

# Cambridge IGCSE™

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## COMBINED SCIENCE

0653/31

## Paper 3 Theory (Core)

October/November 2020

**1 hour 15 minutes**

You must answer on the question paper.

No additional materials are needed.

## INSTRUCTIONS

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

## INFORMATION

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **20** pages. Blank pages are indicated.

- 1 (a) Fig. 1.1 is a diagram of some parts of the body.

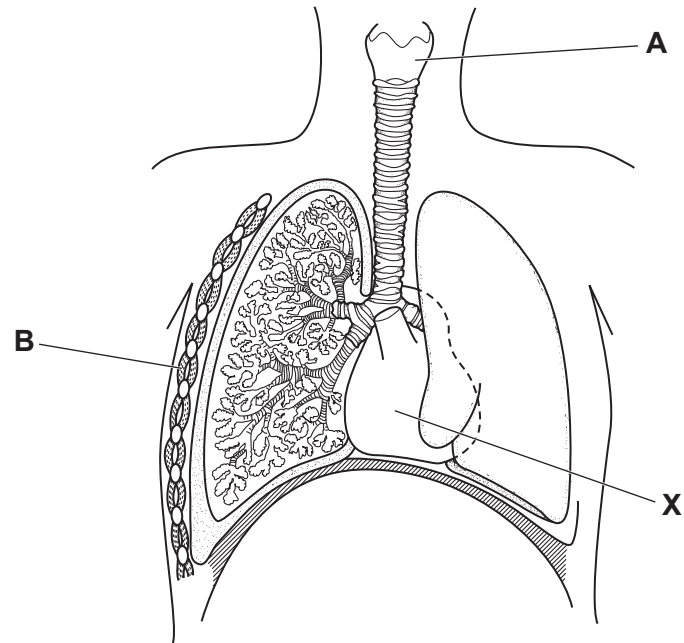


Fig. 1.1

- (i) Identify parts **A** and **B** shown in Fig. 1.1.

**A** .....

**B** ..... [2]

- (ii) Describe the function of part **X** shown in Fig. 1.1.

.....

..... [1]

(b) Fig. 1.2 shows the rate and depth of breathing of a person while at rest and during exercise.

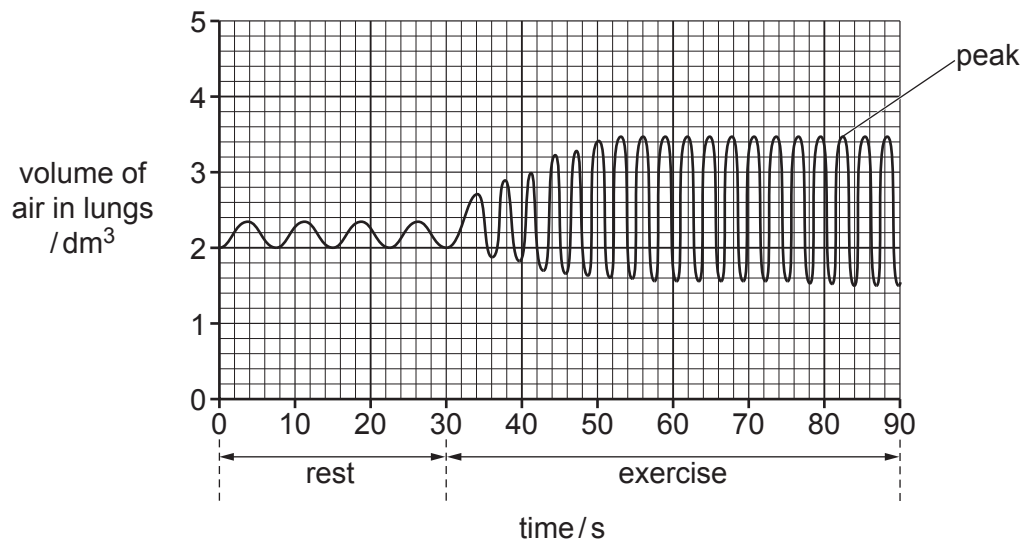


**Fig. 1.2**

Each time the line rises to a peak, the person is breathing in.

(i) Use Fig. 1.2 to determine the number of breaths the person takes while at rest.

number of breaths = ..... [1]

(ii) Describe how the rate and depth of breathing of the person change during exercise, as shown in Fig. 1.2.

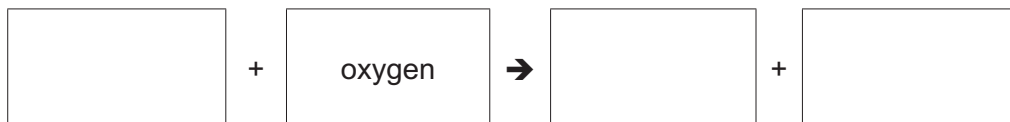
rate .....

depth .....

[2]

(c) The purpose of breathing is to obtain oxygen for respiration.

Complete the word equation for respiration.



[2]

[Total: 8]

- 2 (a) Copper is extracted from copper oxide by heating with carbon, as shown in Fig. 2.1.

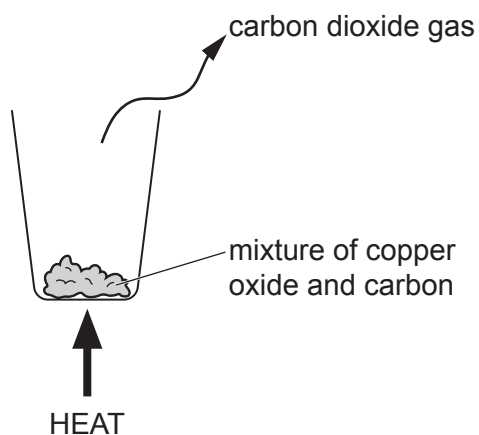
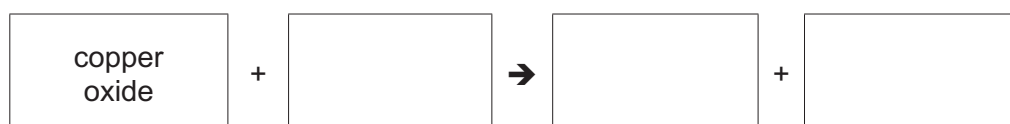


Fig. 2.1

Carbon dioxide is produced in this process.

- (i) Complete the word equation for this process.



[2]

- (ii) Use words from the list to describe substances involved in this process.

Each word may be used once, more than once or not at all.

**atoms**

**compound**

**covalent**

**element**

**ionic**

**ions**

**solution**

Copper oxide is a ..... containing oppositely charged .....

In carbon dioxide, each molecule contains three .....  
chemically joined by ..... bonds.

[4]

- (iii) State whether the change from copper oxide to copper during this process is oxidation or reduction.

Explain your answer.

change .....

explanation .....

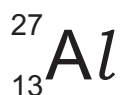
..... [1]

- (b) Aluminium is extracted from the ore bauxite.

- (i) State the method of extraction of aluminium from bauxite.

..... [1]

- (ii) An atom of aluminium is represented by the symbol shown.



Deduce the number of electrons and the number of neutrons in this atom.

electrons .....

neutrons .....

[2]

[Total: 10]

- 3 (a) Fig. 3.1 shows the distance–time graph for a man.

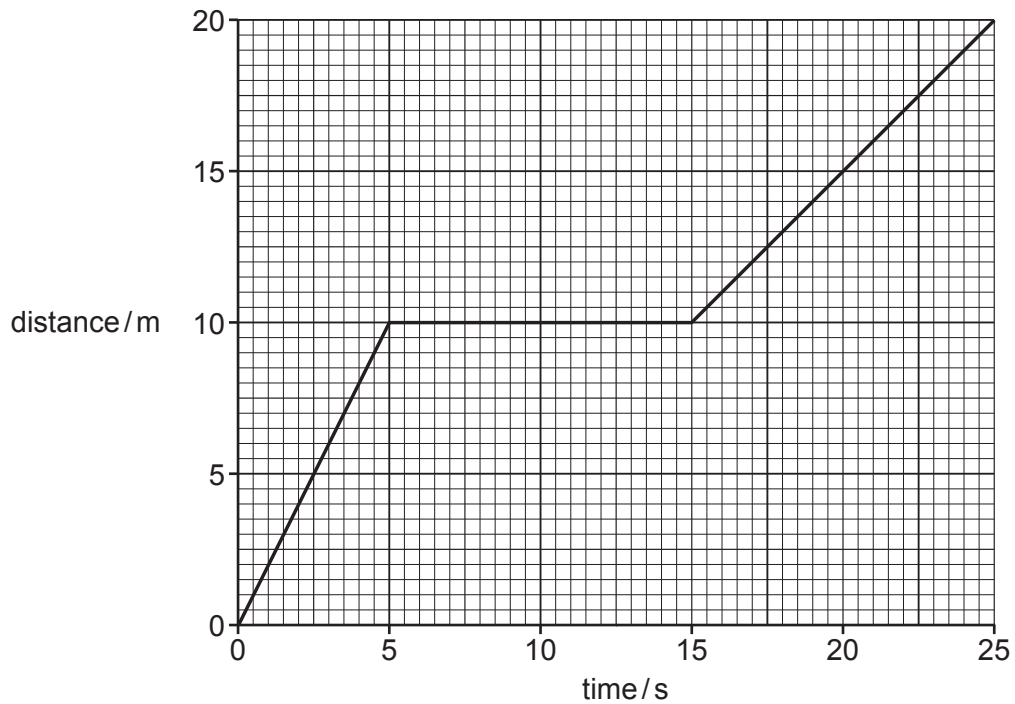


**Fig. 3.1**

- (i) Suggest what the man is doing between 5 s and 15 s.  
 ..... [1]
- (ii) On Fig. 3.1, draw an **X** on the graph to show when the man is moving fastest. [1]
- (iii) Use Fig. 3.1 to calculate the average speed of the man for the 25 s.

speed = ..... m/s [2]

- (b) The weight of the man is 800 N.

The gravitational field strength  $g$  is 10 N/kg.

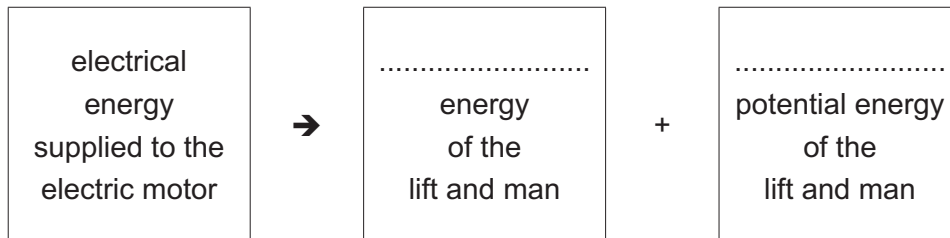
Calculate the mass of the man.

mass = ..... kg [1]

- (c) (i) The man enters a lift (elevator). The lift moves the man vertically upwards.

The lift uses an electric motor.

Complete the useful energy transfers for the lift and man.



[2]

- (ii) The amount of electrical energy supplied to the electric motor is actually greater than the useful work done in moving the lift and man up to the higher level.

Suggest why.

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

[Total: 9]

- 4 (a) Fig. 4.1 shows diagrams of a plant cell before and after the cell is immersed in concentrated sugar solution.

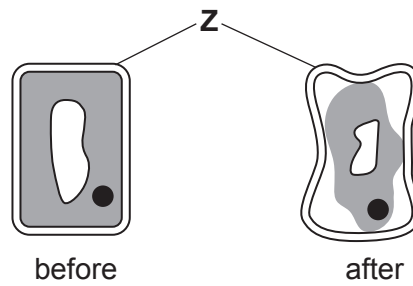


Fig. 4.1

- (i) Identify part **Z** shown in Fig. 4.1.

..... [1]

- (ii) Describe the effect of immersing the cell in concentrated sugar solution.

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

(b) Fig. 4.2 is a drawing of a cross-section of a plant root.

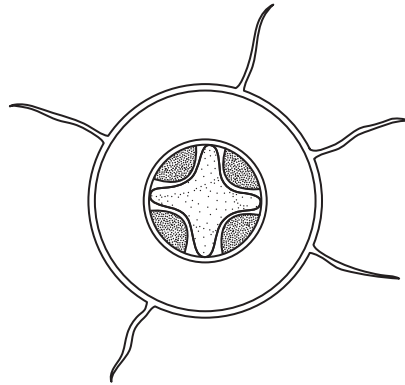


**Fig. 4.2**

(i) On Fig. 4.2, use a label line and the letter **X** to show the position of the xylem. [1]

(ii) State the function of root hair cells.

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

(iii) Water moves through xylem vessels to the leaves due to transpiration.

State the process by which water in the leaves is lost:

from the surface of the mesophyll cells .....  
 through the stomata. .... [2]

(c) Water is used in photosynthesis.

Photosynthesis is the process by which plants manufacture carbohydrates from raw materials using energy from light.

(i) State the name of the structures inside plant cells where photosynthesis takes place.

..... [1]

(ii) State the name of the gas produced in photosynthesis.

..... [1]

[Total: 9]

5 (a) Air is a mixture of different gases.

(i) Name the gas that makes up 78% of clean air.

..... [1]

(ii) Name the gas that must be present for iron to rust.

..... [1]

(iii) Name **one** common air pollutant and describe **one** adverse effect that is caused by this pollutant.

pollutant .....

adverse effect ..... [2]

(iv) State the formulae of **two** greenhouse gases.

1 .....

2 ..... [2]

(b) Fig. 5.1 is an incomplete dot-and-cross diagram of a molecule of water.

On Fig. 5.1, draw dots and crosses to show **all** of the outer shell electrons in a molecule of water.

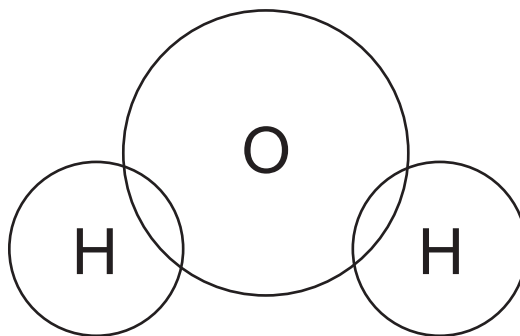


Fig. 5.1

[3]

(c) Describe the effect of water on blue cobalt(II) chloride.

..... [1]

[Total: 10]

- 6 Fig. 6.1 shows a girl using a bicycle pump to add air to a bicycle tyre.

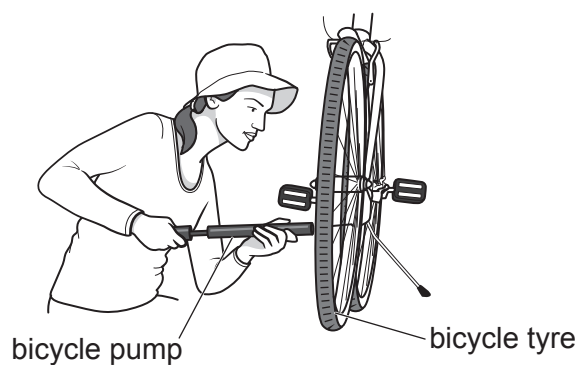


**Fig. 6.1**

- (a) Fig. 6.2 shows the arrangement of molecules in the air inside the bicycle tyre.

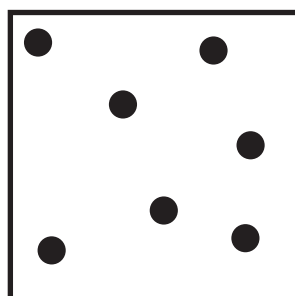


**Fig. 6.2**

- (i) Suggest what happens to the separation of the molecules as the girl pumps more air into the tyre.

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

- (ii) The temperature of the air in the tyre increases.

Describe how the movement of the molecules changes as this happens.

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

(b) Fig. 6.3 shows the girl wearing a cotton hat on a sunny day.

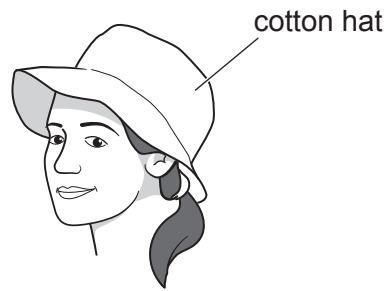


**Fig. 6.3**

(i) State the method of energy transfer from the Sun to the Earth.

..... [1]

(ii) Suggest **two** ways the cotton hat reduces energy transfer from the Sun to the girl's head.

1 .....

.....

2 .....

.....

[2]

(iii) The girl puts a sunscreen cream on the skin of her face.

Suggest how this precaution helps reduce the risk of sunburn.

.....

.....

..... [2]

(c) Fig. 6.4 shows a bell fixed on the handlebars of the bicycle.

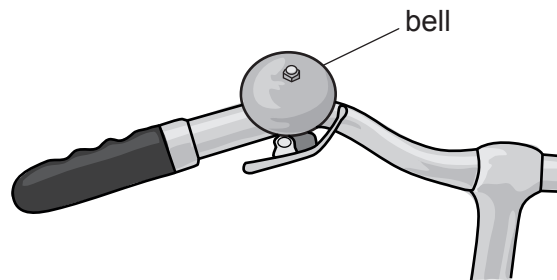


**Fig. 6.4**

(i) Fig. 6.5 represents the sound wave produced when the girl rings the bell.

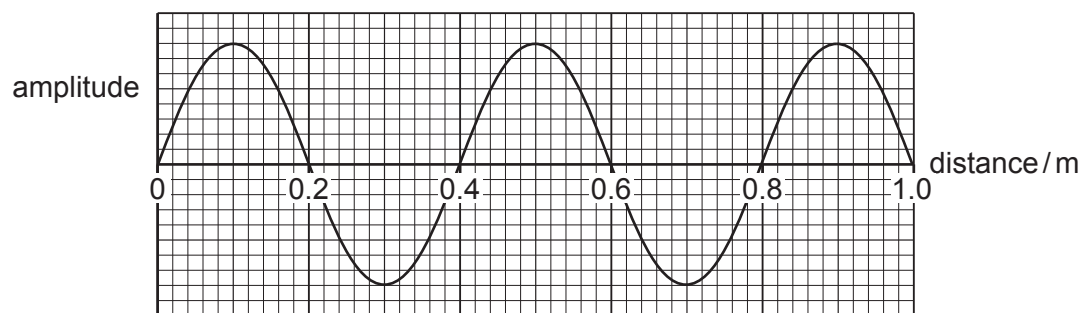


**Fig. 6.5**

Use Fig. 6.5 to find the wavelength of the sound wave produced by the bell.

wavelength = ..... m [1]

(ii) The girl makes the bell ring louder.

Describe the difference this makes to the sound wave produced.

..... [1]

[Total: 9]

- 7 (a) The boxes on the left show some parts of the male reproductive system in humans. The boxes on the right show the function of each part.

Draw **one** straight line from each part to its function.

| part           | function                                              |
|----------------|-------------------------------------------------------|
| penis          | production of sperm                                   |
| prostate gland | secretion of fluid for sperm to swim in               |
| testes         | transfer of semen to vagina during sexual intercourse |

[2]

- (b) Fig. 7.1 is a diagram of the female reproductive system in humans.

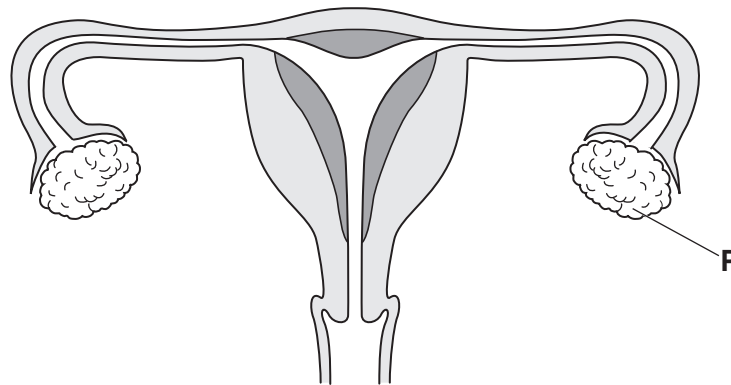


**Fig. 7.1**

- (i) On Fig. 7.1, use a label line and the letter **F** to show where fertilisation occurs.

[1]

(ii) Describe the changes that occur in structure **P** during the menstrual cycle.

.....

.....

.....

..... [2]

(iii) Fig. 7.2 shows the process of human fertilisation and early development of an embryo.

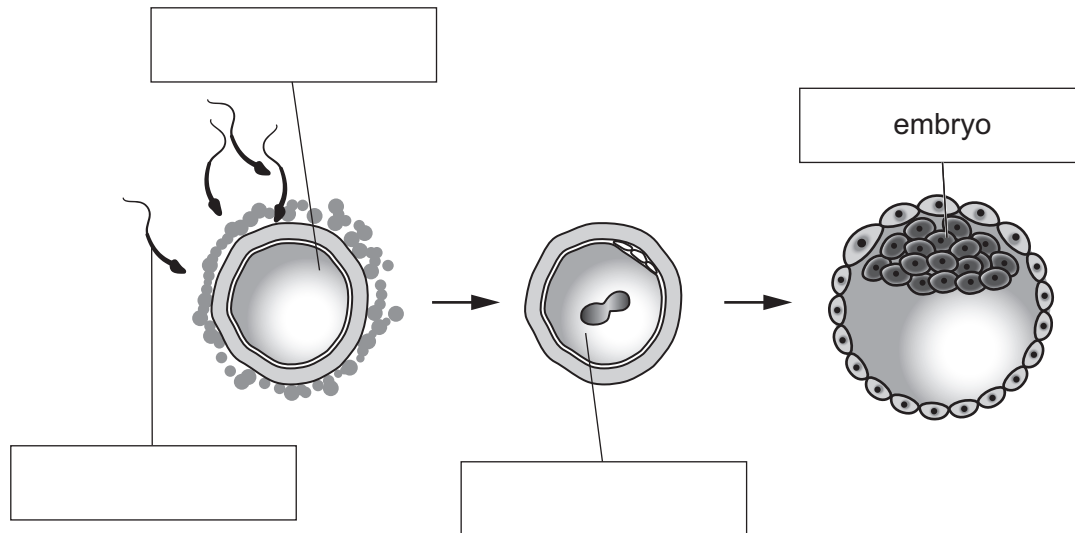


**Fig. 7.2**

Complete Fig. 7.2 using words from the list.

|              |                |               |
|--------------|----------------|---------------|
| <b>fetus</b> | <b>nucleus</b> | <b>ovum</b>   |
| <b>sperm</b> | <b>uterus</b>  | <b>zygote</b> |

[3]

(c) Human immunodeficiency virus (HIV) is a sexually transmitted infection.

State **two** ways of preventing the transmission of HIV.

1 .....

2 ..... [2]

[Total: 10]

- 8 (a) Sodium chloride is made when aqueous sodium hydroxide is mixed with dilute hydrochloric acid.

State what happens to the pH of the mixture as the aqueous sodium hydroxide is added to the dilute hydrochloric acid.

..... [1]

- (b) Sodium is in Group I of the Periodic Table, and chlorine is in Group VII.

- (i) Describe the change in character of elements across a period in the Periodic Table from left to right.

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

- (ii) Describe the trend in reactivity of Group I metals from lithium to potassium.

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

- (iii) Describe the trend in physical state of Group VII elements from fluorine to iodine.

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

- (c) Aqueous bromine reacts with alkenes.

- (i) State the colour change that occurs during this reaction.

..... [1]

- (ii) Name the reaction that produces alkenes from larger alkane molecules.

..... [1]

[Total: 6]

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9 Fig. 9.1 shows an electric toaster that is used for toasting slices of bread.

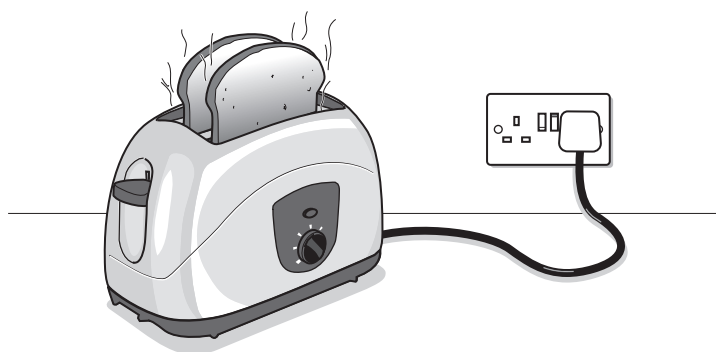


**Fig. 9.1**

(a) The toaster uses a 230 V mains electricity supply as a source of energy.

The toaster contains:

- two heaters connected in parallel
- one switch to turn both heaters on and off
- a fuse to protect the circuit.

On Fig. 9.2, complete the circuit diagram for the toaster.

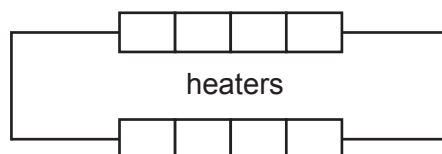
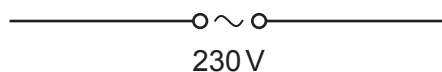


**Fig. 9.2**

[4]

(b) A wire in one of the heaters breaks, and that heater stops working. The fuse is not affected.

(i) Explain why the other heater continues to work.

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

(ii) The potential difference (p.d.) across the working heater is 230 V.

The current in the working heater is 2.5 A.

Calculate the resistance of the heater.

Give the unit of your answer.

resistance = ..... unit ..... [3]

(c) The fuse in the circuit now needs replacing. The current from the source when both heaters are working is 5.0 A.

Circle the most appropriate fuse rating for the replacement fuse. Give a reason for your choice.

**1 A      5 A      13 A**

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

[Total: 9]

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The Periodic Table of Elements

| Group                      |                             |                            |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                                                                |                             |                               |                              |                              |                                |                            |
|----------------------------|-----------------------------|----------------------------|-----------------------------|---------------------------------|------------------------------|------------------------------|------------------------------|----------------------------|------------------------------|--------------------------------|-------------------------------|----------------------------------------------------------------|-----------------------------|-------------------------------|------------------------------|------------------------------|--------------------------------|----------------------------|
| I                          | II                          |                            |                             |                                 |                              |                              |                              |                            |                              |                                |                               | III                                                            | IV                          | V                             | VI                           | VII                          | VIII                           |                            |
|                            |                             |                            |                             |                                 |                              |                              |                              |                            |                              |                                |                               | 1<br>H<br>hydrogen<br>1                                        |                             |                               |                              |                              |                                |                            |
|                            |                             |                            |                             |                                 |                              |                              |                              |                            |                              |                                |                               | atomic number<br>atomic symbol<br>name<br>relative atomic mass |                             |                               |                              |                              |                                |                            |
| 3<br>Li<br>lithium<br>7    | 4<br>Be<br>beryllium<br>9   |                            |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                                                                |                             |                               |                              |                              |                                |                            |
| 11<br>Na<br>sodium<br>23   | 12<br>Mg<br>magnesium<br>24 |                            |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                                                                |                             |                               |                              |                              |                                |                            |
| 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>— | 118<br>Og<br>oganeson<br>—   | 119<br>Ts<br>tennessine<br>— | 120<br>Ug<br>unseptennium<br>— | 118<br>Og<br>oganeson<br>— |

|             |                              |                            |                                 |                              |                             |                             |                             |                               |                            |                               |                              |                           |                               |                              |                              |
|-------------|------------------------------|----------------------------|---------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|----------------------------|-------------------------------|------------------------------|---------------------------|-------------------------------|------------------------------|------------------------------|
| 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 dm<sup>3</sup> at room temperature and pressure (r.t.p.).



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## 0653/32

October/November 2020

**1 hour 15 minutes**

No additional materials are needed.

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

DC (DH/SW) 194547/3  
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**[Turn over**

- 1 (a) Fig. 1.1 shows a food web for a pond habitat.

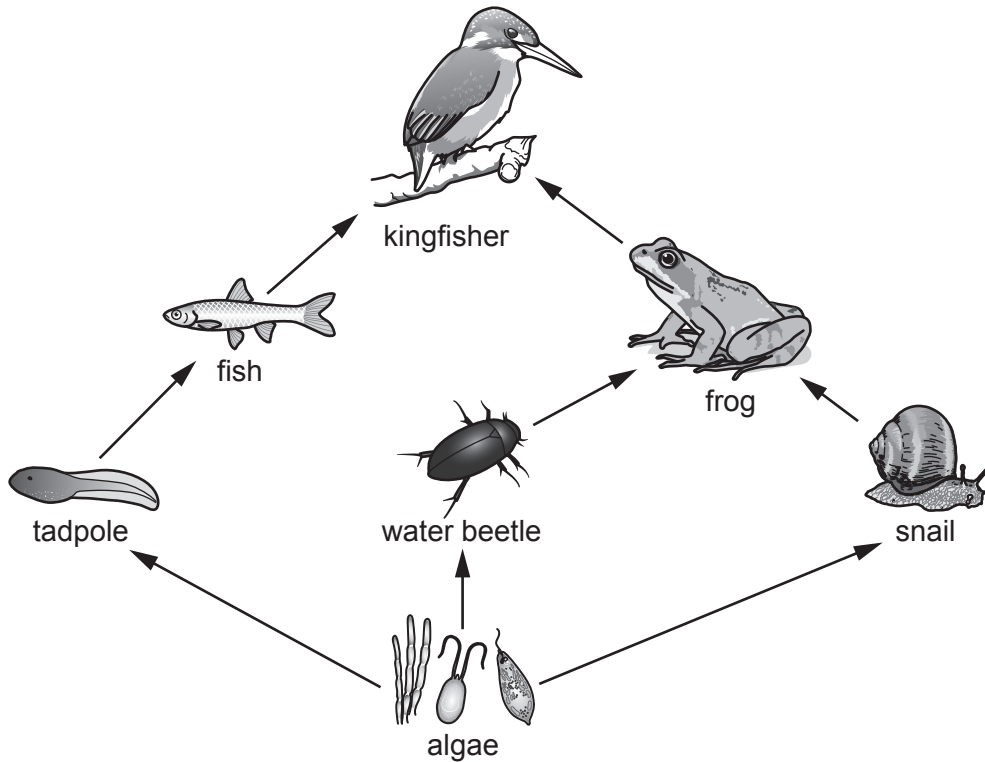


Fig. 1.1

- (i) Identify the producer shown in Fig. 1.1.

..... [1]

- (ii) State the process used by producers to make glucose using energy from sunlight.

..... [1]

- (iii) Identify **one** carnivore shown in Fig. 1.1.

..... [1]

- (iv) Use the information in Fig. 1.1 to construct a food chain including the frog.

..... [1]

- (b) Decomposers are also found in pond habitats.

Define a *decomposer*.

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

(c) Decomposers are an important part of the carbon cycle.

Fig. 1.2 shows a diagram of the carbon cycle.

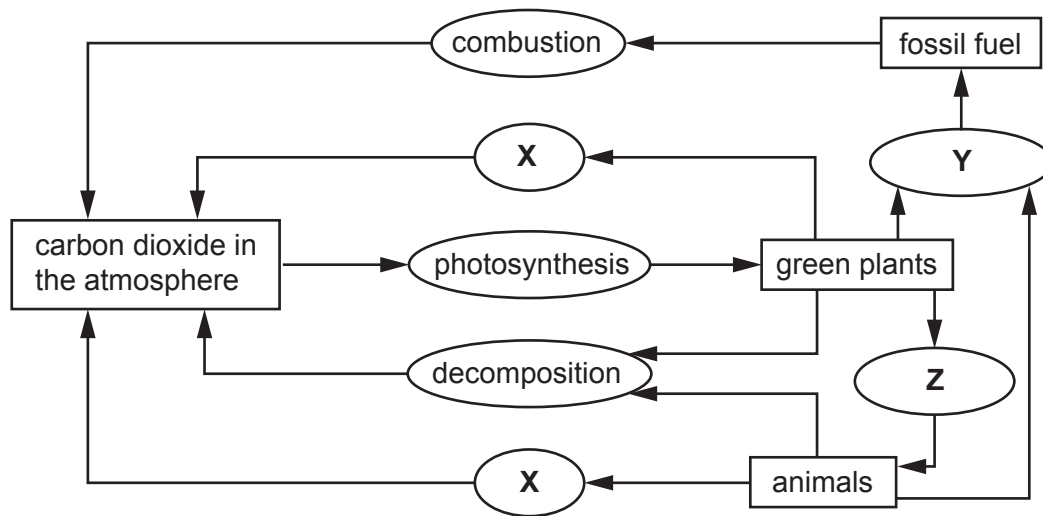


Fig. 1.2

Identify processes **X**, **Y** and **Z** shown in Fig. 1.2.

**X** .....

**Y** .....

**Z** .....

[3]

[Total: 8]

- 2 (a) Brass is a mixture of copper and zinc.

The water tap in Fig. 2.1 is made of brass.

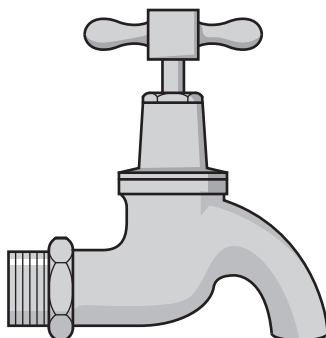


Fig. 2.1

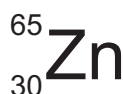
- (i) Name the type of substance that contains a metal mixed with other elements.

..... [1]

- (ii) Suggest **one** property of brass that makes it suitable for use as a water tap.

..... [1]

- (b) An atom of zinc is represented by the symbol shown.



- (i) Deduce the number of neutrons in this atom of zinc.

number of neutrons = ..... [1]

- (ii) State the number of electrons in this atom of zinc.

number of electrons = ..... [1]

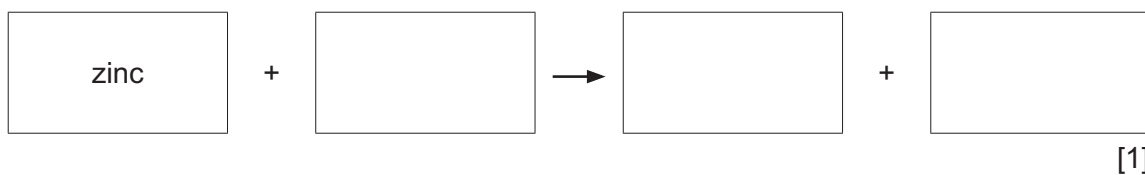
- (iii) Zinc atoms form zinc ions,  $\text{Zn}^{2+}$ .

Deduce the number of electrons in a  $\text{Zn}^{2+}$  ion.

number of electrons = ..... [1]

(c) Zinc reacts with dilute hydrochloric acid to form zinc chloride and hydrogen.

(i) Complete the word equation for this reaction.



(ii) Zinc chloride contains twice as many chloride ions as zinc ions.

Deduce the formula of zinc chloride.

.....

[1]

[Total: 7]

- 3 (a) Fig. 3.1 shows the forces acting on a wheelbarrow full of sand as a man pushes it along a straight path at a constant speed.

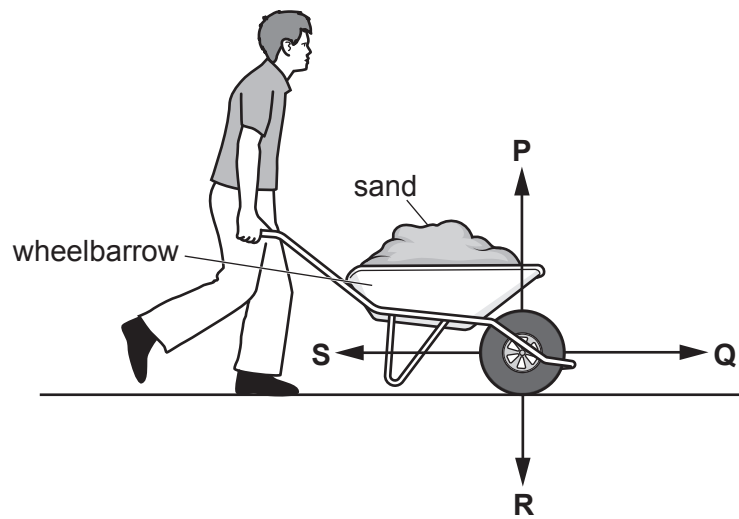


Fig. 3.1

- (i) State the letter, **P**, **Q**, **R** or **S**, of the force due to the man pushing the wheelbarrow.

.....

[1]

- (ii) State the letter, **P**, **Q**, **R** or **S**, of the force due to friction.

.....

[1]

- (iii) State whether the two forces in (i) and (ii) are equal in size.

Give a reason for your answer.

.....

.....

..... [1]

- (b) Fig. 3.2 shows the distance–time graph for the man pushing the wheelbarrow along the straight path.

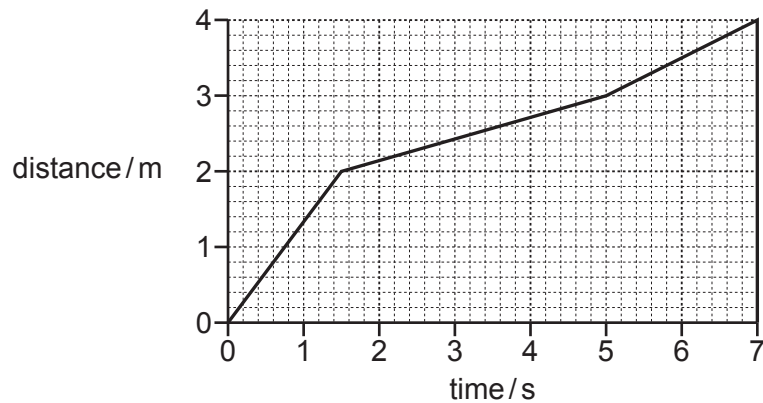
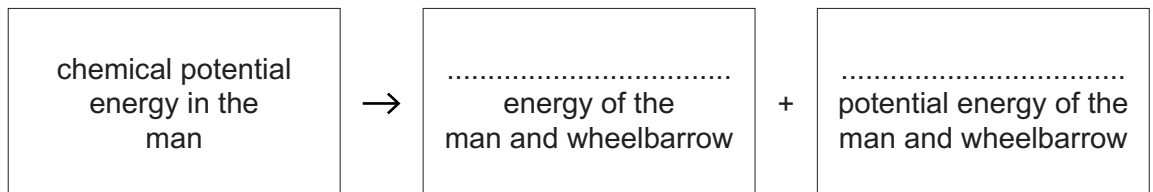


**Fig. 3.2**

- (i) On Fig. 3.2, draw an **X** on the graph to show a point when the man and wheelbarrow change speed. [1]
- (ii) On Fig. 3.2, draw a **Y** on the graph to show a point when the man and wheelbarrow are moving at maximum speed. [1]
- (c) The man pushes the wheelbarrow full of sand up a slope.

- (i) Complete the sequence of **useful** energy changes.



[2]

- (ii) Not all the energy changes taking place are useful. Some energy is lost as thermal energy.

Identify **two** ways that energy is lost as thermal energy.

1 .....

2 .....

[2]

- (d) The man pushes the wheelbarrow up the same slope again but this time with the wheelbarrow **empty**.

Explain why the man does less work on this second journey up the slope.

.....

..... [1]

[Total: 10]

- 4 (a) Fig. 4.1 shows a cross-section of a plant stem as seen under a microscope.

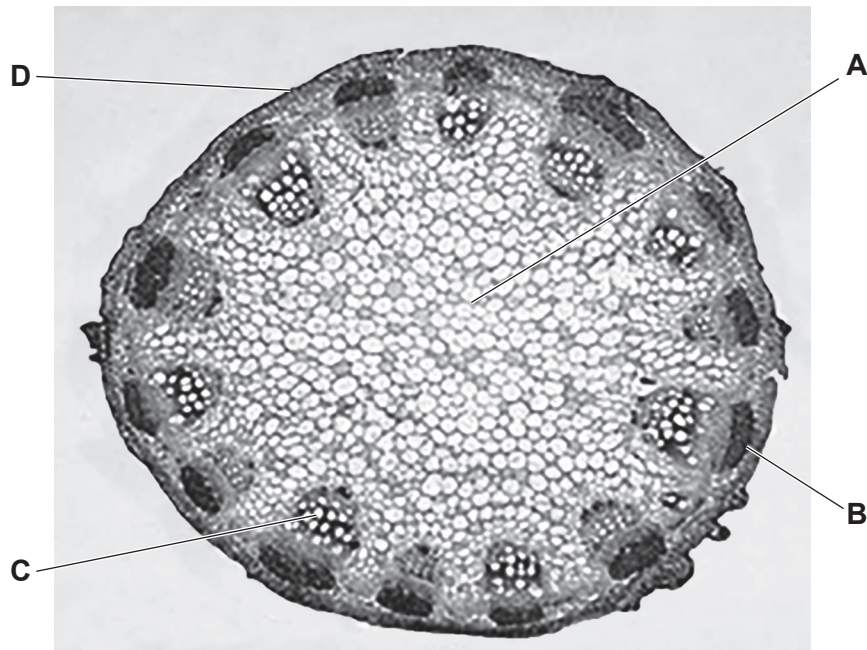


**Fig. 4.1**

- (i) State the letter, **A**, **B**, **C** or **D**, that shows the position of xylem vessels in the plant stem in Fig. 4.1.

..... [1]

- (ii) Name the cells that transport sugar through the plant stem.

..... [1]

- (b) Use words from the list to complete the definition of *transpiration*.

Each word may be used once, more than once, or not at all.

**absorption      diffusion      egestion      evaporation      fusion**

Transpiration is the loss of water vapour from plant leaves by ..... of water at the surface of the mesophyll cells followed by ..... of water vapour through the stomata.

[2]

(c) Fig. 4.2 shows a plant that has been next to a window for a few weeks.



**Fig. 4.2**

- (i) Name the tropic response shown by the plant in Fig. 4.2 that causes the plant to grow towards the light.

..... [1]

- (ii) The plant has flowers with pink petals.

State the function of petals.

..... [1]

(d) Some responses in humans are controlled by hormones.

- (i) Describe how hormones are transported to their target organs.

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

- (ii) Adrenaline is a hormone.

Describe **two** effects of adrenaline on the body.

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

[Total: 10]

- 5 (a) In an experiment, carbon electrodes are used to pass an electric current through concentrated aqueous sodium chloride, as shown in Fig. 5.1.

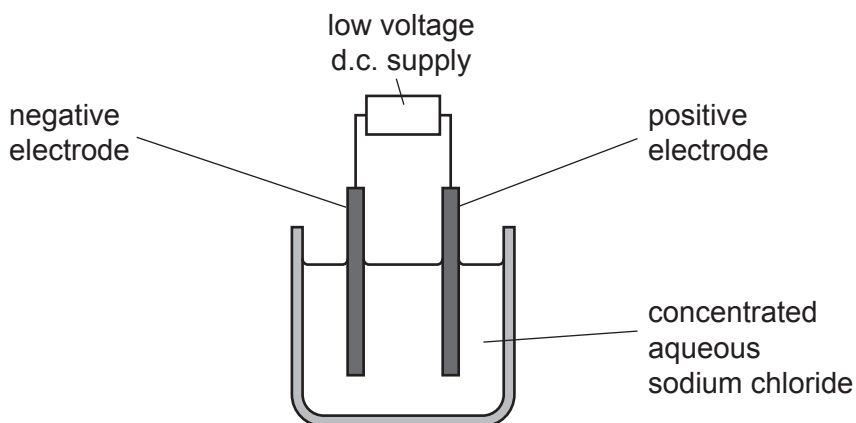


**Fig. 5.1**

- (i) Name the process shown in Fig. 5.1.  
 ..... [1]
- (ii) Identify the solvent in concentrated aqueous sodium chloride.  
 ..... [1]
- (iii) Identify the products which form at the negative electrode and at the positive electrode.  
 negative electrode product .....  
 positive electrode product ..... [2]
- (iv) Name the negative electrode and the positive electrode.  
 negative electrode .....  
 positive electrode ..... [2]

(b) Some metals are extracted from their ores by heating with carbon.

(i) Identify **one** metal that is extracted from its ore by this method.

..... [1]

(ii) In this extraction process, oxygen is removed from the metal.

State the type of chemical reaction that involves the loss of oxygen.

..... [1]

[Total: 8]

- 6 Fig. 6.1 shows a device called a 'solar still'. A solar still is used to produce fresh water from sea water.

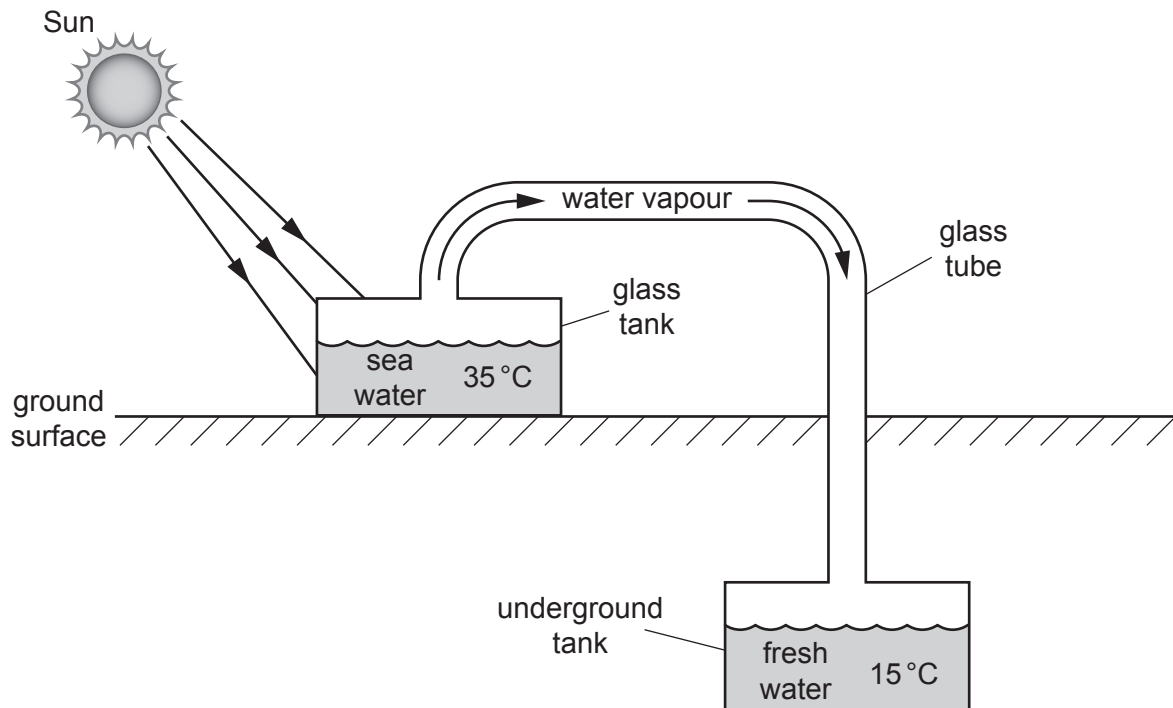


**Fig. 6.1**

Sea water is added to a glass tank. The glass tank is in full sunlight.

The temperature of the sea water in the glass tank increases to a maximum of  $35^{\circ}\text{C}$ .

Water vapour travels through a glass tube to an underground tank. The water vapour cools and condenses.

Fresh water collects in the underground tank.

- (a) (i) Name the process that occurs at the surface of the sea water in the glass tank.

..... [1]

- (ii) State why some water molecules leave the surface of the sea water in this process.

.....

..... [1]

- (iii) State what happens to the temperature of the sea water remaining in the glass tank as a result of this process.

..... [1]

- (b) State whether the sea water in the glass tank boils.

Give a reason for your answer.

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

- (c) The sea water is heated by electromagnetic radiation from the Sun.

- (i) Name the type of electromagnetic radiation involved in heating the sea water.

..... [1]

- (ii) On Fig. 6.2, write a tick (✓) in the part of the electromagnetic spectrum where this type of radiation is found.

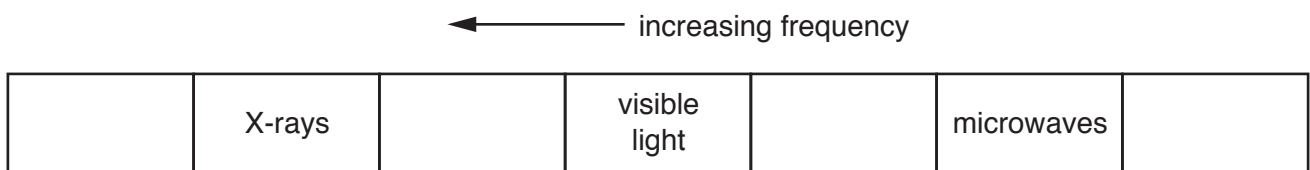


**Fig. 6.2**

[1]

- (iii) State the meaning of *frequency*.

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

- (d) Fig. 6.3 shows a ray from the Sun being refracted as it passes into the glass tank.

On Fig. 6.3, label the angle of incidence  $i$  and the angle of refraction  $r$  for the ray. [2]

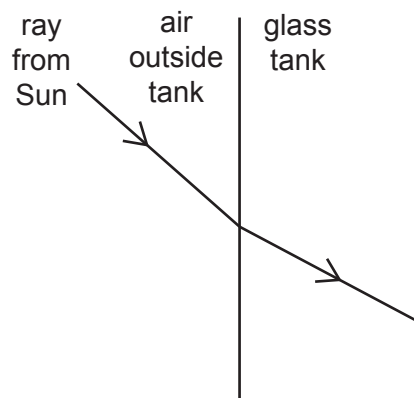


**Fig. 6.3**

[Total: 9]

- 7 (a) Fig. 7.1 shows parts of the human gas exchange system.

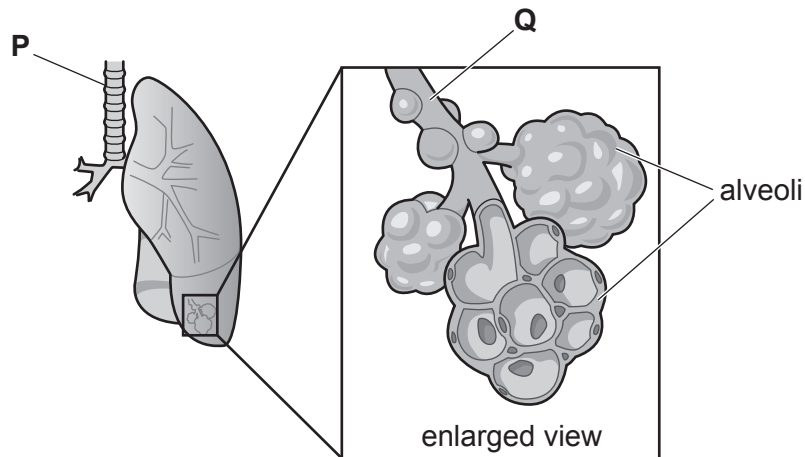


**Fig. 7.1**

Identify parts **P** and **Q** shown in Fig. 7.1.

**P** .....

**Q** ..... [2]

- (b) The lungs remove carbon dioxide from the body. Excess carbon dioxide in the body is toxic.

State the characteristic of living organisms that removes toxic materials from the body.

..... [1]

- (c) The lungs are connected to the heart by blood vessels.

(i) Name the blood vessel that transports blood from the lungs to the heart.

..... [1]

(ii) Name the component of the blood that produces antibodies.

..... [1]

(d) Fig. 7.2 is a diagram of the female reproductive organs.

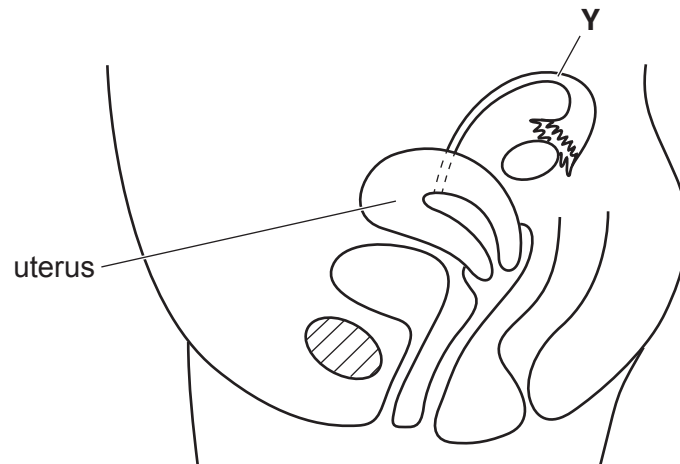


**Fig. 7.2**

- (i) Draw an **X** on Fig. 7.2 to show where gametes are made. [1]
- (ii) Name structure **Y** in Fig. 7.2.  
 ..... [1]
- (iii) Describe the changes that occur to the uterus lining during the first five days of the menstrual cycle.  
 .....  
 .....  
 ..... [2]

[Total: 9]

8 (a) Methane,  $\text{CH}_4$ , is an alkane.

(i) Methane is the main constituent of a fossil fuel.

Name this fossil fuel.

..... [1]

(ii) Name the type of chemical bonds in a molecule of methane.

..... [1]

(iii) Fig. 8.1 is an incomplete dot-and-cross diagram of a molecule of methane.

On Fig. 8.1, draw dots and crosses to show **all** of the outer shell electrons in a molecule of methane.

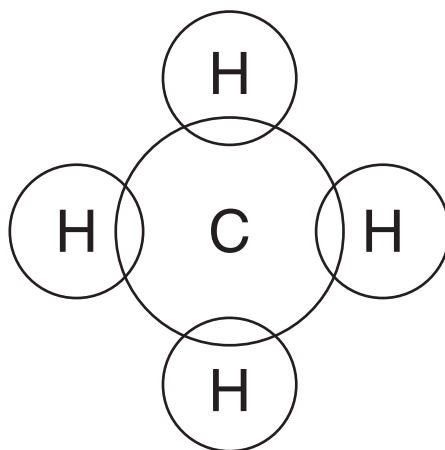


Fig. 8.1

[2]

(b) A sample of refinery gas contains only alkane molecules.

(i) Name the process used to obtain refinery gas from petroleum.

..... [1]

(ii) Describe the effect, if any, of this sample of refinery gas on aqueous bromine.

..... [1]

(c) Fossil fuels are used for heating.

- (i) State the type of chemical reaction that produces a temperature increase during the combustion of fossil fuels.

..... [1]

- (ii) Suggest the effect of the combustion of methane on the number of nitrogen molecules and on the number of oxygen molecules in a limited supply of air.

nitrogen molecules .....

oxygen molecules .....

[2]

- (iii) During the combustion of fossil fuels, carbon dioxide is produced.

State the test and the positive result for carbon dioxide.

test .....

result .....

[2]

[Total: 11]

- 9 The front door of a house has an electric bell and a lamp.
- The electric bell and lamp are connected in parallel to a 6.0 V battery.
  - One switch controls both the electric bell and the lamp.

Fig. 9.1 shows part of the circuit.

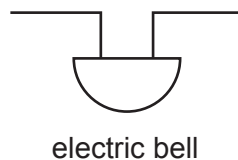
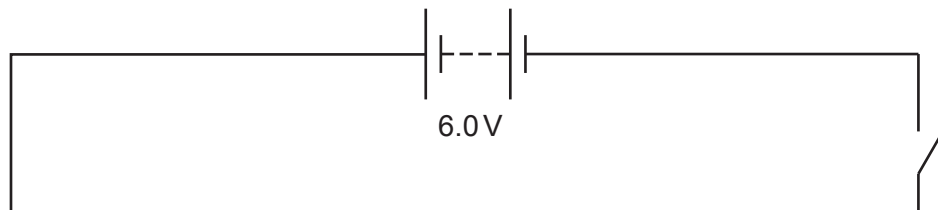


**Fig. 9.1**

- (a) (i) On Fig. 9.1, complete the circuit diagram. [2]
- (ii) Explain why a parallel connection allows the bell to ring even if the lamp is broken.

.....

..... [1]

- (b) A meter is needed to measure the potential difference (p.d.) across the bell.

On Fig. 9.1, draw the circuit symbol for this meter and show how the meter is connected to measure the p.d. across the bell. [2]

- (c) The bell is switched on.

There is a potential difference (p.d.) of 6.0 V across the bell.

There is a current of 0.48 A in the bell.

Calculate the resistance of the bell. Give the unit of your answer.

resistance = ..... unit ..... [3]

[Total: 8]

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The Periodic Table of Elements

| Group                      |                             |                                                                |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                             |                             |                               |                              |                           |                         |
|----------------------------|-----------------------------|----------------------------------------------------------------|---------------------------------|-----------------------------|------------------------------|-----------------------------|------------------------------|------------------------------|--------------------------------|-------------------------------|-------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|------------------------------|---------------------------|-------------------------|
| I                          | II                          | Key                                                            |                                 |                             |                              |                             |                              |                              |                                |                               |                               | III                         | IV                          | V                           | VI                            | VII                          | VIII                      |                         |
|                            |                             | atomic number<br>atomic symbol<br>name<br>relative atomic mass |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                             |                             |                               |                              |                           |                         |
| 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<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>— |                              |                           |                         |

|             |                              |                            |                                 |                              |                             |                             |                             |                               |                            |                               |                              |                           |                               |                              |                              |
|-------------|------------------------------|----------------------------|---------------------------------|------------------------------|-----------------------------|-----------------------------|-----------------------------|-------------------------------|----------------------------|-------------------------------|------------------------------|---------------------------|-------------------------------|------------------------------|------------------------------|
| 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  |
|             | 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 dm<sup>3</sup> at room temperature and pressure (r.t.p.).



CANDIDATE  
NAME

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CENTRE  
NUMBER

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CANDIDATE  
NUMBER

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## 0653/33

October/November 2020

**1 hour 15 minutes**

No additional materials are needed.

- Answer **all** questions.
- Use a black or dark blue pen. You may use an HB pencil for any diagrams or graphs.
- Write your name, centre number and candidate number in the boxes at the top of the page.
- Write your answer to each question in the space provided.
- Do **not** use an erasable pen or correction fluid.
- Do **not** write on any bar codes.
- You may use a calculator.
- You should show all your working and use appropriate units.

- The total mark for this paper is 80.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

DC (ST/JG) 194548/3  
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**[Turn over**

- 1 (a) Fig. 1.1 shows a diagram of muscle cells.

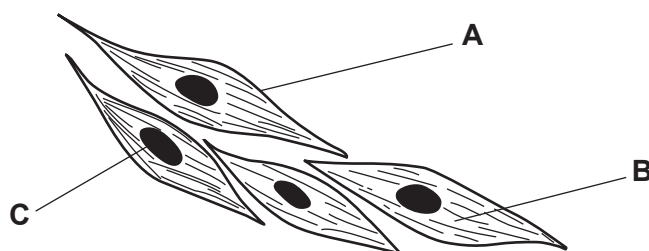


Fig. 1.1

- (i) Complete Table 1.1 for the structures **A**, **B** and **C**.

Table 1.1

| structure | name      | function                                              |
|-----------|-----------|-------------------------------------------------------|
| <b>A</b>  | .....     | controls which substances pass in and out of the cell |
| <b>B</b>  | cytoplasm | .....                                                 |
| <b>C</b>  | .....     | controls the activity of the cell                     |

[3]

- (ii) Muscles are needed in humans for one of the characteristics of living organisms.

Name this characteristic.

..... [1]

- (iii) Muscles need energy to work.

The energy is released by a different characteristic of living organisms.

Name this characteristic.

..... [1]

- (b) Anaemia is a medical condition. A person with anaemia has fewer red blood cells than normal.

Suggest why anaemia can cause a person to have less energy.

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

- (c) The heart is made of muscle tissue.

Fig. 1.2 is a diagram of the heart.

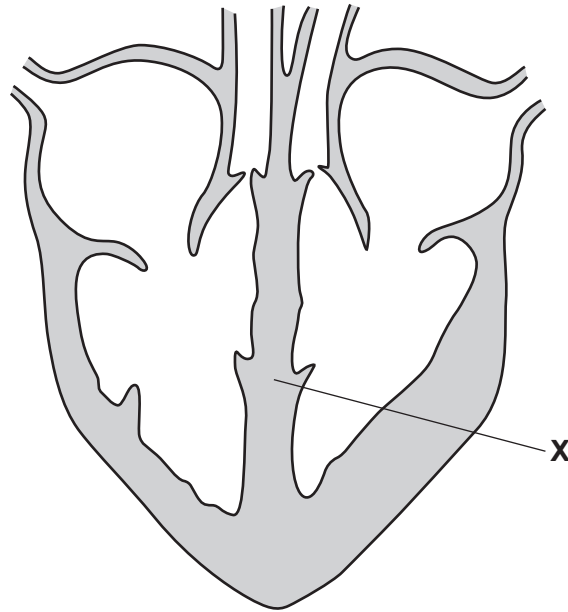


**Fig. 1.2**

- (i) Identify structure **X** on Fig. 1.2.

..... [1]

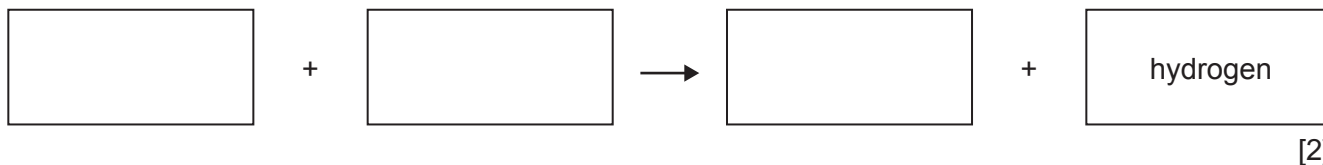
- (ii) On Fig. 1.2, use a label line and the letter **Y** to identify a structure that prevents the backwards flow of the blood. [1]

[Total: 9]

- 2 A student investigates the rate of reaction between a piece of magnesium and excess dilute hydrochloric acid.

(a) During this reaction, hydrogen is produced.

(i) Complete the equation for this reaction.



(ii) Describe the chemical test for hydrogen and state the positive result.

test .....

result .....

[2]

(b) The reaction between magnesium and dilute hydrochloric acid is exothermic.

State the meaning of *exothermic*.

.....

..... [1]

(c) (i) Describe the effect of increasing the concentration of the acid on the rate of reaction.

..... [1]

(ii) Describe the effect of decreasing the temperature of the acid on the rate of reaction.

..... [1]

(d) The student repeats the experiment but uses a piece of zinc instead of a piece of magnesium.

The piece of zinc has the same surface area as the piece of magnesium.

Suggest the effect that using zinc instead of magnesium has on the rate of the reaction.

Explain your answer.

effect .....

explanation .....

.....

[2]

[Total: 9]

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3 Fig. 3.1 shows a climber moving up a rock face.

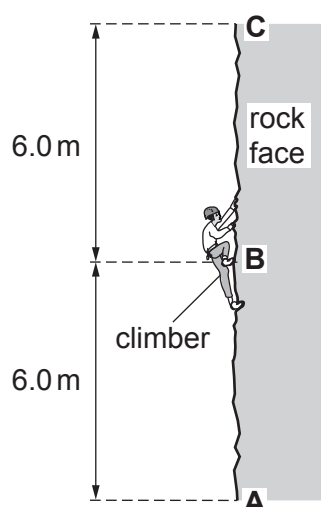


Fig. 3.1

(a) The mass of the climber is 64 kg.

The gravitational field strength  $g$  is 10 N/kg.

(i) Calculate the weight of the climber.

weight = ..... N [1]

(ii) State the source of the gravitational field.

..... [1]

(b) The climber moves up the rock face from A to B at a constant speed.

(i) State the type of energy the climber has that is due to the climber's motion.

..... [1]

(ii) State the type of energy the climber has that increases due to the climber's change in position above the ground.

..... [1]

- (c) The climber takes 120 seconds to move up the rock face from **A** to **B**.

The climber takes 60 seconds to move up the rock face from **B** to **C**.

- (i) Calculate the average speed of the climber for the 12 m climb from **A** to **C**.

average speed = ..... m/s [3]

- (ii) Explain why the useful work done against gravity by the climber moving from **B** to **C** is the **same as** the useful work done against gravity by the climber moving from **A** to **B**.

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

- (iii) Explain why the useful power developed by the climber moving from **B** to **C** is **greater than** the useful power developed by the climber moving from **A** to **B**.

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

[Total: 9]

- 4 (a) Fig. 4.1 shows plant cells as seen with a microscope.

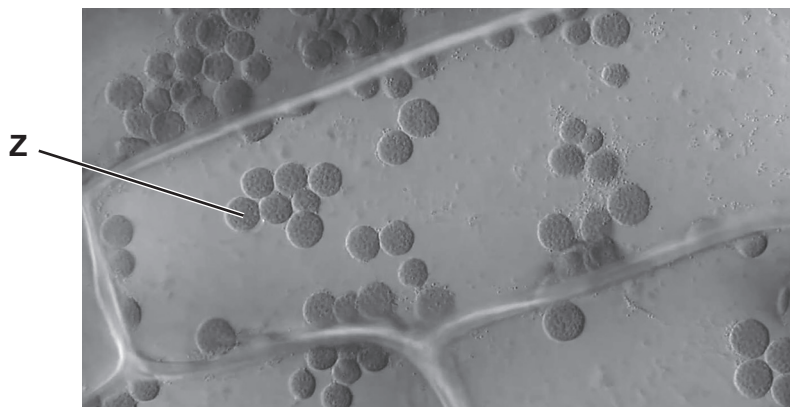


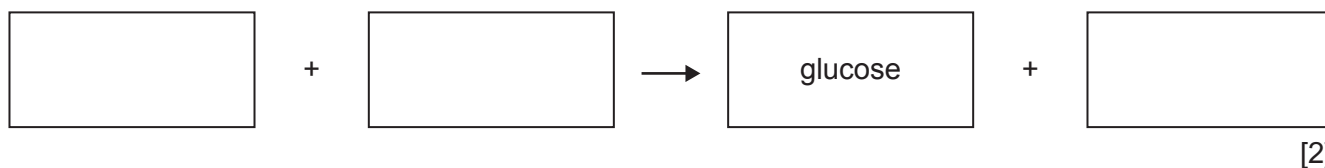
Fig. 4.1

- (i) The structure labelled **Z** in Fig. 4.1 contains chlorophyll.

Name the structure labelled **Z** in Fig. 4.1.

..... [1]

- (ii) Complete the word equation for photosynthesis.



- (iii) Glucose is a carbohydrate.

Circle the **three** elements that make up carbohydrates.

|           |          |          |      |
|-----------|----------|----------|------|
| calcium   | carbon   | hydrogen | iron |
| magnesium | nitrogen | oxygen   |      |

[1]

- (b) Glucose from photosynthesis is stored in the part of the leaf where it is made. The glucose is stored as starch.

A student investigates the need for chlorophyll in photosynthesis.

The student:

- uses a plant with leaves that are green and white
- puts the plant in a room with plenty of light
- waits for three days
- tests the leaves for starch.

Fig. 4.2 shows a leaf before and after testing for starch.

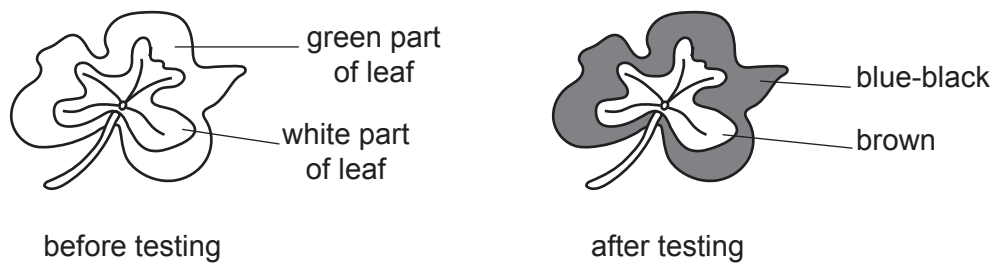


**Fig. 4.2**

- (i) State the name of the solution used to test for the presence of starch.

..... [1]

- (ii) The white parts of the leaf do **not** contain chlorophyll.

Explain the results shown in Fig. 4.2.

.....

.....

.....

..... [2]

- (c) Plants reproduce using flowers.

Name the part of the flower that produces pollen.

..... [1]

[Total: 8]

- 5 (a) The water tap shown in Fig. 5.1 is made of brass.

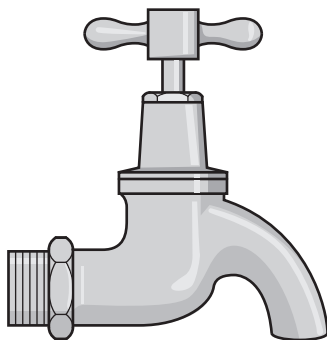


Fig. 5.1

Brass is made by mixing molten copper with molten zinc. The mixture is then allowed to cool to form solid brass.

- (i) State how solid copper is changed into molten copper.

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

- (ii) Describe **two** differences between the arrangement of atoms in solid copper and the arrangement of atoms in molten copper.

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

- (iii) State whether this process of making brass is a chemical change or a physical change.

Explain your answer.

change .....  
 explanation .....  
 ..... [1]

(b) Copper is a transition element.

Sodium is a Group I metal.

(i) Describe **two** physical properties of copper that are **not** properties of sodium.

1 .....

2 .....

[2]

(ii) Describe **one** physical property of copper that is **also** a property of sodium.

..... [1]

(c) Group I is on the left of the Periodic Table.

Transition elements are found in the middle of the Periodic Table.

Describe the change in the character of elements across a period, from left to right.

..... [1]

[Total: 8]

- 6 (a) Gamma rays are a type of electromagnetic radiation.

Fig. 6.1 shows a space telescope that is used for detecting gamma radiation from distant stars.



Fig. 6.1

Fig. 6.2 shows an incomplete electromagnetic spectrum.

On Fig. 6.2, write **gamma radiation** in the correct position.

|  |  |             |               |  |            |  |
|--|--|-------------|---------------|--|------------|--|
|  |  | ultraviolet | visible light |  | microwaves |  |
|--|--|-------------|---------------|--|------------|--|

Fig. 6.2

[1]

- (b) An astronomer uses a telescope to produce an image of a star.

Fig. 6.3 shows visible light rays from the star entering a thin converging lens in the telescope.

- (i) On Fig. 6.3, complete the ray diagram to show how the lens focuses the rays to produce a real image on the screen.

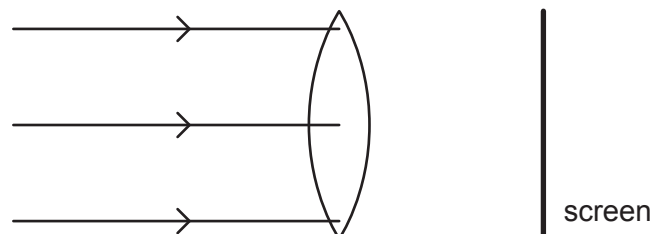


Fig. 6.3

[2]

- (ii) State the name of the distance from the lens to the screen in Fig. 6.3.

..... [1]

- (iii) Light waves from a star slow down as they enter the Earth's atmosphere. This causes them to change direction, as shown in Fig. 6.4.

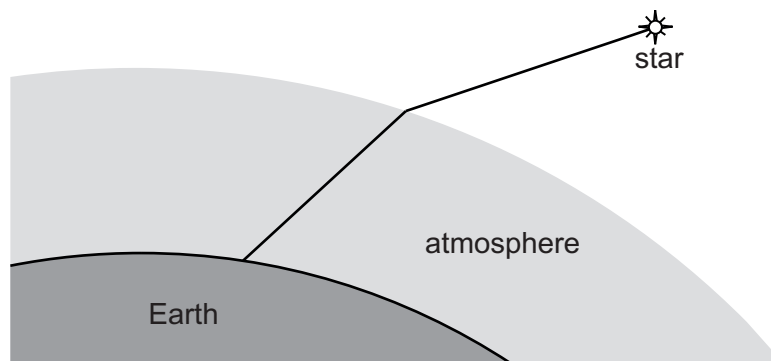


**Fig. 6.4**

State the name of the effect shown in Fig. 6.4.

..... [1]

- (c) Stars can emit radiation at all frequencies of the electromagnetic spectrum.

- (i) State a useful application of microwave radiation.

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

- (ii) Explain why stars **cannot** lose energy by conduction or convection.

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

[Total: 7]

- 7 (a) Fig. 7.1 shows a picture of a sloth and some information about sloths.

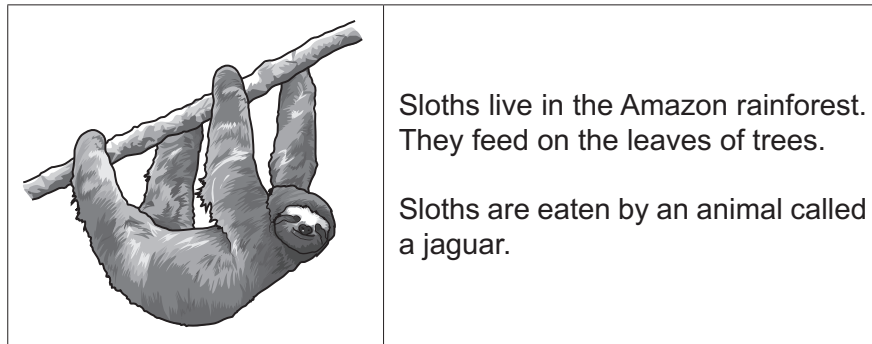


Fig. 7.1

- (i) Use the information in Fig. 7.1 to construct the food chain for the sloth.

..... [2]

- (ii) Complete this sentence about the sloth.

The sloth is a ..... consumer because it eats the producer. [1]

- (b) Rainforests are being destroyed by deforestation.

Fig. 7.2 shows the area of deforestation each year in the Amazon rainforest.

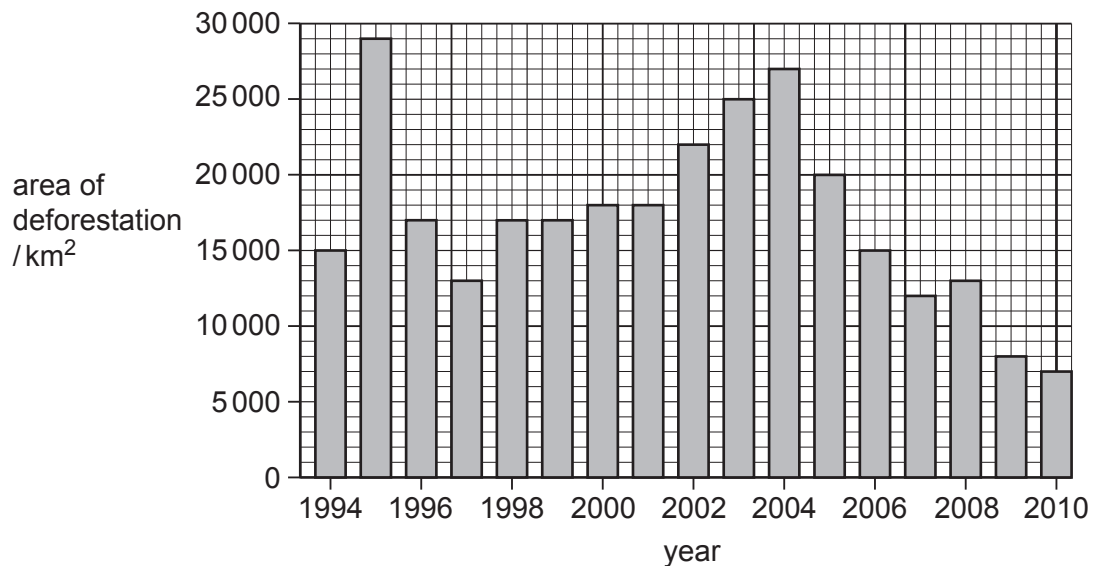


Fig. 7.2

- (i) State the year that had the **greatest** amount of deforestation.

.....

[1]

- (ii) Explain why the trend seen in deforestation between 2004 and 2010 benefits sloths.

.....

.....

.....

..... [2]

- (c) Plants in the rainforest take up water and mineral ions from the soil.

Fig. 7.3 is a diagram showing some of the cells in the root of a plant.

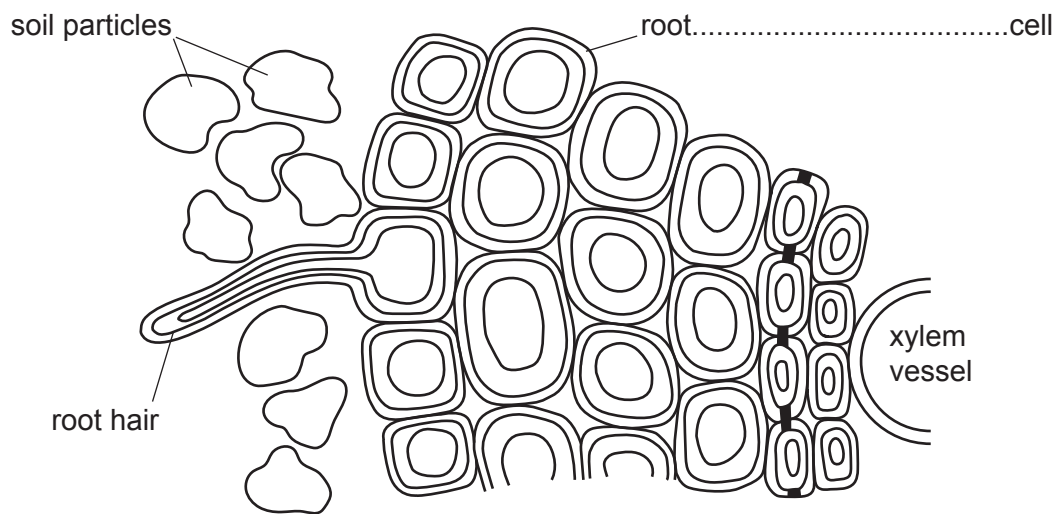


**Fig. 7.3**

- (i) Complete the label on Fig. 7.3 to identify the cells between the root hair and the xylem vessels. [1]
- (ii) Draw **one** arrow to show the pathway taken by water from the soil into the root. [1]
- (iii) Describe how water moves in and out of cells.

.....

.....

..... [2]

[Total: 10]

- 8 (a) A molecule of methane is represented in Fig. 8.1.

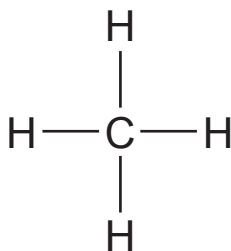


Fig. 8.1

- (i) Name the type of chemical bond present in this molecule.

..... [1]

- (ii) Describe how the bonds in this molecule form.

Use ideas about electrons in your answer.

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

- (iii) State the formula of methane.

..... [1]

- (b) During the complete combustion of methane, two gases are produced.

Gas **A** changes blue cobalt(II) chloride paper to pink.

Gas **B** turns limewater milky.

- (i) Identify the gas in the air which is required for the complete combustion of methane.

..... [1]

- (ii) Identify gas **A** and gas **B**.

gas **A** .....

gas **B** .....

[2]

(c) Methane is a common component of refinery gas.

(i) Name the mixture from which refinery gas is separated.

..... [1]

(ii) Name the process by which refinery gas is separated.

..... [1]

(iii) Identify **one** use for refinery gas.

..... [1]

[Total: 9]

- 9 (a) In the box in Fig. 9.1, draw the arrangement of particles in a gas. One particle has been drawn for you.

Draw 6 more particles.

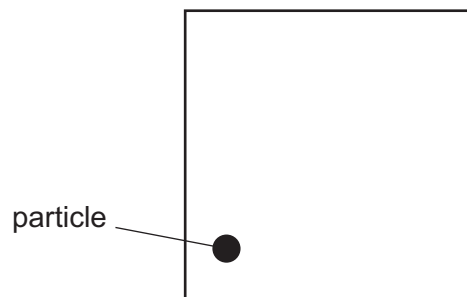


Fig. 9.1

[1]

- (b) Fig. 9.2 shows an extractor fan in the wall of a bathroom. The extractor fan has a small lamp to show when it is switched on.

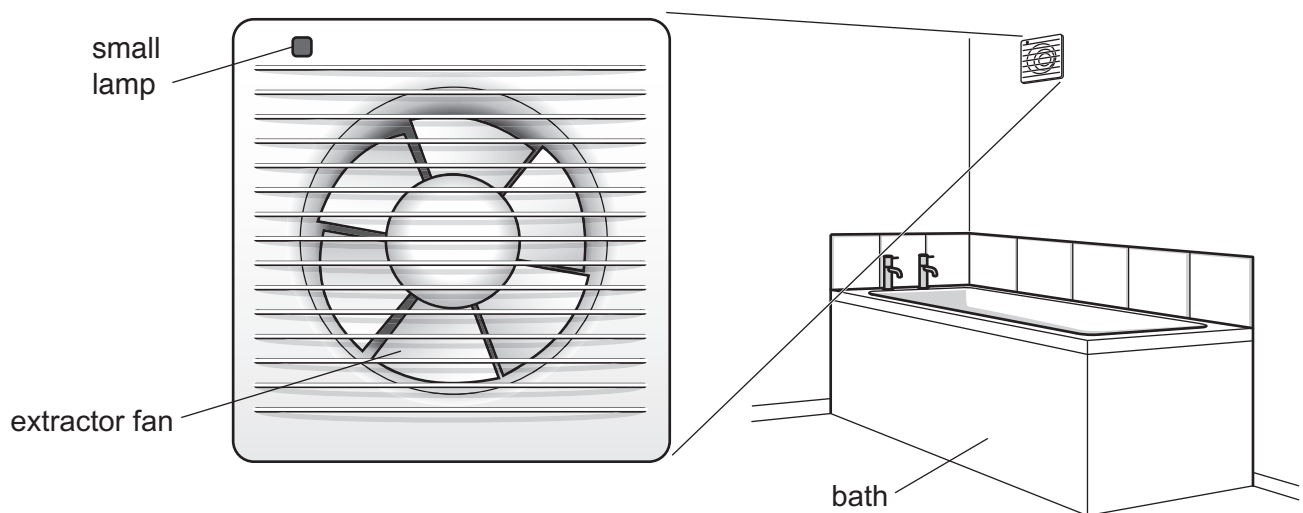


Fig. 9.2

The extractor fan is used to remove damp (wet) air from the bathroom.

- (i) Hot water in the bath makes the air in the bathroom damp.

Name the process that occurs at the surface of the water in the bath to make the air in the bathroom damp.

..... [1]

- (ii) Explain why this process cools the remaining water in the bath.

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

(c) The circuit for the extractor fan contains:

- an electric motor to turn the fan
- the small lamp connected in parallel with the electric motor
- one switch to control both the electric motor and the small lamp
- one fuse to protect both the electric motor and the small lamp.

Fig. 9.3 shows an incomplete circuit diagram for the extractor fan.

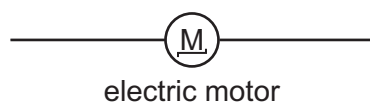
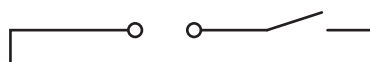


**Fig. 9.3**

On Fig. 9.3, complete the circuit diagram with:

- the small lamp
- the fuse.

[4]

(d) The resistance of the electric motor is  $3000\ \Omega$ .

The current in the motor is  $0.08\text{ A}$ .

Calculate the potential difference across the motor. State the unit of your answer.

potential difference = ..... unit ..... [3]

[Total: 11]

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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   |                                                                                             |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                               |                             |                               |                              |                             |                            |                             |
| 11<br>Na<br>sodium<br>23   | 12<br>Mg<br>magnesium<br>24 |                                                                                             |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                               |                             |                               |                              |                             |                            |                             |
| 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>— | 118<br>Ts<br>tennessine<br>— | 119<br>Og<br>oganesson<br>— | 120<br>Nh<br>nihonium<br>— | 121<br>Fl<br>flerovium<br>— |

lanthanoids

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

actinoids

The volume of one mole of any gas is 24 dm<sup>3</sup> at room temperature and pressure (r.t.p.).