CHAPTER 6

What would happen if the Earth stopped moving?

THE EARTH IN SPACE

Our world is a tiny ball among countless billions scattered through the **universe**. Our Earth is spinning you around at 800 km/h and hurtling you through space at 80 000 km/h.

Our **planet** is one of eight that make up our **solar system**, the ring of planets circling the sun. We see planets because they reflect the light from the sun. The **sun** is one of 100 billion stars in our galaxy. Our **galaxy**, the **Milky Way**, is one of 10 billion galaxies scattered throughout the universe.

The planets

Mercury — A small planet closest to the sun, made of rock and covered with **craters**. Mercury has no **moons**.

Venus — This planet is the same size as Earth, made of rock, covered with thick cloud which traps the heat and makes Venus the hottest planet in the solar system. It has no moons.

Earth — Earth is the 'third rock from the sun'. It appears blue — because a large portion of its surface is covered with water — has air and has organisms on it. It has one moon.

Mars — The fourth planet is half the size of the Earth and is red, due to the high level of iron oxide in the soil. It is covered with rocks and craters, and has a large volcano and two moons. Scientists recently discovered fossil evidence of past life on Mars, in a meteorite that fell to Earth from Mars.

Jupiter — This is the fifth and largest planet. It is made of frozen gases which make the surface slushy — spacecraft would sink. It has 16 moons.

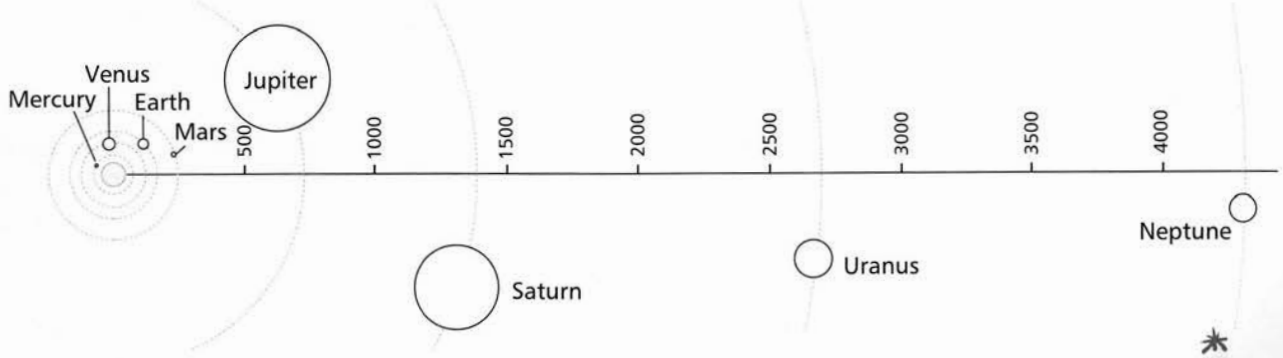
Saturn — The sixth planet is the second largest and is also made of gases. It has seven rings around it which are made of dust and ice. It has 22 moons.

Uranus — Uranus is bigger than Earth, made of frozen gases, has rings around it and 15 moons.

Neptune — Made of frozen gases, does not have rings but has 8 moons.

Pluto — This is a dwarf planet and it has one moon. Scientists do not know much about Pluto because it is so far away.

Can you remember the order of the planets? **M**y **V**ery **E**xcellent **M**other **J**ust **S**wept **U**p **N**ine **P**ins.



Planets of the solar system (Distance in millions of kilometres)

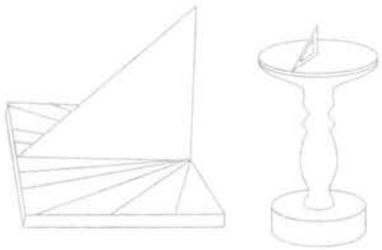
Distances and time in space

Light travels very fast and distances in space are so enormous they are measured in **light years** — the distance light travels in one year (300 000 kilometres per second). Sound travels at only 0.3 kilometres per second.

The moon's **orbit** of the Earth and the Earth's orbit of the sun can be used to measure the passage of time.

The sun can be used to tell the time during the day. The **sundial** is the oldest device known for measuring time. The time at a specific place, according to the sun's position, is called 'solar time', and is indicated by the sundial's pointer.

The **stars** can be used to measure the time at night.



A sundial

Using light years to measure distance

- If you were to go to the moon and flash the light of a torch back to Earth, how long before you would see the flash?

  Answer: 1.5 seconds.
- If you were to continue to the sun and flashed your torch, how long would the light take to reach Earth?

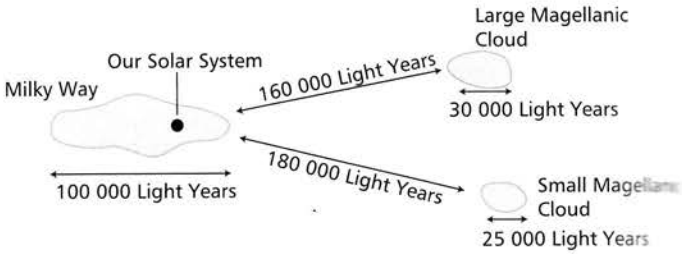
  Answer: 8.5 minutes.
- If you continued to the next closest sun (Alpha Centauri, which is in the next solar system) and flashed your torch, how long would it take the light to reach Earth?

  Answer: 4.3 light years from our sun to Alpha Centauri.

The Milky Way

Our Galaxy, the Milky Way, is shaped like a flying saucer. It is 100 000 light years long and 40 000 light years wide. Our Solar System is about two-thirds the way along its diameter.

The closest galaxies to our Milky Way are the small and large Magellanic Clouds.



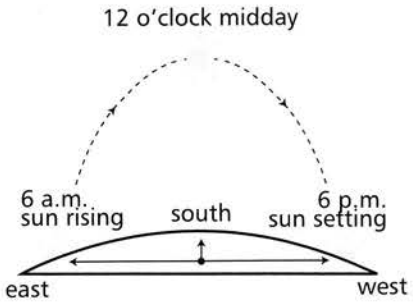
The Milky Way

The spinning Earth

The sun and the stars stand still in space. The Earth is like a big ball with an axis running from the North Pole to the South Pole.

Night and day

Once every 24 hours the Earth revolves on its **axis**. It always spins in the same direction towards the east, so the sun comes up in the east every day and goes down in the west. It is this rotation that gives us night and day. Of course, even though the sun appears to rise and fall, it is the Earth and you that are moving, not the sun.



The reason for seasons

It takes one year for the Earth to spin around the sun. This yearly rotation and the tilted axis of the Earth (it is tilted by 23.5 degrees) causes seasonal changes. There are four seasons, summer, autumn, winter and spring. In the Southern Hemisphere, in summer the South Pole is tilted

towards the sun so we have long summer days. In winter the South Pole is tilted away from the sun so the winter days are shorter. This is reversed in the Northern Hemisphere.

Shadows

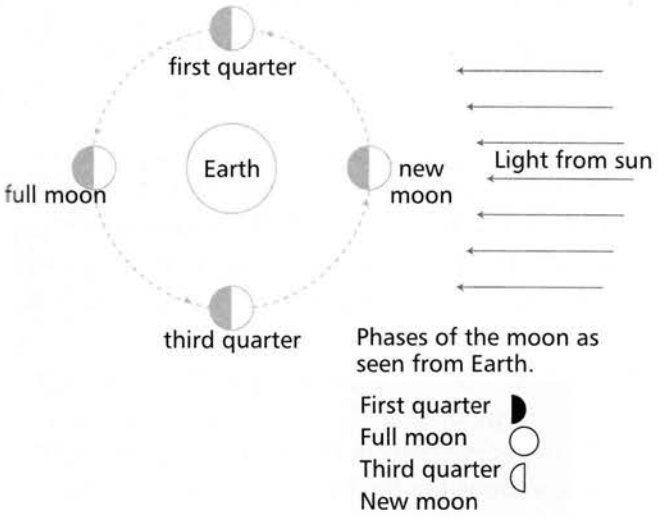
Shadows are shortest at midday when the Earth turns you around to face the sun almost directly. Shadows are longest at sunrise and sunset and in winter. Night falls when the Earth spins so far around that you face away from the sun.

The Moon

The moon is a satellite spinning around the Earth. It is caught by the Earth's gravitational force. The moon has no light of its own but reflects the light of the sun. The moon takes one month to orbit once around the Earth and the same time to spin once on its own axis. This means the same side of the moon is always facing the sun. The moon is always half in sun and half in shade. This gives us the phases of the moon.

Phases of the Moon

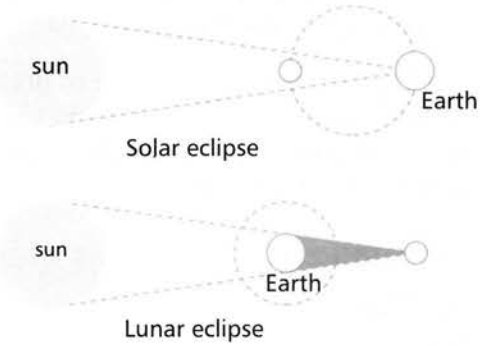
The lunar cycle moves from new moon phase (completely invisible) to full moon and back to new moon again. As it moves from new to full it is said to be **waxing** as it moves back to the new moon it is said to be **waning**.



What's an eclipse?

An **eclipse** occurs when one heavenly body obscures another. A **solar eclipse** occurs when the moon passes directly between the Earth and the sun and hides the sun from view.

In a lunar eclipse the moon passes into the Earth's shadow and the Earth blocks the sun's light from the moon.



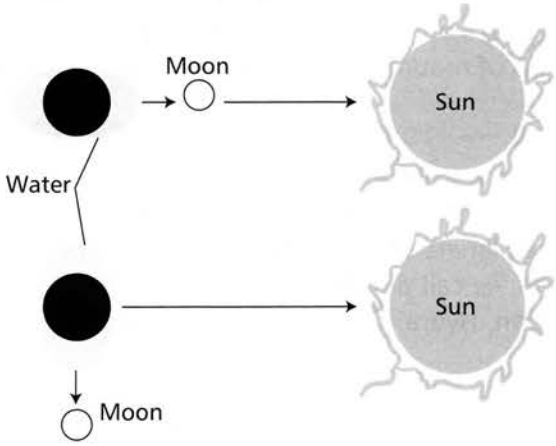
Solar and lunar eclipse

The Moon and the tides

Every 12 hours the oceans on opposite sides of the world rise and then fall a little. The moon pulls the sea toward it causing a high tide on the side of the Earth closest to the moon.

When the sun and the moon are at right angles to the Earth their pulls conflict, causing small tides (neap tides).

When the moon and sun pull the same way there are very high tides (spring tides).



What holds the solar system together?

The moons (satellites) move in their orbits around their planets and the planets move in their orbits around the sun. All this happens because of gravity.

Gravity is an invisible force. All objects attract each other because of their mass. We say that there is a force of gravity between them.

Two small objects have a small force of gravity between them because they have a small mass Large objects have a very strong attraction because they have a large mass.

Why do planets and moons stay in their orbits?

Planets and moons are constantly on the move but the gravitational force of the planet or the sun keeps pulling them in so they stay in orbit.

Planets and satellites stay in their orbits because they are continually moving and because of the force of gravity.

Artificial satellites

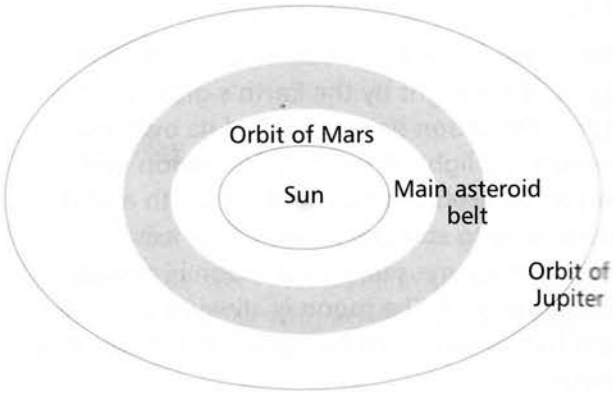
Human-built satellites can be put into orbit around the Earth. They stay in orbit for the same reasons as the planets and moons. Artificial satellites can be used for communications and to observe things on Earth, such as weather and crops. The best place to observe stars is above the Earth's atmosphere, so telescopes are built on top of mountains or, better still, on satellites.

Stars — How are they different?

- There are billions of stars in space. Stars are fixed in space and they don't move around like the planets do. Stars stay in the same patterns and we call these patterns constellations (eg Orion, Hydra, Canis Major, Centaurus).
- All the stars except the sun are a very long way away. They all give out their own light.
- The planets do not give out their own light — they reflect the sun's light.

Asteroids

Asteroids are bits of rock and metal found between Mars and Jupiter. They are believed to be the remains of the materials which formed the planets billions of years ago.



Asteroid belt

Comets

A comet is a mass of frozen gases and dust that orbits the sun. It produces a tail of glowing gases as it gets near the sun and warms up, but the tail fades as the comet moves away.

Halley's comet is the most famous of comets.

Meteors and meteorites

- Shooting stars are produced when a particle (meteor) drifting through space hits the Earth's atmosphere. The **friction** between the air and the particle causes the air close to it to get very hot and glow. Once it hits the Earth it is called a meteorite.
- Most meteors burn up because of friction but some large ones do hit Earth every few years. Some people believe that a very large meteor was responsible for the end of the dinosaurs.

Glossary

Asteroid
Small rocky bodies orbiting the sun in a wide belt between Mars and Jupiter.

Axis
Imaginary line drawn through the poles of the Earth around which it spins.

Comet
A small body of ice and dust that orbits the sun. When it is near the sun the ice vaporises and forms a tail.

Constellation
A group of stars that appears to form a picture.

Crater
Indentations in the surface of planets and moons formed by the impact of meteorites.

Eclipse
The shadow of a celestial object.

Friction
The rubbing of one substance against another creating heat.

Galaxy
A large group of stars held together by gravity and separated from other galaxies by vast areas of space.

Gravity
The force responsible for the attraction of one mass to another, one of the fundamental forces of nature.

Light year
An astronomical unit of distance equal to the distance light travels in a vacuum in one year.

Meteor
A piece of dust which burns up as it enters the Earth's atmosphere.

Meteorite
A chunk of rock or metal from space, too big to burn up and which lands on Earth.

Milky Way
A band of stars — the visible portion of the spiralling, disk-shaped galaxy in which our solar system is located.

Moon
A natural satellite.

Orbit
The path of an object revolving around another object.

Planet
A large body held in orbit about a star by gravity, which shines only by reflected light.

Satellite
An object that orbits a planet.

Solar system
The sun, the planets, asteroids, comets, and other bodies that orbit the sun.

Star
A space object made of hot gases, which emits light.

Sun
The star in the centre of the Solar System. The closest star to Earth.

Tidal forces
A force resulting from different gravitational pull on opposite sides of the object.

Question 1

Light travels at a speed of 300 000 kilometres in one second. Calculate the following:

a Distance light travels in one minute

_____ km

b Distance light travels in one hour

_____ km

c Distance light travels in one day

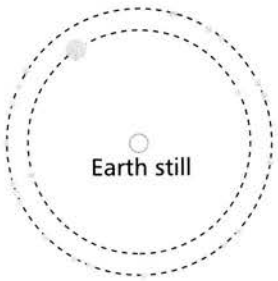
_____ km

d Distance light travels in one year. How many light years is this?

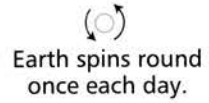
e The sun is about 150 000 000 km from Earth. How long does it take light to reach Earth from the sun?

Question 2

The Earth and the moon both seem to move through the sky. Look at the two diagrams below, then fill in the missing words in the two 'explanations' given. Decide which explanation is the one that scientists now believe to be correct.



Used to believe



Now believe

Explanation 1

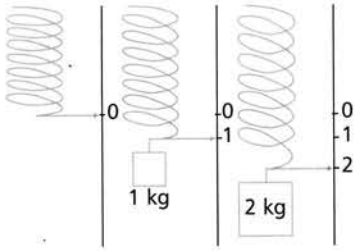
Explanation 2

Explanation 1 — The sun and the stars orbit around the _____. The Earth stands still.

Explanation 2 — The _____ and the _____ don't move but the _____ spins around on its axis once every _____.

Question 3

Measuring mass on Earth is easy, we can use a spring balance. We are really measuring weight or the pull of gravity rather than mass. Twice as much mass means twice as much weight. Look at the diagram:



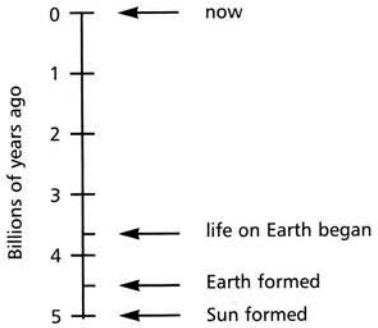
If we mark the spring balance off in kilograms we can measure an unknown mass.

a Would the spring balance work in outer space?

b How could you compare masses in space?

Question 4

Look at the time chart below:

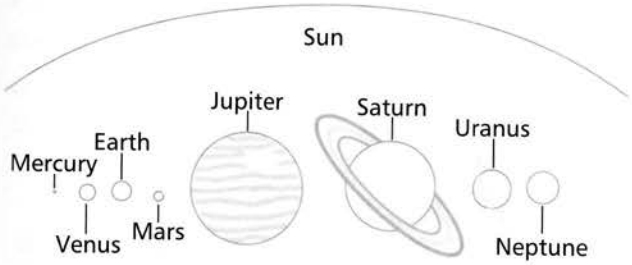


a About how long ago was the Earth formed?

b When did life on Earth begin?

Question 5

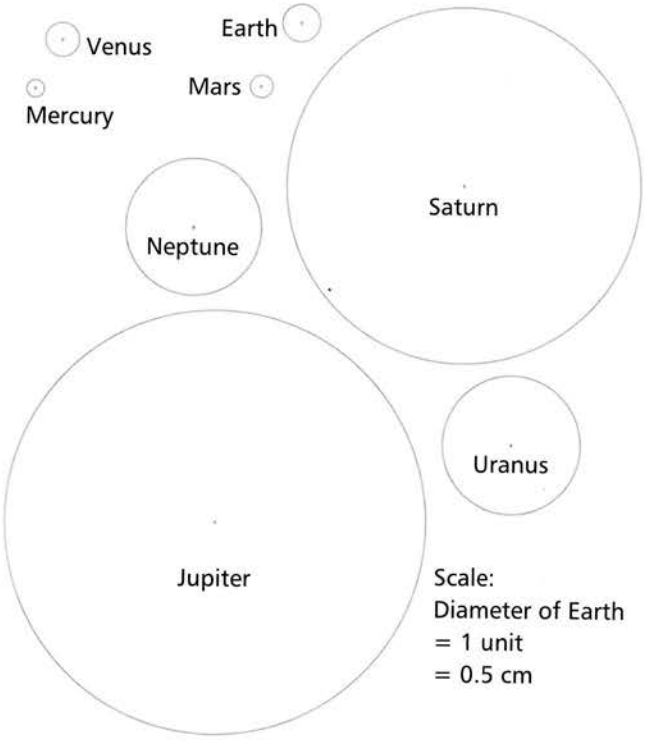
The following diagram shows how big the planets are compared to each other and the sun.



Write down the planets in order of size starting with the smallest planet.

Question 6

Look at the scale diagrams of the planets below.



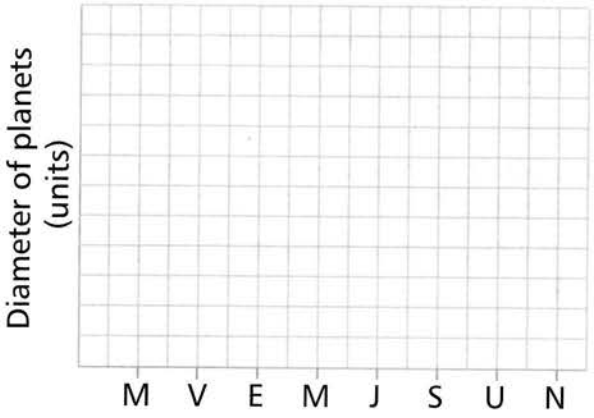
a If the diameter of the Earth is 1 unit, work out the diameter of the other planets.

b If the diameter of the Earth is 12 750 km then what are the real diameters of the other planets?

Record your answers in the following table:

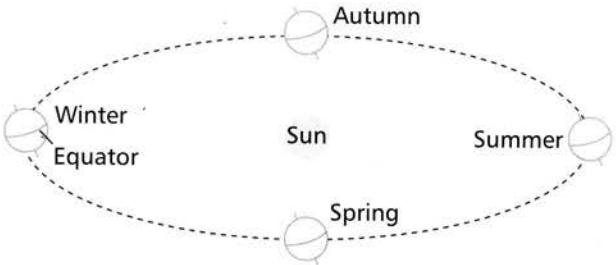
Planet	Diameter (units)	Diameter (km)
Mercury		
Venus		
Earth		
Mars		
Jupiter		
Saturn		
Uranus		
Neptune		

c Using graph paper plot the data in your table as a bar graph.



Question 7

The seasons of the Earth are determined by the Earth's position in its orbit around the sun. The diagram below shows the seasons in the Northern Hemisphere. Draw a similar diagram which shows the seasons in the Southern Hemisphere.



Question 8

Use the following information to help you answer the questions below:

Planet	Distance from sun	Time to orbit sun once	Number of moons
Mercury	58	88 earth days	0
Venus	108	224 earth days	0
Earth	150	365 earth days	1
Mars	228	687 earth days	2
Jupiter	778	12 earth yrs	16
Saturn	1427	29 earth yrs	22
Uranus	2870	84 earth yrs	15
Neptune	4497	164 earth yrs	8

a Which planet has the largest number of moons?

b Look at your answers for question 6. Do you agree with the following statement ?

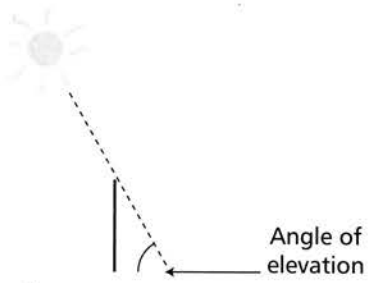
The larger the planet the more moons it has.

c An astronaut from Earth is 42 years old. What would be the astronaut's age if she lived on Mars (to the nearest Mars year)?

d Is there a relationship between time taken to orbit the sun and distance from the sun?

Question 9

The sun's path was recorded by measuring its elevation every hour.

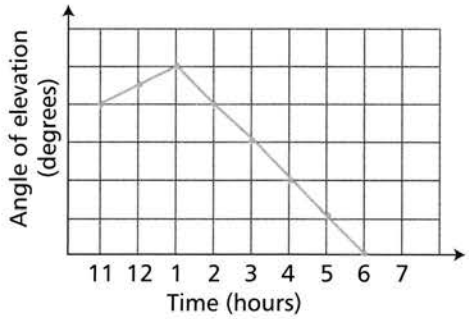


Recorded Data

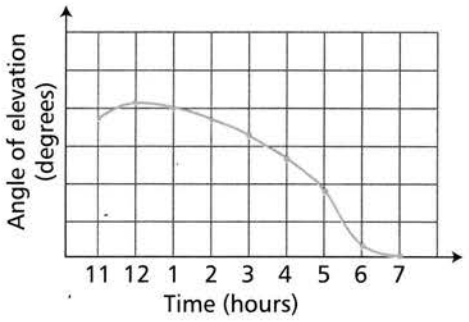
Time	Angle of elevation (degrees)
11.00 am	47
12.00 noon	51
1.00 pm	50
2.00 pm	44
3.00 pm	36
4.00 pm	27
5.00 pm	16
6.00 pm	3
7.00 pm	0

Three students graphed this data. Which student was correct?

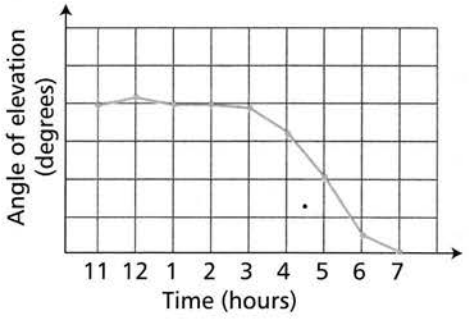
Student 1



Student 2



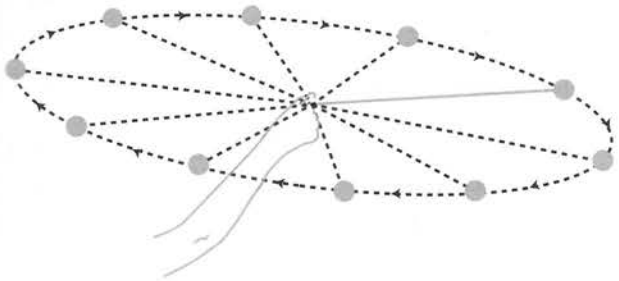
Student 3



Question 10

Escape velocity is the speed a space vehicle must reach so that the Earth's gravity does not pull it back to Earth. At even higher velocities, spacecraft may escape from the solar system.

Look at the diagram of the whirling ball below and answer the questions.



a What happens to the size of the ball's orbit if the ball is whirled faster?

b What force does the hand represent?

c In what part of the orbit is the ball travelling the fastest? The slowest?

d What would happen to the whirling ball if the end of the string was released?

e In what direction would the ball go?

f If an object achieves escape velocity from the Earth, will it return to the Earth?

Question 1

If we look at the night sky, the stars appear to rise in the east and set in the west. This occurs because of:

a Earth's revolution around the sun.

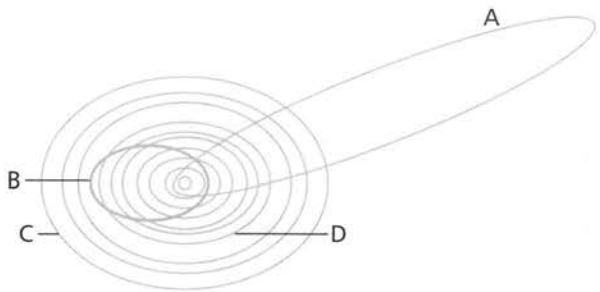
b The stars' constant drift from east to west.

c Movement of our solar system drifting to the east.

d Earth's rotation around its axis.

Question 2

The diagram below represents the solar system. Which labelled path is the orbit of a comet?



Question 3

When the sun, Earth and moon are all in a perfectly straight line, with the Earth in the middle, the event is called:

a a full moon

b a new moon

c an eclipse of the sun

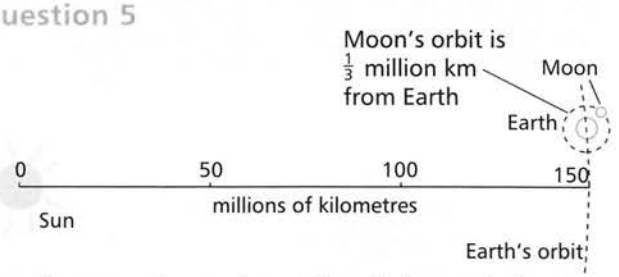
d an eclipse of the moon

Question 4

a Draw up a table with two columns. In the left-hand column list the planets, in order from the sun.

b In the second column add the distances the planets are from the sun.

Question 5



The diagram above shows the distances between the moon, the Earth and the sun.

a How far is the Earth from the moon?

b How far is the sun from the Earth?

c How many times further away from the Earth is the sun from the moon?

Question 6

a What would happen to planets and satellites if the force of gravity suddenly disappeared?

b What would happen to planets and satellites if they suddenly stopped moving?

Question 7

Which of the following groups of planets is not in the right order:

a Mercury, Venus, Earth, Mars

b Jupiter, Saturn, Uranus, Neptune

c Mars, Jupiter, Saturn, Uranus

d Venus, Mars, Earth, Jupiter

Question 8

Before the invention of watches and clocks, what instrument was used to tell the time?

Question 9

The planets are kept in orbit around the sun by:

a light rays

b radiation

c gravity

d accelerating

Question 10

Why is Mars often referred to as the 'red planet'?

Have scientists discovered fossils on Mars?

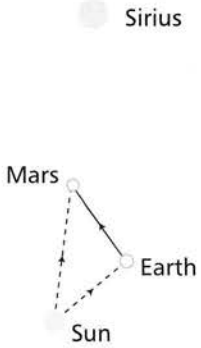
Question 11

Complete the following sentences using the correct words.

All the stars except the _____ are a very long way away. Like the sun, they give out their own _____. The planets all go around the _____. They _____ light from the sun. The Earth is a _____.

Question 12

Sirius is the brightest star in the sky. Look at the diagram and answer the following questions:



This diagram is not to scale.

a How does Sirius compare with the sun — in size and the amount of light it sends out?

b Why doesn't Sirius look as bright as the sun?

c Explain how we can see planets.

Question 13

Astronomers often have trouble seeing stars from Earth because clouds and city lights get in the way.

a Where on Earth's surface can astronomers put telescopes to avoid this problem?

b How can astronomers get telescopes above Earth's atmosphere?

Question 14

Complete the sentences using the correct words.

The natural satellite of the Earth is called the _____. We can put _____ satellites into orbit around the Earth. These can be used by scientists to observe the _____ and what's happening on the Earth's surface.

Question 15

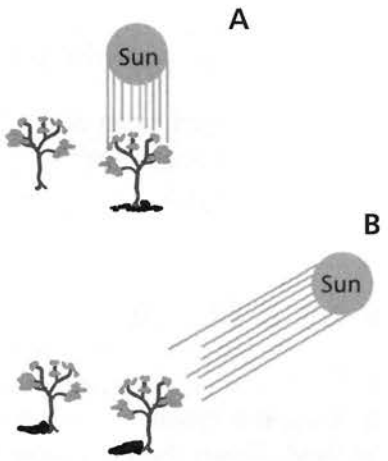
a Why is there only a small force of gravity between two tennis balls?

b Why is there a much stronger force of gravity between a tennis ball and the Earth?

Question 16

a What two factors explain the seasons?

b Which of the following two diagrams would represent winter in the Southern Hemisphere?



Question 17

a What is a constellation?

b Write down the names of three constellations found in the Southern Hemisphere.

Question 18

What would happen if the moon stopped moving?

c and d — **Plan**
Step 1 — Separate iron filings from the mixture. (magnet)
Step 2 — Add water to the remaining sugar, sand and toothpick mixture.
Step 3 — Separate toothpicks. (plastic spoon)
Step 4 — Separate sand from the sugar solution. (funnel & flask)
Step 5 — Separate the sugar from the water. (distillation flask)

2 a **Design**
Set up 7 containers of hot water and 7 of cold water.
Add a spoonful of each powder to a hot and a cold container.
Stir and then observe what happens.

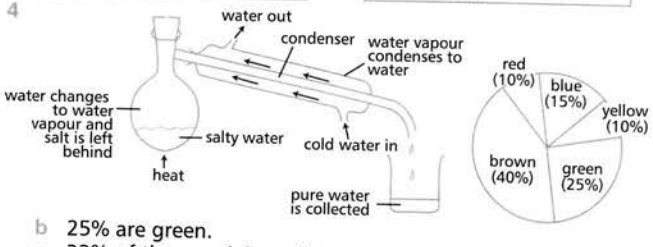
b **Equipment**
14 containers; 7 spoons; 7 brown powders (as listed below); hot water; cold water

c

Powder	Hot water	Cold water
tea	no	no
coffee	yes	no
cocoa	yes	no
cinnamon	no	no
brown sugar	yes	yes
gravy base	no	yes
nutmeg	no	no

3 Stir salt and pepper into some water.
Filter
Pepper stays on the filter paper.
Evaporate the water to get the salt.

4



b 25% are green.
c 33% of the remaining mixture are green.

6 (1) Crush the sugar cane, mix it with water then separate the woody cane bits from the juice. (filter)
(2) Heat the juice so that most of the water from the juice changes to water vapour. (evaporation)
(3) Cool the concentrated juice to form solid sugar and molasses. (crystallisation)
(4) Separate the sugar crystals from the molasses. (decant)
(5) Purify the sugar crystals by redissolving in water and then reseparating the pure sugar. (evaporation)

7

Liquid	Density g/mL	Plastics that float in liquid
alcohol:water (5:1)	0.915	PP
alcohol:water (3:1)	0.945	LDPE, PP
water (distilled)	1.00	HDPE, LDPE, PP
sea water (10%)	1.05	HDPE, LDPE, PP, PS

8 We need to change the filters because the holes become blocked with built up residue.

Filter	Residue	Filtrate
coffee filter	coffee grounds	coffee
clothes dryer	fluff	air
washing machine	clothes	water
colander	peas	water
teabag	tea leaves	tea
sieve	lumps of flour	flour

9 a chromatography
b maid

10 a oxygen
silicon
aluminium

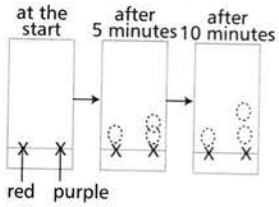
b

Revision questions page 64

1 colour, shape, size, solubility in water

2 d sedimentation

3



4 a Tap water is a mixture and distilled water is a pure substance.
b Sugar is a pure substance and the rest are mixtures.

5 d solid + liquid + gas

6

Pure substance	Mixture
gold	rock or sand
water	river water
oxygen	air
sugar	sugar cane

7 chromatography

8

Method of separation	Difference in properties
flotation	density
filtration	size of particles
crystallisation	saturation
gravity	weight

9 separating funnel

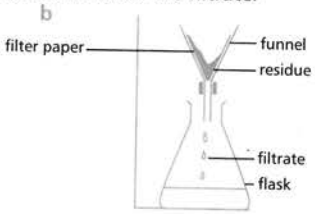
10 b centrifuging

11 Cork dust floats, iron filings are attracted by magnets, sand can be filtered out and salt can be dissolved and then the solution evaporated.

12 Filter the water through sand and then distil the filtrate.

13 a Filter paper has tiny holes in it, so the liquid can pass through, but any solid particles remain on the paper.

b



14 a Dissolve the sugar, filter the tea leaves, evaporate the water.
b Dissolve the salt and filter the flour, evaporate the water.
c Use a magnet to remove the pins.
d Sweep up all the glass and bath salts, dissolve the salts, filter out the glass then evaporate the water to retrieve the salts.

15 filtration

16

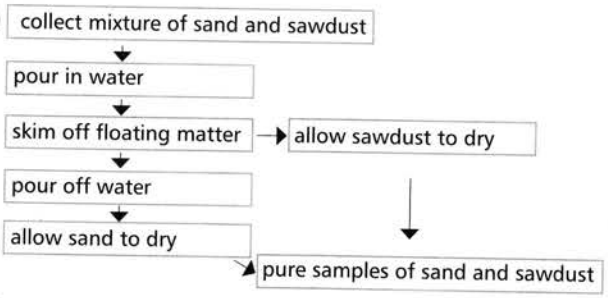
Mixture	Substances in the mixture
milk	water, fat, vitamins, calcium
chocolate	sugar, fat, cocoa, milk
peanut butter	peanuts, oil, salt, sugar
air	oxygen, nitrogen, carbon dioxide, hydrogen etc
glue	PVA, water, chemicals etc

17 No — because food containing 'Colour 133' will make the person sick. The colour could be separated from the food using the process of chromatography.

18 The candle floats on water but sinks in alcohol, therefore alcohol is the less dense liquid.

19 distillation, boils, water vapour, condense, solids

20



Chapter 6

Science skills page 72

1 a 300 000 km × 60 (There are 60 seconds in one minute) = 18 000 000 km = A km
b A km (answer from above) × 60 (There are 60 minutes in 1 hour) = B km

c B km (answer from above) × 24 (There are 24 hours in one day) = C km
d C km (Answer from above) × 365 (There are 365 days in one year) = D km = 1 light year.
e 150 000 000 km divided by 300 000 km (This gives you the time in seconds = 500). Divide the time in seconds by 60 to get the number of minutes it takes to travel from the sun to the Earth = 8.3 minutes.

2 The sun and the stars orbit around the **Earth**. The Earth stands still. The **sun** and the **stars** don't move but the Earth spins around on its own axis once every day. Explanation 2 is correct.

3 a No — the masses would have no weight and so would not stretch the spring at all.
b For example, water displacement.

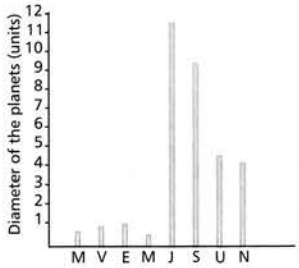
4 a The Earth was formed about 4.5 billion years ago (500 million years after the sun was formed).
b Life on Earth began about 3.5 billion years ago.

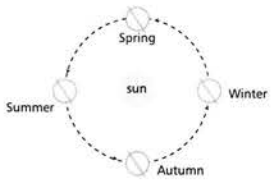
5 Mercury, Mars, Venus, Earth, Neptune, Uranus, Saturn, Jupiter

6 a & b

Planet	Diameter (units)	Diameter (km)
Mercury	0.4	5 100
Venus	0.9	11 475
Earth	1.0	12 750
Mars	0.5	6 375
Jupiter	11.2	142 800
Saturn	9.4	119 850
Uranus	4.1	52 275
Neptune	3.9	49 725

c





8 a Saturn
b No — Jupiter is the biggest planet and it has less moons than Saturn which is the second largest planet.
c One Mars year equals 1.9 Earth years. Therefore the 42 year old astronaut would be 22 years old.
d The further from the sun the longer it takes to go around the sun.

9 Student 2

10 a It gets bigger. b Gravity
c The speed is constant because the orbit is circular.
d It would move away.
e In a straight line. f No

Revision questions page 75

1 **d**
2 A
3 **d**
4

Planet	Average distance from the Sun (millions of kilometres)
Mercury	58
Venus	108
Earth	150
Mars	225
Jupiter	750
Saturn	1400
Uranus	2700
Neptune	4300

5 a about 330 000 km
b 150 million km
c 450 times further away (150 divided by one third)

6 Planets orbit the sun because they are moving and there is a force of gravity. If there was no gravity, a moving planet would speed off into space. If it was not moving, a planet would fall into the sun.

7 d

8 sundial

9 c gravity

10 a Mars is a cold planet and appears to be red because it has a lot of iron oxide in its soil.
b Some meteorites from Mars have been found on Earth and they seem to indicate that life may have existed on Mars.

11 sun, light, sun, reflect, planet

12 a Sirius is a lot bigger than the sun and sends out more light.
b Sirius is a lot further away than the sun.
c Planets reflect light that comes from the sun.

13 a On the tops of mountains
b On satellites

14 moon, artificial, weather

15 a The tennis balls have a very small mass.
b The Earth has a very large mass.

16 a The revolution of the Earth around the sun and the tilt of the Earth on its axis.
b B — Because slanted rays give less heat than direct rays from the sun (A — would represent summer).

17 a A constellation is a large group of stars that, when viewed from the Earth, form patterns or figures in the sky.
b Scorpius, Canis Major, Centaurus, Hydra, Orion.

18 The Earth would leave it behind.

Chapter 7

Science skills page 81

1 a

What does a kilogram mass weigh?	
On the Moon	1.5 newtons
On the Earth	10 newtons

b **i** He weighs 900 newtons on Earth.
ii He weighs 135 newtons on the moon.

2

Planet	Distance from the sun (compared to Earth)	Orbit time (Earth years)
Pluto	40	250
Neptune	30	165
Uranus	19	85
Saturn	9.5	30
Jupiter	5.0	12.5
Mars	1.5	1.9

3 a decreases b increases

4 a yes b F
c The shapes are more streamlined so have less friction.
d B and E

5 a The most friction is between the sandpaper surfaces and the least between the polished surfaces. The friction between the two untreated timber surfaces is the same as between the sandpaper and polished timber. For two surfaces, it doesn't matter which one is on the block and which is on the slope — the friction will be the same.
b larger

6 yes

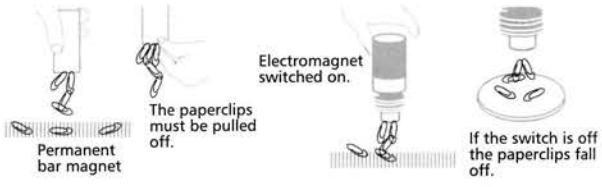
7 a B — because it has the most coils. b iron

8 a

Pole of first magnet	Pole of second magnet	Do they attract or repel?
N	S	attract
N	N	repel
S	S	repel

b different, same

9



CHAPTER 6

THE EARTH'S STRUCTURE

What was soil before it was soil?

Planet Earth is a complex structure floating in space. It is almost round like a ball but the surface has been crumpled and broken. The centre is a fiery furnace, hot enough to melt rock.

Beneath our feet it is churning with awesome power that can make the ground tremble, form mountains, erupt volcanoes and force continents to collide or tear apart as they ride on the molten rock beneath the Earth's crust.

The Earth's layered structure

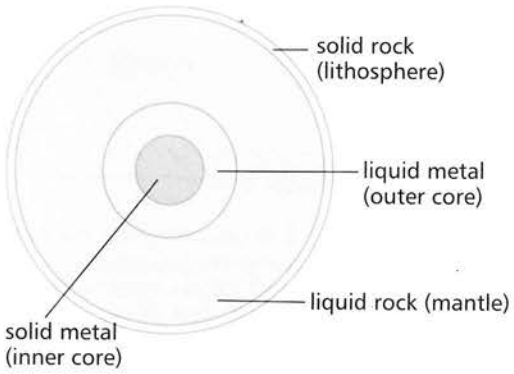
Earth's interior = core + mantle

The core has two parts:

- the inner core which is a solid iron-rich nickel ball; and
- the outer core which is a thick, elastic, molten mixture with an extremely high temperature.

The mantle is 3000 km thick and surrounds the core. It is made of very hot rock that sometimes moves around like thick syrup or molasses. This material is called **magma** and the continents float around on this thick substance.

Cross-section of the Earth



Why is the centre of the Earth so hot?

When the Earth first formed it was cold, but as the radioactive substances inside the rocks decay they release huge amounts of energy which has melted most of the rocks.

Lithosphere

The crust, or **lithosphere**, is the part of the Earth that we live on. The crust is a very thick layer (about 70 km thick) of soil and solid rock. If you have been in a cave you have been inside the crust. No-one has ever dug right through the crust.

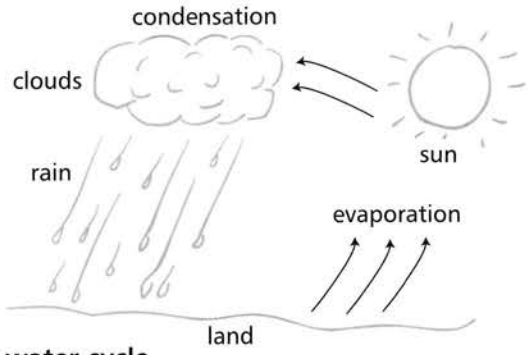
Hydrosphere

Hydrosphere is the name for all the water on the Earth — the lakes, rivers, oceans, glaciers and ground water.

Water sometimes trickles down through cracks in the crust to the hot rocks below. If this water changes to water vapour it forces its way back to the surface. This is called a **geyser** and is a source of energy called **geothermal** energy.

What is the water cycle?

Water is always on the move. Water in lakes, rivers and oceans is heated up by the sun and **evaporates** into the air. High in the atmosphere the vapour loses this energy and it **condenses** to form tiny droplets around microscopic particles in the air. Clouds begin to form and when the droplets grow to a certain size they fall back to Earth as rain.

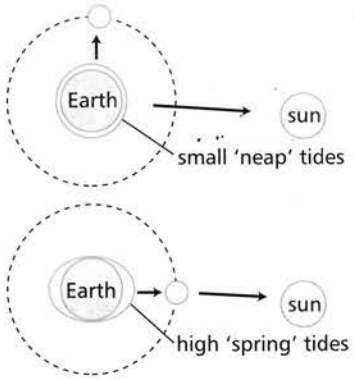


The water cycle

The moon, the sun and the hydrosphere

Ocean tides come in and go out about twice every 24 hours. Tides are caused by the gravitational pull of the sun and the moon on the hydrosphere.

When the moon and sun are pulling together on the same side of the Earth, tides are the highest. These are called **spring tides**. When the sun and moon pull against each other the tides are small and are called **neap tides**.

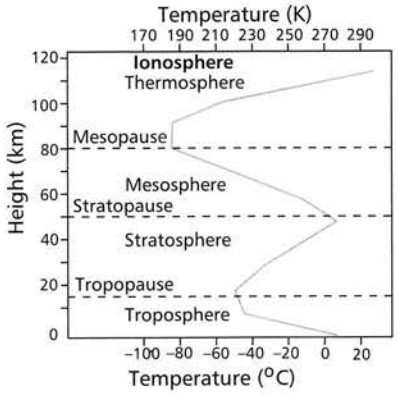


Spring and neap tides

Atmosphere

The atmosphere is a comparatively thin layer of gases which surrounds the Earth.

This gaseous layer is held in place by the Earth's gravity. This layer gives us the air we breathe and the water we drink. The atmosphere keeps us warm and protects us from the harmful rays of the sun.



Layers of the atmosphere

The air around us is pushing constantly in every direction. This is called atmospheric pressure, or air pressure. It is caused by billions of air molecules as they zip this way and that. Air pressure is greatest close to the Earth's surface. The air is densest here because it contains the most molecules. Gravity holds molecules, particularly the heavy ones like oxygen and nitrogen, close to the Earth. Light molecules, like hydrogen and helium, move further away from the Earth as gravity does not pull on them as much. As we move away from the Earth's surface there are less and less molecules until there are none at all.

The lowest layer of the atmosphere is called the **troposphere**. The sun warms the Earth below it and the heat causes the troposphere to churn around giving us our weather — wind, rain, cyclones, clouds and snow.

What is in the air?

Nitrogen makes up 78% of the atmosphere and oxygen is 21%. The other 1% is made up of carbon dioxide, water vapour and small amounts of helium, hydrogen, neon and ozone.

What is ozone?

Ozone is a colourless gas whose particles are made up of three oxygen atoms joined together. Ozone forms the layer that keeps out most of the sun's damaging ultraviolet rays.

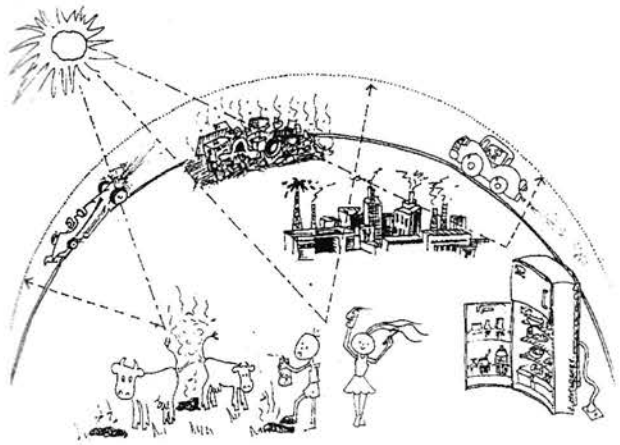
Gases like CFCs (chlorofluorocarbons) from refrigeration, manufacturing and cleaning are 'eating' holes in the ozone layer. Less ozone will cause more sunburn and more skin cancer in animals on Earth.

What is the greenhouse effect?

'Global warming' or the 'greenhouse effect' is the gradual warming of the Earth because carbon dioxide and other gases stop the heat escaping back into space.

The atmosphere is supposed to keep some heat in close to the Earth. The problem is that over the last 100 years the burning of fossil fuels has doubled the level of carbon dioxide in the atmosphere. Humans have also cut down millions of trees that could have helped to absorb the carbon dioxide.

Scientists now believe that the increasing global temperature could cause major changes in weather patterns and in sea levels.



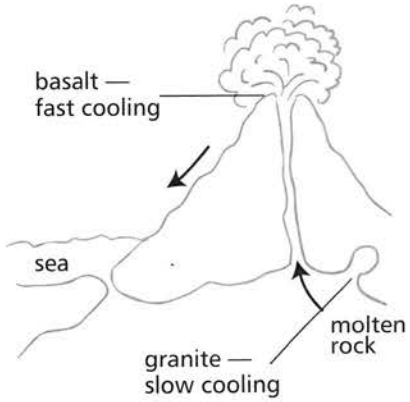
The greenhouse effect

Rocks

Different types of rocks

The crust of the Earth is made up of many different types of rocks, made in different ways. Rocks are mixtures of different minerals. Rocks are classified into three groups.

- **Igneous rocks** were once so hot that they were like a thick liquid in the mantle of the Earth. This molten rock, called magma, forced its way to the surface of the Earth where it cooled and solidified. The longer rocks take to solidify the larger the crystals are. Basalt and granite are examples of igneous rock.



Formation of igneous rock

- **Sedimentary rocks** begin as bits of rock, mud, sand, shell and bone falling to the bottom of the sea or a lake. Examples are limestone, shale and sandstone.
- **Metamorphic rocks** have been heated and put under pressure. Over thousands of years, these rocks slowly change deep in the Earth's crust. Slate and marble are metamorphic rocks formed from shale and limestone respectively.

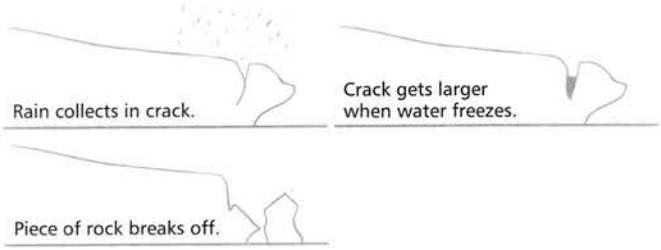
Breaking down the Earth's crust

The Earth's weather breaks up rocks — this process is called **weathering**. Weathering shapes the Earth's crust and produces the soils that we use to grow our food. To produce new soil from rocks takes thousands of years.

Weathering mechanisms

- Heating rocks causes them to expand and cooling causes them to contract. Constant heating and cooling can make rocks crack.
- Rainwater expands when it freezes, and if it gets into the cracks of rocks it can crack the rock further, or even break pieces off.

Weathering of rock by water



- Bits of dust and sand blown by the wind can wear away rocks.
- If seeds germinate in the cracks of rocks their roots force the cracks open further.
- Acid gases in the air also attack rocks. Carbon dioxide dissolves in water to make a weak acid which reacts with some rocks like limestone, chalk and marble. Over thousands of years this reaction can dissolve the rocks away.

Moving soils

Once the rocks have been weathered into particles or soil, natural forces move them about. This process is called **erosion**.

- Windstorms can swirl away huge amounts of dry soil.
- Glaciers scrape rocks along the ground for long distances.
- Running water causes creek banks to erode away, gullies to form and hillsides to slip.

Over millions of years erosion has changed the shape of the Earth. Erosion levels mountains and helps form sedimentary rocks.

Looking after the environment

We live on the Earth's crust, but this is only part of our environment. The Earth's water and its atmosphere are also part of our environment. How we live and what we do affects all these parts.

We are beginning to realise that acid rain, polluted air and water, and accelerated erosion of soils is damaging the way we live. We must look after all parts of our environment.

Glossary

Crust
Earth's solid, outermost layer (up to 70 km thick).

Condensation
The turning of invisible water vapour into water drops and ice.

Core
The incredibly hot metallic centre of the Earth which is thought to be solid on the inside and liquid on the outside.

Erosion
Movement of rock fragments by glaciers, wind, running water and waves.

Evaporation
The loss of water from the Earth's surface as water vapour.

Geothermal
Heat energy from the centre of the Earth.

Geyser
A mixture of water vapour and boiling water forced to the surface through cracks in the Earth's crust.

Hydrosphere
All the water on the planet — oceans, seas, rivers, lake etc.

Igneous rock
One of the three main rock types, forming when magma cools.

Lithosphere
The Earth's shell which includes the crust and the rigid upper part of the mantle.

Magma
Hot molten rock under the Earth's surface.

Mantle
The layer of the Earth's interior between the crust and the core.

Metamorphic rock
Rock made by the reforming of other rocks under intense heat and/or pressure.

Glossary (continued)

Neap tides
Small tides occurring when the moon and the sun are at right angles to the Earth.

Sedimentary rock
One of the three major rock types, made from sediments laid down in beds, mainly on the sea floor.

Spring tides
Very large tides formed when the Earth, the moon and the sun are in a straight line.

Weathering
The breakdown of rock when it is exposed to the sun, the wind and the rain.

Question 1

A mine supervisor checks the temperature of his mine every 100 metres to the bottom level of the mine.

He records his data in the table below:

Mine depth (metres)	Mine temperature (°C)
0	20
100	22
200	24
300	26
400	28
500	30
600	32
700	34
800	36
900	38
1000	40

a Draw a graph and plot the data.

b What is the temperature at ground level?

c What is the temperature at the bottom level?

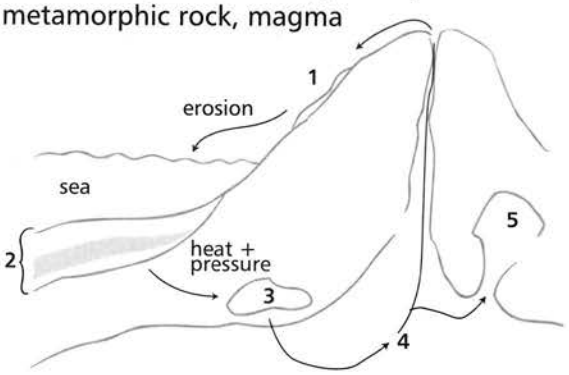
d How deep is the mine?

e Why does the temperature increase as the supervisor goes deeper?

Question 2

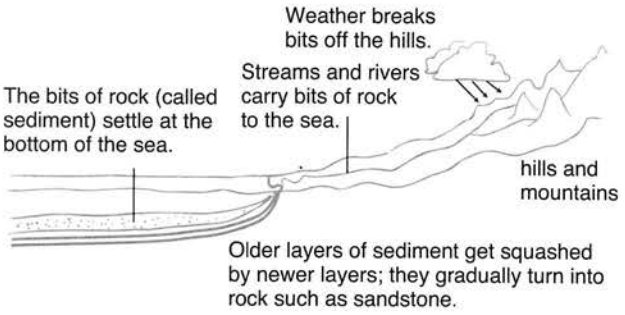
Match the following labels with the numbers 1–5 on the diagram below.

sedimentary rock, basalt, granite, metamorphic rock, magma

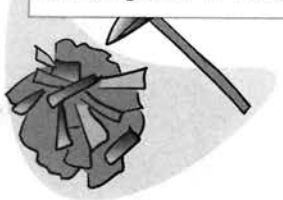


Question 3

Study the diagram below and write the correct words in the blank boxes to describe how sedimentary rock is formed.

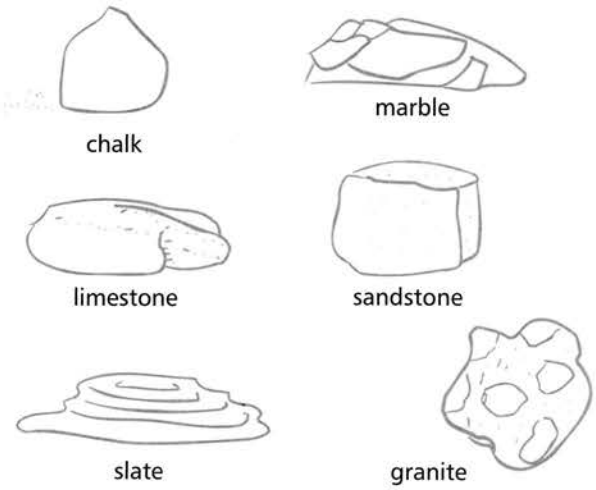


Bits of rock are broken off hills and mountains by the weather.
a
b
c
Over millions of years the bottom layers of sediment stick together to make sedimentary rock.



Question 4

a Look at the rocks below and sort them into the three groups that scientists sort rocks into.



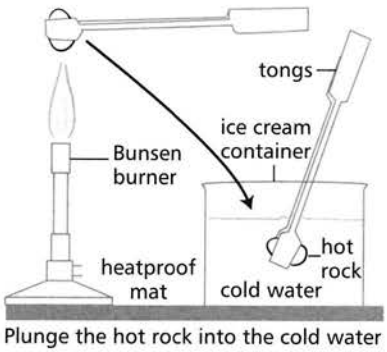
b Which three rocks are made of the same material?

c Which rock are many old buildings made of?

d Which rock can be split and used for floors in homes?

Question 5

Some students decided to investigate the effects of rapid temperature change on rocks. They set up the experiment below. What changes would they expect to see in the rock?

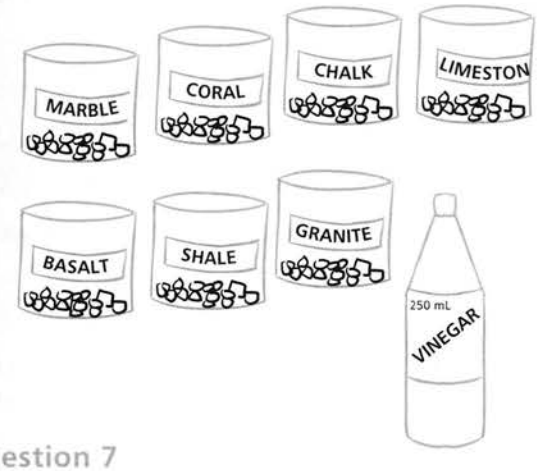


Plunge the hot rock into the cold water

Question 6

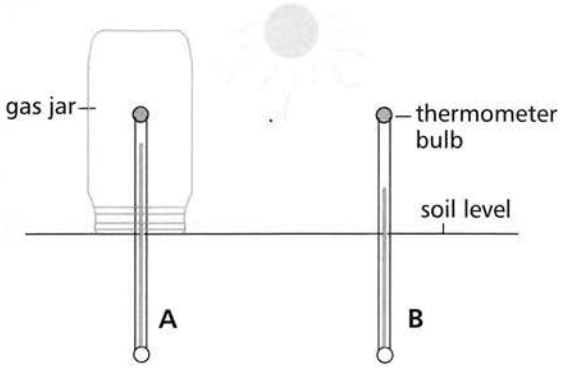
Sedimentary rocks often contain calcium carbonate which reacts with acid to form bubbles of carbon dioxide.

Which of the following rocks will react with the vinegar (ethanoic acid)?



Question 7

Students decided to demonstrate the greenhouse effect by setting up the following experiment.



a Which thermometer will record the highest temperature?

b What does the glass jar represent?

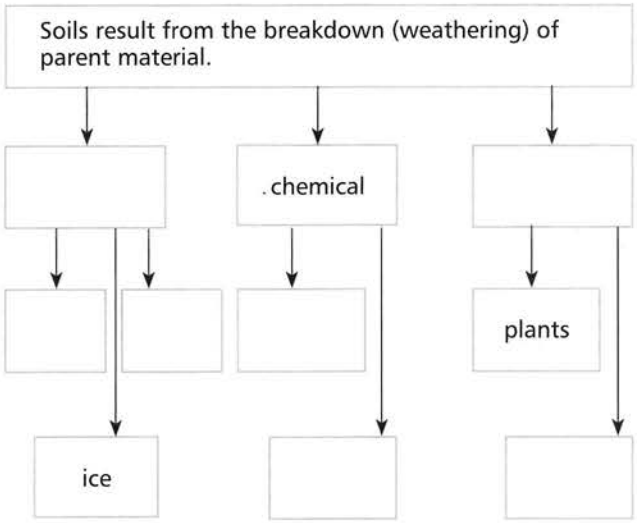
Question 8

Complete the flow chart below by adding the following types of weathering to the boxes.

Physical weathering — wind, water, ice

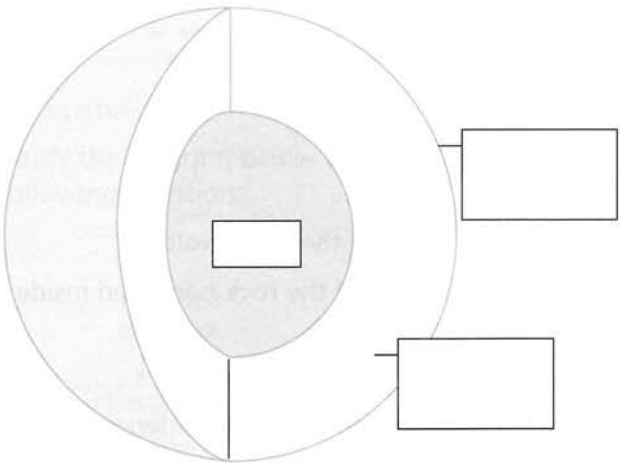
Chemical weathering — acid, rusting

Biological weathering — plants, animals



Question 9

Label the following diagram of a cross-section of the Earth.



Revision questions

Question 1

Just below the crust of the Earth is the —

a inner core

b mantle

c outer core

d atmosphere

Question 2

The temperature is highest in the Earth's —

a crust

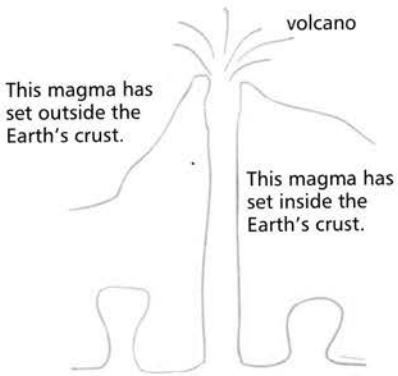
b mantle

c outer core

d inner core

Question 3

Look at the diagram below.



Cross-section through a volcano

a What is the name of the rock hardened inside the Earth's crust?

b What is the name of the rock hardened outside the Earth's crust?

c What is the name given to rocks such as basalt and granite?

Question 4

Some rocks are changed by heat and pressure in the Earth's crust.

a What does heat change limestone to?

b What does pressure change shale to?

c What name is used to describe these types of rocks?

Question 5

Fill in the correct words in the sentences below.

When rocks are worn away by the weather, we call it _____. Changes in temperature from hot to cold can make _____ in rocks. If water gets into these cracks and freezes, it makes them bigger because water _____ when it freezes. Sometimes frozen water makes bits of rock _____ off.

Question 6

a How is acid formed in the atmosphere?

b What happens to limestone and chalk when this acid falls on it?

c This is called _____ weathering.

Question 7

If you wanted to find out if an igneous rock had been formed by slow or rapid cooling you would look for:

a how hard the rock is

b the size of its crystals

c the colour of the rock

d the size of the rock

Question 8

a What are the two main gases in the atmosphere?

b Which gas makes up most of the air?

c Which gas combines with water to form carbonic acid?

Question 9

a List the four things that the atmosphere does that allow life to exist on Earth?

b List three ways that human health is at risk from a thinning of the ozone layer.

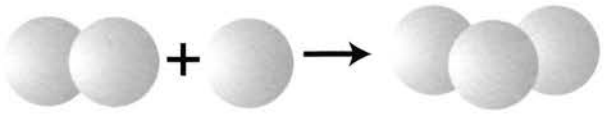
Question 10

a What is the atmosphere?

b What is the name of the layer of the atmosphere in which we live?

c What causes the greenhouse effect?

d Label all the oxygen atoms in the diagram below to show how ozone is formed.



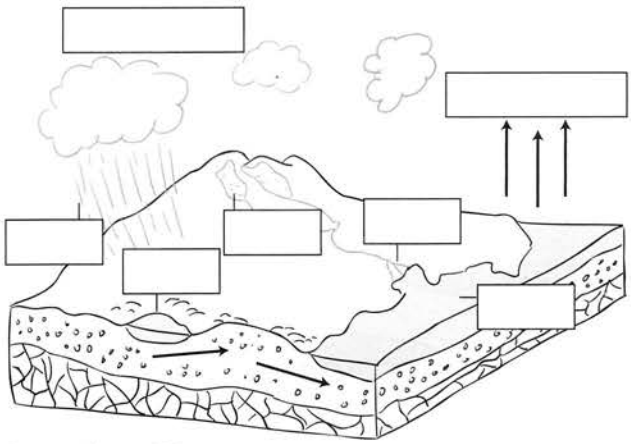
A B

e Which group of oxygen atoms, A or B, is an ozone molecule?

Question 11

Fill in the boxes with the words and phrases below to complete the water cycle.

Evaporation	Rain
River	Ocean
Condensation	Glacier
Lake	Ocean

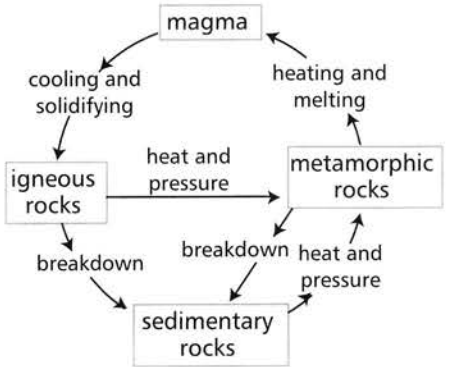


Question 12

If you freeze a full bottle of water, the bottle will crack. How is this related to the formation of soils?

Question 13

Study the diagram below and answer the following questions.



a Which two rock types were originally igneous rocks?

b Which two rock types form sedimentary rocks?

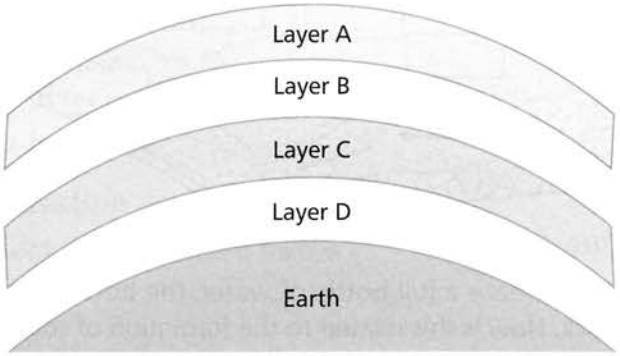
c Which rock type results from the cooling and solidifying of magma?

d What causes sedimentary rocks to become metamorphic rocks?

e Can metamorphic rocks become sedimentary rocks?

Question 14

The diagram below shows the layers in the atmosphere.



The thermosphere is the layer closest to the sun so it is the hottest.

The mesosphere is below the thermosphere.

The stratosphere is above the troposphere.

The troposphere is the layer where we find life.

Which choice places the layers in the correct order from the Earth's surface?

a thermosphere, stratosphere, troposphere, mesosphere

b stratosphere, mesosphere, thermosphere, troposphere

c troposphere, stratosphere, mesosphere, thermosphere

d troposphere, stratosphere, mesosphere, thermosphere

Question 15

Complete the following sentences with the correct words.

One of the greenhouse gases is _____ _____. Scientists think that the amount of carbon dioxide in the air increases because we burn _____ _____. An increase in the greenhouse effect will raise the Earth's average _____.

Question 16

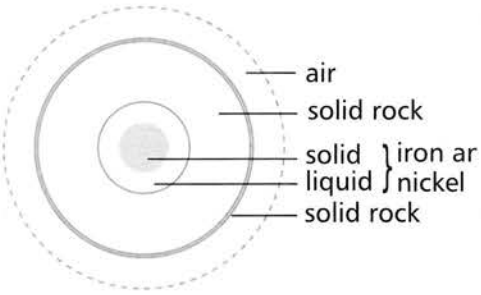
Write down one sentence to say what makes up each of the following parts of the Earth.

a the atmosphere

b the crust

c the magma

d the core



Question 17

The following sentences are about igneous, metamorphic and sedimentary rocks. Are they true or false?

a Sedimentary rocks are made from bits of other rocks that have melted together.

b Sedimentary rocks are made from grains which have been pressed together.

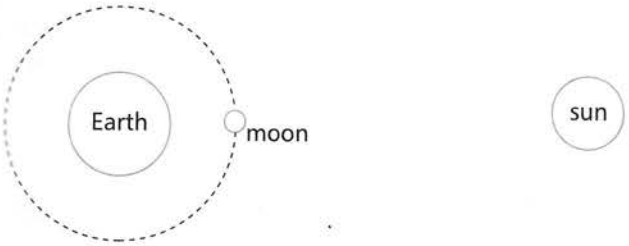
c Igneous rocks can be formed in volcanoes.

d Marble is a metamorphic rock.

e Sandstone is an igneous rock.

Question 18

Will the following arrangement of sun, moon and Earth produce spring tides or neap tides?



Question 19

Complete the following sentences with the correct words.

The air around us is pushing constantly in every direction. This is called _____ _____.

This pressure is greatest at _____ _____ because the air is densest at this level.

Question 20

a What part of our planet is responsible for the Earth's weather patterns.

b What is weathering?

c What is erosion?

d What process is responsible for the breaking up and wearing away of the Earth's rocks?

c Na^+ Cl^-
d chemical bond

4 Precipitation – The formation of an insoluble solid when a reaction takes place in a solution.
Combustion – The chemical change in which oxygen reacts with another substance.
Neutralisation – A reaction in which an acid and an alkali react in an aqueous solution to form a salt and water.

5 a NaOH and H_2
b Na and H_2O

6

Ionic	Molecular
neutral	neutral
made up of cations and anions	made up of molecules
mostly crystalline	mostly gases and liquids
made up of metallic and non-metallic elements	made up of non-metallic elements
eg: **sodium chloride**	eg: **water**

7 charges, Mg^{2+}, negative, Cl^-, two, $MgCl_2$
8 In a chemical reaction no atoms are destroyed nor are any created. They are just rearranged.
9 a word equation
b molecular equation
c ionic equation
10 d
11 a hydrogen + oxygen → water
b carbon + oxygen → carbon dioxide
c copper chloride → copper + chlorine
12 a copper + oxygen → copper oxide
b magnesium + oxygen → magnesium oxide
c copper sulphate + sodium hydroxide → copper hydroxide + sodium sulphate
d zinc + sulphuric acid → zinc sulphate + hydrogen
e hydrochloric acid + sodium hydroxide → sodium chloride + water

13 a combustion reaction
b combustion reaction
c precipitation reaction
d neutralisation reaction
e neutralisation reaction
14 b
15

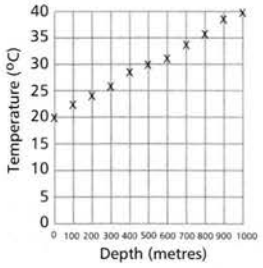
Example	Reaction
respiration	combustion
rusting	corrosion
relieve indigestion	neutralisation
burning fossil fuels	combustion
managing soil pH	neutralisation

16 a compound
b precipitate
c chemical reaction
d oxide
e chemical bond

Chapter 6

Science skills page 65

1 a



b 20 °C
c 40 °C
d 1000 metres
e The supervisor is getting closer to the centre of the Earth.

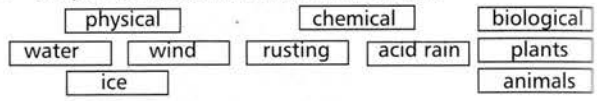
2 1 basalt
2 sedimentary rock
3 metamorphic rock
4 magma
5 granite

3 a Streams and rivers carry bits of rock to the sea.
b The bits of rock (called sediment) settle at the bottom of the sea.
c Older layers of sediment get squashed by the newer layers.

4 a igneous — granite
sedimentary — chalk, sandstone, limestone
metamorphic — marble, slate
b Chalk, limestone and marble are all made from calcium carbonate.
c sandstone
d slate

5 The surface of the rock should start to crack and break off in little bits.
6 marble, coral, chalk, limestone
7 a A
b The jar represents the Earth's atmosphere.

8



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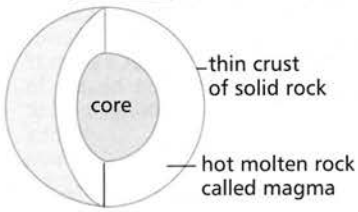

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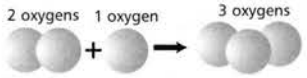
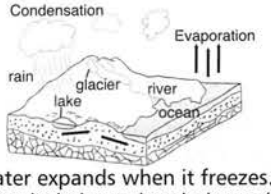
1 b
2 d
3 a granite
b basalt
c igneous rock
4 a marble
b slate
d metamorphic rocks
5 weathering, cracks, expands, break
6 a Carbon dioxide combines with water to form the weak acid carbonic acid.
b The rocks wear away by the chemical reaction between the calcium carbonate in these rocks and the acid.
c chemical
7 b
8 a oxygen, nitrogen b nitrogen c carbon dioxide
9 a fresh water, air, ultra violet protection, keeps us warm
b skin cancer, eye damage, sunburn causing skin ageing
10 a A blanket of gases that surround our planet.
b troposphere
c Incoming solar radiation is absorbed by the Earth. Some is bounced back and it is absorbed by water vapour, carbon dioxide, etc which increases the global temperature.
d



e B
11



12 Water expands when it freezes. This expansion in the crevices of rocks helps to break the rock into smaller and smaller bits and then into soil.
13 a sedimentary and metamorphic
b igneous and metamorphic
c igneous

d heat and pressure
e yes

14 d

15 carbon dioxide, fossil fuels, temperature

16 a The atmosphere is made of air (includes many gases, dust, pollution).
b The crust is made of solid rock (igneous, sedimentary and metamorphic).
c The magma is molten rock.
d The core is made of iron and nickel.

17 a false b true c true
d true e false

18 neap tides

19 air pressure sea level

20 a atmosphere
b Weathering is the breakdown of rock when it is exposed to the sun, the wind and the rain.
c Erosion is the movement of rock fragments and soil by glaciers, wind, waves and running water.
d The weather

Chapter 7

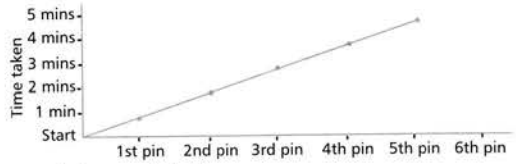
Science skills page 77

1 a Chemical c Kinetic
b Heat d Kinetic

2

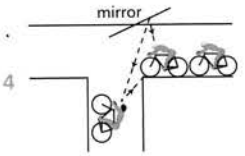
Good heat conductors	Poor heat conductors
copper	wood
steel	glass
iron	plastic
water	wool
brass	rubber

3



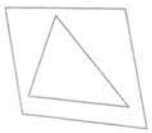
The result is a straight line so heat must flow along the metal rod at an even rate.

4



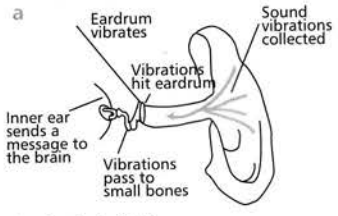
5 a B = 45, X = 45, Y = 45, Z = 90 b 90, 45, 45

6 a



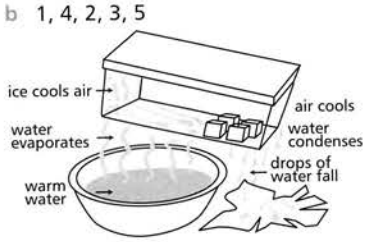
b Light travels in straight line so the shadow is much larger than the wooden triangle.

7 a



b 1, 4, 2, 3, 5

8



9 a chemical → kinetic → light & heat
b chemical → light & heat

10 a shiny can b dull black can

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1 a thermometer
b energy, hotter, colder
c molecules
d Conduction
e reflect

2 Twisting the band builds potential energy. When it is released the stored energy in the band makes the band unwind causing the can to roll. Potential energy becomes kinetic energy. When the potential energy is all used up the can stops.

3 a Yellow light is reflected.
b Green light is reflected.

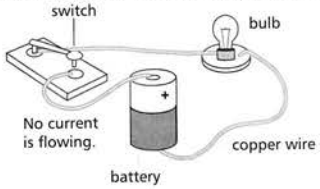
4 white

5 a It is not as light on a cloudy day because clouds reflect some of the light from the sun back into space. They also absorb some light.
b You don't get strong, sharp shadows on a cloudy day.

6 light, absorb, straight lines, corners, shadow

7 a You see lightning before you hear thunder because light travels through the air a lot faster than sound does.
b In 4 seconds light travels 1320 metres (4 × 330)

8 a and b



c The bulb lights up. d no e insulator
f open a gap in the circuit (break the circuit)

9 We burn fuels to make things hotter.
We burn fuels to produce light.
We burn fuels to move things around.

10 a From the food you eat.
b Carbohydrates (sugar, bread, pasta, rice) and fats (butter, chocolate, icecream).
c chemical energy

11 A — potential C — potential
B — kinetic D — kinetic

12 kinetic (25%) + heat (65%) + sound (10%) = 100%

13 a Lungs are using chemical energy from food to force air into the balloon.
b Energy is stored in the springiness of squashed air inside the elastic balloon.
c Elastic energy is transferred to kinetic energy (blast of moving air) when the balloon bursts.

14 a potential b electrical c heat d kinetic

15 torch = electrical to light
battery = chemical to electrical
lift going up = electrical to kinetic
solar cell = light to electrical
TV = electrical to light and sound
bonfire = chemical to heat and light
nuclear power plant = nuclear to electrical

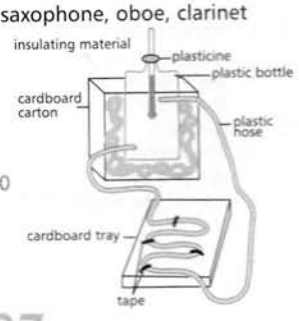
16 a The paper dots start moving around in water currents.
b convection

17 a all potential and no kinetic
b half potential and half kinetic
c no potential and all kinetic

18 a violin, guitar, piano c saxophone, oboe, clarinet
b drums, symbols, xylophone

19 a A (smallest amount of air)
b Because different amounts of air vibrate differently making different sounds.

20



CHAPTER 6

THE UNIVERSE

Is anybody out there?

Scientists refer to the beginning of the universe as the **Big Bang** because evidence indicates that the universe exploded violently into being and has been expanding ever since. Apart from the galaxies near us, all the other ones are rushing away from us. The further away a **galaxy** is, the faster it and our galaxy are moving apart.

Somewhere between 13 and 20 million years ago all the matter in the universe was concentrated into a single point. Physicists believe that time is connected to the existence of space, matter and gravity. Before the Big Bang there was no time or space, so there was no 'before'. The explosion that expanded the point of matter at an unimaginable speed, created the universe. At the same time as this expansion, 'time' was created as well as space.

There is nothing beyond the universe as the word 'universe' means everything that is. As the universe expands it creates space. There is no space beyond the universe. This idea is very hard to imagine as it is at the very edge of what humans can comprehend.

Sizes and distances in the universe are also difficult to visualise. The distances between objects in the universe are so huge that we measure them in **light years**.

The expanding universe

The universe continued to grow explosively. Its temperature was very hot, reaching millions of millions of degrees. It was far too hot for matter as we know it today to exist. As the universe cooled down, sub-atomic particles 'condensed' out of the cooling energy and atoms followed. All the atoms organised themselves in new ways, according to rules and regulations that they still obey, and that we are still discovering.

Ideas about the end of the universe

- The big question is **whether the expansion of the universe will continue?** The only thing that can stop it is gravity. If there is enough mass in the universe, gravitational attraction will eventually slow the expansion and cause contraction. The universe will shrink and the galaxies will come closer together. As they do the strength of the gravitational attraction will increase and this will speed up the contraction. So in a few hundred billion years, long after the sun is burnt out, the universe may end in a **'Big Collapse'**! It could be that the Big Collapse is followed by another Big Bang and a new universe is created — there is of course no scientific evidence for this.
- There may actually be no Big Collapse. If there is not enough matter in the universe for gravity to overcome the initial incredible explosion, **movement may continue outwards**. Clusters of galaxies may continue to fly apart and the universe will continue to expand. Even though most people think that this is what will happen, physicists believe that it will eventually come to an end. The stars will stop shining and concentrations of energy and matter will dissipate further and further apart until only a frozen darkness remains.

- Another possibility is for gravitation to perfectly balance expansion. Then the outward movement becomes slower and slower but never stops completely.

And in the end ...

At the moment most scientists believe that the universe will expand forever. Exciting research carried out by astronomers suggests that the expansion of the universe is faster than they thought and is in fact speeding up. Einstein suggested that there is a force pushing matter apart and therefore opposing gravity. This idea would guarantee that expansion continues. Scientists need more and more information before they can find out for sure what will happen.

Cosmological contents

As well as trillions of stars and lots of gas the universe contains some very curious objects.

Black holes

A black hole is an object with such great mass (and therefore enormous gravitational pull), that nothing can leave it, not even light. Black holes can form when the core of a massive star collapses in on itself. In the centre of the black hole the original material is compressed to an incredibly high density. The force of gravity is great enough to swallow light and space.

Neutron stars

These are incredibly dense objects. Neutron stars form after a supernova occurs (a giant star exploding). After the explosion, the core of the star collapses under its own gravity, forcing the electrons into the nucleus of the atoms, forming particles called neutrons. A teaspoon of neutrons would weigh a billion tonnes!

Pulsars

These are special types of neutron stars that emit beams of radio waves, and also spin. As the pulsar spins, its beam sweeps in our direction and we detect a pulse of radio waves. These signals are very regular. The CSIRO's Parkes telescope holds the record for finding pulsars.

Quasars

Quasars are the bright cores of distant galaxies. The Anglo-Australian telescope at Coonabarabran in New South Wales has observed more than 10,000 quasars, which is helping astronomers to work out the structure of the universe.

Dark matter

Astronomers know that there is more matter out there than they can recognise. Gravity comes from matter but the amount of matter scientists can detect is not enough to account for the amount of gravity. Therefore, there must be a lot of matter out there that does not radiate light. This is called 'dark matter' and scientists believe it makes up most of the universe.

Gravitational lenses

If a light from a distant source passes close to a very massive object, the rays passing near the object will bend. This is called gravitational lensing. Astronomers can use gravitational lensing to study distant objects that they could not normally see as lensing makes their images brighter.

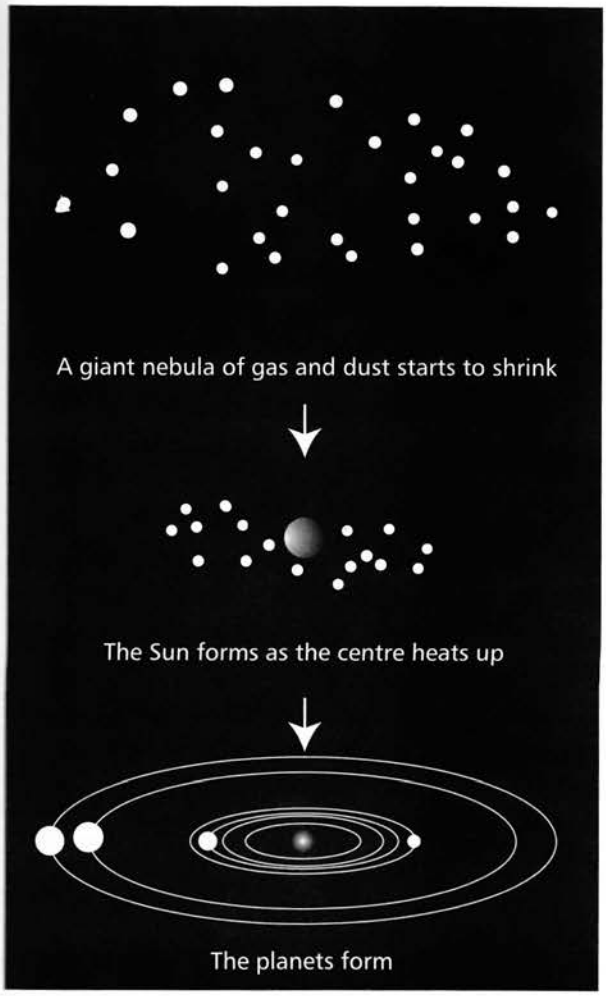
Where did our solar system come from?

Most astronomers believe that all the planets were formed at the same time as the Sun — about 4 500 million years ago.

Scientists say that the solar system began with a huge cloud of cosmic dust, ice, hydrogen and helium gas called a **nebula**. Due to its own gravity, the cloud began to shrink. As it got smaller, particles fell inwards and the centre became hotter and hotter. Eventually the centre of the cloud was white hot and **nuclear fusion** began. It became the **star** we call the **Sun** and the planets formed from concentric rings around the Sun.

Nuclear Fusion occurs when hydrogen nuclei fuse together and release energy. An example of this type of reaction follows.

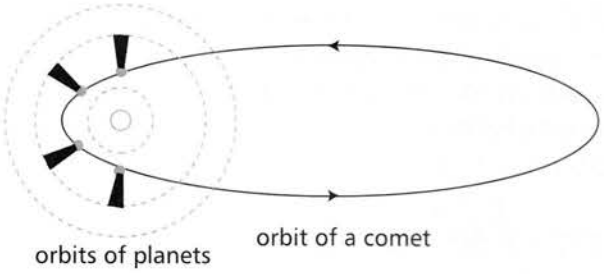
Hydrogen → (Nuclear Fusion) → Helium + Energy



The formation of the planets

The dust began to stick together forming four rocky inner planets. The outer planets formed from the ice and gas to become the 'gas giants' like Jupiter.

Asteroids are some of the rocky bits left over and they orbit between Mars and Jupiter. **Comets** may also be leftovers. They are lumps of ice with wispy tails of gas and dust. They have elliptical orbits that bring them close to the Sun and then far out into the solar system.

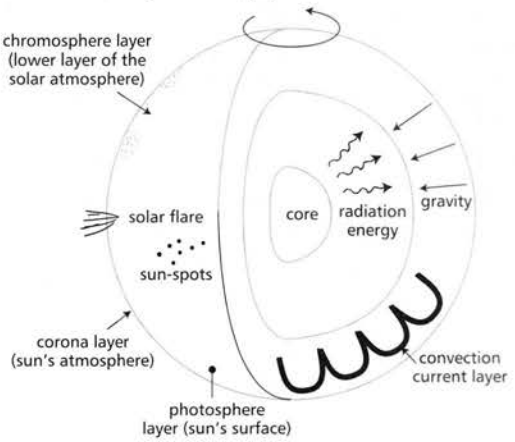


Orbit of a comet

Our star the Sun

Stars are a very long way away. We can see them because they send out huge amounts of light energy. Our Sun is a medium to small sized star. Sirius is the next brightest star in our sky. It is much bigger than the Sun, sending out much more light but it is a long way away. Groups of stars that form patterns are called **constellations**, for example, the constellation of Orion and the Southern Cross.

The Sun consists of several layers surrounding a core. It is made mostly of hydrogen and helium. Overall the Sun is not dense but the matter in the core itself is very densely packed.



Structure of the Sun

The Sun is using up its mass at the rate of 4 million tonnes each second. It has been doing this for 4 500 million years, but is still only halfway through its lifetime. The huge amount of energy radiated out eventually arrives on the earth and keeps us alive.

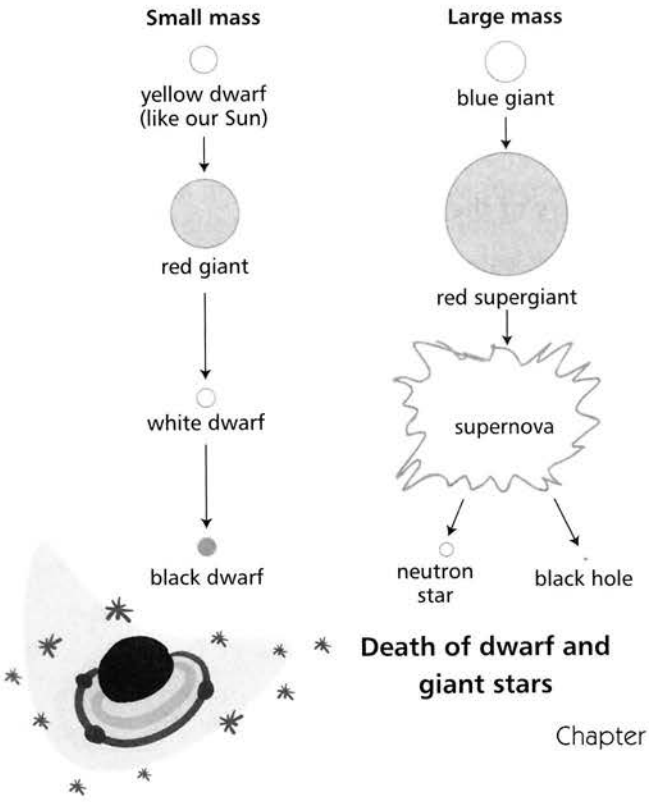
Inside the Sun there is a constant battle of forces — the pull of gravity is trying to crush the sun, while the energy from the very hot core is trying to make it expand. As long as these forces remain balanced the star is stable.

Sunspots are slightly cooler areas on the Sun's surface. These sunspots come and go as the power of the Sun varies. **Solar flares** are the result of intense magnetic activity. They can spew gas more than 300 000 kilometres into space.

The life and death of a star

Stars eventually use up their fuel and start to change. This change depends on how big the star is.

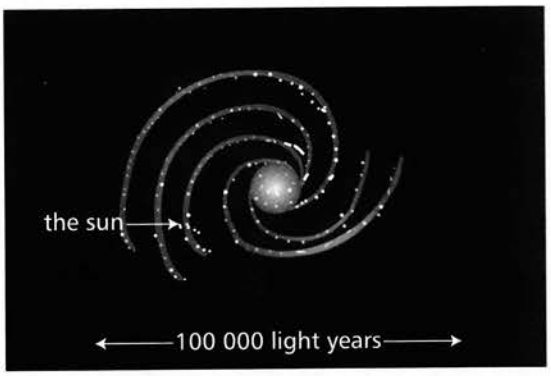
- Small stars like our Sun are called **yellow dwarfs**. After about 10 000 million years the hydrogen is all used up and the star starts to use the helium as fuel. This makes heavier elements like oxygen and carbon. As it does this it expands and cools to become a **red giant**. When it has used up all its fuel it collapses under gravity to form a very hot and dense **white dwarf**. Finally it cools to become a **black dwarf**.
- A larger star burns hotter (a **blue giant**) and runs out of fuel faster. It expands and cools to a **red supergiant**. Later it collapses and blows off its outer layer in an enormous explosion called a **supernova**. The core of a supernova finally collapses to become a very dense **neutron star**. If the star was much bigger that the Sun it will continue to collapse under its own gravity and become a **black hole**.



Death of dwarf and giant stars

The Milky Way

Our galaxy is a collection of about 10 000 million stars; our Sun is just one of them, positioned somewhere near the edge in a spiral arm. The Milky Way rotates around its own centre.



The Milky Way

The Galaxy is huge. It takes eight minutes for light from the Sun to travel from the Sun to the Earth, four years for light to travel from the nearest star, and 100 000 years for light to travel right across our Galaxy.

Are there other solar systems like ours? Could there be Earth-like planets and life elsewhere in the universe? Recent research tends to support the idea that life could have developed somewhere else in the universe.

Glossary

Asteroid
A small, rocky object revolving around the Sun.

Big Bang
A popular name for one of many theories explaining the origin of the universe.

Black hole
A region containing a huge amount of compacted mass, making its pull of gravity so strong that nothing, not even light, can escape from it.

Comet
A ball of rock and ice, usually a few kilometres across, with a long wispy tail of gas and dust which follows an elongated orbit around the Sun.

Cosmology
The study of the universe on the grandest scale, especially its structure, origin, evolution and density.

Dwarf star
Any star comparable to or smaller than the Sun.

Galaxy
A collection of billions of stars and matter held loosely together by gravity. Galaxies are often spread over thousands of light years. The Milky Way is an example.

Giant star
Any star much larger than the Sun.

Light year
The distance travelled by light in one year. Travelling at 300 000 km per second, light travels almost 9 461 trillion km in one year.

Mass
A measure of the total amount of matter contained within an object.

Nebula
A contracting, swirling cloud of dust, ice and gas that forms a concentric series of rings from which the planets were formed.

Nuclear fusion
The reaction whereby hydrogen atoms join together to form helium. Each time this happens a large amount of energy is released.

Star
Distant suns that give out their own light.

Sun
The star at the centre of the solar system.

Solar flare
Violent magnetic activity that releases pent-up energy.

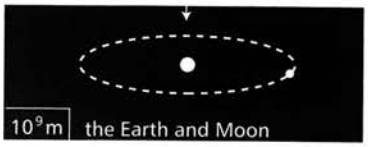
Sunspots
Sunspots appear as dark spots on the surface of the Sun.

Question 1

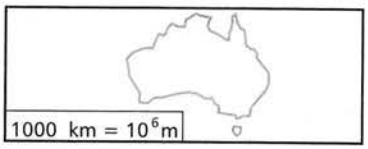
Look at the drawings below. If they are placed in the correct order, each one will be 1000 times wider than the one before it. Unscramble the drawings and arrange them from the smallest to the largest.

A

B



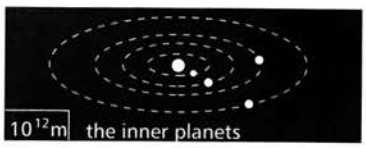
C



D

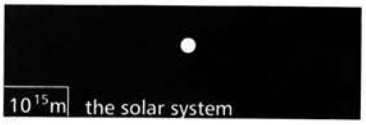
E

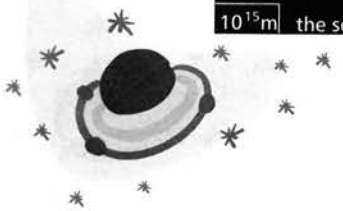
F



G

H

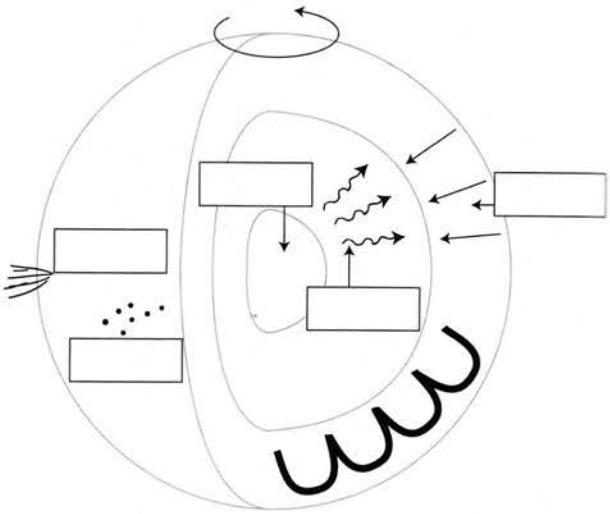




Question 2

Label the diagram of the Sun below with the following structures:

core, solar flare, sunspots, radiation energy, gravity.



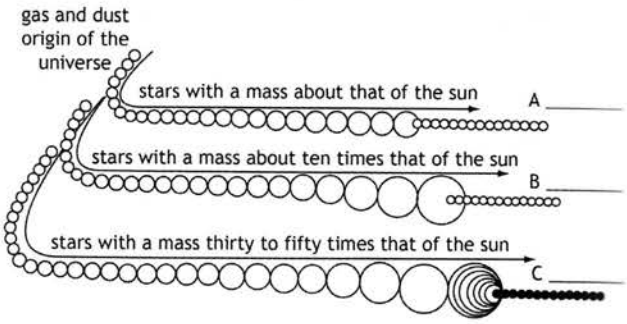
Question 3

The following diagram displays the life and death of three different types sized stars. Use the descriptions below to correctly label the three deaths.

a Collapses to a black hole.

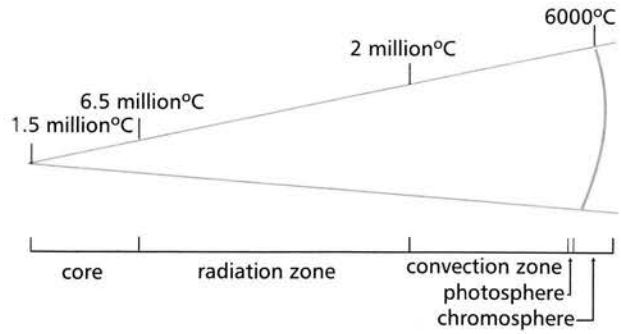
b Contracts to a white dwarf.

c Becomes a supernova then collapses to a neutron star.



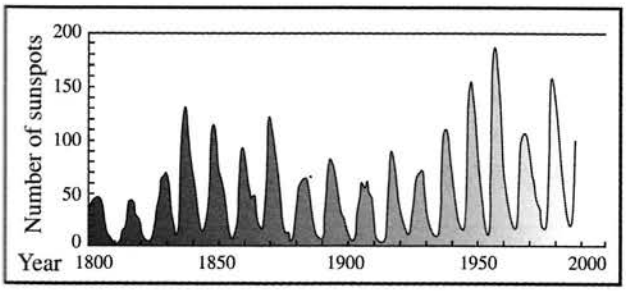
Question 4

The diagram below is a section through to the centre of the Sun. Temperature is measured in Celsius (°C). Draw a histogram to show the temperature of the various layers of the Sun.



Question 5

Sunspots occur in cycles of about 11 years. As shown in the graph below the average number of sunspots varies; periods of unusually large numbers are called sunspot maximum, periods with unusually small numbers, sunspot minimum.



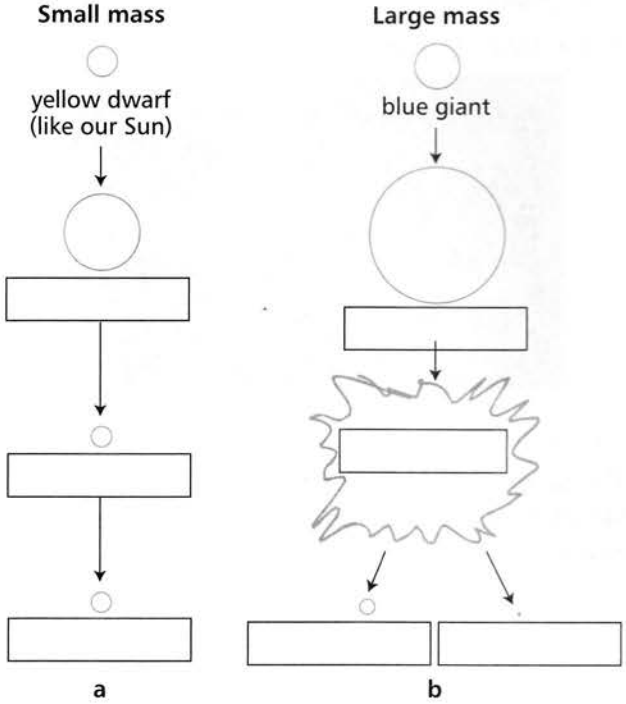
a How many cycles were sunspot maximums (150 or above)?

b How many cycles were sunspot minimums (50 or less)?

Question 6

a Write in the correct terms to describe the stages in the death of a small star like our Sun.

b Write in the correct terms to describe the stages in the death of a large star.



Question 7

Different animals live in different environments to stay alive. Our telescopes are not strong enough for us to be able to see plants and animals on other planets so scientists make guesses based on the information that they do have. Imagine a planet that is just on the edge of what scientists call the 'livable zone' of its sun. This is where scientists think life is most likely to occur. The planet has the following characteristics:

Planet name	Freezeland
Precipitation (rainfall)	High
Average temperature	–10°C
Moons	2

Which of the following forms do you think life on this planet would take? Explain your prediction.

a A long thin shape, like a worm.

b A spherical shape, like an orange.

c An irregular shape, like a star.

d A long shape with lumps at each end, like a dumb bell.

Question 8

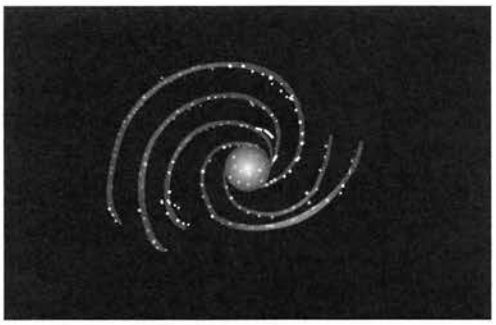
The diagram below is most likely to be:

a A black hole.

b An exploding star.

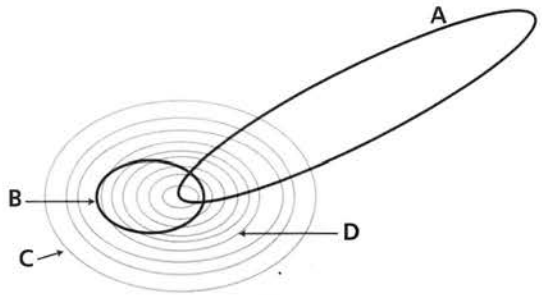
c A galaxy.

d The solar system.



Question 9

The diagram below represents the solar system. Which labelled path represents the path of a comet?



Question 10

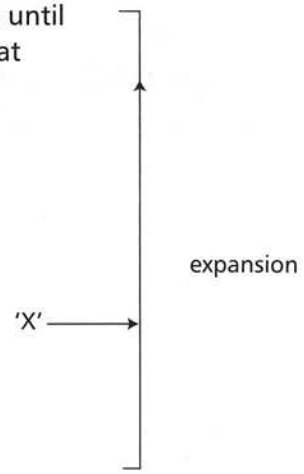
Look at the scale diagram below. The Big Bang is at the bottom and the universe is continually expanding towards the top until it eventually stops. We are at present at point 'X' on the way out. How far has the universe expanded?

a Halfway.

b Almost all the way.

c One third of the way.

d One quarter of the way.



Revision questions

Question 1

Fill in the missing words:

All the stars except the _____ are a very long way away. Like the Sun, they give out their own _____. The brightest star in the sky is _____. This star is much _____ than the Sun and gives out _____ light but it is much further away.

Question 2

Stars are formed from massive clouds of dust and gases in space.

a What force pulls the clouds of dust and gas together to form stars?

b Once formed, a star can have a stable life for billions of years. Describe the two main forces that work in the star while it is stable?

c What happens to a star once this stable period is over?

d What shape are the orbits of comets?

Question 3

Our Sun is a star. It looks much brighter than other stars because:

a It is brighter.

b It is closer than other stars.

c It is yellow when other stars are white.

d The other stars are in other galaxies.

Question 4

A group of stars forming the Southern Cross is an example of a:

a galaxy

b constellation

c solar system

d nebula

Question 5

The energy produced by stars is most likely the result of:

a combustion of hydrogen gas

b gravitational energy

c nuclear energy

d potential energy

Question 6

Which of the following theories for the end of the universe do most scientists support at the moment?

a The Big Bang followed by the Big Collapse — the universe will expand but finally collapse back on itself.

b The Big Bang — the universe will continue to expand until there is just a frozen void left.

c The expansion will be balanced by gravity.

Question 7

a Fill in the missing words:

Our Sun is a _____ dwarf star. Later it will change to a red _____, followed by a _____ dwarf, then a _____ dwarf.

b A larger star (a blue _____) will change to a red _____ and later explode in a _____ leaving a _____ star, or a _____ hole.

Question 8

Provide the cosmological objects with the correct explanation:

Object	Explanation
Black Hole	
Gravitational Lens	
Quasar	
Pulsar	
Neutron Star	
Dark Matter	

Question 9

Refer to the diagram showing the structure of the Sun on page 61, and list the four outer layers of the Sun.

_____

_____

_____

Question 10

Asteroids are made of:

a Ice and gas left over from the solar system.

b Energy from exploding stars.

c Dust.

d Rocky bits left over from the formation of the inner planets.

Question 11

Distances in astronomy are extremely large so they are measured in light years. This is the distance that light can travel in one year (9 461 trillion km).

a The nearest galaxy to us is called the Large Megellanic Cloud. It is only 160 000 light years away. Could a space traveller reach this galaxy within his lifetime?

_____

b This galaxy is 30 000 light-years in diameter. How many trillion km wide is it?

_____

Question 12

Complete the sentences below:

The Sun is a star in our galaxy, the _____ _____. The Sun's energy comes from _____ _____. A star is formed from a _____, and changes as it gets older. The universe continues to _____.

Question 13

a Explain the process of nuclear fusion.

b Write the equation for one example of nuclear fusion.

Question 14

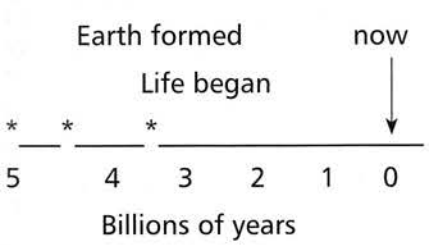
a Where in the solar system is the asteroid belt?

b Do asteroids move around the Sun in orbits?

c What is the difference between a comet and an asteroid?

Question 15

Scientists think that the Sun formed about five billion years ago. Much later the Earth formed and then life began. Look at the time line below:



a When did life on Earth begin?

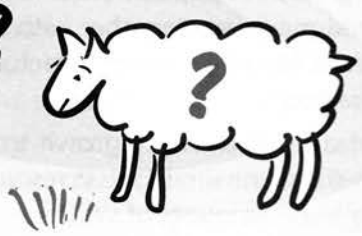
b About how long ago did the Earth form?

c How many more years will the Sun keep on shining if it has so far used up half its mass?

CHAPTER 7

HUMAN IMPACT ON THE BIOSPHERE

Which species is headed for extinction next?



The major problems facing the environment today have been largely caused by humans and their activities. Humans use up a large share of the Earth's resources and create vast quantities of harmful waste and pollution.

Humans in the system

- Humans are a recent part of life on Earth.
- Human intelligence is a unique characteristic that is responsible for the scale of human impact on the environment.
- Humans are not specialised for any particular niche but they can make tools, use fire and they work together. They can cope with almost any terrestrial habitat and have increased their range to cover most of the planet.
- The first Australians were hunters and gatherers. They tended to live with the environment, moving around and allowing each patch of land to recover.
- Agriculture interferes with the ecosystem and diverts energy and nutrients to make biological products chosen by humans.
- Agriculture allowed urbanisation to occur. Cities have expanded and control the land around them, destroying the natural environment. People have moved from agricultural to business and industrial occupations.
- The Industrial Revolution produced the technological power to rapidly make large changes to the environment.

The industrial revolution

The Industrial revolution in the 1800s made a major contribution to the world we know today. Industrial processes based on fossil fuels (non-renewable energy sources), for the first time permitted humans to significantly alter the environment.

The main features were:

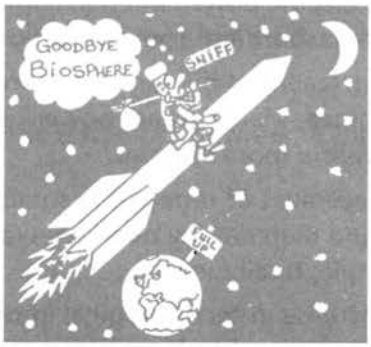
- The application of **new technology** to both urban and rural industries, for example: steam engines, electric power, internal combustion engine, transport and communication.
- The replacement of human and animal labour by **machines**. Machines are powerful and fast, and therefore more efficient.
- The replacement of **renewable** sources of energy and materials by **non-renewable** ones, for example, fossil fuels.
- A vast increase in **technological knowledge**, for example, scientific knowledge, hygiene, clean water and safe disposal of waste.

The main consequences of the Industrial Revolution have been:

- A great increase in the use of energy and resources.
- A great increase in the production of waste such as air **pollution**, toxic and heavy metals and the quantity of household waste.
- A significant increase in the standard of living for a large part of the population. Modern gadgets save time and allow for increased leisure time.

- Rapid and continuous economic growth. Nations build more, mine more and produce more, so there is more wealth.
- A sudden growth in population. Knowledge of hygiene and medicine, together with increased efficiencies in farming and manufacturing, allow more people to live longer.
- Growth of cities. Cities have grown to enormous sizes, consuming vast resources and producing huge amounts of waste.
- An increase in the destructive power available for warfare.
- Widespread changes to the natural environment. The chemicals released by industrial activity have polluted the sea, the air and the land. **Biodiversity** is decreasing and population is increasing.

All societies in the past have had an effect on the natural environment. The difference today is in the numbers of people and the power available to them, hence the scale and speed of the damage.



The global effect of modern humans

With our huge population and our use of science and technology, our impact on the planet is increasing.

The atmosphere

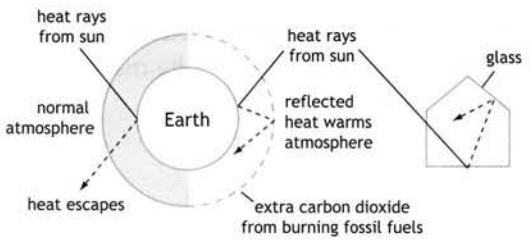
The atmosphere makes Earth unique — it provides our weather and protects the **biosphere** from sun damage. Some of the most extensive, but least visible, human impact has been on the atmosphere.

- **Acid rain** — rainwater dissolves gases in the atmosphere. If the atmosphere contains pollutant gases, such as sulphur oxides from power stations, carbon dioxide from cars, and nitrogen oxides from factories, the rain becomes highly acid. This rain can kill forests and dissolve some rocks.

Acid rain

- **Ozone depletion** — the ozone layer is a band of gas (a form of oxygen) in the atmosphere, about 40 kilometres above the ground. It protects the Earth from some of the harmful ultra violet radiation in sunlight. Recently, synthetic gases such as chlorofluorocarbons (CFCs) have built up in the atmosphere. These gases react with the ozone, making parts of the ozone thinner.

  Ozone depletion allows more UV radiation to reach the earth. This is dangerous for many living things as UV can damage genes, causing cell malfunction, which can lead to cancer.
- **The greenhouse effect** — when the sun's energy reaches the earth, some energy is reflected back and some is trapped in the atmosphere by gases such as carbon dioxide. These gases keep the atmosphere warm enough to support life. Due to deforestation and the burning of fossil fuels there has been an increase in the amount of carbon dioxide in the earth's atmosphere. Many scientists believe this has caused an increase in the earth's average temperature. If **global warming** continues it will have devastating effects on the earth's ecosystems.



Greenhouse effect

The land

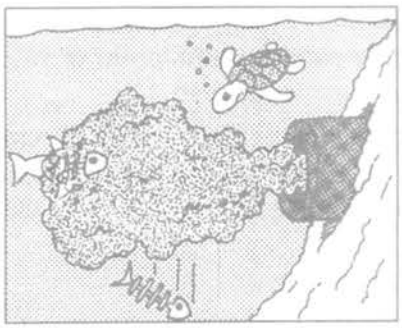
Agriculture is the main agent of change to the Earth's surface.

- **Deforestation** — many parts of the world have been completely cleared of trees to make space for farming. This deforestation often results in **desertification**, a process that results in the mineral nutrients in the soil being washed away, turning fertile land into semi-desert. Loss of forest causes decreases in biodiversity, changes to the world's climate and increased levels of greenhouse gases.
- **Soil erosion** — this is the process of soil being washed or blown away by water and wind. It is the most common and the most devastating form of land degradation. Clearing the land, ploughing and overgrazing destroys the soil structure and the plant roots that hold the soil in place — the soil and its nutrients are lost.
- **Salinity** — clearing deep-rooted trees can result in the ground forming a watertable, and its dissolved salts rising to the surface. Salt accumulation occurs in root zones and on the surface in low-lying areas. Irrigation makes the situation worse. Salting of the land causes severe loss of productive land.
- **Waste** — biodegradable substances in waste materials, such as paper, will be broken down by decomposers into harmless substances and used in the environment. Many plastics, however, are non-biodegradable, cannot be broken down and go on to accumulate and pollute the land for many years. Also, wild animals and sea creatures may try to eat it, or become tangled in waste plastic, and often perish.
- **Biocides** — biocides are chemicals that kill living things, for example herbicides kill plant pests. These chemicals are good for farming but they also destroy other living things. Biological control, however, makes use of natural predators that attack the pest without harming other species or leaving dangerous chemicals in the environment.

Water

In many parts of the world water is a scarce resource.

- **Silting** — once trees have been removed from the ground, water flows very quickly over that land, carrying the soil with it causing flooding and the silting up of creek and river systems.
- **Salinity** — salt on the land is washed into rivers and creeks. The increased level of salt in the water kills many aquatic species and reduces aquatic biodiversity.
- **Eutrophication** — is the process by which all the oxygen in water is used up. Many of the waste substances produced by human activities contain mineral elements, such as nitrates and phosphates. If these are washed into water they act as a fertiliser, and may cause algal blooms. The overgrowth of algae uses up the oxygen in the water, killing other forms of life through oxygen deprivation.



Eutrophication

Oceans

Oceans, like the atmosphere, are used by many countries, but are the responsibility of no one.

- **Marine pollution** — the main pollutants are excess nutrients, synthetic chemicals, plastic, oil, heavy metals and radioactive waste. These pollutants enter the sea via water run-off, sewage, oil spillage from tankers and garbage dumping.

- **Habitat destruction** — coastal habitats such as mangroves and sea grass, which are used by vast numbers of marine creatures for reproduction and as nurseries for their young, are destroyed by human habitation.

Ecological sustainability

Sustainable development is development that is compatible with the rest of the environment, such that the basic needs of all are met.

The key principles follow:

- Intergenerational equity — the present generation should leave the next generation a healthy, diverse and productive environment.
- Conservation of biodiversity and ecological integrity. This should be a constraint on all economic activity.
- Constant natural capital and sustainable income. Only income that can be sustained indefinitely should be taken.
- Precautionary policy approach. Decisions should be cautious until proof of sustainable development is received.
- Pricing environmental values and natural resources to recover the full social and environmental cost.

Conservation

Many human activities damage other forms of life. Conservation is the careful maintenance, management and preservation of living things and natural resources to make sure that we harm the natural world as little as possible. Examples:

- Retain natural environments such as parks and forests.
- Use renewable energy resources.
- Recycle wherever possible.
- Reduce pollutants.
- Reduce our dependency on chemicals.
- Control human population growth.

Glossary

Acid rain
Rain that has been made strongly acidic by atmospheric pollutants.

Biodiversity
The variety of species in an area.

Biosphere
All parts of the earth that make up the living world.

Conservation
The management of resources to protect the natural world.

Deforestation
The permanent removal of trees.

Ecology
The study of the interactions of organisms with their physical environment and with one another.

Eutrophication
The increase in the nutrient content of a body of water, leading to a rapid increase in algae growth. When this algae dies the oxygen level in the water drops until it cannot support other aquatic life forms.

Global warming
An increase in the earth's average temperature due to deforestation and burning fossil fuels.

Greenhouse
The trapping of heat by the earth's atmosphere — like the glass in a greenhouse.

Pollution
The disruption of the natural world by the release of chemicals or other agents.

Salinity
The concentration of salts in the root zone by evaporation from a shallow water table.

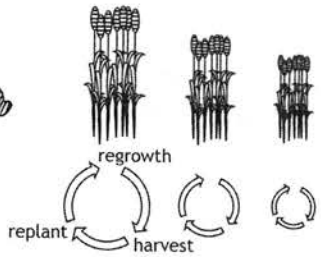
Question 1

The following diagram shows the process of deforestation, farming and land degradation.

List the diagrams A to D in the correct order to show the process.

A Soil baked hard in tropical sun.

B Cycle of maize cultivation continues over many years. Harvest becomes poorer as nutrients are depleted and soils are eroded.

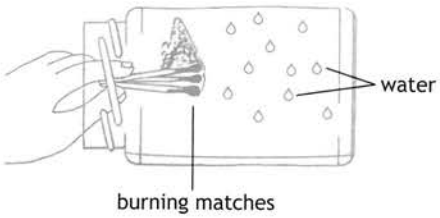


C Felling and burning forest.

D Soil washed away by tropical rains.

Question 2

Some students carried out an experiment on acid rain. They put a little tap water (pH = neutral) into a jar and burnt some matches in the jar and then screwed on the lid.



a They tested the water for acidity. Would the pH be acid or alkaline?

b Explain your answer.

Question 3

The following data refer to a population of micro-organisms in a culture.

Time (days)	0	2	4	6	8
Microbes per mL	30	160	600	620	400

a Graph this data.

b What is happening to the micro-organisms between days 2 and 4?

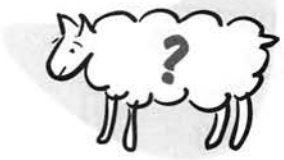
c What is happening between days 4 and 6?

d What is happening on day 8?

Question 4

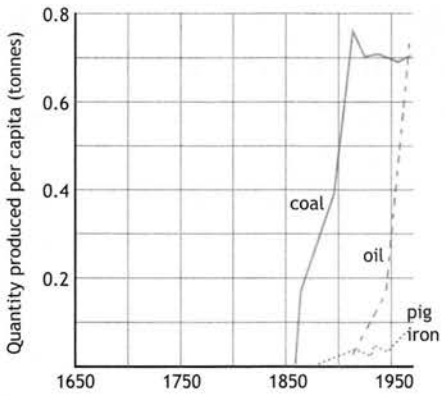
Air pollution is a major source of environmental damage. Complete the table below, which summarises the source and effects of pollutants.

Pollutant	Source	Release	Effects
	domestic industrial	aerosol sprays	destroys the ozone layer
sulphur oxides	domestic industrial		acid rain
nitrous oxides	domestic industrial	burning fossil fuels	
carbon dioxide	domestic industrial	burning fossil fuels	
heavy metals		car fumes	accumulation in plants and animals



Question 5

Study the graph below, which shows the demand for natural resources.

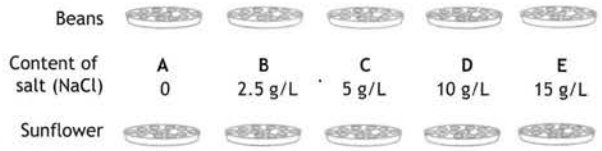


a After what year was there an enormous increase in the demand for fossil fuels?

b What revolution did this coincide with?

Question 6

Students studied the effects of salination on the germination of bean and sunflower seeds. They set up the following experiment:



Germination rates were as follows:

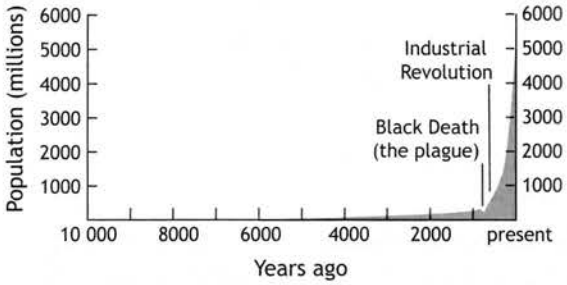
Salt level	Beans	Sunflowers
A = 0	100%	100%
B = 2.5g/L	80%	90%
C = 5 g/L	50%	80%
D = 10 g/L	30%	70%
E = 15 g/L	0	50%

a Which seed is most susceptible to salt?

b Which crop would be best planted in slightly salty soil?

Question 7

The graph below shows the increase in world population from 10 000 years ago until the present.



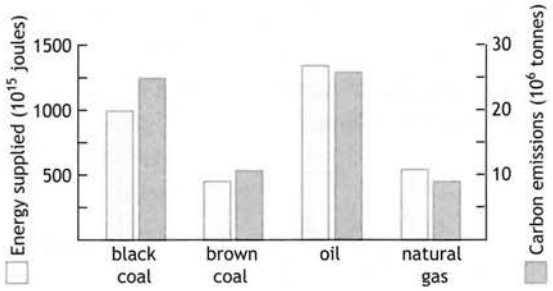
a The most spectacular growth has been over the past how many years?

b How long do you think it will be until there are another 1000 million people on the planet?

c Why did the Industrial Revolution trigger an increase in human population?

Question 8

The graph shows the energy released and the carbon emitted in Australia for the four fossil fuels listed.



a Which two fuels produce the greatest carbon emissions?

b Which fuel produces the least energy?

c Rank the fuels according to their greenhouse potential.

d Explain why some fuels account for more of our energy needs than others?

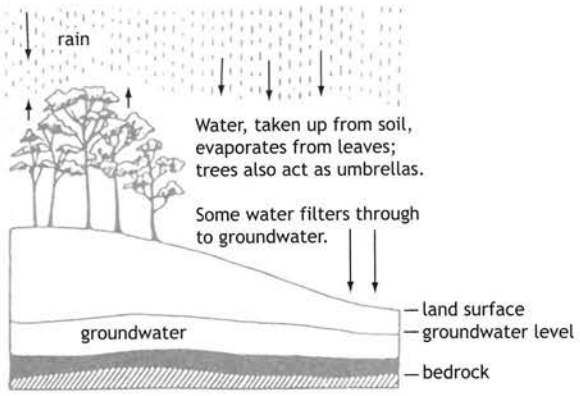
Question 9

The following table outlines the flow of resources into and out of three different ecosystems. Use the words *little*, *some* or *much* to describe the resource flow.

Resource	Urban	Agricultural	Natural
energy in			
energy wastage			
materials in			
recycling			

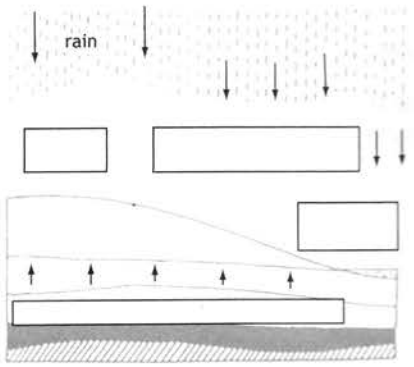
Question 10

The following diagram shows water movement in a healthy environment.



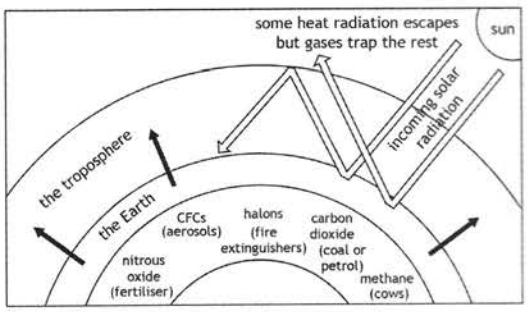
In the diagram below fill in the boxes with the correct statement from the list below to explain the development of salinity in soils.

- trees removed
- salty water emerges
- ground water rises, dissolves salt
- more water filters through to ground water



Question 11

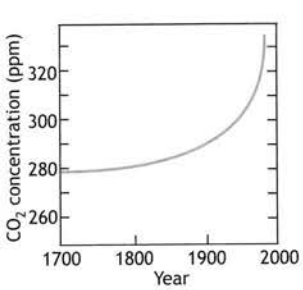
Study the diagram below of the greenhouse effect and write down the names of the gases that contribute to global warming.

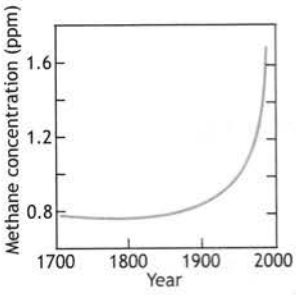


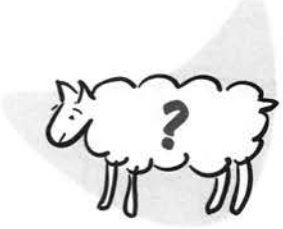
Activities that release gases and contribute to greenhouse effect

Question 12

The two graphs below show carbon dioxide and methane concentration in the air over the past 200 years.





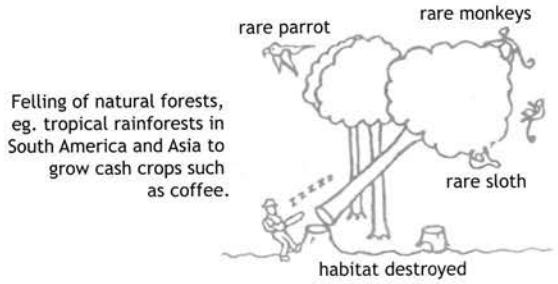


a Why has their been such a large increase in carbon dioxide in recent years?

b Why has there been such an increase in methane production?

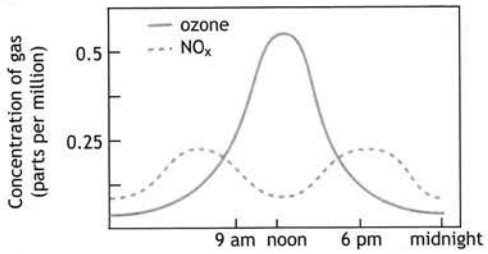
Question 13

What are the environmental consequences of the following situation?



Question 14

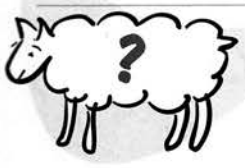
The following graph shows levels of ozone and nitrogen oxides in a city throughout the day.



What is the source of nitrogen oxides?

Why are their two peaks?

Why does ozone peak in the middle of the day?



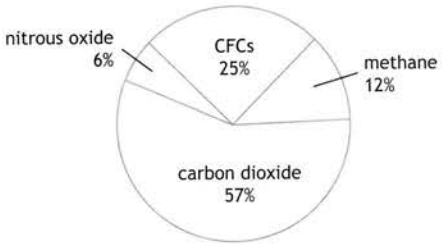
Revision questions

Question 1

What are the special features of *homo sapiens* that make it such an adaptable species?

Question 2

Look at the diagram of the chief gases in the enhanced greenhouse effect. Decide which gas accounts for just over half of global warming.



Question 3

List some of the predicted consequences of global warming.

Question 4

How has recent human activity shortened the storage time of the carbon stored underground?

Question 5

How is deforestation on hillsides related to erosion and flooding?

Question 6

Why are more and more people living in cities?

Question 7

List in the table below some of the inputs and outputs of cities.

Inputs to a city	Outputs of a city

Question 8

Complete the table below by listing the effects of ocean pollutants.

Pollutant	Effect
heavy metals	
crude oil	
plastics	
sewage	

Question 9

The main effects of eutrophication are as follows: species diversity decreases, plant and algal biomass increase, turbidity increases and sedimentation increases.

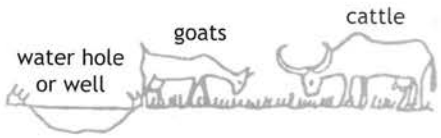
What are some of the problems this will cause humans?

Question 10

The four stages of human development are listed below. Put them in the correct order and match the comment about man's position in the environment with each one.

Agriculturalist	Great control over the environment but with many undesirable consequences.
Hunter gatherer	Controlled by the environment.
Industrialist	Man has increased control over the environment.
Primitive man	Man starts to control the environment.

Question 11



Overgrazing and trampling of grassland around oasis water source, eg. North Africa.

a What are the environmental consequences of the following situation?

b What are the human consequences?

c How could the management of this grazing land be improved?

Question 12

The Industrial Revolution made a major contribution to the world we know now. List 6 of the major consequences.

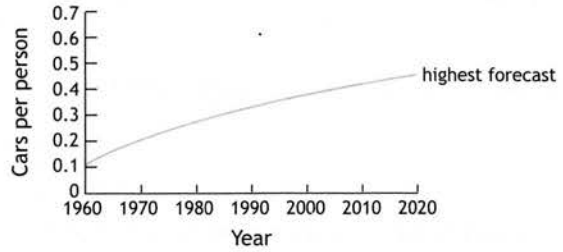
Question 13

Fill in the missing words.

Continuous growing of crops eventually uses up all the soil's _____. These can be replaced by artificial _____ but the cost to the _____ is high. Fertilisers can _____ rivers and add to _____ problems.

Question 14

The invention of the car was one of the biggest changes that occurred in the last 100 years.



a What does the graph tell us about the use of the motor car?

b Do you think pollution from cars will get better or worse in the future? Why?

c By the year 2020 how many cars will every person in the world own?

Question 15

Fossil fuels and resources are:

a non-renewable

b renewable

c recycled

d exponential

Question 16

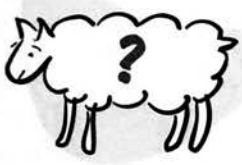
The energy released when some fuels are burnt is shown in the table below. Which fuel releases the most energy per gram?

Fuel	Amount of fuel burnt (g)	Energy released (kJ)
hydrogen	2	285
carbon	12	393
methane	16	890
ethanol	46	1 360
octane	114	5 460

Question 17

a What damage does ultra violet radiation do to living things?

b What synthetic gas causes a thinning in the ozone layer?



Question 18

All the waste we produce has to go somewhere here on earth.

a What happens to waste that seems to disappear when you burn it?

b Where does the waste that we flush down the toilet finish up, treated or not?

c How can we deal with our waste so that it does not damage the environment?

Question 19

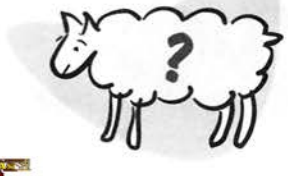
a What is sustainable economic growth?

b List two key principles of sustainable economic growth.

Question 20

a What is conservation?

b List two examples of conservation.

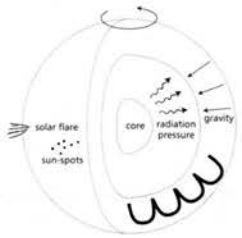


5 They are made of iron and exhaust contains both water and air. Stainless steel does not rust but it is more expensive.
6 a Iron and steel.
b Because they are more reactive.
7 a Coating iron with zinc.
b Zinc (not very reactive) is slow to corrode so it protects the iron for many years.
8 a Sodium is stored in oil to stop it reacting with water vapour in the air.
b Hydrogen and sodium hydroxide.
c Sodium (most reactive), magnesium, then copper.
9 a Dilute hydrochloric acid and magnesium.
b Hydrogen and magnesium chloride.
c A chemical reaction.
10 a new, chemical.
b sulphuric, reactive, vinegar, lemon juice.
11 They repel water from the skin because water is not able to mix with the oils in the cream.
12 a The wood reacts with oxygen from the air.
b Water vapour, carbon dioxide and charcoal.
13 For a bee sting add an alkali and for a wasp sting an acid.
14 Moisture in the air combines with carbon dioxide to form a weak acid called carbonic acid, which reacts with limestone when it rains.
15 a Iron and zinc.
b Because the zinc is less reactive and corrodes much slower, so protecting the iron.
16 If the tin coating is damaged then the exposed iron will corrode, spoiling the food in the can.
17 The chain is oiled.
The can has a layer of tin covering the steel.
The dish drainer is coated in plastic.
The garden furniture is painted.
18 Oxidation, air, water, barrier, corrode.
19 a Use an indicator. b Neutralisation.
c Salt and water. d Indigestion tablets.
20 a The pH gets lower.
b Because the bacteria in the mouth produce acid from the sweet material on teeth.
c The acid may eat through the enamel.
d Because toothpaste is alkaline and neutralises the acid.

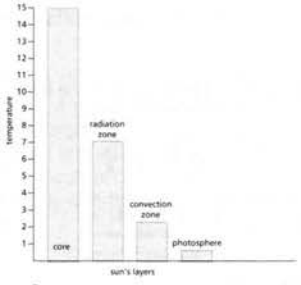
Chapter 6

Science skills page 64

1 E, I, C, B, F, H, A, D, G
2



3 A. Contracts to a white dwarf.
B. Becomes a supernova and then collapses to a neutron star.
C. Collapses to a black hole.
4



5 a 3 b 2
6 a Small mass
yellow dwarf (like our Sun)
red giant
white dwarf
black dwarf
b Large mass
blue giant
red supergiant
supernova
neutron star
black hole
7 b This is the most likely shape for an animal on an ice planet because without any thin areas it would be easiest to keep warm.
8 c
9 A
10 c

Revision questions page 66

1 Sun, light, Sirius, bigger, more
2 a Gravity.
b Gravity tries to crush the star but the energy from the core makes it expand.
c It expands, cools, collapses and dies.
d Elliptical.
3 b
4 b
5 a
6 c
7 a yellow, giant, white, black
b giant, supergiant, supernova, neutron, black
8

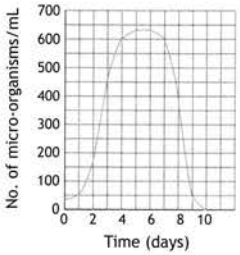
Object	Explanation
Black Hole	Great mass and enormous gravitational pull.
Gravitational Lens	Light rays bend as they pass a massive object.
Quasar	Bright cores of distant galaxies.
Pulsar	Neutron stars that emit radio waves.
Neutron Star	Incredibly dense objects where the electrons have been forced into the nucleus.
Dark Matter	Matter that cannot be seen as it does not give out light.

9 Corona layer
Chromosphere layer
Photosphere layer
Convection Current layer
10 d
11 a no
b (9 461 × 30 000) trillion km
12 Milky Way, nuclear fusion, nebula, expand
13 a The reaction whereby hydrogen atoms join together to form helium. Each time this happens some mass is lost but large amounts of energy are released.
b Hydrogen → (Nuclear Fusion) → Helium + Energy
14 a Between Mars and Jupiter.
b Yes.
c A comet is made of ice, an asteroid is made of rock. A comet has an elliptical orbit.
15 a 3.5 billion years ago.
b 4.5 billion years ago.
c If the Sun has used about half of its mass it should keep shining for another five billion years.

Chapter 7

Science skills page 73

1 D, B, A, C.
2 a Acidic.
b The gases combine with rain to form a weak acid.
3 a



b Rapid population growth.
c The population growth has stabilized.
d Population numbers falling due to competition for resources (food).

4

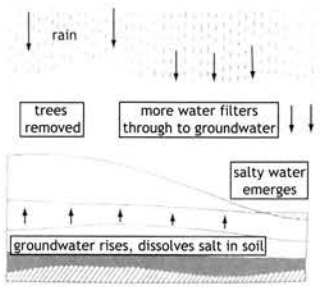
Pollutant	Source	Release	Effects
CFCs	domestic industrial	aerosol sprays	destroys the ozone layer
sulphur oxides	domestic industrial	burning fossil fuels	acid rain
nitrous oxides	domestic industrial	burning fossil fuels	acid rain
carbon dioxide	domestic industrial	burning fossil fuels	greenhouse effect
heavy metals	mostly domestic	car fumes	accumulation in plants and animals

5 a 1850.
b The Industrial Revolution.
6 a Beans.
b Sunflowers.
7 a Over the last 200 years, since the Industrial Revolution.
b Not long!
c Because hygiene and medicine improved.
8 a Oil and black coal.
b Brown coal.
c Black coal, oil, brown coal and natural gas.
d Because these fuels are more abundant and easier and cheaper to mine.

9

Resource	Urban	Agricultural	Natural
energy in	much	some	little
energy wastage	much	some	little
materials in	much	some	little
recycling	little	some	much

10



11 Nitrous oxide, CFCs, halons, carbon dioxide and methane.
12 a Because of deforestation and the burning of fossil fuels.
b Because of the decomposition of organic rubbish and the increase in cattle and sheep numbers.
13 Low nutrient soils erode quickly with no roots to keep the particles together. Rain will wash minerals away and animals will become extinct. Farmers cannot afford fertilisers, cash crops will fail and families suffer malnutrition.
14 a Car exhaust.
b Peak hour in the city occurs twice a day and involves many cars.
c Ozone uses energy to build up.

Revision questions page 76

1 Intelligence, tool making, use of fire and teamwork.
2 Carbon dioxide.
3 A change in climate, sea level changes, and animals unable to adapt leading to possible extinction.
4 The enormous demand for fossil fuels since the Industrial Revolution.
5 The clearing of vegetation removes the roots that hold the soil together so the soil washes away. There are no plants to slow the flow of water so flooding occurs.
6 Material wealth and security used to depend on access to the land. In an industrialised world more work, and therefore money, is available to people in cities.
7

Inputs to a city	Outputs of a city
land	organic waste
materials	waste water
water and food	atmospheric pollution
energy	noise pollution

8

Pollutant	Effects
heavy metals	can accumulate in food chains
crude oil	kills sea birds and marine organisms
plastics	kills marine organisms
sewage	over-enrichment of coastal waters — disease risks

9 Drinking water will need to be treated and algae will reduce oxygen levels; loss of important species and algae may restrict water flow and navigation.
10

Primitive man	Controlled by the environment.
Hunter gatherer	Man starts to control the environment.
Agriculturalist	Man has increased control over the environment.
Industrialist	Great control over the environment but with many undesirable consequences.

11 a Grass roots no longer bind the soil and productive land turns to desert.
b Not enough food; disease and drought conditions.
c Fence off sections for controlled grazing and use dung for fertilizer.
12 1. An increase in the use of resources and energy.
2. An increase in the production of waste.
3. An increase in population growth.
4. Growth of cities.
5. Widespread changes to the natural environment.
6. Western nations build more wealth.
13 nutrients, fertilisers, environment, pollute, salinity.
14 a There are more cars per person now than in the past so we expect this to rise in the future.
b If more cars are produced then pollution should increase, however, new technology may produce less polluting engines.
c 0.45 cars per person.
15 a
16 hydrogen
17 a UV can disrupt nucleic acids in living tissue, causing genetic errors and cell malfunction leading to cancers.
b Chlorofluorocarbons.
18 a It changes into gases that may pollute the atmosphere.
b The oceans.
c We must change all our waste into harmless substances and return them to the air, the land or the oceans.
19 a Development that is compatible with the rest of the environment such that the basic needs of all are met.
b Intergenerational equity, conservation of biodiversity and ecological integrity.
20 a Conservation involves the careful maintenance, management, and preservation of living things and natural resources to make sure that we harm the natural world as little as possible.
b Reducing pollution and using renewable resources.

CHAPTER 4

When is the Earth's birthday?

GEOLOGY AND PLATE TECTONICS

The Earth was formed 4.6 billion years ago. Since then its surface has been scratched, worn, drained, stretched, flattened, flooded and fired. Huge mountain ranges have come and gone and continents of ice have gouged it out. The scars of this abuse can be seen as the flatlands, valleys, mountains and hills that we see every day.

Deep beneath our feet the inside or **mantle** of the planet is churning with awesome power that can make the ground tremble, throw up mountains and volcanoes and force continents to collide or split apart as they ride on the giant conveyor belts of molten rock circulation beneath the Earth's **crust**. The Earth's structure ranges from a twisted, tortured, crumpled and solid broken shell, down to a dense, metallic core where pressures and temperatures are immense.

Continental drift

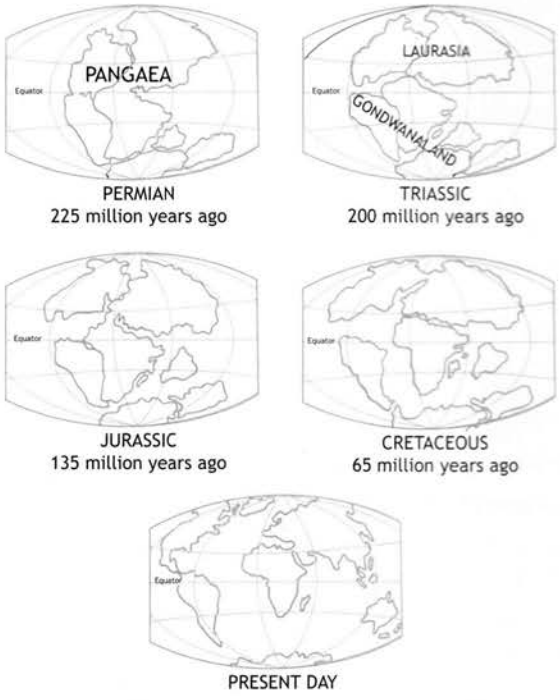
The world is a moving place. Our planet's rocky surface is a restless jigsaw of about twenty slowly moving pieces. During the 1960s geologists came to realise that the crust, or lithosphere, is broken up into plates that move with the currents of the mantle. The theory of global dynamics, in which the lithosphere moves in response to the **convection** in the upper mantle, is called the theory of **plate tectonics**.

The plates, which carry the continents and seas, have drifted for hundreds of millions of years.

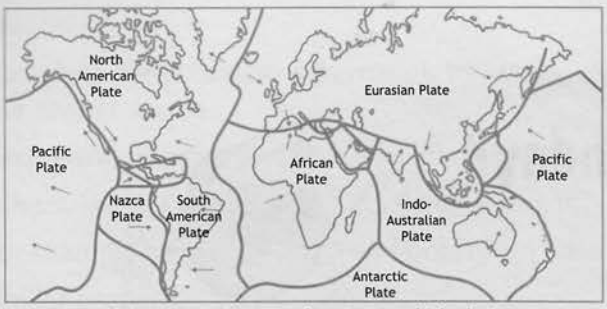
Where the Earth's crust is thick there are continents, where it is thin there are seas.

Tectonic plates

The continents as we know them developed from one giant continent called **Pangaea**. **Pangaea** began to break up about 225–200 million years ago into two super continents, one in the north called **Laurasia** and one in the south called **Gondwana**. These two super continents fragmented into the continents we have today.



The edges of tectonic plates are sites of intense geological activity such as earthquakes, volcanoes and mountain formation. The plates are always moving, sliding over and under each another and even colliding with each other. They move very slowly over small distances of around 2.5 – 5.0 cm a year.



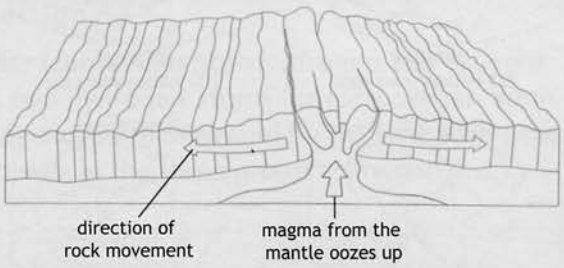
The Earth's tectonic plates

Locations of plate tectonics

The tectonic plates are continually being and destroyed along the mid-Atlantic trenches.

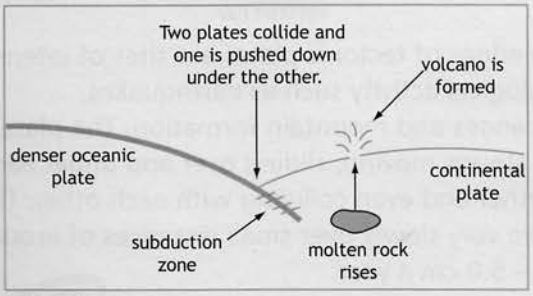
There are three main locations of plate activity:

- **Constructive boundaries** – When two plates move away from each other, they leave a gap out through which magma, from the Earth's mantle, oozes. Huge chains of volcanoes form this way. The mid-Atlantic trench was discovered in the 1950s in the middle of the Atlantic Ocean. It is 60 000 km long and winds through all the oceans of the world. Magma also oozes up from the mantle to build new seabed.



Mid-atlantic trench – constructive plate boundary

- **Destructive boundaries** – Sometimes plates push against each other and one is forced down under the other. The old ocean crust is being dragged back into the mantle. This process is called **subduction**.



Subduction – destructive plate boundary

- **Intraplate hot spots** – Sometimes a narrow section of magma burns through the crust creating a 'hot spot'. This section remains stationary while the plate moves over it. The Hawaiian Islands and the Great Dividing Range were formed this way.

Geology's superstars

- **Earthquakes**

Earthquakes are associated with destructive plate boundaries. Sometimes, as two plates scrape together, one gets caught on the other. Pressure builds up until it is finally released and felt as an earthquake. Small shocks cause avalanches, landslides and tidal waves. Earthquakes associated with the San Andreas Fault on the West Coast of the United States are often much more serious. Pressure builds up as the Pacific and North American plates grind against each other.

Seismologists measure the strength of an earthquake using a seismograph. The Richter Scale ranges from 1–10 and measures the size of an earthquake. A reading of 7 on the Richter Scale is a fairly strong earthquake. A reading of 1 is not.

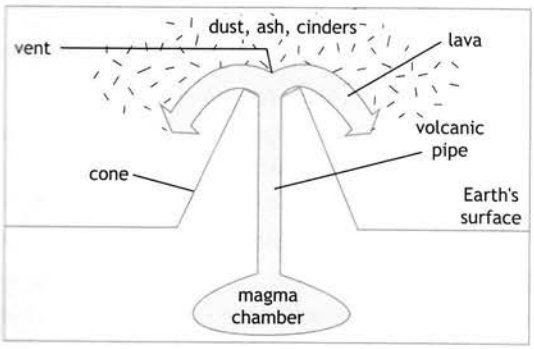
- **Tsunamis**

Tsunamis are gigantic destructive waves mostly caused by earthquakes. As the wave approaches shallow water it slows down, gets higher and finally slams into a coastline.

- **Volcanoes**

A volcano is like a safety valve in the Earth through which **magma**, gases, solid rock fragments, poisonous fumes and ash can be discharged. Underneath volcanoes, in the Earth's mantle, are pockets of magma. As heat and pressure build up in these magma chambers the gases expand, which finally causes an eruption.

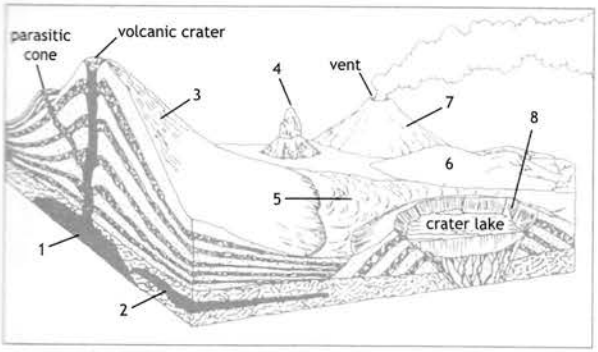
When the magma reaches the surface of the Earth it is called **lava**. Lava can flow very fast and it cools quickly, forming new igneous rocks such as obsidian, pumice and basalt. These are called **extrusive rocks**. Sometimes the magma does not reach the surface, it forces its way instead into or beneath areas of rock in the Earth's crust. It cools very slowly, forming the **intrusive rock** granite, which forms structures such as laccoliths, dykes, sills and batholiths.



Profile of a volcano

There are about 1000 active or potentially active volcanoes in the world. The greatest activity is in the 'Ring of Fire' around the Pacific Ocean. Australia, however, has very few volcanoes or earthquakes because we do not have plate boundaries crossing the country.

Volcanic landforms

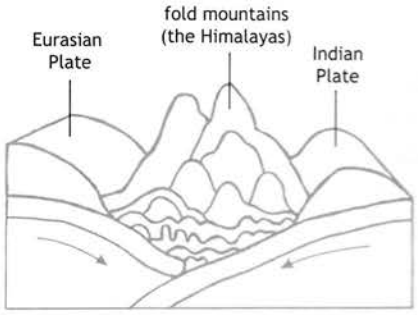


1. Magma chamber, molten rock within the Earth.
2. Lava flow, within rock layers under the ground surface forms intrusive igneous rocks.
3. Composite cone, alternate layers of ash and lava.
4. Volcanic plug, resistant core from an eroded volcanic cone.
5. Lava flow, from the composite cone.
6. Ash deposits, from ash showers.
7. Cinder cone, successive layers of volcanic ash, mud and rock fragments.
8. Caldera, steep-sided crater caused by a violent volcanic explosion.

- **Mountain building**

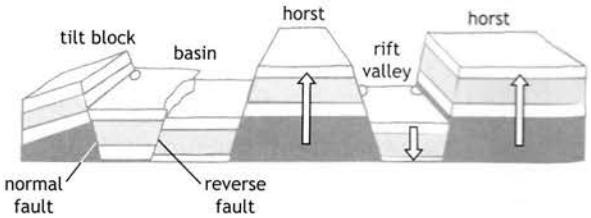
Plates can also push against each other, compressing and folding the land upward into mountains over millions of years.

The Himalayan Mountains started to form 25 million years ago and are still forming as the Indian and Asian plates push against each other. Scientists believe that these mountains are increasing in height by 8 cm per year.



Formation of the Himalayan Mountains

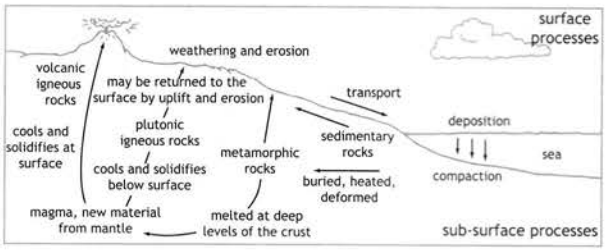
The Earth may also crack under pressure. This is called faulting. A normal fault is when one part of the Earth's surface tilts away from the other. A reverse fault is when one part rides up beside another. The Great Rift Valley of Africa has been formed by faulting. Some examples of surface features caused by faulting are shown in the diagram below.



Surface Features

The rock cycle

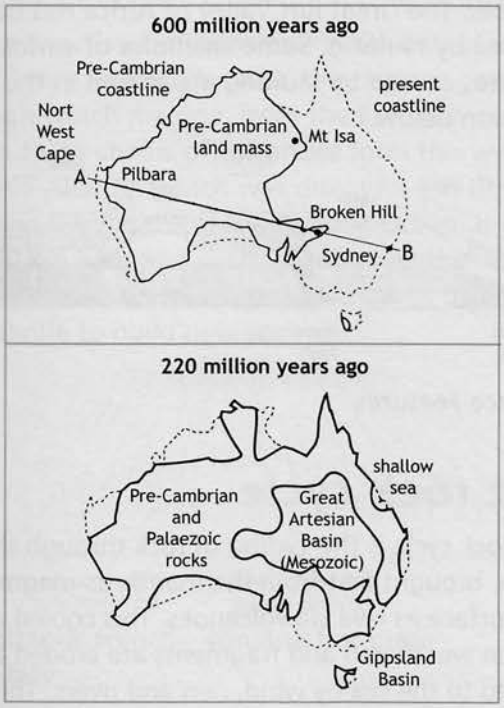
The rock cycle is the cycling of rock through the Earth, brought first from the mantle as magma to the surface as lava via volcanoes. This cooled rock is then weathered and fragments are eroded and carried to the sea by wind, rain and rivers. This debris collects on the ocean bed, solidifies and is drawn back to the mantle at subduction zones.



The rock cycle

The Australian continent

The crustal plates carrying the southern continents started to move apart about 80 million years ago. About 65 million years ago Australia and Antarctica were still narrowly connected. The vegetation of Australia and Antarctica was cool, temperate rainforest. About 55 million years ago Australia and Antarctica started to separate. Australia headed north at about 8 cm per year, carrying with it the plants and animals of the Gondwana rainforest. The climate began to change, the sea flowed into the north western areas and the eastern highlands began to form.



Australia's coastline

Australia has been a separate continent for 45 – 50 million years. This isolation allowed for the evolution of large marsupials, which are now extinct and known only in the fossil record, and many of Australia's current native plants and animals are found nowhere else in the world.

Australia's geology, biology and fossil record provide evidence which supports the theory that all the southern continents were once connected. There are similarities in geology and fossils along the edges of the continents and some plant and animal species are closely related. For example the group of flightless birds called ratites occur in New Guinea (cassowary), Australia (cassowary and emu), New Zealand (kiwi), South America (rhea) and Africa (ostrich). This has now been confirmed through recent DNA comparisons.

Throughout history the continents have drifted to new latitudes, carrying plants and animals that had evolved by that time. The oceans have also been opened up or lost.

Plate tectonics is still an active process and will drastically reshape the face of the Earth over the next 50 million years. For example, scientists are predicting that:

- parts of California will separate from North America
- the Italian 'boot' will disappear
- Australia will become linked to Asia
- Africa will separate from the Middle East.

Glossary

Batholith – A large body of intrusive igneous rock.

Continental drift – The theory that the continents have moved in relation to one another.

Convection – The transference of heat by the movement of the heated parts of a liquid or gas.

Core – The central part of the Earth.

Crust – The outer most layer or shell of the Earth.

Dyke – A vertical igneous intrusion across strata.

Earthquake – A series of waves propagated in the Earth, initiated where stress along a fault exceeds the elastic limit of the rock so that sudden movement occurs along the fault.

Extrusive rock – A type of igneous rock formed when magma erupts onto the Earth's surface and then cools.

Fault – A surface along which a rock body has broken and been displaced.

Fold – A bend or flexure in a rock.

Gondwana – The ancient continental landmass that is thought to have split apart to form the present-day continents of South America, Africa, India, Australia and Antarctica.

Horst – A fault block that has been uplifted in relation to the adjacent rocks.

Intrusive rock – A type of igneous rock formed when hot magma cools beneath the Earth's surface, becoming embedded in older rock layers.

Lithosphere – The relatively rigid outer zone of the Earth.

Laccolith – An igneous intrusion that has arched up the rock strata into which it was forced, forming a lens-shaped body with a flat floor.

Laurasia – The ancient landmass that is thought to have split apart to form Europe, Asia, North America and Greenland.

Mantle – The zone of the Earth's interior between the crust and the core.

Pangaea – A hypothetical continent from which the present continents originated by plate movement.

Plate tectonics – The theory of global dynamics in which the crust is broken up into plates that move over the mantle. The margins of the plates are sites of considerable geologic activity.

Rift valley – A valley formed by a block faulting pulling the crust apart.

Seismologist – A scientist who measures seismic waves or vibrations produced within the Earth.

Sill – A horizontal body of intrusive rock forced between layers of enclosing rock.

Subduction – Subsidence of the leading edge of a lithospheric plate into the mantle.

Tsunami – A seismic sea wave caused by an earthquake, faulting or a landslide on the sea floor.

Volcano – A vent in the Earth's crust from which lava and other materials are ejected.

Science skills

Question 1

The map below shows the major tectonic plates and their present direction of movement.

a Which plate is the African plate pushing against?

b Which mountain range is being pushed up by the Indo-Australian plate?

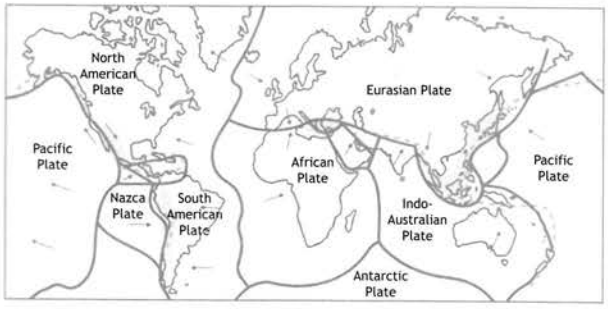
c What problem is the Pacific plate causing in Japan?

d What is happening along the west coast of South America?

e On which plate is Australia?

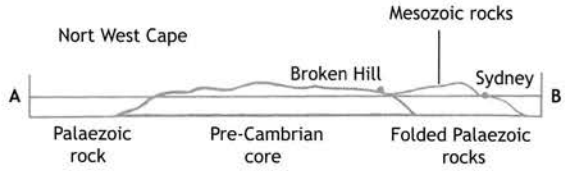
f Is there much earth movement in Australia? Why?

g Which two plates are causing the 'Ring of Fire'?



Question 2

Evidence suggests that Australia first appeared in the Pre-Cambrian era. The following diagram is a cross-section of the Australian continent.



a In which era was the Australian continent's core laid down?

b What happened to this rocky core, being exposed to the weather for millions of years?

c Where did all the eroded material get deposited?

d In which era did this occur?

e What was happening on the eastern seaboard in the Palaeozoic era?

Question 3

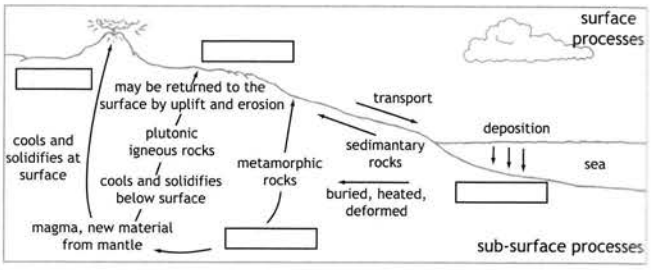
Label the diagram of the rock cycle below by putting the correct letters in the boxes provided.

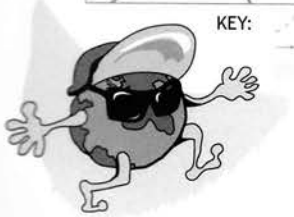
a volcanic igneous rocks

b weathering and erosion

c compaction

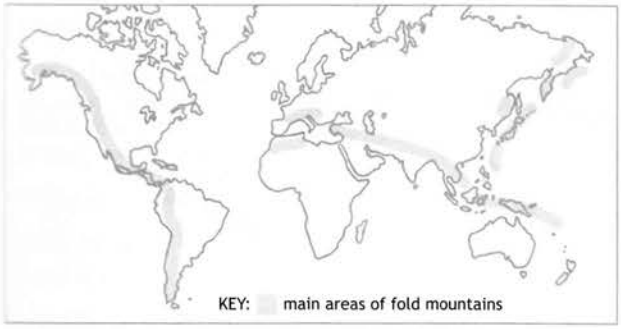
d melted at deep levels of the crust





Question 4

This map shows the main areas of fold mountains. What earth movements would also be found in these areas?



Question 5

A crater lake is formed by a violent volcanic explosion.

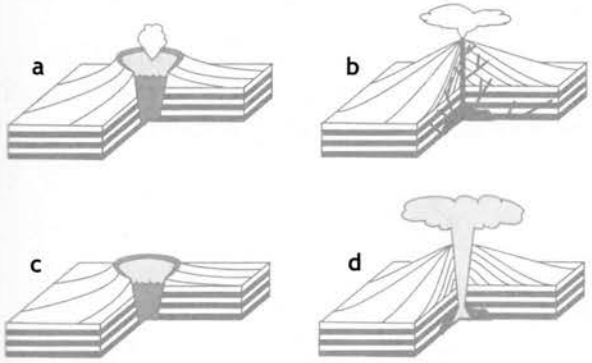
Match the diagrams with the descriptions and put them in the correct order.

i Once the gas pressure in the magma chamber drops below a certain point, the volcano can no longer support the cone. The sides slump creating a crater-shaped cavity.

ii As the magma level declines, ash eruptions continue. This further lowers the pressure in the magma chamber.

iii If magma percolates into fractures beneath the collapsed volcano, small volcanoes may form in the crater floor and water may collect.

iv A crater lake starts forming as repeated eruptions begin to deplete the volcano's magma supply. The gas pressure in the magma chamber drops.



Question 6

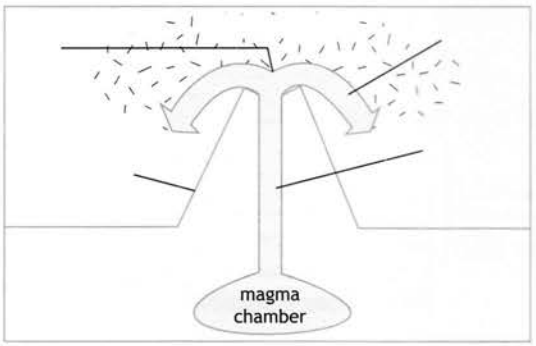
Match the following terms with the correct explanation.

Volcano	A common, coarse grained, light coloured intrusive rock.
Magma	A horizontal body of intrusive rock forced between layers of enclosing rock.
Granite	A vent in the Earth's crust from which lava and other materials are ejected.
Lava	Hot molten rock generated within the Earth.
Sill	An igneous intrusion that has arched up the rock strata into which it was forced, forming a lens-shaped body with a flat floor.
Laccolith	Hot molten rock that reaches the surface of the Earth.

Question 7

Label the diagram of a volcano below with the following terms:

cone, volcanic pipe, lava, magma chamber, Earth's surface, (dust, ash and cinders)



Question 8

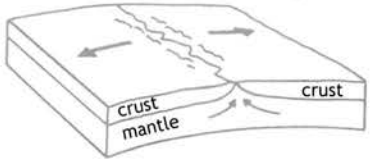
Match the correct diagram to the explanation.

i The plates push together and fold mountains are formed as one plate slides under another. Magma can also flow into the folded crust and volcanoes form.

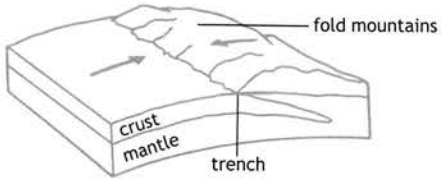
ii The plates slide past each other. The weakness can lead to volcanoes and earthquakes.

iii The plates move apart. Magma flows up into the gap and new rocks are formed.

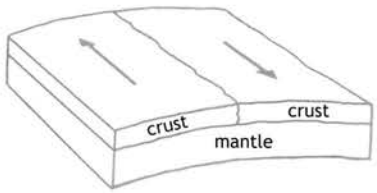
a



b



c

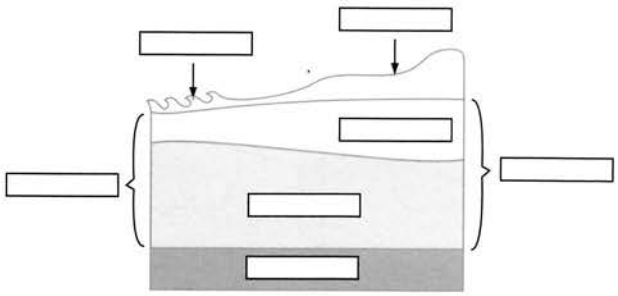


Question 9

Plates are large pieces of rigid crust floating on the mantle. The thickness of a plate varies but they are usually about 100–200 km thick.

Study the diagram below and add the following terms:

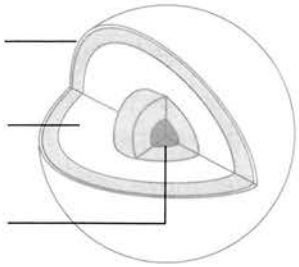
crust, continent, convecting mantle, ocean, lithosphere, plate, rigid mantle

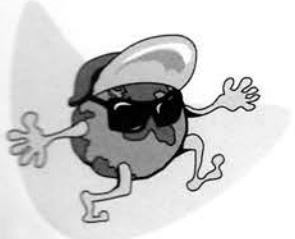


Question 10

Label the following diagram of the internal structure of the Earth with the terms:

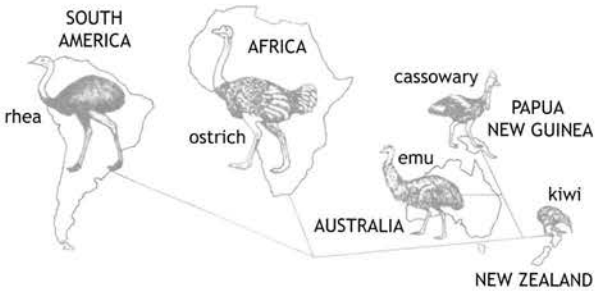
core, mantle, crust and lithosphere





Question 11

The theory of continental drift is supported by a variety of evidence. The following diagram shows several species of flightless birds and the countries in which they are found.



a Which flightless bird is found in South America?

b Which is the smallest flightless bird?

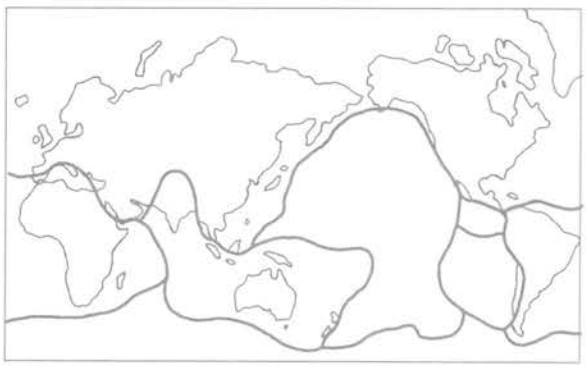
c Explain how these flightless birds provide evidence of continental drift.

d List two other significant pieces of evidence supporting continental drift.

Question 12

Label the diagram below with the names of the following continental plates:

African plate, Eurasian plate, Indo-Australian plate, Pacific plate, North American plate, South American plate, Nazca plate, Antarctic plate.



Question 13

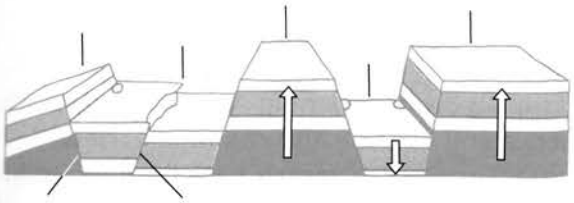
Below is a table containing some of the world's landforms. Identify which are the result of constructive plate boundaries (C), and which are the result of destructive plate boundaries (D).

Landform	Boundary
The Great Dividing Range	
The Himalayan Mountains	
Andes in South America	
Hawaiian Islands	
Mid-Atlantic Trench	

Question 14

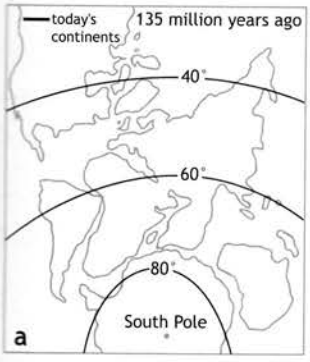
Label the diagram below with the following terms:

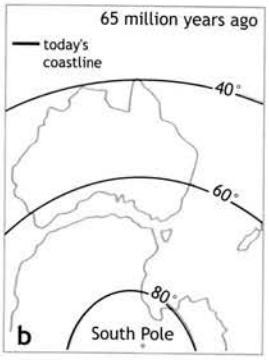
normal fault, reverse fault, horst, rift valley, tilt block

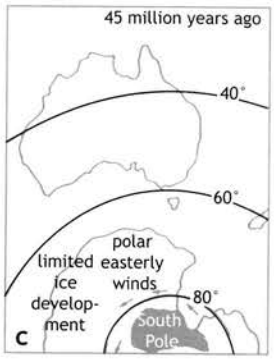


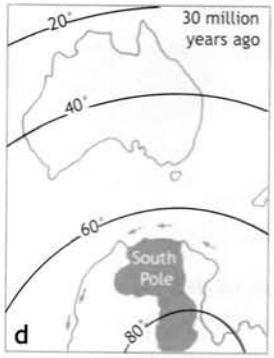
Question 15

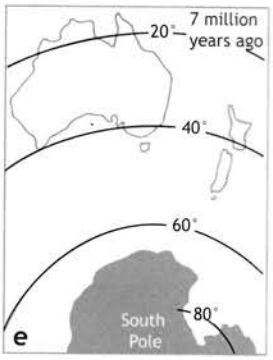
The following diagrams show the movement of the Australian continent over the past 135 million years.











a Between which latitudes did Australia lie 135 million years ago?

b How long did it take for Australia to move completely north of the 60 degree latitude?

c How many degrees south was Sydney 65 million years ago?

d Approximately which latitude is Australia on now?

e What has happened to Australia's climate over the last 135 million years?

Revision questions

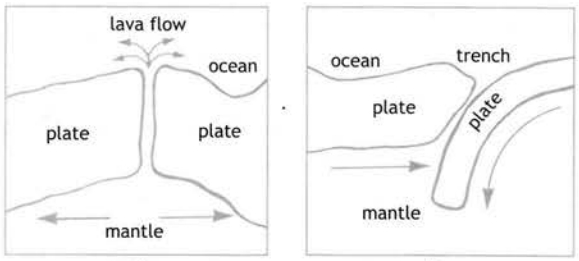
Question 1

The plates of the Earth's crust float on the underlying mantle. The following diagram shows the boundaries of two sets of plates.

a Name both plate interactions.

b Explain what is happening in each diagram.

c What is the name of the process occurring in diagram B?



A B

Question 2

a What causes volcanoes to erupt?

b Where do volcanoes occur?

c What is the name of the ring of volcano activity surrounding the Pacific plate?

d What is the main type of rock formed if magma cools above ground?

e What is a dyke?

Question 3

Complete the sentences below.

A _____ is a gigantic destructive wave caused mainly by underwater _____. As it approaches _____ water it slows down and gets _____. Finally the wall of water slams into a coast.

Question 4

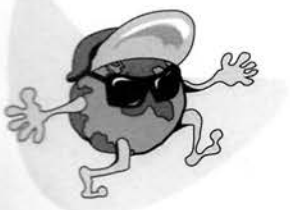
Marsupials are abundant in Australia and South America and they are also common in New Guinea. Fossils of mammals have been found in Antarctica but there is absolutely no evidence of marsupials in Asia. Scientists believe that Australia and South America were both part of Gondwana at the same time, but India, Africa and New Zealand had split off before marsupials developed.

a Which theory does this evidence support?

b How could you explain the existence of fossils in Antarctica?

Question 5

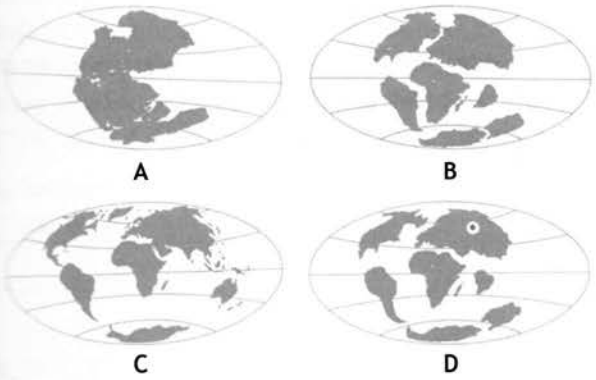
Since the Earth's crust was formed, the continents have always been in motion. Scientists have only been able to track the continent's movement from about 600 million years ago.



a What was the name of the giant continent that existed between 400 and 200 million years ago?

b What are the names of the two super continents that appeared when the giant continent broke up about 200 million years ago?

c Arrange the diagrams below in the correct order of development, from the oldest to present day.



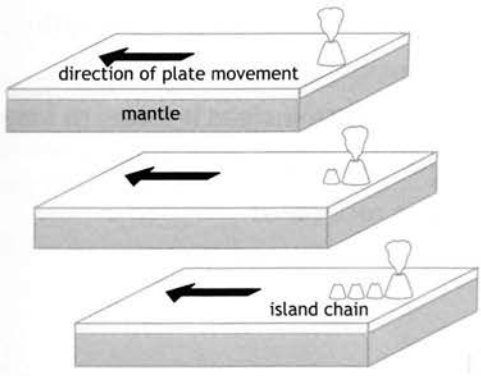
Question 6

The following diagram shows the geological process that formed the Hawaiian Islands.

a Explain what is happening here.

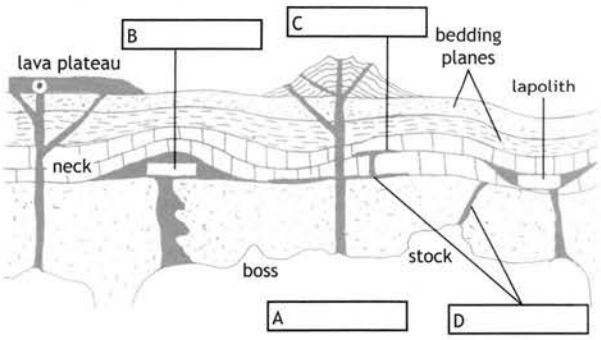
b What is this called?

c What other landform was created this way?



Question 7

Study the diagram below and write in the names of the structures A to D.



Question 8

Write in the correct words to complete the information below.

It is believed that the Earth's surface is divided up into _____ called _____ plates, on which the _____ have drifted about. This continental drift causes _____ and volcanoes and builds _____ ranges. These plates are continually being renewed along the _____ _____, and _____ by subduction.

Question 9

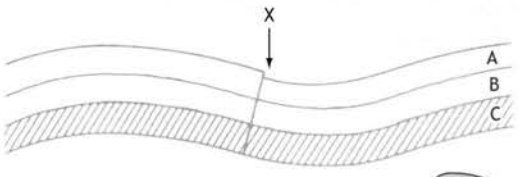
Study the diagram below showing three strata of sedimentary rock.

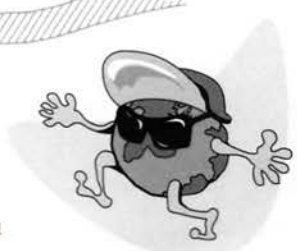
a Which rock is the oldest?

b Which rock is the youngest?

c What is the name of the feature marked 'X'?

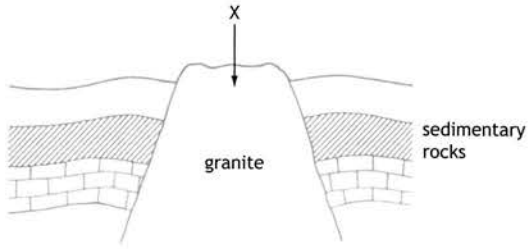
d What other change has taken place since the rocks were deposited?





Question 10

The diagram below shows a cross-section through rocks.



a What type of rock is granite?

b How was the granite formed?

c Why are the layers of sedimentary rock not straight?

d How was structure 'X' formed?

e Why is this granite now exposed to the atmosphere?

Question 11

Which regions of the world were originally part of the same super continent as Australia?

Question 12

a What is land called if it is pushed up as a result of faulting?

b What do we call land which drops as a result of faulting?

Question 13

a Which country is on the same plate as Australia?

b What process is forming the Himalayan Mountains?

c Name a well-known landform in America that has resulted from a fault.

d Name a well-known landform in Africa which has resulted from a fault.

e List three other landforms produced by volcanic activity.

Question 14

Australia's Pre-Cambrian landmass was very different from the present day formation.

a Which states are missing altogether?

b Which basin existed over much of the eastern states about 200 million years ago?

Question 15

Fill in the missing information to complete the sentences below.

_____ rocks such as _____, _____ and basalt, result from _____ cooled _____ on the surface of the Earth. Sometimes magma does not reach the _____ of the Earth's crust. Instead it forces its way between rock layers where it solidifies _____ into a coarse rock called _____.

CHAPTER 5

WEATHER

What if scientists learned to control the weather?

We live at the bottom of a restless ocean of air called the atmosphere. Most of the gases making up the atmosphere occur close to the Earth – this is the region of 'weather'. Some of the gases in the atmosphere are nitrogen, oxygen, carbon dioxide, argon, hydrogen, ozone and water vapour. Without water vapour there would be no major weather systems and no life on Earth.

Meteorology is the study of the atmosphere, its composition, and the changes that take place within it. **Weather** is the term used to describe atmospheric conditions in a specific place at a specific time. **Climate** refers to the average weather conditions of a particular place. These weather conditions are measured and recorded over all the days of the year. Weather records are useful for such things as working out if there is enough solar energy in a particular area for a solar power station, or determining if farming is practical in a certain area. They are also used to predict the weather.

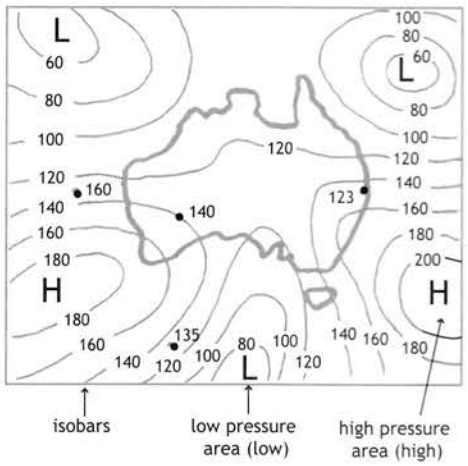
Weather features

Here on Earth the Sun is the main influence on our weather. The Sun's energy stirs the atmosphere into motion, creating wind, rain, clouds and snow. However, the Sun's heat is distributed unevenly around the world, which sets up great currents in the atmosphere and the oceans. These imbalances have a major influence on our weather.

Air pressure

Gravity pulls the atmospheric gases towards the Earth and so they have weight. The weight of the atmospheric gases is called atmospheric pressure. It is strongest at sea level and decreases as the distance from the Earth increases. The international unit for measuring pressure is the **hectopascal**. Air pressure varies from place to place depending largely on the temperature. For example, if the air is cold, the gas molecules move close together and the air weighs more. This is called a high pressure area or a **high**. A low pressure area, or **low**, is when the molecules are warmer and move further apart. High pressure systems are associated with fine weather and light winds, while low pressure systems usually indicate cloudy, rainy weather.

A weather map shows the areas where the air has considerable weight (highs) and relatively little weight (lows). Lines called **isobars** connect areas of the same air pressure and are drawn around the high and low pressure areas. If the numbers get lower moving inwards it is a low, if they get larger it is a high.



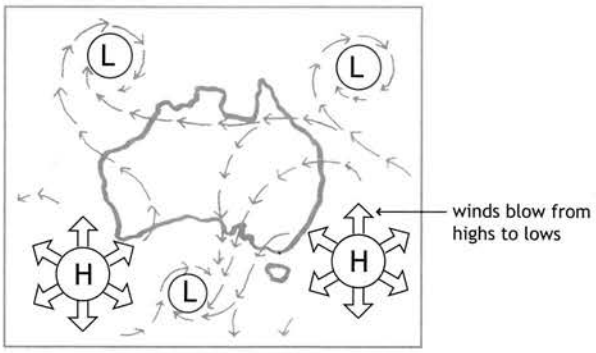
Highs and lows on a weather map

The highs and lows move from left to right across Australia.

Wind

When air begins to move it becomes wind. When a pocket of air is warmer and lighter than the surrounding air, it tends to rise. When it is colder and heavier it tends to sink. Air also moves from high pressure areas to low pressure areas. When isobars are close together there is large difference in pressure, which causes strong winds. If isobars are further apart the winds are gentle. When you see tightly packed isobars around a low, conditions will be very windy.

Winds do not blow in straight lines; they are deflected by the rotation of the Earth – to the right in the northern hemisphere and to the left in the southern hemisphere. This is called the **Coriolis Effect**. The winds mostly follow the isobar lines and in the southern hemisphere move clockwise around a low and anticlockwise around a high.



Rotation of the Earth bends the wind to the left – the Coriolis Effect

Wind brings changes in weather. For example, if winds blow over water they are moist; if they blow over the inland they are dry; if they come from the south they are cold and if from the tropics they are warm.

Humidity

Air contains water vapour. The amount of water vapour in the air at any one time is called the **humidity**. The warmer the air is the more water vapour it can hold and the higher the humidity. **Relative humidity** is measured using a hygrometer, which consists of two thermometers – one kept dry and one wet. The smaller the difference between them the higher the humidity.

Clouds

Two things are needed for clouds to form:

- tiny particles (dust, soot, pollen)
- warm, moist air that is cooled.

Colder air cannot hold as much water vapour as warm air, so as moist air rises and cools, water condenses to form water droplets. For clouds to form, the water vapour must have something to condense around. Billions of particles with tiny water droplets around them form a cloud.

There are many different types of clouds, which are classified by the height of their bases above the Earth. The three main types of cloud are cirrus, stratus and cumulus.

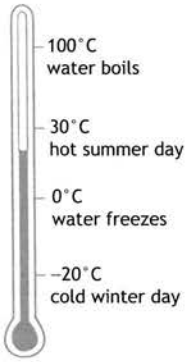
Rain

Water in nature is always moving – rising up to form clouds and falling down again as rain. **Precipitation**, or rain, occurs when the droplets in clouds combine and become so heavy that air currents can no longer hold them up. Clouds may also reach up into the colder, higher parts of the atmosphere and the water droplets will turn to ice (hail) or snow.

Forecasting the weather

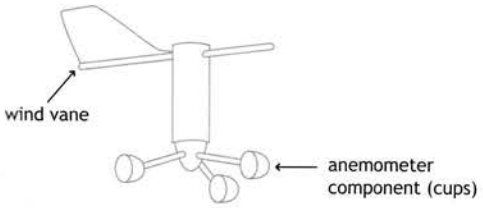
Weather forecasts are made based on data recorded daily using standard instruments and supplemented with satellite information.

- **Temperature** is a measure of the degree of heat in the air. The maximum and minimum temperatures are measured in degrees Celsius, using a thermometer.



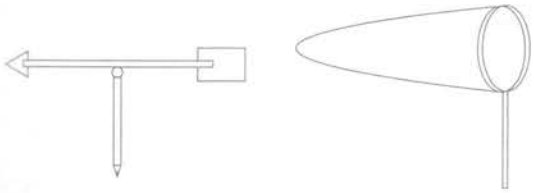
Thermometer

- **Wind speed** can be measured using an instrument called an anemometer. It can also be estimated using the Beaufort Wind Scale (see page 67), which is based on the effect the wind has on the surroundings.



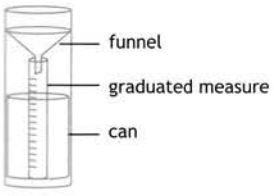
Anemometer

- **Wind direction** is very important in estimating the type of weather change brought by the wind. It is measured using a wind vane or a wind sock. The tail on the wind vane or the mouth of the wind sock points into the wind and indicates the direction from which the wind is blowing.



Wind vane **Wind sock**

- **Atmospheric pressure**, or the weight of the air at a specific location, is recorded using an instrument called a barometer. A falling barometric reading indicates strong winds and storms on the way.
- **Rainfall** is measured in a rain gauge. This instrument consists of a can, a funnel and a graduated measure. Rainfall is measured in millimetres. On a weather map, areas where rain has fallen are shaded.



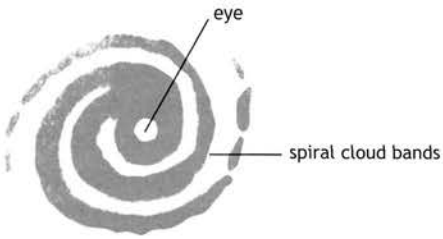
Rain gauge

Humans cannot control the weather, but we do try to predict it. No forecast is ever perfect, as there are many things that meteorologists don't yet understand.

Extreme weather

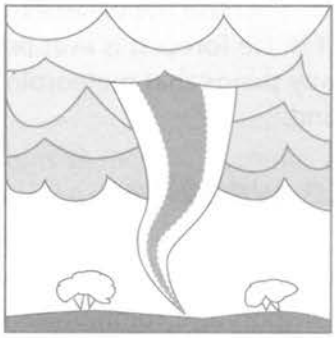
Weather-related disasters, including floods and droughts, result in enormous damage to crops, buildings, transport and communications, and can cause great social and economic hardship.

- **Thunderstorms** – A thunderstorm is a storm accompanied by heavy rain, thunder, squalls, gusty winds and lightning. They don't last very long but can cause severe flooding. The most spectacular thunderstorms occur in the humid tropics.
- **Cyclones** – A cyclone is a closed circulation of air around a centre of low pressure. In the southern hemisphere, cyclones rotate clockwise. Cyclones are associated with severe storms and very strong winds (gusting up to 200 km/h). They can be up to 400 km across and are very destructive.



Cross-section of a cyclone showing the eye (low) and the spiral cloud bands

- **Hurricanes** – A hurricane is a spiralling low pressure system formed over tropical seas. This is the most violent of all storms. It is a massive spiral of cloud up to 1000 km in diameter, with driving rain and devastating winds of up to 300 km per hour.
- **Tornadoes** – A tornado is a violently rotating column of air up to 100 m across. The air spins around a central core at speeds of up to 600 km/h. These winds are able to uproot trees, demolish houses and even fling cars into the air.

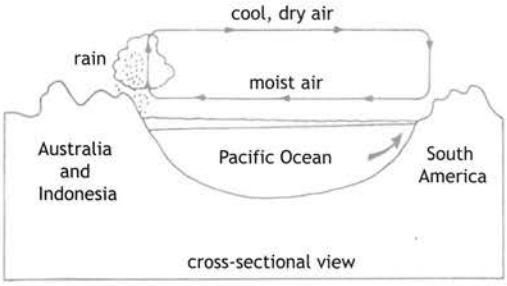


A tornado

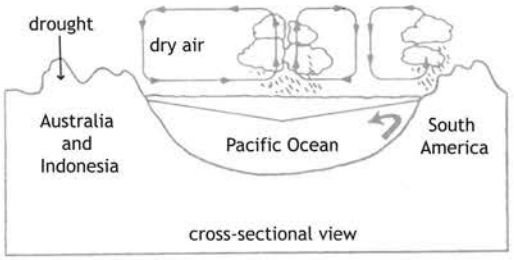
Australia's climate and El Nino

Australia not only has one of the most variable climates in the world, but it is the only continent on Earth where the most overwhelming influence on climate is a nonannual, climatic change. The cycle driving Australia's unpredictable climate is called the **El Nino Southern Oscillation (ENSO)**. This cycle can cause drought one year and floods the next, or drought in one part of the country and floods in another.

Under normal climate conditions, a huge pool of warm water sits in the western pacific – around Indonesia, New Guinea and northern Australia. When an El Nino event occurs, the warm water begins to move eastwards towards South America, warming the water off Peru and Ecuador.



The normal climate situation



The ENSO situation

In Australia an El Nino event causes lower rainfall and droughts. In South America El Nino results in devastating floods and mudslides. This Southern Oscillation is now measured by recording sea surface temperatures using buoys across the Pacific. The Southern Oscillation Index (SOI) is a measure of the strength and phase of the Southern Oscillation. Negative values in the Southern Oscillation indicate an El Nino event, resulting in drought in Australia.

Glossary

Climate – The average weather conditions of a particular place.

Coriolis Effect – The deflection of winds and water by the spinning of the Earth – to the right in the northern hemisphere and to the left in the southern hemisphere.

Cyclone – A region of low atmospheric pressure accompanied by violent storm conditions.

El Nino – A term used to describe the movement of warm surface water from the western pacific to the coast of Peru and Ecuador.

Hectopascal – The international unit for measuring pressure.

High – A high pressure area where air molecules are close together.

Humidity – The amount of water vapour in the air at any one time.

Isobar – A line on a weather map joining points with the same air pressure.

Low – A low pressure area where air molecules are not close together.

Meteorology – The study of the atmosphere, its composition, and the changes that take place in it.

Precipitation – Any form of rain or snow.
Relative humidity – The amount of moisture in the air relative to the maximum it can hold at that temperature.

Southern Oscillation – The seesaw of atmospheric pressures between the South Pacific Ocean and the Indo-Australian areas.

Southern Oscillation Index – Monitors the differences in sea level atmospheric pressures between Tahiti and Darwin.

Tornado – A whirlwind or mass of rotating air with high wind speeds at its centre.

Weather – The atmospheric conditions in a specific place at a specific time.

Wind – Air moving from a high pressure area to a low pressure area.

Question 1

The table below displays the maximum and minimum temperature for several days at the beginning of February.

Day	Maximum temperature (°C)	Minimum temperature (°C)
1	30	22
2	29	21
5	31	21
6	30	22
7	29	21
8	30	22
9	24	21

a Draw a graph which displays this data.

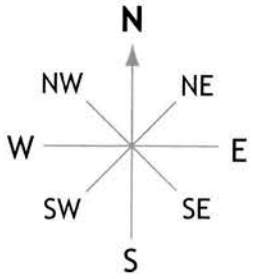
b Which day has the highest maximum temperature?

c Which day has the largest difference between the maximum and minimum temperatures?

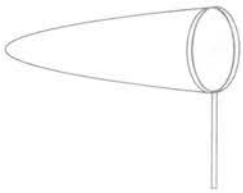
d Which day has the smallest difference?

Question 2

Use the compass diagram below to answer the questions.



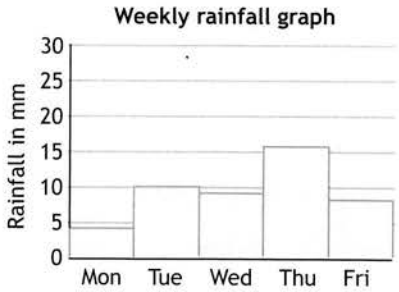
a Look at the wind sock below. From which direction is the wind blowing?



b What other instrument can be used to measure wind direction?

Question 3

The following graph displays the weekly rainfall data for the week ending 9 February 2001.



a How much rain fell on the Friday?

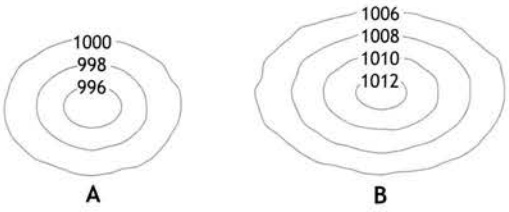
b Which day was the wettest?

c What is the average rainfall for the week?

Question 4

a Label the following diagrams with the terms below:

L, high pressure system, hectopascals, H, isobars, low pressure system

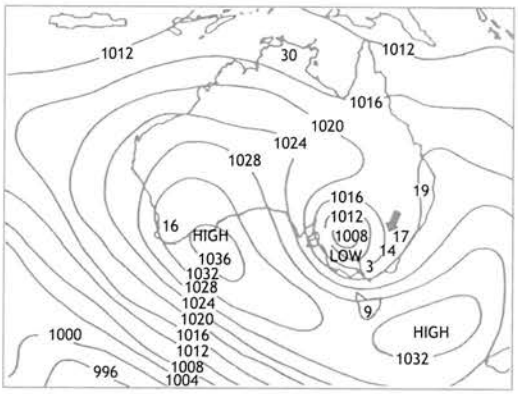


b Which diagram indicates fine weather and light winds?

c What does the term 'hectopascal' describe?

Question 5

Study the following weather chart displaying data for 7 July 2001.



a What sort of weather are Victoria and southern New South Wales experiencing?

b Are the winds over Western Australia strong or gentle? How do you know this?

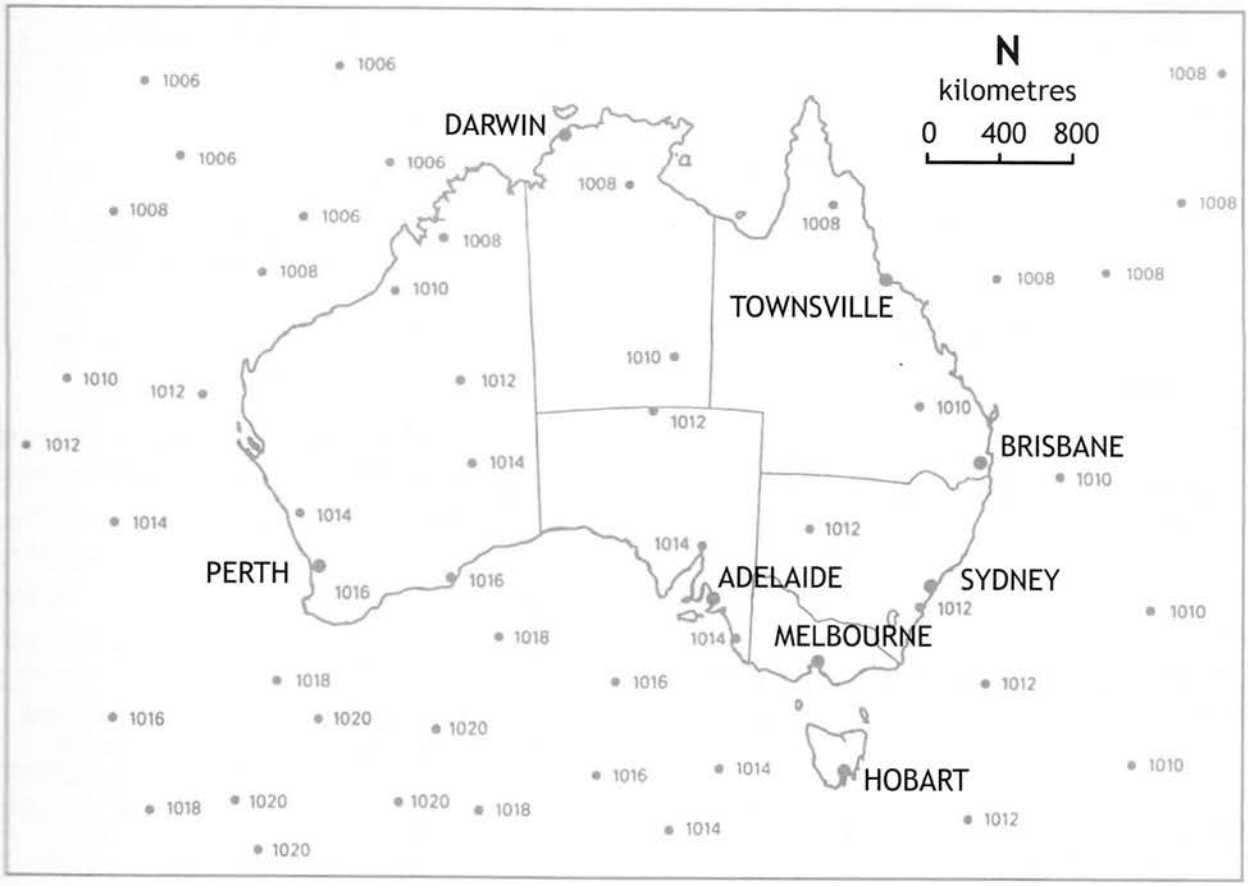
c In which overall direction are these pressure systems moving?

d What is the weather like in Townsville?

e Which direction are the winds in Perth coming from?

Question 6

a On the following diagram draw lines joining the places with equal air pressure.

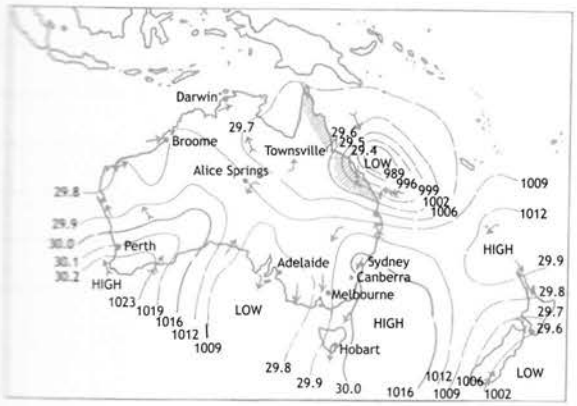


b Mark on the map any highs and lows.

c What is the weather like in Darwin?

Question 7

The following weather chart displays recorded data from a day in February.



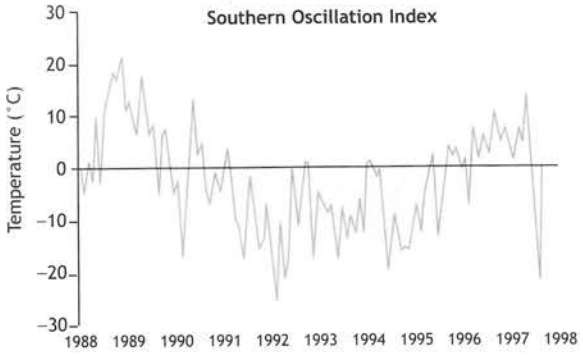
a What is the name of the severe weather pattern forming off the coast of Queensland?

b What does the shading indicate along the coast of Queensland?

c In which direction is this low pressure system rotating?

Question 8

The following diagram displays the Southern Oscillation Index from 1988 until 1998.

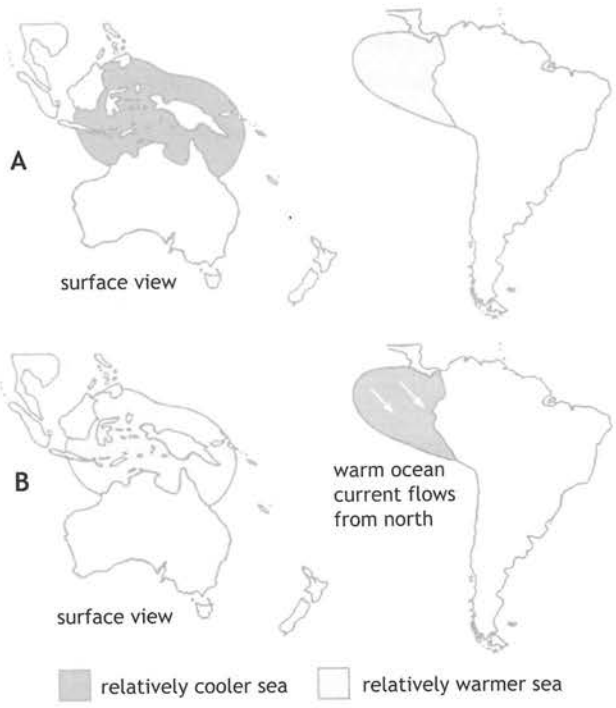


a Was 1989 a wet or dry year in Australia?

b What weather would you have predicted for 1998?

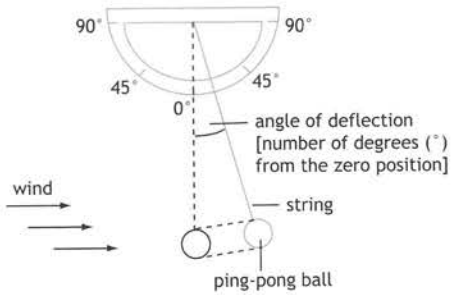
Question 9

Study the diagrams below. Which one shows an El Nino event?



Question 10

Measuring wind speed can be done by using a protractor, string and a ping-pong ball. A student made this device to measure wind speed and used the Beaufort Wind Scale to describe the wind.



a Use the data in the table below to estimate wind speed for the following angles of deflection:

i 20° _____

ii 60° _____

iii 85° _____

String angle (degrees)	Wind speed (km/h)
90	90
85	09
70	19
60	24
55	26
30	42
20	52

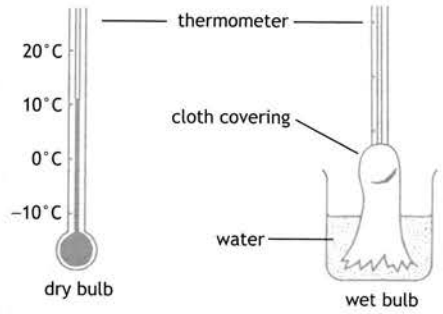
b Use the Beaufort Wind Scale on page 98 to describe the wind and its effect for the above wind speeds.

Question 11

Humidity is the amount of water vapour in the air at a particular temperature.

To work out humidity:

- Measure the air temperature with a dry bulb (T1) and with a wet bulb (T2).

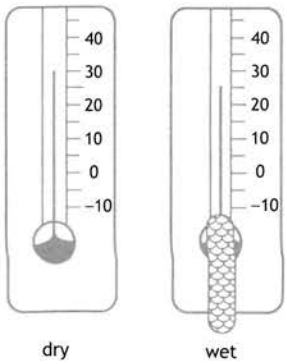


- Subtract T2 from T1 to calculate the difference.
- Use T1 and the temperature difference to work out the per cent humidity, using the table on page 98.

a If the humidity was 54% what was the reading on the wet bulb?

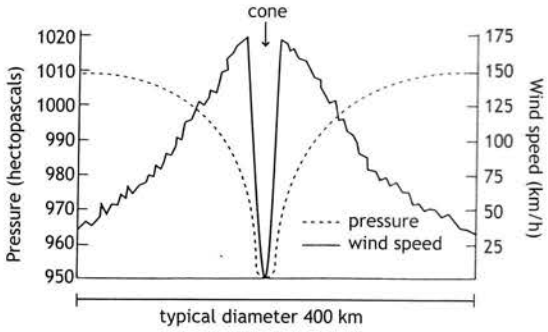
b If the temperature difference was 3°C and the dry bulb was 16°C, what was the humidity?

c What is the humidity when the dry and wet bulbs show the readings below?



Question 12

The following diagram shows typical variations in atmospheric pressure and wind across a severe weather pattern. These patterns often form over tropical waters and can cause widespread devastation.



a What is the name of this weather system?

b What is the wind speed at the edge of this system?

c What is the wind speed around the central core and inside the core?

d What is the atmospheric pressure in the centre of the system?

Question 13

The data below represents the rainfall data for several Australian towns.

City	Jan	April	July	Oct
Adelaide	20	44	66	44
Brisbane	164	87	57	76
Alice Springs	25	14	15	22
Darwin	428	99	1	72
Hobart	48	53	53	63
Perth	8	45	174	55
Sydney	102	124	101	78

a Which town has the highest rainfall in summer?

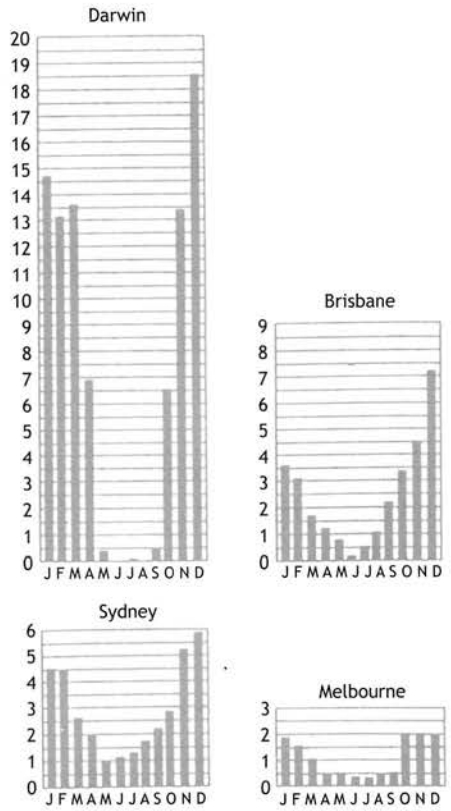
b Which town has the driest winter?

c Which town has consistently low rainfall?

d Which town receives mostly winter rainfall?

Question 14

The following graphs display the frequency of thunderstorms in four Australian cities.



a What is the relationship between thunderstorm activity and distance from the equator?

b In Darwin, which month has the greatest thunderstorm activity?

c What season generally has the lowest risk of thunderstorm activity?

Revision questions

Question 1

Complete the following information by filling in the correct words.

Clouds are visible when _____ _____ in the form of water droplets is present in the air. Clouds are classified depending on how _____ they are in the atmosphere. The three main forms of clouds are _____, _____ and _____.

Question 2

Match the following terms with the correct explanation.

Climate	The study of the atmosphere.
Weather	Average weather conditions of a particular place.
Meteorology	Atmospheric conditions in a particular place at a particular time.

Question 3

Weather is recorded daily using various instruments. What are the following instruments used to measure?

a barometer

b rain gauge

c anemometer

d maximum / minimum thermometer

e wind vane / wind sock

Question 4

a What unit is used to measure temperature?

b On a weather map how are areas of rain marked?

c What is the Beaufort Wind Scale?

d What additional information can be gained by knowing the direction of the wind?

e What does a falling barometric reading mean?

Question 5

Match the following terms with the correct description.

Thunderstorm	A narrow, violently rotating column of air.
Cyclone	A massive, spiralling low pressure system causing widespread devastation.
Hurricane	A storm accompanied by heavy rain, gusty winds and lightning.
Tornado	A region of low atmospheric pressure accompanied by violent storm conditions.

Question 6

Explain the meaning of the following terms.

a ENSO

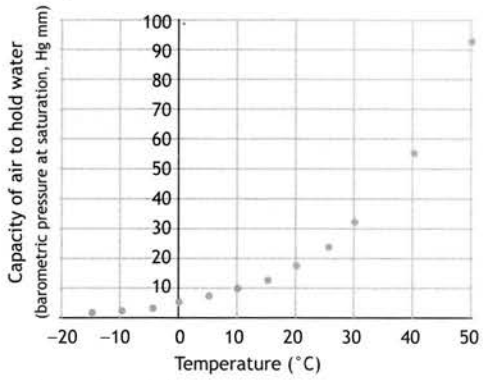
b SOI

c El Nino

d negative SOI/positive SOI

Question 7

Air's capacity to hold water depends on the temperature. The graph below displays this relationship.



a Complete the following information by adding the correct words.

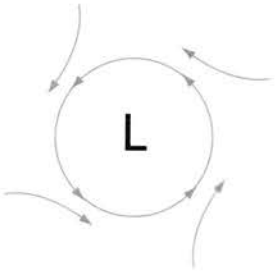
The _____ the water vapour, the _____ it can hold. When the maximum amount of water vapour is present at a certain temperature and the air is _____, the water vapour will begin to _____ around _____ to form water droplets. Billions of droplets form _____.

b Explain the term 'precipitation'.

c How is hail or snow formed?

Question 8

The following diagram represents a tropical low. Is the depression in the northern or southern hemisphere? Explain your answer.



Question 9

a What is the name given to air when it starts moving?

b Air tends to move either vertically or horizontally. In each case, what causes it to move?

c What is the name given to the effect of the Earth's rotation on air movement?

Question 10

a What force holds the atmosphere close to the surface of the Earth?

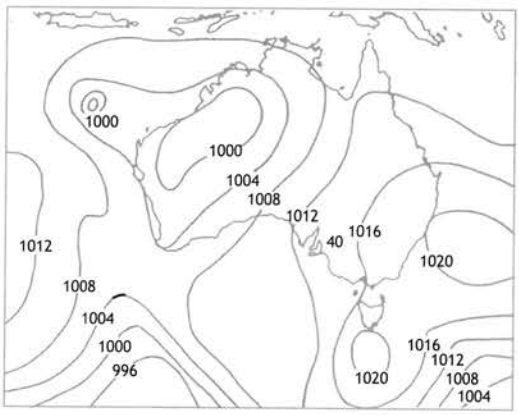
b What term do we use for the weight of air?

c Which weighs the most – cold air or warm air?

d A low pressure system would generally be associated with cloudy, rainy weather or fine weather?

Question 11

a Study the following diagram and then label all the highs and lows.



b What is the lowest pressure recorded here?

c What is the air pressure in Melbourne?

d What instrument is used to measure air pressure?

e What name do we give the lines that connect up points of the same pressure?

f What type of weather is indicated by these lines when they are very close together?

Question 12

The following chart shows the areas of Australia affected by a negative El Nino event in 1992.

Choose the correct answer.

The shaded area represents:

a extremely high temperatures.

b extremely low rainfall.

c higher than average rainfall.

d colder than average temperatures.

Beaufort Wind Scale

Beaufort number	Description	Wind speed (km/h)	Effect
0	calm	less than 2	smoke rises vertically
1	light air	2 – 5	smoke drift shows wind direction; wind vanes don't move
2	light breeze	6 – 12	wind felt on face; wind vanes move
3	gentle breeze	13 – 20	leaves and small twigs in motion; hair disturbed; clothing flaps
4	moderate breeze	21 – 30	dust and loose paper moved; small branches move
5	fresh breeze	31 – 40	small trees with leaves begin to sway; wind force felt on body
6	strong breeze	41 – 51	large branches move; umbrellas difficult to use; difficult to walk steadily
7	moderate gale	52 – 63	whole trees in motion; inconvenience felt when walking
8	gale	64 – 77	twigs broken off trees; difficult to walk
9	strong gale	78 – 86	people blown over; slight structural damage, including tiles being blown off houses
10	whole gale	87 – 101	trees uprooted; considerable structural damage
11	storm	101 – 120	widespread damage
12	hurricane	greater than 120	widespread devastation

The humidity of air

Dry bulb (°C)	Difference between dry bulb and wet bulb readings (°C)																				
	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0	100	82	65	48	31																
2	100	84	68	52	37	22															
4	100	85	70	56	42	29															
6	100	86	73	60	47	35	23														
8	100	87	75	63	51	40	29	18													
10	100	88	76	65	54	44	34	24	14												
12	100	89	78	68	57	48	38	29	20												
14	100	90	79	70	60	51	42	33	25	17											
16	100	90	81	71	63	54	46	37	30	22	15										
18	100	91	82	73	65	56	49	41	34	27	20										
20	100	91	83	74	66	59	51	44	37	30	24	18									
22	100	92	84	76	68	61	54	47	40	34	28	22	16								
24	100	92	84	77	70	63	56	49	43	37	31	26	20	15							
26	100	92	85	78	71	64	58	52	46	40	34	29	24	19	14						
28	100	93	85	78	72	65	59	53	48	42	37	32	27	22	18						
30	100	93	86	79	73	67	61	55	50	44	39	34	30	25	21	17					
32	100	93	86	80	74	68	62	57	51	46	41	37	32	28	24	20	16				
34	100	94	87	81	75	69	64	58	53	48	43	39	34	30	26	22	19	15			
36	100	94	87	81	76	70	65	60	55	50	45	41	37	32	29	25	21	18	14		
38	100	94	88	82	76	71	66	61	56	51	47	43	39	35	31	27	24	20	17	14	
40	100	94	88	82	77	72	67	62	57	53	48	44	40	37	33	29	26	23	20	17	14

2

Factors differentiating atoms	Factors differentiating substances
1. The type of atom.	1. Type of element present.
2. Number of each type of particle.	2. How many atoms of each are present.
3. Patterns in which the particles are combined.	3. Patterns in which the atoms of each element are combined.

3 a false b true c false d true
e true f true g false h true
i false j true

4 a atom b compound
c molecule d element

5 It loses two electrons.

6 a The Periodic Table
b It consists of:
- seven periods or rows of increasing atomic weight
- eighteen columns.

c It is a summary of the atomic weights, numbers and symbols of the elements and it groups elements of similar properties into columns for easy identification.

7 a 11 b 11 protons, 11 electrons, 12 neutrons
c one

8 a cation b ion c anion

9 a There are more metals.
b

Group of elements	Properties
metals	High lustre, conduct electricity, malleable
non-metals	lack lustre, do not conduct electricity
noble gases	unreactive and glow brightly when electricity is passed through them

10 properties, reactive, alkali, halogens

11
- The atom has six protons.
- The atom has six positive particles.
- The atom must have six negative particles.
- The number of neutrons must be 6 (the mass number = 12 – 6).

12 They would be the same.

13

1	2	3	16	17	18
H^+			O^{2-}	F^-	nil
Li^+	Be^{2+}		S^{2-}	Cl^-	nil
Na^+	Mg^{2+}	Al^{3+}	Se^{2-}	Br^-	nil

14

Compound	Pure substance made of more than one element.
Element	Pure substance made of only one type of atom.
Atom	Smallest bit of an atom.
Molecule	A group of atoms.

15 The properties of a substance depend on how many atoms are present and how they are arranged.

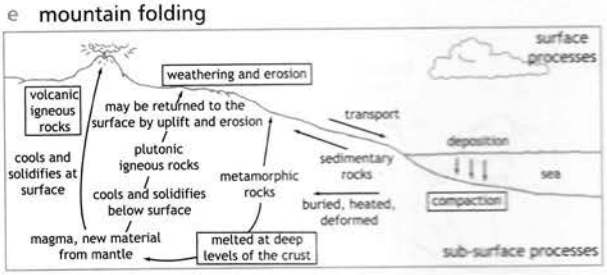
Chapter 4

Science skills page 42

1 a Eurasian plate
b Himalayan mountains
c earthquakes
d The Nazcan plate is pushing the South American plate. This is causing mountain building and earthquakes.
e Indo-Australian plate
f No, because there are no plate boundaries crossing Australia.
g The Pacific plate and the Nazcan plate.

2 a Pre-Cambrian era
b It was weathered.
c On the edges of the continent's core.
d Palaeozoic era
e mountain folding

3



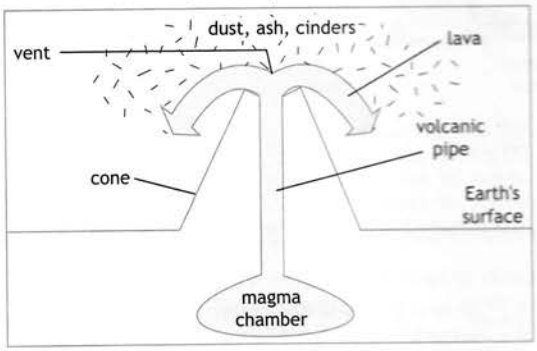
4 volcanoes and earthquakes

5 i = d
ii = b
iii = a
iv = c

6

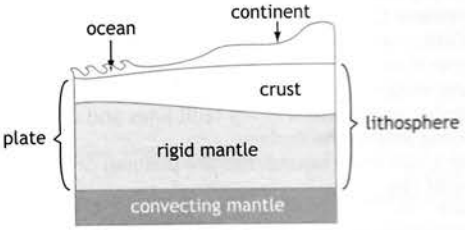
Volcano	A vent in the Earth's crust from which lava and other materials are ejected.
Magma	Hot molten rock generated within the Earth.
Granite	A common, coarse grained, light coloured intrusive rock.
Lava	Hot molten rock that reaches the surface of the Earth.
Sill	A horizontal body of intrusive rock forced between layers of enclosing rock.
Laccolith	An igneous intrusion that has arched up the rock strata into which it was forced, forming a lensshaped body with a flat floor.

7



8 a = i b = iii c = ii

9



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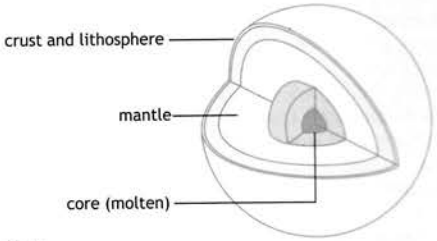
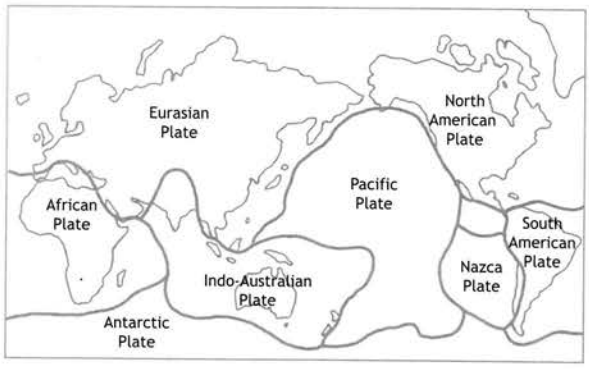


11 a rhea
b kiwi
c Some groups of organisms have a southern hemisphere distribution. DNA comparisons indicate that these flight less birds are very closely related, suggesting that the landmasses on which they are found were once connected.
d Geology and fossil records.

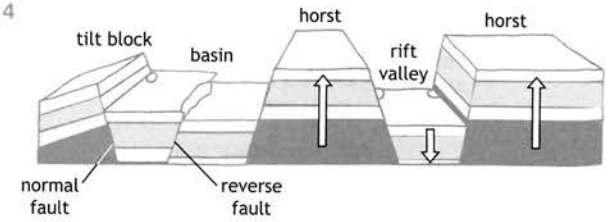
12



13

Landform	Boundary
The Great Dividing Range	C
The Himalayan Mountains	D
Andes in South America	D
Hawaiian Islands	C
Mid-Atlantic Trench	C

14



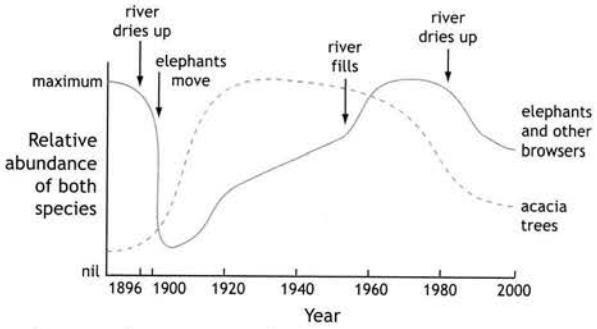
15 a 80° and 60° south
b 90 million years
c about 78° south
d about 44° south
e The climate has gradually got warmer.

Revision questions page 46

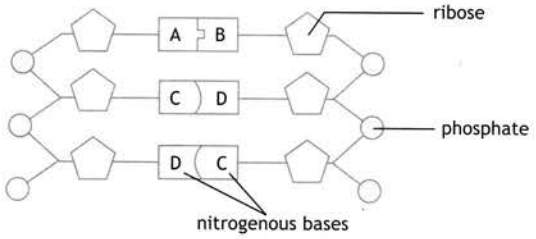
1 a A – Constructive plate boundary
B – Destructive plate boundary
b A – Where two plates move apart, new material wells up as a lava flow.
B – Where two plates collide head-on, one slides under the other returning material to the mantle.
c subduction
2 a Rising magma is stored under pressure in the magma chamber and upwells along fault lines and other zones of weakness to the surface.
b Where two plate boundaries are pushing on one another.
c Ring of Fire
d basalt
e A vertical igneous intrusion across strata.
3 tsunami, earthquakes, shallow, higher
4 a The theory of continental drift.
b Antarctica must still have been connected to Australia when marsupials evolved, but that they died out. Perhaps because Antarctica's climate got too cold as it drifted south after it split from Australia.
5 a Pangaea
b Laurasia and Gondwana
c A, B, D, C
6 a Sometimes a narrow section of magma burns through the crust. This section remains stationary while the plate moves over it.
b A hot spot.
c The Great Dividing Range.
7 A. batholith B. laccolith C. sill D. dykes
8 plates, tectonic, continents, earthquakes, mountain, mid-Atlantic trench, destroyed
9 a C b A
c fault line d folded
10 a igneous
b Molten magma cooling below the surface.
c They have been folded.
d Magma was forced up through a crack in the Earth's crust.
e Erosion of the overlying layers of rock.
11 Antartica, Asia, India, Africa, South America
12 a horst or tilt block b rift valley
13 a India
b folding
c San Andreas Fault
d The Great Rift Valley
e volcanic plug, crater lake, cinder cone, caldera, lava flow, etc
14 a the eastern States b the Great Artesian basin
15 Igneous, obsidian, pumice, lava, quickly, surface, slowly, granite

Test A page 49

1 a Because they are of the same material and have the same fossils.
b 5 and 12, as they also contain the same fossils.
c 10
d 4
2 c
3 a mass extinctions b 5
c Between the Permian and Triassic periods.
4 1. That all living things vary.
2. That they can pass on their characteristics.
3. That they are involved in a struggle for survival.
5 a & b



c Because there were no elephants to browse on the acacias.
d The river filled up and the elephants came back.
6



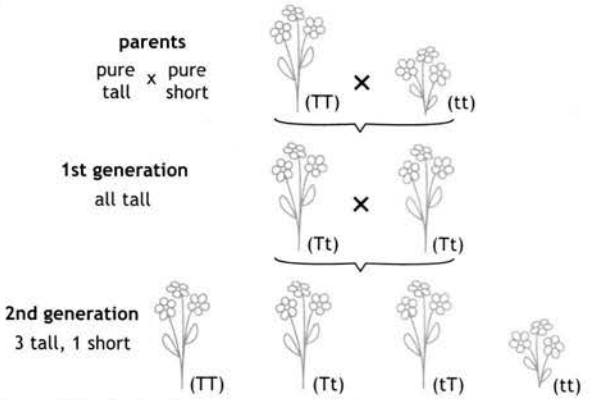
7

Nucleotide	Full name	Where in the cell	Function
DNA	Deoxyribo-nucleic acid	nucleus of a cell	contains the genetic code
RNA	Ribonucleic acid	nucleus and cytoplasm of a cell	carries the genetic code

8 e, b, d, a, c
9 a BB b Bb c all black d 3 black : 1 white
10 a 50% b 25%
11 a 3 long horned : 1 short horned b HH, Hh, hh
12 a homozygous, homozygous
b homozygous, heterozygous

13 b

14



15 No, as all individuals must carry a dominant gene.

16

Atomic number	Mass number	No. of protons	No. of neutrons	No. of electrons
14	28	14	14	14
11	23	11	12	11
19	39	19	20	19
7	14	7	7	7

17

	1												13	14	15	16	17	18
1	1 H	2																2 He
2	3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
3	11 Na	12 Mg	3	4	5	6	7	8	9	10	11	12	13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
4	19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
5	37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
6	55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Rc	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
7	87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt	110 Ds	111 Rg	112 Cn		114 Fl		116 Lv		

18

Element	Symbol	Atomic number	No. of protons	Atomic mass
lithium	Li	3	3	6.94
carbon	C	6	6	12.01
chlorine	Cl	17	17	35.45
barium	Ba	56	56	137.36
gold	Au	79	79	196.97

19 a Pt b Hafnium c 79 d 126.9

20 There are 45 atoms combined in a molecule of sucrose: 12 carbon atoms, 22 hydrogen atoms and 11 oxygen atoms.

21 acids, hydrogen, salts, magnesium chloride

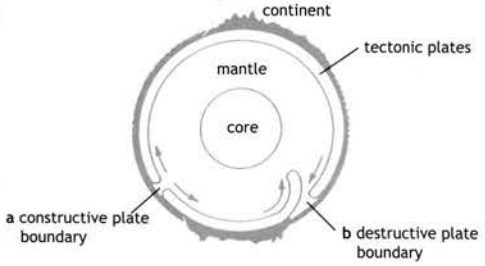
22 Metals: potassium, sodium, magnesium, calcium
Non-metals: sulphur, bromine, iodine, chlorine
Examples: sodium chloride, potassium iodide

23 A the hydrogen ion
B the hydroxide ion
C the ammonium ion
D the nitrate ion

24 c

25 a sodium b negative c neutral

26



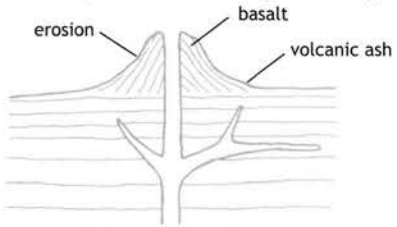
27 crust, plates, slowly, mantle, apart, mid-ocean ridges, subduction, slides, under, mantle, crust

28

29

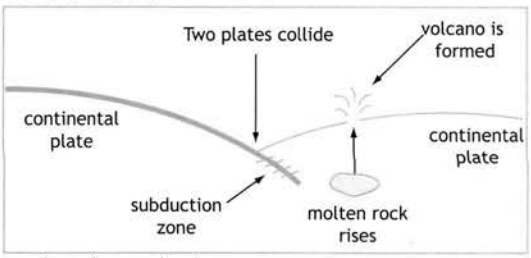
Earthquake	A sudden movement of plates in the Earth's crust, caused by the abrupt release of strain that has built up over time.
Basalt	A common fine-grained extrusive rock.
Crust	Earth's solid outermost layer.
Hot spot	A location where a stationary plume of magma rising from the mantle melts a hole in the Earth's crust, producing a volcano.
Seismograph	An instrument that measures the amount of ground movement produced by an earthquake.

30



31 a Subsidence of the leading edge of a lithospheric plate into the mantle.

b



c earthquakes and volcanoes

32 a Richter scale b E c B d A and B

33

Composite cone	A cone formed from alternate layers of ash and lava.
Caldera	Steep-sided crater caused by a violent volcanic eruption.
Lava flow	Within rock layers under the ground surface it forms intrusive igneous rock.
Volcanic plug	The resistant core from an eroded volcanic

Chapter 5

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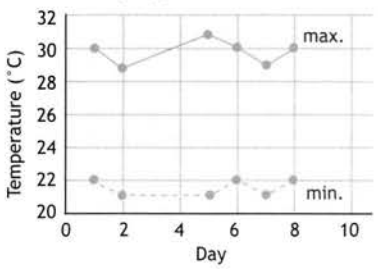
1 a

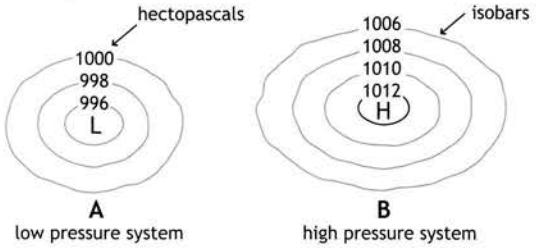


b Day 5
c Day 5
d Day 9

2 a easterly
b wind vane

3 a 8 mm
b Thursday
c 4 + 10 + 9 + 16 + 8 = 47 mm
Average = 9.4 mm

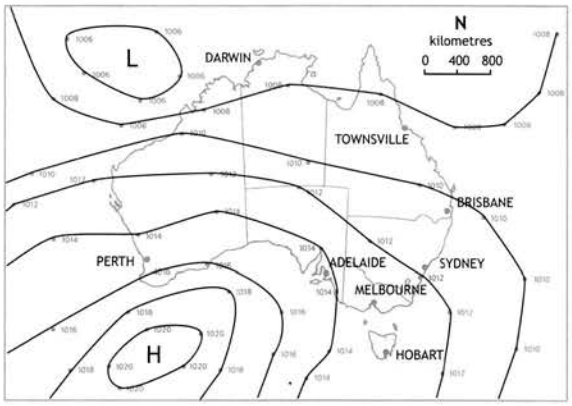
4 a



b high pressure system (B)
c atmospheric pressure

5 a cloudy and rainy
b a gentle breeze – the isobars are not close
c from left to right
d fine with a hardly a breeze
e from the north east

6 a & b



c cloudy with rain approaching from the west

7 a cyclone
b rain
c clockwise

8 a A very wet year.
b A drought year.

9 (B)

10 a i 52 km/h
ii 24 km/h
iii 9 km/h
b i Moderate gale – whole trees in motion; inconvenience felt when walking.
ii Moderate breeze – dust and loose paper move; small branches move.
iii Light breeze – wind felt on face; wind vanes move.

11 a 22 °C
b 71%
c 67%

12 a cyclone
b 25 km/h
c 170 km/h, 0 km/h
d 950 hectopascals

13 a Darwin
b Darwin
c Alice Springs
d Perth

14 a Thunderstorm activity decreases as distance from the equator increases.
b December
c Winter

Revision questions page 64

1 water vapour, high, cirrus, stratus, cumulus

2 Climate — Average weather conditions of a particular place.
Weather — Atmospheric conditions in a particular place at a particular time.
Meteorology — The study of the atmosphere.

3 a air pressure
b rainfall
c wind speed
d temperature
e wind direction

4 a degrees Celcius
b The areas are shaded.
c It estimates wind speed by observing the effect the wind has on its surroundings.
d The type of weather carried by the wind – eg a hot wind comes from blowing over hot land.
e Strong winds and storms are on the way.

5 Thunderstorm — A storm accompanied by heavy rain, gusty winds and lightning.
Cyclone — A region of low atmospheric pressure accompanied by violent storm conditions.
Hurricane — A massive, spiralling low pressure system causing widespread devastation.
Tornado — A narrow, violently rotating column of air.

6 a El Nino Southern Oscillation – the cycling of warm water between northern Australia and northern South America.
b The Southern Oscillation Index monitors the differences in sea level atmospheric pressures between Tahiti and Darwin.
c El Nino is a term used to describe the movement of warm surface water from the western pacific to the coast of Peru and Ecuador.
d A negative SOI indicates low rainfall and drought.
A positive SOI indicates high rainfall and often flooding.

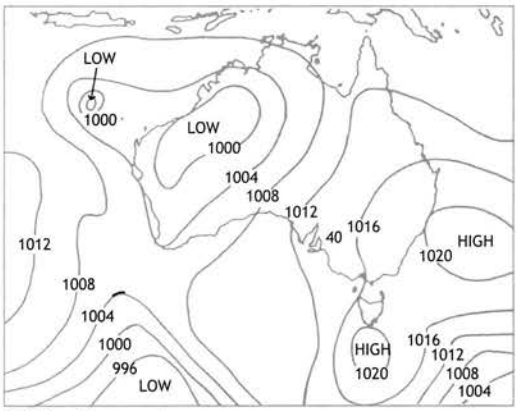
7 a warmer, more, cooled, condense, particles, clouds
b Precipitation, or rain, occurs when the droplets in clouds combine and become so heavy that air currents can no longer hold them up.
e If clouds reach up into the higher, colder parts of the atmosphere the water droplets freeze.

8 The northern hemisphere, because the winds are rotating anticlockwise and to the right.

9 a wind
b Temperature causes air to move vertically (hot air rises). Air pressure causes air to move horizontally (from a high to a low).
c Coriolis Effect

10 a gravity
b air pressure
c cold air
d cloudy, rainy weather

11 a



b 996 hectopascals
c 1016 hectopascals
d barometer
e isobars
f very windy weather

12 b