Chapter 1: Investigating science

Unit 1.1

1  a  Examples: LCD and HD televisions, Blu-ray players, iPods and Wii consoles
    b  Examples: climate change, diseases such as SARS and swine flu which were not heard of until relatively recently

2  Astronomy, biology, chemistry, ecology, geology, physics, psychology

3  a  Biology: zoology, botany, genetics, microbiology, entomology, marine biology, agriculture
    b  Geology: petrology, palaeontology, vulcanology, seismology, geomorphology, crystallography
    c  Physics: acoustics, mechanics, optics, nuclear physics, thermodynamics, quantum physics

4  Everyone needs to have an understanding of science because everyone will need to help decide what we do on current big issues such as climate change and any new issues that will arise.

5  A biologist usually specialises in one sub-branch of biology because it allows them to explore it detail and develop a deep understanding of it without being distracted by what is going on in the other sub-branches.

6  a  Amanda: ecology
    b  Sarah: geology
    c  Brian: astronomy
    d  Yang: physics
    e  Joe: chemistry
7  a  Abdul: biology/entomology
    b  Hon: geology/petrology
    c  Travis: physics/optics
    d  Lisa: geology/palaeontology
    e  Francesca: biology/botany

8  A detective and a scientist both take observations to help them find out what
has happened and why. Scientists plan experiments to test their ideas.
Detectives would not do this; they try to discover events that have already
occurred.

9  a  Biology: chapters 5 (Habitats and interactions) and 6 (Classification)
    b  Chemistry: chapters 2 (Properties of substances) and 4 (Mixtures)
    c  Physics: chapters 7 (Forces) and 8 (Machines)
    d  Geology: chapter 3 (Earth resources)
    e  Astronomy: chapter 9 (Earth in space)

10  Biochemistry includes both biology and chemistry.

Unit 1.2

1  a  A microbiologist needs a microscope.
    b  An astronomer needs a telescope.

2  Pyrex

3  A Bunsen burner flame can reach 1500°C.

4  Many possible dangers might be listed including extreme heat, flames, toxic or
corrosive chemicals, broken glass.

5  Students will need to provide the name of their science teacher and laboratory
   technician.

6  A cross-section is a view that would be obtained if an object was sliced
   vertically, horizontally or at an angle. A scientific diagram takes a vertical cross-
   section through the centre of, for example, a piece of apparatus.

7  a  The markings on beakers and conical flasks are only rough measurements
and therefore should not be used to accurately measure out volumes.

b A measuring cylinder is used to accurately measure volumes.

8 All laboratories are different as they depend on where the scientist works. Some scientists work outdoors, others underwater, and others work in a ‘traditional’ science laboratory. They also vary due to the particular area of science being investigated.

9 A yellow flame is called the safety flame because it is relatively easy to see. This makes it less likely that you or anyone else would carelessly get too close to the flame.

10 a 220 mL  
    b 16 mL

11 a dirty = yellow
    b noisy = blue
    c almost invisible = blue
    d extremely hot = blue
    e closed airhole = yellow

12 a Tying hair back when using Bunsen burner (safe).
    b Sniffing chemicals (unsafe).
    c Sniffing chemicals by waving the smell towards you (safe).
    d Adding unknown chemicals together (unsafe).
    e Putting on safety glasses when using the Bunsen burner (safe).
    f Leaving broken glassware and spilt chemicals on the bench (unsafe).

13 a Explosive
    b Toxic (dangerous chemical)
    c Flammable (will catch on fire)
    d Corrosive (burning)
    e Electrical danger

14 A beaker and a conical flask are similar in that both:
    • are made of Pyrex
are used in experiments

- only provide rough measurements.

They have different shapes and can have different volumes.

15  a  Protect your eyes by wearing safety glasses.

  b  Walk don’t run in the laboratory to avoid slipping while moving around. Also look for spills.

16  a  You should light a match before you turn on the Bunsen burner gas, to ensure there is no build up of gas, which could cause an explosion.

  b  Untied long hair can accidentally get in the flame of a Bunsen burner. This can be avoided by tying it back.

  c  Toxic (poisonous) chemicals and acids are in the laboratory. Biological hazards can also be there because it is also where dissections are carried out. It is incredibly dangerous if any traces of these materials get into food or drink and so eating and drinking is banned in the laboratory.

  d  If you leave a Bunsen burner, it needs to be seen. This is easier when it is left as a yellow flame.

17  Individual student response.

18  Individual student response.

Unit 1.3

1  Your five senses are sight, hearing, smell, taste and touch.

2  Multiple observations can be made, some of which are:

  a  a candle: its shape and colour, the length and diameter of the candle and wick, its smell, its state (solid)

  b  molten (melted) candle wax: its colour, how fast it drips, its temperature, whether it is clear or not, its state (liquid)

  c  a candle flame: its colour, height, noise, heat coming from it

  d  the smoke from a candle that has been blown out: its colour, shape and patterns formed, how long it lasts.
3  a  41
   b  4.4
   c  50
   d  150
   e  110
   f  42
   g  23

4  a  D, g
   b  B, kg
   c  B, mm
   d  D, L
   e  A, min

5  Quantitative observations give more detail than qualitative observations. They are understood by everyone and are not open to individual interpretation.

6  Various answers possible. Students may explain how mirages give an idea that water is present or how the Zolner illusion implies that lines are not parallel when they are.

7  a  mm
   b  m
   c  km

8  a  g
   b  s (or ms)
   c  °C
   d  kg
   e  L

9  a  It uses fractions, not decimals.
   b  There are no units.
   c  The wrong unit is used (should be in litres (L)).
10 Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Activity</th>
<th>Senses that would be safe to use</th>
<th>The sense that would give you the most information</th>
<th>Senses that would be unsafe to use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing a new rat poison</td>
<td>Sight, hearing</td>
<td>Sight</td>
<td>Smell, taste, touch</td>
</tr>
<tr>
<td>Testing whether minced steak is OK to eat or is &quot;off&quot;</td>
<td>Sight, smell, hearing</td>
<td>Smell</td>
<td>Touch, taste</td>
</tr>
<tr>
<td>Testing the lava flowing from a volcano</td>
<td>Sight, hearing</td>
<td>Sight</td>
<td>Touch, taste, smell</td>
</tr>
<tr>
<td>Testing how dangerous an acid is</td>
<td>Sight, hearing</td>
<td>Sight</td>
<td>Touch, taste, smell</td>
</tr>
<tr>
<td>Testing whether tomatoes are ripe</td>
<td>Sight, smell, touch, taste, hearing</td>
<td>Smell</td>
<td>None</td>
</tr>
</tbody>
</table>

11  
   a  i  inference
     ii  observation
     iii  prediction
   
   b  i  observation
     ii  prediction
     iii  inference
   
   c  i  inference
     ii  observation
     iii  prediction

12 Qualitative observations do not include numbers while quantitative observations do. Quantitative observations are objective.

13  
   a  qualitative
   
   b  quantitative
   
   c  quantitative

14  a  observation
Various answers are possible. Here are some ideas:

a  Use an object of small known mass and compare its mass with the unknown mass using a homemade scale or balance. (For example, balance a paddle-pop stick on a pencil. Put the Smartie on one side and a 1 gram object or other object of known mass on the other side and compare.)

b  Students could use a magnifying glass but would need very small measurements on the ruler to see anything. They could fold up the paper many times (recording the number of folds) and then measure the folded thickness (ensuring it is flattened so that air isn’t included) or cut the pieces and put them on top of each other and then measure the thickness of the pile and divide by the number of pieces.

c  Measure your heartbeat for 5 minutes and divide by 5.

Unit 1.4

1  Purpose  aim

Hypothesis  educated guess
Materials  equipment
Procedure  instructions
Discussion  analysis
Conclusion  the end

2  a  Materials: all the equipment and chemicals used, including the amount you used.

b  Procedure: the exact order in which you carried out the experiment, possibly including a diagram.

c  Discussion: the discussion of what the results, calculations and graphs
Scientists would want to read what others have found out in experiments because this will give them ideas and methods to try out and further their own scientific work.

4 C

5 a column/bar graph
   b line graph
   c column/bar graph
d pie chart
e line graph

6 B

7 a B
   b C
c A
d B
e D

Diagrammatic answer required.

Each person hears and remembers the message in a slightly different way, sometimes getting one small part wrong; 25 people in the room could make 25 different changes, radically changing the message.

10 a Conclusion: Fishing line is much stronger than string.
    b Conclusion: Water boils at 100°C.
    c Conclusion: The sponge tested held 35 mL of water.
11  Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Time (min)</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>45</td>
</tr>
<tr>
<td>1</td>
<td>40</td>
</tr>
<tr>
<td>2</td>
<td>38</td>
</tr>
<tr>
<td>3</td>
<td>35</td>
</tr>
<tr>
<td>4</td>
<td>30</td>
</tr>
<tr>
<td>5</td>
<td>26</td>
</tr>
<tr>
<td>6</td>
<td>19</td>
</tr>
</tbody>
</table>

12  a  Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Time (s)</th>
<th>Speed (km/h)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>5</td>
<td>20</td>
</tr>
<tr>
<td>10</td>
<td>30</td>
</tr>
<tr>
<td>15</td>
<td>50</td>
</tr>
<tr>
<td>20</td>
<td>60</td>
</tr>
<tr>
<td>25</td>
<td>80</td>
</tr>
</tbody>
</table>

b  Diagrammatic answer (see below)

Unit 1.5

1  Dependent variable  What you are measuring

Independent variable  Changed during the experiment
Controlled variable Kept the same

2 Various answers are possible:

a  Aim: To test what would happen to a plastic bag full of water when stabbed with pencils.

b  A logical hypothesis: The bag will leak.

3 a  Temperature of water, size of cup, amount of stirring, size of sugar granules

b  Temperature of the day, rain or no rain, day of the week, school holidays or not

c  Type of plant, amount of sunlight, water and fertiliser

d  Size of potato, type and age of potato, temperature of the water, method of cooking

e  The amount you drink, your age, the temperature of the day

4 Only one variable should be changed in any single experiment, so that you know what caused any change in the dependent variable.

5 A few results might show a pattern, but five or more will confirm any pattern you find.

6 Student answers should include the following.

Materials: A brown paper bag, a banana, two unripened avocados (need to be about the same ripeness and size).

Procedure

1  Place the banana and an unripened avocado in the bag and scrunch the end up to close it.

2  Place the second avocado in another bag next to the first.

3  Leave both together and periodically check the ripeness/hardness of the avocados. Check twice a day and see whether or not the banana makes the avocado ripen faster.

7  C (D would also be OK but would be practically difficult.)

8 a  Aim: To compare surfaces on which a tennis ball is bounced.

b  Aim: To compare the bounce of different balls.
9 Variables are the amount of water, detergent and grease on the dishes, and the
temperature of the water.

10 a The dependent variable that Bob tested was the height a ball bounces.
   b Bob changed three variables (ball, surface and drop height) during the
      experiment.
   c The experiment was not a fair test.
   d No conclusion can be made from this experiment since it is not a fair test.

11 Different methods are possible.

Chapter review

1 a biology
   b chemistry
   c physics
   d psychology
   e geology
   f astronomy
   g ecology

2 a distance: mm, cm, m, km
   b volume: mL, L, ML
   c mass: mg, g, kg, t

3 a C
   b B
   c D

4 a Qualitative: appearance, colour, state (solid, liquid or gas), shape
   Quantitative: mass, volume, height and diameter
   b Qualitative: appearance, hair, eye and skin colour, gender, body shape
   Quantitative: mass, height, waist measurement, length of hair

5 a A meniscus is the curved top of liquid in a thin tube.
A cross-section is a cutaway view, as if split vertically, horizontally or at an angle.

A hypothesis is an educated guess of what might happen.

A variable is a factor that might influence an experiment.

6 A safety flame is yellow, quiet and dirty, and is produced when the airhole of the Bunsen burner is closed.

7 Many chemicals are toxic and so taste and smell are rarely used in science.

8 a beaker
   b spatula
   c crucible

9 a s
   b kg or t
   c L

10 a i observation
   ii prediction
   iii prediction
   b i prediction
   ii inference
   iii observation

11 a pie graph
   b line graph
   c column graph
   d bar graph

12 a qualitative
   b quantitative
   c quantitative
   d qualitative

13 If the tap is turned on first, the gas is being pumped into the room. Lighting the
match can then cause it to explode.

14 Diagrammatic answer (see below)

Thinking scientifically

1  C
2  a  B
   b  C
   c  D
3  C
4  B
5  C
6  B
Chapter 2: Properties of substances

Unit 2.1

1 The three states are solid, liquid and gas.

2 a Solid
   b Liquid
   c Gas

3 a Liquid, gases (bubbles); some orange drinks might also have some flakes of solid orange in them
   b Solid, liquid
   c Solid, liquid.

4 Physical properties: solid, flexible (able to be bent and torn), colour (probably white), light (low density), floats on water, absorbs water

   Chemical properties: burns before it melts

5 Examples of biodegradable substances: wood, paper, cardboard, cotton, hessian, linen, wool, soap

   Examples of non-biodegradable substances: cling wrap, most plastics, house paints, polystyrene, glass, metals.

6 a Plasma is a gas but it only exists at temperatures above 6000°C. These temperatures are common on stars but very uncommon on Earth.
   b On Earth, conditions for plasma to form are found in high-voltage sparks and lightning bolts.

7 a Compress: to squash, make smaller
   b Incompressible: not able to be squashed or made smaller
8 Gases can be compressed and so can squash and expand as the suspension travels over bumps. This softens the ride.

9 a Water vapour causes humidity.
   b A humid day feels sticky and uncomfortable.

10 a A banana soon ripens, turning from green to yellow to black. It then starts to rot. These are all signs that bananas are biodegradable.
   b A sausage will soon start to change colour and give off bad smells as it begins to rot and decay. These are all signs that sausages are biodegradable.

11 The walls of a compost bin must be relatively rot resistant. For this reason, stiff plastics or metals like steel are ideal. Wood is biodegradable and will eventually rot; however, it will last many years before it does so.

12 a Fungi break down dead material, eventually returning the nutrients to the soil. Hence they are a sign that the log is biodegradable.
   b Very little of the wood in the log will be left in 10 years time. What may be left will be an area of soil enriched by the nutrients that the log (and fungi) provided.

13 a Each grain of sand has a fixed shape and is a solid. Together, the grains flow over each other so sand has one of the characteristics of a liquid.
   b Toothpaste is like a solid in that it is able to hold its shape for a while. It will drip however, showing liquid characteristics.
   c Hair gel is like a solid in that it is able to hold its shape for a while. It will drip however, showing liquid characteristics.

14 Faeces are biodegradable because they rapidly break down, leaving little behind.

Unit 2.2

1 Energy causes atoms to constantly move.

2 Absolute zero is the same as –273°C.
3 Solid   Particles vibrate on the spot.
   Liquid   Particles vibrate but can also move over one another.
   Gas     Particles move very fast in straight lines
4 a heated: the particles move faster and more vigorously
   b cooled: the particles move less and more slowly
5 a solid: particles are close together in fixed positions
   b liquid: particles are close together but can move over one another
   c gas: particles are far apart and move fast in straight lines.
6 a vibrate: bouncing around on the spot
   b bonds: connections that hold particles together
7 a The particles in solids only vibrate on the spot; they don’t break out of position. This enables solids to keep their shape.
   b The particles in a gas are spread far apart and so they can be pushed closer together; i.e. the spaces between the particles can be compressed.
   c The particles in liquids are close together but are able to move over one another. This allows them to take the shape of the container they are poured into.
   d There is no space between the particles in a solid and so they cannot be compressed.
8 Robert Brown saw that pollen particles moved by themselves, as if being jostled by something.
9 Gas has weight and so the weight of a barbecue gas cylinder will tell how much gas is in it.
10 a The balance is lost when one of the balloons is burst.
   b Gas has weight. There are more air particles compressed inside the balloon than there are on the side of the balloon that burst and so the balloon side is heavier.
11 a Diagrammatic answer required.
   b Shared by all three states: has energy
c  Shared by solids and liquids: fixed volume, incompressible, particles closely packed
   Shared by solids and gases: nothing
   Shared by liquids and gases: changing shape

d  Solid only: fixed shape
   Liquid only: nothing
   Gas only: changing volume, able to be compressed, particles loosely packed

Unit 2.3

1  a  Boils at 100°C
   b  Freezes at 0°C

2  Iodine and carbon dioxide sublime.

3  a  Evaporation = vaporisation
   b  Freezing = solidification

4  a  Condensation
   b  Freezing or solidification
   c  Evaporation
   d  Melting
   e  Deposition
   f  Sublimation

5  The melting point and freezing point of a substance are at exactly the same temperature because both represent the temperature at which the same change of state occurs (but in opposite directions), i.e. between solid and liquid.

6  When a substance is boiling, all the heat energy goes into the particles, breaking the bonds between them and allowing the particles to break free and escape the liquid.

7  The water particles in clothes on a clothes line are not all at the same temperature. Some are moving faster than average, allowing a few to escape and evaporate (others are moving slower than average too). These escaped particles
are lost from the clothes and so they dry.

8 a Snow forms when water freezes around a speck of dust.

b Dew forms when the moisture in the air condenses because the temperature drops overnight.

c Frost forms when dew freezes on a cold night.

9 Various answers possible:

a Examples of substances that melt at relatively low temperatures are ice (water), ethanol, mercury (any liquids at room temperatures).

b Examples of substances that evaporate at relatively low temperatures are alcohol, water.

10 a Solid to liquid (melts)

b Liquid to solid (freezes or solidifies)

c Gas to liquid (condenses).

11 a –50°C: Solid—water, mercury, silver; liquid—ethanol

b –20°C: Solid—water, silver; liquid—ethanol, mercury

c 50°C: Solid—silver; liquid—ethanol, water, mercury

d 200°C: Solid—silver, liquid—mercury; gas—ethanol, water

e 500°C: Solid—silver; gas—ethanol, water, mercury

f 1000°C: Liquid—silver; gas—ethanol, water, mercury

12 Sunglasses often fog up when you walk out of an air-conditioned building on a humid summer day because the hot water vapour in the air hits the cold sunglasses and condenses. This forms a layer of water drops that is seen as a ‘fog’.

13 a Salt decreases the melting point of ice. This helps melt the ice and snow on the roads in the northern USA and Canada even when the outside temperature is below freezing.

b Additives increase the boiling point of water. This means that the engine needs to get to a higher temperature before the radiator coolant boils.

c A mixture of salt and ice has a lower temperature than just pure ice, which helps the ice-cream freeze.
14 a Evaporation happens at all temperatures. Boiling only occurs at the boiling point.

b Melting occurs when a solid changes into a liquid. Sublimation occurs when a solid changes into a gas.

c Steam is water vapour that has condensed to form a fog when it hits the cold air. Water vapour is gaseous water.

Chapter review

1 a Solids have a fixed shape and volume, and, except for solid water, are more dense than their liquids and gases.

b Liquids have a fixed volume; shape flows to fill container.

c Gases change volume and shape, and are the least dense of all states.

2 When heated:

a the particles in a solid vibrate more

b the particles in a liquid move faster over each other

c the particles of a gas move faster in straight lines.

3 a Freezing

b Condensation

c Deposition

4 Consider a particular volume of a substance and compare the solid, liquid and gas forms. Gases have very few particles with a lot of space between them. This makes them very light and their density low. In contrast, liquids and solids have many more particles packed into the same space. This makes them heavier and denser than gases of the same materials.

5 Gases are compressible. This physical property cushions you when you jump around on the castle. The gas is compressed but then spreads back to its original shape and size, allowing you to bounce back.

6 C

7 a Water particles in liquid water are arranged close together but are not joined strongly to each other. As you dive in, the water particles separate and move
apart, allowing you to enter easily.

b Although the water particles move to allow you into the pool, they are closely packed and so can give you a punch in the stomach when you do a 'bellywacker'.

8 a Melting is the change of state in which a solid changes into a liquid. Sublimation is the change of state from a solid directly into a gas.

b Melting is the change of state from solid to liquid; freezing is the opposite, i.e. a change from liquid to solid.

c Plasma and gas are both gases but plasma only exists at temperatures above 6000°C but examples of 'normal' gases exist at almost all temperatures.

9 The water will evaporate and form a gas. Gases take up more room than liquids and so the balloon will inflate (blow up).

10 a Water does not compress, and so the jumping castle will be very firm when you jump onto it.

b The gas particles in the jumping castle push closer together, cushioning your jump. Water particles do not compress and so your jump would not be cushioned.

11 Aerosol cans are filled with gas. When heated (as in a fire) the particles move faster and so push on the walls harder and harder. This may split the walls of the can, causing an explosion.

12 Diagrammatic answer required.

Thinking scientifically

1 C
2 B
3 A
4 A
Chapter 3: Earth resources

Unit 3.1

1 Rocks (including minerals and fossil fuels), soil, air, water, living things and sunlight

2 Temperature change, running water, ice, wind

3 Water, wind, ice

4 • Fine rock particles (sediments)
   • Living organisms (such as worms and moss)
   • Humus, which is decaying wastes and dead organisms
   • Water
   • Dissolved minerals and gases

5 Green plants manufacture food and oxygen is produced.

6 A resource is something that satisfies a particular purpose or need.

7 Living things are a renewable resource because they reproduce.

8 It takes millions of years for most rocks to be replaced.

9 All land plants are grown in soil, which provides the materials plants need. Therefore all animals that eat the plants (or that eat other animals) depend on the soil. This includes humans.

10 Rocks can be used as building materials, to supply minerals, and as a source of fossil fuels.

11 Water

12 Renewable: air, water, living things, sunlight.
   Non-renewable: rocks (including minerals and fossil fuels), soil.

13 a Renewable
b Renewable

c Non-renewable

d Renewable

14 a A renewable resource is one that can be replaced in a fairly short time (much less than a human lifetime) after it has been used or while it is being used. A non-renewable resource may never be able to be replaced, or may take millions of years (much longer than a human lifetime) to regenerate (e.g. fossil fuels (gas, oil, coal), rocks and soil).

b Weathering is the breaking down of rocks into small particles, while erosion is the process of moving these particles away from where they were formed.

c Erosion is the process of particles being moved away from where they were formed, whereas deposition is the process in which these sediments drop out of a moving stream of water, wind or ice.

15 a The trees making up a forest can reproduce themselves and many can grow to maturity within an average human lifetime.

b Soils form from weathered rock and it generally takes many thousands of years to form a thin soil. The sediments also require many other components such as humus, living things, water, minerals and gases to turn into a soil that can support plants.

16 Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Major resource</th>
<th>Use for humans</th>
<th>Renewable in a lifetime</th>
</tr>
</thead>
<tbody>
<tr>
<td>Air</td>
<td>Breathing and to supply gases to some of our food organisms</td>
<td>Yes</td>
</tr>
<tr>
<td>Water</td>
<td>Needed for our bodies to work</td>
<td>Yes</td>
</tr>
<tr>
<td>Soil</td>
<td>Growing food plants and animals</td>
<td>No</td>
</tr>
<tr>
<td>Rocks</td>
<td>Building and supply minerals</td>
<td>No</td>
</tr>
<tr>
<td>Living things</td>
<td>Food supply, clothing</td>
<td>Yes</td>
</tr>
<tr>
<td>Sunlight</td>
<td>Needed by plants to make food for humans, keeps Earth warm enough for life</td>
<td>Yes</td>
</tr>
</tbody>
</table>

Unit 3.2

1 a Fossil fuels release enormous amounts of energy when burnt.
b The supply of fossil fuels is limited and if used continually will eventually run out. Also, when burnt, fossil fuels (apart from nuclear fuels) release large amounts of greenhouse gases, which contribute to global warming.

2 State either advantage:

• A small amount of nuclear fuel produces a large amount of energy.
• No greenhouse gases are produced in the process.

State either major disadvantage:

• The safe disposal of nuclear waste, which remains radioactive for thousands of years, is difficult.
• Although nuclear power plants are typically very safe, if an accident occurred it would potentially be very damaging.

3 The three major sources of the world’s energy are oil, coal and gas.

4 Sunflower, sesame, canola, oil palm, soybean and linseed can be converted into biodiesel fuels.

5 It is also called a photovoltaic cell.

6 One quarter of the world’s population has no access to an electricity supply.

7 A renewable energy source can be used over and over again; for example, solar energy or wind power. A non-renewable energy source is limited in supply and will eventually be depleted if we keep using it; for example, coal or oil.

8 Plant and animal remains compressed under layers of soil and mud are transformed into various types of fossil fuels over a timescale of millions of years.

9 Biomass is the total amount of living or once living organic (plant or animal) remains but does not include fossil fuels.

10 Sunlight can be used:

• to passively heat a house that is orientated towards the Sun and uses interior materials that absorb heat
• to heat water within tubes in rooftop solar heating units to provide hot water
• in a solar cell to produce electricity directly
• to heat salted water in a solar pond, which can be used to generate electricity
• in a large-scale solar energy system that incorporates curved mirrors to focus
light onto a liquid that is heated and used to generate electricity.

11 a The average energy use of an Australian over a year is 240 GJ.

b 1 GJ = 1 000 000 000 J so, the average energy use of an Australian in a year is: 240 GJ = 240 000 000 000 J.

12 a Biomass

b Fossil fuel

c Hydroelectricity

d Solar energy

e Wind energy

f Oscillating wave column

g Tidal barrage

h Geothermal energy

13 a Current production from solar sources is 4 TWh/yr.

b Potential production is 43 600 TWh/yr.

c Students could select any three from the following:

i Africa, Australia, South America

ii Canada and Alaskan coasts, central and east coast of USA, Ireland and the UK, west coast of Spain, France, Germany, west coast of Norway, Western and Southern Australia, west coast of Asia, New Zealand

iii West coast of Canada, Alaska, east coast of USA, southern tip of South America, west coast of Ireland and France, western and southern coast of Australia, New Zealand, tip of Greenland, Iceland

iv USA, Alaska, regions of South America (Chile, Peru, Brazil), regions of Africa (Ethiopia, Egypt), Saudi Arabia, Malaysia, Sumatra, regions of China and Bangladesh, south-eastern Australia, Northern Territory, North Island of New Zealand

d Students could select one, depending upon state or territory:

NT: solar, geothermal

SA: geothermal, wind, solar
WA: wind, tidal, solar
Vic: geothermal, tidal, wind
NSW: solar, geothermal
QLD: solar
Tas: wind, tidal

14  a  37%  b  0.04%  c  6%

15  Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Energy source</th>
<th>Advantages</th>
<th>Disadvantages</th>
</tr>
</thead>
</table>
| Solar         | • Enormous amounts of sunlight fall on the Earth’s surface.  
|               | • It can be used in many ways.                  | • Solar cells are expensive to produce.                                      |
|               | • It is clean and a free energy resource.       | • Large-scale solar energy projects are expensive to establish.              |
|               |                                                  | • Electricity production depends upon the level of sunlight reaching Earth.   |
| Wind          | • Some regions of the world, particularly coastal areas experience high winds often  
|               | • It is a free and clean source of energy       | • The wind flow is not constant, which affects the amount of electricity generated. |
|               |                                                  | • Many turbines are needed to generate sufficient useful electricity.        |
|               |                                                  | • Nearby residents can complain of a loss of scenery or about the noise generated. |
|               |                                                  | • Birds can occasionally be killed by the turbines.                         |
| Tidal         | • A natural and free energy source              | • Systems are expensive to establish.                                       |
|               |                                                  | • They affect the habitat and appearance of a coastline.                     |
| Geothermal    | • A plentiful resource in many regions of the world | • It can raise pollutants to the surface.                                    |
|               |                                                  | • It is only suited to specific regions.                                     |
| Hydroelectric | • Relatively cheap and greenhouse gas free energy source | Building large dams has an impact on the environment in terms of:           |
|               |                                                  | • loss of natural flowing water through affected areas, and                 |
|               |                                                  | • loss of natural habitats for land to construct the power station.          |
16  
   a  It is a non-renewable resource.
   b  Nuclear energy relies upon resources such as uranium or plutonium, found in the Earth’s crust, and so it is a non-renewable resource. However, given that relatively small amounts are required to generate electricity, it is likely that the Earth’s supply of nuclear fuel will last longer than that of fossil fuels.

17  Appliances continue to use power when in standby mode.

18  Green energy refers to energy from a renewable source, such as solar, hydroelectric or wind power.

19  
   a  Individual student response.
   b  Students compile own list of suggestions. Examples are:
      
      Lighting: turn off when leaving a room for some time.
      Cooking: use lids on saucepans to heat liquids more effectively.
      Major appliances: turn these off at the power point to prevent energy wasted by standby lights.
      Water heating: have shorter showers, wash clothes in cold water.
      Refrigeration: turn off a second fridge until it is needed.
      Space cooling: use curtains to cover windows on hot days and keep windows closed.
      Space heating: insulate your home effectively to prevent heat loss.
      TV, DVD player: turn these off when you finish watching something.

20  Individual student response. Advantages are that coal is a cheap and plentiful resource for Australia to use. Disadvantages are that it is limited in supply, produces vast amounts of greenhouse gases and has an environmental impact when mined.

Unit 3.3

1  70%

2  a  97.5%
   b  2.5%
3 Precipitation

4 Three of: state of the water, air temperature, humidity, air movement, landscape.

5 There is a finite amount of water on Earth.

6 Only a very small percentage of the water on Earth is suitable for use by humans.

7 It could run off the surface into rivers, streams, lakes and the ocean. It could evaporate. It could also percolate into the soil, seep through porous rocks and enter an underground store or an aquifer, or be taken up by plants through their roots and then transpired back into the atmosphere.

8 Animals drink the water and it passes back into the soil when they urinate.

Water from the grass they eat also re-enters the water cycle in their urine and through their faeces.

9 The air cannot hold any more water vapour. Any cooling of the air will result in precipitation.

10 a Evaporation
    b Freezing
    c Precipitation
    d Percolation
    e Run-off

11 Diagrammatic answer (see below)
12 Diagrammatic answer (see below)

13 a Evaporation is the change of state from liquid to gas. Transpiration is a particular form of evaporation. It is the evaporation of water from plants—especially the leaves.

b Pervious rocks allow water to seep through them. Impervious rocks do not allow this and prevent water from moving further into the ground.

c Percolation is the movement of water into the soil. Run-off occurs when the water does not penetrate the soil. It flows over the surface towards lakes and streams.

14 a Ice caps and glaciers

b Soil (0.005%) compared to the atmosphere (0.001%)

c Inland seas have less water (0.008%) than the amount in freshwater lakes and rivers combined (0.01%).

15 Soil sample 1 is crumbly and will have a lot of air spaces. Soil sample 2 is very dense and will have few air spaces. Water will percolate more easily through soil sample 1 than sample 2.

16 a Soil sample 2

b The water is not able to percolate through it as easily therefore more water
will remain on the surface and it will remain there for longer. If the land has a slope, the water will flow down the slope as run-off.

17 a They can be considered to be close enough to being correct. A tiny fraction of the water may have been produced by respiration in cells, or may have come from the burning of biomass and fossil fuels, but it is such a small amount that it can be considered insignificant.

b There is a finite amount of water on Earth. The only way we get water to replenish what has been used is by the water being recycled through the water cycle.

18 Diagrammatic answer (see below)
Unit 3.4

1 Two of: location of vegetation, ant trails, dingo tracks.

2 Three of: storing water in dams, using water for irrigation, moving water around, building cities, changing vegetation.

3 Spray irrigation and flood irrigation

4 In Australia the rain does not fall evenly over the country. Dams are built to capture and store water to be used by industry and households in the cities. Large dams are needed to collect enough water for the needs of cities.

5 Water stored in dams does not flow down the river and into the ocean. In a deep dam some water may not be available for evaporation for a very long time, and so is removed from the water cycle.

6 a The water would have run down the Snowy River to the ocean on the east coast of Australia.

   b It is diverted through the mountains to the Murrumbidgee River.
c An area of dry land can be used to grow food crops for people living in cities. Electricity is also produced.

d The flow along the Snowy River is greatly reduced. This affects the native species that live in and around the river and the organisms that depend upon them.

7 Using rain gardens and biopods, capturing the stormwater and using it to refill lakes and for irrigation are some of the ways.

8 a Point A would be more humid than point B. The factors contributing to humidity at point B are transpiration from grass and evaporation from the soil surface. In addition, at point A there is transpiration from the leaves of trees.

b The amount of water flowing would be greater at point D than at point C because rain falling on the forest would be intercepted by the trees and other vegetation. It would reach the ground more slowly and over a longer period of time, and so would have a greater chance of percolating into the soil.

9 Both are adding extra water to the soil, making this water available for percolation into the soil and evaporation into the atmosphere. In both, extra water is available to plants, potentially increasing the amount of water entering the atmosphere via transpiration.

Evaporation rates with spray irrigation will be greater than with flood irrigation. There will be greater percolation from flood irrigation and more water will reach the roots of plants.

10 Both provide water as small droplets that land on the leaves of the plants, and some reaches the soil.

When it is raining there is usually cloud overhead and the air also becomes very humid. This reduces the amount of evaporation.

Spray irrigation can be carried out at any time of the day; therefore, if it is sunny the rate of evaporation would be increased. Also, irrigation is usually carried out when it is dry. The lack of humidity in the air will increase the rate of evaporation.

Spray irrigation focuses on specific areas where it will be of most benefit. A shower of rain cannot do this.

11 a It will fall on the hard surfaces of streets, footpaths and the roofs of houses and office blocks. The water falling on these hard surfaces will run out to
streams and the ocean. In parkland and gardens the rain could percolate into the soil.

b When there were few hard surfaces most of the rain would have percolated into the soil.

12 There will be reduced run-off into the river and increased evaporation from the lake surface. Water stored in the dam will be lost to the water cycle for a very long time.

13 Diagrammatic answer (see below)

14 Student responses

Chapter review

1 a Agents of erosion

b Weathering

2 Examples are computer, CD player, dishwasher, computer printer, DVD player

3 Solid, liquid, gas

4 a A natural resource is something supplied by the Earth that satisfies a particular need of living organisms.

b A renewable natural resource is one that is replaced by natural processes that occur on Earth in a timescale much less than a human life.
c Deposition is the process in which sediments fall out of a moving stream of water, air or ice.

5 Most sources of renewable energy rely upon non-continuous sources. There is a need to store excess energy that is produced when the source (such as wind or sunlight) is present, so that this can be accessed when required.

6 The water in the ice sheets remains there for a long time. Only when the ice melts can the water move to the next part of the water cycle.

7 a The rate of evaporation is much faster on a windy day.

b As the air above a surface reaches saturation the rate of evaporation slows down and stops. Wind (moving air) removes the layer of saturated air above a surface, so evaporation continues as the same fast rate.

8 b Diagrammatic answer (see below)

![Diagram](image)

c It could remain deep in the lake or underground.

d Movement would be fast on the land surface, from plants, and the surface of the lake.

9 Animals drinking from the springs could trample the spring and pollute the water with their faeces.

10 The student should state observations such as that at the beach the sand dunes seem to be washed away by waves or blown around by the wind. In a garden they could discuss wind blowing topsoil around and a strong stream of water from the hose washing soil away. As they travelled by car they may have seen hilly road verges with soil washed off by water or blown around by the wind. They may also have seen soil pushed around on tracks by off-road vehicles.

11 The origins of the energy from fossil fuels was the sunlight absorbed by the plants
and animals from which the fuels was formed.

12 The source of heat of water springing from a geyser is geothermal energy from within the Earth.

13 It is transpiration—evaporation of water from a leaf surface.

14 Soils may take hundreds or thousands of years to form (without human help), but water can fall as rain or flow into the soil from above or below the surface at any time, as long as it is where wind can reach.

15 Rocks may take millions of years to form, but oxygen in the air can be continuously produced during photosynthesis in plants.

16 Renewable energy sources: solar energy, wind energy, wave energy, tidal energy, geothermal energy, wood, paper

Non-renewable energy sources: oil, coal, LPG gas, uranium

17 The amount of water lost using spray irrigation will be greater than the amount lost without irrigation. Also when it rains it is normally overcast and the air is humid, therefore less of the water falling on the soil will be lost.

18 Tides may create fast moving water that can erode the soil on the beach.

19 Individual student response required. Students could argue the benefits to the environment of immediately ceasing the use of fossil fuels in terms of global warming, but at the current time the world’s energy needs could not be met from renewable sources alone. This is due to the cost of getting new energy production systems established and the need for further development of renewable technologies.

20 There are arguments that the harvesting of food crops for use as biofuel will rob developing nations of the land and water resources needed to sustain their food supply. Harvesting algae offers benefits in that it does not require fresh water or good quality soil for its production. Also, the algae take up carbon dioxide and so emissions from industry could be used.

21 The droplets of water in the clouds do not become large enough to fall as precipitation or they evaporate before reaching the ground

22 Individual student responses. Examples include using flexible solar cells to make clothing, to cover outside features such as playground equipment or dog kennels, to cover the outside of a garage roof or the roof of a car.
23 a  Major sources of Australia’s energy supply are brown and black coal used to generate electricity; petrol, LPG or diesel fuel for cars and trucks; and natural gas for cooking and hot water systems.

b  In 50 years time, Australia may use a greater combination of non-renewable and renewable sources to generate electricity that could include coal, solar power, wind power, nuclear energy, geothermal energy and tidal energy.

24 The design of the experiment would have to include containers with different surface areas—all other features of the container should be the same.

The conditions to which the water containers are exposed should be the same in terms of amount of sunshine, air movement, air temperature and humidity.

These factors can be controlled by having the containers in the same place at the same time.
Thinking scientifically

1 A
2 D
3 B
4 C
5 C
Chapter 4: Mixtures

Unit 4.1

1 solute—an example such as salt, sugar
   solvent—an example such as water, kerosene
   solution—an example such as salt solution, sugar solution

2 Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Type of solution</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid dissolved in a liquid</td>
<td>Grease dissolved in petrol, sugar dissolved in water</td>
</tr>
<tr>
<td>Liquid dissolved in another liquid</td>
<td>Liquid detergent in water, oil in petrol</td>
</tr>
<tr>
<td>Gas dissolved in a liquid</td>
<td>Oxygen gas in water, oxygen gas in blood</td>
</tr>
<tr>
<td>Gas dissolved in another gas</td>
<td>Oxygen gas in air, water vapour in air, helium in oxygen</td>
</tr>
</tbody>
</table>

3 Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Type of suspension</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid suspended in a liquid</td>
<td>Sand in water</td>
</tr>
<tr>
<td>Solids suspended in gas</td>
<td>Sand carried by the wind, dust in the air</td>
</tr>
<tr>
<td>Liquids suspended in another liquid</td>
<td>Many medicines</td>
</tr>
</tbody>
</table>
4 Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Type of colloid</th>
<th>Examples</th>
</tr>
</thead>
<tbody>
<tr>
<td>Emulsion</td>
<td>Milk</td>
</tr>
<tr>
<td>Foam</td>
<td>Shaving cream, foam ‘rubber’</td>
</tr>
<tr>
<td>Gel</td>
<td>Jelly</td>
</tr>
<tr>
<td>Sol</td>
<td>Blood</td>
</tr>
</tbody>
</table>

5

<table>
<thead>
<tr>
<th>Mixture</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>a Solution</td>
<td>A substance dissolves in another, forming a clear mixture.</td>
</tr>
<tr>
<td>b Suspension</td>
<td>A type of mixture in which one substance does not dissolve in another but quickly separates out by itself.</td>
</tr>
<tr>
<td>c Colloid</td>
<td>A mixture made of particles smaller than a suspension but bigger than those of a solute in a solution.</td>
</tr>
</tbody>
</table>

6 Dilute the liquid and then shine a torch beam through it. If the beam passes through and is hardly visible, it is probably a solution. In a colloid the beam would glow and show up in the liquid, which will look cloudy.

7 The substances in the Mylanta are in a suspension, so they separate out in the bottle. Shaking the bottle mixes them so you get the right dose of the medicine.

8 A concentrated salt solution has a large amount of salt in a particular volume of solution, whereas a dilute solution has much less salt dissolved in the same amount of water.

9 a A solvents can dissolve a liquid or a gas as well as a solid. A solvent is defined as a substance that dissolves a solid, liquid or gas to form a solution.

b An emulsion is not a solution. A solution is when a solute dissolves in the medium (solvent).

c A suspension does not stay dispersed for long. It usually separates out quite quickly from the medium.

d Colloid particles are smaller than those in a suspension.

e Emulsifiers produce emulsions, not solutions: the substance does not dissolve in the medium.

f A suspension is a mixture because it consists of particles in a dispersal medium.
10 Could be any amount less than 12.5 g.

11 a 10 g in 100 mL = 10/100 = 0.1 g/mL

   b  80–10 = 70 g settles on the bottom of the container.

12 Add some more sugar and watch to see if it collects on the bottom and will not dissolve. If it does settle, the solution is saturated.

13 Both have water as the solvent and contain sugar. However, the concentrated solution has much more sugar dissolved in the same amount of water.

14 Both have water as the liquid medium. The sugar particles are too small to see because they are dissolved and remain in between the water particles. The sand particles are large enough to see individually and will settle to the bottom.

15 When dissolving, the particles separate and spread into the medium. When melting, the particles stay close together and do not spread out into any medium.

16

<table>
<thead>
<tr>
<th>Solution</th>
<th>Suspension</th>
<th>Colloid</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cordial in water</td>
<td>Clouds</td>
<td>Oil in salad dressing</td>
</tr>
<tr>
<td>Carbon dioxide gas in</td>
<td>Dust in air</td>
<td>Egg white in a pavlova</td>
</tr>
<tr>
<td>lemonade</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food colouring in water</td>
<td></td>
<td>Smoke from a car exhaust</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(may contain suspensions as well)</td>
</tr>
</tbody>
</table>

17 In a solution, the solute particles dissolve into particles of similar size to the solvent medium. In a suspension, the suspended particles do not dissolve and stay dispersed for only a short while in the medium, eventually settling to the bottom. In a colloid, the particles are in between the size of a solution and a suspension, and stay dispersed in the medium.

18 The solution must have been saturated with 5 teaspoons of sugar. If it could not be made sweeter, then no more sugar was dissolving in the tea.

19 The questions they ask will depend on the answer given each time. It is probably best to set the questions out like a classification key. Some of the questions the students could ask are:

<table>
<thead>
<tr>
<th>a  Is it a solution?</th>
<th>a  Is it a solution?</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td>NO</td>
</tr>
<tr>
<td>b  Is the solvent water?</td>
<td>b  Is it a suspension?</td>
</tr>
<tr>
<td>YES</td>
<td>YES</td>
</tr>
<tr>
<td>c  Is the solute a solid?</td>
<td>c  Is the dispersal medium water?</td>
</tr>
</tbody>
</table>
### Unit 4.2

1. The list will depend on what they find at home. Examples include coffee percolator, tea bags, vacuum cleaner, air conditioner, car engine, car fuel system, car air cleaner, washing machine, clothes dryer, swimming pool, face mask.

2. Spin-drying with a washing machine.

3. | What is being separated          | Method of separation                  |
<table>
<thead>
<tr>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Solid from another solid</td>
<td>Sieving, magnetic</td>
</tr>
<tr>
<td>Solid from a liquid</td>
<td>Filtration, gravity(e.g. decantation), cyclonic, centrifuging</td>
</tr>
<tr>
<td>Solid from a gas</td>
<td>Filtration, cyclonic, electrostatic</td>
</tr>
<tr>
<td>Liquid from another liquid</td>
<td>Cyclonic, centrifuging, gravity</td>
</tr>
</tbody>
</table>

4. a. There would be a barrier with many small holes through it. (The barrier is actually many fine fibres of wood in a random pattern and the holes are the gaps between the fibres.)

   b. The large particles cannot fit through the holes.

5. The sugar particles are smaller than the holes in the filter, so they can pass through.

6. Scrap metal is fed onto a conveyor belt which passes near a magnetic rotating drum. The magnetic materials are attracted to the drum and are removed from the flow of rubbish, which passes straight through.

---

20. Answers will vary.
Find some old insect wire or buy some. Support it and shovel the soil onto it. Shake the wire to sieve out the sticks and stones.

Use a magnet or try panning like you did in the science4fun activity.

Use a flour sifter to sift out the hundreds and thousands.

Shovel the mixture into a bucket of water. The plant material will float and can be skimmed off.

Use a tea strainer or flour sifter. Tip the liquid through the sifter or strainer into another cup.

Conical and fluted filters both filter solids from liquids. However, the fluted filter allows liquid to pass through faster. The fluted paper is better suited to separating very fine solids from a liquid because there will be more holes in contact with the liquid and which will remain unclogged by the fine solid.

These three methods can be used to separate solids from liquids, and liquids from another liquid. Gravity separation is a method of separating heavier substances from a suspension using gravity. The heavier particles sink to the bottom of the container. Centrifuging uses rapid spinning to force tiny suspended material in the liquid or gas to the sides and then the bottom of the chamber. Cyclonic separation uses rapid spinning like a centrifuge and also uses gravity to separate the mixture. So it is a bit like a centrifuge and a gravity separator combined.

Filtering and sieving both use a barrier with holes in it to prevent a solid passing through. Filters are usually thought of as being composed of microscopically small holes. A sieve has holes you can see and separates out particles big enough to see.

The fluted filter paper and the car air cleaner both have many zigzag folds, like the pleats in a skirt.

The air cleaner has a greatly folded structure to increase the surface area in contact with the air. This will allow the air cleaner to remove dust particles rapidly from the air.

Get two beakers, filter funnel, filter paper, filter stand and water. Put the sand and salt into a beaker and add water. Stir the mixture to dissolve the salt. You may have to add more water if the salt will not all dissolve. When the salt is all
dissolved, filter the liquid. The sand stays in the filter paper and the salt is in the filtrate.

13 The problem with a centrifuge would be if the tubes were not of equal mass all around. If a centrifuge had only one tube filled, it would create strong vibrations that could damage the machine. You would need to put an equal mass on the opposite side to each filled tube.

14 The holes in the filters gradually become clogged with particles, so no material can pass through the filter and it stops working.

15 Find a magnet, tie it to a string and lower it into the drain. Let the nut stick to the magnet and gently pull it out.

16 The test spins are to test whether the clothes are distributed evenly around the washing machine bowl. If the clothes are heavier on one side, the spin will not be balanced and could shake the machine too much and damage it.

17 Tabulated answer (see below)

<table>
<thead>
<tr>
<th>a Method of separation</th>
<th>b How the method works</th>
<th>c Example of use</th>
</tr>
</thead>
<tbody>
<tr>
<td>Gravity</td>
<td>Gravity pulls heavier particles to the bottom of the container</td>
<td>Separating sand from water</td>
</tr>
<tr>
<td>Sieving</td>
<td>Large particles cannot get through a barrier with holes in it</td>
<td>Straining water from pasta</td>
</tr>
<tr>
<td>Filtration</td>
<td>Barrier has many small holes that allow only tiny particles through</td>
<td>Separating dust from air through a face mask</td>
</tr>
<tr>
<td>Magnetic</td>
<td>Magnetic materials and non-magnetic metals can be attracted or pushed away from a mixture of other rubbish</td>
<td>Rubbish recycling of metals</td>
</tr>
<tr>
<td>Centrifuging</td>
<td>Fast-spinning chamber forces fine particles to separate to the bottom</td>
<td>Washing machine</td>
</tr>
<tr>
<td>Electrostatic</td>
<td>Particles made to be positively charged are attracted to a negatively charged plate and vice versa</td>
<td>Smoke chimneys in factories</td>
</tr>
<tr>
<td>Cyclonic</td>
<td>Gas or liquid is made to spin fast in a spiral pattern and larger particles are pushed to the side and fall to the bottom</td>
<td>Dyson vacuum cleaner</td>
</tr>
</tbody>
</table>

18 Depends on student answer.
Unit 4.3

1  a  C  
   b  A  
   c  D  
   d  B  

2  a  chromatography  
   b  evaporation  
   c  distillation  
   d  adsorption  

3  Chromatography is a process that can separate a mixture by making it move through another substance like a paper strip. Chromatography works because all the chemicals in the mixture are attracted to the paper by different amounts. Chemicals that are strongly attracted eventually stick to the paper, so they stop moving before the ones that are weakly attracted.

4  Distillation uses a heat source such as a Bunsen burner to quickly boil a solution in a flask. The solvent (usually water) evaporates. The gas then passes into a water-cooled tube called the condenser, where it condenses back to liquid. The distillate drips into a flask. The solute remaining in the heated flask is called the residue. The distillate will be very pure because the solutes do not evaporate and pass into the condenser.

5  a  Rapid evaporation can be done by heating the liquid in an evaporating basin placed on a wire mat sitting on a tripod stand over a Bunsen burner. The liquid is usually boiled, but care must be taken that it does not spit out of the basin due to overheating.
   b  Slow evaporation can be done by putting the liquid in a watchglass and exposing it to the air in the lab for a few days.

6  The face mask has a filter that can adsorb gases from the air. The gases stick to the carbon filter before they can enter the miners’ airways.

7  a  chromatography  
   b  distillation
evaporation
adsorption filter

8 a Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Component</th>
<th>Distillation</th>
<th>Bush still</th>
</tr>
</thead>
<tbody>
<tr>
<td>Water source</td>
<td>Solution in flask</td>
<td>Vegetation</td>
</tr>
<tr>
<td>Heat source</td>
<td>Bunsen burner</td>
<td>Sun</td>
</tr>
<tr>
<td>Cooling surface</td>
<td>Condenser</td>
<td>Plastic</td>
</tr>
<tr>
<td>Distillate</td>
<td>Water</td>
<td>Water</td>
</tr>
</tbody>
</table>

b The vegetation in the bush still is a water source. The sunlight passes through the clear plastic and evaporates water from the vegetation. This condenses on the underside of the plastic and drips into the container.

9 Evaporation is the change from liquid water to a gas (vapour). It can happen at any temperature above freezing. Boiling can only happen at a high temperature such as 100°C at normal air pressures at sea level.

10 With evaporation, the alcohol will boil off first and be lost, so the whisky will become lower in alcohol. With distillation, the alcohol will evaporate first and be collected as the distillate. Then the producer can add water to it to achieve the required strength.

11 The insert adsorbs the smelly gases and sweat given off by the feet. Carbon would be a good material to use.

12 When you leave the bathers containing salt water to dry in air, the salt remains behind and forms crystals as the water evaporates. When you rinse the bathers in fresh water, it removes most or all of the salt, so they dry without forming any salt crystals.

13 Answers will vary. An example follows:

<table>
<thead>
<tr>
<th>a</th>
<th>Does it separate insoluble substances?</th>
<th>a</th>
<th>Does it separate insoluble substances?</th>
</tr>
</thead>
<tbody>
<tr>
<td>YES</td>
<td></td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>b</td>
<td>Does it have a screen or barrier?</td>
<td>b</td>
<td>Does it involve heating?</td>
</tr>
<tr>
<td>YES</td>
<td></td>
<td>YES</td>
<td></td>
</tr>
<tr>
<td>c</td>
<td>Does it have microscopic holes?</td>
<td>c</td>
<td>Can you recover the solvent?</td>
</tr>
<tr>
<td>YES</td>
<td></td>
<td>NO</td>
<td></td>
</tr>
<tr>
<td>d</td>
<td>Is it filtration?</td>
<td>d</td>
<td>Is it evaporation?</td>
</tr>
</tbody>
</table>
Unit 4.4

1. a. Water, mineral salts such as sodium chloride, fine solid particles, living organisms.
   b. Same as salt water but often has more solid particles, higher levels of wastes and decaying material, some toxic chemicals and organisms such as bacteria.

2. Groundwater originates from rainwater soaking into the ground.

3. Screening → aeration → settling → filtration → sterilisation.

4. Flocculation → filtration → sterilisation → balancing pH → fluoridation.

5. a. Potable water is water suitable for humans to drink.
   b. Non-potable water is not suitable for human consumption.
   c. Flocculants are chemicals that can make fine solid particles clump together and separate out of water.
   d. Desalination means to produce fresh water from salt water by removing the salt.

6. Rainfall has been declining in many areas of Australia so water storage in dams and rivers has decreased. Groundwater is still able to be used without depleting the reserves at present. In most places, though, this will eventually have an impact.

7. The amount of groundwater will eventually decrease because it is also fed by rainwater, which is decreasing.

8. Reverse osmosis: water under pressure is pushed through a very fine membrane that stops salt getting through. This removes salt from the water.

9. It is washed into stormwater drains that lead into rivers and then these reach the ocean.

10. Sieving → gravity separation → filtration.

11. The main difference is that water from dams for potable use is cleaned to a higher level of quality, has its acidity balanced and is fluoridated. Neither of the last two processes occur with recycled water. The processes are similar in that in both, solids are allowed to settle out and the water is filtered and sterilised.
12 It is to prevent unhealthy substances entering the water supply. Camping may add substances such as oils, human waste and detergents to the water in the dams.

13 It creates an air lock so that odours and germs in the waste water do not enter the air in the house, which is unpleasant and unhealthy.

14 a Disinfectant or bleach can kill the bacteria that break down the solid wastes.  
    b Paint can block the spaces in the soil that act as a filter to clean the water and allow it to drain away.  
    c Plastic will not decompose and will eventually block the pipes and tanks.

15 Answers will vary.

Chapter review

1 Answers will vary. Some examples are:  
   a Centrifuge: to separate fine solid particles from a liquid, e.g. solids from blood.  
   b Hydrocyclone: to separate silt from water in irrigation.  
   c Electrostatic separator: to remove smoke particles from factory chimneys.  
   d Carbon filter: to remove poisonous gas from air in a mine.  
   e Reverse osmosis plant: to remove salt from salt water when making potable water.  
   f Paper chromatography: to separate substances in ink to compare different inks.  
   g Liebig condenser: to separate salts from water to purify water.  
   h Eddy current separator: to sort rubbish waste recycling.  
   i Septic tank: to treat toilet waste in homes.

2 You could use a hydrocyclone. The water and oil mixture is squirted in at an angle to the cyclone and the mixture spirals downwards. The water will sink to the bottom and the oil will escape from the exit in the top of the cyclone.

3 a saturated  
   b 1 g/100mL
Decantation involves letting a suspension settle so that the heavier component separates by gravity to the bottom of the flask. The lighter top layer is then gently poured or skimmed off.

It is used especially where there is a heavy solid suspended in a liquid.

Step 1: Place both in a beaker and add water. Stir to dissolve the salt.
Step 2. Filter through filter paper to recover the sand in the filter.
Step 3: Put the filtrate in an evaporating basin and heat to evaporate the water. This will leave the salt in the basin.

Step 1: Put a magnet into the mixture and stir it around. The iron filings will stick to the magnet and can be removed.
Step 2: Filter the remaining mixture. Sand will be residue in filter paper.
Step 3: Distil the filtrate of water and salt. The water will evaporate and condense as distillate. The salt will be left in the basin.

Use paper chromatography. Take two newspaper strips and near the bottom of each strip put a line of one of the substances. Place each strip in a glass in a solvent such as water. If the coloured bands that form on the paper strip are in different places or contain different colours, then the two liquids are different.

The blue dye is adsorbed onto the carbon in the filter, but not onto the paper filter. The blue dye stuck to the carbon dissolves in methylated spirits because that must be a solvent for the blue dye.

In a solution, one substance dissolves in another, forming a clear mixture. There is no solid or liquid suspended in the medium. In a suspension, one substance will not dissolve in another and quickly separates out if left to stand. In a colloid, small particles are dispersed in a liquid or gas. These particles are smaller than those of a suspension.

The solubility of one substance in another affects how they can be separated. Filtration can only remove an insoluble substance. For example, sand will not dissolve in water. Because it is insoluble, the sand can be separated from the water by filtration. However, sugar will dissolve in water. Therefore the sugar cannot be removed by filtration. For soluble substances, a method that can remove the solvent is needed. Evaporation of water from a sugar solution will separate the sugar.
11 a 5g, because 5g dissolves in every 50 mL of pure water.

b The amount of Z would decrease to less than 10 g because most solids are more soluble at higher temperatures.

12 E: Soak it into paper and put it in the bin. This will end up either being burned or in landfill where it can decompose without getting into the groundwater. Putting it down the sink or toilet means it enters the sewerage system or septic tank, giving them extra work to do. Burying it in the garden means that it could enter the groundwater.

13 The egg white becomes a foam. This is a colloid in which air is mixed in the egg white.

14 Step 1: Weigh an evaporating basin.
Step 2: Pour a known volume of a cool drink (say 100 mL) into the basin.
Step 3: Heat the basin with a Bunsen burner to evaporate the liquid.
Step 4: Reweigh the basin and subtract the mass from the original basin mass to find the mass of the solid. Express the answer as mass per 100mL of drink.
Step 5: Repeat with two more samples of the drink and find the average mass.

15 Diagrammatic answer (see below)
Thinking scientifically

1. D. Step Z removes the iron filings; step W then dissolves the salt but not the sand in the water; step X, filtering, separates the sand from the solution and finally step Y evaporates the water leaving the salt.

2. B. Substance E is not soluble in hot water; substance G is soluble in hot water and will dissolve.

3. D. A is incorrect as oxygen is not a solid; B is incorrect as sugar is not a liquid; C is incorrect as detergent is not a gas. D is correct as all substances listed are gases.

4. B. Gravity separation separates magnetite and rutile from the rest, then magnetic separation separates these two.
Chapter 5: Habitats and interactions

Unit 5.1

1 A living thing is also called an organism.

2 A habitat is a place where an organism lives.

3 A habitat must provide food, water, shelter and living space, a suitable temperature, mating partners for reproduction, and gases such as oxygen.

4 An ecologist studies the environment.

5 An adaptation is a special characteristic that helps an organism to get food and water, protect itself, build a home and reproduce.

6 Some organisms have very specific needs for food or conditions of temperature or rainfall. They are only able to live where these conditions are found. They are not adapted to live elsewhere. Other organisms have less restricting requirements and their needs are found over a much wider area. Therefore the organism is able to live in a wider area.

7 Any changes to a habitat such as loss of vegetation will affect the variety of species living in the area and the number of a particular species. For example, the clearing of bushes will remove the nesting places for small birds. It also has the potential to reduce the number of insects and other possible food sources for these small birds. Loss of nesting places and food will reduce the number of small birds living in the area. Other organisms that are suited to the lack of bushes could potentially move into the area.

8 The organisms depend on each other for survival. Some might be a food source for others. Alternatively others, such as trees, provide a living place as well as a food source for many organisms.

9 Commensalism: This is an interaction between two organisms in which only one
of them benefits, but the other one is not affected. For example, on the Great Barrier Reef there are small colourful fish called clown fish, which live in the tentacles of the sea anemones and are protected from predators. They also get bits of food not eaten by the anemones.

Mutualism: This is an interaction in which both organisms benefit from the relationship and neither is harmed. Lichen consists of a fungus and an alga growing together. The alga manufactures its own food using energy from sunlight and the fungus uses this food. The fungus provides the alga with a protected place to live.

Parasitism: This is an interaction where one type of organism (the parasite) lives on or in the host (another type of organism, usually a plant or an animal). The parasite obtains food and shelter from its host, but often harms or may even kill the host in return. Heartworm is a parasite that lives in the hearts of dogs. The worm uses the dog for shelter and food, but in the end the dog often dies, because the large number of worms can clog up the dog’s heart.

10 Organisms have characteristics that suit them to a particular set of conditions. For example, polar bears have white fur that provides camouflage in the snow and ice. They are efficient predators because they are not easily seen by prey. Polar bears would stand out in areas without ice. Many Australian native birds and possums use holes in large trees as nesting places. They do not build nests on branches or in the ground like some other birds and therefore they cannot move to an area without large, old trees.

11 Biotic factors are living factors, that is other living things in the environment. Abiotic factors are non-living.

12 The biosphere is the place where all life exists. An ecosystem is a small part of the biosphere.

13 a Parasitism. The leech is provided with food and the other animal gains no benefit and could be harmed by the loss of blood.

b Commensalism. The baby kangaroo is provided with food and the mother gains no benefit. However, it is unlikely that the mother will be harmed unless she is malnourished.

c Mutualism. The cleaner fish gains food by eating the parasites and the health of the large fish is improved by the removal of these parasites.
d  Mutualism. The bees gain the pollen which is used as a source of nutrients and the flowers are pollinated so that fertilisation can occur and seeds can be produced.

e  Commensalism. The vine reaches the light but the tree gains nothing from the relationship.

14 Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Environments that are very hot</th>
<th>Environments that are very cold</th>
<th>Environments that contain a large number of predators</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature: Organisms would need adaptations that allowed them to keep cool. Being active at night is one such adaptation. Lack of water: Many hot environments are also very dry. Koalas drink very little and get the water they need from the leaves they eat. Trees produce long tap roots to reach water deep in the soil.</td>
<td>Temperature: Organisms would need adaptations that helped them keep warm such as thick fur or fat as insulation. Lack of water: When water is frozen it is not available to plants or animals. Many trees lose their leaves in winter to reduce their need for water. Availability of food: Many plants protect themselves over winter by losing their leaves. This adaptation means they are not eaten by herbivores and so are able to survive.</td>
<td>Number of hiding places: Organisms would have more likelihood of survival if they were able to hide from predators. In this environment some animals adapt by living in tunnels or thorny bushes. Feeding: Organisms would not be able to spend as much time finding food if they were hiding from predators. Some animals adapt by feeding at night and hiding during daylight hours. Reproduction: Predators are more likely to take young animals. Some animals adapt by having large litters of young.</td>
</tr>
</tbody>
</table>

15 a  More light would reach the ground. There would be more wind and there would also be more rain reaching the ground.

b  Plants that do not survive in heavy shade would be able to grow, so the vegetation in that part of the forest would change. Grasses, small shrubs and tree saplings would be present. Shade-loving plants that were growing in the shade of the tall tree would not survive.

16–18 Student answers will vary.

Unit 5.2

1  In a food chain the arrow shows the direction in which the energy is moving.

2  The process that plants use to make their food is photosynthesis.

3  The energy in a plant’s food comes from sunlight.
4 a A producer is an organism that can manufacture its own food.
b A consumer is an organism that must eat other organisms to get the energy and nutrients it needs.
c A decomposer is an organism that gets the energy it needs by breaking down dead matter and waste products.

5 It is from sunlight that energy enters the food chain. Producer organisms trap the energy in the form of food.

6 Only producer organisms are able to trap energy from the Sun and convert it into energy in food.

7 a Dingo and fox both eat rabbits.
b Bird and possum eat the same berries.
c Predator: dingo, prey: rabbit

8 a i Producers: plants
   ii Consumers: grub, aphid, snail, beetle, small bird, large bird, small animal
b Examples of food chains contained within the web:
   Plants, grub, small bird, large bird
   Plants, aphid, beetle, large bird
   Plants, small animal, large bird

9 A food chain is the flow of energy from organism to organism in a series of feeding relationships. A food web is a number of food chains combined.

10 A carnivore is a consumer that eats only other animals. A herbivore is an animal that eats only plants, and an omnivore is an animal that eats both plants and animals.

11 a Carnivorous plants such as the Venus fly trap are producer organisms because they contain chlorophyll and manufacture their own food by photosynthesis.
b They gain nitrogen from the insects they collect but no other nutrition.

12 a If the number of small birds decreased, the numbers of beetles, aphids and snails would increase because they would no longer be preyed on by the
small birds.
The numbers of plants would decrease as more would be eaten by the increased numbers of grubs, aphids and snails.
The food supply for the large bird would decrease. The large bird would eat more small animals to compensate for the lack of small birds and so the number of small animals would decrease.

**b** If the number of large birds increased, the numbers of small birds and small animals would decrease due to increased predation. The organisms below them in the food web would increase in numbers due to decreased predation.

**c** If the number of plants decreased, the herbivores (grub, aphid and snail) would decrease in numbers. This would cause a decrease in numbers up the food web.

**13** Diagrammatic answer (see below)

```
  algae
   /\   \
  snail  small fish
    |     /\     \
   water beetle frog
        |     |     |
         snake
```

**14** Student answers will vary.

**Unit 5.3**

1 Three of: agriculture, logging, mining and urbanisation.

2 Biological control

3 a Endangered—two of: Leadbeater’s possum, the helmeted honeyeater, the blue whale and the beaked gecko

   b Vulnerable—two of: mountain pygmy possum, the Gippsland giant
earthworm, the Mallee fowl, the bilby, and the diamond python

4 Forests were replaced by open woodlands and grasslands. Grazing animals, such as the kangaroos the Aboriginal people used for food, increased in numbers. Plants used as food also flourished.

5 a Different areas of land were burned at different times.

b This practice provided a variety of habitats for different plants and animals. In turn this provided a variety of foods for the Aboriginal people.

6 a Cane toads were first introduced to control cane beetles.

b It does not eat cane beetles. It eats just about anything it can swallow, including insects, mice, small snakes and lizards. Poison from glands on its back kills many potential predators such as snakes and even crocodiles. As a result, toad numbers are increasing rapidly and they are spreading across the north of Australia.

7 The population increased steadily for the next 8 years. In the ninth year the population declined.

8 In sustainable ecosystems there will be a wide variety of species. There will be many different habitats for these species. Each species will have a variety of food sources so that if one food source is in short supply they will be able to use another.

An unsustainable ecosystem does not meet the needs of the species that live there.

9 The water provided by floods can cause an ecosystem to flourish. Seeds that have been dormant in the soil germinate, providing food for herbivores. Many species move into the area to make use of the resources. The ecosystem is productive and becomes more diverse. These changes are not permanent. The dry ecosystem returns when the water dries up.

Floods can also destroy ecosystems. Silt carried by flood waters cover plants and sedentary animals (such as corals) in aquatic ecosystems. The algae cannot photosynthesise and the animals die, causing permanent changes to the ecosystem.

10 Endangered species are close to extinction and only very small numbers remain. Vulnerable species are experiencing a rapid population decline and are in danger
of becoming extinct if the drop in numbers continues. Rare species have low numbers and are often spread out over a large area. Although the populations may be small, they are not decreasing.

11 Organisms that thrive in open grassland are (1) small so that they are easily able to move between the stalks and are provided with protection by the wheat, (2) seed eaters, eating the wheat seed as it ripens, (3) insect eaters, eating the grubs that would thrive in the cultivated soil and in the humid environment created by the wheat crop.

12 Taking the largest trees will change the light patterns on the forest floor. A shaded area with a dense canopy will be replaced by an open sunny area that is more exposed to wind and rain.

Species such as grasses and other herbs that thrive in the more open conditions will come into the area.

Large trees provide nesting places for animals such as birds and possums and many habitats for insects that live under bark or use rotting branches as a source of food. Younger trees do not provide the same variety or number of living spaces therefore some organisms would not be able to remain in the forest in such large numbers.

13 No. Many introduced species provide humans with their major food sources.

14 a The natural vegetation has been removed and all the habitats for the plants and animals that lived there have disappeared.

b Soil carried by run-off could add silt to the water of the creek. Animals that normally live in clear water would not survive. They may not be able to see their prey, or see their predators and not be able to escape from them. Water plants would be covered in a layer of silt and would not be able to carry out photosynthesis.

15 Student answers will vary.

Chapter review

1 It is through the producer that energy enters the food chain.

2 Sunlight
3 Biosphere, ecosystem, habitat

4 Endangered, vulnerable, rare

5 An address is where a person lives. A habitat is where an organism lives in the natural environment (its address).

6 a All things living in an ecosystem are interdependent.
   
b A parasite is an organism that feeds off its host and may kill it.
   
c Plants and animals are sensitive to changes in their environment.

7 a The fox and the eagle would be in direct competition for food and the amount of prey available to the eagle would decrease; therefore, eagle numbers would decrease.
   
b Diagrammatic answer (see below)

8 The prey is the source of food for the predator. The prey is being eaten; the predator is doing the eating.

9 Producers: rose, eucalypt, grass, daisy
   
   Consumers: cat, magpie, sparrow, worm, ant

10 Abiotic: water temperature, rate of water flow, amount of salt in the water
   
   Biotic: water birds, crocodile, water plants, frogs, fish

11 a It could occupy the space that native plants would normally grow in. The dense cover would shade out plants that need full sun. The large numbers of seeds from the berries may be able to out-compete native species.
   
b A large area of Lantana would create a uniform habitat that would provide homes for large numbers of the species that thrive in the environment.
However, there would be fewer different habitats, and therefore the variety of species would be reduced.

**c** Slash it before it produces the berries.

Pull it out—but bare soil would then be ideal for germination of any seeds in the soil.

Poison it—but the poison could affect neighbouring vegetation or get into waterways. Again bare soil would be created.

Use biological control. Find an organism that feeds on the *Lantana*.

12 **a** The number of eastern grey kangaroos increased rapidly for the first five years and then declined rapidly.

The population of the red-necked wallaby has varied. There were peaks in about 1894, 1897, 1907 and 1910, but the peaks have been lower each time and since 1910 the population has declined quickly.

**b** The rabbit population increase rapidly from 1885 until about 1905 when the rate of increase slowed.

**c** As the rabbit population increased the populations of both the eastern grey kangaroo and the red-necked wallaby decreased.

**d** The rabbit could have been out-competing the kangaroos for food. Both animals are herbivores.

**e** Sheep and rabbits are the main competitors. However, the red-necked wallaby is also a competitor.

13 **a** The lizard, bandicoot and bilby compete for grass seeds and insects.

The wallaby and insects compete for grass.

**b** The lizard, bandicoot and bilby would be equally affected because they all eat insects. They all have another source of food.

**c** Eagles would eat more bilbies and wallabies.

Insect numbers could increase, providing more food for bilbies and lizards. They would also have more grass seed. Therefore their numbers should increase. This results in more predation of the insects.

14 Humans are able to build homes, grow food and make clothes. They are also able
to use technology to make environments suitable for their survival.

15 a, b Positive: introduced species, agriculture

Negative: agriculture, mining, urbanisation, logging, introduced species

c Agriculture destroys natural habitats. New habitats that are created cannot survive without human management.

Mining causes vegetation to be removed and so habitats are destroyed.

In urbanisation, natural habitats are replaced by cities. Some organisms such as possums have adapted to live in cities and are thriving in this modified habitat. Possums have become dependent on buildings for shelter, and on vegetable gardens and scraps for food.

Logging removes old trees from forests, and clears plantation forests in which modified habitats have been created.

Introduced species compete with the native species for food, or prey on the native species. This causes native species numbers to decline.

d Introduced species are source of food for humans, so they are not using native species for food. Some introduced species are successfully being used as biological control agents for other pests.

Agriculture has extended grassland for grazing and has increased the food supply for herbivores such as kangaroos, allowing their numbers to increase.

Fruit trees are also a source of food for native animals such as the fruit bat (flying fox).

16 a In the dry season it will be difficult to keep a good water supply for the cattle, and the grass will dry out, reducing the natural feed.

In the wet season the cattle may be caught in floods.

b Store the water from the wet season in dams to make it available during the dry season. Try to grow feed crops on part of the property to provide feed during the dry season.

Channelling water into dams may reduce flooding in a normal wet season.

17 a Grass (producer) — grasshopper (1st-order consumer) — frog (2nd-order consumer) — snake (3rd-order consumer)
b Eucalypt (producer) — caterpillar (1st-order consumer) — kookaburra (2nd-order consumer)

c Water plants (producer) — snail (1st-order consumer) — small fish (2nd-order consumer) — large fish (3rd-order consumer) — shark (4th-order consumer)

18 Diagrammatic answer (see below)

Thinking scientifically

1 D
2 C
3 A
4 C
5 D
Chapter 6: Classification

Unit 6.1

1 Having things in groups (classified) makes communication about the everyday world easier.

2 Dichotomous key

3 Taxonomist

4 When you are looking for a particular item such as soap, or apples, you can go to the part of the supermarket where those items are stocked and then make your choice. Having all the soaps together, or all the apples together, makes it easier to choose the one you want.

5 A strong key is one in which the choices are between characteristics that are easily observed, everyone knows what they mean and they do not change with time.

6 Different people using the key could arrive at different answers.

7 a First decide whether the plant is wanted or not. Weed is a term used to describe plants that are not wanted.

b No, as people would interpret the term differently, depending on whether they wanted or did not want the plant that is growing in a particular place.

8 a i A motor bike is a two-wheeled form of transport that uses petrol.

ii Rollerblades are a form of transport that does not use petrol and that has four wheels all in one row.

b Under the 'Uses petrol' category change the choices to ‘Four wheel’ and ‘Fewer than four wheels’. Then under ‘Fewer than four wheels’ have the choices of ‘Two wheels’ or ‘Three wheels’.

9 Three groups:

• triangles, squares, circles
Two groups:

• spotted, not spotted
• straight sides, curved sides
• right angles, no right angles

10 Footwear, reading material, writing implements

11 a Yellow, green

Fruit, vegetable
Round, long and thin

b, c Colour: only useful if you are looking for different-coloured fruit or vegetables for the diet or the look of a meal.

Fruit/vegetable: tells you something about when they are usually eaten.

Shape: no discernable function.

12 Flow charts: All criteria are seen at a glance. It is easy to trace the path with your finger from one alternative to the next. Take up a lot of space. It is very difficult to lay out a large key.

Table keys: It is more difficult to identify all the criteria used to classify an object—alternatives used have to be read in order. The path from one relevant alternative to the next is not as obvious. They take up less space. Large numbers of alternatives can be accommodated.

13 Possible characteristics are colour, make, number of doors, position of spare wheel, automatic or manual, type of tyres, type of wheels, 2WD or 4WD.

14 a People decide the suburbs they wish to live in and then only have to look at the properties listed for those areas.

b They could be listed by price, number of bedrooms, or real estate agent.

15 a Ability to roll tongue and eye colour are strong characteristics. The other characteristics are weak.

b Ability to roll tongue and eye colour are strong characteristics—they do not change. The other characteristics are weak. People will stop playing soccer or might take up the sport; hair can grow or be cut and hairstyle is easily changed.
16 a  Pink tongue/black and pink tongue; straight hair/curly hair would be best.

b  Pink tongue/black and pink tongue and straight hair/curly hair are characteristics that would not change nor be open to interpretation.

Short hair/long hair is a characteristic of dogs, but there are some that seem to be in between.

Hair hangs over eyes/hair not over eyes is a natural characteristic of dogs but some owners cut the hair from the dogs’ eyes.

Black/brown and large ears/small ears have the potential for different interpretations.

Loud bark/quiet bark, wags tail/does not wag tail are characteristics that could depend on circumstances and may not always be observable.

17 Tabulated answer (see below)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Sporting equipment or venue</td>
<td>Go to 2</td>
</tr>
<tr>
<td>1b</td>
<td>Sport</td>
<td>Go to 6</td>
</tr>
<tr>
<td>2a</td>
<td>Sporting venue</td>
<td>Go to 3</td>
</tr>
<tr>
<td>2b</td>
<td>Sporting equipment</td>
<td>Go to 4</td>
</tr>
<tr>
<td>3a</td>
<td>Venue for squash</td>
<td>Squash court</td>
</tr>
<tr>
<td>3b</td>
<td>Venue for a variety of sports</td>
<td>Playing field</td>
</tr>
<tr>
<td>4a</td>
<td>Ball</td>
<td>Netball</td>
</tr>
<tr>
<td>4b</td>
<td>Racquet or stick</td>
<td>Go to 5</td>
</tr>
<tr>
<td>5a</td>
<td>Racquet</td>
<td>Tennis racquet</td>
</tr>
<tr>
<td>5b</td>
<td>Stick</td>
<td>Hockey stick</td>
</tr>
<tr>
<td>6a</td>
<td>Board game</td>
<td>Chess</td>
</tr>
<tr>
<td>6b</td>
<td>Team game</td>
<td>Go to 7</td>
</tr>
<tr>
<td>7a</td>
<td>Played by kicking a ball</td>
<td>Soccer</td>
</tr>
<tr>
<td>7b</td>
<td>Played by hitting a ball with a bat</td>
<td>Cricket</td>
</tr>
</tbody>
</table>

18 a  It is necessary to look at the internal structure of these fruits to observe characteristics that will give a strong key (see table below)

<p>| | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>A pod containing seeds</td>
<td>Green bean</td>
</tr>
<tr>
<td>1b</td>
<td>Not a pod</td>
<td>Go to 2</td>
</tr>
<tr>
<td>2a</td>
<td>Five pointed star-shaped core</td>
<td>Go to 3</td>
</tr>
<tr>
<td>2b</td>
<td>No such core</td>
<td>Go to 4</td>
</tr>
<tr>
<td>3a</td>
<td>Yellow skin</td>
<td>Yellow apple</td>
</tr>
<tr>
<td>3b</td>
<td>Green skin</td>
<td>Green apple</td>
</tr>
<tr>
<td>4a</td>
<td>Hollow</td>
<td>Capsicum</td>
</tr>
<tr>
<td>4b</td>
<td>Solid flesh inside skin</td>
<td>Banana</td>
</tr>
</tbody>
</table>
b Student answers will vary.

Unit 6.2

1 Five

2 Monera, Protists, Fungi, Plants, Animals

3 Cells

4 Species level

5 Kingdom, phylum, class, order, family, genus, species

6 Binomial nomenclature

7 Both have cells with a distinct nucleus but no cell wall, are multicellular and gain their nutrients by feeding on other organisms.

8 a Plant cells have cell walls, animal cells do not.

   Plants manufacture their own food by photosynthesis, animals feed off other living things.

b Both have cells with a distinct nucleus and a cell wall.

c The cell walls of plants and fungi are chemically different.

   Fungi feed mostly on dead material from other living things, plants manufacture their own food by photosynthesis.

9 Many different names could be used and people could think they are talking about different organisms when they were in fact talking about the same thing. Alternatively they could think they were talking about the same organism when they were in fact talking about totally different species.

   This could be a problem if:

   • the discussion was a warning about poisonous or dangerous species
   • someone was buying plants for the garden or an animal as a pet
   • you were trying to locate a particular species in a zoo.

10 It is multicellular. It does not have chlorophyll.

11 Problem: Some species cause disease.

   Benefit: They are used in the brewing industry and to make bread rise. They are
also used to make cheese, as a source of medicines, and are decomposers that get rid of wastes in the natural environment.

12 a  Two-name naming system

b  All living things that have been described have been given two names. The first part of the name is the genus to which the organism belongs, the second name is the species within that genus.

13 a  *Acacia gunnii* and *Acacia conferta* are the ones most alike.

b  They both belong to the same genus. The other species belong to different genera.

14 *Pan troglodytes*—remove the uppercase T from troglodytes.

*Homo sapiens*—change the h in homo to uppercase and put name into italics.

*Banksia robur*—change the b in banksia to uppercase and the R in Robur to lower case.

15 The macroscopic organism could easily be seen with the naked eye. The microscopic organism could only be seen when it was magnified using a microscope.

16 a  Animal

b  Fungi

c  Monera

17 Both are unicellular and microscopic, although monerans are smaller than protists. Protists have a distinct nucleus but monerans do not.

18 a  A and C will be most alike because they are in the same genus and genus is at a lower level of the system of classification than class and order.

b  If A and C belong to the same genus and B and C belong to the same order, then B and A must also belong to the same order. Order is a higher level in the classification scheme.
Unit 6.3

1 Poriferans, Cnidarians, Echinoderms, Annelids, Nematodes, Platyhelminthes, Molluscs, Arthropods, Chordates

2 Arthropods

3 Cycads, ginkgos, conifers, flowering plants

4 They are both the same level of classification.

5 a An exoskeleton is outside the body; an endoskeleton is inside the body.
   
   b Arthropods, e.g. insects, spiders and crustaceans
   
   c Chordates, e.g. mammals, birds and reptiles

6 Frogs are amphibians and they breathe through their skin as well as through their lungs. The skin must be moist before this can happen. A lizard is a reptile and reptiles only breathe through their lungs, therefore their skin can be dry.
7a, b Diagrammatic answer (see below)

8 Blue whale has a mass of 190,000 kg.

African elephant has a mass of 5000 kg.

Therefore a whale is 38 times as heavy as an elephant (190,000 divided by 5000).

9 Both have a long cylindrical shape that is pointed at the front. Annelids are segmented, nematodes are not.

10 Endothermic is used to describe animals that use heat from inside their body to maintain a constant body temperature. Ecothermic describes animals whose body temperature is affected by the temperature of the environment.

11 a A shark has a skeleton of cartilage and the barramundi has a bony skeleton.

b A lizard is a reptile. Most reptiles lay eggs on land and live all their life on land. They have a dry scaly skin and breathe entirely through lungs.

c Both belong to the class mammals because they have a body covering of hair and feed their young on milk produced by the female. The kangaroo belongs to the subclass marsupial because it gives birth to very immature young that climb into a pouch where they complete their development. The platypus is classified as a monotreme—a mammal that lays eggs.

d Mosses do not have a vascular system for carrying materials around the plant. Ferns have a vascular system.

12 Nematodes are round worms with radial symmetry. Platyhelminthes are flat worms with bilateral symmetry.

13 a Moss

b Cnidarian

c Conifer
14 a Annelid and mollusc

b The top picture is of an organism with a segmented body that has bilateral symmetry. These are the characteristics of annelids.

The lower picture is of an organism with a muscular foot, bilateral symmetry and a shell. These are characteristics of molluscs.

15 Without a skeleton the animals has no support for its body. By living in water, the water supports the body.

16 Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Phylum</th>
<th>Where it lives</th>
<th>Symmetry</th>
<th>Number of body openings</th>
<th>Type of skeleton</th>
<th>Other features</th>
</tr>
</thead>
<tbody>
<tr>
<td>Porifera</td>
<td>Water</td>
<td>Radial</td>
<td>One</td>
<td>None</td>
<td>Body with many holes Filter feeders</td>
</tr>
<tr>
<td>Cnidaria</td>
<td>Water</td>
<td>Radial</td>
<td>One</td>
<td>None</td>
<td>Stinging cells</td>
</tr>
<tr>
<td>Echinodermata</td>
<td>Water</td>
<td>Radial</td>
<td>One</td>
<td>None</td>
<td>Chalky layer under the skin</td>
</tr>
<tr>
<td>Annelids</td>
<td>Water and damp places on land</td>
<td>Bilateral</td>
<td>Two</td>
<td>None</td>
<td>Segmented</td>
</tr>
<tr>
<td>Nematodes</td>
<td>Water, damp soil and parasites</td>
<td>Bilateral</td>
<td>Two</td>
<td>None</td>
<td>Body pointed at both ends</td>
</tr>
<tr>
<td>Platyhelminthes</td>
<td>Water and parasites</td>
<td>Bilateral</td>
<td>Two</td>
<td>None</td>
<td>Flattened body</td>
</tr>
<tr>
<td>Molluscs</td>
<td>Water and on damp places on land</td>
<td>Bilateral</td>
<td>Two</td>
<td>None</td>
<td>Many species have a shell</td>
</tr>
<tr>
<td>Arthropod</td>
<td>Water and on land</td>
<td>Bilateral</td>
<td>Two</td>
<td>External</td>
<td>Segmented</td>
</tr>
<tr>
<td>Chordates</td>
<td>Water and on land</td>
<td>Bilateral</td>
<td>Two</td>
<td>Internal</td>
<td>Nerve cord running down the back</td>
</tr>
</tbody>
</table>

17 Tabulated answer (see below)

1a Animal          Go to 2
1b Plant           Go to 5
2a Chordate        Go to 3
2b Not a chordate  Go to 4
3a Reptile         Snake
3b Mammal          Kangaroo
4a Arthropod       Spider
4b Porifera        Sponge
5a Flowering plant Gum tree
5b Not a flowering plant Go to 6
6a Has a vascular system Fern
6b No vascular system Moss
Diagrammatic answer (see below)

Individual student responses.

Unit 6.4

1 a *Guya* is the name of the group that includes all fish.
   b *Warrakan* includes all land and freshwater animals except snakes, and is subdivided into animals that can fly, walk, crawl or slide.

2 a Plants with woody stems are called *dharpa*.
   b Snakes and lizards are called *bäpi*.

3 It is likely that they would have specific names for the birds very important to them. The others are more likely to be given a collective name.

4 The change in use of the word relates to the place in society of the person and their stage of life. It relates to the use they make of the organisms described as ‘*warrakan*’.

5 In vast areas of Australia the Indigenous people would not have seen snow and therefore would not have a word for it. In the parts of Australia where it does snow, it is most likely that there is a word in the local language for snow, but snow does not last for long and is not as a significant a part of life as it is in Lapland.

6 One group could be trying to tell another group about a poisonous plant or animal and the message might not be understood if the plants and animals had different names.

7 Examples include: types of hot weather such as monsoon rains and the build up
to them; describing types of desert—sand, gibber, stony—and bushfires.

8 Advantage: All groups could communicate more easily to share knowledge about harmful plants and animals, food plants and animals, and plants useful as a source of fibre or medicine.

Disadvantage: Not all plants and animals are found in all parts of Australia. To include all the plants and animals could lead to a classification system that loses its usefulness in specific environments and areas.

9 a It would not be useful.

b The scientific classification would not give Indigenous Australians or any other Indigenous group of people information about the usefulness of organisms in their environment. There is no information about the organism’s usefulness as food, where you would look for it or how you would hunt it.

10 The groups of Indigenous people were often isolated from each other and their languages and understanding of their environments were developed independently. The environments of Australia are diverse. The understandings of these environments are also very diverse.

11 This classification provides information that would help when looking for the animal and then trying to catch it for food.

12 Examples include species of kangaroo, wallaby, koala, wombat, snake and lizard.

13 a Examples include weather (including rain, cloud, wind); soil type and vegetation.

b Student response.

14 a The words that have moved into the English language are the names of Indigenous animals.

Europeans would not have seen these animals before therefore there would not be an English name for them. A version of the local name was used.

b The words that have not been adopted describe the physical environment. They are phenomena that would have an English word to identify them. There was no need to find new names.

15 The fact that it is snowing is clearly visible—it is not information that needs to be shared. The quality of the snow and its impact on activity is information that does
need to be shared.

Chapter review

1 Taxonomist

2 Classification is putting things into groups.

3 Family you belong to, class or year group at school, books in library, goods in supermarket and other shops, videos and DVDs in video shops and music stores.

4 Monera and protists

5 Monera

6 Agnatha, chondrichthyes, osteichthyes

7 Cycads, ginkgos, conifers, flowering plants

8 Linnaeus

9 a Cnidarians

   b Arthropods

   c Molluscs

   d Chordates

10 It is more useful to put similar products together, such as all the vegetables, all the products that have to be kept cold, tinned goods, or cleaning products. Having products in alphabetical order would place cleaning products (polish), goods that should be kept frozen (peas) and dried goods (pasta) together.

11 a Type of clothing—for example, shirts, t-shirts, skirts, trousers.

   Within that they may be sorted by colour and size; male, female, child and baby; and as sportswear, casual wear and work wear.

   b Type of music—jazz, pop; composer; artist’s surname; and solo or group.

12 These are features that can change easily.

13 Organisms are multicellular with eukaryotic cells with cell walls. Some cells contain chlorophyll. It is the combination of all these features that distinguishes plants.

14 Some are plant-like and have cell walls and chlorophyll. Others have no cell wall
and can move independently. Some live in colonies. They are all single-celled eukaryotes and therefore cannot be placed in any other kingdom.

15 Number of legs, antennae or eyes; presence or absence of stripes or spots; colour and size

16 a Kingdom: Animal, phylum: arthropod
    b Kingdom: Animal, phylum: aves (birds)

17 Classification developed by the Yolngu people would be used in their local environment to communicate information about the plants and animals they use on a regular basis. Scientific classification is used to communicate information about living things on a global basis and to identify organisms that have been found.

18 a Plant cells have cell walls, animal cell do not.
    b Monerans are prokaryotic, protists are eukaryotic.
    c Plants contain chlorophyll, fungi do not.

19 The names have only two parts to them. As new species are found they are allocated to a genus and a new, descriptive species name is given. Before the binomial system was used, the names were very long and difficult to remember, and when a new species was described an extra descriptive name was added to the name of a related and previously described species.

20 a Protists
    b Chordate, Mammal, Marsupial
    c Plant, Moss

21 Strong characteristics: felt tip and roller tip; plastic or wood on the outside
   Weak characteristic: thick or thin
   Black or coloured lead is not really strong because a black-coloured pencil could be classified as a pencil.

22 a *Grevillea banksii* and *Grevillea ericifolia*, as both belong to the same genus.
    b *Eucalyptus robusta* and *Eucalyptus banksii*, as both belong to the same genus.
    c There are five species, as all five plants have different binominal names.
    d There are three genera, as there are three different first (genera) names.
23 Tabulated answer (see below)

<table>
<thead>
<tr>
<th></th>
<th>Legs</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>1a</td>
<td>Legs</td>
<td>Go to 3</td>
</tr>
<tr>
<td>1b</td>
<td>No legs</td>
<td>Go to 2</td>
</tr>
<tr>
<td>2a</td>
<td>Antennae</td>
<td>Go to 5</td>
</tr>
<tr>
<td>2b</td>
<td>No antennae</td>
<td>Creature top left (pink)</td>
</tr>
<tr>
<td>3a</td>
<td>Six legs</td>
<td>Creature bottom right (green)</td>
</tr>
<tr>
<td>3b</td>
<td>Fewer than six legs</td>
<td>Go to 4</td>
</tr>
<tr>
<td>4a</td>
<td>Spots</td>
<td>Creature bottom left (blue)</td>
</tr>
<tr>
<td>4b</td>
<td>No spots</td>
<td>Creature bottom middle (purple)</td>
</tr>
<tr>
<td>5a</td>
<td>Teeth</td>
<td>Creature top right (bright orange)</td>
</tr>
<tr>
<td>5b</td>
<td>No teeth</td>
<td>Creature top middle (pale orange)</td>
</tr>
</tbody>
</table>

24 Diagrammatic answer (see below)

---

**Taxonomy** is the science of grouping and naming things.

**Dichotomous keys** are created by taxonomists and are used to identify organisms.

**Classification** is the process of sorting things into groups.

- Animals
- Plants
- Fungi
- Protists
- Monera

Living things are sorted into five kingdoms.

Organisms are then divided into groups in which organisms are more similar: Phylum, Class, Order, Family, Genus, Species.

**Species** is the lowest level of classification.

---

Thinking scientifically

1. D
2. C
3. C
4. D
5. B
Chapter 7: Forces

Unit 7.1

1 a All around us, things move or are in motion.
   b Whenever there is a change in motion, a force has acted.
   c A force can be a push, a pull or a twist.
   d A force can be measured using a spring balance.
   e The unit used to measure force is called the newton.

2 A force can: start something moving, speed it up, stop something, slow it down or change its direction.

3 a False
   b True
   c False
   d False

4 a Sample response: the driving force from the engine of a car as it accelerates speeds an object’s motion.
   b Example response: a tennis ball hit onto the court by a player with a racquet will change direction.

5 The spring on the balance is stretched and the size of a force is measure on a scale.

6 The grocery scales uses a spring that stretches when a mass is placed in the scale. The length of stretch of the spring is converted into the weight of the product being measured. A person standing on bathroom scales compresses the spring in the scales. The decrease in the length of the spring is used as a measure of the person’s weight.
7 a There are two forces acting horizontally: friction and the driving force. There are two forces acting vertically: gravity and the support force of the road.

b The arrows are equal in size because the horizontal forces are equal in size and balanced. The vertical forces are also balanced (although not necessarily the same as the horizontal forces).

8 Airbags cushion the head in a collision.

Anti-lock brakes enable the driver to steer the car while braking heavily.

Reversing sensors provide the driver with warning beeps to alert that they are close to another object while reversing.

Electronic stability control helps the driver regain control of the car when it is skidding and swerving.

Seatbelts restrain the passengers and driver to limit their forward motion in a collision and prevent them from being thrown through the windscreen.

9 Cars have crumple zones so that these panels absorb some of the force of the collision while the occupants inside the passenger shell of the car are (hopefully) protected.

10 Tabulated answer (see below)

<table>
<thead>
<tr>
<th>Force to left (N)</th>
<th>Force to right (N)</th>
<th>Force upwards (N)</th>
<th>Force downwards (N)</th>
<th>Direction object will move</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>10</td>
<td>10</td>
<td>0</td>
<td>Up</td>
</tr>
<tr>
<td>20</td>
<td>30</td>
<td>0</td>
<td>0</td>
<td>Right</td>
</tr>
<tr>
<td>25</td>
<td>5</td>
<td>15</td>
<td>15</td>
<td>Left</td>
</tr>
<tr>
<td>30</td>
<td>30</td>
<td>10</td>
<td>50</td>
<td>Down</td>
</tr>
<tr>
<td>40</td>
<td>40</td>
<td>100</td>
<td>100</td>
<td>None</td>
</tr>
</tbody>
</table>
11 Diagrammatic answer (see below)

12 a  Mien was travelling forwards before he hit the stone. Due to his inertia, his body continues to travel forwards, even after his foot is stopped by the stone. As a result, he falls forwards onto the footpath.

b  All of the items inside Madeline’s car (including Madeline) are travelling forwards at a reasonable speed. When she suddenly brakes, the car slows down, but due to their inertia, all of the contents of the car continue to travel forwards. This includes the plates that were resting on the back seat, which fall forwards onto the floor.

c  While the train is stationary, Carl is stationary. When it moves forward, his body resists moving due to his inertia. As a result, he falls back as the train moves beneath him.

13 a  Push force

b  Pull force

c  Push force

d  Push force

e  Twist force

f  Push force

g  Pull force
14 a  
   i  D  
   ii B and C  
   iii A and D  

   b The object would move to the right, as force B is larger than force E.

15 a  Diagrammatic answer (see below)

   b According to inertia, the yo-yo has a tendency to continue in its state of motion. This motion is at right angles to the yo-yo string. So, if the string breaks, the yo-yo would continue to move in a straight line path.

Unit 7.2

1 Student answers will vary but may include: pick up a glass, walk around, play tennis, turn a page in a book, use brakes on a bike.

2 a Your shoe and the football  
   b Your body and the water  
   c Your shoes and the footpath  
   d The tyres of the car and the road (also some friction between the people’s
3  a  False
   b  False
   c  False

4 Friction exists because tiny bumps on the surfaces of materials get caught on each other as they slide over one another, slowing the movement down and producing heat.

5 Traction is the grip, or hold on a surface. Without friction your fingers would not be able to grip the apple. It would simply slip through your hands.

6 Friction between moving parts in the car engine produce a large amount of heat. Fluid in the car radiator absorbs heat from the engine so that the car can operate.

7 The full toy chest pushes down harder on the ground, increasing friction and making it more difficult to slide the chest over the floor.

8 Ball bearings inserted in the hub of a wheel reduce friction and allow the wheel to roll more freely over the axle.

9 Student answers will vary. Examples include:
   • Use a trolley with wheels to reduce friction.
   • Slide the refrigerator onto a mat and pull it across the floor.
   • Tilt the refrigerator and put rollers underneath it. Push the refrigerator along on the rollers. Reinsert the rollers as necessary.

10 A mountain bike travels over more dirt tracks and roads and so requires greater traction. Friction between the tyres and the ground increases with weight, so a heavier bike will provide greater traction and prevent slipping. A road bike is ridden on sealed roads or paths and the extra traction required for more rugged tracks is not needed. Riders aim to ride faster and can do this better with a lighter weight bike.

11 a  There is little friction between the ice and the blade of the skate. There would be much greater friction between feet and a footpath.
   b  Sliding across the surface of the ice, turning without lifting a foot and rapid spins would not be possible without the low level of friction found on the ice.
c Because only a small surface area of the skate is in contact with the ice, the amount of friction is further reduced.

12 From those experiencing greatest to the least friction:

- A couch being dragged across carpet
- A child’s tricycle being pulled along the footpath
- A waxed pair of skis travelling on snow
- An ice-hockey puck hit across the ice

13 a Friction exists as air resistance between the vehicle and the air flowing over and around it, and between the tyres and the road.

b These friction forces act to the left on the diagram, to oppose motion of the minibus.

c To maintain a constant speed, the driver must continue to provide a driving force by pressing on the accelerator pedal.

d i The friction would decrease.

ii The surfboard on the roof made the minibus less streamlined. This means that the air resistance from air rushing over this would increase the total amount of friction acting on the minibus.

e Tyres not properly inflated will be in greater contact with the road surface and increase the friction between the tyres and the road.

14 The moving parts of the mixer rub against each other as it operates, producing heat due to friction.

15 a Weightlifters use this chalk to absorb perspiration from their hands. This perspiration, if present, would reduce the friction between the weightlifter’s hands and the bar being lifted. The weightlifter will not have good grip and the bar could slip.

b If too much chalk is used, the powder will act as a lubricant and reduce the grip the weightlifter has on the bar.

16 Individual student response. For example, students could mention that clothes slip through their fingers, food slides around inside their mouths, they slip as they try to walk, etc.
Unit 7.3

1  a  Gravity is a **non-contact** force.
    
    b  Gravity **pulls** objects towards the Earth.
    
    c  All objects naturally **attract** each other.
    
    d  Objects fall at different speeds due to their **surface area**.

2  Kilogram (kg)

3  Newton (N)

4  Air resistance

5  a  Air flows more quickly over the top surface of an aircraft wing.
    
    b  This creates a lift force.

6  a  It experiences a gravitational force that acts towards the Earth.
    
    b  As an object moves further away from Earth, the strength of the Earth’s gravitational field decreases.
    
    c  The force of gravity is applied to objects that are located within a gravitational field. It is called a non-contact force because this force acts from a distance without direct contact with the object.

7  Individual student responses, for example:

   •  High jumpers and pole-vaulters must launch themselves upwards, against the force of gravity.

   •  Cyclists in a road race and marathon and cross-country runners need to exert greater effort to climb a hill because they are working against the force of gravity.

   •  Divers and skydivers rely upon the force of gravity to pull them towards Earth as they complete their dives.

8  Individual student responses, for example in assisting the athlete to:

   •  throw baseballs, cricket balls or basketballs with correct curve or spin

   •  hit a ball with a cricket bat, billiard cue, tennis racquet or baseball bat in the desired manner
• control their use of the wind while sailing
• keep their centre of gravity as low as possible to keep their balance when competing in various sports
• dive into a pool efficiently
• swim with an efficient stroke
• throw a javelin correctly
• adjust a tennis racquet to best suit the player

9 A sports scientist applies scientific ideas and techniques to improve an athlete’s performance.

10 a Air friction (or air resistance) and the weight force
b As soon as the skydiver jumps from the aircraft, their weight force is larger than the force of air friction. The size of air friction increases as their speed increases, so this force increases as the skydiver falls. Just after jumping, however, the skydiver accelerates towards the ground.
c When the forces of air friction and weight are balanced, the skydiver falls at a constant speed. This is called terminal velocity.

11 a The force of thrust is greater than the force of drag.
b Its drag force is greater than its thrust force.
c The forces of thrust and drag are balanced.

12 Mass is the amount of matter in a substance. It is measured in kilograms and is the same, no matter where we are. Weight is the force pulling us towards Earth. Its size depends upon our mass and also the strength of gravity where we are. Weight is measured in newtons and will change as we travel from Earth to the Moon, or to any other planet, due to the differences in their gravitational field strengths.

13 If air resistance is not considered, then all three balls will all fall at the same rate.

14 Gravity is a force of attraction existing between any two objects. The strength of this attractive force increases with mass. As the Moon has a large mass, its force of gravity pulls surrounding objects towards it. This force is just the same as the gravitational force that pulls us towards the Earth, except that it has about one-sixth the strength of gravity on Earth, due to the smaller size of the Moon.
15 a A person's mass would change as they grow from being a baby, to a child, to an adult; if they gain or lose weight; if they have a baby; if they lose a limb or have internal tissue removed in surgery.

b If a person were to travel to the Moon (or one of the other planets), their weight would change due to the difference in the gravitational field strength on the Moon, but their mass stays the same.

16 a The small rock will hit the ground first.

b The force of gravity acts equally on the leaf and the small rock. However, the shape of the leaf means it will catch more air as it falls. A larger force of air resistance opposes the motion of the leaf and it will fall more slowly than the rock as a result.

c On the Moon there is no atmosphere, so Min-Jee would find that the leaf and small rock would hit the ground at the same time.

17 a The aircraft would not take off.

b If the wings of an aircraft were attached upside down, the air would flow faster under the wing than over it. This would create a force pushing the wing downwards, instead of upwards. This downwards force would add to the weight force acting downwards on the aircraft. There would be no lift force and aircraft would not take off because all the forces are pushing the aircraft down.

18 Individual student response in which an argument is made to oppose Aristotle’s view that heavy objects contain more gravity than light objects. For example, two balls of the same size, one made of chalk and the other made of iron will fall at the same rate because they have the same surface area.

19 Individual student response of a diagram showing three objects being repelled by the Earth rather than falling towards it.

Unit 7.4

1 a A magnetic force is a **non-contact** force.

b As you get closer to a magnet, the size of the magnetic force **increases**.

c A north pole of one magnet is attracted to the **south** pole of another magnet.
d A magnet is **strongest** at its poles.

2 Student responses will vary. Examples are: on the refrigerator, in the letterbox as advertising, as construction toys, in toy train sets, as a knife holder.

3 a A proton  
b An electron

4 It becomes positively charged.

5 Oersted noticed that a compass needle moved when he turned an electric current on in a nearby wire.

6 Steel consists mainly of iron, which is attracted to a magnet, so the steel ball will be attracted.

7 a attract  
b attract  
c attract  
d repel

8 a A compass at point X would point left.  
b The nail will be attracted with greatest force at point X, because it is closest to a pole.  
c The magnetic field is strongest at point X.  
d The field lines are closest together at this point.

9 a B is positively charged.  
b C is negatively charged.  
c A is neutral.

10 a The hundreds and thousands slide over the walls of the plastic container to build up charge.  
b The body of the car is charged as it moves through air.  
c The clothes rub against each other to build up charge.

11 a If the bar and horseshoe magnet first shown attract, then A must be a north pole and B is a south pole. This means combination A will repel and combination B will attract.
b As A and B are unlike poles they must attract each other, so no additional information was required for this part of the question.

12 a Electrical conductor  
b Electrical insulator  
c Electrical insulator  
d Electrical insulator  
e Electrical conductor  
f Electrical insulator

13 Nylon fibres rubbing against the air can gain electrons from the air and build up a negative charge. The crackle heard is the sound of electrons jumping off the nylon as it is discharged.

14 A stray spark in an area such as a petrol station, where there is highly flammable fuel, could be deadly.

15 a Julia’s feet rubbing against the carpet have gained electrons. They have built up a static charge. This is discharged through Julia’s body when she touches a metallic banister, as the extra electrons jump onto it as a spark.

b If Julia is very worried, she could wear shoes that have some metal on their sole to disperse any charge as it is collected, otherwise the banister could be covered with a non-conducting material.

16 a Diagrammatic answer (see below)

b Diagrammatic answer (see below)

Chapter review

1 a True
b  False

c  False

d  False

e  False

f  True

g  False

h  True

2 Many possible responses. For example: pushing a shopping trolley, pushing a pram, pushing a child on a swing, pushing a revolving door

3 Ice has little friction

4 Nickel, cobalt and iron are attracted to magnets.

5 An electromagnet is a temporary magnet.

6 A contact force touches the object it acts upon; for example, friction between a skateboard wheel and the footpath. A non-contact force acts from a distance and does not touch the object it acts upon; for example, an iron nail attracted by a magnetic force.

7 As the wet lettuce spins in the salad spinner, its inertia resists the continual change in direction and keeps the lettuce pressed to the outside of the meshed insert. The water on the leaves is also pushed in this direction, but can pass through the meshed insert to collect in the outer container.

8 If air flows more rapidly over a surface, such as the top of an aircraft wing, than the air that flows beneath it, it produces an area of lower pressure. The surrounding air pushes towards this region of lower air pressure, pushing the wing upwards (a lift force). This is called the Bernoulli effect.

9 Dropping a magnet may result in knocking the magnetic domains out of alignment, and the magnet losing its magnetism.

10 Your hair will become positively charged.

11 If you rub a CD with a cloth to clean it, you have built up a static charge. The charged CD will attract small, neutral particles in the air, such as dust.

12 a  Not at all
b) Moves left

c) Moves down

d) Moves right

13 a) Old tyres on wet, smooth asphalt have the longest braking distance.
b) Old tyres have little tread. On a smooth, wet road, they will not effectively remove water from beneath them and not provide sufficient traction to stop quickly.
c) New and old tyres vary greatly in wet weather conditions.
d) Old tyres vary the most in braking distance.
e) Old tyres will have less tread than new tyres and do not have as much traction with the road surface.

14 a) The boat is moving forwards.
b) As more fish are caught in the net, the size of the drag force will increase and the speed of the boat will decrease.
c) If the speed of the boat is constant, the thrust and drag forces acting on it are equal.

15 a) The coin will travel further along the stone bench than on the sand.
b) There is less friction between the smooth surface of the benchtop and the coin and it is friction that slows the motion of the coin.

16 The block that would move with the least friction would be block B (on rollers) and that which moves with the most friction is block A.

17 a) Coil C
b) Given that these were all made from the same type of wire, the wire with the most coils will produce the stronger electromagnet. This is coil B or coil C. Coil C also has an iron insert in its core, which means it will produce a stronger magnetic field than coil B when connected to a power supply.
Thinking scientifically

1 A
2 C
3 D
4 D
Chapter 8: Machines

Unit 8.1

1 Machines can make a task easier by:
   • changing the size of a force
   • changing the direction of a force or
   • making something speed up.

2 Force is measured in newtons (N).

3 a True
   b False
   c True
   d True

4 Third-class lever

5 The mechanical advantage of a lever can be calculated as

\[
\frac{\text{distance from effort to fulcrum}}{\text{distance from load to fulcrum}} \quad \text{or} \quad \frac{\text{load}}{\text{effort}}
\]

6 a Although a greater effort force is needed, a third-class lever provides a wide arc of movement and speed. This is useful for sports using a racquet or bat, or when throwing or kicking a ball.

   b Tossing the ball into the air and reaching upwards to hit it provides the maximum length of the lever used to hit it, and produces the greatest possible speed of the ball when hit.

7 Lengthening the arms of the nutcracker will extend the length of its levers and enable it to provide more force.
8 a  An axe changes the direction of a force.
   b  The crowbar changes the size of a force.
   c  A hand-drill speeds something up.

9 a  The load is the lid.
   b  The effort is supplied by Ping as he tries to remove the lid.
   c  The fulcrum is the position where the chisel pivots on the edge of the paint tin.

10 a  Second-class lever
   b  Third-class lever
   c  First-class lever

11 a  Force = \( \frac{900}{10} = 90 \text{ N} \)
   b  This force advantage occurs because when the machine is used, the effort will travel through a greater distance than the load.

12 a  Mechanical advantage

   \[
   \text{Mechanical advantage} = \frac{\text{distance from effort to fulcrum}}{\text{distance from load to fulcrum}}
   \]

   \[
   = \frac{15}{5} = 3
   \]

   b  Mechanical advantage

   \[
   \text{Mechanical advantage} = \frac{\text{distance from effort to fulcrum}}{\text{distance from load to fulcrum}}
   \]

   \[
   = \frac{8}{2} = 4
   \]

   c  Mechanical advantage

   \[
   \text{Mechanical advantage} = \frac{\text{distance from effort to fulcrum}}{\text{distance from load to fulcrum}}
   \]

   \[
   = \frac{80}{40} = 2
   \]
13 a  First-class lever
    b  Third-class lever
    c  Second-class lever
    d  Third-class lever

14 a  Diagrammatic answer (see below)

b  The shovel acts as a third-class lever.
   The fishing rod acts as a third-class lever.
   The pliers act as a first-class lever.

c  The pliers are a force multiplier, and the shovel and fishing rods used in this way are speed multipliers.

15 a  Mechanical advantage

\[
\text{Mechanical advantage} = \frac{\text{distance from effort to fulcrum}}{\text{distance from load to fulcrum}}
\]

\[
= \frac{3}{12} = \frac{1}{4}
\]

This means that the lever used in this way does not provide a force advantage. The effort needed to lift the load is four times the load force

\[
= 4 \times 600 = 2400 \text{ N.}
\]

b  Mechanical advantage

\[
= \frac{12}{3} = 4
\]

The lever is now an effective force multiplier. Only one-quarter of the load
force must be supplied to lift it:

\[ \text{Effort} = \frac{600}{4} = 150 \text{ N} \]

16 a Zuzu has a greater mass than Keung, so if both boys each sit on the end of the see-saw, it will not be balanced. A lever such as a see-saw has greater mechanical advantage if the effort is positioned further from the fulcrum. As a result, Keung should sit right at one end of the see-saw, gaining maximum mechanical advantage, and Zuzu should gradually move closer to the fulcrum until they are balanced.

b The principle of levers states that:

\[ \text{Effort} \times \text{distance (of effort to fulcrum)} \]
\[ = \text{load} \times \text{distance (load to fulcrum)} \]
\[ 35 \times 1 = 50 \times d \]

so \[ d = \frac{35}{50} = 0.7 \]

Keung should sit 0.7 m from the pivot (fulcrum).

17 a Your hand moves through a greater arc of distance when opening with handle X than when using handle Y.

b Because it moves through a greater distance, it is easy to open the cupboard door using handle X with little force. Handle Y moves through a small distance, requiring a large force, which is quite awkward.

c Handle X is in the correct position.

Unit 8.2

1 Various answers possible; for example: entering a library, shopping centre, railway station.

2 Various answers possible; for example: a knife, an axe, a doorstop.

3 a Wedge

b Screw

4 a True
b False

c False

d True

5 Various answers possible; for example:

a wood screw

b boat propeller

c aircraft propeller

6 Stone implements such as chisels, axes, saws, knives and the spear tips can be produced by flaking.

7 A spear thrower is also called a woomera in some regions of Australia.

8 a To reach the top of the dam wall, a person can either use a greater effort force to climb the wall vertically, or a smaller effort force to climb the stairs.

b This person can apply a large effort force over a shorter distance to climb the wall vertically, or they can apply a smaller effort force over a greater distance when using the stairs.

9 A screw provides a force advantage because force is applied over a greater distance along the spiral inclined plane.

10 A stone to be flaked is struck with another stone (called a hammerstone), to flake off sections of stone.

11 Stone rich in silica is hard but brittle, making it suitable to be flaked off, but also strong when used in a tool.

12 A spear thrower or woomera hooks into one end of the spear. When the spear is thrown, this acts as an extension of the thrower's arm and allows the force to be applied to the spear for a greater length of time. As a result, the spear is launched at a greater speed and travels further.

13 a Screw

b Wedge

c Screw

d Inclined plane

e Wedge
Inclined plane

14 Mechanical advantage

\[
\text{Mechanical advantage} = \frac{\text{load}}{\text{effort}} = \frac{100}{20} = 5
\]

15 Mechanical advantage

\[
\text{Mechanical advantage} = \frac{\text{length of slope}}{\text{height of slope}}
\]

<table>
<thead>
<tr>
<th>Length of slope (m)</th>
<th>Height of ramp (m)</th>
<th>Mechanical advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>15</td>
<td>3</td>
<td>(\frac{15}{3} = 5)</td>
</tr>
<tr>
<td>50</td>
<td>25</td>
<td>(\frac{50}{25} = 2)</td>
</tr>
<tr>
<td>12</td>
<td>2</td>
<td>(\frac{12}{2} = 6)</td>
</tr>
<tr>
<td>20</td>
<td>5</td>
<td>(\frac{20}{5} = 4)</td>
</tr>
<tr>
<td>240</td>
<td>30</td>
<td>(\frac{240}{30} = 8)</td>
</tr>
</tbody>
</table>

16 a Mechanical advantage of first ramp

\[
\text{Mechanical advantage of first ramp} = \frac{\text{length of slope}}{\text{height of slope}} = \frac{20}{4} = 5
\]

Mechanical advantage of second ramp

\[
\text{Mechanical advantage of second ramp} = \frac{\text{length of slope}}{\text{height of slope}} = \frac{8}{4} = 2
\]
The first ramp provides a mechanical advantage of 5, so the effort force needed is one-fifth of the load force

\[ \frac{500}{5} = 100 \text{ N}. \]

The second ramp provides a mechanical advantage of 2, so the effort force needed is one-half of the load force

\[ \frac{500}{2} = 250 \text{ N}. \]

17 A blunt nail is a less effective wedge and has less chance of splitting the wood than a sharp nail.

18 In order to complete the job with the removalists not using more than 200 N of effort force, the ramp must have:

Mechanical advantage

\[ \frac{\text{load}}{\text{effort}} = \frac{10000}{200} = 50 \]

The mechanical advantage of a ramp

\[ \frac{\text{length of slope}}{\text{height of slope}} \]

The height of the ramp is 1 m. This means that the ramp must have a length of 50 m in order to produce the required mechanical advantage of 50.

Unit 8.3

1 a The fulcrum is located at B.

b The lever arm is 45 cm long.

2 The rim

3 Various answers are possible; for example, a steering wheel and a tap.

4 Various answers are possible; for example, a fan and the wheel of a car.

5 Various answers are possible.

a For example, in an eggbeater
b For example, in a violin

c For example, a car steering assembly

6  a The turning force a driver applies to a steering wheel is multiplied at its axle, enabling the vehicle to turn.

b The turning force applied to a screwdriver is multiplied at its centre, enabling its user to apply greater force to a screw being used.

c The turning force applied to the sardine lid handle is multiplied at its centre, enabling it to tear the tin away so that it can be rolled back.

7  a A block and tackle is a combination of a number of pulleys that are used together.

b A block and tackle is used to lift heavy objects.

8 A single pulley can only change the direction in which a force acts. A pulley system, consisting of more than one pulley, obtains a force advantage because it allows a smaller pulling force to be applied through a longer distance. The greater the force advantage supplied, the greater the length of cable is pulled through the system.

9 Student answers will vary.

10 a Gear ratio

\[
\text{Gear ratio} = \frac{\text{number of teeth on driving gear}}{\text{number of teeth on driven gear}} = \frac{25}{10} = 2.5
\]

b This gear combination would be useful when coasting along an easy, flat road.

11 a Ten (One pulley here is not part of the system.)

b It should be 10 times easier to lift using this arrangement. (Ignoring the effect of friction.)
13 a  Mechanical advantage

\[ \text{Mechanical advantage} = \frac{\text{load}}{\text{effort}} = \frac{600}{150} = 4 \]

Hence, the farmer must be using four pulleys in the system.

b  The farmer must pull the rope four times further than that if he was using a single pulley.
Chapter review

1 A wedge

2 Mechanical advantage = \frac{\text{load}}{\text{effort}}

3 a i Third-class lever
   ii Second-class lever
   iii Second-class lever
   iv Third-class lever
   v First-class lever

b Force multipliers are ii, iii and v. Speed multipliers are i and iv.

4 a False. A steeper ramp provides less mechanical advantage than a ramp with a gentle slope.

b False. A pair of tongs acts as a third-class lever.

c False. Two interconnected gears rotate in opposite directions.

d False. When a driving gear is smaller than the driven gear, the driven gear rotates slower than the driving gear.

5 Mechanical advantage is a measure of how much easier a machine can make a task. It is the load force divided by the effort force.

6 A person’s speed will depend not only upon how fast they pedal, but also on the gear combination selected. A person riding a bike in a low gear can pedal more slowly but supply greater force to the rear wheel than pedalling faster in a higher gear.

7 Viewed from above, the length of the tap handle that extends from its centre is the length of the lever arm of the tap. The longer this distance, the greater the force applied to the handle is multiplied onto the central spindle. The handle is required to multiply the force we can apply to the spindle, which would otherwise be extremely difficult to turn.
8 a  Mechanical advantage

\[ \text{Mechanical advantage} = \frac{\text{distance from effort to fulcrum}}{\text{distance from load to fulcrum}} \]

\[ = \frac{1.5}{0.5} = 3 \]

b  Mechanical advantage

\[ \text{Mechanical advantage} = \frac{\text{distance from effort to fulcrum}}{\text{distance from load to fulcrum}} \]

\[ = \frac{1.2}{0.05} = 24 \]

9 a  The gear ratio

\[ \text{The gear ratio} = \frac{\text{number of teeth on driving gear}}{\text{number of teeth on driven gear}} \]

\[ = \frac{25}{75} = \frac{1}{3} \]

b  It is a force multiplier.

10 a  By the principle of levers:

\[ \text{Effort} \times \text{distance (of effort to fulcrum)} = \text{load} \times \text{distance (load to fulcrum)} \]

Using masses in grams and distances in cm:

\[ 25 \times \text{distance (of effort to fulcrum)} = 10 \times 10 = 100 \]

So that the distance from effort to fulcrum = 4 cm

The 25 g mass should be placed 4 cm to the right of the fulcrum to balance the 10 g mass on the other side.

b  By the principle of levers:

\[ \text{Effort} \times \text{distance (of effort to fulcrum)} = \text{load} \times \text{distance (load to fulcrum)} \]

Using masses in grams and distances in cm:

\[ 25 \times \text{distance (of effort to fulcrum)} = 100 \times 2 = 200 \]
So that the distance from effort to fulcrum = \( \frac{200}{25} = 8 \text{ cm} \)

The 25 g mass should now be placed 8 cm to the right of the fulcrum to balance the 100 g mass on the other side.

11 a  Gear 2 will turn anticlockwise, gear 3 will turn anticlockwise and gear 4 will turn clockwise.

b  Gear 1 will turn faster because it has fewer teeth.

12 a  The drive shaft will turn faster than the motor.

b  The speed of the motor will be the same as the speed of the small pulley Z. This will cause large pulley 3 to rotate more slowly. This means the drive shaft will turn more slowly than the motor.

13 a  Welding car bodies together is a repetitive task that requires precision. Robots don’t tire, and are cheaper than people.

b  It is a task that is dangerous for humans to do.

14 a  Using five pulleys will \( \frac{400}{5} \) reduce the effort required by a factor of 5:

\[
\text{effort force required} = 80 \text{ N}
\]

b  Some additional effort force would be required to overcome energy losses due to friction.

15 The driving gear must be larger than the driven gear in order for the driven gear, onto which the propeller is attached, to spin faster. This gear combination is a speed multiplier.
Diagrammatic answer (see below).

A simple machine makes a task easier by acting as a force multiplier or a speed multiplier. This provides a mechanical advantage.

Simple machines are:
- Inclined planes
- Levers
- Wheels (a type of lever)
- Gears

Thinking scientifically

1. D
2. B
3. C
Chapter 9: Earth in space

Unit 9.1

1. It is the nuclear fusion reaction.

2. a. The Sun
   
   b. It takes about 8 minutes.

3. It is called the Milky Way.

4. a. About 2000 stars are visible to the naked eye.
   
   b. Factors include: the weather, city lights, the Moon’s light, time of night.

5. a. The Southern Cross can only be seen in the southern hemisphere.
   
   b. Polaris can only be seen in the northern hemisphere.

6. a. Mercury, Venus, Earth, Mars
   
   b. Jupiter, Saturn, Neptune, Uranus
   
   c. Pluto, Haumea, Eris, Makemake, Ceres

7. Most likely to least likely: star, planet, meteors, satellites and space junk, comets

8. Planets are sometimes mistaken for stars because they too appear as points of light in the night sky.

9. Pluto doesn’t have enough mass or gravity to clear its neighbourhood of dust and rocks.

10. a. A planet is a relatively small object that can be made of rock or gas; a star is a massive ball of burning hydrogen gas.
   
   b. A planet reflects light from the star it orbits; a star produces its own light.
   
   c. Planets are smaller than stars.
   
   d. Planets will orbit stars; stars never orbit planets.
b Astrology is a belief system with no basis in scientific evidence; astronomy is the scientific study of the universe, its stars, planets, constellations, comets and asteroids.

11 a Student responses will vary.

b Student responses will vary.

12 Mars is a solid, rocky (terrestrial) planet and so it can support an astronaut on its surface. In contrast, Jupiter is a gas giant. It has no solid surface and so it would be unlikely to support an astronaut on it.

13 Diagrammatic answer similar to Figure 9.1.3 is required.

14 Student responses will vary.

15 Diagrammatic answer required. The name of the constellation should spring logically from the diagram.

Unit 9.2

1 Everything around you exerts a weak gravitational pull including pens, textbooks, desks, books, other people.

2 The Earth is currently exerting a strong gravitational pull.

3 a Natural satellites of the Sun are Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune, the dwarf planets and comets.

b The only natural satellite of Earth is the Moon.

c Artificial satellites of Earth include communication satellites, the Hubble Space Telescope, the International Space Station (ISS) and space junk.

4 Highest gravity to lowest gravity: D (Lake Eyre), C (Bells Beach), B (Q1 tower), A (Mt Kosciuszko)

5 There will be two high tides and two low tides.

6 a The heliocentric model

b The geocentric model.

7 A scientific model must be simple and explain all the evidence available at the time.
8 A wall does not have a lot of mass and so the gravitational attraction between you and it is small, far too small to pull you towards it.

9 The times for high and low tides differ around Australia because Australia’s coastline covers hundreds of kilometres east to west.

10 The orbits of the planets are all in the same plane, but the orbits of Pluto and the comets are in different planes set at an angle to the other orbits. Pluto and the comets also have highly elliptical orbits.

11 A satellite is in continual free-fall and so does not need to be powered to keep it in orbit.

12 Complex modifications were required to make the geocentric model explain the observed motions of the planets. The heliocentric model did not need these complex modifications and so was adopted as the most logical explanation of planetary movements.

13 Spring tides produce greater changes in sea levels than neap tides. This is because the Sun and Moon are both pulling in the same direction. Neap tides are caused by the Sun and Moon pulling perpendicular to each other. Refer to Figure 9.2.3 for a diagram explaining how.

14 Diagram should be similar to Figure 9.2.16.

15 The solar system is shown as geocentric because Earth is at its centre.

16 A natural satellite is an object such as the Moon orbiting the Earth or a planet that is orbiting the Sun. An artificial satellite is a satellite that was placed in orbit by humans, usually around Earth (e.g. a communications satellite).

17 The bullet would go into orbit and travel around Earth, returning to its starting point. Hence you would accidentally shoot yourself.

18 Although half the Moon is visible, it occurs a quarter of the way through the orbit around Earth.

**Unit 9.3**

1 D

2 A year = 365.25 days
   A ‘normal’ calendar = 365 days
A leap year = 366 days

3 a 1 day is the time taken for a planet to rotate on its own axis (for Earth 24 hours).

b 1 year is the time taken for a planet to revolve once around the Sun (for Earth 365.25 days).

c 1 revolution = 1 complete orbit

4 If the calendar year was taken as 365¼ days, then each year would start 6 hours later than the previous one. This would make every fourth year ‘out’ by one day.

5 The tropics are found near the equator because that is where sunlight falls more directly, concentrating its light and heat. Hence the climate there is hot throughout the year.

6 a There are two equinoxes each year.

b One equinox occurs in autumn and the other in spring.

7 Diagrammatic answer similar to Figure 9.3.2 is required.

8 They were born on 29 February (a leap year and hence only occurring every fourth year).

9 a The equator is moving the fastest. This is because the distance from the axis (the Earth’s radius) is greatest.

b The north and south poles are just turning on the spot.

10 a 1896 = leap year

b 1900 = normal year

c 2225 = normal year

d 2400 = leap year

11 a Summer = C

b Winter = B

c Sun doesn’t set = D

d Sun never appears = A
12 a In Australia:
   i  21 March = autumn
   ii 30 June = winter
   iii 1 January = summer
   iv 25 April = autumn

b In northern hemisphere:
   i  21 March = spring
   ii 30 June = summer
   iii 1 January = winter
   iv 25 April = spring

13 a One quarter of a day = 6 hours
   
   b i  At 6 a.m.
   ii  At noon.

   c Four years would pass.

   d If the year was taken as 365\(\frac{1}{4}\) days, each new year would start 6 hours later than the previous year. It would start at midnight only every 4 years.

14 In eastern China, the Sun would rise and set at earlier times than in the west.

15 Russia is a huge country and spreads a long way from east to west. In summer, the Sun would be rising in the east at about the same time as it was setting in the west of the country. To account for such a wide spread of sunrise and sunset times, 11 time zones are needed.

16 Angled torch covers a greater area than the direct torch.

17 a 1500, 1700, 1800, 1900, 2100, 2200, 2300 and 2500 are normal years; 1600, 2000 and 2400 are leap years.
   
   b The length of a year is a little less than 365\(\frac{1}{4}\) days long.

18 a At 0° tilt there would be no seasons.
   
   b At 45° tilt, the seasons would be more intense (i.e. hotter and longer days, colder and shorter days) than now.
At 10° tilt (i.e. less than now), the seasons would be milder than they are now.

19 Students write a creative story.

Unit 9.4

1 SSSB = small solar system bodies

2 Comets brighten and then fade over a period of time. They have a coma and a tail and reappear periodically.

3 Diagrammatic answer required, similar to Figure 9.4.3.

4 A comet’s tail is produced by the solar wind that streams out from the Sun. This pushes the tail in the same direction as the solar wind, hence the tail always points away from the Sun.

5 When the Earth passes through the tail of a comet, particles from the tail enter the Earth’s atmosphere and produce a meteor shower.

6 Although a meteor might look like a star shooting across the sky, it is very different from a star:
   • A meteor is a rock; a star is a ball of burning gas.
   • A meteor gives off light because friction between the rock and the Earth’s atmosphere causes it to burn up, producing heat and light. A star gives off light because of nuclear fusion reactions that produce heat and light.
   • Meteors are relatively small but stars are massive.

7 It has an orbital period of 40 months.

8 The next three sightings of Halley’s Comet will be in 2062, 2138, 2214.

9 An asteroid is an irregular rocky object but a comet is a ‘dirty snowball’ of ice, carbon dioxide and other carbon-based molecules.

10 A comet’s tail is produced when the icy surface of a comet vaporises. Since asteroids and meteors are made of rocky material, their surfaces cannot vaporise to form a tail.

11 a Halley’s Comet was seen in 88 BCE, 12 BCE, 64 CE.
It is very unlikely that Halley’s Comet was the ‘Star in the East’ because none of the dates of Halley’s comet coincide with the date thought to be the birth date of Jesus.

Students will give various arguments. These are some of the most likely ones in support of the research:

• The devastation that a strike by a large meteor, asteroid or comet would be so huge that many life forms (including humans) may be killed off, leading to their extinction.

• A 10% chance is relatively high, far higher than the chances of, for example, aircraft accidents, drowning, all risks which society takes action to prevent.

• If the cost was shared by all countries, the cost per person would be relatively small.

• The investment would create jobs.

Some likely arguments against such research:

• A 10% chance means that it is more likely that it won’t happen.

• The cost would be borne by the ‘wealthy’ countries and not by everyone.

• The new technologies could be used in warfare instead of a protective role.

Various answers possible, depending on the reasons given by the students to part a.

Diagrammatic answer (poster) required.

Chapter review

1 a False: All objects have a gravitational field, but planets, stars and moons have a much greater mass and hence a much larger gravitational field than you or the objects around you.

b True

c False: A day on Earth is the time it takes for Earth to rotate once around its own axis.

d True
e  True
f  False: Pluto is a dwarf planet.

2 a  The terrestrial planets are Mercury, Venus, Earth, Mars.
     b  The gas giants are Jupiter, Saturn, Neptune, Uranus.

3  The Sun and the Moon both affect the tides.

4  Since different cultures use different tools and have different histories and stories,
    they will recognise different objects when they look at a group of stars.

5  An ellipse is an oval or slightly flattened circle.

6  Some light from the Sun is bent by the Earth’s atmosphere during an eclipse,
    allowing some light to fall on the Moon. This makes it slightly visible.

7  The Earth experiences seasons because it is tilted on its axis. Summer occurs in
    the hemisphere that is tilted towards the Sun, while it is winter in the hemisphere
    tilted away from the Sun. Spring and autumn occur when the tilt of the Earth
    towards the Sun is small.

8  A day is the time it takes for Earth to rotate once on its own axis. A year is the
    time it takes to orbit the Sun.

9  If there were no time zones and the globe was all at exactly the same time then
    some parts would be in the dark at midday while others would be in bright sunlight
    at midnight.

10

<table>
<thead>
<tr>
<th>Type of object</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Planet</td>
<td>Orbits the Sun</td>
<td>Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus, Neptune</td>
</tr>
<tr>
<td></td>
<td>Spherical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Has enough mass/gravity to clear its neighbourhood of dust and rocks</td>
<td></td>
</tr>
<tr>
<td>Dwarf planet</td>
<td>Orbits the Sun</td>
<td>Pluto, Haumea, Eris, Makemake, Ceres</td>
</tr>
<tr>
<td></td>
<td>Roughly spherical</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Does not have enough mass/gravity to clear its neighbourhood of dust and rocks</td>
<td></td>
</tr>
<tr>
<td>Comet</td>
<td>‘Dirty snowball’ made of ice, carbon</td>
<td>Halley’s Comet</td>
</tr>
</tbody>
</table>
dioxide and carbon compounds
Highly elliptical orbit
Appears periodically with a coma and a tail
Comet Shoemaker-Levy 9

Asteroid
Irregular rocky object
Found in asteroid belt
Ceres
Ida and Dactyl

Meteor
Lump of space rock that burns up in the Earth’s atmosphere
‘Shooting stars’

Meteorite
Meteoroid so big that it reaches to the Earth’s surface
Meteorite thought to have caused the extinction of the dinosaurs
1908 meteorite in Siberia
Meteorite that caused the impact crater in Arizona

11 Your gravity will be:
   a  the least while at maximum altitude
   b  the greatest while on the ground.

12 a  C = Earth (an inner planet with Moon)
   b  D = the Moon
   c  E = Neptune (an outer planet)
   d  A = Pluto (furthest from the Sun)
   e  B = Halley’s Comet (very elliptical orbit)

13 a  The mass that affects you the most is the Earth.
   b  Other things have very little mass and so their gravitational force is very small and won’t have much effect on you.

14 Diagrammatic answer similar to Figure 9.4.3 on page 355 is required.

15 Answer will depend on individual birth years.

16 a  A comet is a ball of ice and other molecules that orbits the Sun in a large highly eccentric, highly elliptical orbit. A meteor is a lump or rock that burns up in the Earth’s atmosphere.
   b  The geocentric model of the solar system has Earth at its centre and all the
planets, the Moon and the Sun revolving around it. The heliocentric model has the Sun at its centre with all the planets revolving around it.

c An eclipse occurs when the Moon casts a shadow on the Earth or when the Earth casts a shadow on the Moon. An ellipse is an oval shape.

17 Gravity always pulls you down but down is a relative term. What is down to you is up on the other side of Earth. It is better to say that gravity pulls you towards the centre of the Earth.

18 The prefix geo- is used to indicate that it is to do with Earth.

19 Students’ answers will vary.

20 Students’ answers will vary.

21 Sarah is correct. There must be gravity at that height because the ISS is in orbit. If there was no gravity at that height then the ISS would have moved off in a straight line away from Earth.

   a The ISS is in orbit meaning that it is in free-fall.

   b Gravity is needed for free-fall and so there must be gravity at this height.

22 Students’ answers will vary.

23 Diagrammatic answer required similar to Figure 9.4.3.

24 Students write a creative story.

25 Diagrammatic answer (see below)
Thinking scientifically

1 G
2 D
3 A
4 D
5 C
6 D