantitative observations?
4 When you and your teacher are happy with your plan, get started.

Writing your report

1 Write a full report of your experiment, using the headings: Title, Aim, Materials, Method, Results, Discussion and Conclusion.
2 Your discussion should contain an inference that tries to explain your observations.
3 Your conclusion should contain a generalisation that links weight and the folds in the paper.
4 You might like to take a digital photo of your set-up and include it in your report.

Extending the experiment

You might like to extend your experiment by testing these predictions:

1 Two layers of folded paper will support twice the weight supported by a single piece of paper.
2 Heavier paper will support more weight than ordinary paper.
3 Dry paper is much stronger than damp paper.

Learning experience

How are investigations and experiments different? Ask the students to draw a two-column table, writing the heading 'Investigations' above one column and 'Experiments' above the other. Get them to fill in their table by going through their textbook, listing each activity in the correct column. While they are completing this task, they should think how investigations and experiments differ.

Hints and tips

When students do experimental work, they generally like to know the relevance of performing the investigation. The principles behind paper bridges could be explored by teacher and students to investigate any real-life applications it may have. (Consider reinforcement in walls in buildings.)

Lab notes

Paper bridges

- Use paper from the recycling box to minimise waste.
- Small metal masses are ideal to use, as the students can obtain accurate quantitative data.
- If plastic containers are not available for holding the masses, pieces of heavy cardboard could be used instead.

Extension

- Does spreading the mass affect the strength of the bridge? Why or why not?

Check!

1 Use the following words to complete the sentences below.
A generalisation…
Predicting…
An experiment…
- **a** ______ is a scientific test.
- **b** ______ is a statement that is true in most cases.
- **c** ______ is saying what may happen in the future.

2 Look at the photo on page 1.
- **a** What observation did the girls make?
- **b** What inferences could they make?

3 For each statement below say whether it is an observation, inference, prediction or generalisation.
- **a** It tends to rain more in winter than in summer.
- **b** She must have eaten something that doesn't agree with her.
- **c** There should be a full moon next week.
- **d** The leaves on this plant are turning yellow.
- **e** That colourless liquid must be an acid.

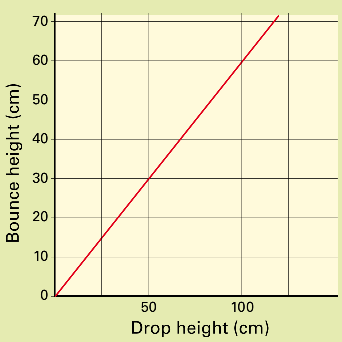
4 You placed a young mouse in a cage with dishes containing three different foods. After observing her for 30 minutes you noticed that she had eaten nothing. What inferences could you make from this?

5 Cameron has a mouse in a cage. The mouse has an exercise wheel with a counter on it. Cameron wrote down the counter reading each morning, but the bottom of his results sheet has been torn off.
- **a** Predict what the counter reading for Day 4 should be (approximately).
- **b** Explain how you made this prediction.

day	counter reading
1	49
2	100
3	152
4	

challenge

1 Heidi dropped a ball from two different heights and measured how high it bounced each time. She used her data to draw a graph.



- **a** Predict how high the ball will bounce if she drops it from 75 cm.
- **b** Predict the bounce height for a drop height of 150 cm.

2 Mick peeled a banana for lunch and left it in his bag when he went to play soccer. Later he discovered that the banana had turned brown and soft.
- **a** Pose a question based on Mick's observations.
- **b** Suggest an inference that tries to answer this question.

3 Ask other students in your group these questions:
- Will it rain tomorrow?
- Will it be a full moon tonight?
- How fast can you swim 50 metres freestyle?
- **a** Decide whether the answers they gave you are predictions (based on observations and knowledge), or just guesses.
- **b** What information would you need to turn the guesses into proper predictions?

Check! solutions

1
- a An *experiment* is a scientific test.
- b A *generalisation* is a statement that is true in most cases.
- c *Predicting* is saying what may happen in the future.

2 Referring to Fig 4:
- a Two observations are that the vase is broken and the girl is holding something behind her back.
- b Two inferences that could be made are that the girl broke the vase with the ball she is hiding or that the dog broke the vase.

3
- a generalisation
- b inference
- c prediction
- d observation
- e inference

4 The most likely inferences that can be made are that either the mouse is not hungry or that the mouse does not like any of the foods being offered.

5
- a The predicted reading for Day 4 is approximately 200.
- b The reason for this prediction is that the average for the previous three days is about 50.

Challenge solutions

1 Using the data in the graph:
- a We can predict that the ball will bounce about 50 cm if dropped from 75 cm.
- b We can predict that if the ball is dropped from 150 cm it will bounce about 100 cm. For this you have to extend the axes on the graph or simply double the height for a drop from 100 cm.

2
- a A possible question is: 'Why did the banana turn brown?'
- b One possible inference is that the bag was left in a warm place and the heat caused the discoloration of the banana.

3
- a The best way to decide whether it is a prediction rather than a guess is whether a reason can be provided instead of just 'Because I think so'.
- b A prediction is usually based on some other information. For example, another student may have watched the weather forecast, may be able to interpret a weather map, or may be a club swimmer who knows his or her best lap time.

- Spaghetti bridges may be an alternative or an extension to the paper bridges. If building spaghetti bridges, assign a set number of spaghetti strands and starch-based glue. 'Hot glue' is preferable to PVA as it is less messy and dries more quickly.

Homework

Ask students to investigate real-life applications in the building industry which use the same principle as the paper bridge. A simple multimedia (PowerPoint) task could be completed, incorporating any relevant pictures.

Activity notes

- For a pendulum, the string is considered to have negligible mass while the 'bob' has mass and is concentrated at one point (in this case the end of the pendulum). The time taken for one complete swing is called its *period*. Make sure the students do not confuse the pendulum's *period* (time) and its *frequency* (number of cycles in a given time).
- Length of string not only affects the pendulum's period but also its frequency. A long pendulum has a longer period, meaning it is slower. A short pendulum has a shorter period and swings back and forth more frequently. Compare a giraffe walking to a mouse walking—larger slower gait, shorter faster gait!
- A pendulum's period does not depend on its mass, only on its length and the acceleration due to gravity. This is why some timepieces (clocks) use pendulums because the period is not affected by the mass of the pendulum.
- If the students do the experiment the equipment needed is: retort stand and clamp, string, small masses, stopwatch and ruler.

1.2 Experimenting

In the paper bridges experiment, you tried to find out if the number of folds in the paper affected the weight the paper could support. Was your experiment a *fair test*? Did you consider the other factors that might have affected the result?

Controlling variables

There are other factors that could have affected the results of your paper bridge experiment. Look at the photos below.

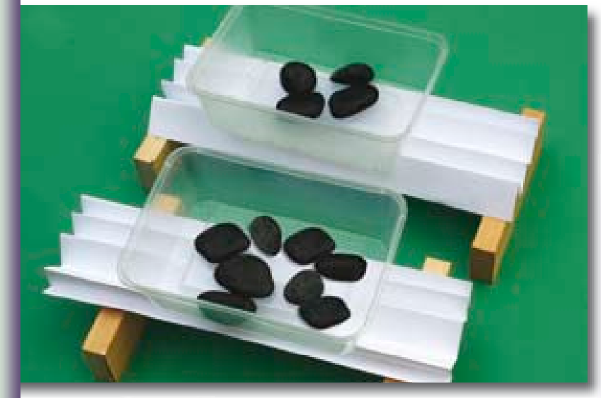


Fig 7 One paper bridge is longer than the other. The shorter bridge can support more weight.

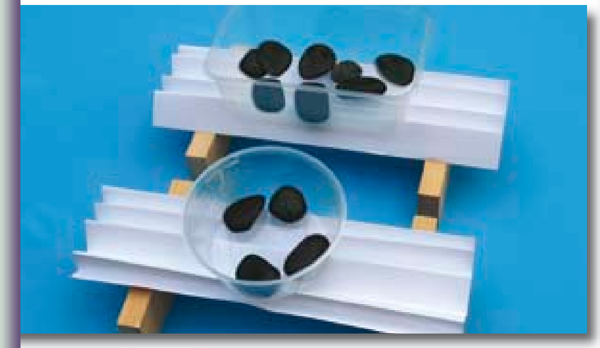


Fig 8 The containers are different shapes. The paper bridge supports the rectangular container better than the circular one.

There are at least three factors that could affect the results of this experiment:

1 the number of folds in the paper
2 the length of the paper between the supports
3 the shape of the weight container.

These factors that could change the results of an experiment are called **variables**.

You should test only one variable at a time. If you want to increase the number of folds in the paper, then you must keep the other two variables the same: use the same type of container, and keep the length of the bridge the same. This is then called a **fair test**.

The test becomes a fair test when you **control the variables**. You keep all the variables the same, except one.

Activity

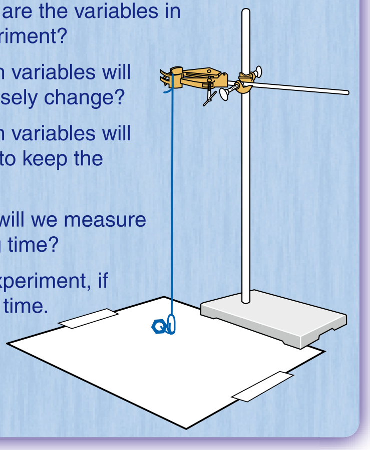
You can make a pendulum by suspending a steel nut on a paper clip tied by cotton to a metal clamp and stand.

Suppose your group wants to find out whether the mass of a pendulum makes any difference to the time it takes to do a complete swing (from start back to start again).

Use the questions below to design an experiment that will test the statement above.

- What are the variables in this experiment?
- Which variables will we purposely change?
- Which variables will we need to keep the same?
- How will we measure the swing time?

Do the experiment, if you have time.



Learning experience

Teacher demonstrations are a good way to illustrate concepts and help focus the students' attention. Explaining what makes a test a fair one could be done as a demonstration, especially if you exaggerate the concept of an unfair (biased) test! In doing so, students gather information about what variables are and how controlling them affects possible outcomes.

A teacher demonstration could be to dissolve sugar in water:

1 Have two different types of sugar (eg icing sugar and raw sugar) and different amounts of cold water and hot water.
2 Before you demonstrate to the class, allow students to see the materials you are going to use, and pose the question, 'Does sugar dissolve in water?' The response is likely to be 'Yes'.
3 Put half a teaspoon of icing sugar in a large amount of hot water and stir (sugar dissolves). Now place a tablespoon of raw sugar in a small quantity of cold water but do not stir (sugar does not dissolve).

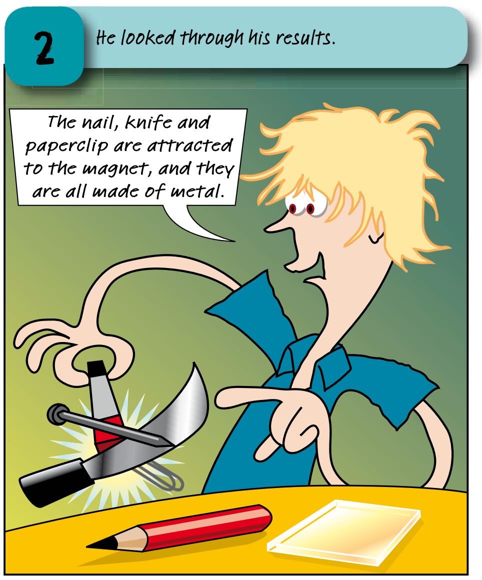
The students will probably be upset with you for not 'controlling the variables'! Ask them to explain why your test was not fair, and how to make it fair.

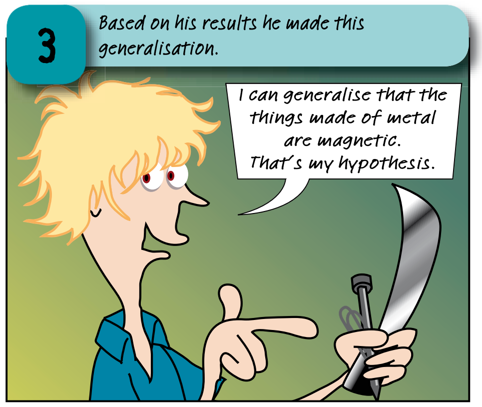
Testing a hypothesis

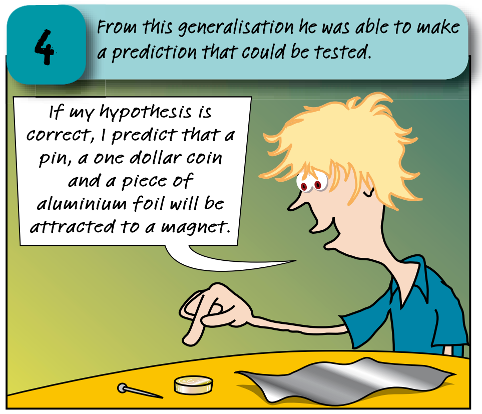
A **hypothesis** (high-POTH-e-sis) is a generalisation which can be tested. It explains a set of observations or gives a possible answer to a question. Note that the plural of hypothesis is hypotheses (high-POTH-e-sees). An example of a hypothesis is given on this page.

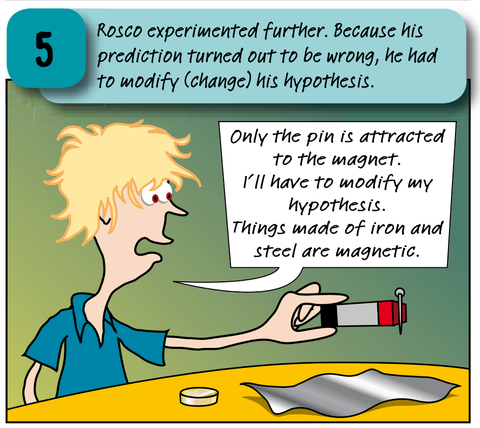
1 Rosco recorded his observations of the effect of a magnet on various materials.

Material tested	Magnetic (✓) Non-magnetic (✗)
nail	✓
piece of glass	✗
wooden pencil	✗
knife	✓
paperclip	✓









Hints and tips

Hypotheses and generalisations are closely linked. Generalisations do not necessarily have to be tested, but hypotheses do as they are an explanation of 'observed' facts. Students could go back to the previous experiment and activity to write a hypothesis for each one—*Experiment: Paper Bridges* (page 4) and *Activity* (page 6).

Learning experience

Give the students a worksheet or write statements on the board, asking them to distinguish between hypotheses, generalisations and observations. They might like to draw their own cartoon for the *Experiment: Paper Bridges*, clearly identifying each statement as an observation, record of data, generalisation, hypothesis, etc. Use page 7 as a guide.

Hints and tips

If muddy water is not available, powdered blackboard chalk works just as well. Make sure you thoroughly stir the water before pouring off small beakers of liquid for the students to filter.

Lab notes

Which filter?

- Allow a set number of pieces of filter paper per group. Three pieces will probably be adequate—one piece folded in quarters, one fluted and one for their own design.
- To make the paper adhere to the funnel, add a few drops of water.
- Remind students not to damage the filter, especially the apex of the cone, with the stirring rod or their fingers.

Extension

A possible extension is to demonstrate how a Büchner funnel can be used to speed up the process. (The porcelain Büchner funnel has small holes in it and filters by suction.)

Experiment
WHICH FILTER?

In *ScienceWorld 1* you learnt how to filter some muddy water. In this experiment you will design tests to see whether folding a filter paper in different ways has any effect on the time it takes to filter some muddy water.

The problem to be solved

To compare the time it takes to filter muddy water using filter papers folded in different ways. Do you know how to fold a filter paper? If you have forgotten, ask someone. Follow the instructions below for making a fluted (folded many times) filter paper.

Designing the experiment

1 Work in a small group and discuss the tests you will do.

2 Write a hypothesis for the experiment.

3 Make a list of the equipment you will need.

4 Make a list of the safety precautions you will take.

5 Which variables will you control? Which variable are you going to change?

6 Discuss how you are going to record your observations.

7 When you and your teacher are happy with your plan, get started.

Writing your report

1 Write a full report of your experiment, using the headings: Title, Aim, Materials, Method, Results, Discussion and Conclusion.

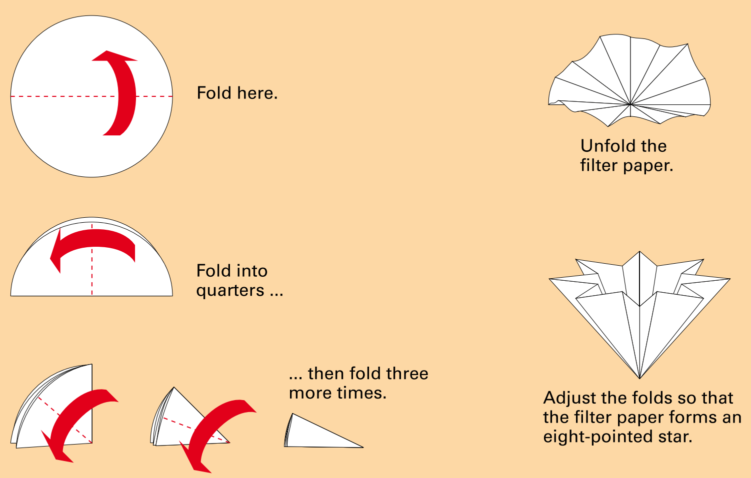
2 Your discussion should contain an inference that tries to explain your observations.

3 Do your results support your hypothesis? If not, write a better hypothesis.

Extending the experiment

You might like to test this prediction: *A sixteen-fold fluted filter paper filters twice as fast as an eight-folded one.*

Making a fluted filter paper



Graphing

A line graph is a way of displaying data so that it can be interpreted easily. It may be a straight line or a curved line. A line graph shows you the relationship between two variables.

Look at this data from the side of a milk carton. The data was obtained by storing milk at various temperatures and recording the average time before it 'went off'.

WHEN STORED AT	WILL LAST AT LEAST
4°C	9 DAYS
6°C	5 DAYS
10°C	2 DAYS
16°C	1 DAY

KEEP REFRIGERATED, STORE BELOW 4°C. CONTENTS WILL THEN KEEP AT LEAST UNTIL USE-BY DATE.

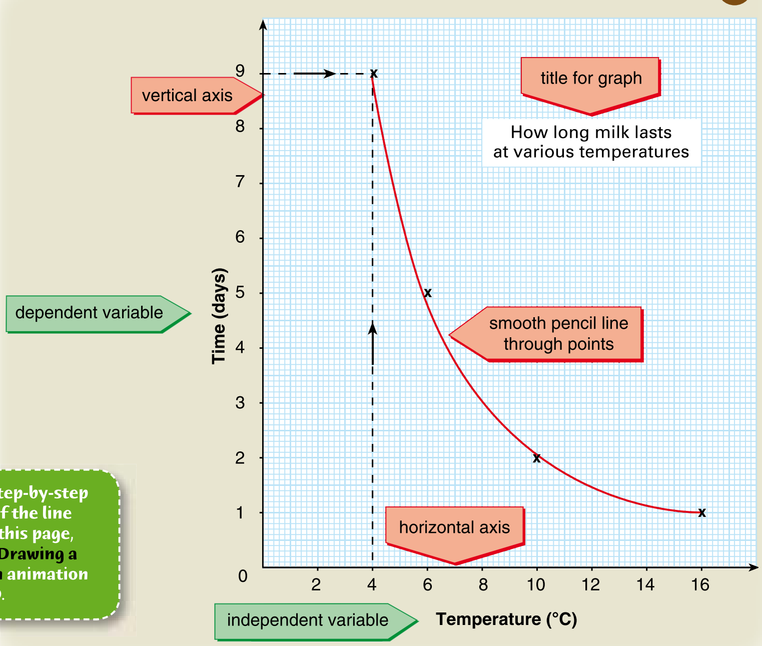
Independent and dependent variables

The temperature was changed on purpose. It is called the **independent variable**, because you can select any value for it. The number of days the milk lasted is called the **dependent variable**, because it depends on the temperature. All other variables, eg brand of milk and type of container, were *controlled* (kept the same).

Skillbuilder

Drawing graphs

1 On a piece of graph paper draw the horizontal axis and the vertical axis.
2 On a line graph, the dependent variable is plotted on the *vertical* axis. The independent variable is plotted on the *horizontal* axis. Label the horizontal axis 'Temperature (°C)'. Label the vertical axis 'Time (days)'.



Working with technology

To see a step-by-step drawing of the line graph on this page, open the **Drawing a line graph** animation on the CD.

Hints and tips

- Graphing is a very important skill for students to learn. Always deduct marks for inadequate or incorrect labelling, wrong type of graph, incorrect scales, joining the dots up as a 'dot-to-dot' rather than a smooth line of best fit, and having the dependent and independent variables the wrong way around.
- If students have not had enough practice drawing graphs, a mistake they often make is incorrectly scaling each axis. Make sure you carefully explain how to decide on an appropriate scale and how to scale a graph. Do not assume they remember graphing skills from mathematics.

Skillbuilder notes

If the class has access to computers, you could show the students how to draw graphs using Microsoft Excel. Alternatively, students with graphic calculators could be shown how to use the statistics editor, enter data into the lists and produce a graph. However, using any form of electronic technology to draw lines of 'best fit' requires a reasonably high degree of mathematical understanding—more than is required at this stage.

Homework

An invaluable homework task is to finish off an incomplete written practical report. Be sure students have data that requires graphing in the Results section, and questions to be answered in the Discussion. Make sure students write their own Conclusion based on the aim.

Learning experience

Give students sets of experimental data to practise graphing. Accompany each set of data with a description (ie the aim of the experiment) which explains the data and puts it into context, so students can more easily identify the dependent and independent variables.

Hints and tips

Gather some interesting information about milk, such as the pasteurisation process, which industries use a lot of milk, what breeds of dairy cows are farmed in Australia, what happens when milk goes off and how low-fat milk is produced. Ask the students if they can think of other examples of science in action.

Assessment task

This would be a good place to set *Assessment task 1: Types of scientists*.

Activity notes

- Questions 1 and 2 involve *interpolation* (a point within the given data range). It is a good idea to think up an *extrapolation* question (a point outside the given data range).
- Ask the students to give reasons for temperature being the independent variable and time the dependent variable.
- Question 4 asks the student to complete the hypothesis. But what do they think is the *aim* of the experiment?

3 Select suitable scales for the two axes so that the graph fills most of the page.

4 Look at the first pair of numbers in the data table. They are:

temperature	4°C
time	9 days

In pencil, mark the point where the grid lines meet with a small neat cross, as shown on the previous page. Then do the same with the other pairs of numbers.

5 By looking at the four crosses you have drawn, you can see that this graph is a curved line. Use a pencil to draw a smooth curve through the crosses, as shown. (This may take some practice.) Don't join the crosses with straight lines.

6 Finally, write a title for the graph at the top. This tells others what the graph is about.

Activity

Use the graph on the previous page to answer these questions.

1 How long does milk last when stored at 8°C?

2 A carton of milk lasted 1½ days. At what temperature was it probably stored?

3 Describe in your own words what the shape of the graph tells you about the relationship (link) between the temperature of the milk and how long it lasts.

4 Complete this hypothesis. *The lower the temperature…*

Science in action

Elaine Perriman is a food technologist. She works in the laboratory of a country milk factory that makes a range of full fat, reduced fat and skim milks, cream and flavoured milks.

She routinely samples the pasteurised milk from the factory and tests for the presence of disease-causing bacteria. In this way she can tell that the pasteurisation process is working correctly.

She also samples the raw milk that comes in from dairy farms to make sure there are no antibiotics in the milk. When farmers treat sick cows with antibiotics, the antibiotics pass into the milk. Some people are allergic to certain antibiotics, so it is Elaine's responsibility to make sure that the raw milk does not contain antibiotics.

Milk is a very important food in most people's lives. Most states have milk factories, but 61% of all the milk produced in Australia comes from Victoria.

Learning experience

Photocopy a previous year's student practical report *without* teacher corrections. Ask the students to correct it for you, write a better conclusion and award an appropriate mark. Ensure there are easily identifiable errors. This task could be tackled in pairs with a set time limit. A task like this draws together all the concepts they have learned so far about scientific report writing.

Investigate

1 DISSOLVING TIME

Aim

To write and test a hypothesis about how temperature affects the time it takes an antacid tablet to dissolve in water.

Materials

- beaker, eg 250 mL
- thermometer
- stopwatch or watch with a second hand
- 4 antacid tablets, eg Alka-Seltzer
- hot water (from hot tap)
- ice water
- sheet of graph paper

Note: Clear aspirin tablets can be used instead of Alka-Seltzer.

Planning and Safety Check

1 Write down your hypothesis about how you think temperature affects dissolving time. (Base your hypothesis on your previous experience of making hot and cold drinks or doing the washing up.)

2 Prepare a data table like the one below in which to record your results.

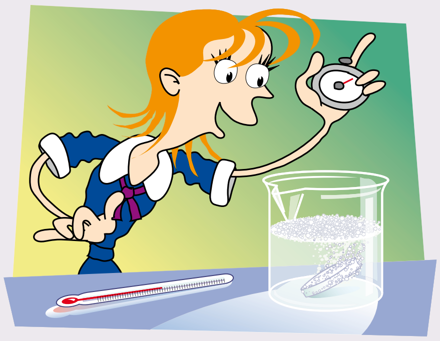
	Temperature (°C)	Time to dissolve (seconds)
Ice water		
Room temperature		
Warm water		
Hot water		

Write down all the variables that could affect the dissolving time. Which ones will you need to keep the same?

Method

1 Fill the beaker with water from the tap. Use the thermometer to measure the temperature of the water.
Record this temperature in your data table.

2 Drop in an antacid tablet. Do not stir. Time how long it takes for the tablet to dissolve: that is, how long before it disappears completely.
Record this time in your data table.



3 Repeat Steps 1 and 2 for the other temperatures. Remember to control the variables you listed in the Planning and Safety Check.
Record your results.

4 Plot a graph with water temperature on the horizontal axis and dissolving time on the vertical axis. Draw a smooth curve through the four crosses. This line shows how the dissolving time depends on the temperature of the water.

5 Write a report of the investigation using the usual headings.

Discussion

1 Which is the independent variable, and which is the dependent variable in this experiment?

2 What does your graph tell you about the relationship between temperature and dissolving time?

3 Do your results support (agree with) your hypothesis from the Planning and Safety Check? If not, write a better hypothesis.

Lab notes

- It is a good idea to have a class discussion about the factors that are essential for a 'fair test', and ask them how they will know that the tablet is all dissolved. Ask the students which variable(s) are being controlled.
- Remind students how to handle thermometers.
- Before the students start the experiment, it is better if they have partly written their practical report and have a neatly constructed results table ready to fill in.
- To minimise water wastage from running the hot water tap until the water is warm, boil some water using an electric kettle and add the boiling water to a jug partly filled with cool water. Allow the students to fill their beakers using this water.

Check! solutions

1 No, this is not a fair test. The test could be improved by using the same size darts and dropping them from the same height. The only difference should be the type of wood.

2 The variables will depend on how you normally travel to school. However, here are some possibilities: the weather, the traffic lights, who is driving the car, and whether you are hurrying because you think you might be late.

3 To test the three powders:
- a You will need to control the amount of the powders, the volume of the water and whether it is stirred or not.
- b The variable that you will purposely change is the type of powder.
- c You will measure the time taken for each powder to completely disappear or dissolve.

4
- a This statement is an inference about magnets because it is based on some observations.
- b This statement is a hypothesis because it a generalisation about falling objects, which is able to be tested.
- c This statement is a hypothesis because it a generalisation about the growth of plants, which is able to be tested.
- d This statement is an inference about accidents because it is based on some observations.

5
- a A suitable data table would look like this

Speed of car (km/h)	*Volume of sound recorded (dB)*
0	
10	
20	
30	
40	

- b The independent variable is the speed of the car. The dependent variable is the sound made by the car.

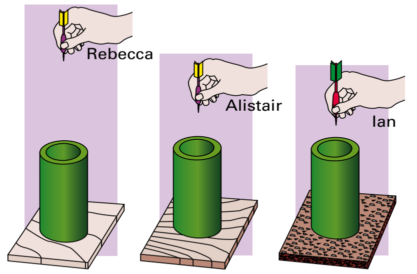
6 Using the information from the graph:
- a Paul was 5 years old when he was 100 cm tall.
- b Assuming that Paul continues to grow at a steady rate, he will be approximately 112 cm when he is 8 years old.
- c It is difficult to predict how tall Paul will be when he is 20 years old because growth does not continue at a steady rate. Generally, humans have a growth spurt between the ages of about 13 and 17 and then do not grow much more.

7 A fair test would be to have the bikes travelling at the same speed on the same surface with a rider of the same mass applying the brakes equally hard, then measuring the distance taken to stop. To get more accurate results you should repeat the test several times and average the results.

8
- a The hypothesis was: 'The amount of water given will affect the germination and growth of the bean seeds.'
- b All bean seeds are slightly different and sometimes a bean seed will die for no obvious reason. To average out any differences Ace planted two seeds in each pot.

Check!

1 Rebecca, Alistair and Ian compared the hardness of three different types of wood. They did this by measuring how far a dart went into the wood, as shown below. Was this a fair test? If not, explain how the test could be improved.



2 What are the variables that affect how long it takes you to get to school?

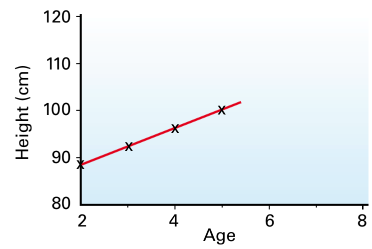
3 You have three different powders. You want to find out which one dissolves most rapidly in water.
- **a** Which variables will you need to control in your test?
- **b** Which variable will you purposely change?
- **c** What will you measure?

4 Which of the following are inferences and which are hypotheses?
- **a** This piece of iron must be a magnet.
- **b** All things fall towards the Earth because of gravity.
- **c** Plants grow more in summer than in winter.
- **d** I think the wet road caused this accident.

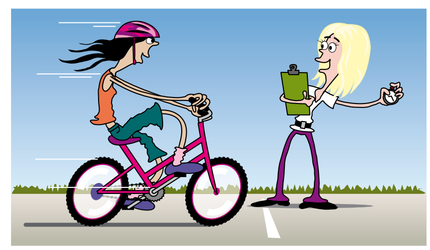
Justify your answers (explain why they are inferences or hypotheses).

5 Dan used a decibel meter to measure the noise given off by a car travelling at different speeds.
- **a** Design a data table for Dan's results.
- **b** Which measurement is the independent variable? And which is the dependent variable?

6 Paul's parents measured his height every year, starting when he was two. They recorded these measurements on a graph.
- **a** How old was Paul when he was 100 cm tall?
- **b** Predict how tall he will be when he is eight.
- **c** Can you predict how tall he will be when he is 20? Explain.



7 Rebecca and Megan want to test whose bike has better brakes. Design a fair test for them. Remember, when designing fair tests you:
- change something
- measure something
- keep everything else the same.



8 Ace planted 2 bean seeds in each of 4 pots of soil. Every three days he added water to the pots as shown below.

Pot 1	no water
Pot 2	10 mL of water
Pot 3	20 mL of water
Pot 4	40 mL of water

- **a** Write a hypothesis for Ace's experiment.
- **b** Why did he plant 2 bean seeds in each pot and not just one?

challenge

1 The following questions refer to Investigate 1 Dissolving time on page 11.
   - **a** Suppose you wrote *Antacid tablets dissolve faster in hot water* for your hypothesis. What would you need to do to test this hypothesis?
   - **b** Use the graph you drew to predict how long a tablet would take to dissolve in water at 35°C.
   - **c** What temperature would the water need to be for a tablet to dissolve in exactly one minute?

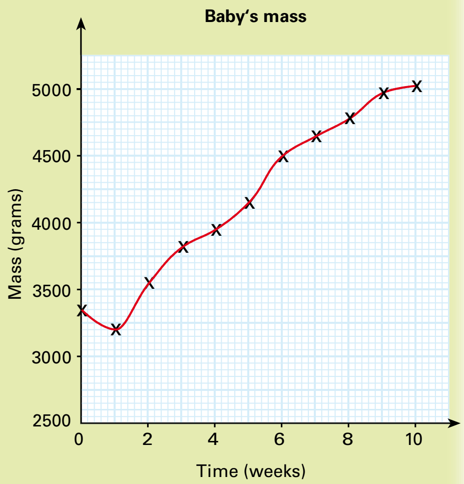
2 A group of students was investigating the growth of seedlings. They measured the average height of the seedlings every day.
   - **a** Draw a graph of their data.
   - **b** Is the graph a straight line or a curve?

Time (days)	Height (cm)
0	0
1	1.0
2	2.1
3	2.6
4	3.8
5	5.0
6	5.8

3 Mark and Dylan used a datalogger and temperature probe to find out how quickly the temperature of ice-cold water changed as it was heated. They obtained the data list below on their calculator screen.
   - **a** Draw a graph to display their results.
   - **b** Use the graph to find out approximately how long it took the melted ice to reach a temperature of 70°C.
   - **c** What was the approximate temperature of the heated ice after three minutes?

Time (min)	Temperature (°C)
0	0
2	5
4	30
6	75
8	93
10	98

4 Use the graph below to answer the following questions.
   - **a** What is the graph about?
   - **b** Which is the independent variable?
   - **c** Which is the dependent variable?
   - **d** By what amount do the numbers on the vertical axis increase?
   - **e** How much mass does each small grid line on the vertical axis represent?
   - **f** By what amount do the numbers on the horizontal axis increase?
   - **g** What was the mass of the baby at birth?
   - **h** When did the baby reach a mass of 4000 grams?
   - **i** What was the baby's mass at the end of the seventh week?
   - **j** During which week did the baby's mass decrease?



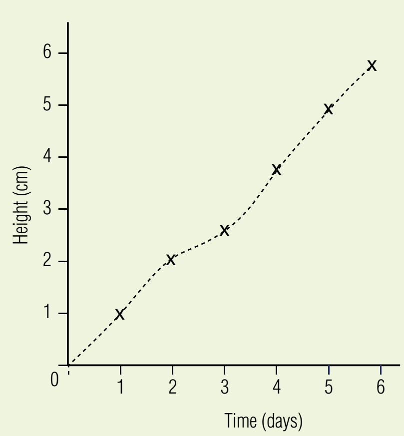
try this

Use the ideas from Investigate 1 on page 11 to design an experiment to test the effect of stirring on dissolving time.

Challenge solutions

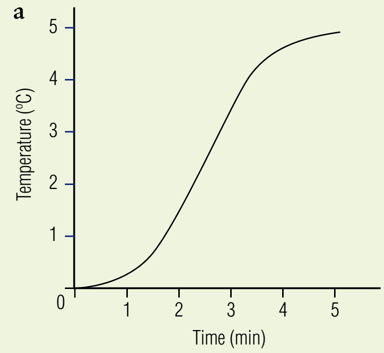
1 a To test this hypothesis, you would need at least three antacid tables and three beakers with water at different temperatures (eg 10°C, 30°C, 60°C).
  b Answers will differ, but it should take several minutes to dissolve at 35°C.
  c Again, answers will differ but it will probably be about 70°C (which is too hot to put your hand in).

2 a



  b These points are best joined by a curved line because things do not always grow at a constant rate.

3 a



  b It took approximately six minutes to reach a temperature of 70°C.
  c After three minutes the temperature is approximately 15°C.

4 a The graph shows the change in a baby's mass during the first 10 weeks of its life.
  b The independent variable (on the horizontal axis) is the age of the baby in weeks.
  c The dependent variable (on the vertical axis) is the mass of the baby in grams.
  d The numbers on the vertical axis increase in intervals of 500 grams.
  e Each small grid line on the vertical axis represents 50 grams.
  f The numbers on the horizontal axis increase in intervals of two weeks.
  g The mass of the baby at birth was 3350 grams.
  h The baby's mass reached 4000 grams at the age of approximately 4.3 weeks, or 30 days.
  i At the end of the seventh week the mass of the baby was 4650 grams.
  j The baby's mass decreased during the first week.

Hints and tips

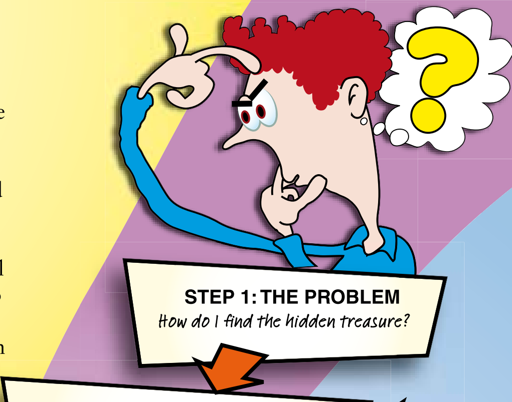
Students should already be familiar with the idea that problems do not always have straightforward solutions, whether in science or in everyday life. It would benefit any science class to have visual access to the problem-solving process. Assign groups of students to write out the problem-solving steps clearly on coloured poster paper to display in the room.

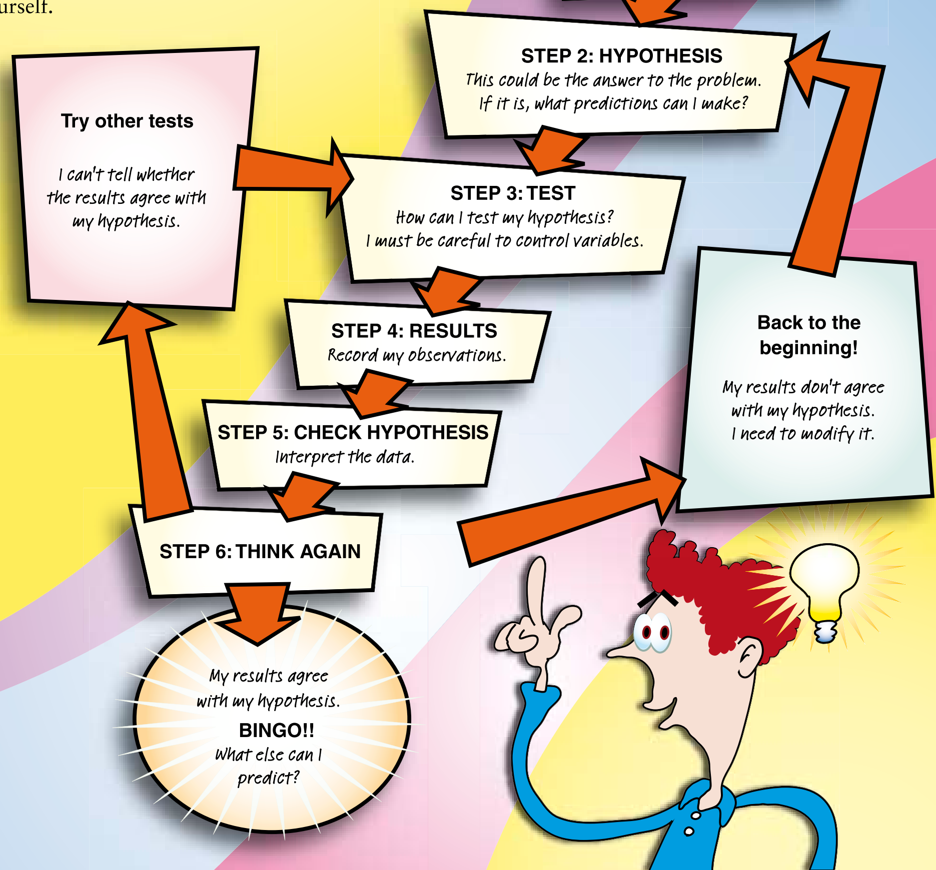
1.3 Solving problems

Josh is playing a computer game in which he has to find the buried treasure. He is using his science skills to solve this problem.

Read carefully through the six steps on this page. Note that at Step 6 you should be prepared to change your hypothesis if necessary. You cannot ignore some data or change it to fit in with what you think should happen. Also, not all problems are easy to solve. And you may have to do many experiments.

In Investigate 2 you can try to solve a problem yourself.



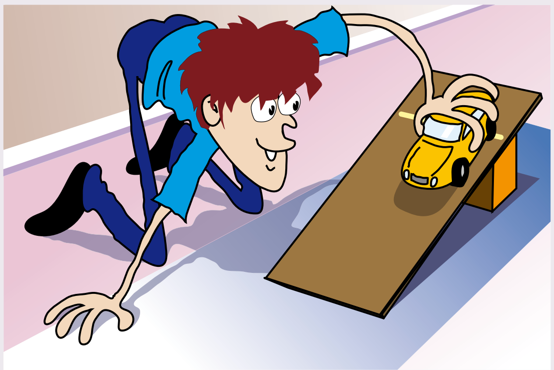


Learning experience

Give the class a quick quiz based on the material they have already learned. This will indicate any concepts that need to be revised. Ask the students to write the answers only (no need for the questions).

Investigate

2 STOPPING DISTANCE



Aim

To investigate the variables that affect the distance it takes a moving vehicle to stop (stopping distance).

Method

Step 1: The problem

Form a group with other students, and make a list of all the variables you think may affect a moving vehicle's stopping distance.

Step 2: Hypothesis

Decide which one of the variables from Step 1 you are going to test.

Write a hypothesis that says how this variable will affect the stopping distance. (Make sure your hypothesis is testable.)

Using your hypothesis, write a prediction you can test. (See Step 4 on page 7 for an example.)

Step 3: Test (experiment)

In your group, decide what equipment you will need to test your prediction. For the vehicle you could use a toy car or truck. Or you could build one out of Lego or a similar building kit. To get the vehicle moving you could run it down a ramp.

Write a brief plan for your experiment. Remember to control all variables except the one you are purposely changing. Show your plan to your teacher.

Step 4: Results

Do your experiment. You may need to do some trial runs before making any measurements.

Record all your results in a data table. Which is the independent variable and which is the dependent variable?

You may want to display your results on a graph. (This would be useful for showing to the rest of the class.)

Repeating the measurement

If you repeat a measurement of the stopping distance, you will probably get a slightly different value. This is because there are some variables you cannot control, eg whether the vehicle runs straight or not. For this reason it is a good idea to do each measurement three times and calculate the average.

The more measurements you make, the more reliable the average will be, but three measurements are usually enough.

Step 5: Check hypothesis

Do your results support your hypothesis? That is, was your prediction in Step 2 correct?

Write a conclusion, giving an answer to the question you investigated.

Which variables did other groups investigate? What did they find? How do their results compare with yours?

Step 6: Think again

How accurate do you think your results are? Can you think of ways to improve your experiment?

Write a report of your experiment using the usual headings.

Hints and tips

For any practical work, groups of three are ideal to avoid any student being only a passive member. Before each group starts the investigation make sure their plan has been approved by you.

Lab notes

- Dynamic carts or small trolleys from physics could be used.
- It is important to insist on repeating the experiment at least three times in order to average results.
- Placing the cart on a ramp and letting go allows for gravity to act rather than having to apply an equal push each time in order to move it.
- Variables to consider are the surface type, gradient of ramp, possible friction in the wheels and the mass of the cart. Remind students about controlling variables and how to ensure the test is fair.
- Plasticine can be used to smooth the gap between the floor and the ramp.
- Use strips of carpet, different grades of sandpaper, smooth wood, shiny paper and so on for surface types.

Hints and tips

This is a good opportunity for students to think up their own problem/experiment to investigate. A starting point is to test a manufacturer's claim about a product, eg paper towelling being twice as absorbent as any other brand, washing detergents being just as powerful in cold water as in hot, etc.

Lab notes

Problem A

- A filter funnel works just as well as a thistle funnel, and is easier to use.
- An alternative to this problem is to fill up burettes or cylinders with liquids differing in viscosity and measuring the time it takes for a dropped ball bearing to reach the bottom.

Problem B

- It may be possible to obtain some flat roof guttering for the 'blocked section of drain'. Alternatively you may be able to use a ripple tank tray (with care).

Problem C

- Technology in the form of a datalogger with temperature sensors could be used, especially with three temperature sensors—black cloth, white cloth and room temperature.
- Infrared lamps could be used as a heat source for non-sunny days.
- Students might also investigate coloured roofing material or painted surfaces as an extension.

Problem D

- For this experiment to be successful it needs to be performed over several days. Make sure the students have a vase of 'control flowers' placed in the same location as the 'test flowers'. Air temperature plays a significant role in the longevity of cut flowers. Cutting the stems underwater stops air bubbles entering the vascular tissue and interrupting the flow of water in the plant stem.

Experiment

WORKING SCIENTIFICALLY

It is fun to solve everyday problems by experimenting. Choose one or more of the problems below or think of your own problem.

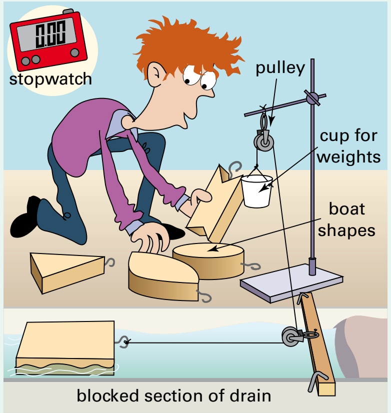
In designing your experiment, use the six steps in investigating you used in Investigate 2, starting with a hypothesis you can test.

PROBLEM A

What sorts of liquids flow through the funnel most easily? Liquids you could try are water, glycerine, cooking oil, sugary water …

PROBLEM B

Does the shape of a boat's hull affect its speed?

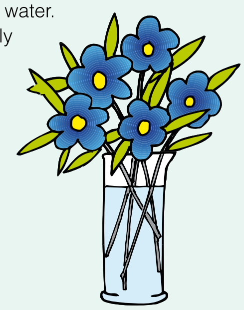


PROBLEM C

Which colour cloth is the coolest in summer? Which is the warmest in winter?

PROBLEM D

Florists say that a vase of flowers will last longer if the stems of the flowers are crushed and if you add a little sugar to the water. Do these variables really affect the life of the flowers?



Science in action

Scientists are ordinary people who solve problems using the skills you have learnt in this chapter.

Over the years scientists have made many important discoveries which affect our daily lives. Five of these are described on the following pages. Select at least one of these and answer the questions about it.

Post-it self-stick notes

Some discoveries in science are made by accident, or serendipity.

Art Fry was in church one Sunday in 1974. He sang in the choir but he had a problem. The bits of paper he had put in his book to mark the hymns kept falling out. Suddenly he had an inspiration. Several years ago the 3M company where he worked had made a glue that was thrown out because it wasn't sticky enough. Perhaps it would be sticky enough to make sticky bookmarks for his choir book.

Fry went back to his laboratory at 3M and tried the old glue. It worked, but he spent a year and a half modifying and testing it. When he took it to the advertising department they weren't very keen on his idea for sticky note pads. However, they put them on the market, and soon people around the world were buying Post-it self-stick notes.

Questions

1 Use a dictionary to find the meaning of the word *serendipity*.

2 Did Art Fry work scientifically to make self-stick notes? Explain.

3 Suggest uses for Post-it self-stick notes.

4 For information on Art Fry go to www.scienceworld.net.au and follow the links to **Inventions at play**.

Dung beetles

Cattle were introduced to Australia over 200 years ago. We now have a problem of too much cattle dung. It covers grazing land and flies breed in it. George Bornemissza, who came to Australia from Hungary, started studying the problem in 1951. He found that Australia has dung beetles that can break down the dung of native animals such as kangaroos. However, very few of these beetles can break down cattle dung. He therefore suggested bringing dung beetles from other parts of the world to Australia.

The first of these beetles were released in 1967, and today dung beetles are well established in some areas. However, they have not spread far enough, and flies are still a problem throughout Australia. Scientists from CSIRO, Australia's largest scientific research organisation, are therefore still working on the problem.

Questions

1 Why is cattle dung such a problem?

2 Why was it necessary to introduce dung beetles to Australia when there were some here already?

3 How can the spread of dung beetles throughout Australia reduce the number of flies?

4 Suggest a plan to spread dung beetles more evenly across Australia.

5 What precautions must be taken when a foreign animal or plant is planned to be introduced to this country?

Hints and tips

Recently the CSIRO undertook a biological trial on Kangaroo Island using a dung beetle from France to help reduce methane (a gas contributing to the greenhouse effect) produced from cow dung. The beetle rapidly burrows the dung into the subsoil where worms decompose it with glee! Not only are greenhouse gases reduced, but the worm casts nourish the soil so much that there is no need to use artificial fertilisers.

Learning experience

On poster paper (or butcher's paper) write a topic/question to be investigated, or use the five sets of questions given on pages 17–19. Allow students to work in groups of no more than four members per group. Each group needs to assign a group leader, scribe and researchers. Set a time limit for the exercise. At the end of the investigation the group leader reports to the class what they investigated, what they found, and their findings' importance to science and everyday life.

Research

Consider getting the class to do some further research. For example:

- *Teflon*: What was its original purpose and what is it used for today?
- *Ballpoint pen*: Who invented it and how does it work?
- *Silicon chip*: Why is this device so amazing?
- *Penicillin*: How has it changed our lives?

When the students do their own research they need to devise a good set of questions. What is best is a combination of factual and extended answers. Ask questions like:

1 What was/is the need for it?
2 Who discovered, implemented and invented it?
3 How was it tested?
4 Was it a fair test and were/are there any long-term studies?
5 Has its use or implementation caused any unforeseen problems and, if so, what were/are they and have they been fixed/eradicated?
6 Has it solved the problem?
7 If the problem is not fixed, how would you suggest solving it?

It is also important to explore what happens when things go wrong, particularly with biological controls like the cane toad.

Twin lambs

Dr Helen Newton Turner was experimenting with the breeding of sheep. In 1951 someone sent her some ewes that produced twins much more often than usual. She knew that twin lambs were rare, and wondered whether she could use the ewes to breed whole flocks of sheep that produce twins more often. She therefore set up a series of experiments with ewes that had produced twins and rams that had been twins. At the same time she did similar experiments with single-bearing ewes mated with single-born rams.

Her results showed that 'twinned' parents produced three times the number of sets of twin lambs as the 'single' parents. She then worked with a farmer near Cooma (NSW) and by 1972 his merino flock was producing 210 lambs each year for every 100 ewes!

The sheep industry has benefited enormously from Dr Turner's work.

Questions

1 Why do sheep farmers like twin lambs?
2 What is meant by 'twinned' parents and 'single' parents for sheep?
3 How did Dr Turner control the variables in her sheep breeding experiments?

Medicines from frogs

Dr Michael Tyler from the University of Adelaide has been studying frogs for 30 years. The secretions produced by the skin of frogs contain many different chemicals. Some of these are toxic, but others have been found to be useful as medicines. For example, scientists have recently isolated a pain-killer 200 times more powerful than morphine.

Dr Tyler wanted to find a way of extracting the secretions from the frogs without harming them. One day he was having acupuncture for a headache. The acupuncturist inserted needles in his skin and passed a small electric current through him, causing his skin muscles to twitch slightly. This caused him to wonder whether frogs would release their secretions when their skin muscles were twitched using a small electric current.

Back in his laboratory Dr Tyler found that his idea worked, without harming the frog, and without using needles. From a single 'milking' he could obtain up to 100 milligrams of secretions. He found that these secretions contain as many as 30 different chemicals. The secretions kill several different bacteria, fungi and viruses, and his recent work has been to find out which secretions kill which organisms.

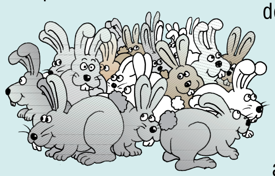
Questions

1 Dr Tyler discovered a new laboratory technique. What is it?
2 He repeated his tests several times. Why do you think he did this?
3 Suggest how he could find out which of the 30 chemicals in the secretions kills a particular virus.
4 Suppose he identifies the virus-killing chemical. What do you think he should do next?

Fig 34 Dr Tyler with one of his frogs

Rabbit plague

Thomas Austin liked to go shooting at the weekends. So in 1859 he imported 24 rabbits from England to his property near Geelong in Victoria. A female rabbit can produce 40–50 young in one year, and with few natural enemies there was soon a plague of rabbits. In one year Tom Austin shot over 14 000, and within 20 years or so the rabbits had spread to almost all parts of Australia. Fences didn't seem to keep them out. They ate every blade of grass and stripped the bushes they could reach, turning once green areas into deserts. Many of Australia's wallabies and native rodents became extinct or endangered.



In 1919 a Brazilian scientist said he knew about a virus called myxoma which infected rabbits and gave them a disease called myxomatosis (MIX-a-mat-toe-sis). However the Australian government ignored his advice because people were making lots of money selling rabbit meat and using the fur to make hats. By the 1940s the rabbit plague was out of control and Jean MacNamara, an Australian expert on viruses, eventually convinced CSIRO to try the myxoma virus. At first CSIRO scientists couldn't get the virus to spread, but they found that it spread more quickly in wet weather, because the disease is carried from one rabbit to another by mosquitoes, which breed when it is wet.

Myxomatosis killed up to 80% of the rabbits in most of Australia and as a result beef and wool production increased. However, as the years passed the virus was less effective. So in 1991 the CSIRO found another weapon against the rabbits—the calicivirus (cal-LEE-sea-virus) which doesn't need mosquitoes to spread it. It was released in 1996 and one year later about 100 million of Australia's 300 million rabbits had died. For the first time in living memory there was lush vegetation across the Nullarbor Plain and in the Simpson Desert.

Questions

1 Why was the rabbit plague such a disaster for sheep and cattle farmers, and for native plants and animals?

2 The rabbit plague resulted in severe soil erosion, with soil washed away during heavy rain. Why did this happen?

3 Suggest why the Australian government was reluctant to introduce the myxoma virus into Australia.

Check!

1 When you are doing an experiment, what is the usual order for the following?

check hypothesis	results
hypothesis	test
predict	think again

2 Which of the following are true, and which are false?
- **a** An experiment is a test containing a series of steps used to solve problems.
- **b** Hypotheses are always correct.
- **c** Scientists don't know the answers to some questions.
- **d** In an experiment all variables must be kept the same.
- **e** You should ignore data that does not agree with your hypothesis.
- **f** A good hypothesis allows you to make predictions.

3 **a** When you write a report of an experiment, what should the section headed 'Aim' tell the reader?
- **b** What should the conclusion of a report tell you?
- **c** Under which heading would you describe how you carried out the experiment?

Hints and tips

Show the class some TV segments of science inventions, or new medical or technological breakthroughs. Programs such as *The New Inventors* and *Catalyst* on the ABC, or scientific testing demonstrations such as *MythBusters*, could be used.

Check! solutions

1 The usual order is: HYPOTHESIS, PREDICT, TEST, RESULTS, CHECK HYPOTHESIS and then THINK AGAIN.

2 a True
- b False
- c True
- d False
- e False
- f True

3 In any experimental report, the following structure applies.
- a The 'Aim' section should tell the reader what you are trying to do.
- b The conclusion should indicate whether you achieved your aim. It should usually be brief—only a sentence or two.
- c You should describe how you carried out the experiment under the heading 'Method'.

Learning experience

ESL (English as a second language) students or students with language difficulties may find the reading tasks challenging. Extra assistance and a longer time may need to be given to these students.

4 Sometimes you have to modify a hypothesis. When would you need to do this?

5 While cooking on the barbecue Tammy was annoyed by all the insects that were attracted to the light. Then she remembered reading that insects are less attracted to yellow light. Use the steps on page 14 to design an experiment to test Tammy's idea. Discuss your design with others.

6 An oil company claims you get more kilometres per litre from their petrol. They say this is because of an additive called Z. How could you test this claim?

7 A group of students collected the equipment shown below. They wrapped can A in four layers of aluminium foil each 0.25 mm thick. They wrapped can B (identical to can A) in a single layer of foil 1 mm thick. They filled both cans with hot water and recorded the temperature of each can every two minutes for 10 minutes. (The data table is shown below.)

a What hypothesis were the students testing?

b Look at the students' data and decide whether it supports their hypothesis.

c Write a conclusion for the experiment.

Times (minutes)	Can A (°C)	Can B (°C)
0	90	90
2	87	87
4	85	84
6	84	82
8	84	80
10	83	78

WEBwatch

For the websites listed below, go to www.scienceworld.net.au and follow the links.

1 What does CSIRO stand for? If there is a branch of CSIRO in your city or town, see if you can find out what scientists do there. Your teacher may be able to arrange a visit or a scientist may visit your school to talk with you. Visit the **CSIRO** website.

2 Join a science club such as **CSIRO's Double Helix Science Club**. Visit their website. Perhaps your teacher could help you set up one at school.

3 During the next few weeks check newspapers and magazines. Collect articles about new discoveries in science and technology. You can also check out the latest science news at these websites:

Science Daily

New Scientist

Nova

CNN

4 Use a library to find out about the life and work of one particular scientist. Once you have collected your information, prepare a three minute talk to the class about your scientist. You may like to use the plan below.

Name of scientist:

Dates born (and died):

Country of birth:

Details of work:

Any other interesting information:

The **Bright Sparcs** site has information on more than three thousand Australian scientists.

4 A hypothesis should be modified when the results of an experiment do not agree with your predictions and you are planning to do another experiment.

5 There are several ways that Tammy could test her idea. In any case, she should only change the colour of the light while keeping everything else the same. Tammy's hypothesis is that insects will not be attracted to yellow light and from this she can predict that if the light is yellow instead of white then there will be fewer insects. To test this, she can either replace the normal light bulb with a yellow one or cover it with some yellow cellophane. She could get results by counting the number of insects flying around the light near the barbecue and comparing this number with the number around a normal light. It would be best to do this experiment on the same night in the same place. She can then check her hypothesis and perhaps think again.

6 This problem can again be solved using the scientific method of investigation. The hypothesis is that 'Z' will improve fuel economy and from this you can make a prediction that an engine using petrol with 'Z' will be able to get more kilometres per litre than an engine using normal petrol. To test this we could use the same motor car driven by the same person (or perhaps a robot) on the same track in the same weather conditions for the same amount (eg 5 litres) of both types of petrol. From this you can find the distance travelled on a certain amount of petrol. You could then check the hypothesis and perhaps think again about the way the test was conducted, and about possible further tests.

7 This is a simple experiment that students can do themselves.

a The hypothesis being tested in this experiment is 'Four layers of aluminium foil will keep the heat in the can better than a single layer'. Note that the total thickness of foil is the same in each case.

b The results indicate that there is a difference of 5°C after 10 minutes. This result supports their hypothesis.

c From this experiment you can conclude that having four layers of foil rather than one provides better insulation. A further inference is that the reason for this difference is that there are three small layers of air trapped between the layers of foil.

Hints and tips

Do the Webwatch activity if you have access to computers in the class, or give as a homework exercise.

MAIN IDEAS

Copy and complete these statements to make a summary of this chapter. The missing words are on the right.

1 _____ is a way of finding answers to questions by doing experiments.

2 Solving _____ by doing experiments involves using skills such as observing, inferring, predicting and _____.

3 A _____ is something which can change the results of an experiment.

4 In an experiment you purposely change one variable and keep all the rest the _____. This process is called _____ variables.

5 A _____ is a generalisation which explains a set of observations or gives a possible answer to a question.

6 Hypotheses can be tested by doing _____. If necessary they can be modified to explain further observations.

7 A _____ is a way of displaying data. It can also be used to show the _____ between two variables.

controlling
experiments
generalising
graph
hypothesis
problems
relationship
same
science
variable

Try doing the Chapter 1 crossword on the CD. Working with technology

Main ideas solutions

1 science
2 problems, generalising
3 variable
4 same, controlling
5 hypothesis
6 experiments
7 graph, relationship

REVIEW

1 What name is given to a generalisation which a scientist can test?
A experiment
B hypothesis
C inference
D observation

2 Lim is checking the burning of a candle. He finds that after 2 hours, one-quarter of the candle has burnt. Predict how long it will take the whole candle to burn.
A 1 hour
B 2 hours
C 4 hours
D 8 hours

3 Sally and Bonita both bought the same kind of rubber ball. Sally said: *My ball will bounce better than yours*. Bonita answered: *I'd like to see you prove that*. What should they do to find out which ball bounces better?
A Drop both balls from the same height and see which ball bounces higher.
B Hit the balls against a wall and see how far each bounces off the wall.
C Throw the balls against the floor and see how high they bounce.
D See which ball can be squeezed the most.

4 Tamika tested a number of substances to see whether or not they conduct electricity (allow an electric current to pass through them). She also noted whether the substances were metals or non-metals. Her results are shown below.

Substance	Metal or non-metal?	Does it conduct electricity?
sulfur	non-metal	✗
zinc	metal	✓
copper	metal	✓
iodine	non-metal	✗
lead	metal	✓
phosphorus	non-metal	✗
steel	metal	✓

a Use Tamika's results to write down two specific observations about steel.

Review solutions

1 **B**

2 **D**—One-quarter of the candle burns in 2 hours, so you can predict that the whole candle will burn in 4 x 2 = 8 hours.

3 **A**—It is difficult to control how hard you hit (**B**) or throw (**C**) the balls.

4 **a** Steel is a metal and conducts electricity.

4 **b** Metals conduct electricity, but non-metals don't conduct electricity.

c You would not expect carbon (a non-metal) to conduct electricity. You could modify the hypothesis as follows: Metals conduct electricity, but *most* non-metals don't.

5 **C** (**D** is incorrect because the solubility increases with temperature at a uniform rate. In other words, the graph is a straight line.)

6 **a** about 1 pm

b about 11.30 am and between 12.30 pm and 1.30 pm

c at the top of the high range

d Most probably there were clouds around 12 noon that blocked some of the UVB.

7 **a** Cut a piece of dirty cloth into equal-sized pieces. Using the same quantities of soap powder and water, wash one piece of cloth in Sudso and the others in other types of washing powders for the same time. Compare the results. Do the experiment in both hot and cold water.

b The variables to control are:

- how big and how dirty each piece of cloth is
- amount of washing powder you use
- volume of water you use
- temperature of water
- method of washing the cloth
- how long you wash the cloth

c You are purposely changing the type of washing powder.

d You will measure the cleanness of the cloth.

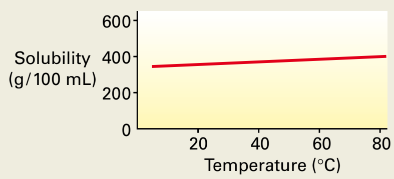
b Write a hypothesis about metals and non-metals and electricity.

Tamika tested two more substances:

Substance	Metal or non-metal?	Does it conduct electricity?
carbon	non-metal	✓
tin	metal	✓

c Do these results support your hypothesis? If not, modify it.

5 The amount of salt that will dissolve in 100 mL of water is called its *solubility*. This solubility was measured at different temperatures and the results graphed.



Which of the following statements best describes this graph?

A As the temperature changes the solubility stays the same.

B As the temperature increases the solubility decreases.

C As the temperature increases the solubility increases slowly.

D As the temperature increases so does the solubility, slowly at first, then more quickly.

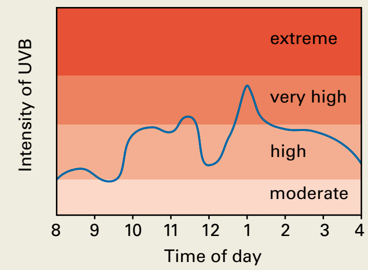
6 The graph above right is from a TV news weather report. It shows the amount of UVB radiation received on a particular day.

a At what time did the UVB radiation reach its peak?

b During what times of the day was the UVB reading in the very high range?

c In which range was the UVB reading at 10 am?

d How could you explain the dip in the graph around 12 noon?



7 You see this advertisement on TV.

You decide to do an experiment to see if Sudso is in fact better than other washing powders.

a Write a brief plan for your experiment.

b Which variables will you need to control?

c Which variable will ysou purposely change?

d Which variable will you measure?

Check your answers on page 317.