Chapter 3

Investigating

CONTEXT AREA

- How do you know which product is better?
- Could you do your own experiment to find out for yourself?
- This chapter is about collecting data, showing it in graphs so it is easy to understand, using your observations to answer problems, making an inference and hypothesis, and doing meaningful experiments to answer questions about the world we live in.

PRESCRIBED FOCUS AREAS

4.4 identifies choices made by people with regard to scientific developments

4.5 describes areas of current scientific research

DOMAINS

SKILLS

4.13 clarifies the purpose of an investigation, and with guidance, produces a plan to investigate the problem

4.14 follows a sequence of instructions to undertake a first-hand investigation

4.15 uses given criteria to gather first-hand data

4.16 accesses information from identified secondary sources

4.17 evaluates the relevance of data and information

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

4.19 draws conclusions based on information available

4.20 uses an identified strategy to solve problems

4.21 uses creativity and imagination to suggest plausible solutions to familiar problems

4.22 undertakes a variety of individual and team tasks with guidance

VALUES AND ATTITUDES

4.23 demonstrates confidence and willingness to make decisions and to take responsible actions

4.25 recognises the relevance and importance of life long learning and acknowledges the continued impact of science in many aspects of everyday life

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

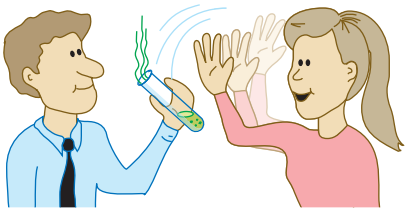
CONCEPTS

Being observant	Importance of being observant
	Using senses to identify types of fruit
Showing data—tables and histograms	
	Data in tables
	Drawing column graphs
Showing data—graphs	Bar graphs
	Line graphs
Observation, inference, hypothesis	
	Meaning of each
	Designing experiments to answer a problem
How to do a fair experiment	Use of control in experiment
	Designing and doing experiments with control
	Steps in the scientific method
Your own investigation	How to do the Student Research Project
Can you learn better?	Homework and study tips
	Does practice improve your skills?

3.1 Being observant

To be good at investigating and solving problems, you need to be observant. This means noticing things around you. All your senses—seeing, tasting, hearing, smelling and feeling—are important. Remember these safety tips:

- You should never taste anything in the laboratory. This includes drinking from beakers and eating food, even cough lollies.
- When smelling, waft the fumes towards your nose. Breathe gently so you don't inhale the fumes into your lungs.
- Wear safety glasses whenever there is any risk of injury to your eyes.
- Don't place yourself at risk of an injury–wear the correct shoes and tie up long hair.



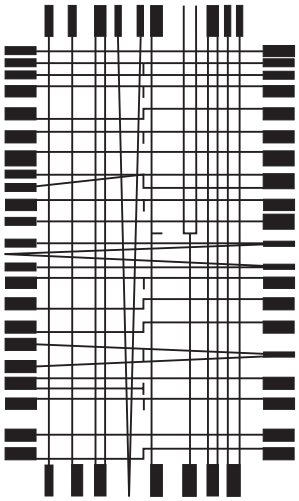
Waft fumes to your nose

Look at the two drawings below. Working with a friend, list the differences between the drawings. Then write your differences on the board. Does everyone in the class agree on the differences?

Spot the differences

Only observant people notice the messages in drawings and pictures. There is a word message hidden in the drawing on this page. What is the message?

Being observant means using your senses to notice small details. Sometimes you should ignore some observations, and only focus on important observations. An example is comparing handwriting. You would look at the shape of the letters, and the style of the writing.

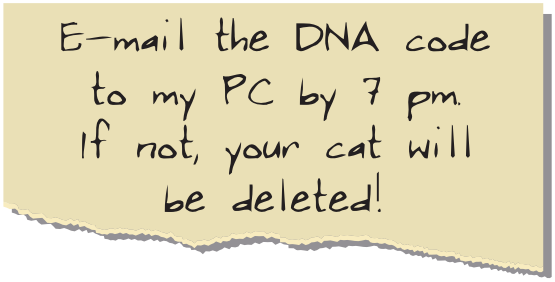


What is the secret message?

Ransom note

Professor Jill Catlove is a genetic scientist and a cat lover. She has discovered the code of DNA in the genes of a cat which causes them to grow floppy ears. Her own cat has been kidnapped (or is that catnapped?) and is being held to ransom.

Jill received the following note. Compare the handwriting to find who wrote the note. In your note book, write the reasons why you selected your suspect.



SUSPECT	WRITING SAMPLES		
Gill T. Uronner	your cat	my PC	7pm
Ivor Confeshin	your cat	my PC	7pm
Kate Napper	your cat	my PC	7pm
Freda Matlast	your cat	my PC	7pm.
Betty Diddit	your cat	my PC	7pm

EXPERIMENT

AIM: To test your senses

The secret to being observant is to use your senses. These activities will make you more aware of your senses. In some of these activities you will need a blindfold. It is best to use safety glasses that have been painted black, or covered with dark paper. Note that we will not test our fifth sense, taste, as it is not good safety practice to eat in the laboratory.

Touch

Wearing your blindfold, feel some common objects. They might be fruit, fabric, sandpaper, plastic, or something else. Your task is to describe the feel of each one, and recognise each substance by its touch.

Smell

Your teacher has some test tubes (wrapped in paper) lined up in a test tube rack. Gently smell each one, and see if you can name them. They might be paint, banana peel, a piece of cake, leaves from a lemon tree, or something else. Your task is to recognise each substance by its smell.

Hearing

Sit at your desk, and put on your blindfold. As your partner taps on the desk, point to where you think the noise is coming from. How good are you at finding the direction of a sound?

Sight

We have binocular vision, which means that we have two eyes that function together. Two eyes help us judge distance. Cover one eye, and then ask your partner to hold a pencil within the reach of your arm. Stretch out your arm and touch the top of the pencil with your finger. Most times you judge the correct direction, but not the correct distance. This is because you need two eyes to judge distance.

CHECKPOINT:

COPY AND COMPLETE

To be good at _____ and _____ problems, you need to be _____. This means _____ things around you. All your senses—_____, _____, _____, _____ and _____— are important.
Remember these _____ tips: You should never _____ anything in the _____. When _____, ____ the _____ towards your nose.
Being observant means using your _____ to _____ small _____. Sometimes you should _____ some _____, and only _____ on _____ observations.

QUESTIONS

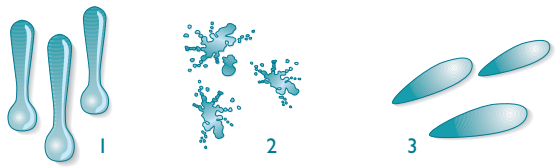
1 What does observant mean?

2 List your senses. Which sense should not be used in a laboratory?

3 Name some movies in which the main character solves a crime or mystery. What are some features of these movie heroes? Do they use all their senses?

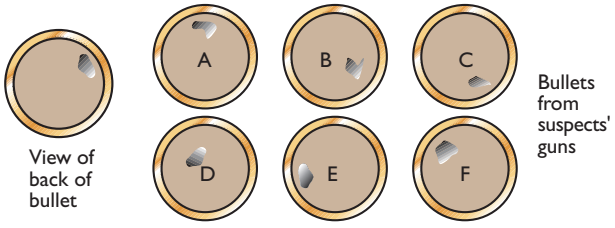
4 If you were going to become a good investigator, such as tracing the factory that tipped pollution into the bay, what qualities would you need? Which qualities would be the most important?

5 When a bullet is fired from an old-style gun, the firing pin leaves a mark on the back of the bullet. This mark can help determine which gun fired the bullet. Here is the mark on a bullet from the scene of a crime, and the pattern on the bullets from the guns of six suspects. Which gun fired the bullet?



6 Two students in your class have had a water fight and the teacher has caught them. There are drops of water splashed in different places, including the blackboard, floor and bench.

Using your knowledge, which drop would be found:
a on the floor where it fell
b on the floor where it was flung
c on the blackboard?



3.2 Showing data: tables and graphs

Data is information that has been collected. There is information available in computers and books covering just about every subject. The amount of information available is enormous.

How can you sort information into groups? How can you see information at a glance? How can you make information easier to study?

Information presented in a table or graph is easy to see. This activity summarises the main ideas about tables and graphs.

Drawing tables and graphs

In his diary, Ken recorded the time he spent on homework. Later he went back and read the diary with a view to drawing a table and a column graph of the time he spent. The following diary entry provided the data Ken needed to make his table and graph.

'On Monday I watched television for a while, then rang Anne, before spending $1\frac{1}{2}$ hours on homework. On Tuesday I had soccer training, and after tea I worked on my maths homework for 1 hour and on geography for 1 hour. On Wednesday I went swimming, and then did some English homework for 1 hour. Then I went to Anne's house and watched a movie. On Thursday the homework had built up. I had to spend $1\frac{1}{2}$ hours on maths, 30 minutes finishing my science, and 30 minutes to finish the geography questions. I was really tired. On Friday I finished all the maths I had to do so there would be no homework for the weekend. That took 1 hour to finish it.'

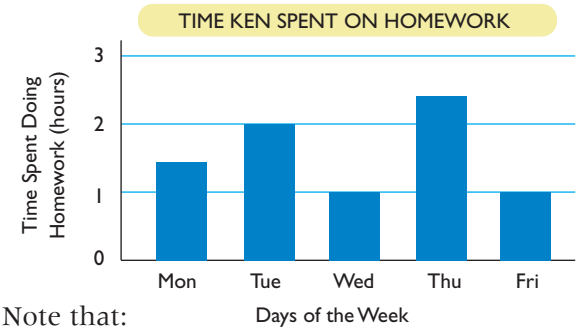
Time Ken spent on homework

Day	Time (hours)
Monday	$1\frac{1}{2}$
Tuesday	2
Wednesday	1
Thursday	$2\frac{1}{2}$
Friday	1

Note that:

- The table has a title, or heading
- The time spent is all in hours. The minutes have been converted into hours. The times are in the same units so that they can be compared easily.
- The units (hours) are written at the top of the column. You don't have to write the units after each number.
- The table has neat lines drawn with a ruler, and the numbers are in a vertical line.
- The table summarises the information. It does not tell us the time spent on each subject, or what Ken did besides his homework. The table only records the time taken on his homework.
- If Ken had not done any homework, a zero would be recorded in the Time column. If Ken had forgotten to record his homework and no result is available, then a dash (—) would be written in. Do not leave any blanks in a table.

Column graph

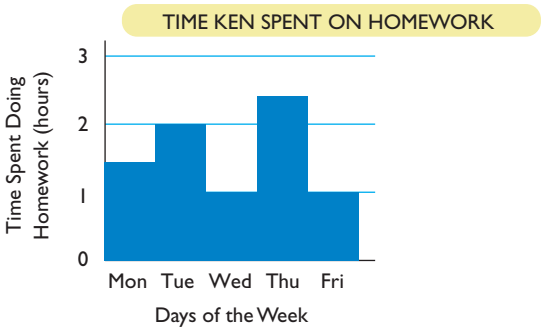


Note that:

- The graph has a heading, or title.
- Each axis has a title and units.
- The scale on each axis is even. There is the same distance between the days on the horizontal (bottom) axis, and between the numbers of hours on the vertical (side) axis.
- The graph is neatly drawn, using a ruler.
- The columns are the same thickness and same distance apart.
- The information is easy to see.

A histogram is a type of column graph. It shows the information in the table in a visual form, like a picture. It allows us to 'see' the information easily.

Histogram



Sometimes the information we have needs to be sorted. A table lets you sort data quickly.

Here are the marks scored in a test by a class. The test was out of 20 marks. There were 30 students in the class. The highest mark was 20 and the lowest was 11.

20	14	19	14	18	16
19	18	20	18	13	18
15	17	14	16	19	14
18	16	19	11	18	17
17	19	15	18	16	18

Record the data in a table like the one below.

Test score	Number of students
20	
19	
18	
etc.	

Draw a column graph of the data. The Test Score should go across the horizontal axis. The number of students should go on the vertical axis.

CHECKPOINT:

COPY AND COMPLETE

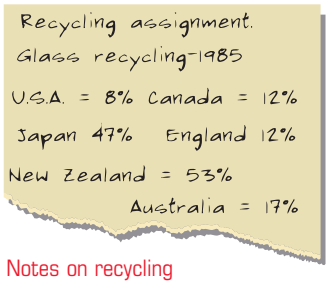
Data is _____ that has been collected. Information _____ in a _____ or _____ is easy to see. A histogram is a type of _____ _____. It shows the _____ in the table in a _____ form, like a _____. It allows us to '___' the _____ easily.

QUESTIONS

1 What is the advantage of a histogram over a table of results?

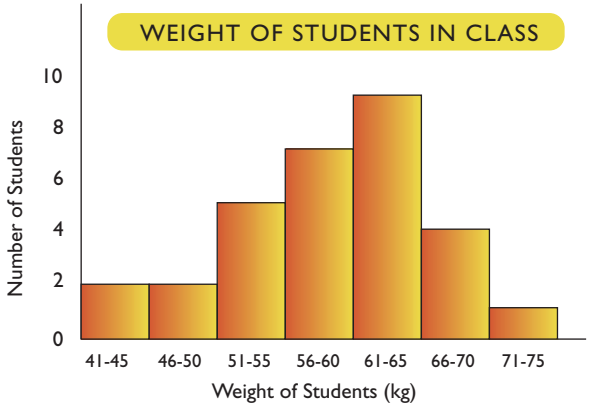
2 Why are tally marks used when sorting data into groups?

3 Marie had an assignment on the amounts of glass recycled in different countries. While she was researching, Marie made notes, as shown. Organise these notes into a table and then draw as a histogram.



Notes on recycling

4 This question refers to the histogram below.



a How many students weigh between 56 and 60 kg?
b What is the most common weight of students in this class?
c What could be the smallest weight in this class?
d What could be the weight of the heaviest student in this class?
e How many students are in this class?
f List two pieces of information which this column graph does not tell you.

5 Draw a column graph showing the strength of gravity on the planets (an accurate measure of Pluto's gravity is not currently known).

Planet	*Strength of gravity (m/s^2)*
Mercury	3.7
Venus	8.8
Earth	9.8
Mars	3.7
Jupiter	24.9
Saturn	10.5
Uranus	7.8
Neptune	11.8

3.3 Showing data: other graphs

In Activity 3.2 we looked at histograms. There are other ways of showing information in a visual (or easy to see) form. These are bar graphs, pie graphs and line graphs.

Bar graphs and pie graphs

A bar graph is used to show parts or fractions. For example, we can graph the amounts of the main gases in clean air.

Amount of gases in air

Gas	Percentage (%)
nitrogen	78
oxygen	21
other gases	1

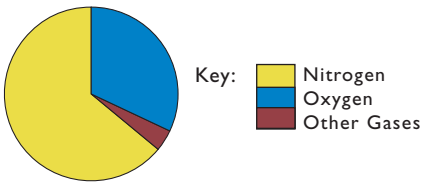
A bar graph shows these amounts as different colours in a bar.

Bar graph

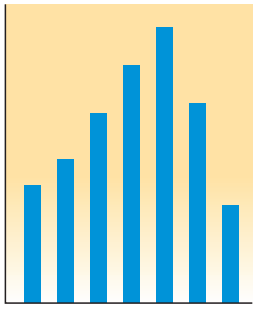
Hints:

- Make your bar graph 10 cm long. That makes 1 mm equal to 1%.
- Don't forget to include a key. A key shows which parts of the graph stand for the different gases.

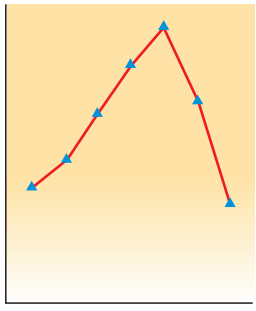
A pie graph, like a bar graph, shows parts. To draw a pie graph accurately, you need a protractor to measure angles.



Pie graph



Column graph

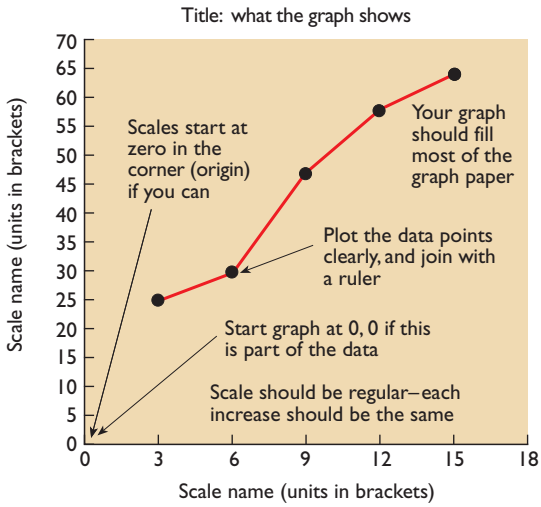


Line graph

Line graphs

A column graph shows the data in a series of columns. A line graph has a line joining the points where the middle of the tops of the columns would be. These points are called data points. All that you draw on a line graph are the data points and the lines joining them. Most of the graphs used in science are line graphs.

Here are some hints for drawing the best line graphs.



Hints for drawing line graphs

Use this as a checklist when drawing a line graph:

1. Is there a title? Does it explain the graph?
2. Do both axes have a name?
3. Are the scale numbers regular?
4. Do the scale numbers start at zero?
5. Are the units shown on each axis?
6. Are the data points plotted clearly?
7. Is the graph line drawn with a ruler?
8. Does the graph take up most of the graph paper?

Double graphs

You don't have to draw two graphs to show two sets of data. You can use the same graph. Using the same graph is important if you want to compare data.

Plot the data on the next page, showing temperature in the sun and in shade, on the same line graph. Don't forget to include a key. Check with the checklist that you have followed all the hints.

Temperature in school grounds

Time	Temperature in Sun (°C)	Temperature in Shade (°C)
8 a.m.	19	18
9 a.m.	21	20
10 a.m.	23	22
11 a.m.	26	23
12 noon	29	25
1 p.m.	31	26
2 p.m.	32	27
3 p.m.	30	26
4 p.m.	27	23
5 p.m.	25	21

CHECKPOINT:

COPY AND COMPLETE

In the previous section we looked at _____ . There are other ways of _____ information in a _____ form. These are ___ graphs, pie graphs and ____ graphs.
A column graph shows the ____ in a series of _____. A ____ graph has a line _____ the points where the ____ of the _____ would be. These points are called ____ points. All that you draw on a ____ graph are the ____ _____ and a line _____ them.

QUESTIONS

1 What is the advantage of graphing data rather than making a table?

2 What is a key? Why are keys drawn on some graphs?

3 Draw a line graph to show the following data.

Number of sparrows counted on the 15th day of each month

Month	*Sparrows*	*Month*	*Sparrows*	*Month*	*Sparrows*	*Month*	*Sparrows*
January	*23*	*April*	*24*	*July*	*10*	*October*	*14*
February	*29*	*May*	*17*	*August*	*9*	*November*	*16*
March	*33*	*June*	*12*	*September*	*8*	*December*	*20*

4 Draw a bar graph and a pie graph showing the use of the products obtained from petroleum.

Products obtained from petroleum	
Product	*Percentage*
Petrol	20
Diesel	10
Kerosene	64
Heavy oil	6

5 This data shows the water use in the ACT according to sectors, one of which is residential. Further data shows the use of water in the residential sector. Select an appropriate method to show this data and draw it. Remember to include a key.

Total Water Use	
Sector	*Percentage*
Residential	70
Government departments	16
Business	4
Industry	2
Other	8

Residential Water Use	
Part of home	*Percentage*
Garden	52
Other outdoor use	3
Showers/baths	16
Toilet	14
Laundry	10
Kitchen	5

3.4 Observation, inference, hypothesis

These three words—observation, inference and hypothesis—are important to people who do experiments. Their meanings are important if you are to find answers by experiment.

An observation is something that you notice using any of your senses. We have five senses, which convey information to our brain. Being observant means using all your senses to notice things around you. It is important to be accurate in your observations.

Some observations are:

- Smelling onions in the kitchen.
- Finding that a fabric feels like satin.
- Seeing a man running down the street.
- Hearing an electronic alarm.
- Finding that lemon juice tastes sour.

An inference is a likely explanation of what you observed. It is how you explain the observation. The explanation may or may not be true.

Here are some inferences you might have made about the observations above:

- You will have onions with your dinner.
- Mum bought the fabric for the concert.
- The man is scared of dogs.
- A cat caused the alarm to sound.
- Lemons contain an acid.

A hypothesis is a guess at an answer, which you can test by experiment. Some things cannot be tested by experiment, such as personal likes and dislikes.

Some hypotheses you might make about the observations above:

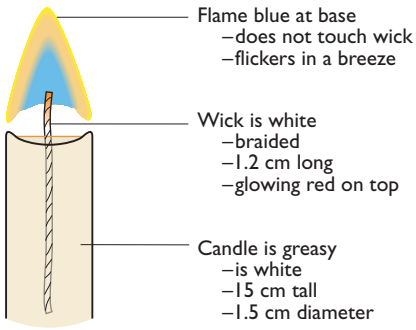
- Onions smell more on a hot day than on a cold day.
- The fabric feels smooth because the fibres are close together.
- The man running from the dog was bitten last year.
- Cats climb onto cars, and the movement activates the car alarm.
- Lemons are sour because they contain citric acid.

Before starting any experiment, it is important that you plan what you are going to do. Write it in your note book. It is important to check with your teacher, so that you don't waste materials and your time.

EXPERIMENT

AIM: To distinguish between observations and inferences

How good are you at making observations? Do you confuse observations with inferences? There are many things which you could observe. Did you know that you can make over 100 observations of a burning candle?



Draw a table with two columns, one for observations, and one for inferences. Light a candle and list six observations of the burning candle, and write down three inferences you can make from your observations.

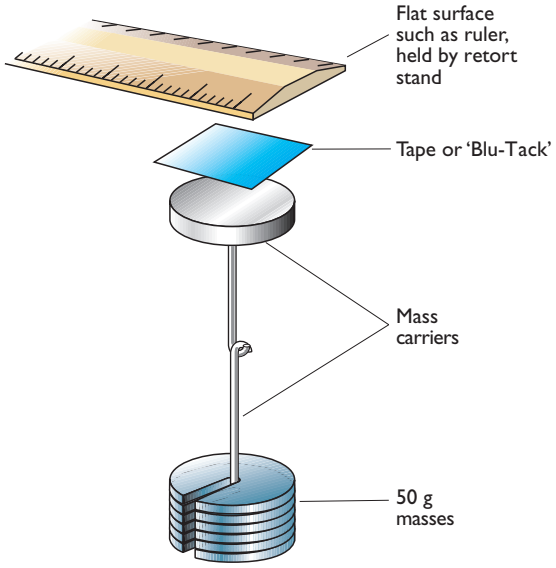
EXPERIMENT

AIM: To test a hypothesis

You may know that some candles burn faster than other candles. Why does this happen? The hypothesis you will test in this experiment is: 'thin candles burn faster than thick candles because there is less wax to burn'.

Plan an experiment. Talk with your experiment partner, then a larger group, and finally with the teacher and class. The experiment should find out whether the hypothesis is correct. Your method should include some way of measuring the height of the candle as well as its mass. The mass of a candle is a measure of the amount of wax in it. Write a plan of the experiment in your notebook, and check it with your teacher before you start.

EXPERIMENT



Testing different sticking materials

AIM: To test different sticking materials

Which is the best material for keeping posters stuck to the ceiling of your bedroom: Blu-Tack, invisible sticky tape, or double-sided sticky tape? The best way to find out is to set up an experiment as shown:

Record your results:

Material	Weight needed to pull away from tape
Blu-tack	
invisible tape	
double-sided tape	

Which is strongest? Why? Before using this material to hang posters on a ceiling, are there other things to consider? Will it damage the ceiling? Should it be reusable? Should it be biodegradable? Is the strongest material the best? Is there another material that might be better?

CHECKPOINT:

COPY AND COMPLETE

An observation is something that you _____ using any of your _____. We have ____ senses, which convey _____ to our brain. Being _____ means using all your _____ to notice things around you.
An inference is a likely _____ of what you _____. It is how you _____ the observation.
A hypothesis is a _____ at an _____, which you can test by _____.
Before starting any _____, it is important that you ____ what you are going to do. It is _____ to check with your _____.

QUESTIONS

1 What are the five senses? List them in order of usefulness to you in everyday life.

2 What is the correct order of the words hypothesis, observation, inference, in planning an experiment?

3 Which of the following are observations? Which are inferences?
- **a** You smell a strong odour from a garbage bin.
- **b** Coffee stays hotter if you add the milk before the hot water.
- **c** I measured the temperature today at 37°C.
- **d** It is so hot that the temperature must be 37°C.
- **e** There is a person in a Santa suit. It must be Christmas.
- **f** I can smell fish cooking.
- **g** This candle has a greasy feel.
- **h** I believe that this candle is made of special wax.
- **i** This soup is so hot that it hurts my teeth.
- **j** Shh! I can hear an animal on the roof. It must be a possum.

4 Match the words 'hypothesis', 'observation' or 'inference' with the different meanings written below.
- **a** something you notice
- **b** an explanation
- **c** a guess at an answer
- **d** tested by experiment
- **e** a quiet sound that you hear
- **f** I think they are for the party next week.

3.5 How to do a fair experiment

If you want to find the answer to a question, you might:

- look it up in a reference book or magazine, or on the Internet or a CD-ROM
- ask someone who might know
- find out yourself by doing an experiment.

The answers to all the big questions in the world were first found by observation or experiment. All experiments have to be fair and valid, so that someone else can repeat them and get the same answer.

In all experiments, you must use a control. A control is a comparison that is used to make sure a fair test is carried out. Each of your experiments should have two parts, which you do at the same time. One part is what you test, and the other is the control that you will compare it with. All the experiments in this activity use a control. Consider the following experiment as an example.

EXPERIMENT

AIM: To find out how hot drinks cool down

You might have seen people blowing into tea, coffee or soup to make it cool. Does it work?

Because it is hard to use real tea or coffee in an experiment, we will use hot water. Set up two beakers side by side. They should be identical in every way. The size and type of beaker, the amount of water, the temperature of the water, and the size of the thermometers should be the same.

The experiment will compare blowing and not blowing. You will blow air onto one beaker. This beaker is called the test beaker. The other beaker will be left in still air, and you won't blow on it. This beaker is called the control. It is a comparison with the test beaker.

You will measure the temperature of each beaker every minute, and write the temperatures in a table like the one to the right. You will need two thermometers, one for each beaker.

Time since start	Temperature still beaker	Temperature blowing beaker
(min)	(°C)	(°C)

When you are ready to start this experiment, write it into your note book, and then do it. Record the temperatures for at least 12 minutes. If there is no difference after 12 minutes, keep measuring until a result becomes evident. What can you conclude from this experiment? Does blowing air over the beaker or cup lower the temperature of the water quicker than not blowing?

EXPERIMENT

Extension experiments

There are many other experiments you can try. Here are three questions and hints about how to do the experiment. Check with your teacher before proceeding. (Different groups in your class could do each experiment and report to the class with their results.)

1 Imagine you have made yourself a cup of hot chocolate. Before you can add the milk, the phone rings. If you want the drink to stay as hot as possible, should you add the milk before answering the phone, or wait until after the phone call and then add the milk? Do an experiment to help you decide. Instead of hot chocolate and milk, use hot water for the drink and cold water for the milk. Record your results in a table like the one on page 59.

2 Some people put a saucer or other covering over their cup to keep the drink warm. Does this work? In your experiment, think about where you

will place the thermometer. Would you place it in the centre of the liquid or at the edge?


Coffee cup and saucer


Beaker and watchglass

3 Does leaving a metal teaspoon in a hot drink make it cool faster? No hints with this one. Plan what you are going to do, then check with your teacher before starting. The steps in planning an experiment are:

a Observing. Note as much as you can.
b Inferring. Think of an explanation for what you observed.
c Hypothesis. Make a guess at the answer that you can test by experiment (see Activity 3.4).

The next steps are:

d Design a fair experiment, with a control, to test your hypothesis.
e Do the experiment, and study the results.
f Form a conclusion by seeing if your results agree with (prove) or disagree with (disprove) your hypothesis. A good conclusion must answer the hypothesis.

Do the results confirm or support your hypothesis? Was your guess correct? If it was, you have answered your question. But think: is the result true all the time? What conclusion can you make?

Do the results make no sense? Was your guess wrong? If so, change your hypothesis and your experiment plan, and then try again. Your results should confirm or reject the hypothesis.

This series of steps is called the 'scientific method' or 'scientific process'. It is the series of steps which every scientist has to go through when planning and doing experiments.

Time since start	Temperature of water with "milk" added	Temperature of water without "milk"
(min)	(°C)	(°C)
0		
1		
2		
3		
		Add water ("milk"), stir in
	Final temperature	Final temperature

CHECKPOINT:

COPY AND COMPLETE

All experiments have to be ____ and _____, so that someone else can _____ them and get the ____ answers. In all experiments, you must use a _____. A control is a _____ that is used to make sure a ____ test is carried out.

The steps in planning an _____ are:

1 _____. **2** _____. **3** _____.

4 _____ a ____ experiment, with a _____, to test your _____.

5 Do the _____, and _____ the results.

6 Form a _____ by seeing if your _____ agree with (_____) or disagree with (_____) your _____.

This series of steps is called the _____ method. It is the _____ of _____ which every _____ has to go through when _____ and _____ experiments.

QUESTIONS

1 What is a control in an experiment?

2 **a** What are the steps in writing a scientific report? (Look back to Activity 1.6.)
b What is a conclusion? Why is it written at the end of an experiment?

3 Is it fair to use hot water in these experiments instead of tea and coffee? What could you do to test your answer?

4 What are the six steps in the scientific method?

5 When taking the temperature of water, it is a good idea to stir the water first. Why is this?

3.6 Your own investigation

During this year you will have to carry out an investigation on your own. This investigation is called the Student Research Project, or SRP. This activity will help you to choose your topic. It will also show you how to set up the investigation, make any equipment that you might need, and write a report about what you discover.

Your teacher might not want you and your class to start work on your investigation or SRP until later in the year. You will know more science by then. Remember to refer back to this activity when you are planning your investigation.

Choosing a topic

Choose a topic that interests you, and that you can do with the things you have at home. Ask for advice from your parents, teacher and friends when you are choosing a topic. Here are some ideas:

Using plants

- Does talking to plants make them grow better? What about music?
- Does fertiliser make plants grow better? What type of fertiliser? What type of plants?
- Do plants grow as well if you water them with coffee? Or tea? Or sugary water?
- Do hydroponic plants grow faster than plants in the ground?
- How does the type of soil change in your local area?

Using food

- Why do bread and other foods go mouldy? Can you stop mould from growing?
- What happens inside eggs when they are put into boiling water?
- Can you freshen stale bread?

Around the home

- How good is the garden hose as a solar water heater?
- How much water, electricity or gas is used in your home in a week? How can you reduce this?
- How much hotter or cooler is it inside your house compared to the outside? How can you change this?
- Are expensive detergents better than cheap detergents?
- How much water is in dishwashing detergents?

Still confused? Here's a different way of finding a topic:

1. List your interests and ideas.
2. Who can help you? What can they help you with?
3. What have other students done? Ask last year's class and your friends.
4. Look through this book. Check at the end of each chapter.
5. Check in the school library for information on your area of interest. Magazines like *The Helix* are ideal.
6. Define your investigation precisely. Keep it simple so that you only test one thing.

As a final check, ask yourself:

1. Is your topic simple?
2. Do you need background information?
3. Can you get the equipment that you need?
4. Is it safe?

Setting up the investigation

Once you have chosen your topic, it is time to start work. Plan a fair experiment; don't forget to include a control. Set aside a place and time to do the experiment. Allow yourself plenty of time.

Remember that if you are not sure about anything, ask someone. Your teacher will be only too pleased to check what you plan to do.

Writing a report of your discovery

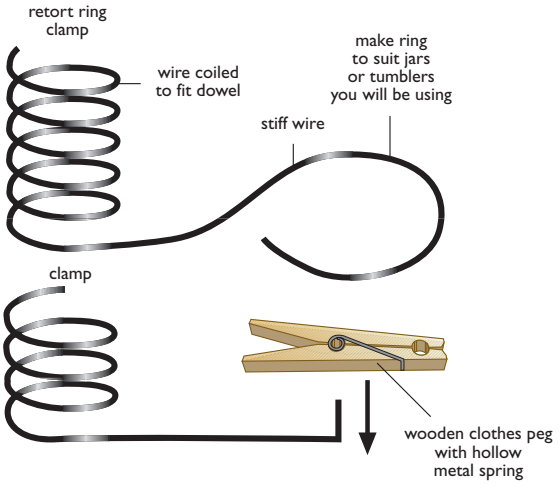
When you begin your investigation you should begin writing your report. As you work through your investigation, write the method and the results. Write the report neatly (or type it into the computer) so that you will not have to write it out again later. Your report should be divided into sections like this:

1 Question or problem. What were you trying to show or find out?
2 Outline of the investigation. How did you set it up? What did you do? This part is like the method of a school science report.
3 Results. Record your results using tables and graphs.
4 Discussion. What do your results mean? What have you discovered?
5 Conclusion. Your discovery might not change the world, but it is still important. After doing this investigation, what can you conclude? What advice can you give because of this investigation?

Making equipment

You don't need expensive laboratory equipment for an investigation. Most students get all they need from the cupboards in the kitchen at home, and don't need to make anything. If you do need some equipment, here are some ideas and hints:

- Make a retort stand using some dowel, with a piece of flat timber as a stand.
- Make a ring clamp from wire. Loops of wire will stop it from sliding down the stand.
- A wooden clothes peg can be used as a clamp.
- Use coffee drip paper as filter paper.
- Instead of a beaker, use a jar, tin or plastic tumbler.



Making home-made science equipment

- If you don't have a filter funnel at home, you can buy a plastic one for $1 to $2 from a hardware shop or supermarket.
- Plastic spoons make good spatulas.

Use yoghurt containers and bean seeds for plant experiments. Punch tiny drain holes in the bottom of the yoghurt containers. Bean seeds germinate in about five days, and grow fast for the first week.

Animal experiments are not a good idea. You can cause distress and suffering to the animals.

Lastly, be safe. If in doubt, ask someone. Do not heat anything in your home investigation. Keep your equipment away from younger brothers and sisters.

Some home-made science equipment

- Measuring spoons and jugs can be used in place of a measuring cylinder.

Remember to clearly label any substances, such as fertiliser, that you store. Do not store chemicals in food containers.

CHECKPOINT:

Make a checklist of the things you should do for a good investigation or your Student Research Project.

3.7 Can you learn better?

In each subject at school, there will be many new ideas to learn and use. In Chapter 1 you learnt about all the new equipment in a science laboratory. Most of this equipment you may not have seen before. Chapter 2 had more skills, experiments, knowledge and ideas to remember, all of them about water. This chapter has shown you ways of organising data and drawing graphs and how to plan fair experiments with controls.

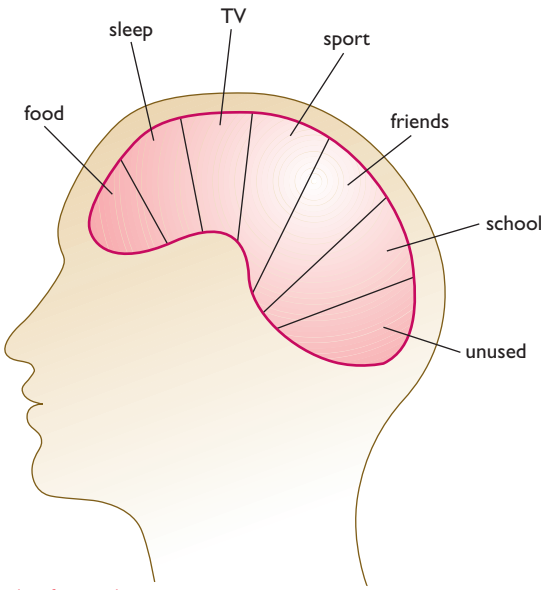
There is a lot to learn. The flow of new ideas and things to learn is constant while you are at school. Even after school, you never stop learning, no matter what you do.

There has to be a better way. How can you work smarter and not harder? Everyone can be an effective learner. Here are some hints:

1 Everyone learns by doing. This can be doing experiments, writing reports, or drawing diagrams. Homework gives you practice in doing and learning.

2 Plan your time. Don't leave an assignment until the night before it is due. Pace yourself, and do a little each night. Or do your other homework at other times to give yourself a free night for the assignment.

3 Have some time to yourself. Don't do school work all the time. Spend some time with your friends, watching television, reading books, or playing sports—whatever you do for recreation.



The brain of a student

Everyone has the ability to do well. Everyone can learn. It helps if you are motivated and interested. Use all your ability.

Here are some hints to help you learn better:

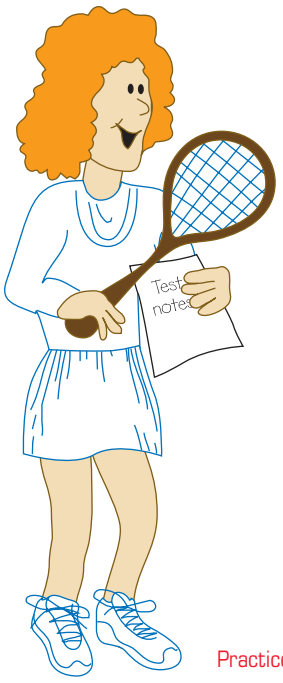
1 Read your notes each day. You forget the most within the first day after learning it.

2 Make a summary or notes or list of key words or a concept map. (Look back to Activity 1.10.) This reminds you of the important ideas.

3 Don't get left behind. Keep up to date. If you are absent from school for a few days, ask a friend if you can photocopy their notes from the classes you missed. You can write the notes into your own book later.

4 Practise what you have to learn. You need a lot of practice to get a good tennis serve or golf swing. Learning school work is no different. The more you practise … You know the rest.

Remember that you can have the time to do well at school and still go to parties, play sport, visit friends, read books and watch movies. It all depends on you and how you organise yourself.



Practice helps you learn

International sports stars practise and train everyday. This keeps them at the top of their sport. For a student, the equivalent of practice and training is study and revision. You may have heard of the saying 'No study pain, no exam gain'.

EXPERIMENT

AIM: To find out if practice helps you learn

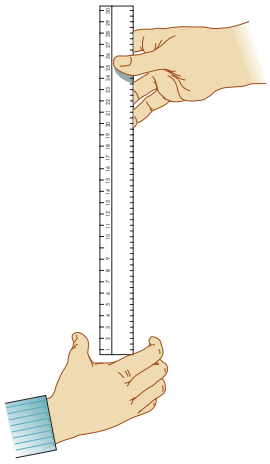
Everyone gets better when they practise something. How much better do you get? This experiment is about catching a ruler as it is falling.

Ask a friend to hold a ruler so that the zero mark is near your open hand, and then let the ruler fall. You have to grab the falling ruler as quickly as you can. Do the experiment once. Record how far the ruler falls before you catch it. Repeat this for everyone in your group.

Now practise catching the ruler. About ten more times is ideal. Then repeat the experiment and record the distance that the ruler falls.

Write a report of the experiment and record your data in a table similar to the one below. From the results of your experiment, can you conclude that practice makes you better?

Distance Ruler Fell: Without Practice (cm)	Distance Ruler Fell: After Practice (cm)



An experiment: catching a ruler

CHECKPOINT:

COPY AND COMPLETE

Everyone can be an effective learner. Here are a few hints:

1 Everyone _____ by doing. Homework gives you _____ in _____ and _____.
2 Plan your ____.
3 Have some ____ to _____.

Everyone has the _____ to do ____. Everyone can _____.

Here are some _____ to help you learn better:

1 Read your _____ each ___.
2 Make a _____ or notes or list of ___ _____ or a ____ map.
3 Don't get ____ behind. Keep __ __ ____.
4 _____ what you have to _____.

QUESTIONS

1 Draw a concept map showing the three hints to help you learn better, and the four strategies to help you learn.

2 Read the following paragraph about memory.

> *All memory is not the same. The types of memory depend on how long they last. Short-term memory is when things are remembered for a short time. Remembering a sentence while you are saying it is one type of short-term memory. Looking up a phone number and remembering it while you are dialling it is another type of short-term memory. We forget everything in short-term memory very quickly. Long-term memory is what we remember for a long time. We learn some things the first time we experience them, such as touching a hot stove. Repeated activities can be learnt, such as learning to play the guitar. Less repetition is needed to relearn these if we forget them. Proper sleep is also a part of memory function. You will recall more in a test if you sleep after studying instead of studying all night long. Eating breakfast will also improve your memory in tests later in the morning.*

a In one word, what is the paragraph about?
b Select two important words from the paragraph, and write the meaning of them.
c Select three hints from the paragraph which you could tell someone to help them learn better.

Review and Research

Review questions

1 Rosemary recorded the following information in her diary. It concerns the time she spent doing her science assignment, and the time she spent on homework for other subjects.

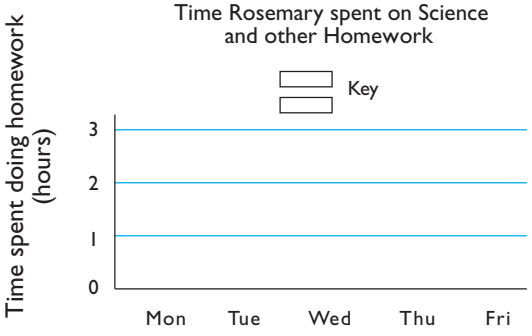
> *On Monday, I worked for 2 hours on science and then only had time for $\frac{1}{2}$ an hour for other homework before watching television. On Tuesday, I went to hockey training and had some maths homework. This took $1\frac{1}{2}$ hours, and I copied up some notes for my science for 30 minutes. On Wednesday I was able to spend $1\frac{1}{2}$ hours on both homework and the science assignment, making a total of 3 hours. The next day was a disaster. I was sick and did no science and only one hour of homework. Friday is the end of the school week, but I copied up some notes for the science assignment for one hour. On Saturday I did some English and maths homework but I forget how much, and I spent 2 hours finishing the science assignment.*

Record this information in a table, using the format below.

Time Rosemary spent on science and other homework

Day	*Time spent on science assignment (hours)*	*Time spent on other homework (hours)*
Monday	.....	.....
Tuesday	.....	.....
Wednesday	.....	.....
Thursday	.....	.....
Friday	.....	.....
Saturday	.....	.....

Now draw a histogram using the format below.

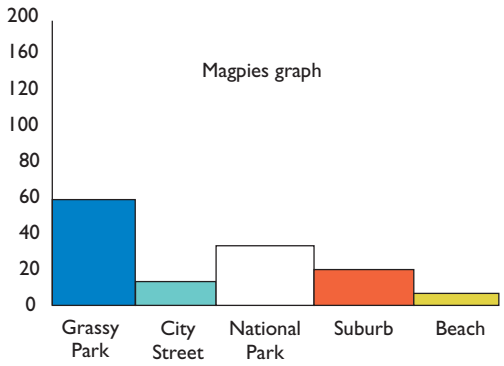


2 Draw a line graph of this data. Remember to follow the hints given in Activity 3.3 and join the points with a smooth curved line.

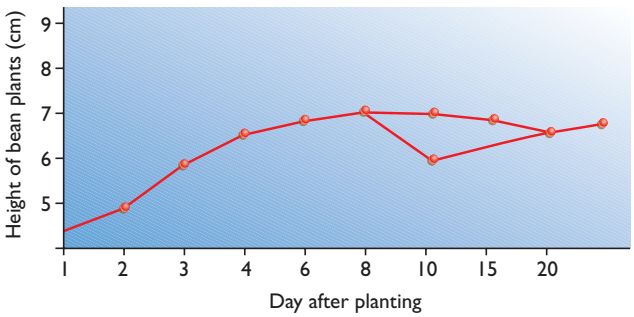
Temperature during the day

Time of day	*Temperature °C*
7.00 a.m.	*13*
8.00 a.m.	*15*
9.00 a.m.	*18*
10.00 a.m.	*22*
11.00 a.m.	*27*
12.00 noon	*30*
1.00 p.m.	*31*
2.00 p.m.	*32*
3.00 p.m.	*30*
4.00 p.m.	*25*
5.00 p.m.	*22*
6.00 p.m.	*21*

3 List as many faults with this histogram as you can. List them neatly in your note book.



4 List as many faults as you can with this line graph.



5 Match each word with its meaning.

hypothesis	something you notice with your senses
observation	a comparison so that a fair experiment is done
mnemonic	a project or experiment you do to answer a question
control	an explanation of what you observed
graph	a guess at an answer you can check by experiment
data	a rhyme, picture or clues to help you remember
prediction	another name for information
investigation	a way of showing information in a visual form
inference	a way of showing information in columns and rows
table	a guess made using a graph or other data

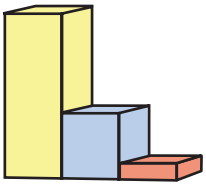
6 What rubbish goes into your wheelie bin at home? What rubbish is thrown out at school? Write the following data into one table, then draw two bar graphs side by side to compare the types of rubbish thrown out at home and school.

Wheelie bin at home	
plastics	*5%*
metals	*3%*
glass	*7%*
paper	*25%*
food and garden waste	*47%*
other waste	*13%*

Garbage at school	
food and garden waste	*38%*
plastics	*11%*
paper	*42%*
metals	*3%*
others	*6%*

7 Design and draw a three-dimensional histogram, like the one drawn below, to represent the different types of water on Earth.

Type of Water	*Millions of cubic kilometres*
Oceans	1370
Ice caps	30
Groundwater	50
Atmosphere	0.2



Example of a 3-D histogram

8 Draw three different graphs of your choosing to show the amount of water in living things.

Organism	*Percentage*
Jellyfish	95
Chicken	74
Watermelon	97
Fish	67
Human	65

Thinking questions

Here are two big questions. They have many answers.

1 How can you keep a beaker of water hot for as long as possible? List as many ways as possible and show in an experiment that your ideas are correct.

2 How can you make a beaker of hot water go cold as quickly as possible? List your ideas and test them by experiment.
Class Competition—Your teacher will select one of the two questions above. To stop anyone adding hot or cold water, the water will be coloured with food dye. You must keep the water the same colour.

Word check

bar graph	hypothesis	observation
column graph	inference	pie graph
control	information	prediction
data	investigation	scatter graph
histogram	line graph	table

Concept map

Draw a concept map of the ideas in this chapter.

Research questions

1 What is an optical illusion? Find some illusions and explain how they work.

2 Who was M.C. Escher? Find one of his drawings and explain what is unusual about it.

3 When researchers test new medicines, they use a control. Some people are given the new drug and some people are given a placebo. What is a placebo, and why don't all the people in the experiment get the drug to see how it works?

4 Make a collection of articles in newspapers concerning scientists and other people doing research. This could be medical research, or wildlife research, or the development of a new chemical, or anything else you might find.