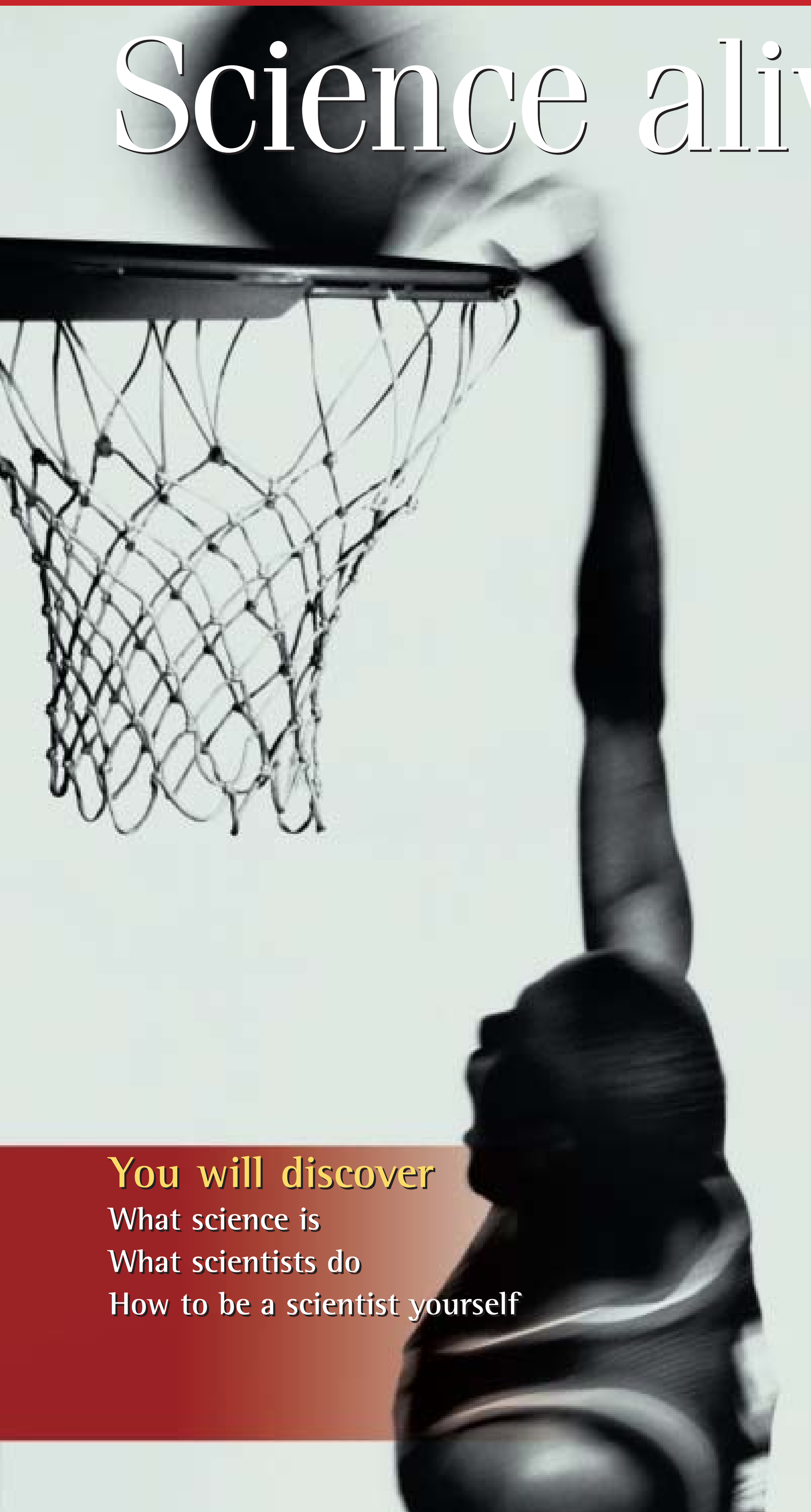
CHAPTER 1

Science alive!



You will discover

What science is

What scientists do

How to be a scientist yourself

Air time

When basketball players leap into a slam dunk, they hang in the air before sinking the ball through the hoop. Air time seems to vary for different slam-dunk artists. But scientists who study how bodies move tell us that most air times are between 0.8 and 0.9 seconds. Some players' air times are sightly longer because of the way their bodies are built or because they train to be better jumpers.

Scientists also help design the shoes worn by athletes and the surfaces they play on. They study the flight of balls through the air and the performance of different materials and clothing. Scientists and engineers create devices that measure the movement — how high, how long and how fast — of athletes and their sporting equipment.

It's not just sport that benefits from science. Scientists are at work in places you might not think of right away.

1 List three ways in which a scientist may have been involved in the design of a sports shoe.

2 What equipment might scientists use in a laboratory?

3 As a class, list 10 everyday objects. For each object, suggest how a scientist may have been involved in its design.

Where are the scientists?

You can find scientists just about anywhere. They could be in a desert finding out how plants survive without water. They could be digging deep into the ice in Antarctica. You might find a scientist searching for fossils on a rocky shore, counting rare animals in a rainforest or measuring electricity in a power station. Some scientists work in laboratories, searching for a cure for a disease. Others work with chemicals. You might even find a scientist in space.

Branching out

Earth science

Earth scientists, or ***geologists****, study the Earth. They investigate and explain how rocks and mountains form. Some specialised geologists, called seismologists, study earthquakes. Palaeontologists study fossils and ancient rocks. Vulcanologists study volcanoes.*

Biology

Biologists *study living things. They investigate how living things function and how they live together. Some biologists, like botanists and horticulturists, study plants.* ***Zoologists*** *and veterinarians study animals. Microbiologists study very small living things. People like doctors and dentists use their knowledge of biology to help keep people and their teeth healthy.*

HOW ABOUT THAT!

Humble beginnings for famous scientists

Some of the most famous scientists in history started out as average students! Albert Einstein was slow to learn to speak and hated going to class. He passed his university exams by reading notes taken by his friends. Much of Einstein's knowledge and understanding of physics came from reading and experimenting.

Isaac Newton started out studying law at university. His love for maths and science began only after he started reading about them in his own time. Newton is most famous for his explanations of gravity and colour.

Marie Curie was the first person to be awarded two Nobel Prizes. She is famous for her work on radioactivity. Marie's love for science began when she attended an unofficial university. When she was accepted into a proper university, Marie's skills and knowledge were below that of the other students. Her determination and hard work led to her success.

A mix of science

The boundaries between the different sciences are often crossed. Biophysicists and biochemists work in more than one field. Scientists often work together to solve problems. A physicist worked with medical staff to design the bionic ear. Physicists and geologists work together to locate underground mineral deposits using sound. And chemists work with biologists to find cures for diseases.

Physics

Physicists *study different types of energy. They investigate and explain things like movement, heat, nuclear energy, light and electricity. Some* ***engineers*** *use their knowledge of physics to make sure buildings are strong and cars are safe. Physics knowledge is also used in electronics, computer design and even special effects in movies.*

Astronomy

Astronomers *study the sky. They are concerned with planets, moons, stars, comets and other objects in space.*

Chemistry

Chemists *study how substances react with other substances. They investigate and explain why some substances behave differently from others and how they can best be used. Industrial chemists might look for ways to make better paints, or special plastics. Pharmacists are chemists too. They work with chemicals that are used to treat illness and disease.*

Activities

REMEMBER

1. Which science is concerned with comets?
2. State whether the following are true or false:
   (a) A biologist is more likely to study the human body than the speed of a motor car.
   (b) Isaac Newton was the first person to be awarded two Nobel Prizes.
   (c) Chemistry is the study of different types of energy.
   (d) Computer design requires knowledge of physics.

THINK

3. What type of scientist would examine rocks to see how old they are?
4. Give an example of what you think a biophysicist and a biochemist might do.
5. Look at the photograph of the basketballer on page 1. Suggest how each of the following scientists might be involved in improving his performance:
   (a) biologist
   (b) chemist
   (c) physicist.

INVESTIGATE

6. Find out what biomechanics is. Where would these scientists work? Who else would they work with?
7. Leonardo da Vinci was an early scientist who learnt a lot about science by experimenting. Find out about some of the machines that Leonardo da Vinci invented.

IMAGINE

8. Work in groups of three or four. Imagine that you are a group of scientists. Write and perform a short play or mime that tells the audience about what you do.

checklist

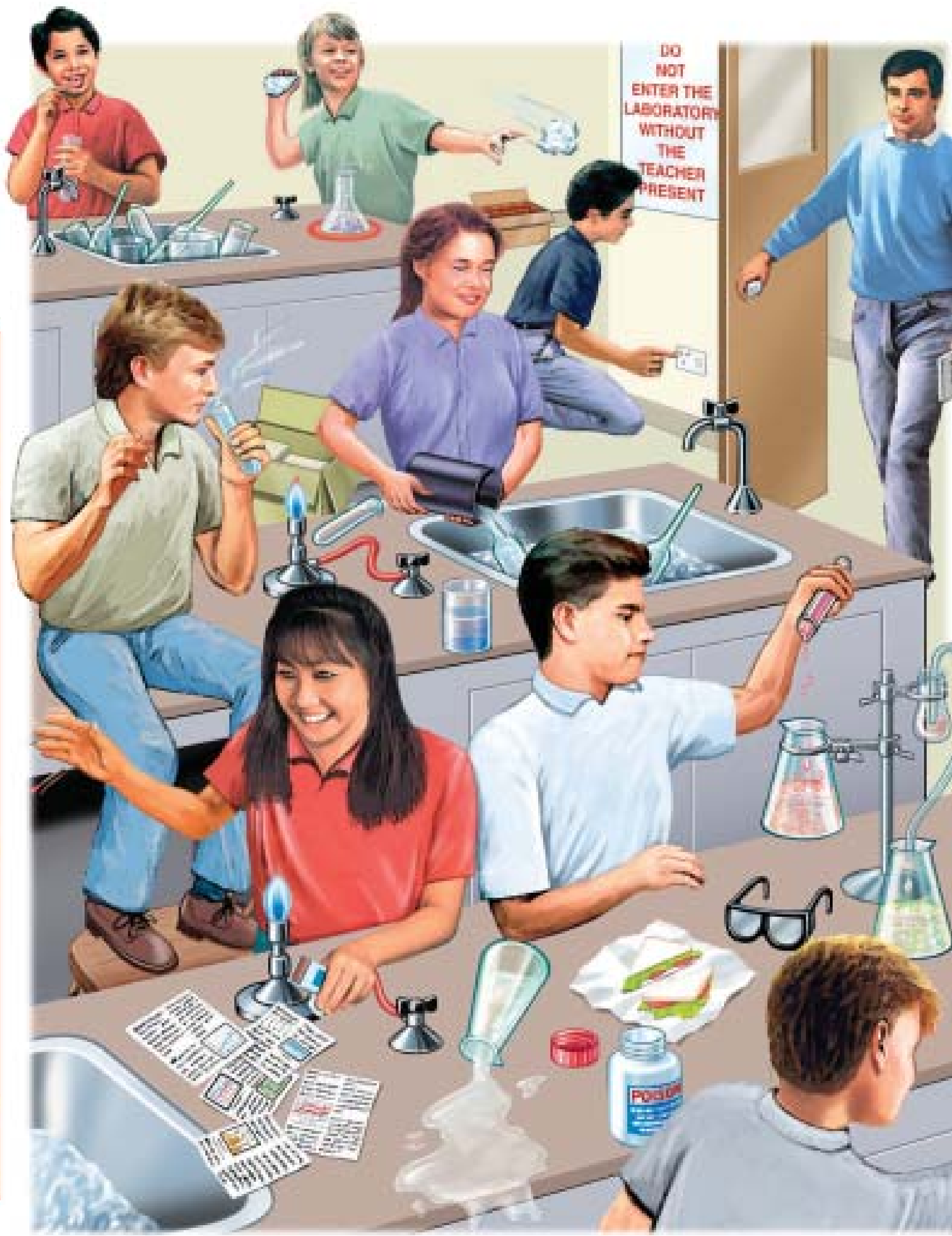
I can:

- ☐ appreciate that scientists work in a variety of situations
- ☐ list different areas of science
- ☐ describe what is involved in each science area.

Play it safe

The equipment and tools that scientists use can be unsafe if they are not used properly. It is also important that the correct equipment is used in each experiment, as each item is designed for a particular purpose.

Before you begin working in a laboratory, it is important to know the safety rules and how to use the equipment correctly. A full list of safety rules and equipment appears in the Laboratory Toolbox on pages 241–2. The safety rules are designed to keep you and your classmates safe. Look for any dangerous activities taking place in this picture.

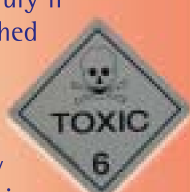


Warning signs

Your teacher will tell you how to handle the chemicals in each experiment. At times you may come across warning labels on the substances you are using. These are some of the labels you are likely to come across in a school laboratory.

Always wear gloves when using chemicals with this symbol. Corrosive substances can cause severe damage by eating away at living things and objects like metal containers. Acid is an example of a corrosive substance.

Chemicals with this label can cause death or serious injury if swallowed or breathed in. They are also dangerous when touched without gloves because they can soak into the skin. Mercury is a toxic substance.



These substances are easily set on fire. Methylated spirits is flammable.

Fire alert!

All schools have a fire-safety program. Your teacher will be able to tell you the quickest and safest way to leave the building in case of a fire. If a fire does break out in the science laboratory, don't panic:

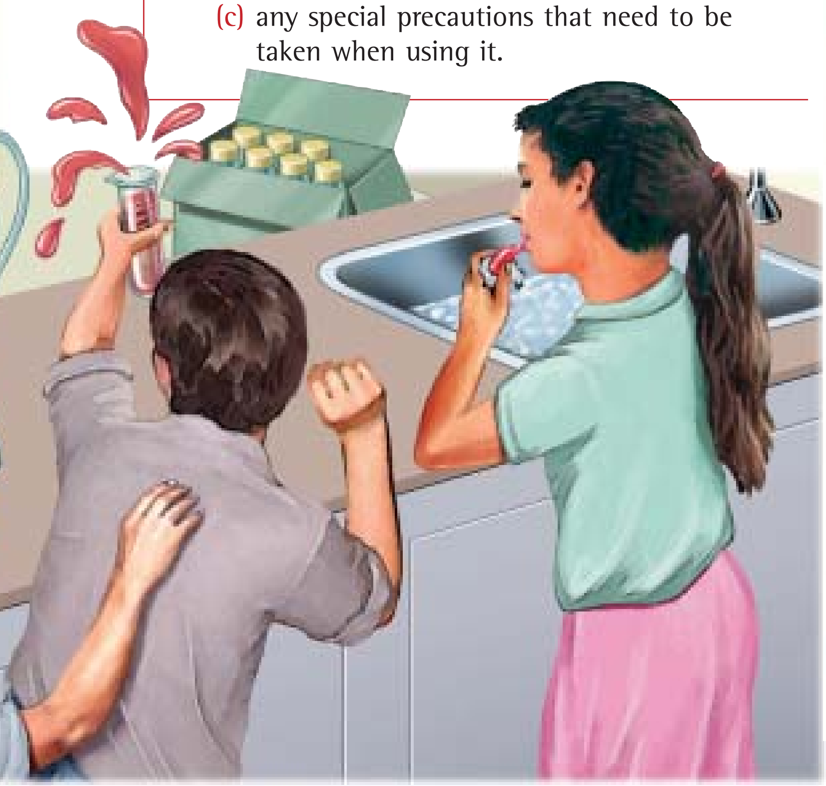
- If equipment is on fire, let your teacher know immediately. Your teacher will use sand, a fire blanket or a fire extinguisher to put out a small fire.
- If the fire is too big to be put out, you will need to follow your school's fire-exit plan. Your teacher will direct you to the safest exit and may ask you to close doors and windows, and turn off the lights. Move quickly, without running, to the assembly area.
- If you or your clothes are on fire, STOP, DROP and ROLL. Call out for help. Someone will smother the flames with a fire blanket.

Using the right stuff, safely

You will need:

all of the equipment listed on page 242 of the Laboratory Toolbox
pencil
ruler.

- Draw a two-dimensional scientific diagram of each piece of equipment. You may need to refer to page 251 of the Laboratory Toolbox.
- For each piece of equipment, list:
  (a) the name of the equipment
  (b) what it is used for
  (c) any special precautions that need to be taken when using it.



Activities

REMEMBER

You may need to refer to pages 243–7 to answer some of these questions.

1. What colour should the Bunsen burner flame be when you are not using it for heating?
2. What protective equipment or clothing should you always wear when using a Bunsen burner?
3. State whether the following are true or false. Correct any false statements by re-writing them so that they are true:
   (a) Long hair must be tied back when using a Bunsen burner.
   (b) Matches can be safely washed down the sink.
   (c) Always point a test tube towards you when heating, so you can see what is happening inside it.
   (d) Safety glasses need to be worn only when heating over a blue Bunsen-burner flame.
   (e) Use a heatproof mat under all equipment and chemicals.
   (f) Water spills do not need to be cleaned up because they are not dangerous.

THINK

4. If the teacher says it's safe to smell a chemical, how should you do it?
5. Why is there a sand bucket and a fire blanket in the laboratory?
6. Why should safety glasses be worn during an experiment?
7. Why is a heatproof mat placed under a Bunsen burner when heating?
8. When a mixture is being filtered, the filter funnel can be placed in the mouth of a conical flask. What is the advantage of using a conical flask rather than a beaker?

CREATE

9. Design a poster that outlines one of the laboratory safety rules on page 241.
10. Use a multimedia tool to give a presentation to the class explaining the fire safety procedure at your school.

checklist

I can:

- ☐ list the school laboratory rules
- ☐ recognise warning labels on chemicals
- ☐ follow the school evacuation plan in case of a fire
- ☐ label equipment and know what it is used for.

Heating in the laboratory

In many scientific experiments, substances need to be heated. A **metallurgist** might want to find out how heat affects metals used to build a space rocket. **Chemists** sometimes need to use heat to speed up chemical reactions. A **biologist** might use heat to separate some of the chemicals from plants.

In school laboratories, heating is usually done with a Bunsen burner or a hotplate. Each of these 'tools' has advantages and disadvantages.

Electric hotplate
A hotplate is used when substances need to be heated slowly. Hotplates are also used when heating substances that are highly flammable. Electric hotplates take some time to warm up.

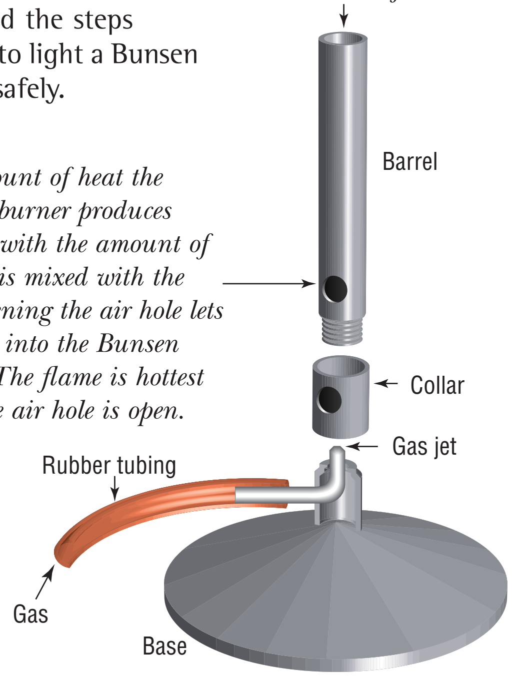
HOW IT WORKS

Bunsen burner

It is most likely that you will use a Bunsen burner when you need to heat a substance in the laboratory. A Bunsen burner heats objects with a naked flame, so care needs to be taken when using it. Make sure you know the safety rules and the steps needed to light a Bunsen burner safely.

Lighting a mixture of air and gas produces the Bunsen-burner flame.

Air hole
The amount of heat the Bunsen burner produces changes with the amount of air that is mixed with the gas. Opening the air hole lets more air into the Bunsen burner. The flame is hottest when the air hole is open.



Important equipment

Whenever heating equipment is used, there is a risk of fire. Fire extinguishers should be located in every school laboratory. The fire extinguishers in laboratories work by stopping oxygen from 'feeding' the fire. A fire cannot burn without oxygen.

Sand and fire blankets work in a similar way to an extinguisher. They starve the fire of oxygen. Sand is used on small equipment or bench fires. Use a fire blanket to smother flames on a person who is on fire.

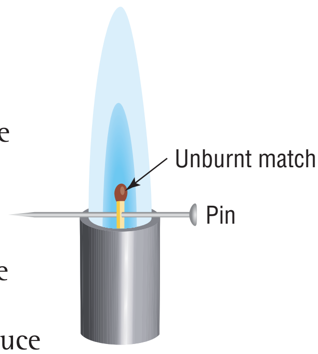
Go to worksheet 1

BODILY/KINAESTHETIC

Where is the hottest part of the flame?

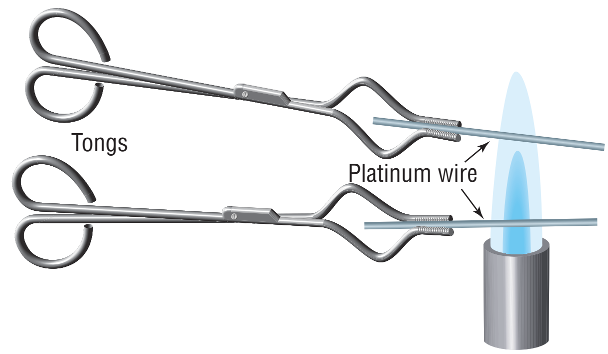
You will need:
Bunsen burner
heatproof mat
matches
platinum or nichrome wire
tongs
pin
safety glasses.

- Use a pin to hang an unburnt match over the barrel of a Bunsen burner.
- Light the Bunsen burner according to the rules on page 243.
- Turn the collar to produce a blue flame.



1. What happens to the match hanging over the barrel?

- Turn the Bunsen burner off and remove the match and pin with tongs.
- Re-light the Bunsen burner and turn the collar to produce a blue flame again.
- Use the tongs to hold the wire across the flame, close to the barrel of the Bunsen burner.



2. What colour does the wire become?

- Move the wire up a little.

3. Is the colour of the wire different now?
4. Draw a diagram of the Bunsen-burner flame, labelling the parts that are hottest.

Which flame is hotter?

You will need:
Bunsen burner
matches
pieces of porcelain
clock or watch.
heatproof mat
tongs
safety glasses

- Light the Bunsen burner according to the rules on page 243.
- Open the air hole.

1. Describe the flame. What colour is it? Does it make a noise?

- Hold a piece of porcelain over the flame with the air hole open.
- Take notice of roughly how long it takes for the porcelain to turn red-hot.
- Let the porcelain cool down on the heatproof mat.
- Close the air hole.

2. Describe the flame. Is it easy to see?

- Hold the porcelain in the flame.

3. Does it turn red-hot?
4. Do you notice anything else about the porcelain after heating in this flame?
5. Which flame is the hottest flame?

Activities

REMEMBER

1. Which is the safest flame when the Bunsen burner is not being used?
2. Which is the hottest part of a blue flame?

THINK

3. Make a list of the safety equipment needed when using a Bunsen burner.
4. Why would a hotplate be better than a Bunsen burner for heating methylated spirits?

CREATE

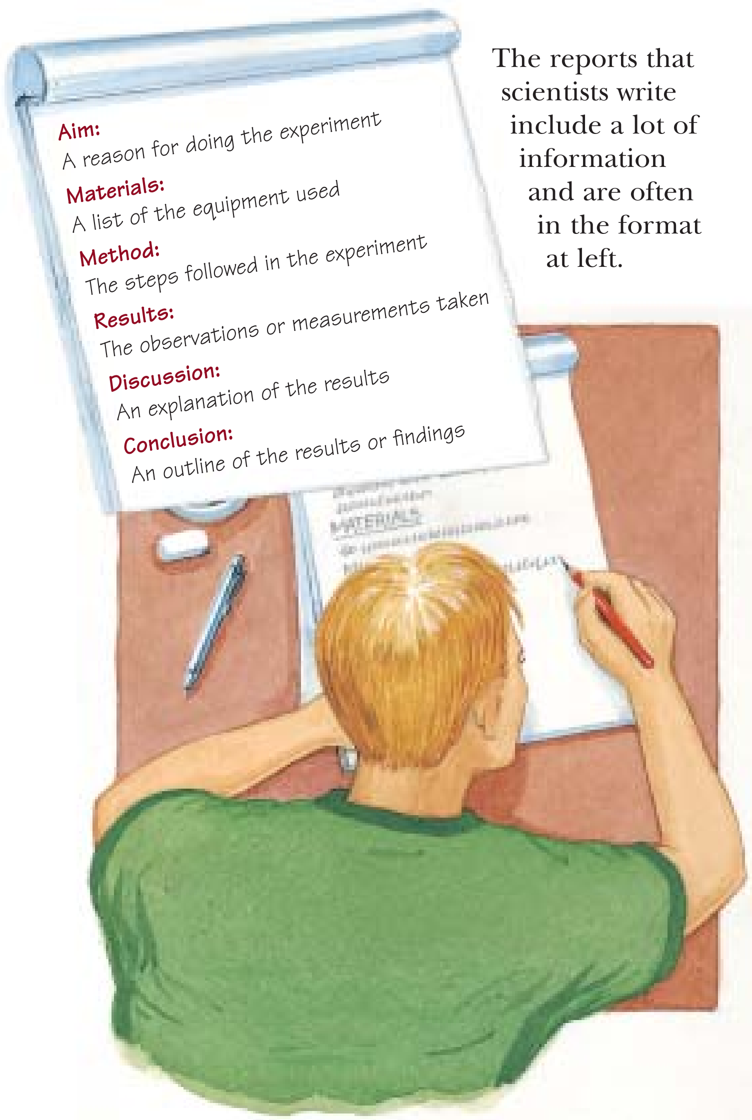
5. Draw a map of the laboratory. On your map, make sure to include benches, sinks, exit, eye-wash, fire blanket, fire extinguisher, gas taps, glass bin, glassware, power points, rubbish bins and sand bucket.

checklist

I can:
- ☐ label the parts of a Bunsen burner
- ☐ use a Bunsen burner safely
- ☐ locate fire-safety equipment in the classroom.

Reporting back

Scientists perform experiments to find out answers to their questions. When their experiments are completed, a report is written to tell others about their work.



The reports that scientists write include a lot of information and are often in the format at left.

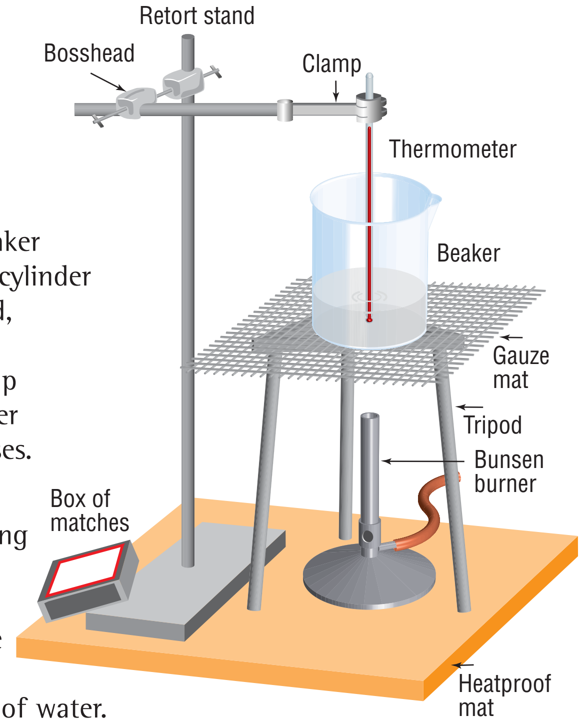
A more detailed explanation of what a laboratory report must include is on page 250 of the Laboratory Toolbox.

Temperature graphs

A graph is a useful way to present the results of an experiment. A graph gives an overall picture of the results. It can also be used to predict values that occur between, or after, those measured during an experiment.

The aim of this experiment is to show how the temperature of water changes while it is heated over a Bunsen burner.

You will need:
Bunsen burner
heatproof mat
matches
tripod
gauze mat
250 mL beaker
measuring cylinder
retort stand, bosshead and clamp
thermometer
safety glasses.

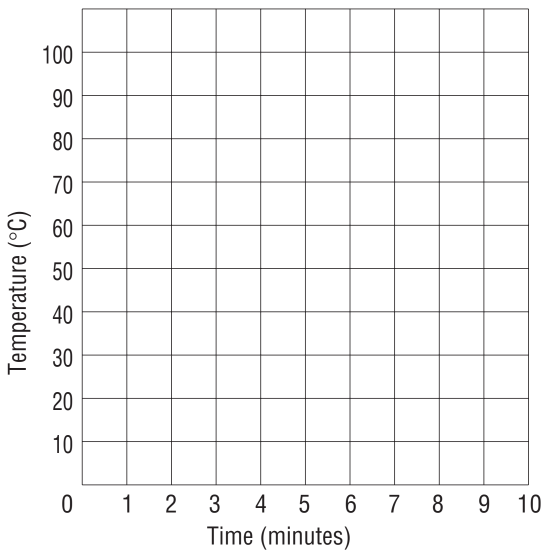


- Use a measuring cylinder to measure out 100 mL of water.
- Pour the water into the beaker.
- Set up the equipment as shown in the diagram. Make sure that the bulb of the thermometer is not on the bottom of the beaker or out of the water.
- Wait for a minute to allow the thermometer to adjust to the water temperature.
- Measure the temperature of the water. Record the starting temperature in a table. The starting temperature is recorded when time is 0 minutes.

Time (min)	Temp (°C)	Time (min)	Temp (°C)
0		6	
1		7	
2		8	
3		9	
4		10	
5			

Go to worksheet 2

- Put your safety glasses on.
- Light the Bunsen burner according to the rules on page 243.
- Open the air hole and heat the beaker over a blue flame.
- Measure and record the temperature of the water every minute for ten minutes.
- Turn off the Bunsen burner and allow the equipment to cool down.
- Plot a line graph of the data you have collected.



- Join the data points with a smooth line.

1. Describe how the temperature of the water changes over time.
2. How does your graph compare with the graphs of other students?
3. Use your graph to estimate the temperature of the water four and a half minutes after heating started.
4. Predict the temperature that the water would have reached 11 minutes after heating started.

Extension

- Set up data-logging equipment with a temperature probe. Your teacher will help you with this.
- As soon as the Bunsen burner is turned off, place the temperature probe in the water.
- The data logger will record the temperature of the water as it cools.

1. Describe the cooling graph.
2. List the advantages of using a data logger instead of a thermometer to measure temperature.

HOW ABOUT THAT!

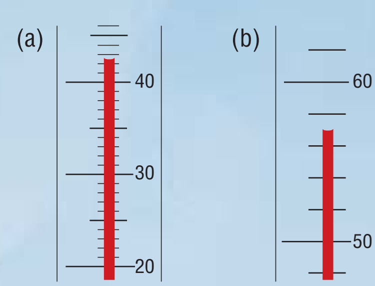
Hot and cold

The hottest air temperature ever measured on Earth is 58 °C. The measurement was taken in 1922 in Libya. The lowest temperature ever measured was in 1983 in Antarctica. That temperature was –86.6 °C.

Activities

REMEMBER

1. Why do scientists write reports about the experiments they conduct?
2. In which part of a laboratory report would a graph of distance against time be drawn?
3. What is the difference between the results of an experiment and the conclusions made?
4. What temperatures are shown on the following thermometers?



THINK

5. Why shouldn't a thermometer rest on the bottom of the beaker during heating?
6. Why would you not use a thermometer with a scale from 0 °C to 30 °C for measuring the temperature of your body?

INVESTIGATE

7. Does adding salt to water change the way the temperature rises when the water is heated? Design an experiment to test your answer.

checklist

I can:
- ☐ write a laboratory report
- ☐ measure temperature with a thermometer
- ☐ use tables and graphs to record results.

Checkpoint

Science on the move

Who invented the car? Well, it depends on what you mean by 'car'. Since the ancient Greeks, people have had ideas about moving without the help of animals. A steam-driven vehicle was invented in 1792. But was it really a car? In the 1880s, cars with more modern motors were built.

Cars have been changed bit by bit by many people over hundreds of years. For this reason, it is hard to say who invented the type of car that people drive today.

Steaming ahead

The first cars were powered by steam. They were big, heavy and very noisy. Many people complained about the safety of 'road steamers'. New laws had to be passed. In 1865, a law was written to limit the speed of road steamers in Britain to 3 km/h in the city. A man waving a red flag had to walk in front of the steamer to warn people of its approach.

New ideas

While some inventors worked on steam-driven cars, others worked on different types of motor. Through their experiments, they found that battery cars were quieter than the steam cars. But the battery cars needed constant re-charging. Then, in the 1880s, Karl Benz and Gottlieb Daimler designed the earliest relatives of the modern car. Benz and Daimler each had their own designs and **patented** them at about the same time. Karl Benz and Gottlieb Daimler were not scientists. They were **engineers**. Engineers use scientific ideas to build new **technology** and make it work.

When Daimler died in 1900, his company took his name off the car he had created. They replaced it with 'Mercedes'. The new name came from the daughter of a businessman who sold Daimler's cars. In 1926, the Mercedes company merged with Karl Benz's company to form Mercedes-Benz. This company still exists today, but their cars look very different.

The vintage Mercedes (top) is an early relative of this late-model Mercedes-Benz E320 sedan (bottom).

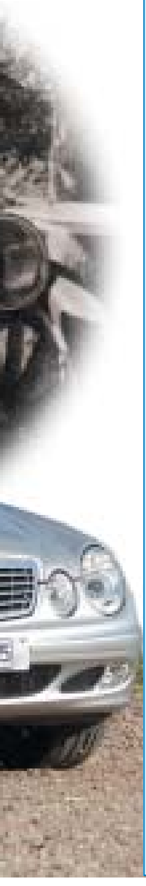
HOW ABOUT THAT!

What's in a name?

In 1792, Oliver Evans applied for a patent on a steam carrier, his early version of a car. (A patent gives an inventor permission to use and sell his or her ideas without competition from someone else.) Evans called his machine the '*oruktor amphibolos*'. Luckily, other people had similar inventions with better names. Otherwise, what we call the car or automobile today, could have been called the '*oruktor amphibolos*'!

Fact: The word *amphibolos* comes from amphibian. The *oruktor amphibolos* could drive on land as well as propel through water.

The people who make and test Formula One racing cars are also engineers. The engineers work together to make the cars safer, lighter and faster.



Engineering cars

CAREER PROFILES

Engineers design all cars, not just Formula One cars. Car companies employ many different types of engineer. Each engineer has his or her own part to design and test.

Jacquie Fox is a product engineer with Toyota. She assists with the design and development of **resin** (plastic) parts like exterior lights. The parts she designs have to fit in with parts designed by other engineers. Jacquie must make sure that her designs work properly, are safe and improve the look of the car.

Jacquie says the most exciting part of her job is '... seeing the finished product on a vehicle'. Jacquie and her team spend long hours solving problems and finetuning designs; however, she says that '... the rewards far outweigh the hours worked'.

Jacquie loved physics at school, but didn't enjoy chemistry. After studying engineering at university, she became more interested in chemistry. Now Jacquie uses her understanding of both physics and chemistry in her designs.

> 'Our jobs benefit the community because we are continually improving the safety and performance of cars. Some obvious examples are airbags, ABS brakes and **traction** control. We are also continually finding ways to reduce exhaust **emissions** for cleaner air.'

Go to worksheet 3

MI INTERPERSONAL

Activities

REMEMBER

1. What was an advantage of battery cars over steam cars?
2. (a) What was the speed limit in British cities during 1865?
   (b) Why was a speed limit needed?
3. How does the work of engineers like Jacquie Fox benefit the community?

THINK

4. Why do inventors patent their inventions?
5. What is the difference between a scientist and an engineer?
6. A four-wheel drive is built differently from a sedan.
   (a) What are four-wheel drives designed to do?
   (b) List some of the features of a four-wheel drive that allow it to do this.

PREDICT

7. Draw what you think cars will look like in 20 years from now. Think about the shape and size of the car and what energy source it might use.

checklist

I can:

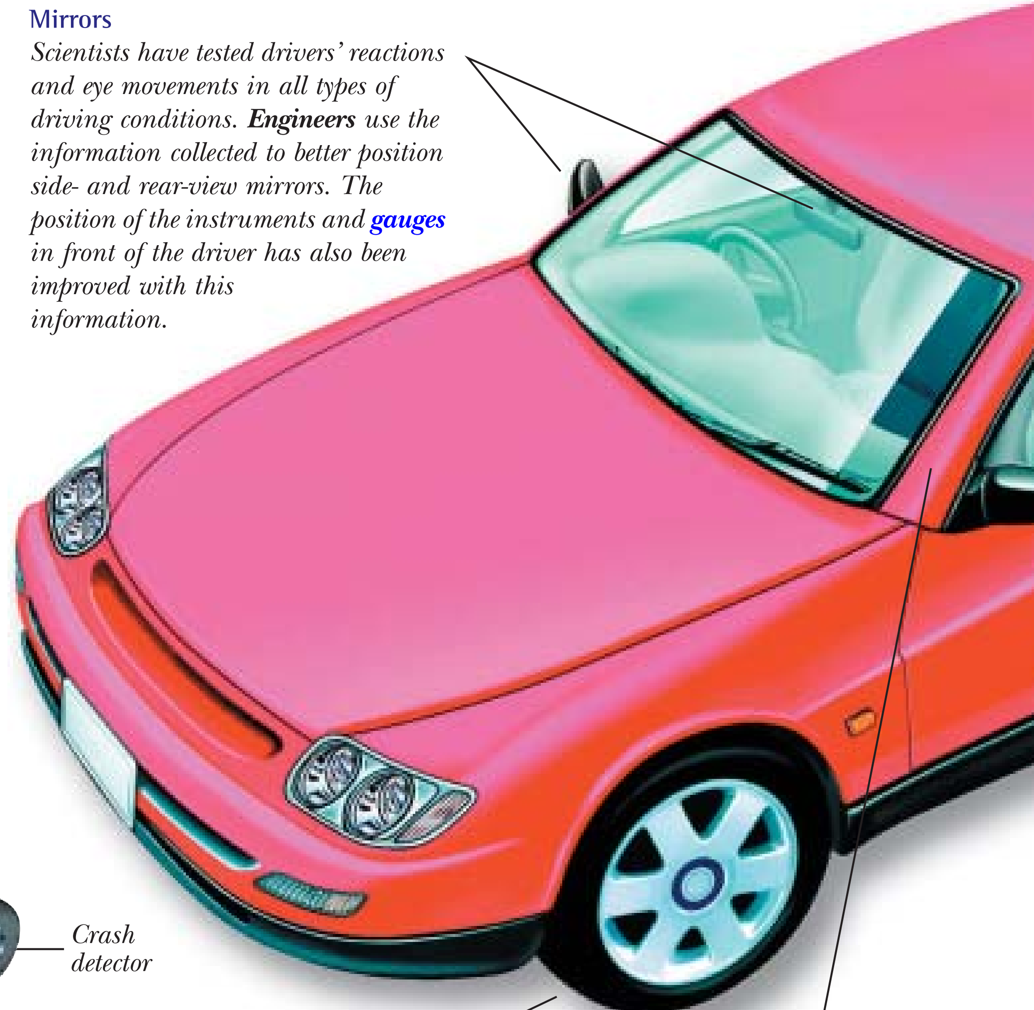
- ☐ describe some early cars
- ☐ understand the role of an engineer
- ☐ discuss the difference between a scientist and an engineer.

High-tech cars

The inventors of the car could never have imagined some of the latest developments in cars brought about by science. Scientific knowledge is used to improve the design of every new car. The cars we drive today are safer, stronger, lighter and faster than ever before.

Mirrors

Scientists have tested drivers' reactions and eye movements in all types of driving conditions. ***Engineers*** *use the information collected to better position side- and rear-view mirrors. The position of the instruments and* ***gauges*** *in front of the driver has also been improved with this information.*



Airbags

Airbags are designed to stop a person colliding with the inside of the car. If the car is involved in a crash, the airbags fill within one twenty-fifth of a second and burst from their storage area at about 300 km/h. Soon after, the air escapes from the airbag through tiny holes in the fabric.

Tyre treads

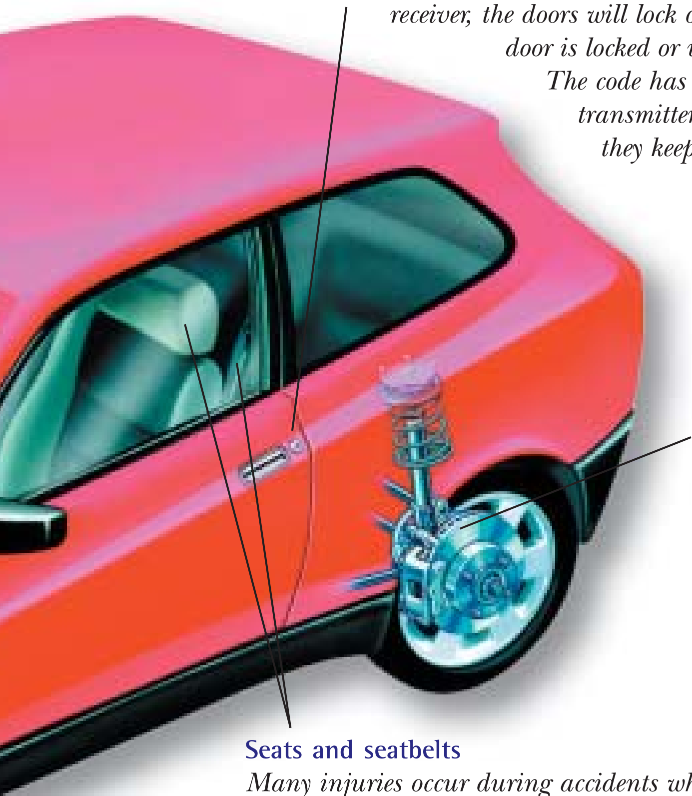
The lines and grooves in tyres are called treads. Treads help keep the car under control in wet weather. Engineers design treads so that, in wet weather, water can squirt out from under the tyre. If this did not happen, the tyres would have no grip on the road and would slide over the water instead.

Better vision

Engineers have designed stronger windscreens and pillars, so that the thickness of the pillar can be made smaller. The size and the position of the pillars give the driver a better view of the road, making the car safer to drive.

Remote keyless entry

Most new cars are locked and unlocked by pressing a button on a key ring. These key rings have ***transmitters*** *inside them that send out signals. A* ***receiver*** *picks up the signal. If the signal matches a code in the receiver, the doors will lock or unlock. Each time the door is locked or unlocked, the code changes. The code has to change in both the transmitter and the receiver, so that they keep recognising each other.*



ABS brakes

Anti-lock Braking Systems (ABS) help cars stop more safely. If the wheels of a car lock up (stop turning) on a slippery road, then it is almost impossible to stop. ABS brakes work by stopping the wheels from locking up. They make sure that the wheels keep turning and slow down with the car, rather than sliding.

Seats and seatbelts

Many injuries occur during accidents when passengers are not properly supported or are 'thrown' from their seats. Headrests are designed to stop the passenger's head from 'whipping' backwards during an accident. To stop passengers from being thrown from their seat, all cars are fitted with seatbelts. Seatbelts are designed to lock during sudden forward movements.

HOW IT WORKS

Cars with wings

The same **technology** that helps aeroplanes to fly keeps racing cars on the ground. The wings of an aeroplane are designed to lift it off the ground and keep it in the air. A racing car uses the same idea, but in reverse. The wing or **aerofoil** on a racing car is upside down compared to an aeroplane. The aerofoil on a racing car keeps the car on the ground. Without it, a racing car could take off. Racing cars often travel faster than light aircraft just before take-off.

Activities

REMEMBER

1. What is the purpose of the treads on tyres?
2. Why are cars fitted with airbags?
3. List two ways that scientists and engineers have improved the driver's vision from a car.

THINK

4. Why are airbags made with fabric that has tiny holes in it?
5. What might happen to a racing car if its aerofoil was turned upside down?

BRAINSTORM

6. What might be the aim of the experiment below?

7. In groups of three or four, make a list of other technology used in cars.

IMAGINE

8. Imagine you could design any type of technology. What technology would you put into a car of the future? Explain why you chose this.

checklist

I can:
- ☐ list new technology that makes cars safer
- ☐ describe how scientific knowledge has improved cars
- ☐ understand how technology is important in motor cars.

Science in the swim

Australian swimmers are among the best in the world. The facilities they use have been especially designed by scientists. Scientists also assist with training methods and keeping our swimmers healthy.

Gliding through the water

Scientists at the Australian Institute of Sport use a video connected to a computer to analyse every part of an athlete's swim. The information they collect is used to tell a swimmer exactly where and how they can improve. The area of science that studies how animals (including humans) move is called **biomechanics**. **Marine biologists** study the animals in our seas and oceans. Their knowledge of the skins of marine animals was used to help design the FastSkin suit.

Keeping the head down creates a lot less drag. It also helps keep your hips and legs higher in the water, creating a more streamlined shape.

*In the past, swimmers shaved their bodies to reduce **drag**. Now, swimmers cover up as much as possible. This suit produces less drag than human skin.*

After years of studying different techniques, scientists agree that a bent arm, pulled through the water in an S shape, helps a swimmer swim faster. Swimmers also keep their fingers slightly spread to push against a greater amount of water.

Go to worksheet 4

The fast pool

Australian scientists and engineers designed a 'fast pool' for the 2000 Sydney Olympics. Many records were broken. However, scientists had to make sure that the pool's design complied with Olympic rules.

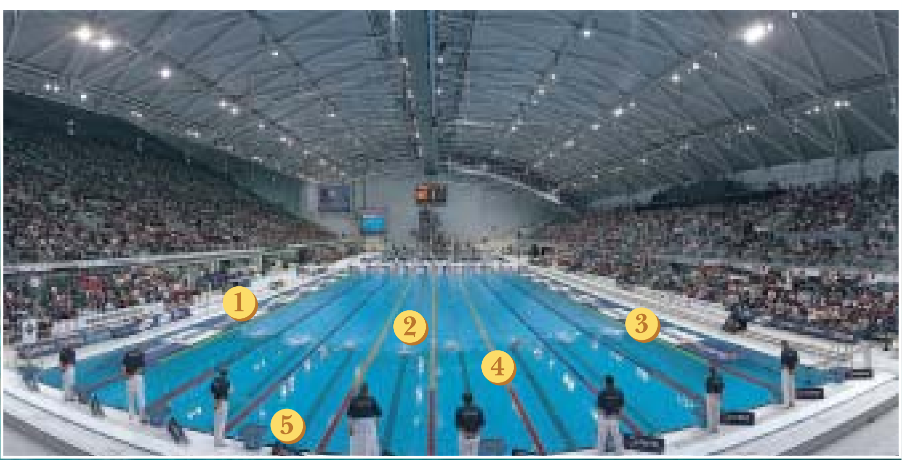
1 *The concrete pool had to be built to very accurate lengths. The rules allow a pool to be up to 3 cm longer than the 50 m official length. If Ian Thorpe had raced the 200 m freestyle in a pool that was 3 cm too long, his time could have been 0.015 s longer. That's long enough to rob a swimmer of a world-record time!*

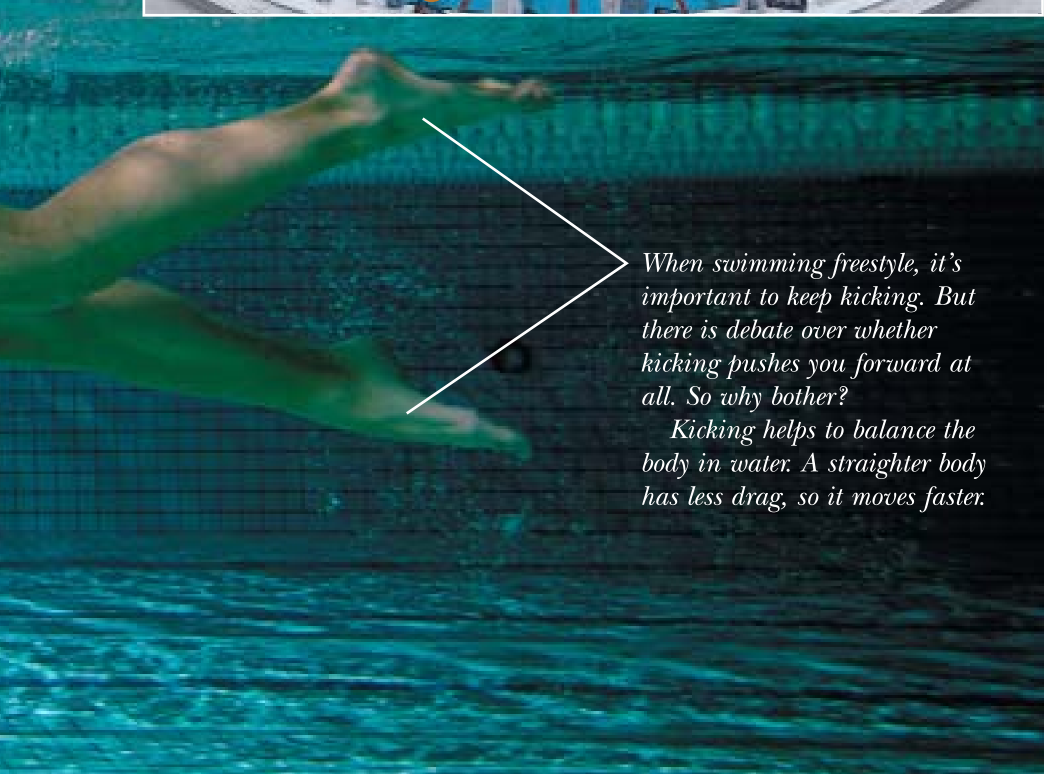
2 *Deep pools do not reflect waves as much as shallow pools. The Olympic pool has a minimum depth of 2 m.*

3 *Wavy water is more difficult to swim through than still water. The sides of a pool are the waviest parts, because the waves crash into the sides and bounce back again. The gutters on the side of the Olympic pool are designed to stop water waves bouncing back to the centre of the pool.*

4 *These anti-wave lane ropes were developed by scientists to help keep the water still. The slotted discs are attached to a steel cable that stops waves crossing into the next lane.*

5 *These starting blocks are on a slight slope. The design of the hand- and foot-grips give the swimmer the best chance for a good start.*





When swimming freestyle, it's important to keep kicking. But there is debate over whether kicking pushes you forward at all. So why bother?

Kicking helps to balance the body in water. A straighter body has less drag, so it moves faster.

Activities

REMEMBER

1. How long is an Olympic-sized swimming pool?
2. What type of scientist helped design the FastSkin suit?
3. Why do swimmers keep their fingers slightly spread?

THINK

4. How does a knowledge of marine biology help with the design of suits like the FastSkin?

CALCULATE

5. If an Olympic-sized swimming pool were 3 cm too long, how much further would a competitor swim in an 800 m race?

INVESTIGATE

6. What role do scientists play in checking for drug use among athletes?

CONNECT

7. Go to www.jaconline.com.au/science/weblinks and click on the Australian Institute of Sport link for this textbook to answer the following questions.
   (a) What are the important physical characteristics of swimmers?
   (b) Apart from swimming, what other types of training do swimmers do?

DESIGN

8. Create your own swimming suit that is designed to be fast in the water.

checklist

I can:

- ☐ understand how science helps improve swimming times
- ☐ list ways that scientists contribute to sporting achievement and fairness.

Healthy science

It is easy to see how studying biology could lead to a career in health science. However, other studies in science are also very useful. Much of the **technology** used in the health industry is designed and tested by scientists who have backgrounds in a combination of biology and other sciences.

CAREER PROFILES

Name: Arianne Lee

Job title: Clinical trials assistant

Company: Medtronic Australasia

Field of science: Medical clinical research

What first interested you in science?

Arianne's interest in science was first sparked in grade four, after learning about famous scientists from the past. She has always been fascinated by how relevant science is to everyday life.

Some time ago, Arianne was a patient in clinical trials for asthma medication and has since taken an interest in the health sciences. Her father's work in the **pharmaceutical industry** has also given her an interest in this field of science.

Study

Arianne has a Bachelor of Science from Monash University. Her major areas are **physiology** and **pharmacology**. These areas are related to human biology and chemistry.

The nature of her work

Arianne is a link between a research company that tests **pacemakers** and the hospitals that run the tests. She decides who will test the pacemakers and in which hospitals. Arianne seeks permission from the Ethics Committee before any tests are conducted. These committees decide whether the tests are appropriate and also make sure that proper procedures will be followed. After collecting data from the clinical tests, she reports on the results.

Arianne's job as a clinical trials assistant allows her to work for a company whose technology saves lives. She says, 'Every day I am able to experience the feeling that my scientific knowledge makes a real difference in the lives of everyday people. Not only does this technology improve the quality of people's lives, but it saves lives too'.

Name: Paula Fisher

Job Title: Laboratory Scientist

Company: Vision BioSystems, Ltd

Field of science: Histology

Paula Fisher is a **histologist**. Histology is the study of the **cells** and tissues that make up animals, including humans. Histologists look at small samples of cells and tissues under microscopes.

How does your job benefit the community?

Cancer is a condition where cells grow abnormally. Each year, many people are **diagnosed** with cancer. Experts agree that the earlier treatment starts, the better the chances of survival.

Paula and her team help engineers to design machines. Their machines make diagnosing cancer a much faster process.

Paula's job requires her to run the machines and make sure that the **cells** are clear and easy to see. This makes diagnosing cancer more accurate as well as faster.

What is the most exciting part of your job?

Aside from helping people, Paula sees many benefits to her job. She says, 'The company is new and still growing. There are lots of opportunities available and the work varies as the company changes. There is also the possibility of travel'.

Study

Paula enjoyed biology and chemistry at high school. She studied Applied Science at university and followed this up with a Graduate Diploma in Medical Laboratory Science. Many universities require students wanting to get into this field to have studied chemistry and one other science, usually physics or biology.

A controlled pace

An artificial pacing system is a device that is used to control the rate of a heartbeat. A pacing system is used for conditions where a heart has an irregular or slow beat. A pacing system has three parts: a pacemaker, leads and a programmer. The pacemaker and leads are inserted into the patient during an operation.

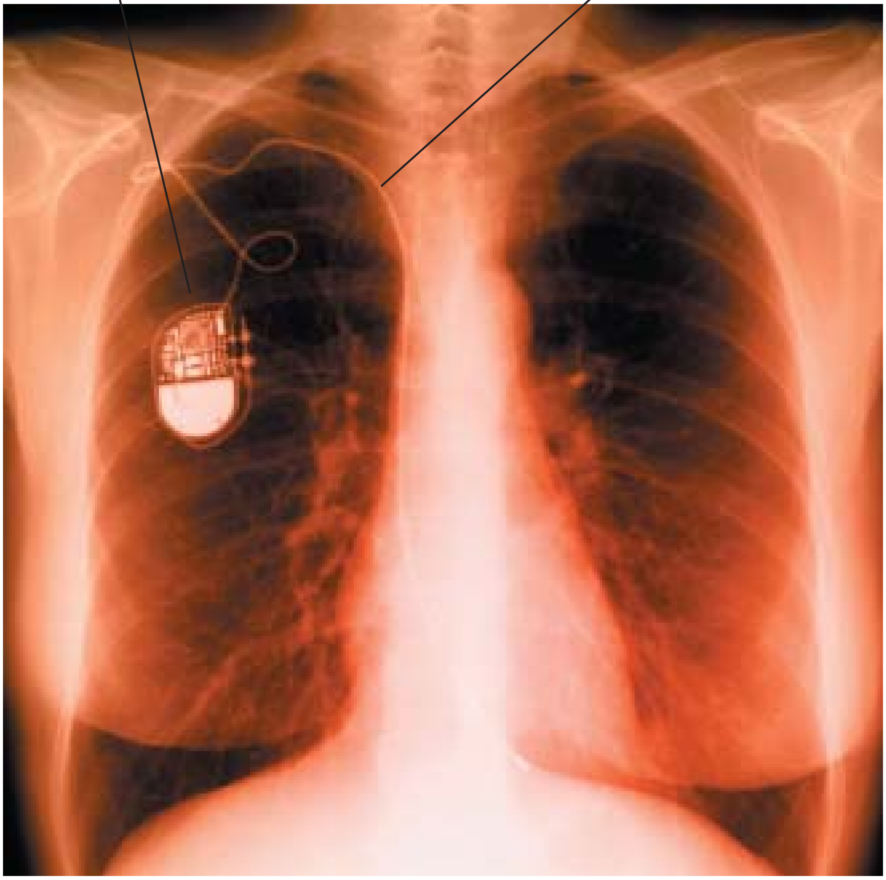
Pacemaker

Some pacemakers send a regular electrical pulse to the heart to tell it when to beat. Others remind the heart to beat only if it begins to beat too slowly. Some pacemakers can even detect the amount of activity the patient is doing and will change their heartbeat to match the activity level.

Pacemakers run on batteries that last from 7–12 years.

Leads

Electrical wires, called leads, connect the pacemaker to the heart. The leads carry electrical impulses to the heart and send messages from the heart back to the pacemaker. The leads are inserted through veins into the heart.



Programmer

The programmer is a computer system used by doctors and nurses to send and receive messages from the pacemaker. A doctor or nurse can change the settings of a pacemaker without surgery by using a magnetic-programming head. The programming head is placed over the pacemaker during a regular visit to the hospital or clinic. Some patients can even have their pacemakers checked over the phone through special transmitters.

Activities

REMEMBER

1. What medical trials did Arianne participate in herself?
2. Which sciences would you need to study at high school to become a histologist?

THINK

3. What do the two professions on this double page have in common?

BRAINSTORM

4. In groups of two or three, make a list of the skills and other qualities people in the health sciences need to have.

IMAGINE

5. Imagine you have just completed a design for the first pacemaker. List three issues you will need to research before you connect the pacemaker to a human body.

CONNECT

Use the Internet or other resources to answer the following questions.

6. Find out what the medical name for a slow-beating heart is.
7. Find out how the batteries in a pacemaker are changed.
8. On average, how many times per minute does a heart beat?

checklist

I can:

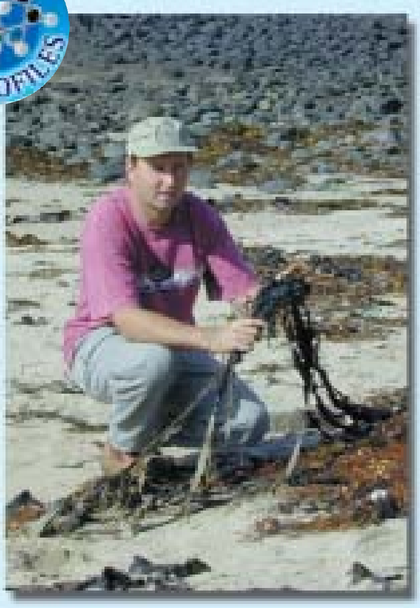
- ☐ describe some scientific jobs in the health industry
- ☐ describe how a pacemaker works
- ☐ appreciate some of the issues faced by the inventors of the pacemaker.

Out and about

When some people think of science and scientists, they think of people in laboratory coats, mixing substances in test tubes. Some scientists do exactly that. But many scientists don't spend much time in laboratories.

The scientists on this double page work outside. They are concerned about the environment, and the plants and animals that share it.

CAREER PROFILES



Name: **Peter Dann**

Job title: Research Manager

Company: Phillip Island Nature Park, Victoria

Field of science: Zoology

The purpose of the Phillip Island Nature Park is to protect the wildlife in the area. That means keeping the animals safe from threats to them and their environment. It also means managing the tourists that visit the park every day.

The job

Peter works with the penguins that nest on Phillip Island. He counts the birds and observes their behaviour. He uses **technology** to track the diving depths of the penguins and writes articles about his findings. At other times, Peter helps other people conduct research on penguins. He decides what will be researched and who will do it.

High-school science

Peter enjoyed science at school, but his interest in the environment mainly came from regularly camping out in the bush. His parents inspired and encouraged his interest in nature. He is now a **zoologist**. Zoology is a field of biology. He says, 'One of the good things about being in this job is that you work with interesting people. The people working around me and with me are a source of inspiration . . . You don't do this for the money. It suits my nature; I'm a curious sort of person. I like working outside and away from the big cities. There are also benefits for the community'.

Name: **Roger Kirkwood**

Job title: Research Biologist

Company: Phillip Island Nature Park, Victoria

Field of science: Marine biology

Roger also works at the Phillip Island Nature Park. He takes care of the fur seals in the area. Roger travels out to Seal Rocks every month to collect samples of animal wastes. From this he can tell what the seals eat. He collects data on the population of the seals and uses satellites to track their paths. Roger is often called on to rescue seals that become entangled in fishing nets.

The best and worst

Roger says that, 'The best part of the job is that there are no typical days. I get to work outdoors on something that is worthwhile and valuable. There is freedom to research and go to places others dream of going to. I scuba dive all the time and travel to the islands in Bass Strait. I've been to Antarctica nine times and to South America four times'.

Roger finds that the most difficult part of his job is sitting at his desk, looking at data. He says, 'It can also be frustrating to start new projects. A new project has to be accepted by so many people that it can take several months before the project can actually start'.

Study and skills

Roger has a Bachelor of Applied Science. He completed extra studies in zoology. People who work in this field often have a background in biology. They need to be able to get along with people, but also work in isolated situations.

Name: Tony Ladson

Job title: Project Leader (river restoration)

Company: University of Melbourne, Cooperative Research Centre for Catchment Hydrology

Field of science: Environmental engineering

Our waterways are important. They supply us with water, animals live in them and plants grow along them. But, sometimes, the waterways get 'sick'.

Tony has been described as a stream doctor. He works in the field to collect data about the flow of rivers. He studies materials along the beds and banks of rivers and is part of a large effort to improve their health. Tony says that the most exciting part of his job is '... coming up with new ideas, working with committed people and influencing what happens in the real world'. He also has the opportunity to write books, reports and manuals about the data he collects.

As a student

Tony enjoyed studying science — especially the 'hands on' parts. He has an engineering degree from the University of Melbourne, a Master of Science from the University of Minnesota, USA and a PhD from the University of Melbourne.

Looking to the future

Environmental engineering combines biology with geography and environmental studies. Tony says that, 'There are many jobs available in this field because it is so new. Improving the environment is essential for our future. Many of the jobs that will be in this field in the near future don't even exist now'.

Go to worksheet 5

MI NATURALIST

Activities

REMEMBER

1. List two animals that the Phillip Island Nature Park looks after.
2. Why is Tony Ladson sometimes called a stream doctor?

THINK

3. Which area of science is common to all three of the jobs on these pages?

BRAINSTORM

4. In groups of two or three, discuss and write down answers to the following:
   (a) Outline the reasons why the three jobs on this page are important.
   (b) What would the world be like if these jobs did not exist?

INVESTIGATE

5. Investigate why fishing nets and pollution are dangerous to seals. Design a poster that aims to stop the problem.
6. What is the major natural predator of fur seals?

checklist

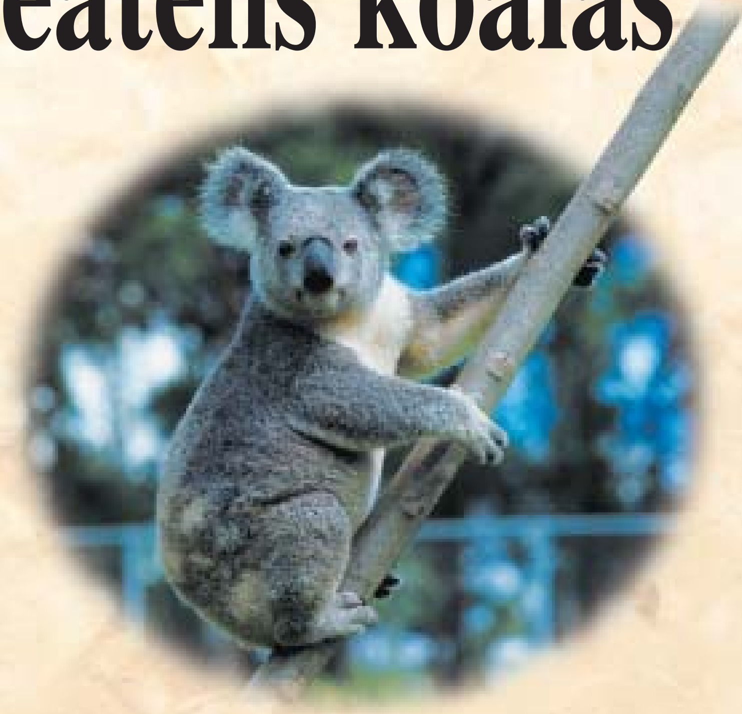
I can:

- ☐ appreciate that not all scientists work in laboratories
- ☐ list some of the jobs that environmental scientists do
- ☐ discuss how science can help to improve our environment.

The Eastern Shores Weekly

26 May 2007 | Weather: 17°C

New road threatens koalas



Environmental experts and koala protection groups are concerned about a proposed new highway that is to be built through several koala colonies. The information was leaked a week ago to a member of the Eastern Shores Koala Protection Group. The highway is to extend into a previously protected area of the Eastern Shores Forest.

Garry Michaels, an **ecologist** and spokesperson for the koala protection group, says that members have been observing the area closely for the past twelve months. 'We have attached collars with radio-tracking devices to the koalas in the area to monitor their movements. Our results show that building a section of the highway through the forest will destroy the homes of 30 koalas', he said.

The future for the Eastern Shores koalas

The highway is the first part of a new development plan for the area. Land along the new highway will be turned into house blocks, parks, shopping areas and restaurants. Council members say the development will boost the number of tourists to the area and become an inviting, new place to live. New homes will have fantastic ocean and forest views.

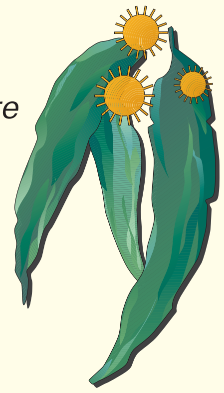
A local council member was available for comment and said, 'We have done our homework. The koalas can be relocated to another part of the forest, where currently there are no koalas. They will have a larger area than the space they occupy now. We can fence off the area with new koala-proof fences so that they will not venture onto the new road'.

Garry Michaels and his team have thoroughly researched the diets of the local koalas by tracking them and by analysing their droppings. He claims that the koalas will not be able to move to another part of the forest because the trees that grow there are not the type the koalas prefer.

Experienced **zoologist** Carrie Taylor agrees that moving the koalas is not the answer. 'Koalas are fussy eaters. Each individual koala has its own preference for food and shelter. Moving a koala could be difficult, as you would need to find the same type of trees in another spot. Changing the social mix within a group of koalas could also be disastrous', she said.

Pathologists working with Carrie Taylor have gathered their own data from relocated koala colonies. Their research shows that many koalas have died of starvation when moved to other areas. Others have also become ill from the stress of being handled. Mr Michaels is afraid the same thing will happen to the Eastern Shores koalas.

K-Fence

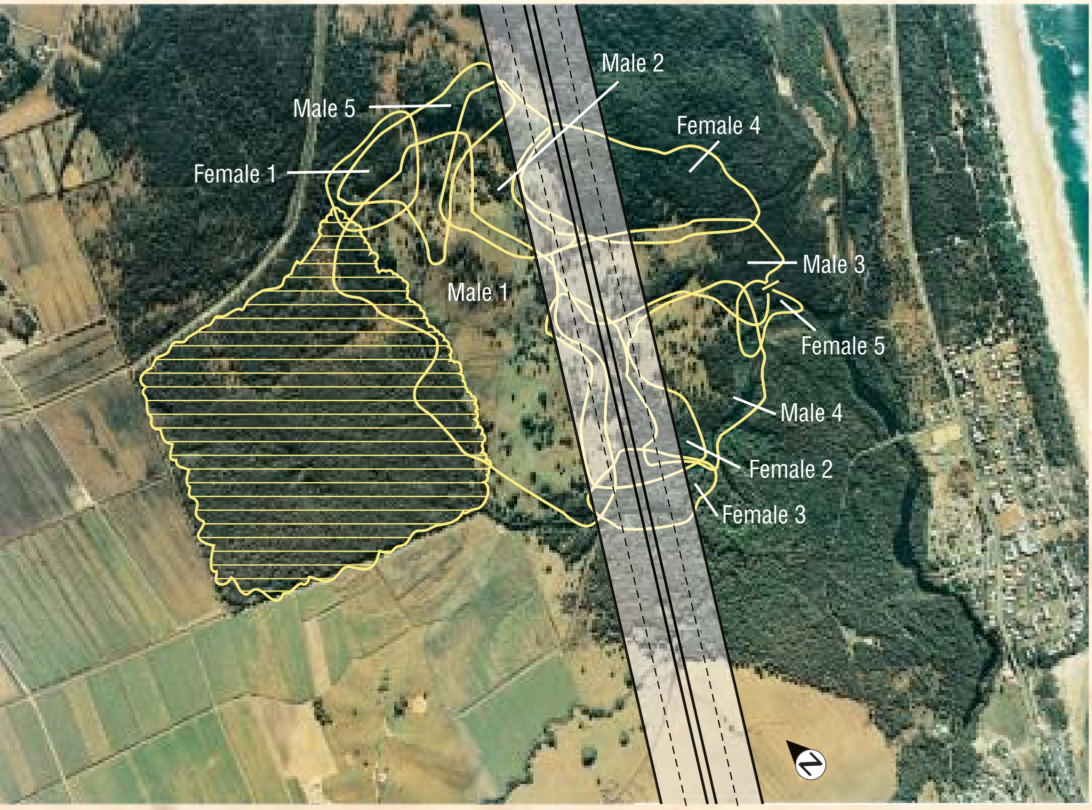


Research suggests that cars are one of the biggest killers of koalas. Do your bit to save the koalas on your property from reaching the roads.
Install a K-Fence NOW!!

Our fences are proven to be completely koala-proof. They are strong, environmentally friendly and easy to install.

Note: K-Fence is only for use along roadways. It is not to be installed between joining properties.

The secret life of koalas



This map shows one of the koala colonies in the Eastern Shores Forest that will be affected by the proposed new highway. Each area shows the home range of a single koala. The shaded area is where the koalas could be relocated.

Each koala moves and feeds in its own home range until it's time to mate. The overlap between some regions is where the shared 'social' trees are located. These are the trees where the koalas mate.

The home ranges of males are larger than those of females. The size of the range gives a male more access to female koalas.

Activities

REMEMBER

1. Why are trees being cut down in the Eastern Shores Forest?
2. How does the koala protection group keep track of the koalas' movements?
3. How does Garry Michaels know what the koalas eat?

THINK

4. The council's solution to the koala problem is to relocate them. State the arguments against the council's solution.
5. Look carefully at the map of Eastern Shores Forest.
   (a) Which is the dominant male?
   (b) With which females does the dominant male share social trees?
   (c) Which social trees are in danger from the proposed highway?
   (d) What could happen if a single shared tree was removed from a colony of koalas?
   (e) How would this affect the overall population of koalas in the area?

BRAINSTORM

6. Make a list of the various scientists that could help people to decide whether the road should go through the forest.
7. In groups of three or four, brainstorm some solutions to the problem of the proposed highway. Take into account the research done by the local council, the koala protection group, Carrie Taylor and her team.

checklist

I can:
- ☐ see how research is important in science
- ☐ explain how scientists can be involved in solving community issues
- ☐ discuss some of the threats to koalas.

Check and challenge

THE WORLD OF SCIENCE

Check

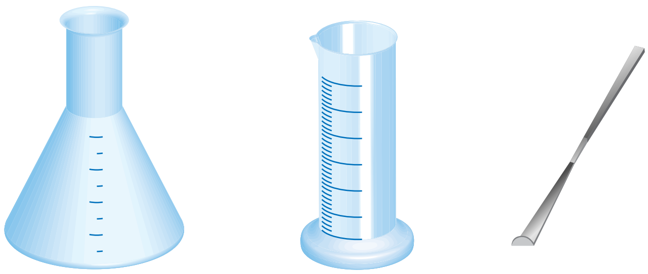
Scientists

1. Match the following scientists with their work.

Physicist	Investigates how rocks and mountains form
Chemist	Studies living things
Biologist	Explains things like movement, heat and light
Astronomer	Studies how substances react with others
Earth scientist	Studies the sky

Equipped for science

2. Draw and label the parts of a Bunsen burner. At the top of the Bunsen burner, draw in the safety flame. Show whether the air hole is open or closed.
3. Name these pieces of equipment and describe what they are used for.

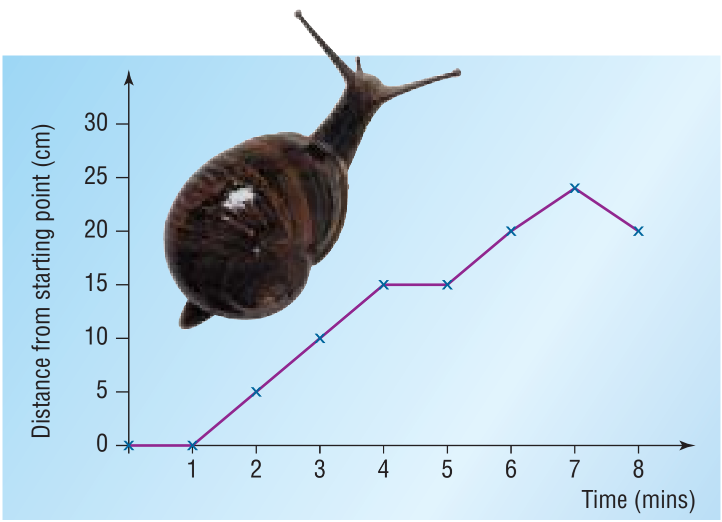


Hands on science

4. List two safety rules and explain why they are important.
5. (a) Give an example of a substance you might use in a laboratory that is:
   (i) corrosive
   (ii) flammable.
   (b) What precautions should be taken when using these substances?
6. Re-write the following sentences correctly by selecting the appropriate words in *italic*.
   (a) When lighting a Bunsen burner, light the match *before* / *immediately after* turning on the gas.
   (b) When using a thermometer to measure the temperature of a liquid as it is heated, place the bulb of the thermometer on the *bottom* / *near the centre* of the beaker.
7. Four students each measured the temperature in the classroom using a thermometer. Their results were:

Student	Temperature (°C)
1	23.5
2	24.0
3	25.0
4	22.0

   (a) Enter the results into a spreadsheet.
   (b) Draw a bar graph of the results.
   (c) What are some possible reasons for the difference between measurements?
8. The following graph shows how far from the starting point a snail moves in an experiment.



   (a) How far from the starting point was the snail after seven minutes of timing?
   (b) During what times did the snail not move at all?
   (c) What does the graph tell us about the snail's movement between the seven- and eight-minute marks?
9. Make a list of the information that a laboratory report should include.

Sports science

10. Up until 1964, a hand-held stopwatch was used to time events at the Olympics and other games. Since then, electronic and computerised timing have been introduced. Stopwatches can measure accurately to 0.1 s and electronic timers to 0.01 s. Computerised timers measure to 0.001 s.
    (a) Why is this type of technology important?
    (b) Why is it more important today than 50 years ago?
11. The following table shows the winning times for the men's 400 m freestyle swimming event. The data are from various Olympic games from 1896 until 2000.

Year	Name, country	Time (min/s)
1896	Paul Neumann, Austria	8:12.6
1908	Henry Taylor, Great Britain	5:36.8
1920	Norman Ross, USA	5:26.8
1932	Buster Crabbe, USA	4:48.4
1948	Bill Smith, USA	4:41.0
1960	Murray Rose, Australia	4:18.3
1972	Bradford Cooper, Australia	4:00.27
1984	George DiCarlo, USA	3:51.23
1996	Danyon Loader, New Zealand	3:47.97
2000	Ian Thorpe, Australia	3:40.59

(a) Are all of the data over equally spaced time intervals?
(b) Plot a graph of the times for the men's 400 m freestyle. Take into account your answer to question (a).
(c) Use your graph to estimate what the winning time for this event was in the 1956 Melbourne Olympic games. Go to www.jaconline.com.au/science/weblinks to check your answer.
(d) How have the winning times changed over the 104-year period?
(e) Suggest some reasons for the change in winning times.
(f) Discuss how you believe the times for the men's 400 m freestyle might change over the next 40 years.

Challenge

Science: driving careers ahead

1. Read Laura Thomas's profile. Use the profile and any other resources to answer these questions and statements:
    (a) Make a list of some of the jobs that people with a science background can do in the automotive industry.
    (b) Which of these skills would be useful for engineers in the automotive industry: physics, biology or chemistry? Explain your answer.
    (c) What types of emission do cars produce?
    (d) What measures have car manufacturers taken to reduce emissions?
    (e) Make a list of the safety features that car manufacturers include in modern cars.
    (f) Imagine you are a reporter for a science magazine. What questions would you ask Laura Thomas and members of her team?

CAREER PROFILES

Name: Laura Thomas
Job title: Monaro program manager
Company: Holden Ltd
Field of science: Program management (engineering)

Laura has worked as a manufacturing engineer, design and development engineer, value analysis engineer, estimator, business analyst and program manager at various automotive companies.

Laura's current job is as a program manager with Holden Ltd. She says, 'I lead a team that turns ideas in people's minds into real cars driving on our roads. My team members come from styling, engineering, manufacturing, purchasing, quality, marketing and other departments. My job is to make sure that the car produced at the end of the project meets our customers' expectations, makes money and inspires our employees to come back for more . . . With every new car introduced, we make some progress in the areas of **technology, emissions** and safety which benefits road users and the community at large'.

2. Look at the photograph of the scientist. What do you think the scientist is doing?

Summary of key terms

aerofoil: a wing designed to assist the lift in an aeroplane. It is used in reverse to stop lift in fast-moving cars.

astronomer: a scientist who studies the sky beyond the Earth's atmosphere

biologist: a scientist who studies living things

biomechanics: the study of how animals, including humans, move

cells: the small parts that make up living things

chemist: a scientist who studies how substances react with other substances

diagnose: to identify a disease or condition

drag: a push from air or water against an object. The push acts against the movement of the object.

ecologist: a scientist who studies the relationship between a living thing and its environment

emissions: chemicals released into the air. Cars release emissions.

engineer: a person who uses scientific ideas to build new technology and make it work.

gauge: an instrument for measuring pressure, volume, dimensions, petrol, speed etc.

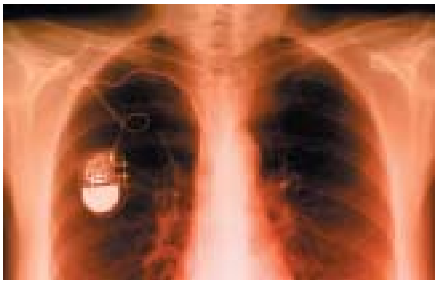
geologist: a scientist who studies the Earth

histologist: a scientist who studies the **cells** and tissues that make up animals — including humans. Histologists look at small samples of cells and tissues under microscopes.

marine biologist: a scientist who studies **organisms** that live in the sea

metallurgist: a scientist who works to shape metals or improve its quality. A metallurgist may also be involved with mining for metals.

pacemaker: a device used to control the rate of a heartbeat



patent: permission to use or sell ideas without competition from someone else

pharmaceutical industry: an industry that manufactures medicines and other medical treatments

pharmacology: the study and manufacture of medicines and other drugs

physicist: a scientist who studies the laws of nature. For example, movement, heat, light, gravity and sound.

physiology: a study of how the parts of living things work together

receiver: a device which receives electrical or other signals

resin: a type of plastic

technology: the application of science to the design of a device or process

traction: the grip of an object (like a wheel) to a surface (like a road)

transmitter: a device which sends out electrical or other signals

zoologist: a scientist who studies animals