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0653/41

May/June 2017

**1 hour 15 minutes**

No Additional Materials are required.

## READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

A copy of the Periodic Table is printed on page 24.

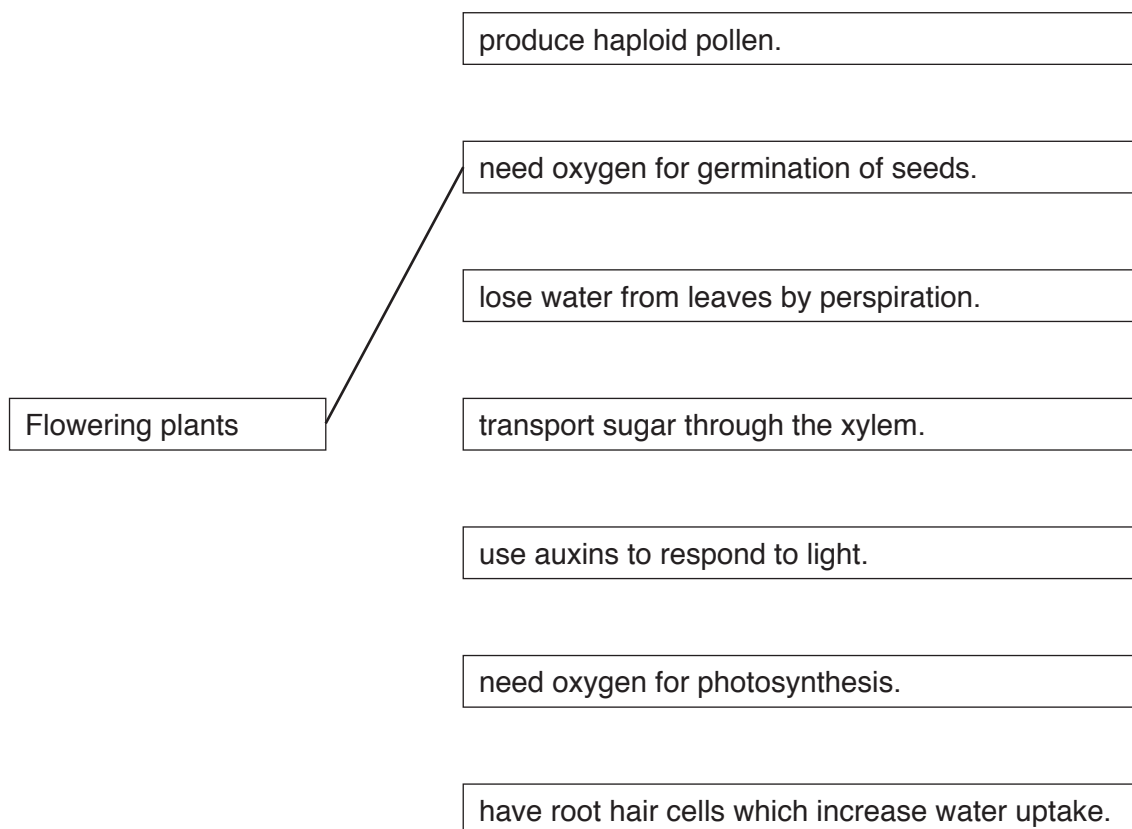
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **22** printed pages and **2** blank pages.

- 1 (a) Use lines to connect the box on the left to different boxes on the right to make correct sentences.

One is done for you. The sentence reads 'Flowering plants need oxygen for germination of seeds'.

Draw **three** more lines to make three more correct sentences.



[3]

- (b) Fig. 1.1 is a diagram of a wind-pollinated flower.

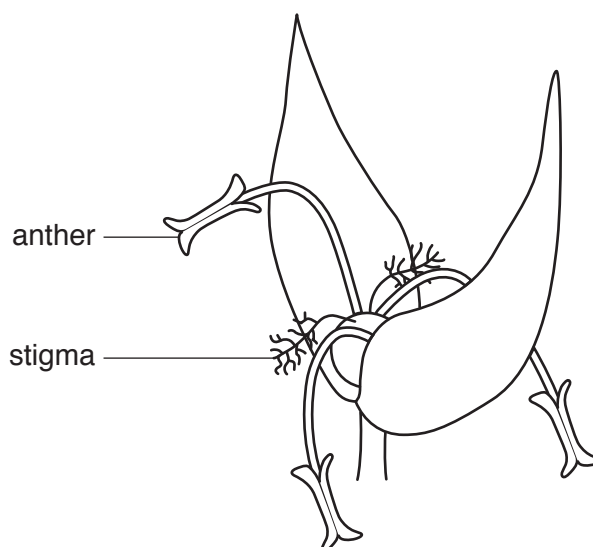


Fig. 1.1

- (i) Describe how the following structures make the flower in Fig. 1.1 suitable for wind-pollination.

the anthers

.....

.....

.....

the stigmas

.....

.....

.....

[2]

- (ii) Suggest **one** reason why wind-pollinated crops are grown close together by farmers.

.....

..... [1]

- (c) The growth of crops can be reduced by acid rain.

- (i) Describe how burning fossil fuels can lead to acid rain.

.....

.....

.....

..... [2]

- (ii) Suggest how acid rain reduces the rate of growth of crops.

.....

..... [1]

- 2 (a) Fig. 2.1 is a dot-and-cross diagram to show the outer-shell electrons in a molecule of hydrogen chloride,  $\text{HCl}$ .

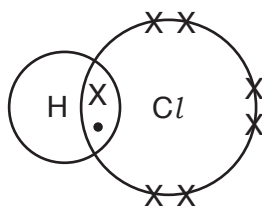


Fig. 2.1

- (i) State the type of chemical bond shown in Fig. 2.1.

..... [1]

- (ii) Draw a dot-and-cross diagram to show the outer-shell electrons in a molecule of methane,  $\text{CH}_4$ .

[2]

- (b) (i) Name the **two** products of the complete combustion of methane.

1. ....

2. ....

[2]

- (ii) Explain, in terms of energy changes, why methane is used as a fuel.

.....

..... [1]

- (c) Methane is the main constituent of one fossil fuel.

- (i) State the name of this fossil fuel.

..... [1]

- (ii) State the names of **two other** fossil fuels.

..... and ..... [1]

- 3 Fig. 3.1 shows a wind surfer on a surf board, driven by the wind, sailing at a constant speed across the sea. The arrows labelled **A**, **B**, **C** and **D** show the forces acting on the surf board.

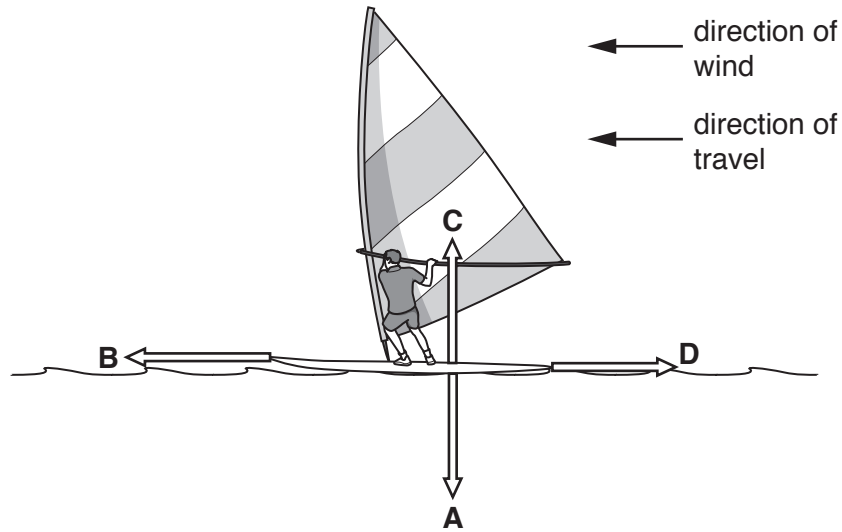


Fig. 3.1

- (a) (i) State which letter, **A**, **B**, **C**, or **D** corresponds to

1. frictional force .....

2. upthrust .....

[1]

- (ii) Force **A** is measured and found to be 1200 N.

State whether force **C** is 1200 N or has a different value.

Give a reason for your answer.

.....  
 ..... [1]

(b) The surf board travels at a constant speed of 2 m/s.

The wind speed then increases, and the surf board moves with an acceleration that is not constant until the surf board reaches a constant speed of 4.5 m/s after 10 s.

On Fig. 3.2 sketch the shape of the speed-time graph of the motion of the surf board from the time the wind speed increases until just after the constant speed of 4.5 m/s is achieved.

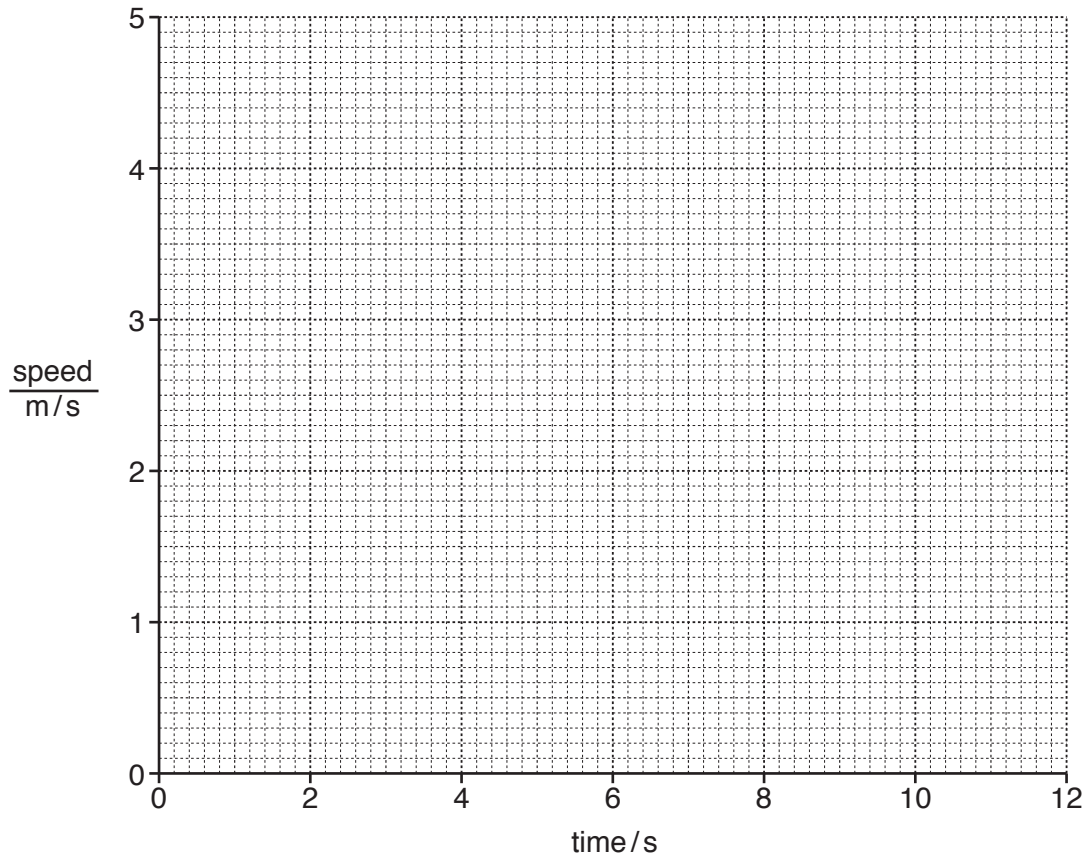


Fig. 3.2

[2]

- (c) The kinetic energy of the wind provides the work needed to move the surf board across the sea.

- (i) The mass of the surf board and surfer is 120 kg.

Calculate the kinetic energy of the surf board and surfer when they are moving at 3 m/s.

State the formula you use and show your working.

formula

working

kinetic energy = ..... J [2]

- (ii) The wind transfers 90 kJ of energy to the surf board when moving it along at 3 m/s for 50 s.

Use the work done by the wind to calculate the driving force of the wind.

State any formula you use and show your working.

formula

working

driving force = ..... N [3]

- 4 (a) Fig. 4.1 shows a drawing of a single-celled organism called *Euglena* as seen using a light microscope.

This organism has features of both plants and animals.

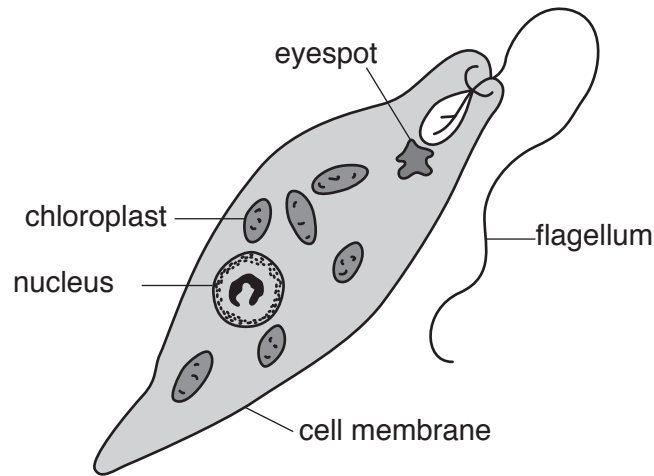


Fig. 4.1

- (i) Chloroplasts are usually found in plant cells.

Describe in detail the function of chloroplasts.

.....

.....

.....

.....

..... [3]

- (ii) Name **one** feature of *Euglena* you would more likely see in an animal than a plant.

Explain your answer.

feature .....

explanation .....

.....

.....

[2]

- (b) Fig. 4.2 shows an aquatic food web. Phytoplankton are microscopic plants that float on the surface of the water. Zooplankton are very small animals.

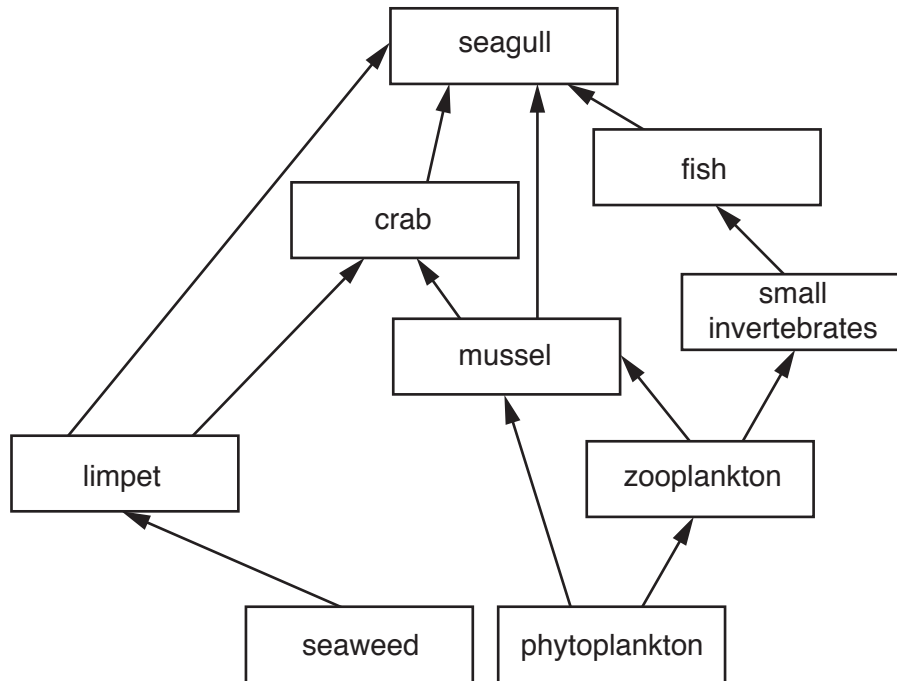


**Fig. 4.2**

- (i) Use Fig. 4.2 to draw a food chain containing five organisms, including the crab.

[2]

- (ii) The chemical energy contained in the producers is transferred through the food web to the seagull as shown in Fig. 4.2.

Suggest why the seagull gets more energy transferred from the phytoplankton by eating mussels rather than fish. Explain your answer in detail.

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.....

.....

..... [3]

- 5 A student investigates the reaction between dilute sulfuric acid and excess copper(II) carbonate powder.

The apparatus she uses is shown in Fig. 5.1.

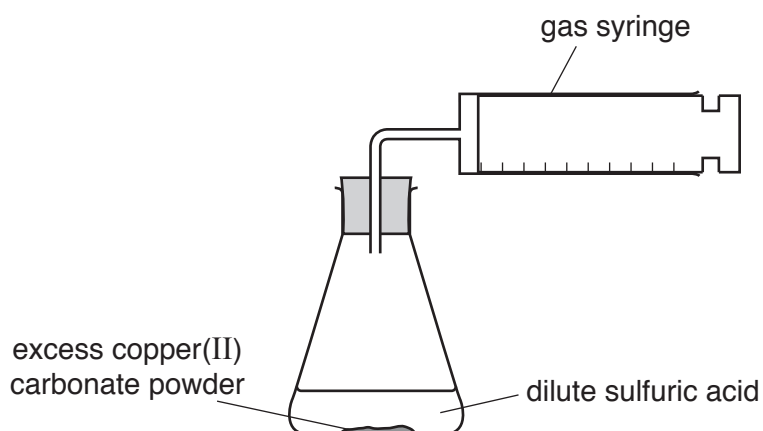


**Fig. 5.1**

The reaction produces a gas which is collected in the gas syringe.

A salt and another compound are also produced.

- (a) (i) Describe the pH change, if any, of the reaction mixture.

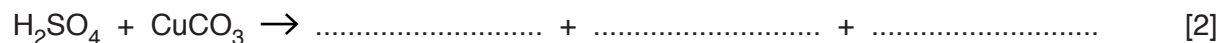
Name this type of reaction.

pH change .....

reaction type .....

[2]

- (ii) Complete the balanced symbol equation for the reaction between dilute sulfuric acid and copper(II) carbonate.



- (b) Copper(II) carbonate is insoluble in water.

The salt which is produced in this reaction is soluble in water.

Suggest a method of making pure, dry crystals of this salt from the mixture that is left after the reaction is complete.

.....

.....

.....

..... [2]

- (c) The student records the volume of gas in the syringe for 10 minutes.

Her results are shown in Fig. 5.2.

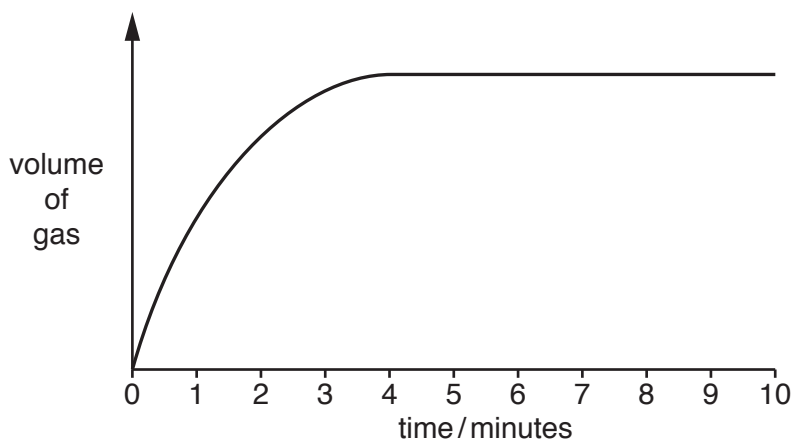


**Fig. 5.2**

Describe how the shape of the graph shows the change in the rate of the reaction.

.....

.....

.....

..... [2]

- (d) She repeats the experiment using the same volume of less concentrated sulfuric acid.

(i) Draw a line on Fig. 5.2 to show her results. [2]

(ii) Explain, in terms of particle collisions, the effect of using less concentrated sulfuric acid on the rate of the reaction.

.....

..... [1]

- 6 Fig. 6.1 shows a man standing in the sea on a sunny day.

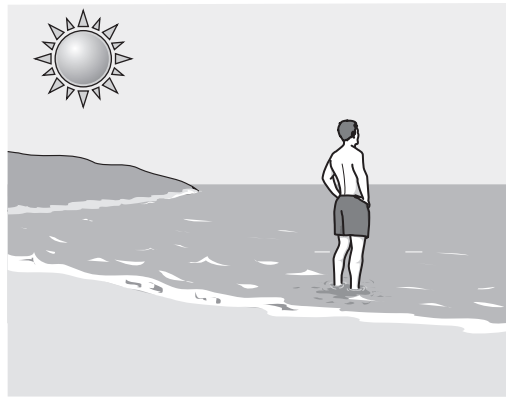


**Fig. 6.1**

- (a) (i) The man says that his back is getting too hot in the Sun.

Explain why wearing a white shirt can prevent the temperature of his back from increasing.

.....  
 .....  
 ..... [2]

- (ii) The temperature of the man's body is  $37^{\circ}\text{C}$ . The temperature of the sea water is  $15^{\circ}\text{C}$ .

Explain why the man says that the water feels cold to his feet.

.....  
 .....  
 .....  
 ..... [2]

- (iii) The man walks out of the sea, and his wet feet slowly become dry. He says that his feet get colder as they dry.

Complete the sentences below that explain in terms of the movement of molecules why his feet get colder as they dry.

The ..... water molecules escape from the  
 surface of the water on his feet.

This means that the remaining water molecules have less

..... so the remaining water on his feet is at a  
 lower ..... [2]

- (b) Fig. 6.2 shows a man spear fishing. He sees a fish in the sea in front of him. He says that the fish appears to be near the surface.

The man thinks the fish is at point **F** on Fig. 6.2.

Draw a ray diagram on Fig. 6.2 to show where the fish really is. Mark this point with a letter **X**.

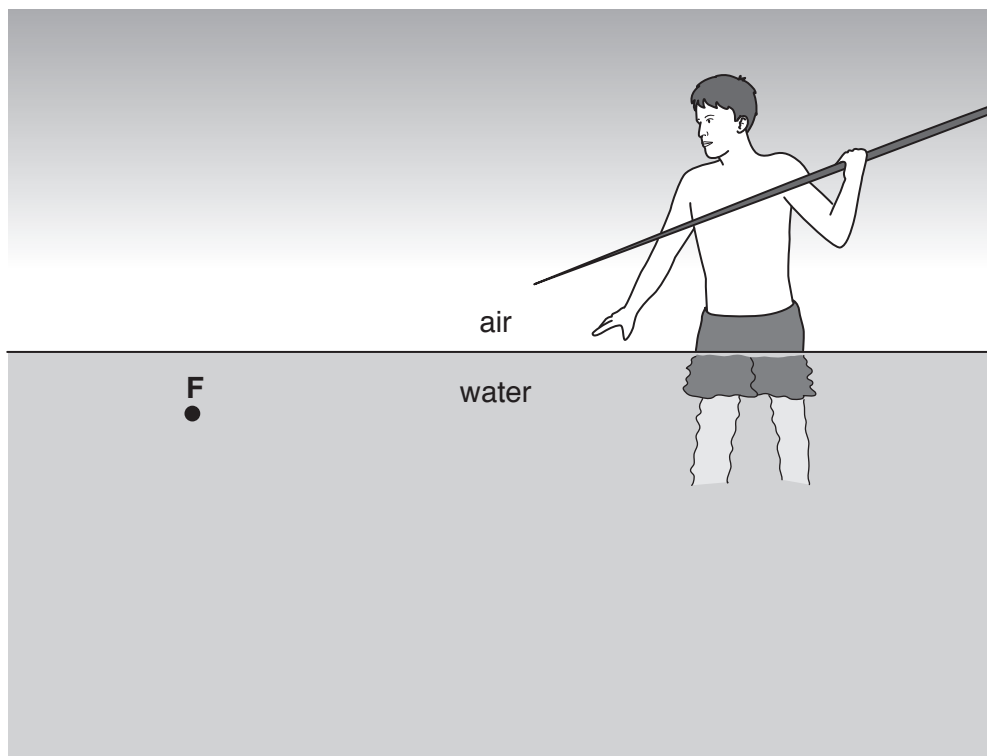


**Fig. 6.2**

[2]

- (c) The man cooks a fish in a microwave oven.

- (i) On Fig. 6.3 place microwaves in their correct position in the incomplete electromagnetic spectrum.

|            |  |  |               |  |  |             |
|------------|--|--|---------------|--|--|-------------|
| gamma rays |  |  | visible light |  |  | radio waves |
|------------|--|--|---------------|--|--|-------------|

**Fig. 6.3**

[1]

- (ii) Microwaves travel at a speed of  $3 \times 10^8$  m/s. The wavelength of the microwaves used in the microwave oven is 0.12 m.

Calculate the frequency of the microwaves used.

State the formula you use and show your working.

formula

working

frequency = ..... Hz [2]

- 7 Table 7.1 shows the mass of some of the contents of three foods in a 100 gram sample of each food.

**Table 7.1**

| food  | number of grams in the 100 gram food sample |              |         |       |
|-------|---------------------------------------------|--------------|---------|-------|
|       | fat                                         | carbohydrate | protein | water |
| bread | 7                                           | 60           | 13      | 20    |
| egg   | 11                                          | 1            | 13      | 75    |
| milk  | 3                                           | 5            | 3       | 89    |

- (a) The energy for the body provided by one gram of each nutrient is shown below.

fat 37 kJ

carbohydrate 17 kJ

protein 17 kJ

A student cooked a meal using 200 grams of eggs.

Use the information contained in Table 7.1 to calculate the energy provided by the 200 grams of eggs.

Show your working.

energy provided = ..... kJ [2]

- (b) A person has a family history of coronary heart disease and it is likely that he will develop the condition too. State which food listed in Table 7.1 he should avoid.

Explain your answer.

food .....

explanation .....

.....

.....

[1]

- (c) (i) The energy from food is released by respiration.

Complete the balanced symbol equation for respiration.



- (ii) Describe how oxygen is transported in the blood.

.....  
.....  
..... [2]

- (d) Fats, carbohydrates and proteins are made up from large molecules. They have to be broken down by chemical digestion into small molecules.

Name the areas of the alimentary canal where the following processes occur.

1. chemical digestion

..... and .....

and .....

2. absorption

..... [2]

**Please turn over for Question 8**

- 8 (a) Use the Periodic Table on page 24 to determine the electronic structure of an aluminium atom.

.....

[1]

- (b) Aluminium is extracted from aluminium oxide by electrolysis, as shown in Fig. 8.1.

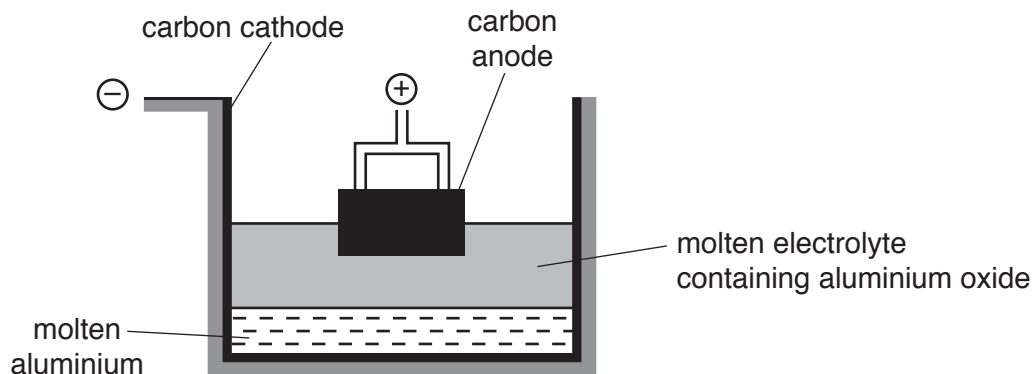


Fig. 8.1

Aluminium oxide,  $Al_2O_3$ , contains aluminium ions,  $Al^{3+}$ , and oxide ions,  $O^{2-}$ .

- (i) Name the product of electrolysis at the anode.

..... [1]

- (ii) Describe, in terms of atoms, ions and electrons, the reaction that takes place at the cathode.

.....  
 .....  
 .....  
 ..... [2]

- (c) Iron is extracted from iron(III) oxide in a blast furnace.

- (i) Name a substance that reduces iron(III) oxide in this process.

..... [1]

- (ii) Explain why aluminium cannot be extracted from aluminium oxide in a blast furnace.

.....  
 ..... [1]

(d) A student investigates the reactions between aluminium and solutions of metal sulfates.

- (i) When a freshly cleaned piece of aluminium is placed into a solution of magnesium sulfate, no change is seen, as shown in Fig. 8.2.

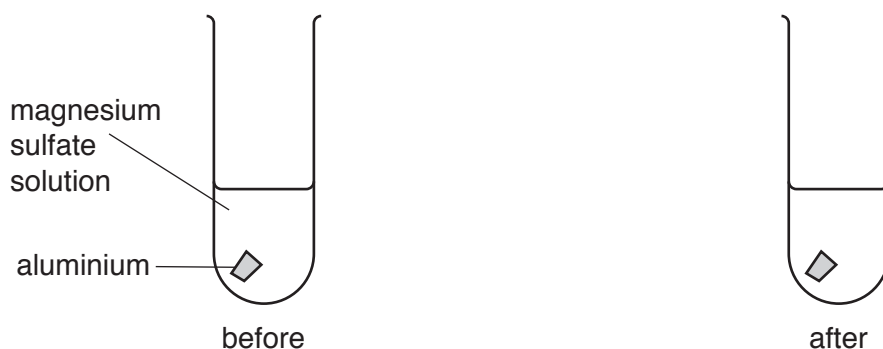


**Fig. 8.2**

Explain this observation.

.....  
..... [1]

- (ii) When a freshly cleaned piece of aluminium is placed into a solution of copper(II) sulfate, the surface of the aluminium turns brown and the solution starts to decolourise, as shown in Fig. 8.3.

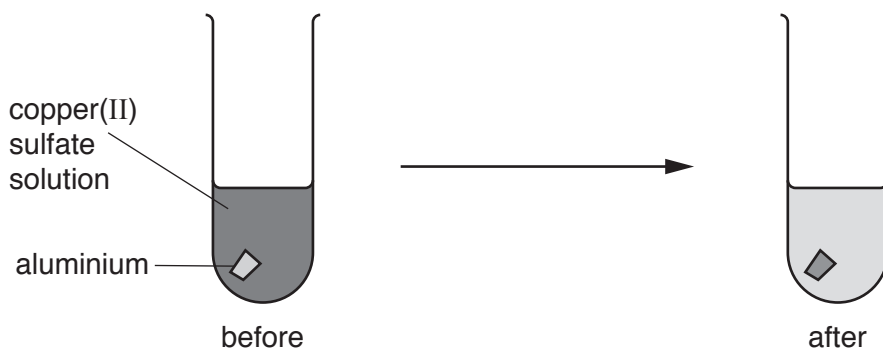


**Fig. 8.3**

Explain this observation.

.....  
..... [1]

- 9 Fig 9.1 shows a simple test circuit for testing different materials to see how well they conduct electricity. The material being tested is connected between **X** and **Y**.

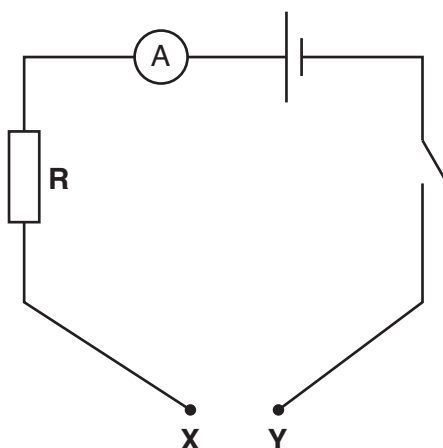


**Fig. 9.1**

- (a) Name **two** materials other than copper that would be found to be good conductors when tested.

..... and ..... [1]

- (b) A piece of copper wire is connected between **X** and **Y**, and a voltmeter is connected in parallel to resistor **R**.

The ammeter reads 0.5 A. The voltmeter reads 2 V.

Use the formula  $R = \frac{V}{I}$  to calculate the resistance of **R**.

Give the unit of your answer.

working

resistance = ..... unit ..... [2]

- (c) Two pieces of wire, **P** and **Q**, with the same length and made of the same alloy, are connected in parallel between **X** and **Y**.

The current in wire **P** is 5A. The ammeter reading is 7A.

- (i) Predict the current in wire **Q**.

Give a reason for your answer.

current in wire **Q** = ..... A

reason .....

[1]

- (ii) Deduce why different currents flow in wires **P** and **Q**. Give reasons for your answer.

.....  
.....  
.....  
..... [2]

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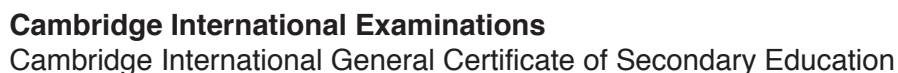


# The Periodic Table of Elements

| Group                      |                             |                                                                              |                             |                             |                              |                             |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|----------------------------|-----------------------------|------------------------------------------------------------------------------|-----------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|----------------------------|------------------------------|---------------------------|----------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------------|------------------------------|---------------------------|
| I                          | II                          | 1<br>H<br>hydrogen<br>1                                                      |                             |                             |                              |                             |                              |                            |                              |                           |                            | III                         | IV                          | V                           | VI                           | VII                          | VIII                      |
|                            |                             | <div>Key</div>                                                               |                             |                             |                              |                             |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
|                            |                             | <div>atomic number<br/>atomic symbol<br/>name<br/>relative atomic mass</div> |                             |                             |                              |                             |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |
| 3<br>Li<br>lithium<br>7    | 4<br>Be<br>beryllium<br>9   |                                                                              |                             |                             |                              |                             |                              |                            |                              |                           |                            | 5<br>B<br>boron<br>11       | 6<br>C<br>carbon<br>12      | 7<br>N<br>nitrogen<br>14    | 8<br>O<br>oxygen<br>16       | 9<br>F<br>fluorine<br>19     | VIII<br>He<br>helium<br>4 |
| 11<br>Na<br>sodium<br>23   | 12<br>Mg<br>magnesium<br>24 |                                                                              |                             |                             |                              |                             |                              |                            |                              |                           |                            | 13<br>Al<br>aluminium<br>27 | 14<br>Si<br>silicon<br>28   | 15<br>P<br>phosphorus<br>31 | 16<br>S<br>sulfur<br>32      | 17<br>Cl<br>chlorine<br>35.5 | 18<br>Ar<br>argon<br>40   |
| 19<br>K<br>potassium<br>39 | 20<br>Ca<br>calcium<br>40   | 21<br>Sc<br>scandium<br>45                                                   | 22<br>Ti<br>titanium<br>48  | 23<br>V<br>vanadium<br>51   | 24<br>Cr<br>chromium<br>52   | 25<br>Mn<br>manganese<br>55 | 26<br>Fe<br>iron<br>56       | 27<br>Co<br>cobalt<br>59   | 28<br>Ni<br>nickel<br>59     | 29<br>Cu<br>copper<br>64  | 30<br>Zn<br>zinc<br>65     | 31<br>Ga<br>gallium<br>70   | 32<br>Ge<br>germanium<br>73 | 33<br>As<br>arsenic<br>75   | 34<br>Se<br>selenium<br>79   | 35<br>Br<br>bromine<br>80    | 36<br>Kr<br>krypton<br>84 |
| 37<br>Rb<br>rubidium<br>85 | 38<br>Sr<br>strontium<br>88 | 39<br>Y<br>yttrium<br>89                                                     | 40<br>Zr<br>zirconium<br>91 | 41<br>Nb<br>niobium<br>93   | 42<br>Mo<br>molybdenum<br>96 | 43<br>Tc<br>technetium      | 44<br>Ru<br>ruthenium<br>101 | 45<br>Rh<br>rhodium<br>103 | 46<br>Pd<br>palladium<br>106 | 47<br>Ag<br>silver<br>108 | 48<br>Cd<br>cadmium<br>112 | 49<br>In<br>indium<br>115   | 50<br>Sn<br>tin<br>119      | 51<br>Sb<br>antimony<br>122 | 52<br>Te<br>tellurium<br>128 | 53<br>I<br>iodine<br>127     | 54<br>Xe<br>xenon<br>131  |
| 55<br>Cs<br>caesium<br>133 | 56<br>Ba<br>barium<br>137   | 57–71<br>lanthanoids                                                         | 72<br>Hf<br>hafnium<br>178  | 73<br>Ta<br>tantalum<br>181 | 74<br>W<br>tungsten<br>184   | 75<br>Re<br>rhenium<br>186  | 76<br>Os<br>osmium<br>190    | 77<br>Ir<br>iridium<br>192 | 78<br>Pt<br>platinum<br>195  | 79<br>Au<br>gold<br>197   | 80<br>Hg<br>mercury<br>201 | 81<br>Tl<br>thallium<br>204 | 82<br>Pb<br>lead<br>207     | 83<br>Bi<br>bismuth<br>209  | 84<br>Po<br>polonium         | 85<br>At<br>astatine         | 86<br>Rn<br>radon         |
| 87<br>Fr<br>francium       | 88<br>Ra<br>radium          | 89–103<br>actinoids                                                          | 104<br>Rf<br>rutherfordium  | 105<br>Db<br>dubnium        | 106<br>Sg<br>seaborgium      | 107<br>Bh<br>bohrium        | 108<br>Hs<br>hassium         | 109<br>Mt<br>meitnerium    | 110<br>Ds<br>darmstadtium    | 111<br>Rg<br>roentgenium  | 112<br>Cn<br>copernicium   | 114<br>Fl<br>flerovium      | 116<br>Lv<br>livermorium    |                             |                              |                              |                           |

|                               |                               |                                 |                               |                              |                             |
|-------------------------------|-------------------------------|---------------------------------|-------------------------------|------------------------------|-----------------------------|
| lanthanoids                   |                               |                                 |                               |                              |                             |
| 57<br>La<br>lanthanum<br>139  | 58<br>Ce<br>cerium<br>140     | 59<br>Pr<br>praseodymium<br>141 | 60<br>Nd<br>neodymium<br>144  | 61<br>Pm<br>promethium<br>—  | 62<br>Sm<br>samarium<br>150 |
| 63<br>Eu<br>europium<br>152   | 64<br>Gd<br>gadolinium<br>157 | 65<br>Tb<br>terbium<br>159      | 66<br>Dy<br>dysprosium<br>163 | 67<br>Ho<br>holmium<br>165   | 68<br>Er<br>erbium<br>167   |
| 69<br>Tm<br>thulium<br>169    | 70<br>Yb<br>ytterbium<br>173  | 71<br>Lu<br>lutetium<br>175     |                               |                              |                             |
| actinoids                     |                               |                                 |                               |                              |                             |
| 89<br>Ac<br>actinium<br>—     | 90<br>Th<br>thorium<br>232    | 91<br>Pa<br>protactinium<br>231 | 92<br>U<br>uranium<br>238     | 93<br>Np<br>neptunium<br>—   | 94<br>Pu<br>plutonium<br>—  |
| 95<br>Am<br>americium<br>—    | 96<br>Cm<br>curium<br>—       | 97<br>Bk<br>berkelium<br>—      | 98<br>Cf<br>californium<br>—  | 99<br>Es<br>einsteinium<br>— | 100<br>Fm<br>fermium<br>—   |
| 101<br>Md<br>mendelevium<br>— | 102<br>No<br>nobelium<br>—    | 103<br>Lr<br>lawrencium<br>—    |                               |                              |                             |

The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.)



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0653/42

May/June 2017

**1 hour 15 minutes**

No Additional Materials are required.

## READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

A copy of the Periodic Table is printed on page 20.

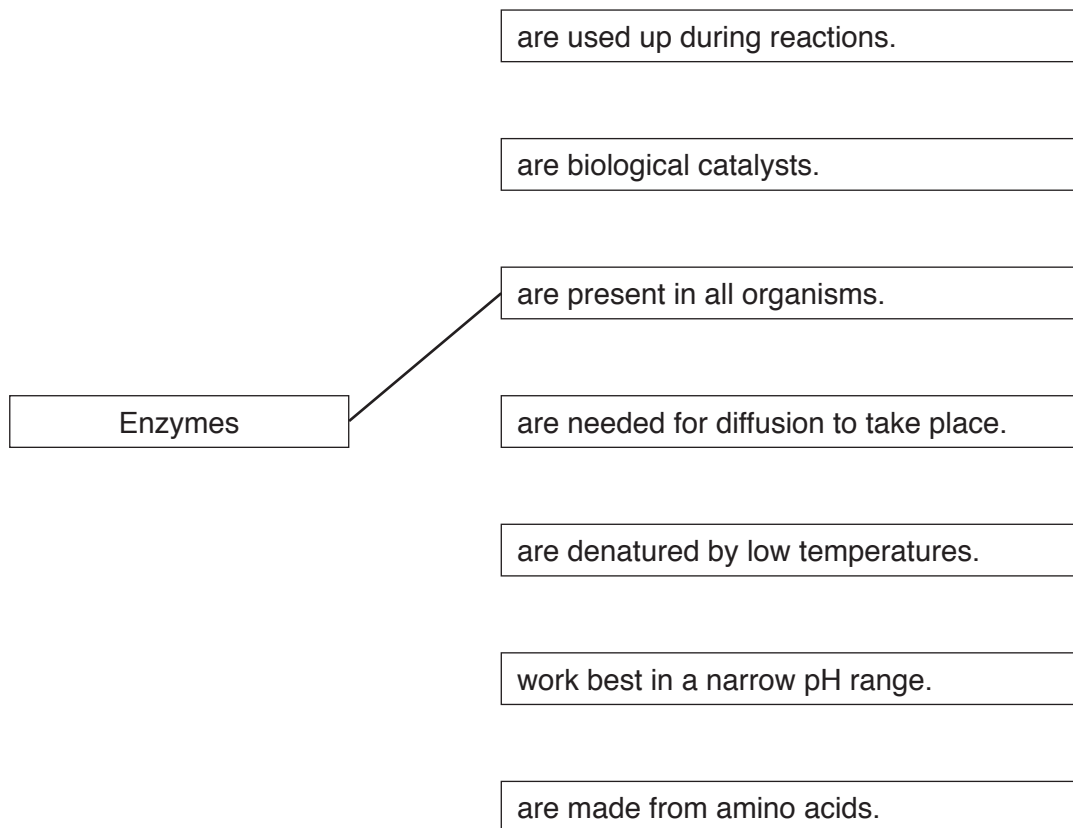
The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **20** printed pages.

- 1 (a) Use lines to connect the box on the left to different boxes on the right to make correct sentences.

One is done for you. The sentence reads 'Enzymes are present in all organisms'.

Draw **three** more lines to make three more correct sentences.



[3]

- (b) Microorganisms are used in the production of yoghurt.

If the temperature increases the rate of yoghurt production also increases until 46°C is reached. As the temperature increases further, the rate of yoghurt production rapidly decreases.

A student thinks that enzymes in the microorganisms are involved in making yoghurt.

Suggest whether the student is correct. Explain your answer.

.....

.....

.....

.....

..... [2]

(c) Fig. 1.1 shows a small section of a starch molecule.

Starch is a very large molecule, made up from many basic units which are joined together.

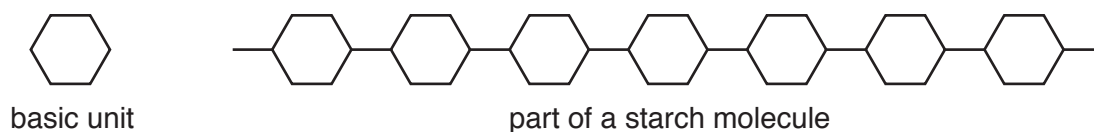


**Fig. 1.1**

(i) Name the basic unit shown in Fig. 1.1.

..... [1]

(ii) Name another **large** molecule, found in some living organisms, which could be made up from the same basic unit as shown in Fig. 1.1.

..... [1]

(iii) Name the element found in a protein molecule which is absent from a starch molecule.

..... [1]

- 2 (a) A teacher places the first three metals of Group I in the Periodic Table into separate beakers of water. This is shown in Fig. 2.1.

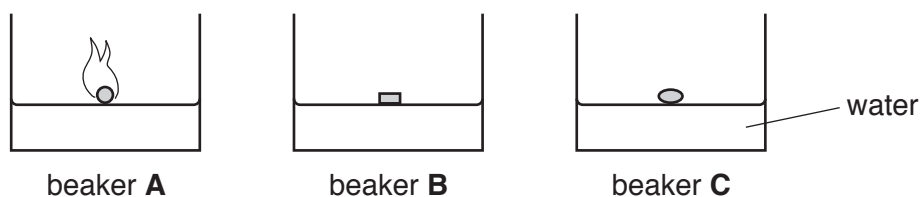


Fig. 2.1

The three pieces of metal are the same size.

A student records her observations in Table 2.1.

Table 2.1

| beaker   | the metal floats | the metal melts | time for metal to fully react in seconds | flames are seen |
|----------|------------------|-----------------|------------------------------------------|-----------------|
| <b>A</b> | yes              | yes             | 15                                       | yes             |
| <b>B</b> | yes              | no              | 60                                       | no              |
| <b>C</b> | yes              | yes             | 40                                       | no              |

- (i) Use the information in Table 2.1 to identify the three metals in beakers **A**, **B** and **C**.

beaker **A** .....

beaker **B** .....

beaker **C** .....

[2]

- (ii) Complete the sentences about the reaction in beaker **A** using suitable words or phrases.

The temperature in the beaker increases because this is an

..... reaction.

During this reaction ..... energy is changed into

..... and ..... energy.

[3]

- (iii) The fourth metal in Group I is rubidium, Rb.

The student observes the reaction between a piece of rubidium and water. The piece of rubidium is the same size as the other metals.

Suggest how long it takes for the piece of rubidium to react completely.

..... seconds [1]

- (b) Suggest why Group I metals **must not** be added to dilute hydrochloric acid.

.....  
..... [1]

- (c) Saucepans are usually made from an iron alloy rather than from pure iron.

Some coins are made from a copper alloy rather than from pure copper.

Explain why these alloys are used instead of the pure metals.

- (i) iron alloy for saucepans

.....  
..... [1]

- (ii) copper alloy for coins

.....  
..... [1]

- 3 (a) Fig. 3.1 shows an aircraft flying at a constant height and constant speed above the Earth's surface. The arrows labelled **A**, **B**, **C** and **D** show the forces acting on the aircraft.

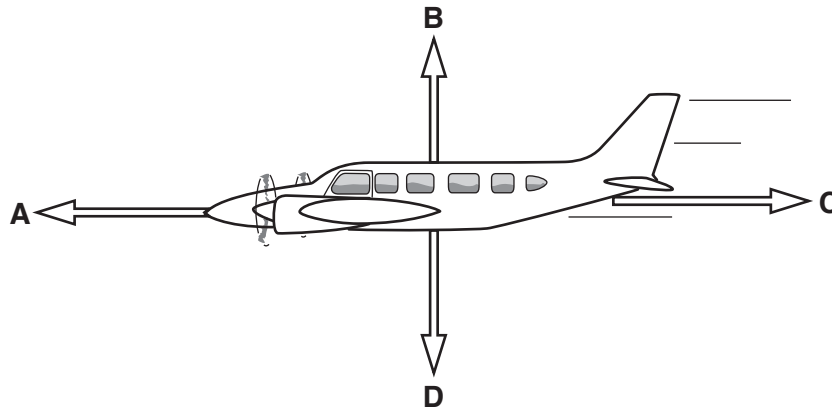


Fig. 3.1

- (i) State which letter, **A**, **B**, **C** or **D**, corresponds to:

1. frictional force, .....
2. lifting force. ....

[1]

- (ii) Force **D** is measured and found to be 500 000 N.

State whether force **B** is 500 000 N or has a different value.

Give a reason for your answer.

.....  
 ..... [1]

- (iii) During the flight, the aircraft burns 1000 kg of fuel.

State the effect this has on force **D**.

Explain why this happens.

effect on force **D** .....

explanation .....

.....  
 ..... [1]

(b) The speed of the aircraft increases steadily in 30 s from 100 m/s to 160 m/s.

(i) Calculate the acceleration of the aircraft.

Show your working and state the unit of your answer.

acceleration = ..... unit ..... [2]

(ii) As the speed increases, the aircraft loses height from 10 000 m to 8000 m.

The aircraft has a mass of 50 000 kg.

Calculate the loss in gravitational potential energy of the aircraft.

State the formula you use and show your working.

( $g = 10 \text{ N/kg}$ )

formula

working

potential energy lost = ..... J [2]

- 4 (a) Fig. 4.1 shows a diagram of the internal structure of the heart.

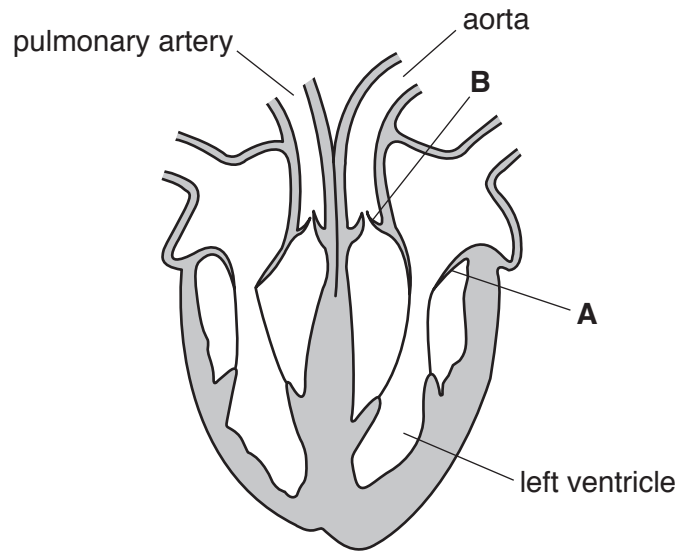


Fig. 4.1

- (i) The ventricles contract to send blood out of the heart.

State what happens to the valves at **A** and **B** when the ventricles contract.

**A** .....

**B** ..... [1]

- (ii) There is a difference in pressure of the blood travelling in the aorta compared with the blood travelling in the pulmonary artery.

Explain why it is important for blood to have different pressures in these arteries.

.....  
 .....  
 .....  
 ..... [2]

- (b) (i) The heart muscle must be supplied with blood.

Explain how coronary heart disease affects the blood supply to the heart muscle.

.....  
 .....  
 ..... [2]

(ii) State **one** way in which sufferers of coronary heart disease can improve their lifestyle.

..... [1]

(c) The hormone adrenaline is secreted into the blood by the adrenal glands which are above the kidneys. One of the effects of adrenaline is to increase the heart rate.

(i) Describe **one** situation when the rate of adrenaline secretion increases rapidly.

.....  
 ..... [1]

(ii) State how the hormone adrenaline is removed from the blood.

.....  
 ..... [1]

(d) Hormones can affect the direction of growth in plants.

Fig. 4.2 shows what happens when a plant has bright light coming from one side.

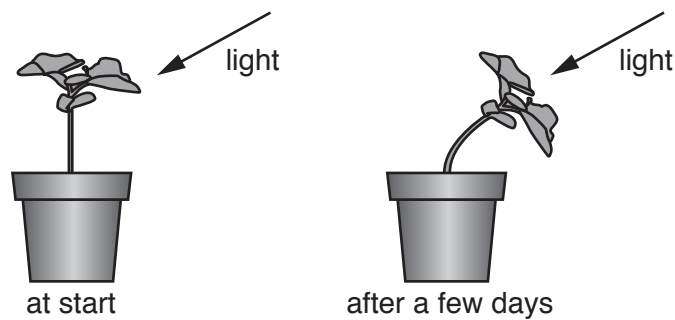


**Fig. 4.2**

Explain how hormones in the plant caused the phototropic response shown in Fig. 4.2.

.....  
 .....  
 .....  
 .....  
 ..... [3]

5 Petroleum is a mixture of hydrocarbons.

(a) (i) Name the process that is used to separate liquids with different boiling points.

..... [1]

(ii) Describe the relationship between the size of hydrocarbon molecules and the size of intermolecular attractive forces.

.....

.....

..... [1]

(iii) Describe the relationship between the size of the intermolecular attractive forces between hydrocarbon molecules and the boiling points of the hydrocarbons.

.....

.....

..... [1]

(b) The structures of two hydrocarbon molecules, **D** and **E**, are shown in Fig. 5.1.

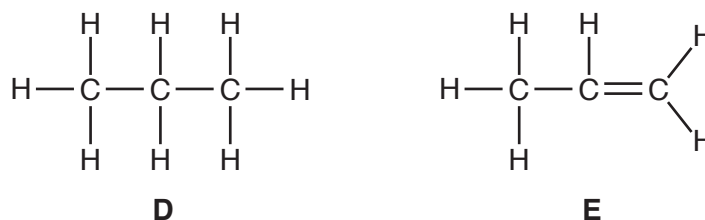


**Fig. 5.1**

(i) Name the **types** of hydrocarbon shown by molecules **D** and **E**.

**D** .....

**E** .....

[2]

- (ii) Describe a chemical test used to distinguish between **D** and **E**.

State the observation for each.

test .....

observation with **D** .....

.....

observation with **E** .....

.....

[2]

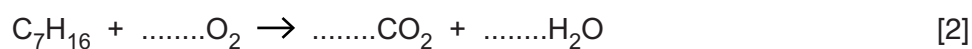
- (iii) Molecule **E** is made by heating larger hydrocarbon molecules in the presence of a catalyst.

Name this process.

..... [1]

- (c) Heptane,  $C_7H_{16}$ , undergoes complete combustion in the presence of excess oxygen.

Complete the equation for this reaction.



- 6 An aircraft is flying at a height of 10 000 m. Outside the aircraft the temperature is  $-55^{\circ}\text{C}$ , but inside the aircraft the air temperature is kept at  $21^{\circ}\text{C}$ .

- (a) (i) State the main method of thermal energy transfer from air inside the aircraft to the air outside.

..... [1]

- (ii) Describe in terms of molecular motion how thermal energy is lost from air inside the aircraft to the air outside.

.....

.....

.....

..... [2]

- (b) Inside the aircraft's jet engines, the temperature reaches  $1700^{\circ}\text{C}$  as the jet fuel burns. The combustion of the fuel forms exhaust gases containing carbon dioxide and water molecules.

- (i) State which of the diagrams in Fig. 6.1, **X**, **Y** or **Z**, shows the arrangement of these molecules as they are formed in the engine.

Give a reason for your answer.

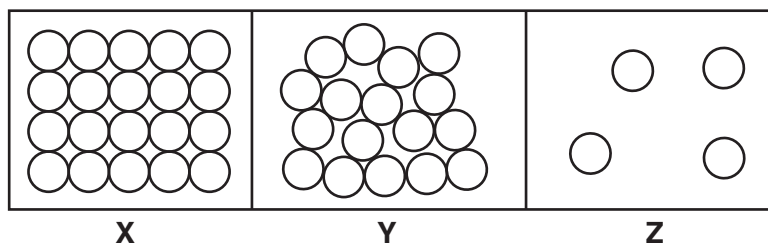


Fig. 6.1

diagram .....

reason .....

.....

[1]

- (ii) Suggest how the motion of the water molecules formed in the jet engines differs from the motion of water molecules in a glass of water inside the aircraft.

Give a reason for your answer.

.....

.....

..... [2]

- (c) Radar is a method of tracking aircraft from the ground using electromagnetic waves.

A radar signal is transmitted from the ground to an aircraft several kilometres away. The signal is then reflected by the aircraft back to the ground.

- (i) The reflected signal is received back at the transmitting station 0.0002s after transmission.

The speed of radar waves is  $3 \times 10^5$  km/s.

Calculate the distance of the aircraft from the transmitter.

Show your working.

distance = ..... km [3]

- (ii) The radar signal has a frequency of  $1.5 \times 10^9$  Hz.

Table 6.1 shows the range of frequencies across the electromagnetic spectrum.

**Table 6.1**

| radiation                   | gamma radiation    | X-rays                       | ultra-violet                 | visible light                                  | infrared                     | micro-waves               | radio waves     |
|-----------------------------|--------------------|------------------------------|------------------------------|------------------------------------------------|------------------------------|---------------------------|-----------------|
| approximate frequency range | above $10^{19}$ Hz | $10^{16}$ Hz to $10^{19}$ Hz | $10^{14}$ Hz to $10^{16}$ Hz | $4 \times 10^{14}$ Hz to $8 \times 10^{14}$ Hz | $10^{11}$ Hz to $10^{14}$ Hz | $10^9$ Hz to $10^{11}$ Hz | below $10^9$ Hz |

Use this data to state whether the radar signal is at the short or long wavelength end of the electromagnetic spectrum.

Explain your answer.

.....  
 .....  
 .....  
 ..... [2]

- 7 The lake shown in Fig. 7.1 is a balanced ecosystem. The steady flow of nutrients into the lake enables the water plants to grow and provide food for the small animals and fish.

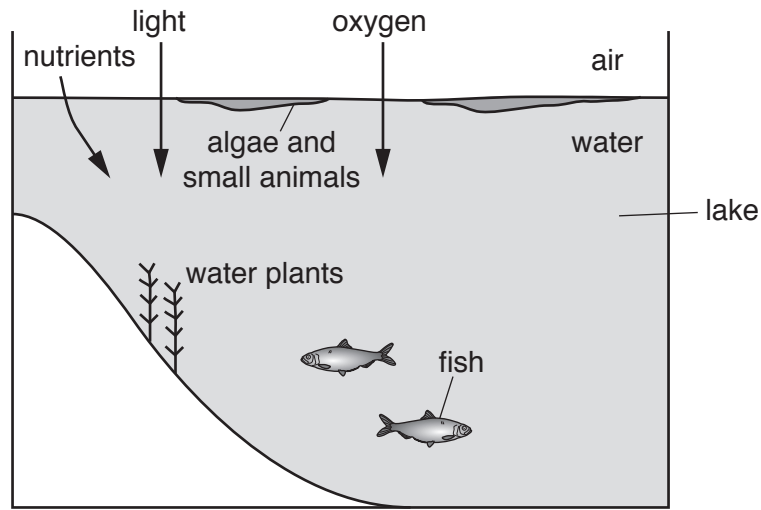


**Fig. 7.1**

- (a) Define the term *ecosystem*.

.....

.....

..... [2]

- (b) The feeding relationships of the organisms in Fig. 7.1 are as follows.

- the small animals feed on algae
- the fish feed on the algae, water plants and small animals.

Use the information provided to complete the food web which has been started below.

↑  
algae

↑  
water plants

[2]

- (c) The ecosystem becomes unbalanced when fertiliser is accidentally added to the lake.

The fertiliser increases the concentration of nutrients in the lake.

Fig. 7.2 shows the lake after a few weeks.

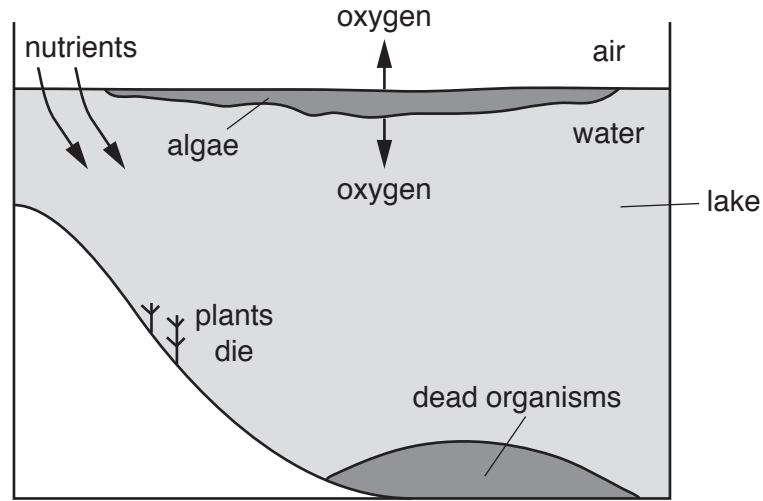


**Fig. 7.2**

- (i) Explain why the water plants beneath the surface die.

.....

.....

.....

..... [2]

- (ii) The fish die due to lack of oxygen. However, Fig. 7.2 shows the algae producing oxygen, some of which goes into the lake.

Explain what happens to the oxygen in the lake.

.....

.....

..... [2]

8 (a) An atom of element **X** is in Group VI of the Periodic Table.

(i) State the number of outer-shell electrons in an atom of **X**.

.....

[1]

(ii) State whether element **X** is a metal or a non-metal.

Suggest **one** physical property of element **X**.

metal or non-metal .....

physical property .....

[1]

(b) Chlorine,  $Cl$ , is in Group VII of the Periodic Table.

(i) Complete Fig. 8.1 to show the electronic structure of an atom of chlorine.

Use the Periodic Table on page 20.

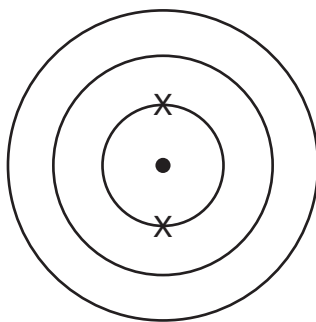


Fig. 8.1

[1]

(ii) Draw a dot-and-cross diagram to show all of the outer-shell electrons in a molecule of chlorine,  $Cl_2$ .

$Cl$        $Cl$

[1]

**(c)** Chlorine reacts with sodium to form a compound.

**(i)** State the type of chemical bond in this compound.

..... [1]

**(ii)** Describe what happens to sodium atoms and to chlorine atoms when they react together to form this compound.

Use ideas about electrons in your answer.

sodium atoms .....

chlorine atoms .....

[2]

**(d)** Noble gases are unreactive.

Explain this observation using ideas about the electronic structure of noble gas atoms.

.....

..... [1]

- 9 Fig. 9.1 shows a simple circuit set up to investigate the electrical properties of a lamp.

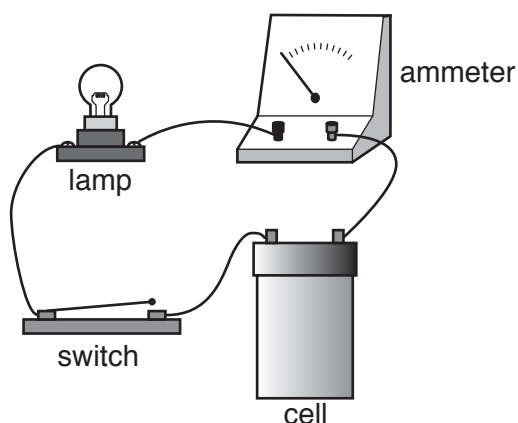


**Fig. 9.1**

- (a) (i) On Fig. 9.2 use the correct circuit symbols to complete the circuit diagram for the circuit shown in Fig. 9.1.

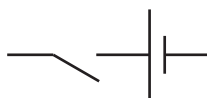


**Fig. 9.2**

[2]

- (ii) On Fig. 9.2, using the correct circuit symbol, connect a meter into the circuit that can measure the potential difference across the lamp. [2]

- (b) The cell has a voltage of 1.5V, and the reading on the ammeter is 0.6A for the circuit in Fig. 9.1. The lamp is brightly lit and hot to the touch.

Show by calculation that the power dissipated in the circuit is less than 1 W.

power = ..... W [1]

- (c) A second identical lamp is added in series with the lamp in the circuit in Fig. 9.1.

The reading on the ammeter decreases, and both lamps are now dimly lit and cool to the touch.

- (i) Explain why adding the second lamp causes the current to decrease.

.....

.....

..... [1]

- (ii) Explain why less light and thermal energy are emitted by the two bulbs than by one bulb on its own in the circuit.

.....

.....

.....

..... [2]

## The Periodic Table of Elements

| Group                      |                             |                                                                                                                    |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                             |                             |                               |                           |                              |                         |
|----------------------------|-----------------------------|--------------------------------------------------------------------------------------------------------------------|---------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|--------------------------------|-------------------------------|-------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|---------------------------|------------------------------|-------------------------|
| I                          | II                          | Key                                                                                                                |                                 |                             |                              |                             |                              |                              |                                |                               |                               | III                         | IV                          | V                           | VI                            | VII                       | VIII                         |                         |
|                            |                             | <div>1<br/>H<br/>hydrogen<br/>1</div> <div>atomic number<br/>atomic symbol<br/>name<br/>relative atomic mass</div> |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                             |                             |                               |                           |                              |                         |
| 3<br>Li<br>lithium<br>7    | 4<br>Be<br>beryllium<br>9   |                                                                                                                    |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             | 5<br>B<br>boron<br>11       | 6<br>C<br>carbon<br>12      | 7<br>N<br>nitrogen<br>14      | 8<br>O<br>oxygen<br>16    | 9<br>F<br>fluorine<br>19     | 10<br>Ne<br>neon<br>20  |
| 11<br>Na<br>sodium<br>23   | 12<br>Mg<br>magnesium<br>24 |                                                                                                                    |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             | 13<br>Al<br>aluminium<br>27 | 14<br>Si<br>silicon<br>28   | 15<br>P<br>phosphorus<br>31   | 16<br>S<br>sulfur<br>32   | 17<br>Cl<br>chlorine<br>35.5 | 18<br>Ar<br>argon<br>40 |
| 19<br>K<br>potassium<br>39 | 20<br>Ca<br>calcium<br>40   | 21<br>Sc<br>scandium<br>45                                                                                         | 22<br>Ti<br>titanium<br>48      | 23<br>V<br>vanadium<br>51   | 24<br>Cr<br>chromium<br>52   | 25<br>Mn<br>manganese<br>55 | 26<br>Fe<br>iron<br>56       | 27<br>Co<br>cobalt<br>59     | 28<br>Ni<br>nickel<br>59       | 29<br>Cu<br>copper<br>64      | 30<br>Zn<br>zinc<br>65        | 31<br>Ga<br>gallium<br>70   | 32<br>Ge<br>germanium<br>73 | 33<br>As<br>arsenic<br>75   | 34<br>Se<br>selenium<br>79    | 35<br>Br<br>bromine<br>80 | 36<br>Kr<br>krypton<br>84    |                         |
| 37<br>Rb<br>rubidium<br>85 | 38<br>Sr<br>strontium<br>88 | 39<br>Y<br>yttrium<br>89                                                                                           | 40<br>Zr<br>zirconium<br>91     | 41<br>Nb<br>niobium<br>93   | 42<br>Mo<br>molybdenum<br>96 | 43<br>Tc<br>technetium<br>— | 44<br>Ru<br>ruthenium<br>101 | 45<br>Rh<br>rhodium<br>103   | 46<br>Pd<br>palladium<br>106   | 47<br>Ag<br>silver<br>108     | 48<br>Cd<br>cadmium<br>112    | 49<br>In<br>indium<br>115   | 50<br>Sn<br>tin<br>119      | 51<br>Sb<br>antimony<br>122 | 52<br>Te<br>tellurium<br>128  | 53<br>I<br>iodine<br>127  | 54<br>Xe<br>xenon<br>131     |                         |
| 55<br>Cs<br>caesium<br>133 | 56<br>Ba<br>barium<br>137   | 57–71<br>lanthanoids                                                                                               | 72<br>Hf<br>hafnium<br>178      | 73<br>Ta<br>tantalum<br>181 | 74<br>W<br>tungsten<br>184   | 75<br>Re<br>rhenium<br>186  | 76<br>Os<br>osmium<br>190    | 77<br>Ir<br>iridium<br>192   | 78<br>Pt<br>platinum<br>195    | 79<br>Au<br>gold<br>197       | 80<br>Hg<br>mercury<br>201    | 81<br>Tl<br>thallium<br>204 | 82<br>Pb<br>lead<br>207     | 83<br>Bi<br>bismuth<br>209  | 84<br>Po<br>polonium<br>—     | 85<br>At<br>astatine<br>— | 86<br>Rn<br>radon<br>—       |                         |
| 87<br>Fr<br>francium<br>—  | 88<br>Ra<br>radium<br>—     | 89–103<br>actinoids                                                                                                | 104<br>Rf<br>rutherfordium<br>— | 105<br>Db<br>dubnium<br>—   | 106<br>Sg<br>seaborgium<br>— | 107<br>Bh<br>bohrium<br>—   | 108<br>Hs<br>hassium<br>—    | 109<br>Mt<br>meitnerium<br>— | 110<br>Ds<br>darmstadtium<br>— | 111<br>Rg<br>roentgenium<br>— | 112<br>Cn<br>copernicium<br>— |                             | 114<br>Fl<br>flerovium<br>— |                             | 116<br>Lv<br>livermorium<br>— |                           |                              |                         |
|                            |                             |                                                                                                                    |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                             |                             |                               |                           |                              | 2<br>He<br>helium<br>4  |

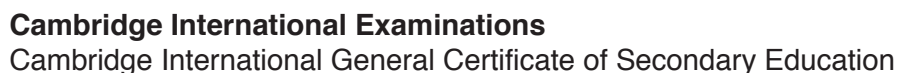
lanthanoids

|    |    |              |     |
|----|----|--------------|-----|
| 57 | La | lanthanum    | 139 |
| 58 | Ce | cerium       | 140 |
| 59 | Pr | praseodymium | 141 |
| 60 | Nd | neodymium    | 144 |
| 61 | Pm | promethium   | —   |
| 62 | Sm | samarium     | 150 |
| 63 | Eu | europlum     | 152 |
| 64 | Gd | gadolinium   | 157 |
| 65 | Tb | terbium      | 159 |
| 66 | Dy | dysprosium   | 163 |
| 67 | Ho | holmium      | 165 |
| 68 | Er | erbium       | 167 |
| 69 | Tm | thulium      | 169 |
| 70 | Yb | ytterbium    | 173 |
| 71 | Lu | lutetium     | 175 |

actinoids

|     |    |              |     |
|-----|----|--------------|-----|
| 89  | Ac | actinium     | —   |
| 90  | Th | thorium      | 232 |
| 91  | Pa | protactinium | 231 |
| 92  | U  | uranium      | 238 |
| 93  | Np | neptunium    | —   |
| 94  | Pu | plutonium    | —   |
| 95  | Am | americium    | —   |
| 96  | Cm | curium       | —   |
| 97  | Bk | berkelium    | —   |
| 98  | Cf | californium  | —   |
| 99  | Es | einsteinium  | —   |
| 100 | Fm | fermium      | —   |
| 101 | Md | mendelevium  | —   |
| 102 | No | nobelium     | —   |
| 103 | Lr | lawrencium   | —   |

The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.)



|  |
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0653/43

May/June 2017

**1 hour 15 minutes**

No Additional Materials are required.

## READ THESE INSTRUCTIONS FIRST

DO **NOT** WRITE IN ANY BARCODES.

A copy of the Periodic Table is printed on page 24.

The number of marks is given in brackets [ ] at the end of each question or part question.

This document consists of **24** printed pages.

- 1 (a) Use lines to connect the box on the left to different boxes on the right to make correct sentences.

One is done for you. The sentence reads 'Tobacco smoke contains nicotine'.

Draw **three** more lines to make three more correct sentences.

|               |                                                                   |
|---------------|-------------------------------------------------------------------|
|               | keeps bacteria out of the airway.                                 |
|               | increases the concentration of carbon monoxide in the blood.      |
|               | damages the cilia in the airway.                                  |
| Tobacco smoke | contains nicotine.                                                |
|               | can cure bronchitis.                                              |
|               | does not contain tar if a filter tip is present on the cigarette. |
|               | causes more mucus to be produced in the lungs.                    |

[3]

- (b) Fig. 1.1 shows a diagram of an alveolus and a blood capillary.

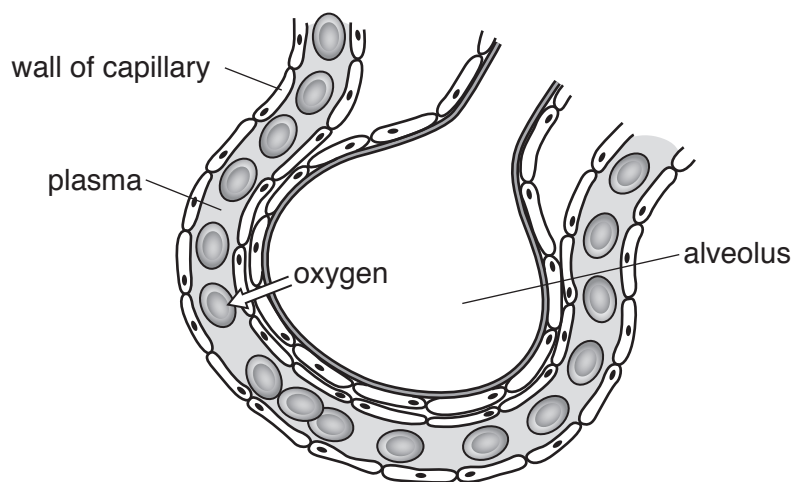


Fig. 1.1

- (i) On Fig. 1.1 draw an arrow to show the net movement of carbon dioxide molecules at the alveolus.

[1]

(ii) List **two** features of alveoli that make them a good gas exchange surface.

1. ....
  2. ....
- [2]

(c) Oxygen enters the blood as shown in Fig. 1.1.

Describe how oxygen is transported from the alveolus to the heart.

.....

.....

.....

.....

..... [3]

(d) Increased secretion of adrenaline causes the concentration of blood glucose and pulse rate to increase. This enables an increase in the respiration rate in cells to occur.

(i) Describe how an increase in blood glucose concentration enables an increase in the respiration rate in cells to occur.

.....

.....

..... [1]

(ii) Describe how an increase in pulse rate enables an increase in the respiration rate in cells to occur.

.....

.....

..... [1]

- 2 (a) Ethane and octane are obtained from petroleum by fractional distillation.

The structures of a molecule of ethane and a molecule of octane are shown in Fig. 2.1.

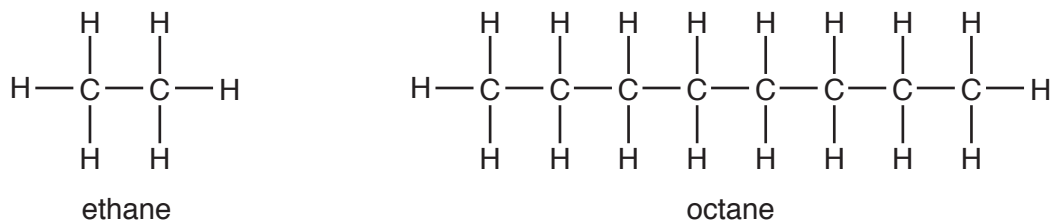


**Fig. 2.1**

- (i) State the formula of octane.

..... [1]

- (ii) Different fractions obtained from petroleum contain different amounts of ethane and octane.

Explain why a fraction formed higher up the fractional distillation column contains more ethane than octane.

Use ideas about molecular size, boiling points and intermolecular attractive forces in your answer.

.....

.....

.....

.....

.....

..... [3]

- (b) Ethene molecules are made from large hydrocarbon molecules.

Name this process.

..... [1]

- (c) Ethane, ethene and octane are hydrocarbons.

Identify the type of each of these hydrocarbons.

ethane .....

ethene .....

octane .....

[2]

(d) Complete the diagram below to show the bonding electrons in a molecule of ethene,  $\text{C}_2\text{H}_4$ .

Use dots and crosses to represent the electrons.



[2]

- 3 Fig. 3.1 shows a cyclist riding her bicycle at a constant speed along a road. The arrows labelled **A**, **B**, **C** and **D** show the forces acting on the bicycle.

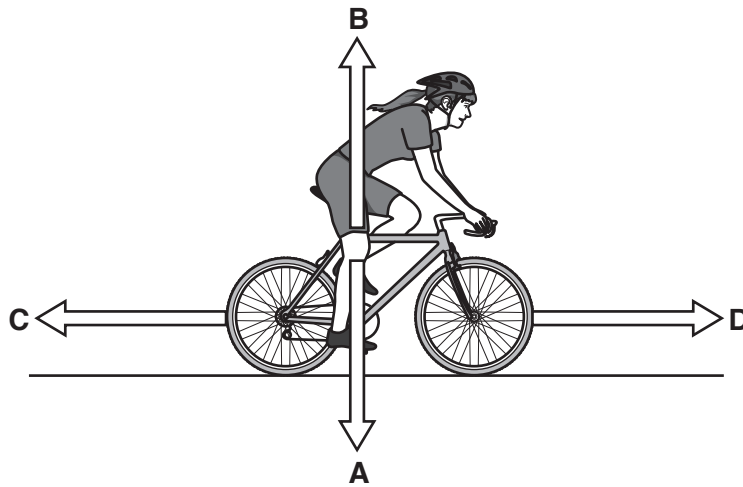


Fig. 3.1

- (a) (i) State which letter, **A**, **B**, **C** or **D**, corresponds to

1. frictional force .....

2. weight .....

[1]

- (ii) Force **A** is measured and found to be 1000 N.

State whether force **B** is 1000 N or has a different value.

Give a reason for your answer.

.....

..... [1]

- (b) The cyclist goes downhill at a constant speed of 15 km/h. The road down the hill is 1 km long.

Calculate the time in seconds for the cyclist to reach the bottom of the hill.

Show your working.

time = ..... s [2]

- (c) The cyclist and her bicycle have a total mass of 100 kg. She is moving at 4 m/s.

Calculate the kinetic energy of the cyclist and her bicycle.

State the formula you use and show your working.

formula

working

kinetic energy = ..... J [2]

- (d) The cyclist works at a rate of 120 W as she cycles. She produces a driving force of 25 N to move the bicycle.

The cyclist and bicycle travel 1000 m in 250 s.

- (i) Calculate the energy input by the cyclist for this journey.

Show your working.

energy input = ..... J [1]

- (ii) Calculate the work done in moving the cyclist and bicycle for this journey.

State the formula you use and show your working.

formula

working

work done = ..... J [2]

- (iii) Calculate the percentage efficiency of the bicycle.

State the formula you use and show your working.

formula

working

efficiency = .....% [2]

**Please turn over for Question 4**

- 4 Fig. 4.1 shows what happens to a seed after it is planted. The responses shown by the shoot and root are controlled by plant hormones called auxins.

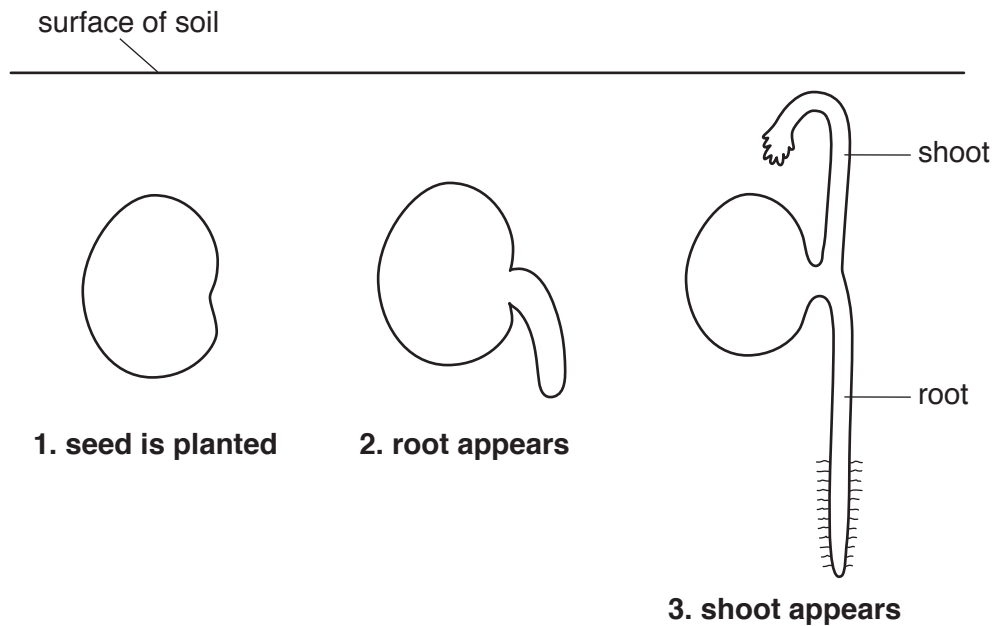


**Fig. 4.1**

- (a) Name the response shown by both the root and the shoot in Fig. 4.1.

..... [1]

- (b) A second similar seed is germinated and pinned on a vertical board as shown in Fig. 4.2. The apparatus is kept in the dark. The distribution of auxin hormones becomes uneven in the seedling.

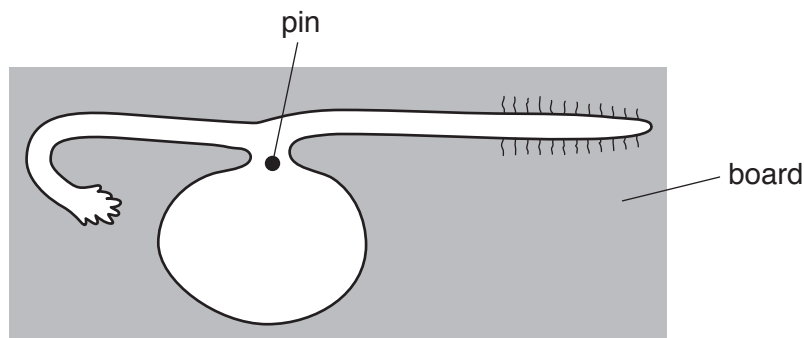


**Fig. 4.2**

- (i) Complete Fig. 4.3 to show how the growth of the shoot and root will change over the next few days.

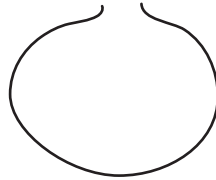


**Fig. 4.3**

[2]

- (ii) In terms of the action of auxins, explain your answer to (i) for the **shoot** only.

.....

.....

.....

..... [2]

- (c) Acid rain is produced as the result of burning fossil fuels. Acid rain can reduce the rate of germination of seeds.

- (i) Describe how acid rain is produced.

.....

.....

.....

..... [2]

- (ii) Suggest how acid rain reduces germination of seeds.

.....

.....

..... [1]

- 5 (a) The atomic number of magnesium is 12.

Complete Fig. 5.1 to show the electronic structure of a magnesium atom.



Fig. 5.1

[2]

- (b) A student investigates the reaction between magnesium and dilute hydrochloric acid.

The student uses the apparatus shown in Fig. 5.2 for the investigation.

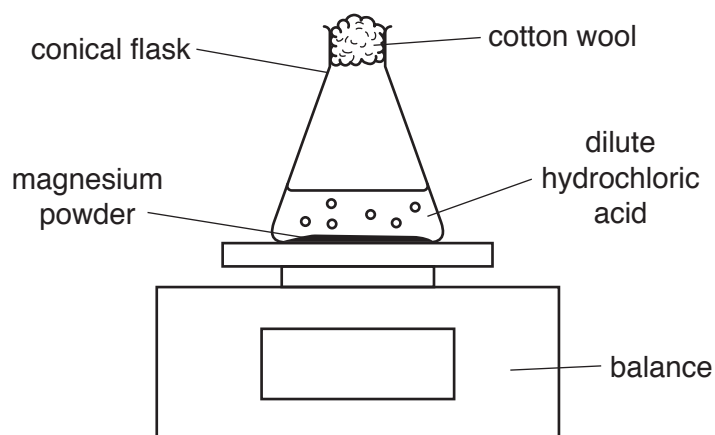


Fig. 5.2

Fig. 5.3 shows the mass of the conical flask and its contents during the reaction.

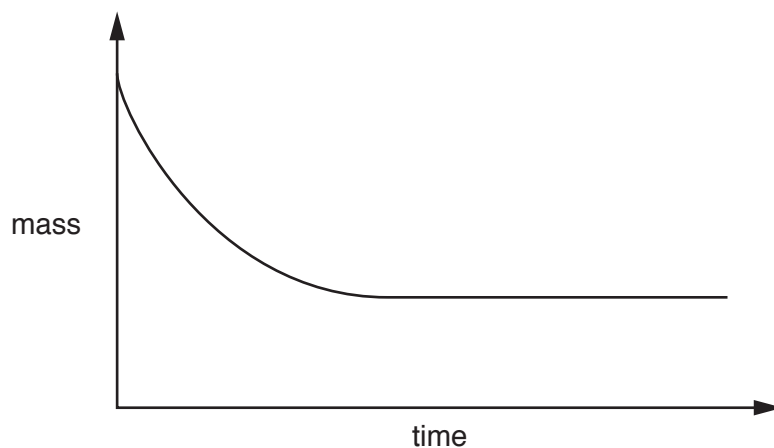


Fig. 5.3

(i) Explain why

at first the mass decreases,

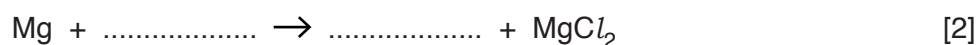
.....  
 .....

later on the mass does not change.

.....  
 .....

[2]

(ii) Complete and balance the symbolic equation for this reaction.



(c) (i) State the effect, if any, of using a higher temperature on the rate of a reaction.

Explain your answer in terms of particle collisions.

effect .....

explanation .....

.....  
 .....

[2]

(ii) State the effect of using a catalyst on the rate of a reaction.

Describe the change, if any, to the catalyst at the end of the reaction.

effect .....

change to catalyst .....

[2]

- 6 Fig. 6.1 shows a man riding a snowmobile across snow and ice at a research station in Antarctica.



Fig. 6.1

- (a) The temperature of the air is  $-40^{\circ}\text{C}$ , but the man must keep his body temperature at  $37^{\circ}\text{C}$ .
- (i) State the main method of thermal energy transfer from the man through his clothing to the outside.
- ..... [1]
- (ii) The man wears several layers of thin clothing which trap air between them, instead of one layer of thick clothing.

Suggest **one** reason for this.

.....

..... [1]

(b) The snowmobile is driven by a gasoline (petrol) engine. Inside the engine, temperatures reach  $800^{\circ}\text{C}$  as the fuel burns. The combustion of the fuel forms carbon dioxide and water molecules.

(i) State which of the diagrams in Fig. 6.2, **X**, **Y** or **Z**, shows the arrangement of molecules as they are formed in the engine.

Give a reason for your answer.

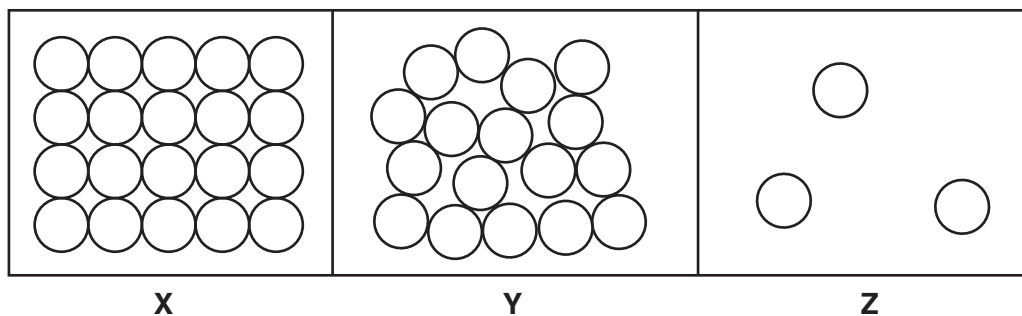


**Fig. 6.2**

diagram .....

reason .....

..... [1]

(ii) Fig. 6.3 shows white trails coming out of the engines of an aircraft landing at the research station when the air temperature was  $-45^{\circ}\text{C}$ .

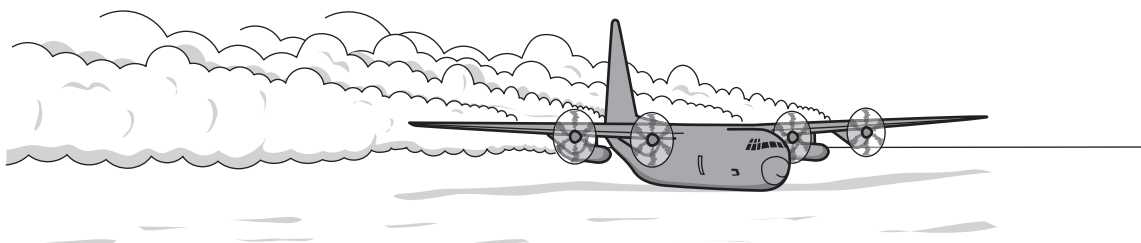


**Fig. 6.3**

Suggest what these white trails are made of. Give a reason for your answer.

The white trails are made of .....

reason .....

..... [2]

(c) Antarctic research stations use satellites to relay communications to their home bases.

(i) Name the part of the electromagnetic spectrum used for satellite communications.

..... [1]

(ii) On Fig. 6.4, put the part of the electromagnetic spectrum you have named in (i) in its correct place in the incomplete electromagnetic spectrum.

|  |        |  |                  |  |  |  |
|--|--------|--|------------------|--|--|--|
|  | X-rays |  | visible<br>light |  |  |  |
|--|--------|--|------------------|--|--|--|

Fig. 6.4

[1]

(d) The man on the snowmobile uses a radio to talk to the aircraft pilot as he watches the aircraft landing. He can hear the sound of the engines of the aircraft in Fig. 6.3 several kilometres away.

(i) The man hears the sound of the engines for several seconds after the pilot says over the radio that the engines have been switched off.

Explain why this happens.

.....  
..... [1]

(ii) Describe how the engines produce sound and how this is transmitted to the man.

.....  
.....  
..... [2]

**Please turn over for Question 7**

7 Fig. 7.1 shows a diagram of the cells in a cross section of a leaf.

(a) Most photosynthesis takes place in the palisade cells of the leaf.

Complete the balanced symbol equation for photosynthesis.

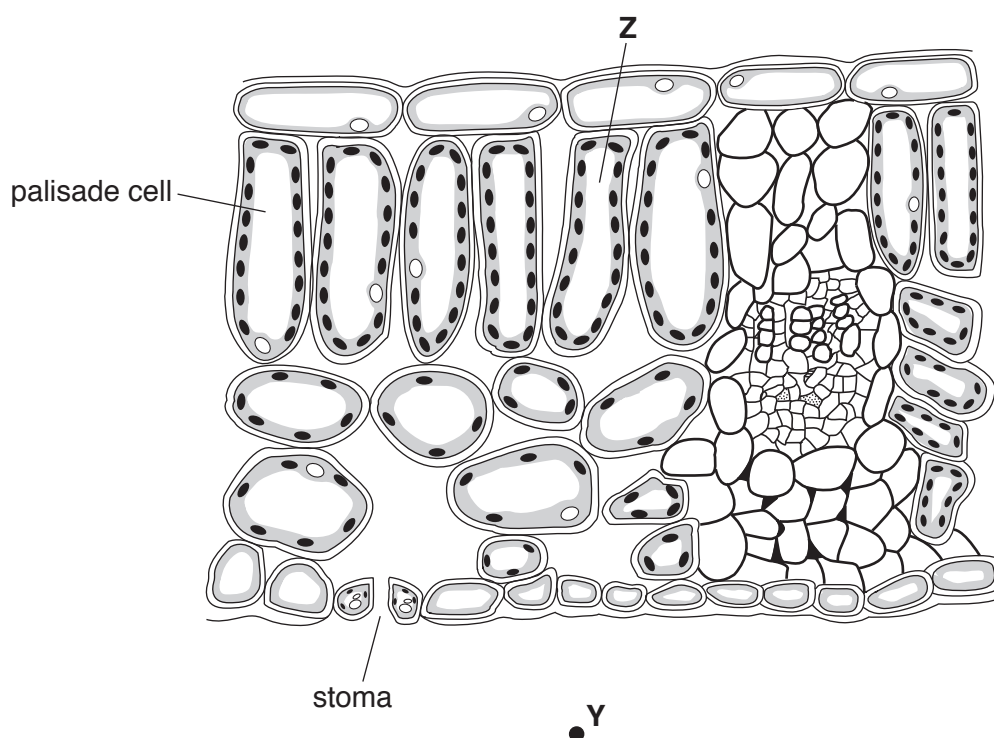


Fig. 7.1

(b) On Fig. 7.1

- (i) draw a line to show a possible path taken by carbon dioxide from point Y to palisade cell Z, [1]
- (ii) label the tissue that provides water for the leaf. [1]

- (c) When the stomata are open there is a net movement of water molecules by diffusion out of the leaf. This is called transpiration.

Fig. 7.2 shows the area around the stoma of the leaf shown in Fig. 7.1.

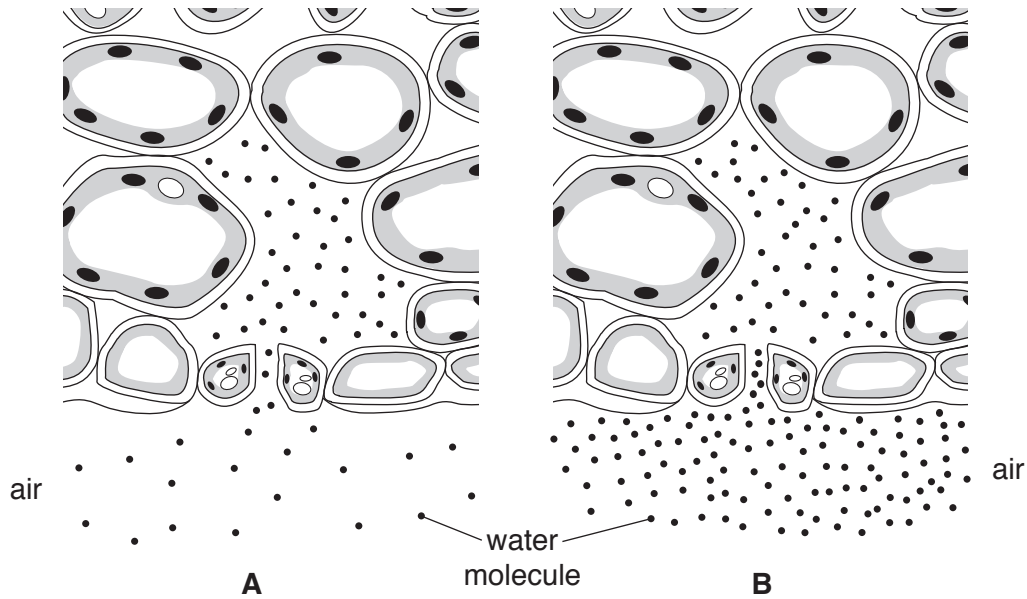


Fig. 7.2

- (i) Describe how the water molecules get into the space inside the leaf above the stoma, as shown in Fig. 7.2.

.....  
 .....  
 ..... [2]

- (ii) Fig. 7.2 shows a difference in the environment around the leaf in diagram **A** compared with diagram **B**.

Predict whether the rate of transpiration will be greater in **A** or **B**.

Explain your answer.

.....  
 .....  
 ..... [2]

- 8 (a) The melting points of the first four Group I metals are shown in Table 8.1.

**Table 8.1**

| Group I metal | melting point/°C |
|---------------|------------------|
| lithium, Li   | 180              |
| sodium, Na    | 98               |
| potassium, K  | 64               |
| rubidium, Rb  | .....            |

Complete Table 8.1 by suggesting the melting point of rubidium, Rb.

[1]

- (b) A student investigates the reaction between four metals, **A**, **B**, **C** and **D**, and the oxides of these metals.

The results of this investigation are shown in Table 8.2.

**Table 8.2**

| metal    | metal oxide |         |         |         |
|----------|-------------|---------|---------|---------|
|          | A oxide     | B oxide | C oxide | D oxide |
| <b>A</b> |             | ✓       | X       | ✓       |
| <b>B</b> | X           |         | X       | ✓       |
| <b>C</b> | ✓           | ✓       |         | ✓       |
| <b>D</b> | X           | X       | X       |         |

key  
 ✓ reaction  
 X no reaction

- (i) Deduce the order of reactivity of the four metals, from most reactive to least reactive.

..... most reactive  
 .....  
 .....  
 .....  
 ..... least reactive

[2]

- (ii) The reaction between metal **A** and metal **B** oxide is exothermic.

Describe the energy transformation which occurs during an exothermic reaction.

.....

.....

..... [2]

- (c) Sodium, Na, is extracted from sodium chloride, NaCl, by electrolysis, as shown in Fig. 8.1.

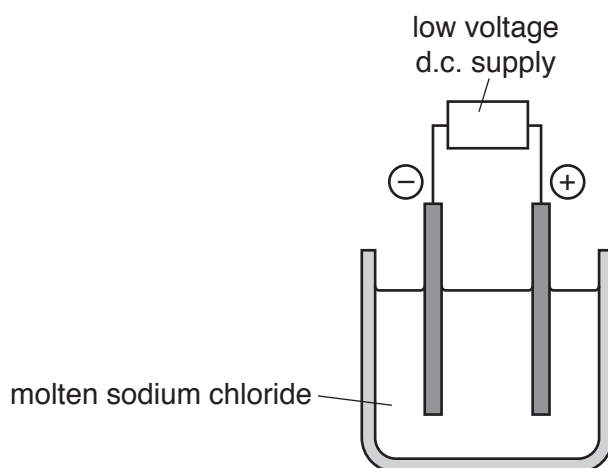


**Fig. 8.1**

- (i) Name the electrode at which sodium forms.

..... [1]

- (ii) State the gas that is formed during this electrolysis.

..... [1]

- (iii) Explain, in terms of ions, why the sodium chloride must be molten rather than solid during this electrolysis.

.....

.....

..... [1]

- 9 Fig. 9.1 shows a circuit set up to measure the current in different parts of a circuit.

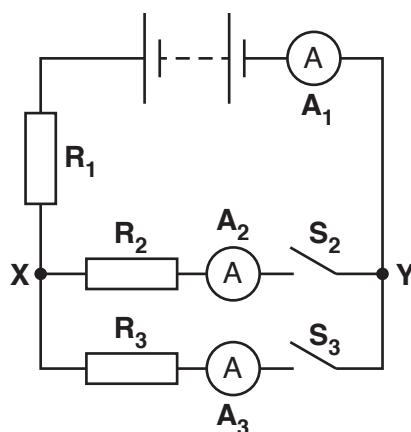


Fig. 9.1

- (a) When both switches are closed, ammeter  $A_1$  reads 6A and ammeter  $A_2$  reads 1.5A.

- (i) Predict the reading on ammeter  $A_3$ .

Give a reason for your answer.

Reading on  $A_3$  = ..... A

reason .....

.....

.....

[1]

- (ii) Deduce why different currents are recorded on ammeters  $A_2$  and  $A_3$ .

Give reasons for your answer.

.....

.....

.....

..... [2]

(b) A voltmeter is connected across the battery. The reading is 12 V.

Switch  $S_2$  is closed, but switch  $S_3$  is left open. Ammeter  $A_1$  reads 3 A.

The voltmeter is now connected between points **X** and **Y**. The reading is 3 V.

(i) State the reading on ammeter  $A_2$ .

reading = ..... A [1]

(ii) Deduce the value of resistance  $R_1$ .

Show your working.

value of  $R_1$  = .....  $\Omega$  [2]

# The Periodic Table of Elements

| Group                      |                             |                                                                              |                             |                             |                              |                             |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |  |
|----------------------------|-----------------------------|------------------------------------------------------------------------------|-----------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|----------------------------|------------------------------|---------------------------|----------------------------|-----------------------------|-----------------------------|-----------------------------|------------------------------|------------------------------|---------------------------|--|
| I                          | II                          | 1<br>H<br>hydrogen<br>1                                                      |                             |                             |                              |                             |                              |                            |                              |                           |                            | III                         | IV                          | V                           | VI                           | VII                          | VIII                      |  |
|                            |                             | <div>Key</div>                                                               |                             |                             |                              |                             |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |  |
|                            |                             | <div>atomic number<br/>atomic symbol<br/>name<br/>relative atomic mass</div> |                             |                             |                              |                             |                              |                            |                              |                           |                            |                             |                             |                             |                              |                              |                           |  |
| 3<br>Li<br>lithium<br>7    | 4<br>Be<br>beryllium<br>9   |                                                                              |                             |                             |                              |                             |                              |                            |                              |                           |                            | 5<br>B<br>boron<br>11       | 6<br>C<br>carbon<br>12      | 7<br>N<br>nitrogen<br>14    | 8<br>O<br>oxygen<br>16       | 9<br>F<br>fluorine<br>19     | 2<br>He<br>helium<br>4    |  |
| 11<br>Na<br>sodium<br>23   | 12<br>Mg<br>magnesium<br>24 |                                                                              |                             |                             |                              |                             |                              |                            |                              |                           |                            | 13<br>Al<br>aluminium<br>27 | 14<br>Si<br>silicon<br>28   | 15<br>P<br>phosphorus<br>31 | 16<br>S<br>sulfur<br>32      | 17<br>Cl<br>chlorine<br>35.5 | 18<br>Ar<br>argon<br>40   |  |
| 19<br>K<br>potassium<br>39 | 20<br>Ca<br>calcium<br>40   | 21<br>Sc<br>scandium<br>45                                                   | 22<br>Ti<br>titanium<br>48  | 23<br>V<br>vanadium<br>51   | 24<br>Cr<br>chromium<br>52   | 25<br>Mn<br>manganese<br>55 | 26<br>Fe<br>iron<br>56       | 27<br>Co<br>cobalt<br>59   | 28<br>Ni<br>nickel<br>59     | 29<br>Cu<br>copper<br>64  | 30<br>Zn<br>zinc<br>65     | 31<br>Ga<br>gallium<br>70   | 32<br>Ge<br>germanium<br>73 | 33<br>As<br>arsenic<br>75   | 34<br>Se<br>selenium<br>79   | 35<br>Br<br>bromine<br>80    | 36<br>Kr<br>krypton<br>84 |  |
| 37<br>Rb<br>rubidium<br>85 | 38<br>Sr<br>strontium<br>88 | 39<br>Y<br>yttrium<br>89                                                     | 40<br>Zr<br>zirconium<br>91 | 41<br>Nb<br>niobium<br>93   | 42<br>Mo<br>molybdenum<br>96 | 43<br>Tc<br>technetium      | 44<br>Ru<br>ruthenium<br>101 | 45<br>Rh<br>rhodium<br>103 | 46<br>Pd<br>palladium<br>106 | 47<br>Ag<br>silver<br>108 | 48<br>Cd<br>cadmium<br>112 | 49<br>In<br>indium<br>115   | 50<br>Sn<br>tin<br>119      | 51<br>Sb<br>antimony<br>122 | 52<br>Te<br>tellurium<br>128 | 53<br>I<br>iodine<br>127     | 54<br>Xe<br>xenon<br>131  |  |
| 55<br>Cs<br>caesium<br>133 | 56<br>Ba<br>barium<br>137   | 57–71<br>lanthanoids                                                         | 72<br>Hf<br>hafnium<br>178  | 73<br>Ta<br>tantalum<br>181 | 74<br>W<br>tungsten<br>184   | 75<br>Re<br>rhenium<br>186  | 76<br>Os<br>osmium<br>190    | 77<br>Ir<br>iridium<br>192 | 78<br>Pt<br>platinum<br>195  | 79<br>Au<br>gold<br>197   | 80<br>Hg<br>mercury<br>201 | 81<br>Tl<br>thallium<br>204 | 82<br>Pb<br>lead<br>207     | 83<br>Bi<br>bismuth<br>209  | 84<br>Po<br>polonium         | 85<br>At<br>astatine         | 86<br>Rn<br>radon         |  |
| 87<br>Fr<br>francium       | 88<br>Ra<br>radium          | 89–103<br>actinoids                                                          | 104<br>Rf<br>rutherfordium  | 105<br>Db<br>dubnium        | 106<br>Sg<br>seaborgium      | 107<br>Bh<br>bohrium        | 108<br>Hs<br>hassium         | 109<br>Mt<br>meitnerium    | 110<br>Ds<br>darmstadtium    | 111<br>Rg<br>roentgenium  | 112<br>Cn<br>copernicium   | 114<br>Fl<br>flerovium      | 116<br>Lv<br>livermorium    |                             |                              |                              |                           |  |

|                               |                               |                                 |                               |                              |                             |
|-------------------------------|-------------------------------|---------------------------------|-------------------------------|------------------------------|-----------------------------|
| lanthanoids                   |                               |                                 |                               |                              |                             |
| 57<br>La<br>lanthanum<br>139  | 58<br>Ce<br>cerium<br>140     | 59<br>Pr<br>praseodymium<br>141 | 60<br>Nd<br>neodymium<br>144  | 61<br>Pm<br>promethium<br>—  | 62<br>Sm<br>samarium<br>150 |
| 63<br>Eu<br>europium<br>152   | 64<br>Gd<br>gadolinium<br>157 | 65<br>Tb<br>terbium<br>159      | 66<br>Dy<br>dysprosium<br>163 | 67<br>Ho<br>holmium<br>165   | 68<br>Er<br>erbium<br>167   |
| 69<br>Tm<br>thulium<br>169    | 70<br>Yb<br>ytterbium<br>173  | 71<br>Lu<br>lutetium<br>175     |                               |                              |                             |
| actinoids                     |                               |                                 |                               |                              |                             |
| 89<br>Ac<br>actinium<br>—     | 90<br>Th<br>thorium<br>232    | 91<br>Pa<br>protactinium<br>231 | 92<br>U<br>uranium<br>238     | 93<br>Np<br>neptunium<br>—   | 94<br>Pu<br>plutonium<br>—  |
| 95<br>Am<br>americium<br>—    | 96<br>Cm<br>curium<br>—       | 97<br>Bk<br>berkelium<br>—      | 98<br>Cf<br>californium<br>—  | 99<br>Es<br>einsteinium<br>— | 100<br>Fm<br>fermium<br>—   |
| 101<br>Md<br>mendelevium<br>— | 102<br>No<br>nobelium<br>—    | 103<br>Lr<br>lawrencium<br>—    |                               |                              |                             |

The volume of one mole of any gas is  $24 \text{ dm}^3$  at room temperature and pressure (r.t.p.)