Chapter 1 Starting Science

CONTEXT AREA

- Welcome to science!
- What is science? What will you learn in science? Will science help you get a job? Will science help you in your daily life? Is it important to know about science?
- Science is always in the news:

  'Scientists find cause of disease outbreak'

  'Scientists predict people will live on Mars in 10 years'

  'Scientists find defective gene'

  'Scientists find why fish died in river'
- It is important for everyone in our society to understand science, and how it relates to their lives and to the world they live in. Science is about understanding our world.

PRESCRIBED FOCUS AREAS

4.3 identifies areas of everyday life that have been affected by scientific developments

4.5 describes areas of current scientific research

DOMAINS

SKILLS

4.18 with guidance, presents information to an audience to achieve a particular purpose

4.19 draws conclusions based on information available

4.22 undertakes a variety of individual and team tasks with guidance

VALUES AND ATTITUDES

4.26 recognises the role of science in providing information about issues being considered and in increasing an understanding of the world around them

CONCEPTS

What is science?	Science is knowledge and experiments
	Different branches of science
	Australian scientists and what they do
Playing it safe	Why we have rules
	Rules in the science laboratory
	What to do in case of an accident
Working in the laboratory	Lighting and using a Bunsen burner safely
	Safety flame and heating flame
Using equipment	Naming equipment
	Setting up an apparatus
Dissolving and filtering	Soluble, insoluble, solution, suspension
	Setting up an experiment to filter
Keeping records	Drawing diagrams of equipment, apparatus
	Writing reports
Investigations	Hypothesis and theory
	How to find answers to problems
Measurements	Why measuring is important
	Why units of measurements are needed
	How to use measuring instruments
Concept maps	Drawing a concept map for a given topic
	Researching Australian Scientists

1.1 What is science?

Science is an exciting subject, where you can do experiments and work in a laboratory. But what is science? What will you do and learn in science lessons?

Science is two things at once.

1 Science is doing experiments. Experiments are a way of finding answers to problems. You will also learn a lot from doing your own experiments. In this book there are investigations which require you to find an answer to a question by doing an experiment.

2 Science is knowledge. It can be what your teacher tells you, what you learn in books like this one, what you look up in a library, or what you learn from a CD-ROM or on the Internet.

People whose career is studying science are called scientists. They may work in a science laboratory, which may be in a factory or in a hospital or some other place. Lots of scientists work outdoors.

Many scientists study only one part of science. We say that they specialise in that part. Such a person may become a specialist in that field. Areas of special study in science have special names.

- Biology is the study of living things. A person who specialises in this study is called a biologist.
- Chemistry is the study of chemicals and how to change them, and is studied by a chemist.
- Physics is the study of energy, matter and movement and is studied by a physicist.
- Geology is the study of rocks and the earth, and is studied by a geologist.
- Ecology is the study of how plants and animals interact together in the environment, and is studied by an ecologist.
- Astronomy is the study of the planets, stars and the universe, and is investigated by an astronomer.
- Genetics is the study of heredity, and the genes (made of DNA) that are involved in heredity. Genetics is studied by a geneticist.
- Engineering is using the ideas of science to build machines and structures that people can use. Engineers build bridges, factories, rockets and satellites.

The names of some fields of science are combined, such as biochemistry and geochemistry.

New branches of science are being developed as people's knowledge expands. The study of possible life on other planets and moons is called exobiology (exo = outside) or astrobiology.

Some scientists only study one aspect of science. Biologists could become specialists in the study of reptiles or birds or plants or microscopic life. Other scientists may study the animals which live in the oceans, or only whales and dolphins, or only fish. Some people pretend that they are scientists. Their studies are called pseudo-science. Pseudo ('syoo-doe') means false.

Some scientists at work

A geologist at work

One common example of pseudo-science is astrology, the prediction of your future by looking at the positions of stars and planets.

Australia has a long tradition of producing talented scientists such as Adrienne Clarke and Andy Thomas. Many of our scientists have been awarded the Nobel Prize, the highest science honour in the world. Some other Australian scientists are highlighted on page 26.

ADRIENNE CLARKE is a botanist who specialises in the invention of new plants. By transferring genes, it is possible to make plants that grow more food, do not get eaten by insects and grow on land currently unsuited to farming.

ANDY THOMAS has orbited the earth 2250 times, and has travelled almost 100 million kilometres. As an astronaut he has spent 141 days in space. Andy went to school in Adelaide and trained to be an astronaut in the USA and Russia.

CHECKPOINT:

COPY AND COMPLETE

Science is ___ things at once. Science is _____. Science is doing _____. Experiments are a way of finding _____ to _____.
People whose career is studying _____ are called _____. They may work in a science _____. Lots of scientists work _____.
Many _____ study only one ____ of science. We say that they _____ in that part. Areas of _____ study in _____ have _____ names.

QUESTIONS

Answer these questions in your note book.

1 Copy and then complete the table below.

Part of science	***Name of scientist***	***What is studied or learnt***
.....	*biologist*	.....
.....	.....	*study of chemicals and how to change them*
physics	.....	.....
.....	*geologist*	.....
ecology	.....	.....
.....	.....	*study of planets, stars and the universe*
.....	*geneticist*	....

2 What is pseudo-science? How is it different to science?

3 What does it mean when a scientist specialises in something? What is a specialist?

4 Some parts of science are combinations of different branches of scientific study. Can you guess what is studied in these areas: biochemistry, geophysics, astrophysics, exobiology, exogeology, microbiology, astrogeology?

5 What is a meteorologist? What is the name of the meteorologist on a TV channel that you watch?

6 Library Research: Do you know the names of other scientists? Research the life and times of one scientist. Describe when and where they lived, and why they are remembered today.

1.2 Playing it safe

In the laboratory there are gas taps and burners, glass beakers and flasks, water taps, and electrical power points. The laboratory could be a dangerous place if there were not some safety rules.

When you ride your bike, there are rules for your safety. Some of these rules are to wear a safety helmet, don't ride on the footpath, and look before crossing the road. These rules make it safe for riders and other people.

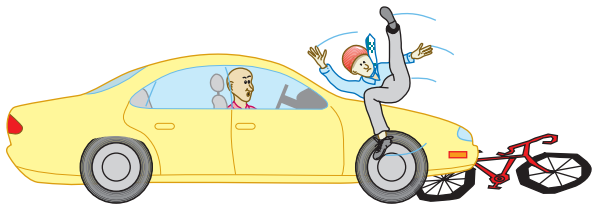
The same applies in the science laboratory. There are safety rules that apply to everyone in all laboratories. They are more commonsense than rules. It is important that everyone remembers these rules and obeys them.

LABORATORY SAFETY RULES

1. No running or pushing. The floor is slippery and hard. Remove anything that might cause someone to trip. Leave your school bag in a safe and secure place, away from places where people walk.
2. Keep your notebook neat and tidy, and away from where you are doing experiments. Plastic covers will help to protect your books.
3. Do not taste any chemicals, or lick anything in the laboratory. Always wash your hands after working in a laboratory, and especially before eating food. Cover cuts with a dressing in case you spill something on them.
4. If you cut or burn yourself, or don't feel well, tell your teacher. Your teacher has a first-aid kit nearby. If you spill any chemicals, or break any glassware, tell your teacher. Your teacher can tell you how to quickly, easily and safely clean the mess.
5. When heating or mixing substances, never look inside the flask or beaker. Don't point these experiments at your friends, or enemies, or anybody.
6. Never eat food or lollies or chew gum in the laboratory, or drink from laboratory glassware.
7. Rinse and dry the glassware that you use, and return it to the correct cupboard. Leave your bench clean and dry. Don't put rubbish in the drain or sink.
8. Follow the correct procedure for lighting a Bunsen burner, handling hot equipment, dealing with chemical spills, and disposing of unwanted chemicals and rubbish.
9. Never mix chemicals at random. Always follow your teacher's instructions.

Other safety tips

- Wear safety glasses whenever you are doing an activity in which you could injure your eyes. This includes using all chemicals or small objects that could flick into your eyes.
- If you have long hair, keep it tied back and away from flames and chemicals.
- Always wear leather-topped shoes in the laboratory, never thongs or sandals or synthetic sneakers or joggers.
- Place a heat mat under hot beakers. Don't scorch the bench, or burn your fingers.
- It is important that you obey your teacher's instructions and the laboratory rules.
- If you have ever suffered from breathing problems such as asthma, epilepsy, blackouts, or diabetes, you should tell your teacher. Your teacher can then help you if you get sick. If you are embarrassed, tell your teacher in private.



A safety rule for cycling: wear a safety helmet and look before you cross the road

Fire!

What should you do in case of a fire at your school? Three things:

1. Evacuate the area.
2. Tell a teacher there is a fire.
3. Check that everyone is safe.

In emergency evacuations, everyone leaves the room in an orderly fashion and gathers for roll call in a safe location. Ask your teacher to explain the evacuation at your school.

EXPERIMENT

AIM: To recognise unsafe practices

Look at this picture. On your own, list all the wrong things that you can find. Then join with a friend and compare your lists. Then join with another group of two, and compare lists again. Select one person from your group of four to report to the class on how many wrong things your group found.

An unsafe laboratory

CHECKPOINT:

COPY AND COMPLETE

In the laboratory there are ___ taps and _____, glass _____ and _____, _____ taps, and _____ power _____. The _____ could be a _____ place if there were not some _____ rules.
When you ride your ____, there are _____ for your safety. The same applies in the _____ _____. It is important that everyone _____ these _____ and ____ them.
If you have long ____, keep it ____ back and away from _____ and _____.
Always wear _____-topped shoes in the _____, never _____ or _____ or _____ sneakers.
Place a ____ ___ under ___ beakers. Don't _____ the bench, or ____ your _____.
It is important that you ____ your teacher's _____ and the _____ _____.

QUESTIONS

Answer these questions in your note book.

1 Write three rules for safe cycling that we have not mentioned.

2 Some notes about safety are written below. Which Laboratory Safety Rule do they relate to? Write the number of the rule (1 to 9).
- **a** walk, don't run
- **b** correct cupboard
- **c** tell your teacher
- **d** don't taste or lick
- **e** never point experiments
- **f** never eat food or lollies
- **g** clean and dry
- **h** cut or burn yourself
- **i** clean up the mess
- **j** wash your hands
- **k** note books neat and tidy
- **l** leave school bags out of the way
- **m** lighting a Bunsen burner
- **n** leave your bench tidy
- **o** don't put rubbish in sink or drain
- **p** handling hot equipment
- **q** spill any chemicals
- **r** drink from laboratory glassware
- **s** remove all obstacles

3 What are the three things you should do when there is a fire?

4 What is the evacuation route from your science laboratory? Where is the assembly location when your school has an evacuation?

5 List the correct procedure when the following events happen in your school laboratory:
- **a** A person knocks over an empty beaker which breaks when it hits the floor.
- **b** A person knocks over a beaker of water, the beaker breaks when it hits the floor, and water splashes over the floor and chair legs.
- **c** As **b**, but the beaker contained acid.
- **d** Your friend complains of feeling sick.
- **e** Your friend has a chemical on her hands, and then rubbed her eyes. Her eyes begin stinging.

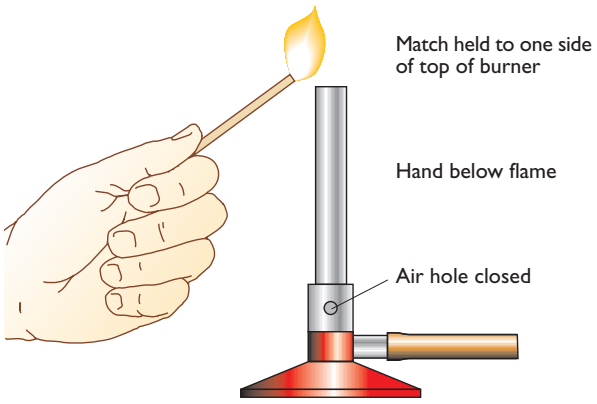
1.3 Working in the laboratory

The Bunsen burner is a gas burner which is used to provide heat. It is the most useful and the most dangerous piece of equipment in the laboratory. It is similar to the gas burners on barbecues and stoves. Most Bunsen burners in laboratories burn bottled gas such as LPG, or they burn natural gas.

RULES FOR LIGHTING A BUNSEN BURNER:

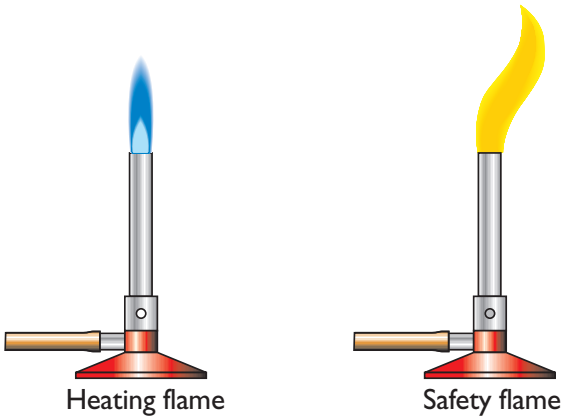
1. Push the rubber or plastic tube onto the gas outlet.
2. Close the air hole. You do this by turning the collar.
3. Light the match or taper.
4. Turn on the gas. Always turn on the gas last.

Hold your hand as shown in the diagram, so you will not be burnt by the flame.



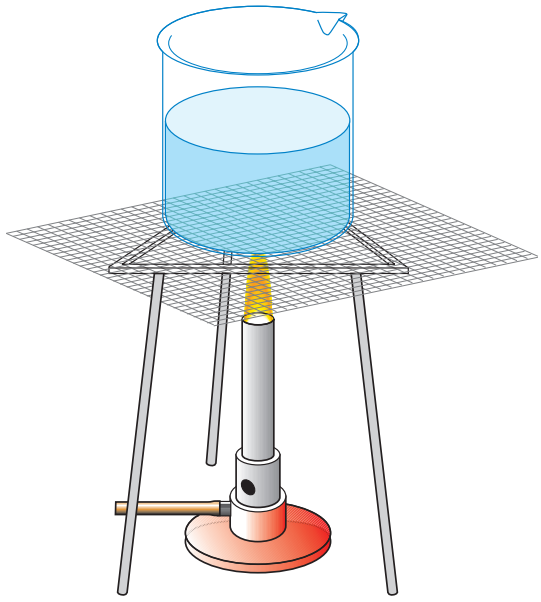
The right way to light a Bunsen burner

The collar can be rotated, which changes the size of the air hole. When the air hole is open, air gets in and mixes with the gas. This makes the gas burn hotter, so the colour of the flame is pale blue. When the air hole is closed, no air gets in, so the colour of the flame is bright yellow. This yellow flame is called the safety flame. It is not as hot as the blue flame, and it is very sooty. This means that it is not good for heating. But it can still burn you!



Blue (heating) and yellow (safety) flames on the Bunsen burner

The Bunsen burner is used with other equipment. Usually it is used with a tripod stand, a gauze mat and a beaker. These are shown in the diagram below.



Bunsen burner, tripod stand, gauze mat and beaker

After an experiment when you have been heating, where is the safest place to lift the hot equipment? Ask your teacher to show you how to lift hot equipment and how to stand it on a heat mat until it is cool enough to put away in the correct cupboard.

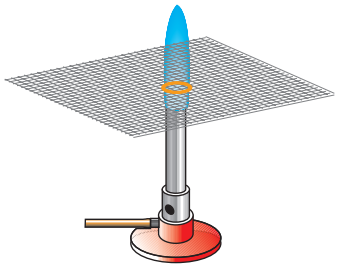
EXPERIMENT

AIM: To light a Bunsen burner

Follow this experiment with your teacher before doing it yourself.

1 Light the Bunsen burner, and observe the flame with the air hole open and closed. Complete the table in Question 1 at the bottom of this page.

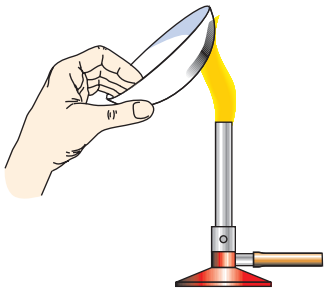
2 Flames are very interesting. They are made of partly burnt gases. The blue flame is very hot, and it is hollow. You can see this by heating a gauze mat.



Using a gauze mat with a blue flame

The yellow flame is very bright, but very sooty. You can see the soot it leaves by holding a white dish (such as an evaporating basin) over the flame. The yellow flame is not very hot when compared with the blue flame.

Your hand should be **below** the flame



Testing the soot from a yellow Bunsen burner flame

CHECKPOINT:

COPY AND COMPLETE

Rules for lighting a _____ burner:

1 Push the _____ or _____ tube onto the gas _____.

2 Close the ___ hole. You do this by _____ the _____.

3 Light the _____ or _____.

4 Turn on the ___. Always turn on the gas ____.

The _____ burner is a gas _____ which is used to provide _____. The _____ can be rotated, which changes the ____ of the air _____. When the air ____ is open the gas burns _____. When the air ____ is _____, the colour of the flame is _____ _____. It is called the _____ flame.

QUESTIONS

Answer these questions in your note book.

1 When using a Bunsen burner, the air hole is sometimes open and sometimes closed. Copy and complete the table below.

Use of Bunsen burner	*Should air hole be open or closed?*
lighting it	.....
using it for heating	.....
turned on but not heating	.....

2 The steps used in lighting a Bunsen burner can be put into four words: light, push, close, gas. Place the words into the correct order.

3 Answer these questions about flames.
- **a** Why is a safety flame important?
- **b** How can you make a safety flame using your Bunsen burner?
- **c** The safety flame is not good for heating. Give two reasons why.
- **d** Which is the best flame to use for heating?

4 How should you lift a hot Bunsen burner and tripod stand to return them to the cupboard or shelf or rack? Why will your teacher ask you five minutes before the end of the lesson to pack up any experiments you have been doing?

5 Copy and complete.

Feature	*Air hole open*	*Air hole closed*
colour of the flame	.....	.....
sound made	.....	.....
easiness to see	.....	.....
sootiness of the flame	.....	.....
shape of flame	.....	.....

6 What is meant by the 'safety flame'? How can you make it?

7 Most scientists who work in a laboratory use a modified safety flame. The flame is blue at the top of the Bunsen burner and yellow at the tip. How do they produce this flame? What are the advantages of this flame over the blue (heating) flame and the yellow (safety) flame?

1.4 Using equipment

Equipment is the name given to the beakers, burners, flasks and stands you use in the laboratory. The equipment is there to help you do experiments.

The diagram shows the names of commonly used equipment. You will soon remember the names of the equipment when you do the experiments in this book. You will use most of it in experiments you will do in the coming weeks.

The equipment in your school laboratory might be slightly different from that shown in the illustration. Don't worry if your school laboratory does not have all this equipment. It might be kept in another room or in a storeroom.

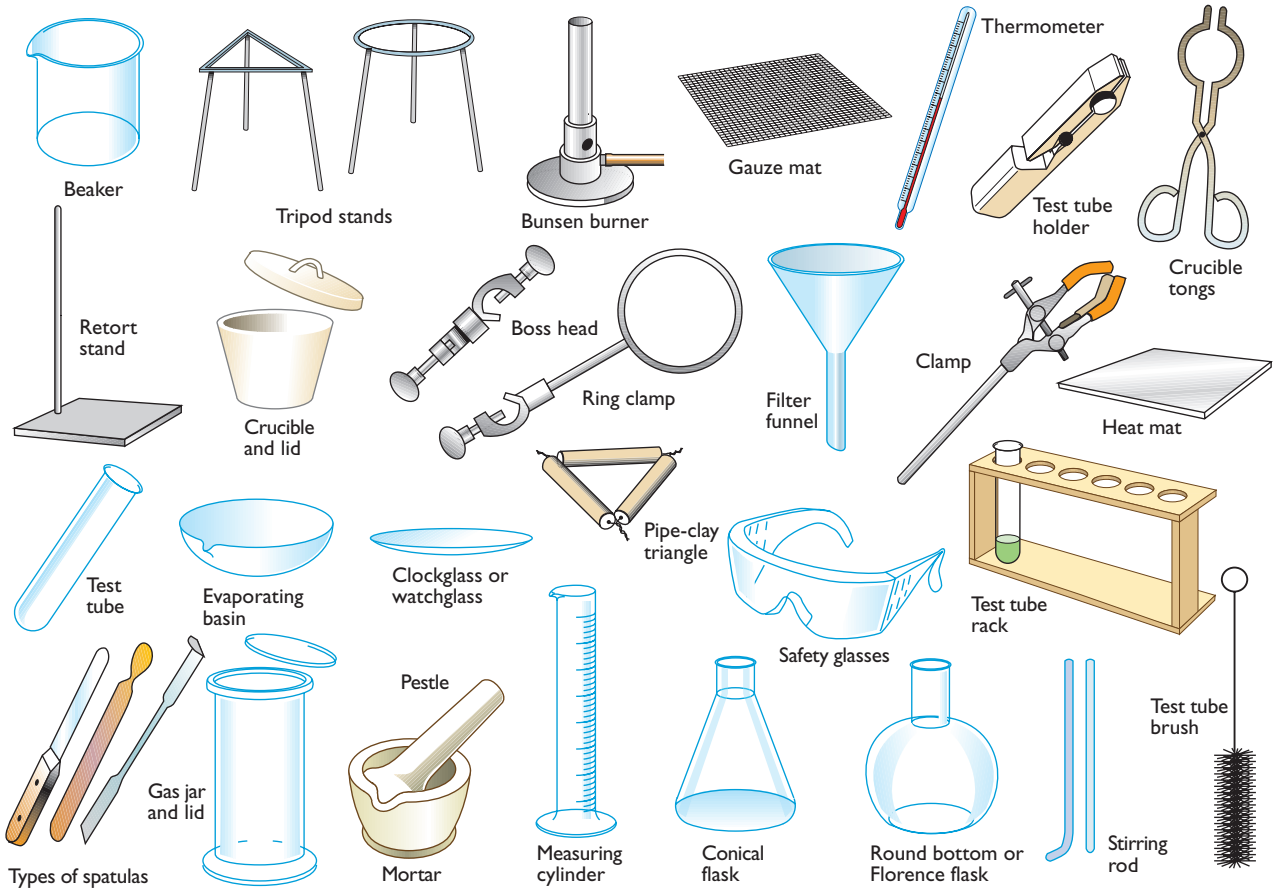
Building an apparatus

Items of equipment can be used together in an experiment. When you put the equipment together it is called an apparatus. You need an apparatus to boil water, filter chalk, and do many other tasks.

Types of glass

All glass is not the same. Beakers and other laboratory glassware are made from Pyrex glass. Pyrex glass is more resistant to heat and cracking than the glass in windows and glass jars. It is important to put a gauze mat between the tripod stand, glass beakers and flasks. The gauze mat spreads out the heat. This helps prevent the glassware from breaking.

Some items of laboratory equipment



EXPERIMENT

AIM: To use a Bunsen burner to boil water

How would you boil water in the laboratory? The equipment you need is a Bunsen burner, tripod stand, heat mat, a beaker, and some matches or gas guns which you might share with other groups.

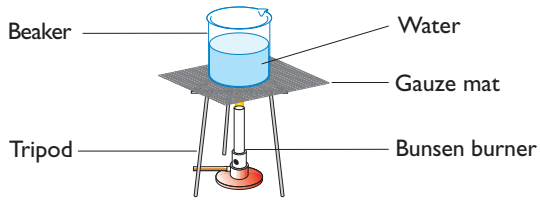
Your teacher will give you a thermometer. Use it to measure the temperature of the water. It is easier if you hold the thermometer in a clamp, using a boss head and retort stand.

Answer the following questions:

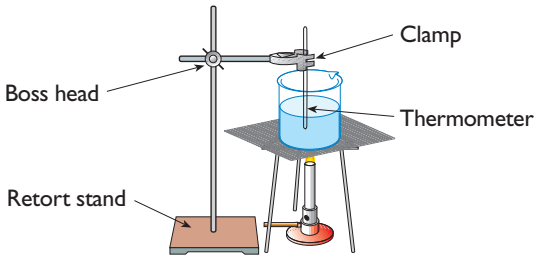
1 What did you measure the boiling point of water to be?

2 Does the boiling point change as the water is heated?

3 Does the amount of water in the beaker change as the water is heated?



How to boil water



Measuring water temperature with a thermometer

CHECKPOINT:

COPY AND COMPLETE

Equipment is the name given to the _____, _____, _____ and _____ you use in the _____. The equipment is there to help you do _____. When you put the equipment together it is called an _____. Beakers and other _____ glassware are made from _____ glass. _____ glass is more resistant to ____ and _____ than the glass in _____ and glass ____. It is important to put a _____ ___ between the _____ stand and glass _____ and _____. The _____ mat _____ out the ____.

QUESTIONS

Answer these questions in your note book.

1 Draw a table, using the headings below, and list the equipment in the correct columns in your table. Your teacher will put the equipment on the benches, or tell you where to find it.

Made only of glass	***Made only of plastic***	***Made only of metal***	***Made only of wood***	***Made of two materials***

2 Match the word with its meaning.

equipment	*place with equipment and apparatus in it*
apparatus	*uses equipment and apparatus to answer a problem*
laboratory	*equipment which is put together to do an experiment*
experiment	*beakers, stands, clamps, and other items used in experiments*

3 What is the equipment in a laboratory used for? Work with your experiment group to make a table of equipment using the following headings:

Equipment name	***What it is used for***	***Hazards and safety***

4 Draw a map of your science laboratory. Draw on the map where each item of equipment is located.

5 Why is it important to keep glassware clean?

1.5 Dissolving and filtering

If you add sugar to a hot drink and stir it, the sugar dissolves. A substance which dissolves, like sugar, is said to be soluble. The opposite is insoluble. Sand is insoluble because it does not dissolve.

When sugar has dissolved in tea, coffee or water, we cannot see it. We know it is there because we can taste it. This is called a solution. A solution is a liquid with something dissolved in it.

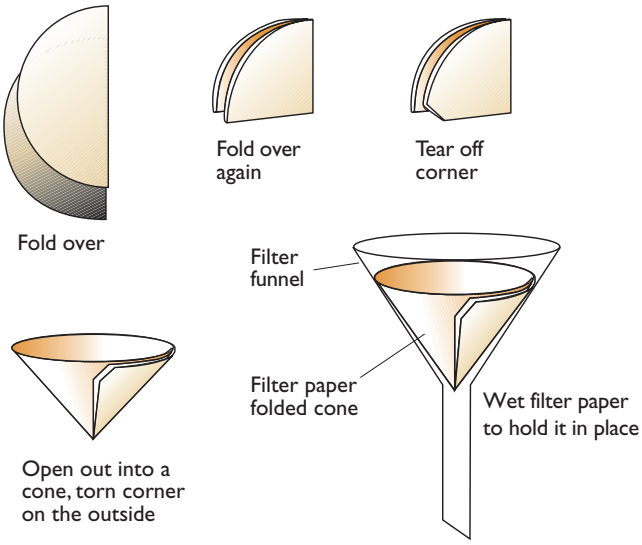
If you put chalk in a beaker of water and stir it, the chalk will not dissolve. Chalk is insoluble. The water turns murky, but clears as the chalk settles to the bottom. Water with an insoluble chemical floating in it is called a suspension.

In our experiments we use copper sulfate as a soluble chemical. It is blue, and we can see when it is dissolved.

Filtration

Filtration is the process which removes an insoluble substance from a suspension. Special paper, called filter paper, is used. People who drink percolated coffee use filter paper to filter the coffee grains from the coffee solution they drink.

The illustration shows how filter paper is folded to fit into a filter funnel. Note that the filter paper hangs in the filter funnel. The paper only touches the funnel at the top.



How to fold filter paper

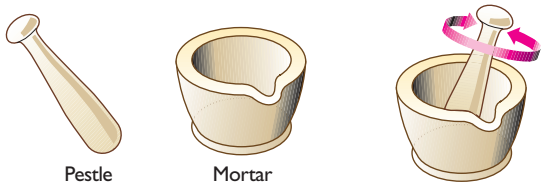
Crystallisation

Crystallisation occurs when the water is removed from a solution. The water evaporates and crystals are left behind. It is the reverse process of dissolving. Crystallisation is explained in Activity 1.7, pages 16 and 17.

EXPERIMENT

AIM: To filter a suspension and a solution

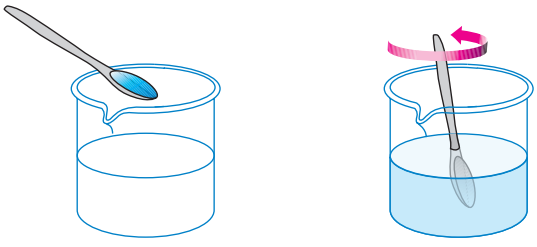
Chalk is insoluble, and can be used to make a suspension. Crush some white chalk in a mortar and pestle. Remember that P = pestle = pushing, and that M = mortar = mixing. Grind the chalk in a circular motion, but don't hammer it. Crush it all. Scrape the chalk out of the mortar and tip it into a 150 mL beaker. Add 100 mL water and stir to make a suspension.



Using a mortar and pestle

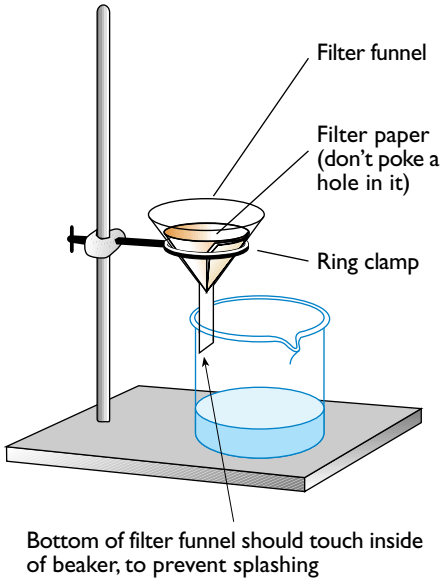
Always wear safety glasses when using chemicals, copper sulfate is especially corrosive to skin and eyes.

Copper sulfate is soluble and can be used to make a solution. Dissolve two level teaspoons of copper sulfate in 100 mL of water in a 150 mL beaker. Stir with a stirring rod until it all dissolves.



Dissolving copper sulfate

Filter the suspension and the solution. Observe what is left in the filter paper, and what is in the beaker.



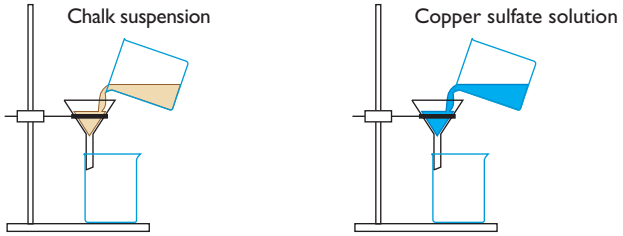
Filtration apparatus

Tip the copper sulfate solution into an evaporating basin or clockglass. Leave the evaporating basin in a warm, draughty place, so that the water will evaporate quickly. (A quicker way to evaporate the water is to heat it with a Bunsen burner. We will do this in the next chapter.) Now answer these questions:

1 Complete the table.

Question	A suspension	A solution
Can you see through it?	.....	.....
Can it be filtered?	.....	.....
Does it settle on standing?	.....	.....

2 Copy the diagrams below, and write down where the chalk, water and copper sulfate will end up.



Where do chalk and copper sulfate end up?

CHECKPOINT:

COPY AND COMPLETE

A substance which dissolves, like _____, is said to be _____. The opposite is _____. A _____ is a liquid with something _____ in it. Water with an _____ chemical floating in it is called a _____. Filtration is the process which removes an _____ substance from a _____. Special paper, called _____ paper, is used.

Crystallisation occurs when the _____ is removed from a _____. The water _____ and _____ are left behind.

QUESTIONS

Answer these questions in your note book.

1 Construct a table with two columns—one for soluble substances, and one for insoluble substances. Write these substances into the correct column: sand, salt, sugar, glass, steel, instant coffee, copper sulfate, plastic.

2 Write one sentence which explains the meaning of each pair of words.
- **a** soluble and insoluble
- **b** soluble and solution
- **c** insoluble and suspension

3 Imagine you have a jar containing three different powdered chemicals that are mixed together. The chemicals are called A, B and C. Their solubilities are shown in the table to the right.

Chemical substance	*Solubility in hot water*	*Solubility in cold water*
A	*insoluble*	*insoluble*
B	*soluble*	*soluble*
C	*soluble*	*insoluble*

Devise a method of separating them. They can be wet or in solution after the separation.

4 Cut open a tea bag and examine the paper. Feel it and look closely at it. Do you think that it contains small holes? How is a tea bag like filter paper?

5 Which of the following are solutions or suspensions? Name the solvent and solute where appropriate.
- **a** sea water
- **b** lemonade
- **c** mineral water
- **d** tomato sauce

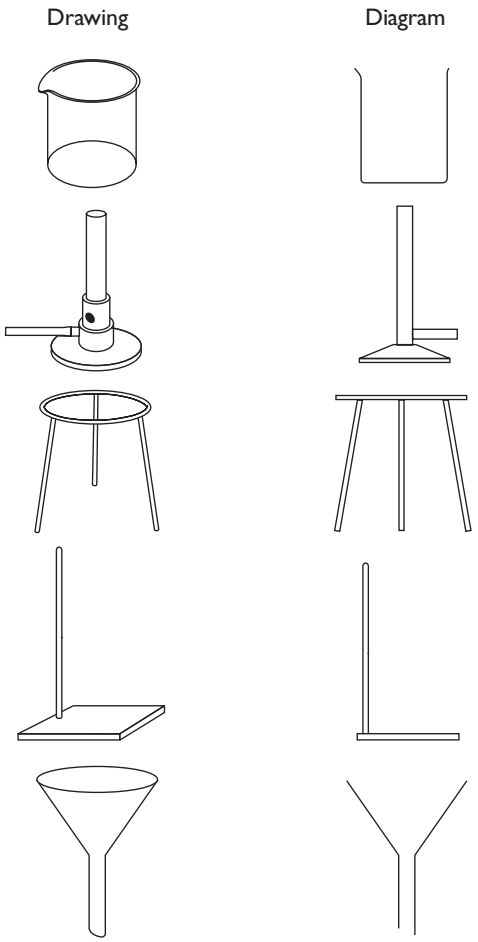
6 Blood is a solution and a suspension. Explain why this is true.

1.6 Keeping records

Everyone keeps records. A photograph album is a record of important events in your life. A diary is a record of important things that you have done, and may contain a record of important phone numbers. At school you keep records of your lessons in your note books for each subject. Some people keep their records in a computer or electronic organiser.

In science lessons you make notes in your science note book. Your science book is very important. Keep your book neat and tidy. Put a waterproof cover on it.

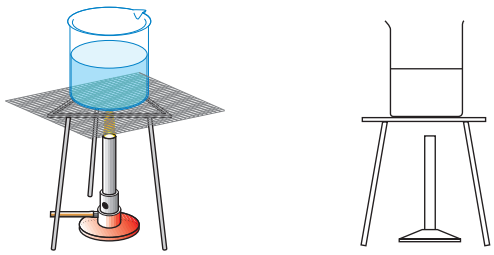
There are two parts to keeping records in science. One is a record of the equipment you have used in an experiment. These are drawn in a diagram. The other part is a written story of what you did. This is called the report. This activity looks at both of these parts.



Drawings and diagrams of a beaker, Bunsen burner, tripod stand, retort stand and filter funnel

Drawing diagrams

You don't have to be a great artist to draw the apparatus used in an experiment. All you need to do is to draw a diagram. A diagram is a simple line drawing, looking from the side. A diagram is quick and easy to draw, and still shows all the information that a drawing or picture shows.



Drawing and diagram of apparatus for boiling water

Every diagram you draw should be neatly drawn in pencil, and the lines drawn with a ruler. Labels should be neatly printed, and connected to the diagram with an arrow. The arrow head should touch the object it is pointing to. Diagrams should be between 6 and 10 cm high.

Writing reports

A report is a written story of what you did in an experiment. Each report you write should consist of four parts:

1 Aim, Question or Problem—What you are trying to find out, or why you are doing the experiment.

2 Method—How you did the experiment. Always include a diagram of the apparatus you used. Always use a ruler and pencil for your diagrams.

3 Results—An explanation of what happened or what you measured.

4 Conclusion—The answer to the aim, question or problem.

Whenever you do an experiment and you record it in your note book, you should write it as a report.

EXPERIMENT

AIM: To check an experiment report

Look at this report of a filtration experiment.

On your own, list as many wrong things as you can find in the report to the right. Then join with a friend, and compare your lists. Then join with another group of two, and compare lists again. Select one person from your group of four (not the person who reported last time) to report to the class on the incorrect things your group found.

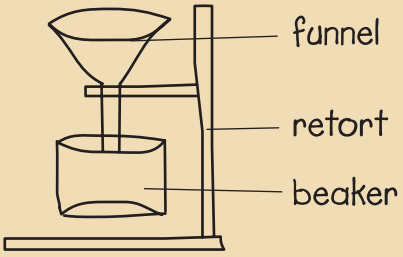
Select one other experiment you have done so far this year. Write a correct report on the experiment.

Experiment 30 Feb

Filtration

Aim: To find a good way to separate chalk from water.

Method: A solution of chalk and water was made, which we filtered. using filter paper.



Results: The chork stayed in the filler paper and the water went into the beaker.

Conclusion: ~~chalk~~ and water can be separated by filtering. The chalk stays in the filter paper and the water goes through.

An inaccurate report

CHECKPOINT:

COPY AND COMPLETE

There are ___ parts to keeping _____ in _____. One is a record of the _____ you used in an _____. These are _____ in a _____. The other part is a _____ _____ of what you did. This is called the _____. A diagram is a simple ____ _____, looking from the ____. Every _____ you draw should be neatly drawn in _____, and the lines drawn with a _____.

A report is a _____ story of what you did in an _____. Each _____ you write should consist of ____ parts: 1. ___, _____ or _____, 2. _____, 3. _____, 4. _____

QUESTIONS

Answer these questions in your note book.

1 What is the difference between a drawing and a diagram?

2 Draw a diagram of a retort stand, a filter funnel and an evaporating basin.

3 Put these words into their correct order for a report: conclusion, method, results, problem.

4 How should a correct science diagram be drawn? How large should it be?

5 Rewrite the experiment report correctly. Show it to a friend and ask them to check it for errors.

6 Think back to the experiments in Activities 1.4 and 1.5, where you measured the temperature of boiling water and filtered an insoluble substance. Write a report on each of these experiments, including a diagram of the equipment and what you found out.

7 The experiments in Activity 1.7 involve crystallising and heating a crucible. Write a proper report of each of these experiments.

1.7 Crystallisation and crucibles

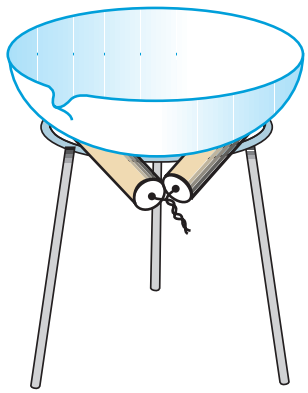
Sometimes after you have had a swim in the sea, or been in a salt water pool, you will see crystals of salt on your skin.

Sea salt is a mixture of substances with the group name of salts. The most abundant salt in this group is table salt. Its chemical name is sodium chloride.

Sea water is a solution. The solvent is water, and the solute is salt. Crystallisation is the process of evaporating the solvent so that crystals of the solute remain. Crystallisation is the reverse of the process of dissolving.

Crystallisation is best done in an evaporating basin. This is a shallow wide topped container made of porcelain. Your teacher will show you the best size to use.

Unlike glass, flames can play directly onto porcelain. You do not need a gauze mat to spread out the heat. But you do need to use a pipe-clay triangle. This allows the evaporating basin to rest on the top of the tripod stand, but not to touch the metal. (Sometimes a gauze mat is used to stop the crucible from becoming too hot.)



An evaporating basin is used for crystallisation of liquids

EXPERIMENT

AIM: To crystallise salt from sea water

Your teacher will give you a solution of salt water. Pour it into an evaporating basin. Put on your safety glasses.

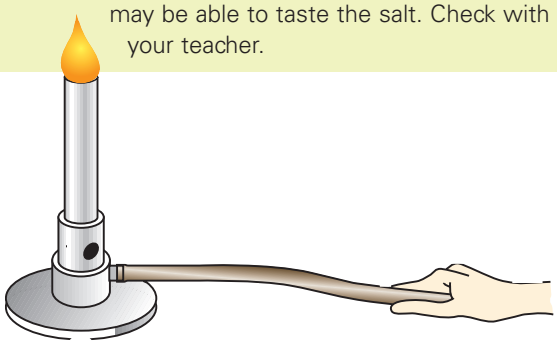
Light the Bunsen burner and heat the evaporating basin, gently at first. You can best do this by gently pushing and pulling on the gas tube to move the Bunsen burner around so that it heats a large area on the bottom of the evaporating basin. Do not put your hands under the evaporating basin in case it breaks or boils over. The hot water will badly scald your skin.

When the solution boils, pull out the Bunsen burner using the tube, until all the bubbling has stopped. Let the solution boil slowly and gently. When the last of the water is nearly evaporated you can turn off the Bunsen burner. The stored heat in the evaporating basin will dry out the last pieces of salt without making the basin too hot. Large crystals will grow if evaporation of the solvent is slow. Leave the basin for at least five minutes before touching it or moving it.

While the evaporating basin is cooling, write a proper report of this experiment. Use the headings Aim, Method, Results and Conclusion as described in the previous activity. Remember to draw your diagram with a pencil and ruler.

CAUTION

- Do not put your head too close to the evaporating basin. Small crystals of salt can fly off as the solution dries out.
- Leave your safety glasses on all the time while you are heating. A crystallisation is one of the most dangerous procedures you do in the laboratory.
- If the evaporating basin moves, or if salt crystals fly out, pull out the Bunsen burner immediately. If you cannot do this, turn off the gas.
- If you have used a new or very clean evaporating basin, and clean salt water, you may be able to taste the salt. Check with your teacher.

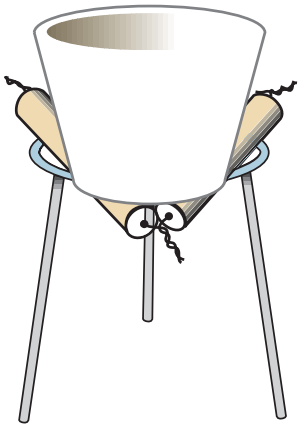


Pull out the Bunsen burner using the hose

Crucibles

Beakers and evaporating basins are ideal for heating liquids and solutions. When you need to heat a solid, a crucible has to be used.

Like an evaporating basin, a crucible is made of porcelain. It also sits on the top of a pipe-clay triangle on a tripod stand. Crucibles also have a lid, but we do not need to use it in this experiment.



A crucible is used for crystallisation of solids

Because they are being heated strongly, crucibles get very hot. A pair of crucible tongs is used to lift a hot crucible from the pipe-clay triangle onto a heat mat. Crucible tongs can be used with one hand or two hands. It is safer to use two hands with the crucible tongs while you are learning to use them.

EXPERIMENT

AIM: To heat a crucible

Your teacher will give you a crucible and some green copper carbonate powder. Work out a method of weighing the powder before heating and after heating.

Set up the equipment as shown by your teacher and gently heat the powder. *Remember to wear your safety glasses.* The powder will change colour rather quickly. Stop heating when you think that all the powder has changed colour.

Write a proper report on this experiment, using the headings Aim, Method, Results, and Conclusion. Did the powder change colour? Did the powder change its mass? After you have written this report, and the powder has cooled, tip it onto a piece of paper. Green streaks in the powder show parts that were not heated hot enough.

CHECKPOINT:

COPY AND COMPLETE

Crystallisation is the process of _____ the solvent so that _____ of the solute remain. Crystallisation is the _____ of the process of _____.
Crystallisation is best done in an _____ _____. This is a _____ wide _____ container made of _____.
When you need to heat a _____, a _____ has to be used. A ____ of crucible _____ is used to lift a ___ crucible from the _____ triangle onto a ____ mat.

QUESTIONS

1 How does the size of crystals produced by fast evaporation differ from the size of those produced by slow evaporation?

2 What is the difference between dissolving and crystallisation?

3 When you are heating glass a gauze mat is needed to spread out the heat. What equipment can be used when heating a crucible or evaporating basin?

4 Outline three safety hazards when heating an evaporating basin or crucible.

5 What is the function of crucible tongs?

6 Why does an evaporating basin have a wide open top?

7 What is the advantage of porcelain compared to glass for equipment that needs to be heated to high temperatures?

8 Fast crystallisation with a Bunsen burner causes the solution to spit. What is spitting? What can you do to reduce it? Why should you wear safety glasses during a crystallisation?

1.8 Investigations

Science is about finding answers to questions and problems. In this activity there are questions which you may not know the answers to.

Have a guess at the answer. Your guess is called a hypothesis. A hypothesis predicts what will happen in an experiment. Test your guess by doing an experiment.

If your hypothesis cannot explain what happens in the experiment, have another guess. Talk to people, ask advice, or look up some information. Make a new hypothesis.

Explaining your hypothesis is harder. The explanation is called a theory. Theories are important when people try to explain why things happen. Some important theories are the oxygen theory of burning, the germ theory of disease, and the theory that all substances are made of atoms. These theories have given scientists a greater understanding of the world that we live in. They allow scientists to visualise what they cannot see. Some aspects of our world are regular and predictable, and have been called Laws. An example is the Law of Gravitation.

Your teacher will demonstrate how to answer the problems below. They will explain the techniques of doing experiments to solve problems.

Scientists find the answers to questions by doing experiments like these. They then think about and talk about the results. The results are usually reported at meetings and published in scientific journals or magazines. Your school library should have some of these. Look for *New Scientist*, *Science Mag*, *Nature Australia* and *Ecos*. Some science magazines are written for high school students, and contain experiments that you can do. Two of these are called *QuestaconMag* and *The Helix*.

EXPERIMENT

AIM: To investigate tea bag rockets

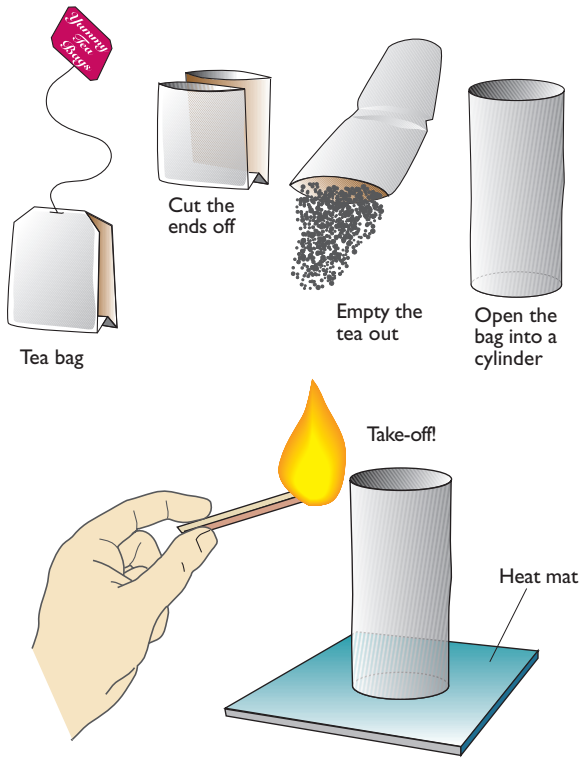
Only do this activity when your teacher is in the room. If you want to do it at home, ask an adult first.

Get a tea bag (not the round type) and cut the ends off. Tip the tea out and make the bag into a tube shape.

When you set fire to the top of the tea bag, the flame burns the paper and when nearly all the paper has been burnt, the rocket lifts off. Why is this? Here are some other questions to investigate:

1. What happens if we cut the rocket in half, to make two shorter rockets?
2. Can we use other paper, or a toilet roll, to make a rocket?
3. What is the shortest rocket we can make that will still fly?
4. Do all brands of tea bags make good rockets?
5. Will the rocket lift off if it is inside a beaker?
6. Does the size of the beaker (in Question 5) make any difference?

Talk with your teacher about some theories to explain why the tea bag rocket lifts off the bench. Write the reasons in your note book.



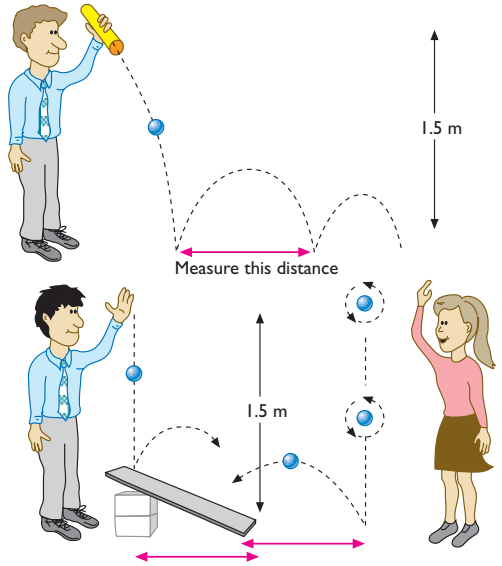
Making a tea bag rocket

EXPERIMENT

AIM: To investigate how to make a ping pong ball bounce sideways

These experiments can be completed in small class groups, or at home.

How far can you make a ping pong ball travel sideways after it bounces? Drop it from a height of 1.5 metres above the ground. You can only drop the ball, or roll it out of a tube. Do not throw or flick it. You can spin the ball, so long as it does not go forward while it is falling.



The ping pong ball experiment

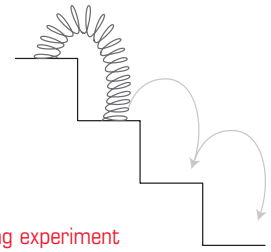
Test as many ideas as you can. Some ideas that you could test include the effect of the colour of the ball, temperature of the ball, type of floor covering and whether the ball has holes drilled in it.

In your note book, describe what you tried and the distance of the sideways bounce. What did you find was the best way to make the ping pong ball bounce sideways?

AIM: To make a slinky spring walk down steps

A slinky spring is a loose flat spring. They can be purchased at museum shops and other science shops. They come in a variety of sizes, and can be made of metal or plastic.

Use bricks or books to make a series of steps. Experiment in a small group to find the best size of steps for your slinky spring to 'walk' down the steps.



The slinky spring experiment

AIM: To use a sheet of paper to hold up your books

A single sheet of paper, if folded and glued in the correct places, can hold up all of your school books.

The aim is to hold a school note book or folder at least 12 cm off the table. You can only use one sheet of A4 paper, and 10 cm of sticky tape.

If your structure can hold up one book, try it with two books. How can you make the strongest structure? What are the tips for making a strong structure?

CHECKPOINT:

COPY AND COMPLETE

Science is about finding _____ to _____ and _____.
Your guess is called a _____. A hypothesis _____ what will _____ in an experiment. Test your _____ by doing an _____. Explaining your _____ is harder. An _____ is called a _____.
Scientists find the _____ to _____, by doing _____ like these. The results are reported at _____ and published in _____ _____ or _____.
Some science _____ are written for high school _____, and contain _____ that you can do. Two of these are called _____ and _____ _____.

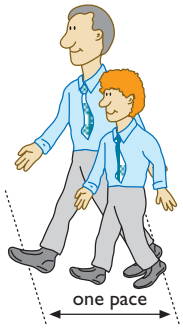
QUESTIONS

1 What is a hypothesis? What is a theory?
2 What are the reasons why scientists do experiments?
3 What is one theory to explain why tea bag rockets fly?
4 Make a collection of science stories you find in newspapers. Sort them into groups, such as medicine, astronomy, physics, and so on.
5 Name some science magazines. Where are they located in your library?
6 How would you find background information for an investigation? List at least three places where you could look.

1.9 Measurements

Measurements are all around us. We use them every day. You can buy your milk in a one litre carton, buy 500 grams of meat for the family, and walk 800 metres to school. Even the time on your watch is a measurement.

An object must be the same length no matter who measures it. People have agreed on how long one metre is. To make sure measurements are consistent, we use standard measuring amounts, called units of measurement. Units of measurement include the metre, litre and kilogram. Measurements which are not consistent, such as walking paces, are not used in science.



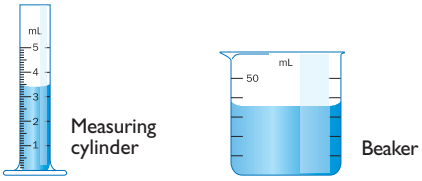
Paces are not good for measuring distances

Length

Length is measured in the unit called metres. For long distances, kilometres are used. For short distances, centimetres or millimetres are used. The symbols are m, km, cm, and mm. The devices we use to measure length and distance are the trundle wheel, metre rule and tape measure.

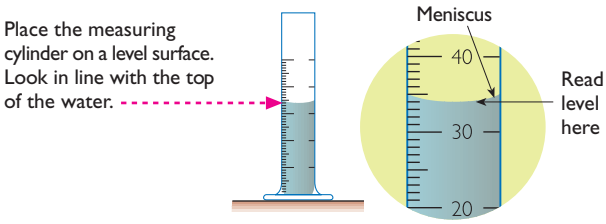
Volume

Volume is how much space something takes up. It is measured in units called litres or millilitres, which have the symbols L and mL. Some beakers have a measuring scale on them, but measuring cylinders are more accurate than beakers. Scientists prefer to use measuring cylinders to measure the volume of water and solutions.



Two items of equipment for measuring volumes: a measuring cylinder and a beaker

In a glass beaker, water is pulled up where it touches the glass. This is called the meniscus. When you measure volume, always read the scale from the bottom of the meniscus.



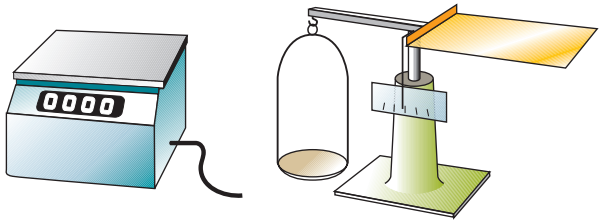
Read the water level at the bottom of the meniscus. (Here the correct measurement is 34 mL.)

Reading from a meniscus

Mass

Mass is how much matter or substance is in an object. Mass-measuring devices are called scales or balances. You will use a beam balance, spring balance and electronic scales to measure mass.

Mass is measured in the units called grams and kilograms. Tiny masses are measured in milligrams. The symbols are g, kg and mg.



Electronic scales Beam balance

Two items of equipment for measuring mass: electronic scales and a beam balance

Time

Time is measured with a watch or clock. A sundial tells the time of day. If a watch or clock is set on the correct time, it can tell you the time of day. A stopwatch measures how much time has passed. In our experiments, time is measured in the unit called seconds. Its symbol is s.

Temperature

Temperature is measured using a thermometer or a thermistor. Some of these have a digital scale. Temperature is measured in the unit called degrees Celsius. Its symbol is °C.

Writing measurements

Every measurement has two parts: the number and the unit. The unit is what we have used as our standard of measurement. The standards of measurement are metres for length, seconds for time, kilograms for mass.

Five metres is written as 5 m. Writing 5 ms is wrong, because s means seconds, so 5 ms means 5 milliseconds.

EXPERIMENT

AIM: To measure objects

Your teacher will give you some objects to measure. You will have to select which measuring device will give an accurate measurement. Record your results in a table in your note book. Don't forget to write the units with your measurement. Here are some ideas:

1. The volume and mass of a cup of water.
2. The mass of a film canister partly filled with sand.
3. The distance from your laboratory to where you sit in the playground.
4. The thickness of a page in this book.
5. The time a ball is in the air when it is thrown.

CHECKPOINT:

COPY AND COMPLETE

Length is measured in _____. For long distances, _____ are used. For short distances, _____ or _____ are used. The symbols are m, km, cm, and mm.

Volume is how much _____ something takes up. It is measured in _____ or _____, which have the _____ L and mL. When you measure _____, always read the _____ from the bottom of the _____.

Mass is how much _____ or _____ is in an object. Mass is measured in units called _____ and _____. The _____ are g and kg.

Time is measured with a _____ or _____. Time is measured in the unit called _____. Its symbol is s.

Every measurement has ___ parts: the _____ and the ____. The unit is what we have ____ as our _____ of _____.

QUESTIONS

1. What do milli, centi and kilo stand for? What is a millisecond, a kilolitre and a centigram?
2. Match the measurement, measuring instrument and the unit of measurement in the list below.

length	*thermometer*	*second*
mass	*stopwatch*	*litre*
volume	*balance*	*degree Celsius*
temperature	*trundle wheel*	*kilogram*
time	*measuring cylinder*	*metre*

3. What are the units for temperature, time, mass, distance, length and volume?
4. What is meant by a unit? Why do we have units with measurements?
5. What would happen if units were not the same everywhere in Australia?
6. **a** What is meniscus?
   b Why do all glass containers have meniscus?
   c When you measure volume, what part of the meniscus is used?
   d Does this rule always apply in measuring volumes in glass containers?

1.10 Concept maps

A concept map is a way of linking all the ideas you have learnt in a topic. It's a summary, a study guide and a revision sheet all in one.

Here is an example of how to make a concept map. A class was given some sheets of cardboard. The teacher wrote the first card, 'Science is'. She then asked each person in the class to write one idea about the topic 'Getting Started' onto the sheet of cardboard.

Some students were interested in what scientists study, so they wrote the names of the types of science. Their cards have words like 'biology' written on them. Other students were interested in how scientists work, such as predicting and discovering. Other students wrote about what scientists do in our society. Their cards had words like 'satellites', 'cures for diseases', and 'endangered species' written on them. The class, and their cards, are shown in the drawing below.

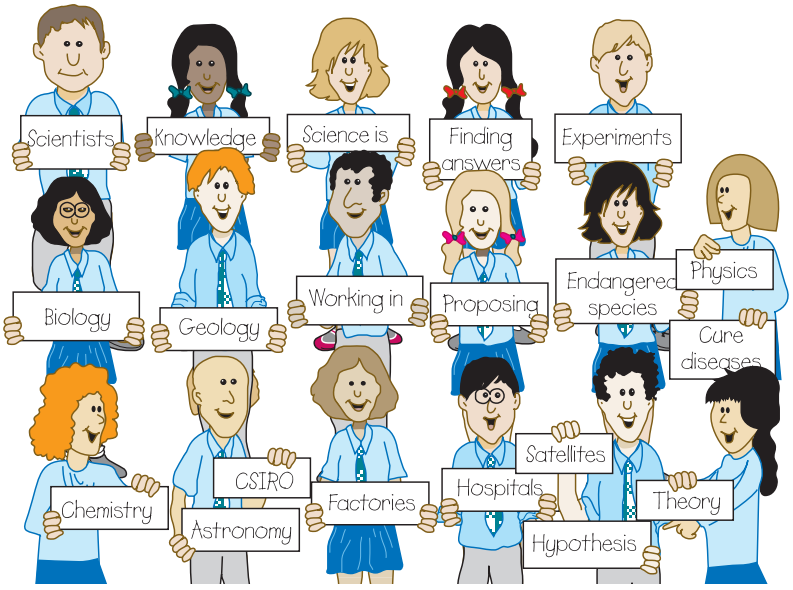
A concept map is made when cards with similar ideas are placed near each other. If you write the ideas onto paper, you can draw a box around the word or words. Then join the idea boxes which are similar, or ideas which depend on each other, with an arrow. An explanation can be written along the arrow. A concept map is made of words written in boxes, and lots of arrows which join them. Start with the idea at the top. The secret is to keep your concept map simple. Only include the most important ideas.

A concept map is best if it has about 20 to 30 ideas, but it can be bigger. Each idea should be joined to other ideas by arrows. Writing on the arrows explains the connection between the ideas. Concept maps can be drawn for any topic. They can be drawn in your book, or on a whiteboard for the whole class to see. Don't wait for the end of a topic, because you can draw a concept map at any time.

In your note book, draw concept maps for the following ideas. Check your work with your teacher.

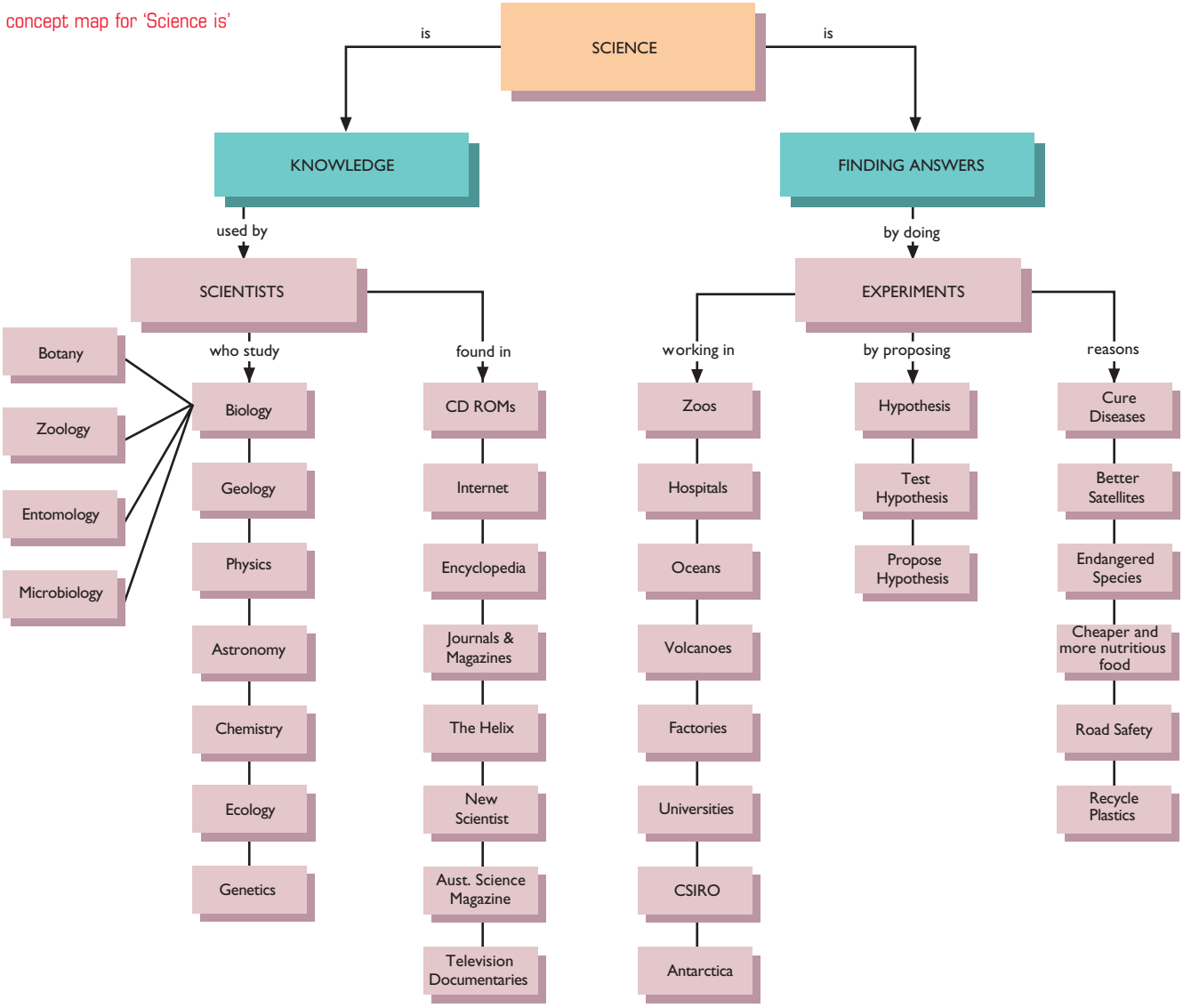
1 Laboratory equipment. Put the idea 'Laboratory equipment' in the box at the top of the page. Then you can list equipment such as Bunsen burner, filter funnel, beaker, gauze mat, retort stand, bosshead, and filter paper. Add other ideas or names until you have about 20 of them written on your page.

2 Science knowledge. Put this idea in the box at the top of the page. List under it the six branches of science shown in the concept map for this topic. Add new words such as telescope, volcanoes, and so on, until you have at least three words for each branch of science.



Concept map cards

A concept map for 'Science is'



CHECKPOINT:

COPY AND COMPLETE

A ____ ___ is a way of linking together all the _____ you have _____ in a _____. It acts as a _____, a study _____ and a _____ sheet all in one.

A concept map is ____ if it has about 20 to 30 _____, but it can be bigger. Each ____ should be _____ to other _____ by _____. Writing on the _____ explains the _____ between the _____. Concept maps can be _____ for any _____.

QUESTIONS

1 What is a concept map? What does it show?

2 Why can a concept map be used as a spelling list? Can a spelling list be used as a concept map?

3 Prepare a small concept map showing the following words: soluble, insoluble, solution, suspension, dissolve, filter, chalk, copper sulfate.

Review and Research

Review Questions

These questions check what you have learnt from the notes and experiments in this chapter. Write complete answers in your note book.

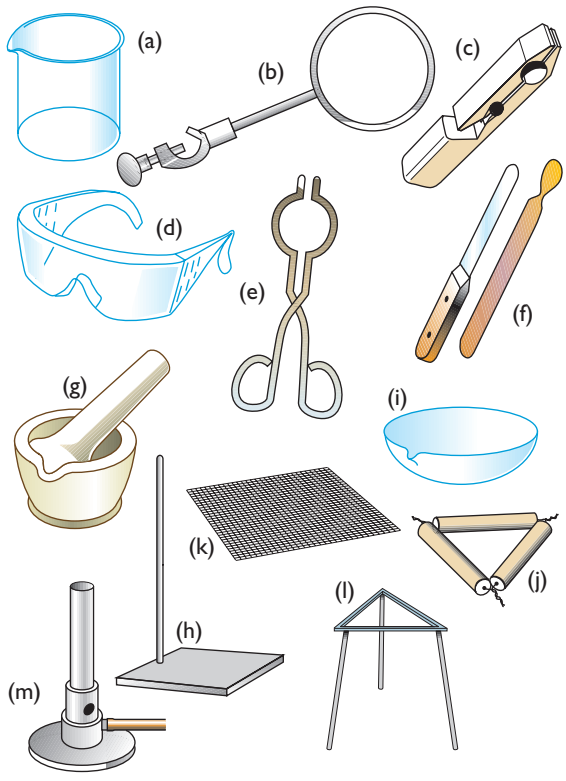
1 Are these statements true or false?

- **a** You should light the Bunsen burner with the air hole closed.
- **b** Beakers are made from heat-resistant glass.
- **c** Always use a gauze mat when you are heating a beaker with a Bunsen burner.
- **d** Running is allowed in the laboratory.
- **e** You are not allowed to eat food in the laboratory.
- **f** When lighting a Bunsen burner, always turn on the gas before lighting the match.
- **g** The safest flame for a Bunsen burner is yellow.

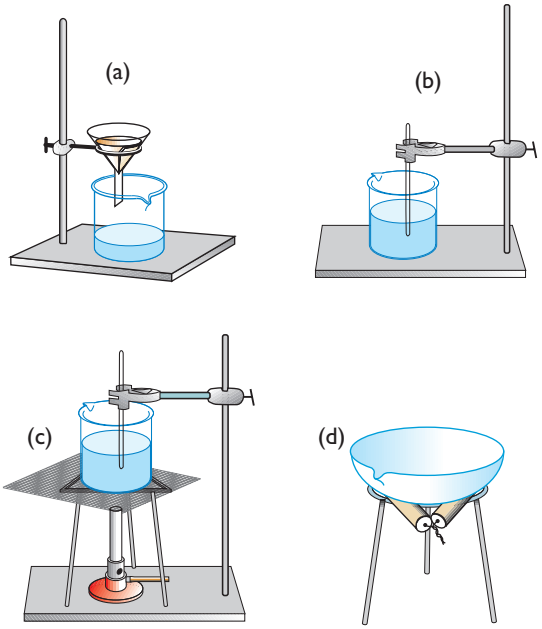
2 Which of these statements about heating a test tube are correct?

- **a** Always fill the test tube to the top.
- **b** Never point the test tube at people.
- **c** Have the test tube holder away from the flame.
- **d** Move the test tube around in the flame.
- **e** Use the Bunsen burner on the yellow flame to avoid too much heat.

3 Name these pieces of equipment. Your spelling must be correct.



4 Here are some pictures of the apparatus used in some experiments. Redraw them as diagrams, name each item of equipment, and state what the apparatus is used for.



5 This is how a student described the way to light a Bunsen burner. Read it carefully and list each error, then rewrite this paragraph to describe the way that a Bunsen burner should be lit.

> *Take the Bunsen burner from the cupboard and push the rubber tube lightly onto the gas outlet. Then turn the gas full on and open the air hole in the burner. Light the match and hold it so that it touches the top of the burner. Wait until the gas lights.*

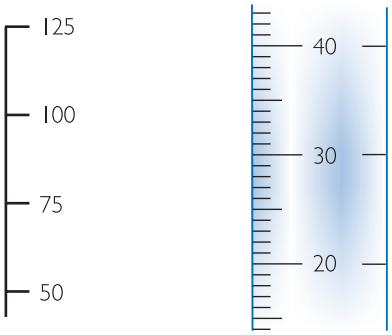
6 Here is a list of areas of scientific study. What is the name given to each area of study? Choose from these answers: astronomy, chemistry, microbiology, biology, physics, geology, ecology, genetics.

- **a** The study of rocks and the earth.
- **b** The study of movement, energy and machines.
- **c** The study of living things.
- **d** The study of chemicals and how to change them.
- **e** The study of stars, space and planets.
- **f** The study of the environment and how it works.
- **g** The study of heredity and genes.
- **h** The study of microscopic living things.

7 a Why is there a laboratory rule against running?
b What should you do if you break a beaker?
c What is the correct way to boil water in a test tube?
d What is the advantage of drawing a mind map for each topic of work?

8 Which equipment is best used to measure the following?
a volume of a cup of water
b mass of a cup of sand
c temperature of tap water
d time taken to walk across the room
e distance to the school's main office
f distance across this page
g mass of a small beaker
h volume of a glue pot
i temperature inside a refrigerator
j time taken to walk one kilometre

9 Which of the two scales below would be the most accurate for measuring? Give reasons for your answer.



Scales for measuring

10 Which is best for measuring volume: a measuring cylinder or a beaker? Explain why.

11 What is the rule when you are reading a volume?

Word Check

Can you spell these words? Do you know what they mean? Write these words into your Spelling and Vocabulary List.

apparatus	laboratory	Pyrex
astronomer	meniscus	scientist
boss head	mortar	solution
diagram	pestle	spatula
equipment	pharmacist	stopwatch
filtration	physician	suspension
insoluble	physicist	

Research Questions

You will have to look in a dictionary, encyclopedia, the Internet or CD-ROM to answer these questions.

1 There are many unusual measurements. Can you find the answers to these measurement problems?
a What equipment is used to measure rainfall?
b How would you find the temperature inside a furnace?
c How can you measure the thickness of a sheet of paper?
d What is the width of a hair? How would you measure it?
e How fast do your fingernails grow? How could you measure this?
f How would you find the volume of water in a dam?
g How can you measure the amount of medicine in a tablet?
h How can you measure one thousandth of a second?
i How could you find the heaviness of a grain of sand?
j How would you find out how far a pen would write before it runs out of ink?

2 a How is rainfall measured? Draw a diagram of the equipment.
b Why is rainfall measured in millimetres and not in millilitres?

3 For what purpose are the following pieces of equipment used?
a pyrometer
b micrometer
c pycnometer

4 Research the life and achievements of one of these scientists who lived long ago:
a Ibn Sina, known in Europe as Avicenna
b Archimedes of Syracuse
c Al-Razi, known in Europe as Rhazes
d Abu Rayahan al-Biruni
e Aristarches of Samos
f Ibn al-Haytham
g Hero of Alexandria
h Al-Battani, known in Europe as Albategnius of the Latins

5 The metric system was introduced in the late 1700s. This system replaced units such as inches, ounces, furlongs and hundredweight. Find some of these old units and their metric equivalent.

Cameo Profiles

SIR MARK OLIPHANT, a physicist, studied microwaves in relation to radar and telecommunications. His discoveries led to the development of microwave ovens.

HELEN CALDICOTT believes that people are not careful enough with their environment. She has campaigned against nuclear testing and against the destruction of the environment. She writes on health and environment issues, and speaks at conferences all around the world.

LYN BEAZLEY is a zoologist and is fascinated with animals. Her main interest is in finding out how eyes develop and work, with a view to curing eye disease.

KARL KRUSZELNICKI is a science broadcaster and writer. He talks on the radio, on television, and at lectures and museums, as well as writing books. Listen to him on ABC Radio or read one of his books.

MICHAEL ARCHER is a palaeontologist who studies fossils to discover past plants, animals and the environment they lived in. His best known 'dig' is Riversleigh.

JEAN MACNAMARA, a doctor, studied new ways to treat the crippling disease polio, and developed ways to help with physiotherapy and rehabilitation of all handicapped people.

SUZANNE CORY is a molecular biologist researching how our chromosomes can cause cancer. She works at the Walter and Eliza Hall Institute in Melbourne, and is a world renowned research scientist.

HOWARD FLOREY, a biochemist, extracted penicillin in large quantities so it could be used as the first antibiotic.

Activity

Research a notable Australian scientist, and record details of their life and achievements. Write it in cameo form, like the ones above. Some ideas are: Lucy Bryce, Macfarlane Burnet, John Tebbutt Joseph Bosisto, Catherine Hamlin, Lawrence Hargrave, Dorothy Hill, Gabi Hollows, Douglas Mawson, Gustav Nossal, John Eccles, William McBride, Nancy Millis, John Cornforth, Eric Worrell, Beryl Nashar, Tim Flannery, David Warren, Paul Davies, Strahan Sutherland.

Puzzle

Match the descriptions on the left with the equipment on the right. Each number will then correspond to a letter. Write the letters in the grid below, using the numbers as a guide. What is the message?

1 tripod stand
2 gas burner used in laboratory
3 protects your eyes in experiments
4 equipment used with a pestle
5 clamp to hold filter funnel
6 used to hold hot objects
7 spreads out heat from Bunsen burner
8 double clamp attaches to retort stand
9 tall metal stand
10 measures temperature

A mortar
B bosshead
E retort stand
F thermometer
I three-legged stand
O gauze mat
P safety glasses
S tongs
T Bunsen burner
Y ring clamp

1	2		3	4	5	6		2	7		8	9		6	4	10	9

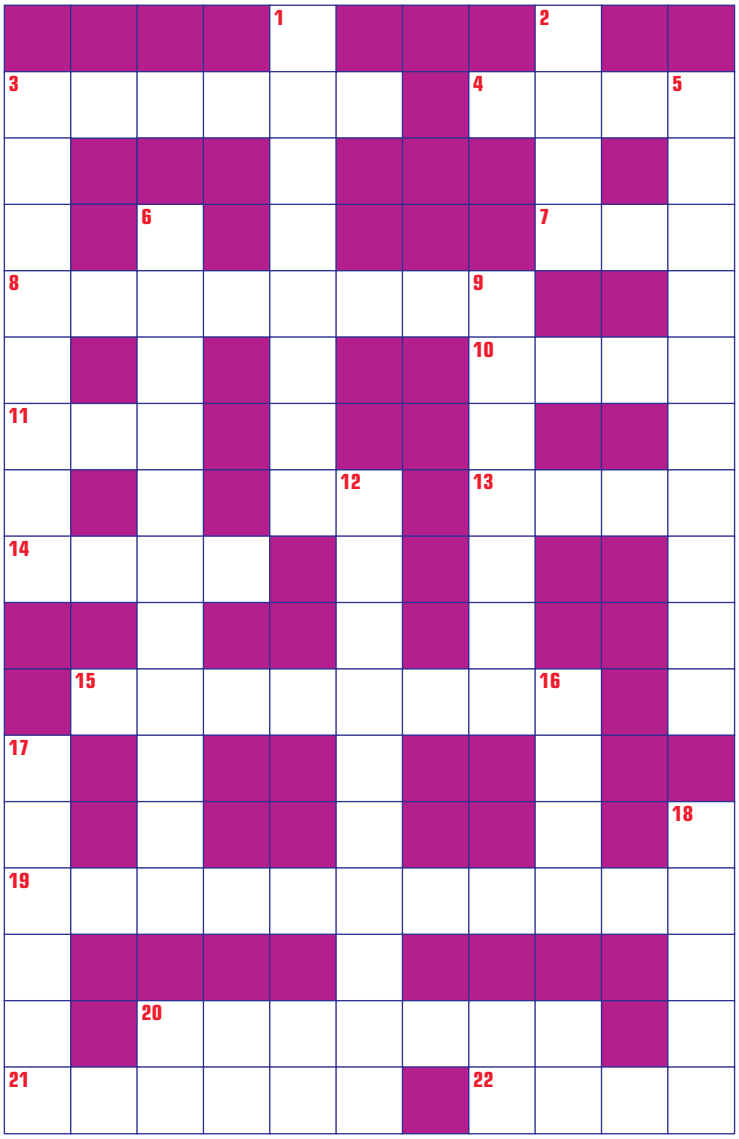
Crossword

Across

3 Glassware used to hold and heat solutions (6 letters)
4 What you aim for in sport and school life (4)
7 Abbreviation of laboratory (3)
8 Used to cut paper (8)
10 Means to tip a liquid into something else (4)
11 Do not do this in the laboratory (3)
13 Type of glass tube (4)
14 Opposite of light (4)
15 Spreads out the heat between a flame and glass (5,3)
19 Wrapped around a person to smother the flames on their clothes (4,7)
20 A tiny cube of sugar or salt (7)
21 Footwear not to wear in the laboratory (6)
22 Grainy insoluble substance in a fire bucket (4)

Down

1 Curved surface of water, measure at the bottom of it (8 letters)
2 Happens to water at 100°C (4)
3 Holds the clamp to the retort stand (8)
5 Place where you do experiments (10)
6 Essential part of a filtration (6,5)
9 Used to remove chemicals from their containers (7)
12 Heat resistant glass used in beakers (5,5)
16 Name shared by a small animal and a mark meaning correct (4)
17 To do well, you need to make this (6)
18 Retort and tripod (5)



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