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0653/21

May/June 2016

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

## READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

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

At the end of the examination, fasten all your work securely together.

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) Complete the sentences below using words or phrases from the list.

You may use each word or phrase once, more than once, or not at all.

**downwards      phloem      respiration      root hairs      transpiration**  
**upwards      upwards and downwards      xylem**

In the plant, water travels upwards in the .....

Dissolved sugar travels in the ..... and moves

..... The evaporation of water from the

surfaces of the mesophyll cells is called ..... [4]

- (b) Some plant cells were placed on a microscope slide and observed through the microscope. Fig. 1.1 shows one of these cells.

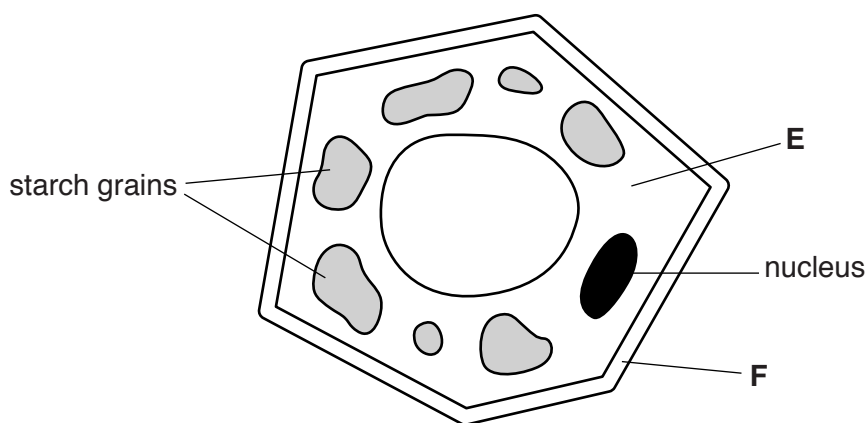


**Fig. 1.1**

- (i) State the names of structures **E** and **F**.

**E** .....

**F** ..... [2]

- (ii) State **one** piece of evidence from the diagram in Fig. 1.1 that suggests that the plant cell came from under the ground.

.....

..... [1]

- (iii) State the name of the chemical that can be added to the slide to confirm that the plant cell contains starch.

.....

Describe the result of the test.

.....

.....

[2]

(c) A starch test can also be used to investigate the conditions needed for photosynthesis.

- A variegated plant, with green and white areas of leaf, is put in the dark to remove the starch from its leaves.
- One leaf of the plant has some black paper put on it as shown in Fig. 1.2 (a), and the plant is left in the light.
- A few hours later small discs of leaf, **P**, **Q**, **R**, and **S** are removed from the leaf and tested for the presence of starch. Fig. 1.2 (b) shows the areas of the leaf that are tested.

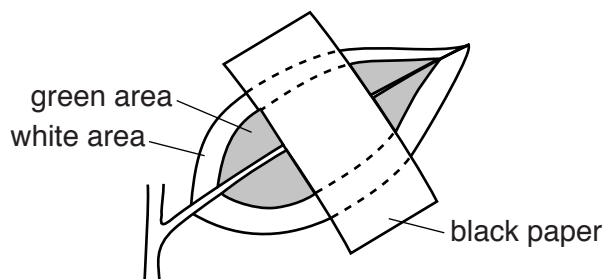


**Fig. 1.2 (a)** leaf at the start

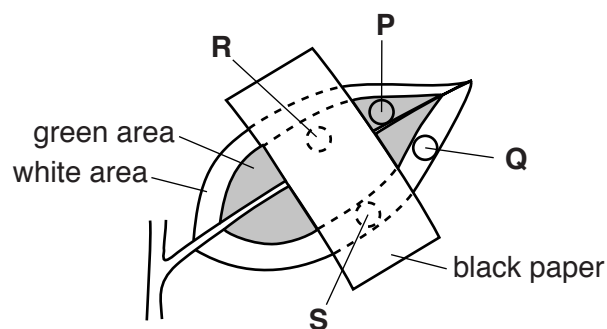


**Fig. 1.2 (b)** after a few hours

Complete Table 1.1 to predict the results of the starch tests.

Write an explanation for each prediction.

**Table 1.1**

| disc     | starch present<br>yes (✓) or no (✗) | explanation |
|----------|-------------------------------------|-------------|
| <b>P</b> |                                     |             |
| <b>Q</b> |                                     |             |
| <b>R</b> |                                     |             |
| <b>S</b> |                                     |             |

[4]

- 2 A student investigates the speed of reaction between dilute hydrochloric acid and calcium carbonate.

The reaction produces carbon dioxide gas.

- (a) Fig. 2.1 shows some of the apparatus the student uses.

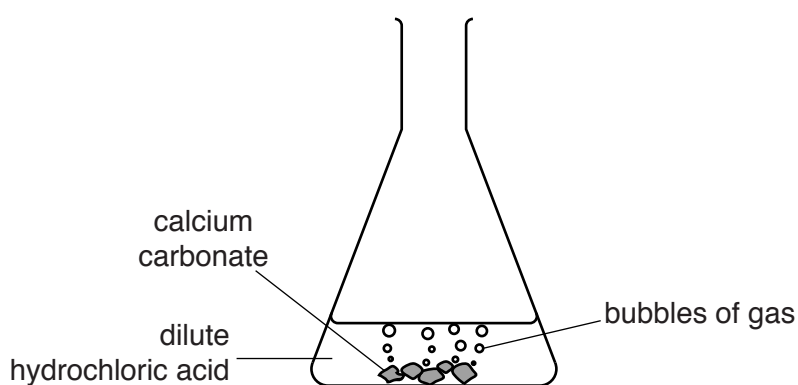


**Fig. 2.1**

- (i) The student wants to measure the volume of gas produced in this reaction every minute for 10 minutes.

Complete Fig. 2.1 to show how the student collects and measures the volume of gas. [2]

- (ii) Describe the test for carbon dioxide gas.

test .....

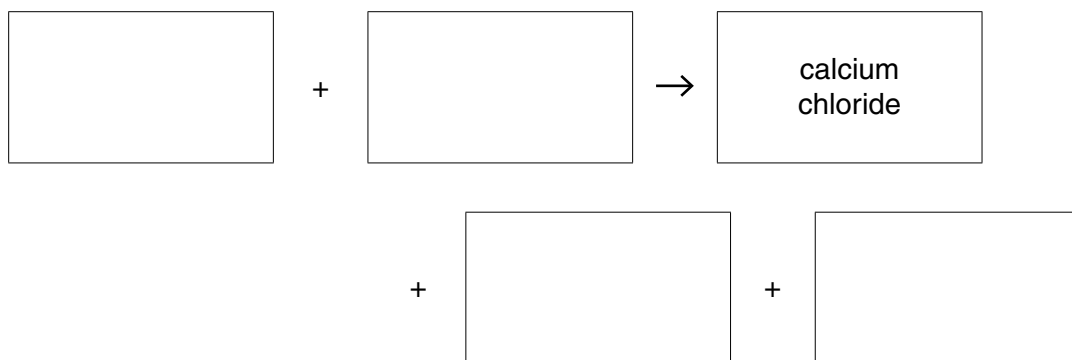
result ..... [2]

- (iii) As the reaction proceeds, the acid concentration decreases.

Describe what happens to the speed of the reaction.

..... [1]

(b) Complete the word equation for the reaction between hydrochloric acid and calcium carbonate.



[2]

(c) In a separate reaction, the student adds sodium carbonate to dilute nitric acid. Deduce the name of the salt that is made.

.....[1]

- 3 Fig. 3.1 shows a television camera that moves on rails alongside the athletes on an athletics track.

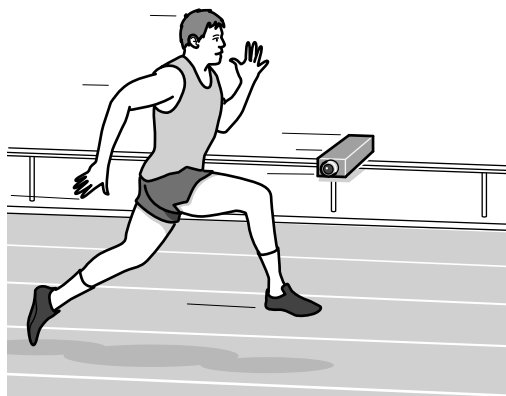


**Fig. 3.1**

The camera records a 100 metre race from start to finish.

At the start the camera begins to move alongside the athletes. They quickly reach their maximum speed and maintain this speed until they cross the finish line.

At the end of the race the athletes and the camera quickly stop moving.

- (a) (i) On the axes in Fig. 3.2, sketch a speed/time graph for the camera from the start until it stops after the end of the race. (Scales and numbers are NOT required.)

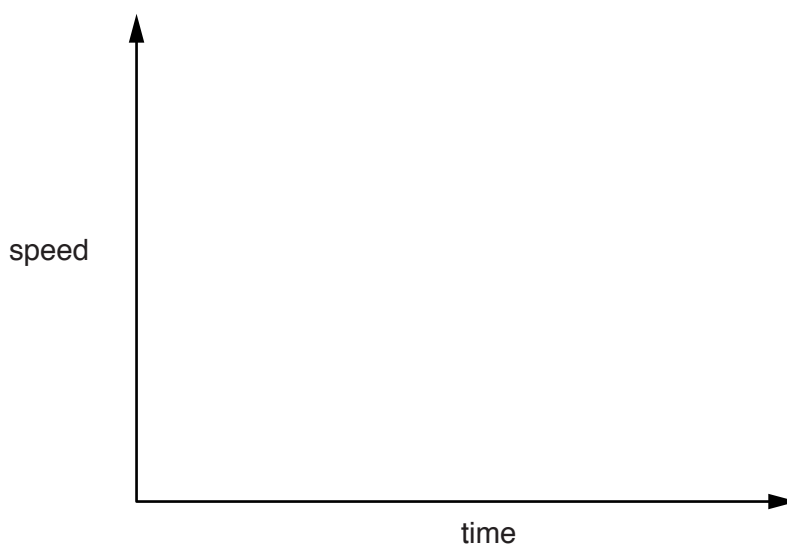


**Fig. 3.2**

[2]

- (ii) On Fig. 3.2, use the letter **P** to label a point on the graph when the camera is moving at constant speed. [1]

- (iii) On Fig. 3.2, use the letter **R** to label a point on the graph when the camera is accelerating. [1]

- (b) The winning athlete recorded a time of 9.8s.

Calculate the average speed of this athlete during the 100m race.

Show your working.

average speed = ..... m/s [1]

- (c) The camera uses a thin converging lens to focus light rays coming from the athlete onto the light sensor inside the camera.

- (i) Complete the ray diagram in Fig. 3.3 to show how this happens.

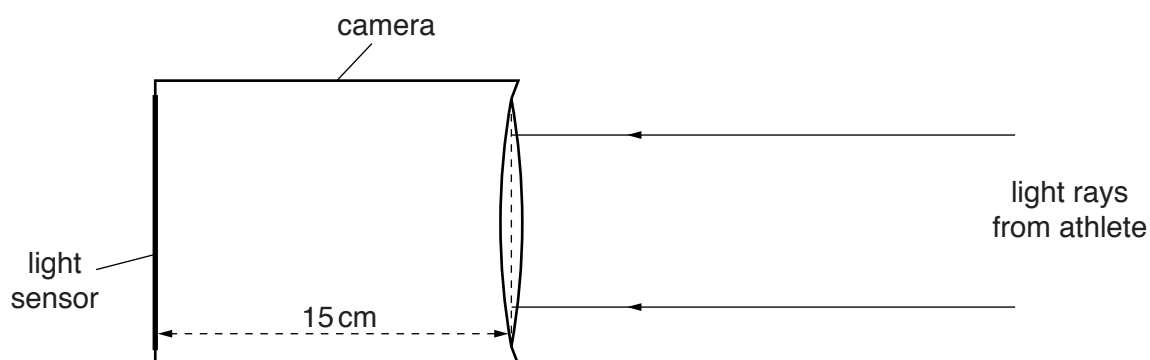


**Fig. 3.3**

[1]

- (ii) The distance from the lens to the light sensor is 15 cm.

State the focal length of the lens.

.....[1]

- (d) The camera is moved along the rails by an electric motor powered by a battery.

Complete the energy transfers that take place while the camera is moving.

From .....chemical..... energy stored in the battery

to ..... energy supplied to the motor

to ..... energy of the moving camera.

[2]

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

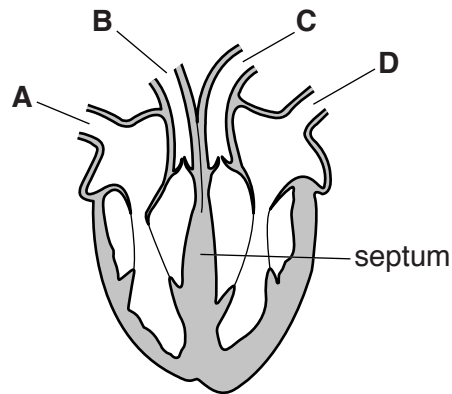


Fig. 4.1

- (i) State which of the vessels labelled **A**, **B**, **C** and **D** are arteries.  
 .....[1]
- (ii) On Fig. 4.1 label and name the chamber of the heart that receives blood from the lungs.  
 .....[2]
- (iii) State the function of the septum in the heart.  
 .....  
 .....  
 .....[1]

- (b) Fig. 4.2 shows cross sections of an artery and a vein. The diagrams are not drawn to the same scale.

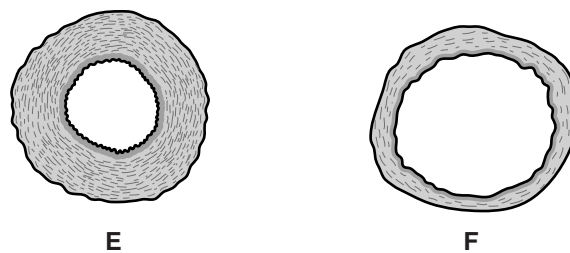


Fig. 4.2

State which diagram shows an artery.

Explain your answer.

diagram .....

explanation .....

.....[1]

- (c) Table 4.1 shows the effect of exercise on an athlete's heart. The volume of blood pumped by the left ventricle in one minute is called the cardiac output.

**Table 4.1**

| activity   | volume of one heart beat<br>/ cm <sup>3</sup> | pulse rate / beats<br>per minute | cardiac output /<br>cm <sup>3</sup> per minute |
|------------|-----------------------------------------------|----------------------------------|------------------------------------------------|
| resting    | 65                                            | 70                               | 4550                                           |
| exercising | 105                                           |                                  | 18690                                          |

- (i) Calculate the pulse rate of the athlete during exercise.

Show your working.

answer = ..... beats per minute [2]

- (ii) The increased cardiac output means that the blood is travelling more quickly around the body. This carries more oxygen to the exercising muscles.

Describe other changes in the athlete's body that enable more oxygen to be taken in at the lungs.

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

- 5 (a) Five substances are to be separated from mixtures. Fig. 5.1 shows the five mixtures and five methods of separation.

Draw a straight line from each mixture to the method that is used to obtain the underlined substance from the mixture. One has been done for you.

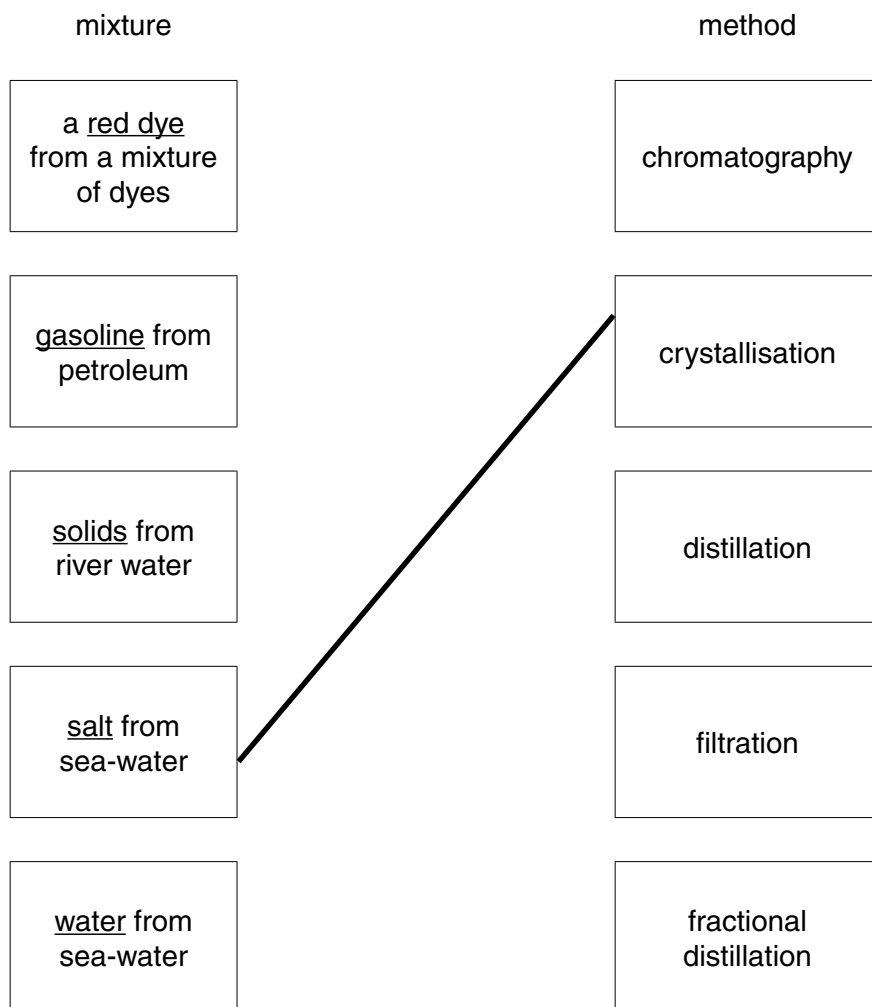


Fig. 5.1

[3]

- (b) An atom of iron has proton number 26 and nucleon number 56.

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

number of electrons .....

number of neutrons .....

[2]

- (c) (i) Predict the type of bonding that occurs when the following pairs of elements react to form compounds.

|                                 |   |                                     |                    |
|---------------------------------|---|-------------------------------------|--------------------|
| rubidium,<br>a Group I<br>metal | + | iodine,<br>a Group VII<br>non-metal | bonding type ..... |
|---------------------------------|---|-------------------------------------|--------------------|

|                                    |   |                                       |                    |
|------------------------------------|---|---------------------------------------|--------------------|
| sulfur,<br>a Group VI<br>non-metal | + | fluorine,<br>a Group VII<br>non-metal | bonding type ..... |
|------------------------------------|---|---------------------------------------|--------------------|

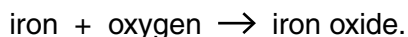
[2]

- (ii) During the reaction between rubidium and oxygen the rubidium melts due to a change in the temperature.

State the type of chemical reaction that causes this temperature change.

.....[1]

- (d) (i) Iron reacts with oxygen. The equation for this reaction is



State whether the iron is oxidised or reduced in this reaction.

Explain your answer.

iron is .....

explanation .....

.....[1]

- (ii) Another substance is involved in the formation of rust.

Name this substance.

.....[1]

- (iii) Describe **one** method of rust prevention. Explain how this method prevents rust from forming.

method .....

explanation .....

.....

.....[2]

- 6 Fig. 6.1 shows a thermometer containing a liquid at  $20^{\circ}\text{C}$  and at  $60^{\circ}\text{C}$ .

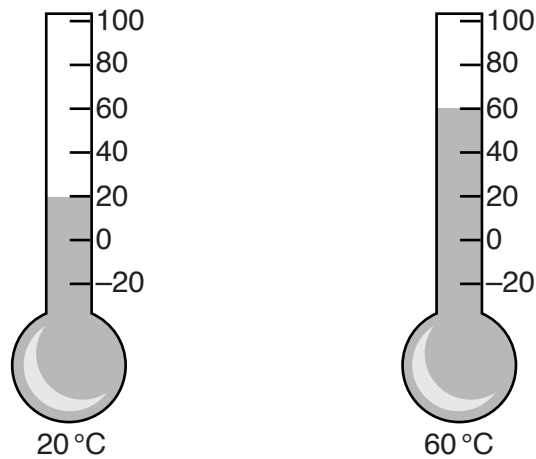


**Fig. 6.1**

- (a) Complete the sentences below by choosing the correct words from this list:

**density      force      mass      power      volume      work**

When the liquid is heated, the ..... of the liquid remains the same. The ..... of the liquid increases on heating, which means that the ..... of the liquid decreases. [3]

- (b) Water freezes at  $0^{\circ}\text{C}$ . Explain why the scale on the thermometer in Fig 6.1 shows that the liquid in the thermometer cannot be water.

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

(c) Fig. 6.2 shows the bulb of the thermometer placed in hot water at  $80^{\circ}\text{C}$ .

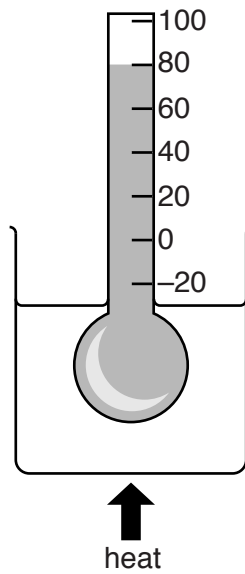


**Fig. 6.2**

The bulb and stem of the thermometer are made of glass.

When the thermometer is placed in the hot water, the top of the stem of the thermometer remains cold to touch, but the liquid level rises to the  $80^{\circ}\text{C}$  mark.

(i) Name the method of thermal energy transfer that takes place in the liquid.

.....[1]

(ii) Suggest why the top of the thermometer stem remains cold to the touch.

.....

.....[1]

(d) Fig. 6.3 shows simple diagrams of the arrangements of molecules in a solid, a liquid and a gas.

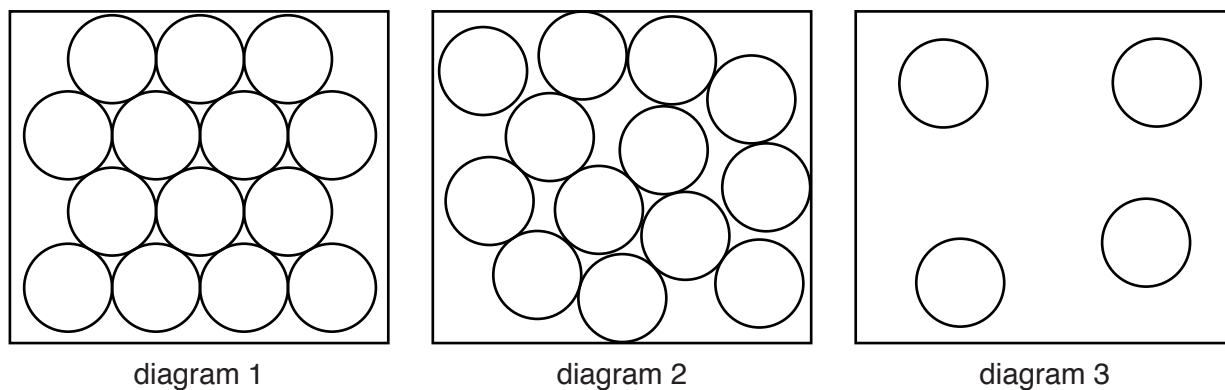


**Fig. 6.3**

Complete the statement.

Diagram 2 shows a liquid because .....

.....

.....

.....[2]

**7** Sometimes humans add untreated sewage to rivers.

Fig. 7.1 shows how the concentration of dissolved oxygen and number of bacteria in the river is affected after some sewage is added at point **X** on the river.

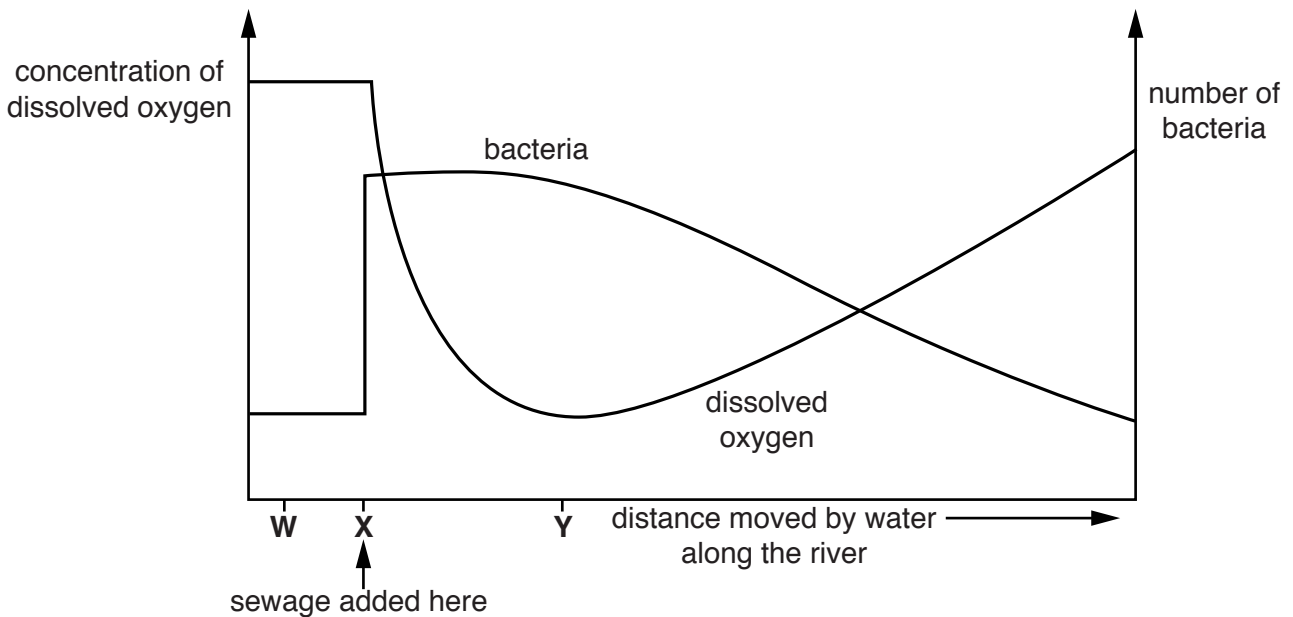


**Fig. 7.1**

After the sewage is added to the water at point **X**, the water continues to move along the river.

- (a)** Describe and explain how the concentration of dissolved oxygen changes immediately after the sewage is added to the water.

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

- (b)** The numbers of fish change after the sewage is added to the water.

Suggest why there are fewer fish when the water is at point **Y**, compared with point **W**.

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

- (c)** Explain why it is unsafe for humans to drink water containing untreated sewage.

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

- 8 (a) Coal is a fuel that is used to heat homes. Fig. 8.1 shows a coal fire.

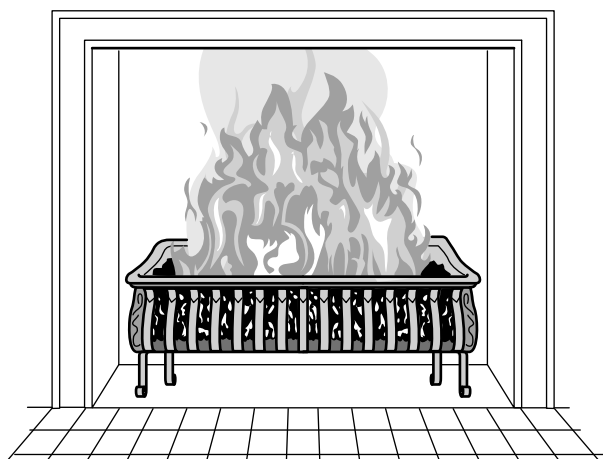


Fig. 8.1

Name the main substance produced during the complete combustion of coal.

.....[1]

- (b) Natural gas and petroleum are two other fuels.

- (i) Coal, natural gas and petroleum are all examples of one type of non-renewable fuel.

Name this type of fuel.

.....[1]

- (ii) Name the main constituent of natural gas.

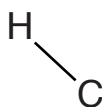
.....[1]

- (c) Ethene is a hydrocarbon.

- (i) State the meaning of the term *hydrocarbon*.

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

- (ii) Complete the structure of one molecule of ethene.



[2]

- 9 A student investigates the current through a lamp as she varies the potential difference (p.d.) across the lamp. She designs the circuit in Fig. 9.1 to use in her investigation.

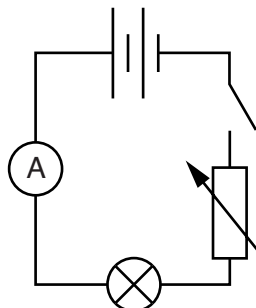
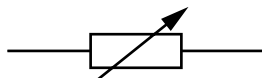


**Fig. 9.1**

- (a) (i) Name the component represented by this symbol



.....[1]

- (ii) The student has left out an important component from her design. This component is needed to make some of her measurements.

On Fig. 9.1 draw the symbol for this missing component in its correct place.

[2]

(b) The student uses the correct circuit to carry out her experiment.

Fig. 9.2 shows her results plotted as a graph.

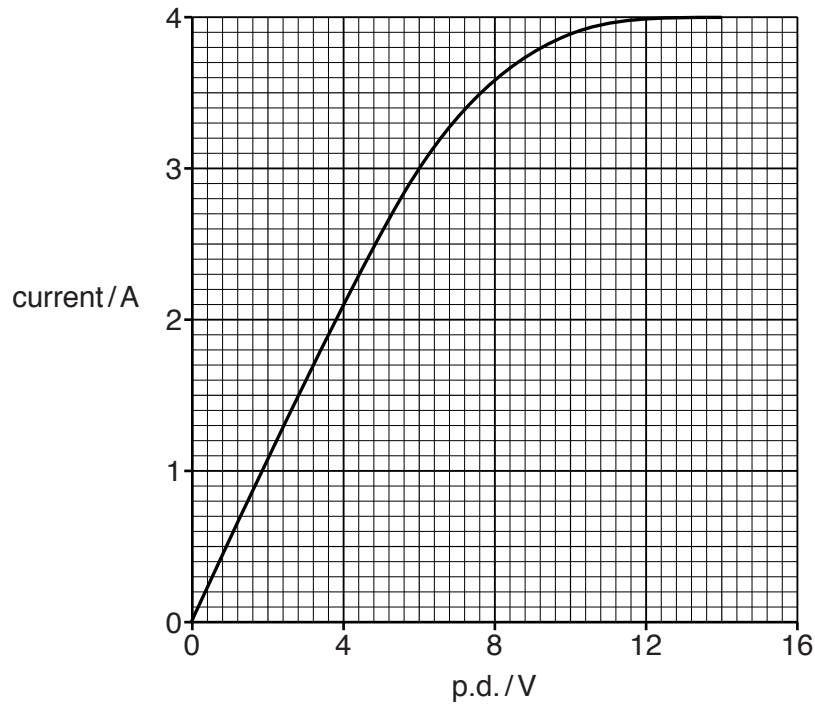


**Fig. 9.2**

The resistance of the lamp is given by the formula

$$\text{resistance} = \frac{\text{potential difference (p.d.)}}{\text{current}}$$

The student says that the resistance of the lamp is higher when the p.d. is 12V than when the p.d. is 6V. The resistance at 6V is  $2\Omega$ .

Use the graph in Fig. 9.2 to calculate the resistance at 12V to show that the student was correct.

resistance at 12V = .....  $\Omega$  [2]

- (c) The current through the metal filament in the lamp is a flow of electric charges.

Name the charged particles that carry these charges.

.....[1]

- (d) The lamp, when lit, emits radiation in the form of visible light and infra-red radiation.

Infra-red radiation has a longer wavelength than visible light.

- (i) In Fig 9.3 below, write visible light and infra-red in their correct positions in the electromagnetic spectrum.

|                 |  |             |  |  |  |             |
|-----------------|--|-------------|--|--|--|-------------|
| gamma radiation |  | ultraviolet |  |  |  | radio waves |
|-----------------|--|-------------|--|--|--|-------------|

**Fig. 9.3**

[2]

- (ii) State which type of radiation in the electromagnetic spectrum has the highest frequency.

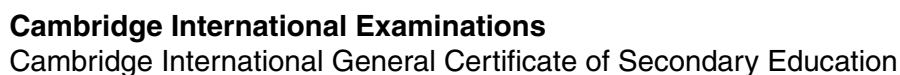
.....[1]

The Periodic Table of Elements

| Group                                                                                      |                                       |                                      |                                           |                                       |                                        |                                       |                                        |                                        |                                          |                                         |                                         |                                       |                                       |                                       |                                        |                                        |                                     |
|--------------------------------------------------------------------------------------------|---------------------------------------|--------------------------------------|-------------------------------------------|---------------------------------------|----------------------------------------|---------------------------------------|----------------------------------------|----------------------------------------|------------------------------------------|-----------------------------------------|-----------------------------------------|---------------------------------------|---------------------------------------|---------------------------------------|----------------------------------------|----------------------------------------|-------------------------------------|
| I                                                                                          | II                                    | <div>1<div>Hhydrogen1</div></div>    |                                           |                                       |                                        |                                       |                                        |                                        |                                          |                                         |                                         | III                                   | IV                                    | V                                     | VI                                     | VII                                    | VIII                                |
| <div>Key<div>atomic number<br/>atomic symbol<br/>name<br/>relative atomic mass</div></div> |                                       |                                      |                                           |                                       |                                        |                                       |                                        |                                        |                                          |                                         |                                         |                                       |                                       |                                       |                                        |                                        |                                     |
| 3 <div>Li<br/>lithium<br/>7</div>                                                          | 4 <div>Be<br/>beryllium<br/>9</div>   |                                      |                                           |                                       |                                        |                                       |                                        |                                        |                                          |                                         |                                         | 5 <div>B<br/>boron<br/>11</div>       | 6 <div>C<br/>carbon<br/>12</div>      | 7 <div>N<br/>nitrogen<br/>14</div>    | 8 <div>O<br/>oxygen<br/>16</div>       | 9 <div>F<br/>fluorine<br/>19</div>     | 10 <div>Ne<br/>neon<br/>20</div>    |
| 11 <div>Na<br/>sodium<br/>23</div>                                                         | 12 <div>Mg<br/>magnesium<br/>24</div> |                                      |                                           |                                       |                                        |                                       |                                        |                                        |                                          |                                         |                                         | 13 <div>Al<br/>aluminium<br/>27</div> | 14 <div>Si<br/>silicon<br/>28</div>   | 15 <div>P<br/>phosphorus<br/>31</div> | 16 <div>S<br/>sulfur<br/>32</div>      | 17 <div>Cl<br/>chlorine<br/>35.5</div> | 18 <div>Ar<br/>argon<br/>40</div>   |
| 19 <div>K<br/>potassium<br/>39</div>                                                       | 20 <div>Ca<br/>calcium<br/>40</div>   | 21 <div>Sc<br/>scandium<br/>45</div> | 22 <div>Ti<br/>titanium<br/>48</div>      | 23 <div>V<br/>vanadium<br/>51</div>   | 24 <div>Cr<br/>chromium<br/>52</div>   | 25 <div>Mn<br/>manganese<br/>55</div> | 26 <div>Fe<br/>iron<br/>56</div>       | 27 <div>Co<br/>cobalt<br/>59</div>     | 28 <div>Ni<br/>nickel<br/>59</div>       | 29 <div>Cu<br/>copper<br/>64</div>      | 30 <div>Zn<br/>zinc<br/>65</div>        | 31 <div>Ga<br/>gallium<br/>70</div>   | 32 <div>Ge<br/>germanium<br/>73</div> | 33 <div>As<br/>arsenic<br/>75</div>   | 34 <div>Se<br/>selenium<br/>79</div>   | 35 <div>Br<br/>bromine<br/>80</div>    | 36 <div>Kr<br/>krypton<br/>84</div> |
| 37 <div>Rb<br/>rubidium<br/>85</div>                                                       | 38 <div>Sr<br/>strontium<br/>88</div> | 39 <div>Y<br/>yttrium<br/>89</div>   | 40 <div>Zr<br/>zirconium<br/>91</div>     | 41 <div>Nb<br/>niobium<br/>93</div>   | 42 <div>Mo<br/>molybdenum<br/>96</div> | 43 <div>Tc<br/>technetium<br/>—</div> | 44 <div>Ru<br/>ruthenium<br/>101</div> | 45 <div>Rh<br/>rhodium<br/>103</div>   | 46 <div>Pd<br/>palladium<br/>106</div>   | 47 <div>Ag<br/>silver<br/>108</div>     | 48 <div>Cd<br/>cadmium<br/>112</div>    | 49 <div>In<br/>indium<br/>115</div>   | 50 <div>Sn<br/>tin<br/>117</div>      | 51 <div>Sb<br/>antimony<br/>122</div> | 52 <div>Te<br/>tellurium<br/>128</div> | 53 <div>I<br/>iodine<br/>127</div>     | 54 <div>Xe<br/>xenon<br/>131</div>  |
| 55 <div>Cs<br/>caesium<br/>133</div>                                                       | 56 <div>Ba<br/>barium<br/>137</div>   | 57–71 <div>lanthanoids</div>         | 72 <div>Hf<br/>hafnium<br/>178</div>      | 73 <div>Ta<br/>tantalum<br/>181</div> | 74 <div>W<br/>tungsten<br/>184</div>   | 75 <div>Re<br/>rhenium<br/>186</div>  | 76 <div>Os<br/>osmium<br/>190</div>    | 77 <div>Ir<br/>iridium<br/>192</div>   | 78 <div>Pt<br/>platinum<br/>195</div>    | 79 <div>Au<br/>gold<br/>197</div>       | 80 <div>Hg<br/>mercury<br/>201</div>    | 81 <div>Tl<br/>thallium<br/>204</div> | 82 <div>Pb<br/>lead<br/>207</div>     | 83 <div>Bi<br/>bismuth<br/>209</div>  | 84 <div>Po<br/>polonium<br/>—</div>    | 85 <div>At<br/>astatine<br/>—</div>    | 86 <div>Rn<br/>radon<br/>—</div>    |
| 87 <div>Fr<br/>francium<br/>—</div>                                                        | 88 <div>Ra<br/>radium<br/>—</div>     | 89–103 <div>actinoids</div>          | 104 <div>Rf<br/>rutherfordium<br/>—</div> | 105 <div>Db<br/>dubnium<br/>—</div>   | 106 <div>Sg<br/>seaborgium<br/>—</div> | 107 <div>Bh<br/>bohrium<br/>—</div>   | 108 <div>Hs<br/>hassium<br/>—</div>    | 109 <div>Mt<br/>meitnerium<br/>—</div> | 110 <div>Ds<br/>darmstadtium<br/>—</div> | 111 <div>Rg<br/>roentgenium<br/>—</div> | 112 <div>Cr<br/>copernicium<br/>—</div> |                                       |                                       |                                       |                                        |                                        |                                     |
|                                                                                            |                                       |                                      |                                           |                                       |                                        |                                       |                                        |                                        |                                          |                                         |                                         |                                       |                                       |                                       |                                        |                                        |                                     |
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|                                                                                            |                                       |                                      |                                           |                                       |                                        |                                       |                                        |                                        |                                          |                                         |                                         |                                       |                                       |                                       |                                        |                                        |                                     |
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|                                                                                            |                                       |                                      |                                           |                                       |                                        |                                       |                                        |                                        |                                          |                                         |                                         |                                       |                                       |                                       |                                        |                                        |                                     |
|                                                                                            |                                       |                                      |                                           |                                       |                                        |                                       |                                        |                                        |                                          |                                         |                                         |                                       |                                       |                                       |                                        |                                        |                                     |
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| lanthanoids            |                      |                           |                        |                       |                       |                       |                         |                      |                         |                        |                     |                        |                        |                       |  |  |  |
| 57                     | 58                   | 59                        | 60                     | 61                    | 62                    | 63                    | 64                      | 65                   | 66                      | 67                     | 68                  | 69                     | 70                     | 71                    |  |  |  |
| La<br>lanthanum<br>139 | Ce<br>cerium<br>140  | Pr<br>praseodymium<br>141 | Nd<br>neodymium<br>144 | Pm<br>promethium<br>— | Sm<br>samarium<br>150 | Eu<br>europium<br>152 | Gd<br>gadolinium<br>157 | Tb<br>terbium<br>159 | Dy<br>dysprosium<br>163 | Ho<br>holmium<br>165   | Er<br>erbium<br>167 | Tm<br>thulium<br>169   | Yb<br>ytterbium<br>173 | Lu<br>lutetium<br>175 |  |  |  |
| 89                     | 90                   | 91                        | 92                     | 93                    | 94                    | 95                    | 96                      | 97                   | 98                      | 99                     | 100                 | 101                    | 102                    | 103                   |  |  |  |
| Ac<br>actinium<br>—    | Th<br>thorium<br>232 | Pa<br>protactinium<br>231 | U<br>uranium<br>238    | Np<br>neptunium<br>—  | Pu<br>plutonium<br>—  | Am<br>americium<br>—  | Cm<br>curium<br>—       | Bk<br>berkelium<br>— | Cf<br>californium<br>—  | Es<br>einsteinium<br>— | Fm<br>fermium<br>—  | Md<br>mendelevium<br>— | No<br>nobelium<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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**0653/22**

May/June 2016

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

## READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.

Write in dark blue or black pen.

You may use an HB pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

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

At the end of the examination, fasten all your work securely together.

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 Fig. 1.1 shows some parts of the human alimentary canal and its associated organs.

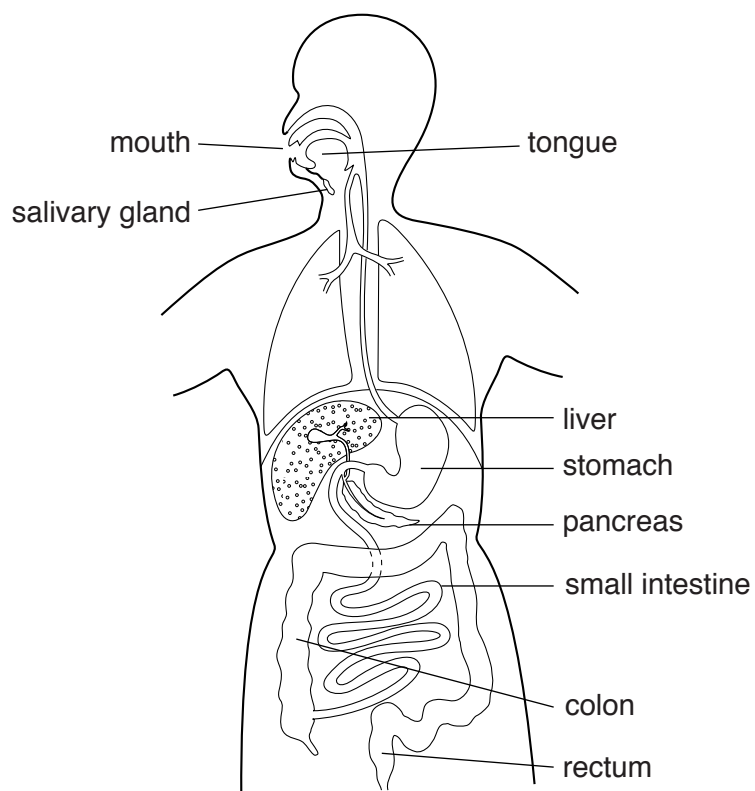


**Fig. 1.1**

- (a) Use the labels in Fig. 1.1 to complete Table 1.1.

**Table 1.1**

| function                    | name of organ(s)               |
|-----------------------------|--------------------------------|
| ingestion                   | .....                          |
| absorption of digested food | .....                          |
| secrete digestive enzymes   | stomach and<br>..... and ..... |

[4]

- (b) After the absorption of digested food, the blood takes the nutrients to the body cells.

State the part of the blood that transports dissolved nutrients.

..... [1]

- (c) Fig. 1.2 shows a section of a capillary next to some body cells.

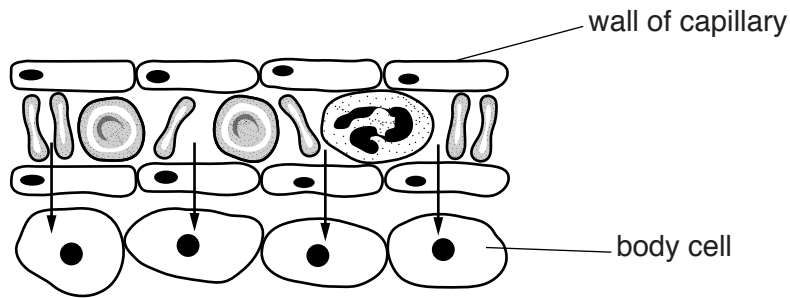


**Fig. 1.2**

Describe the process by which glucose moves in the direction shown by the arrows.

.....

.....

..... [2]

- (d) Fig. 1.3 shows the effect of pH on the activity of an enzyme which is secreted into the food in the stomach. The environment in the stomach has a low pH because of the presence of hydrochloric acid.

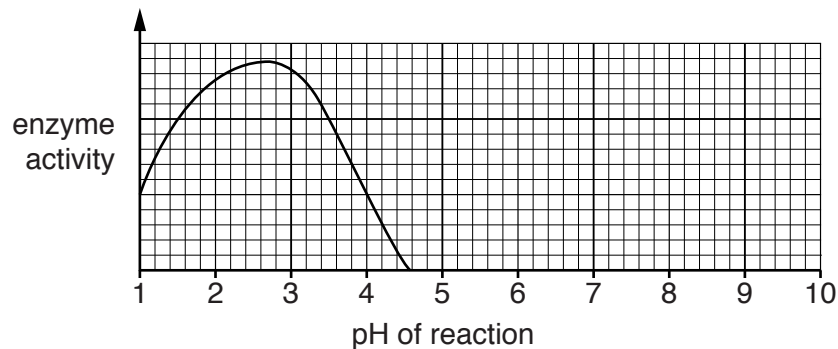


**Fig. 1.3**

- (i) State the optimum pH for this enzyme. .... [1]
- (ii) The stomach contents enter the duodenum. The pH in the duodenum is approximately 8.

Suggest what happens to the activity of the enzyme when it enters the duodenum.  
Explain your answer.

.....

.....

.....

..... [2]

- 2 (a) Lead bromide can be broken down into its elements using the apparatus shown in Fig. 2.1.

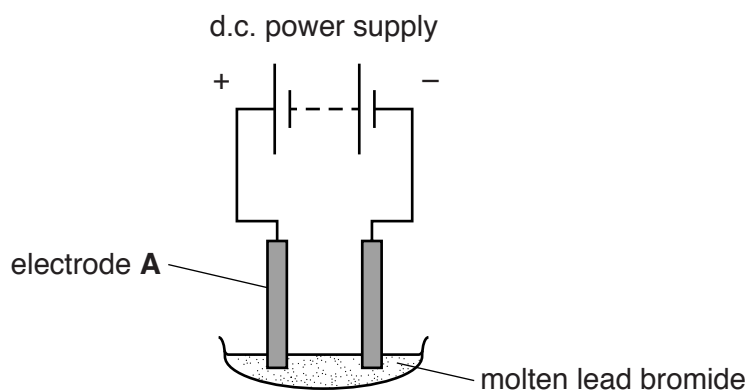


Fig. 2.1

- (i) Name the process shown in Fig. 2.1.

..... [1]

- (ii) Name the element produced at electrode **A** and state the colour of this element.

name .....

colour .....

[2]

- (b) In a similar process, copper chloride is broken down into a metal and chlorine.

Write the word equation for this reaction.

..... [1]

- (c) (i) Describe the trend in the boiling points of the elements going down Group VII of the Periodic Table, from chlorine to iodine.

..... [1]

- (ii) Fluorine is another element in Group VII. Fig. 2.2 shows an atom of fluorine.

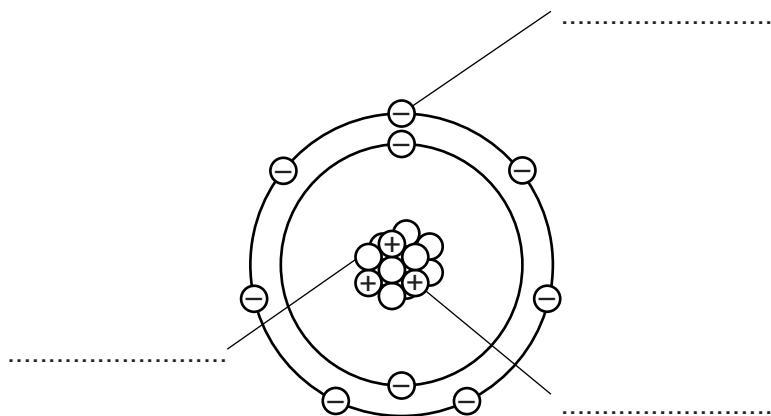


**Fig. 2.2**

Not all of the particles present in the atom of fluorine are shown.

Label the particles shown in Fig. 2.2.

[3]

- (iii) State what is meant by the term *nucleon number*.

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

- 3 Fig. 3.1 shows a small cart on 4 wheels with no engine. The cart runs down a sloping track steered by a driver.

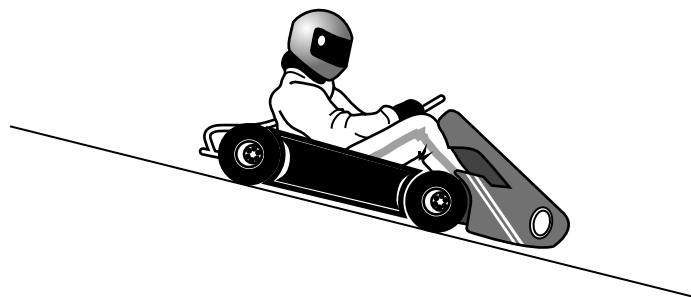


**Fig. 3.1**

- (a) Name the force that causes the cart to move down the slope.

..... [1]

- (b) Fig. 3.2 shows the track becoming horizontal at the bottom of the slope.

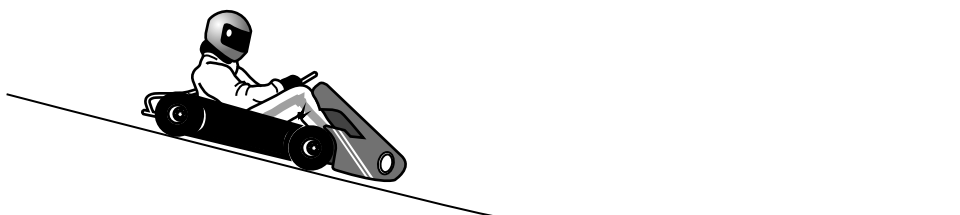


**Fig. 3.2**

- (i) The force in part (a) may change the motion of the cart along the horizontal track.

Tick the box alongside the statement that describes the effect of this force.

Give a reason for your choice.

It increases the speed of the cart.

☐

It does not affect the speed of the cart.

☐

It decreases the speed of the cart.

☐

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

- (ii) The cart moves along the horizontal track at an average speed of 8 m/s for a distance of 20 m before the driver applies the brakes.

Calculate the time taken to travel this distance.

State the formula you use, and show your working.

formula

working

time = ..... s [2]

- (iii) After applying the brakes, the cart comes to a stop in 10 m.

On the axes in Fig. 3.3, sketch the speed/time graph for the journey of the cart from the start of the horizontal track until it stops. (Scales and numbers are NOT required).

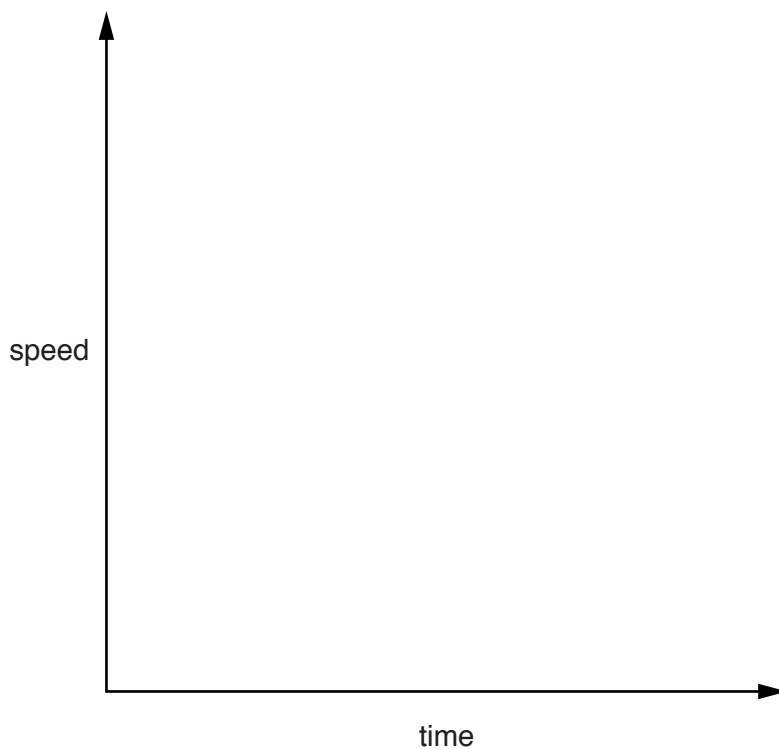


**Fig. 3.3**

[2]

- (c) Complete the energy transfers that take place while the cart is moving.

From ..... energy at the top of the slope

to *kinetic* ..... energy on the track

to ..... energy as the cart stops.

[2]

- 4 Fig. 4.1 shows a germinating seed and a diagram of one of the root hair cells.

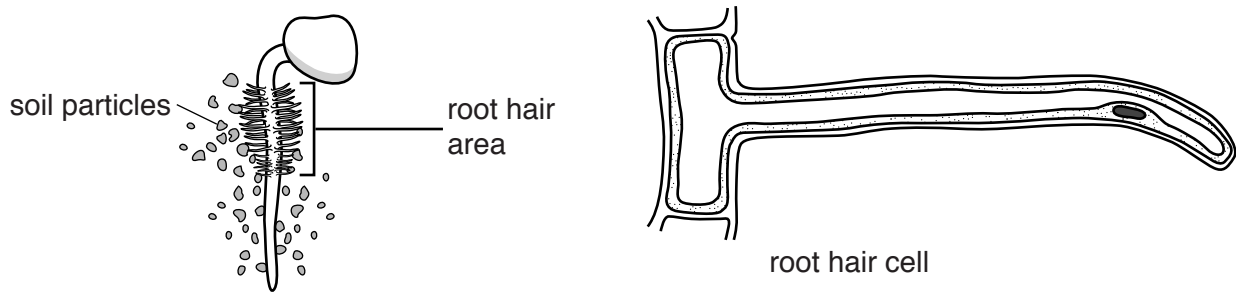


**Fig. 4.1**

- (a) Use the following terms to complete the sentences.

You may use each term once, more than once, or not at all.

**amino acids      cell membrane      cell wall      ions      nucleus**  
**phloem      photosynthesis      respiration      transpiration      xylem**

The root hair cell has a ..... to control what enters and

leaves the cell. The main function of this cell is to absorb water and

..... . Water goes from the root hair cell to the

..... to be taken to the rest of the plant. Water

evaporates from the plant by .....

[4]

- (b) Study the germinating seed in Fig. 4.1.

Suggest why the root hair cells constantly have to be replaced as the root grows.

.....

.....

..... [1]

- (c) A few days later the germinated seed in Fig. 4.1 develops leaves above ground and starts to photosynthesise.

- (i) Write the word equation for photosynthesis.

..... [2]

- (ii) List **two** conditions needed for photosynthesis.

1. ....

2. ....

[2]

- 5 Petroleum is a mixture of hydrocarbons. Fig. 5.1 shows how it is separated into useful products.

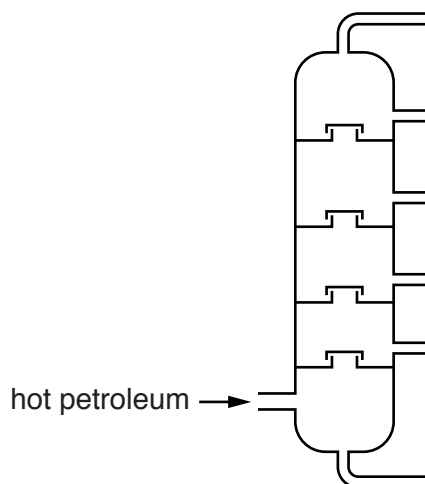


**Fig. 5.1**

- (a) (i) Name the process shown in Fig. 5.1.

..... [1]

- (ii) State what is meant by a *hydrocarbon*.

.....

..... [2]

- (b) Natural gas is often found with petroleum when it is extracted from the Earth's crust. It burns in air.

- (i) Name the main constituent of natural gas.

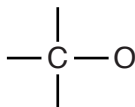
..... [1]

- (ii) Name the gas in air that reacts with natural gas when it burns.

..... [1]

(c) Ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , is a compound made from petroleum.

(i) Complete the diagram to show the structure of one molecule of ethanol.



[2]

(ii) Ethanol and hydrocarbons burn to form the same products.

Name the two substances formed during the complete combustion of ethanol.

1. ....

2. ....

[2]

6 Global warming causes ice caps to melt. This causes a rise in sea level.

(a) Warming of the water in the oceans causes the sea level to rise for a different reason.

Explain this reason.

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

(b) Global warming causes more water from the sea to move into the atmosphere.

(i) Name the process that causes this movement.

..... [1]

(ii) In the process named in (b)(i), the more energetic water molecules escape from the surface of the sea.

Suggest the effect this will have on

1. the energy of the molecules remaining in the sea water.

.....

2. the temperature of the sea water.

..... [2]

(c) Global warming happens when more of the energy coming from the Sun is trapped in the Earth's surface and atmosphere.

(i) State the form of energy transfer between the Sun and the Earth.

..... [1]

(ii) Table 6.1 shows part of the electromagnetic spectrum.

**Table 6.1**

|            |        |  |  |  |  |             |
|------------|--------|--|--|--|--|-------------|
| gamma rays | X-rays |  |  |  |  | radio waves |
|------------|--------|--|--|--|--|-------------|

In Table 6.1, write in the correct boxes

1. the name of the part of the spectrum often involved in thermal energy transfer.  
 Circle your answer.

2. the name of the part of the spectrum that enables you to read this question.  
**Do not** circle your answer.

[4]

7 Fig. 7.1 shows the members of a food chain in a habitat.

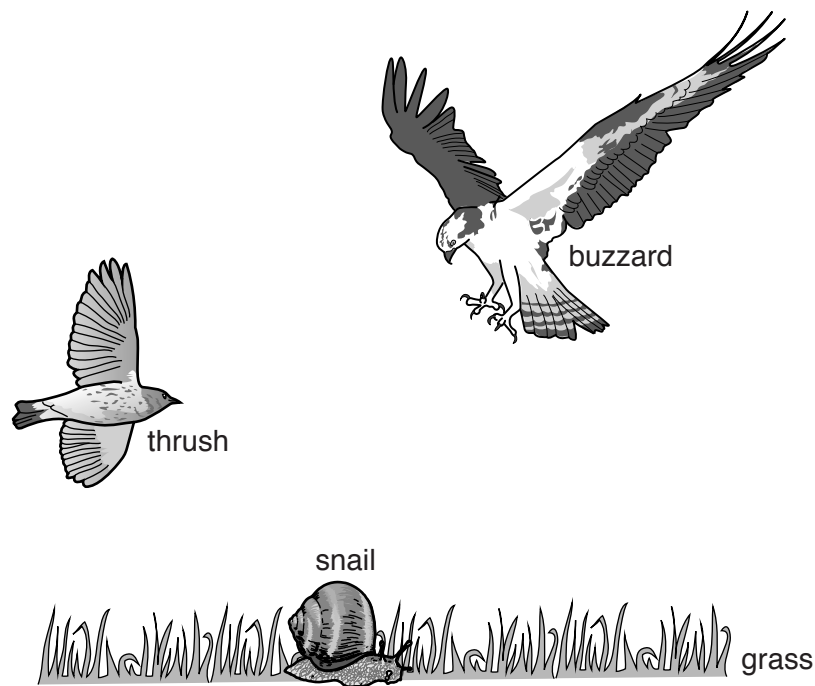


**Fig. 7.1**

The buzzard eats the thrush. The snail eats grass and the thrush is the snail's predator.

- (a) (i) Complete each row of Table 7.1 by ticking the boxes that apply to each organism. One has been done for you.

**Table 7.1**

| organism | producer | consumer | herbivore | carnivore |
|----------|----------|----------|-----------|-----------|
| buzzard  |          |          |           |           |
| grass    |          |          |           |           |
| snail    |          |          |           |           |
| thrush   |          | ✓        |           | ✓         |

[3]

- (ii) Construct a food chain showing **all** of the organisms in Fig. 7.1.

[2]

**(b)** The activities of humans can cause air pollution by gases such as methane.

**(i)** State one large-scale activity of humans that adds methane to the atmosphere.

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

**(ii)** Explain why large amounts of methane in the atmosphere are harmful.

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

- 8 Four metals are added to a dilute acid. Fig. 8.1 shows the pieces of metal before they are added to the acid.

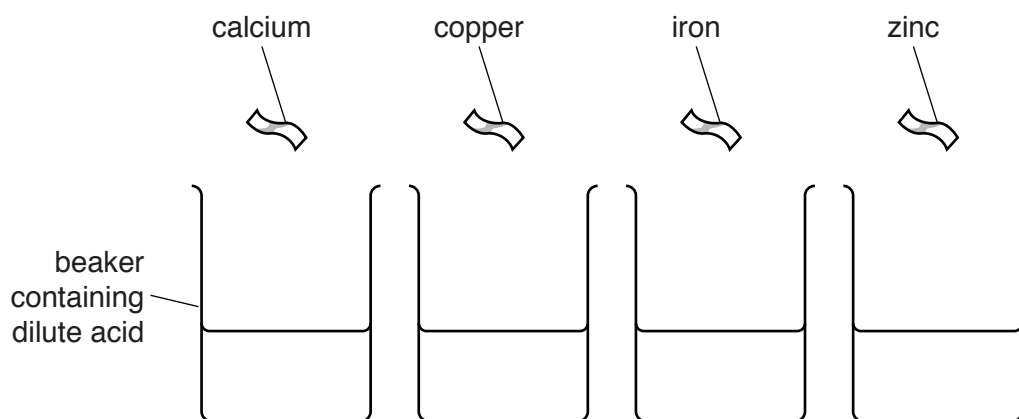


**Fig. 8.1**

- (a) (i) Place the four metals named in Fig. 8.1 in order of reactivity.

most reactive .....

.....

.....

least reactive .....

[1]

- (ii) The pieces of metal are added to the acid in the beakers.

Describe what is seen in the beakers where a reaction takes place.

.....

..... [1]

- (b) One student thinks that iron reacts to form iron(II) ions. Another student thinks that iron reacts to form iron(III) ions.

Suggest a test for iron(II) ions and iron(III) ions, and state the observations for each.

test .....

iron(II) ions .....

iron(III) ions .....

[3]

(c) Fig. 8.2 shows a piece of sodium added to water in a beaker.

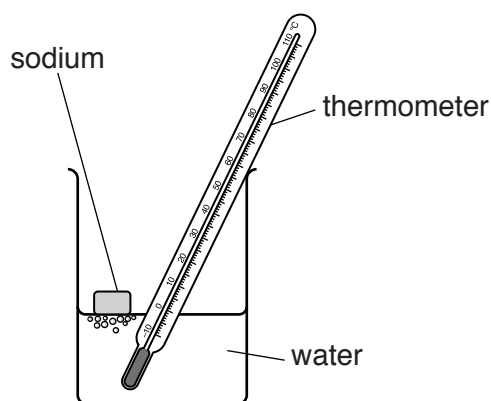


**Fig. 8.2**

The thermometer is used to measure the temperature of the water before and during the reaction.

The temperature of the water increases.

The equation for the reaction is



(i) State the type of chemical reaction that causes an increase in temperature.

..... [1]

(ii) In this reaction sodium atoms turn into sodium ions.

State the charge of a sodium ion.

..... [1]

(iii) Describe how sodium ions are formed from sodium atoms.

.....

..... [1]

- 9 A student investigates the current through an electric buzzer. He designs the circuit in Fig. 9.1 to use in his investigation.

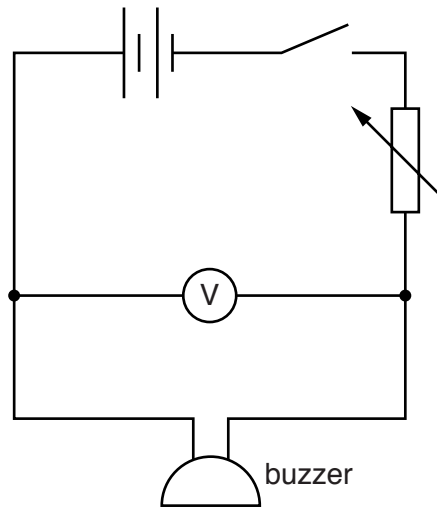
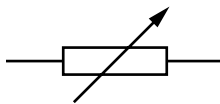


**Fig. 9.1**

- (a) (i) Name the component represented by this symbol.



..... [1]

- (ii) State and explain why the student includes this component in his circuit.

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

- (iii) The student has left out an important component from his circuit that is needed to measure the current.

On Fig. 9.2 complete the circuit diagram and include the symbol for this missing component in its correct place.

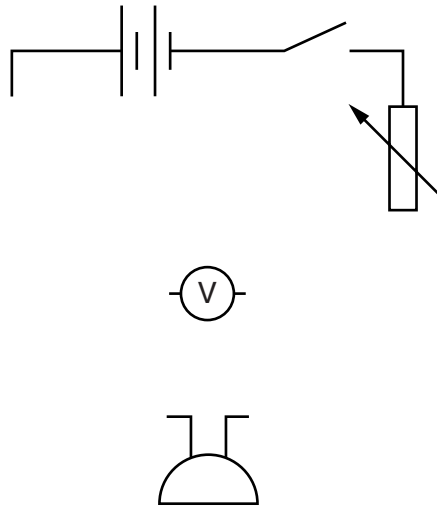


**Fig. 9.2**

[3]

- (b) The student used the correct circuit for his experiment. Fig. 9.3 shows his results plotted as a graph.

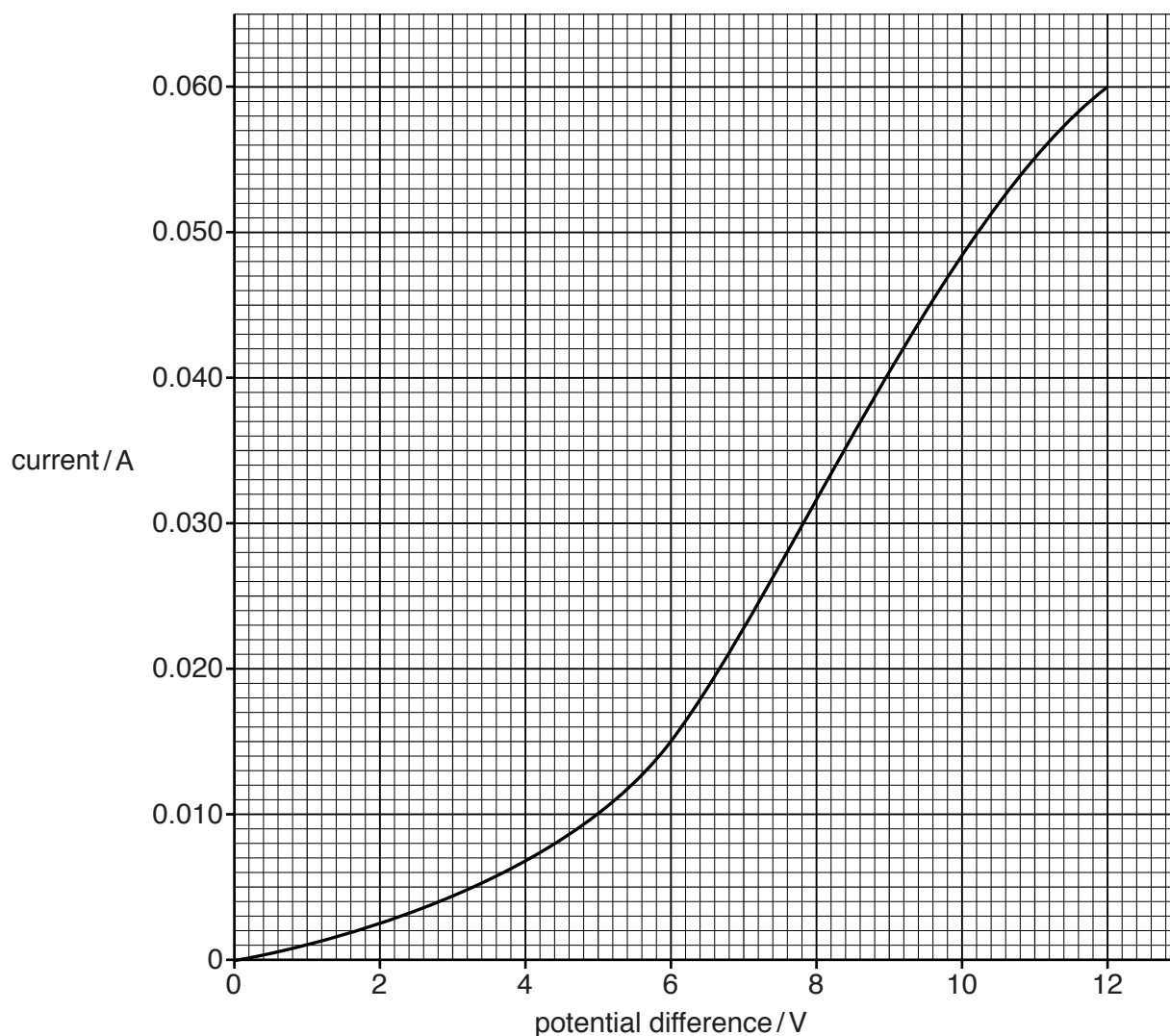


**Fig. 9.3**

The resistance of the buzzer is given by the formula

$$\text{resistance} = \frac{\text{potential difference (p.d.)}}{\text{current}}$$

The student says that the resistance of the buzzer is lower when the p.d. is 12V than when the p.d. is 6V. The resistance at 12V is  $200\,\Omega$ .

Use the graph in Fig. 9.3 to calculate the resistance at 6V to show that he was correct.

resistance at 6V = ..... $\Omega$  [2]

- (c) As the current increases the sound emitted by the buzzer becomes louder but has the same pitch.

State what happens to

the frequency of the sound waves,

.....

the amplitude of the sound waves.

.....

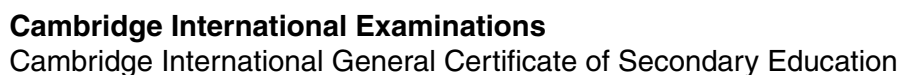
[2]

## The Periodic Table of Elements

| Group                      |                             |                                                                              |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                                      |                             |                               |                              |                              |                            |  |
|----------------------------|-----------------------------|------------------------------------------------------------------------------|-----------------------------|---------------------------------|------------------------------|------------------------------|------------------------------|----------------------------|------------------------------|--------------------------------|-------------------------------|--------------------------------------|-----------------------------|-------------------------------|------------------------------|------------------------------|----------------------------|--|
| I                          | II                          | Key                                                                          |                             |                                 |                              |                              |                              |                            |                              |                                |                               | III                                  | IV                          | V                             | VI                           | VII                          | VIII                       |  |
|                            |                             | <div>1<br/>H<br/>hydrogen<br/>1</div>                                        |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                                      |                             |                               |                              |                              |                            |  |
|                            |                             |                                                                              |                             |                                 |                              |                              |                              |                            |                              |                                |                               |                                      |                             |                               |                              |                              |                            |  |
| 3<br>Li<br>lithium<br>7    | 4<br>Be<br>beryllium<br>9   | <div>atomic number<br/>atomic symbol<br/>name<br/>relative atomic mass</div> |                             |                                 |                              |                              |                              |                            |                              |                                |                               | 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>—  |  |
| 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>oganesson<br>—  | 119<br>Ts<br>tennessine<br>— | 120<br>Nh<br>nihonium<br>— |  |
|                            |                             |                                                                              |                             |                                 |                              |                              |                              |                            |                              |                                |                               | <div>2<br/>He<br/>helium<br/>4</div> |                             |                               |                              | VIII                         |                            |  |

|             |           |    |           |          |     |    |        |         |     |    |              |              |     |    |           |         |     |    |            |           |     |    |          |           |     |    |           |           |     |    |            |        |     |    |         |           |     |    |            |             |     |    |         |             |     |     |        |         |     |     |         |            |     |     |          |          |     |     |          |            |     |
|-------------|-----------|----|-----------|----------|-----|----|--------|---------|-----|----|--------------|--------------|-----|----|-----------|---------|-----|----|------------|-----------|-----|----|----------|-----------|-----|----|-----------|-----------|-----|----|------------|--------|-----|----|---------|-----------|-----|----|------------|-------------|-----|----|---------|-------------|-----|-----|--------|---------|-----|-----|---------|------------|-----|-----|----------|----------|-----|-----|----------|------------|-----|
| 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 | europtium | 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  | yterbium | 173      | 71  | Lu  | lutetium | 175        |     |
|             | actinoids | 89 | Ac        | actinium | 227 | 90 | Th     | thorium | 232 | 91 | Pa           | protactinium | 231 | 92 | U         | uranium | 238 | 93 | Np         | neptunium | 237 | 94 | Pu       | plutonium | 244 | 95 | Am        | americium | 243 | 96 | Cm         | curium | 247 | 97 | Bk      | berkelium | 247 | 98 | Cf         | californium | 251 | 99 | Es      | einsteinium | 252 | 100 | Fm     | fermium | 257 | 101 | Md      | mercedeium | 288 | 102 | No       | nobelium | 289 | 103 | Lr       | lawrencium | 262 |

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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**0653/23**

May/June 2016

**1 hour 15 minutes**

No Additional Materials are required.

Write your Centre number, candidate number and name on all the work you hand in.  
Write in dark blue or black pen.  
You may use an HB pencil for any diagrams or graphs.  
Do not use staples, paper clips, glue or correction fluid.  
**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

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

At the end of the examination, fasten all your work securely together.

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 Fig. 1.1 shows some parts of the human alimentary canal and its associated organs.

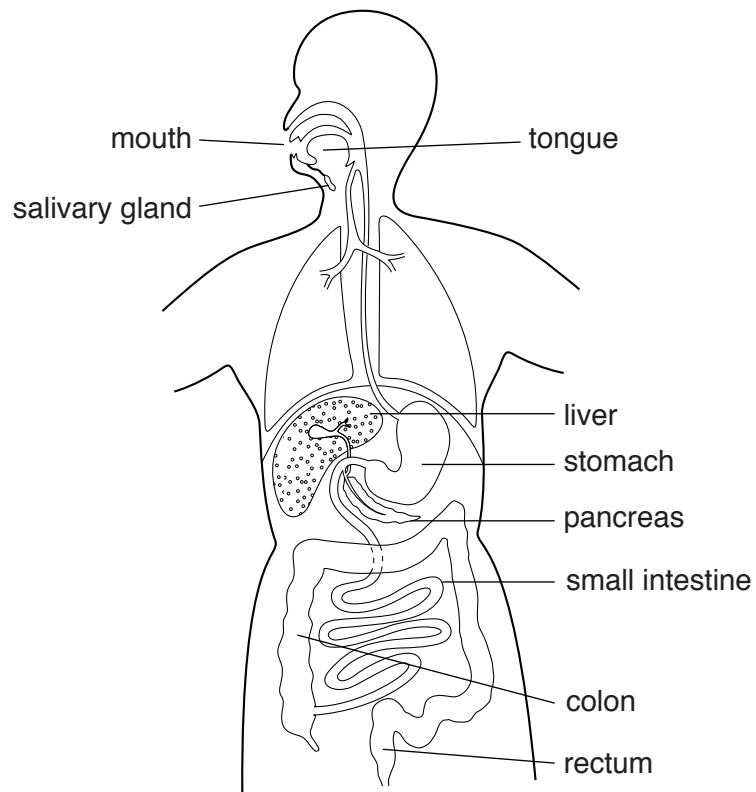


**Fig. 1.1**

- (a) Use the labels in Fig. 1.1 to complete Table 1.1.

**Table 1.1**

| function                    | name of organ(s)               |
|-----------------------------|--------------------------------|
| ingestion                   | .....                          |
| absorption of digested food | .....                          |
| secrete digestive enzymes   | stomach and<br>..... and ..... |

[4]

- (b) After the absorption of digested food, the blood takes the nutrients to the body cells.

State the part of the blood that transports dissolved nutrients.

..... [1]

- (c) Fig. 1.2 shows a section of a capillary next to some body cells.

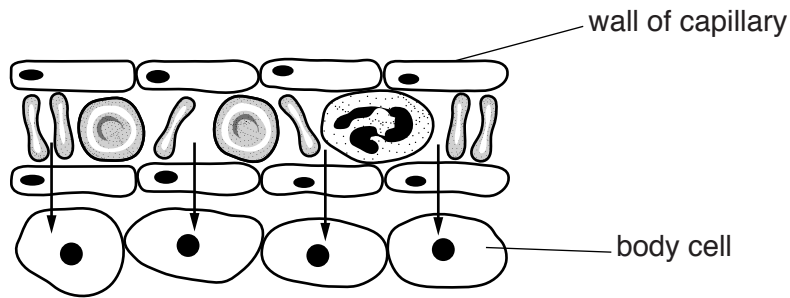


**Fig. 1.2**

Describe the process by which glucose moves in the direction shown by the arrows.

.....

.....

..... [2]

- (d) Fig. 1.3 shows the effect of pH on the activity of an enzyme which is secreted into the food in the stomach. The environment in the stomach has a low pH because of the presence of hydrochloric acid.

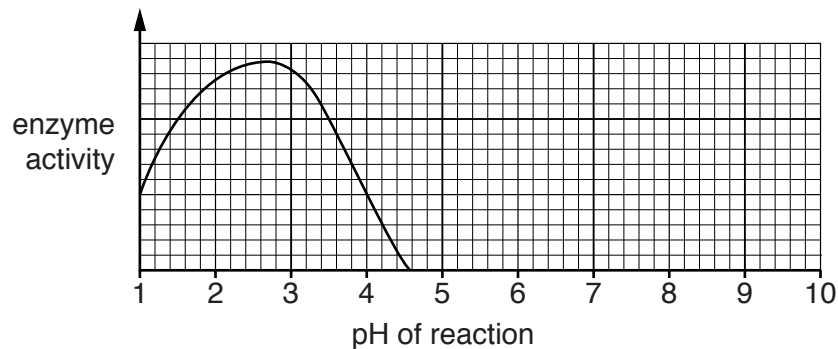


**Fig. 1.3**

- (i) State the optimum pH for this enzyme. .... [1]
- (ii) The stomach contents enter the duodenum. The pH in the duodenum is approximately 8.

Suggest what happens to the activity of the enzyme when it enters the duodenum.  
Explain your answer.

.....

.....

.....

..... [2]

- 2 (a) Lead bromide can be broken down into its elements using the apparatus shown in Fig. 2.1.

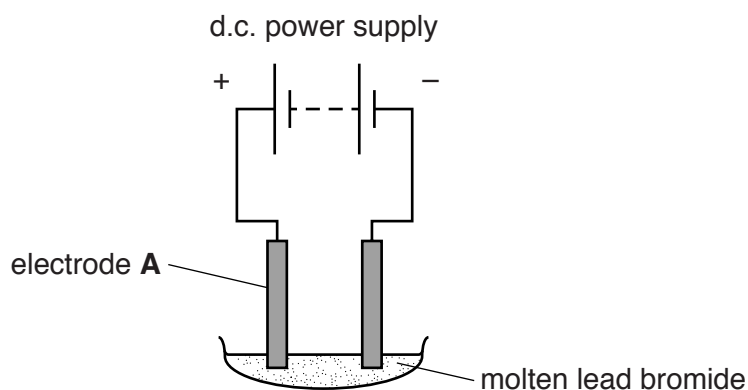


Fig. 2.1

- (i) Name the process shown in Fig. 2.1.

..... [1]

- (ii) Name the element produced at electrode **A** and state the colour of this element.

name .....

colour .....

[2]

- (b) In a similar process, copper chloride is broken down into a metal and chlorine.

Write the word equation for this reaction.

..... [1]

- (c) (i) Describe the trend in the boiling points of the elements going down Group VII of the Periodic Table, from chlorine to iodine.

..... [1]

- (ii) Fluorine is another element in Group VII. Fig. 2.2 shows an atom of fluorine.

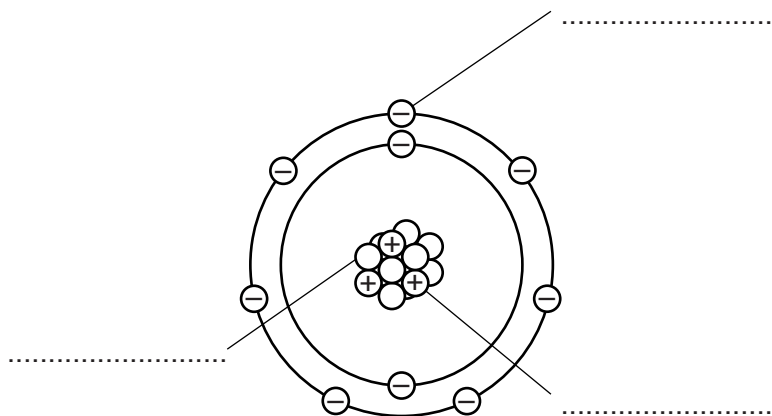


**Fig. 2.2**

Not all of the particles present in the atom of fluorine are shown.

Label the particles shown in Fig. 2.2.

[3]

- (iii) State what is meant by the term *nucleon number*.

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

- 3 Fig. 3.1 shows a small cart on 4 wheels with no engine. The cart runs down a sloping track steered by a driver.

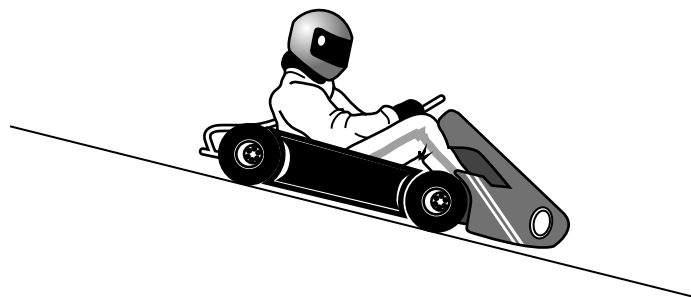


**Fig. 3.1**

- (a) Name the force that causes the cart to move down the slope.

..... [1]

- (b) Fig. 3.2 shows the track becoming horizontal at the bottom of the slope.

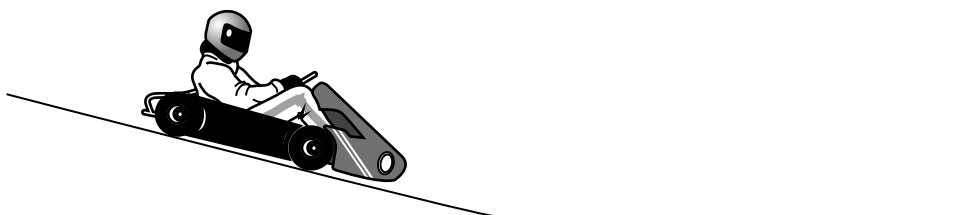


**Fig. 3.2**

- (i) The force in part (a) may change the motion of the cart along the horizontal track.

Tick the box alongside the statement that describes the effect of this force.

Give a reason for your choice.

It increases the speed of the cart.

☐

It does not affect the speed of the cart.

☐

It decreases the speed of the cart.

☐

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

- (ii) The cart moves along the horizontal track at an average speed of 8 m/s for a distance of 20 m before the driver applies the brakes.

Calculate the time taken to travel this distance.

State the formula you use, and show your working.

formula

working

time = ..... s [2]

- (iii) After applying the brakes, the cart comes to a stop in 10 m.

On the axes in Fig. 3.3, sketch the speed/time graph for the journey of the cart from the start of the horizontal track until it stops. (Scales and numbers are NOT required).

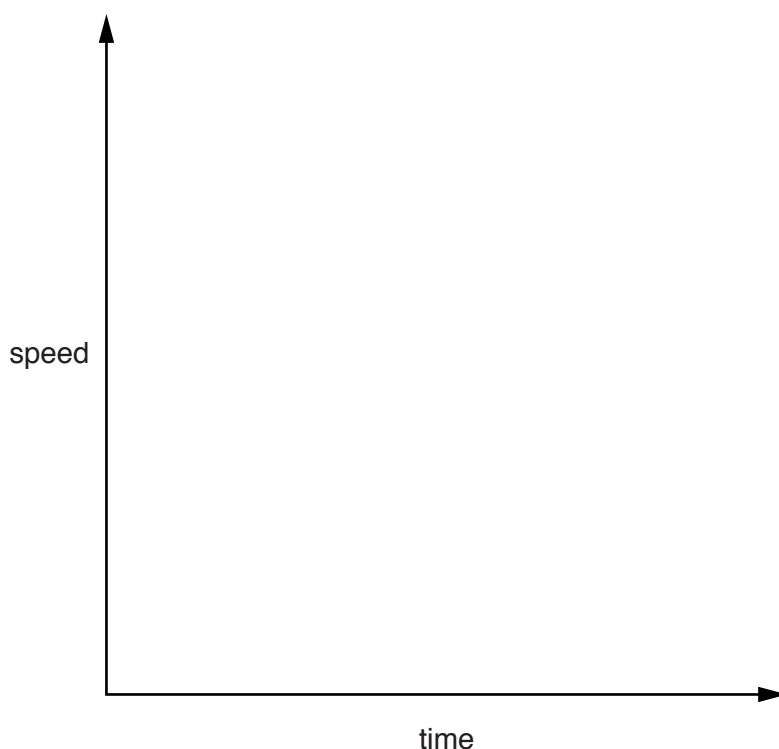


**Fig. 3.3**

[2]

- (c) Complete the energy transfers that take place while the cart is moving.

From ..... energy at the top of the slope

to *kinetic* ..... energy on the track

to ..... energy as the cart stops.

[2]

- 4 Fig. 4.1 shows a germinating seed and a diagram of one of the root hair cells.

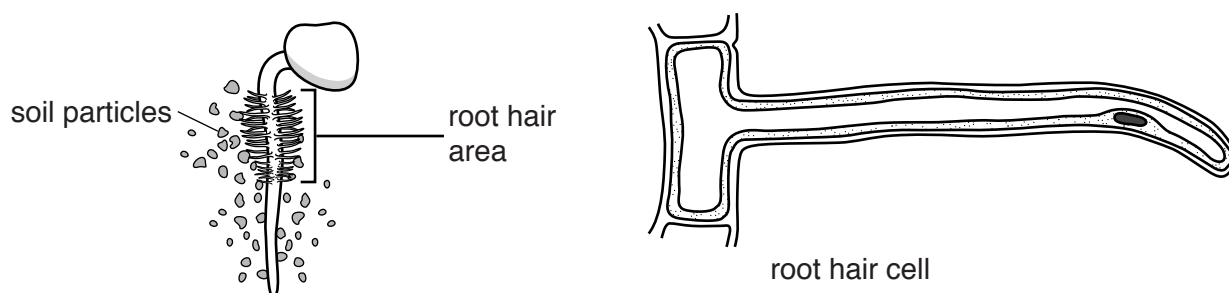


**Fig. 4.1**

- (a) Use the following terms to complete the sentences.

You may use each term once, more than once, or not at all.

**amino acids      cell membrane      cell wall      ions      nucleus**  
**phloem      photosynthesis      respiration      transpiration      xylem**

The root hair cell has a ..... to control what enters and leaves the cell. The main function of this cell is to absorb water and ..... . Water goes from the root hair cell to the ..... to be taken to the rest of the plant. Water evaporates from the plant by ..... .

[4]

- (b) Study the germinating seed in Fig. 4.1.

Suggest why the root hair cells constantly have to be replaced as the root grows.

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

- (c) A few days later the germinated seed in Fig. 4.1 develops leaves above ground and starts to photosynthesise.

- (i) Write the word equation for photosynthesis.

..... [2]

- (ii) List **two** conditions needed for photosynthesis.

1. ....  
 2. ....

[2]

- 5 Petroleum is a mixture of hydrocarbons. Fig. 5.1 shows how it is separated into useful products.

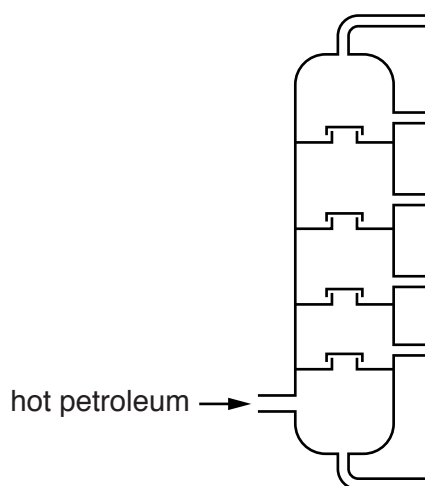


**Fig. 5.1**

- (a) (i) Name the process shown in Fig. 5.1.

..... [1]

- (ii) State what is meant by a *hydrocarbon*.

.....

..... [2]

- (b) Natural gas is often found with petroleum when it is extracted from the Earth's crust. It burns in air.

- (i) Name the main constituent of natural gas.

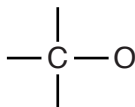
..... [1]

- (ii) Name the gas in air that reacts with natural gas when it burns.

..... [1]

(c) Ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , is a compound made from petroleum.

(i) Complete the diagram to show the structure of one molecule of ethanol.



[2]

(ii) Ethanol and hydrocarbons burn to form the same products.

Name the two substances formed during the complete combustion of ethanol.

1. ....

2. ....

[2]

6 Global warming causes ice caps to melt. This causes a rise in sea level.

(a) Warming of the water in the oceans causes the sea level to rise for a different reason.

Explain this reason.

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

(b) Global warming causes more water from the sea to move into the atmosphere.

(i) Name the process that causes this movement.

..... [1]

(ii) In the process named in (b)(i), the more energetic water molecules escape from the surface of the sea.

Suggest the effect this will have on

1. the energy of the molecules remaining in the sea water.

.....

2. the temperature of the sea water.

..... [2]

(c) Global warming happens when more of the energy coming from the Sun is trapped in the Earth's surface and atmosphere.

(i) State the form of energy transfer between the Sun and the Earth.

..... [1]

(ii) Table 6.1 shows part of the electromagnetic spectrum.

**Table 6.1**

|            |        |  |  |  |  |             |
|------------|--------|--|--|--|--|-------------|
| gamma rays | X-rays |  |  |  |  | radio waves |
|------------|--------|--|--|--|--|-------------|

In Table 6.1, write in the correct boxes

1. the name of the part of the spectrum often involved in thermal energy transfer.  
 Circle your answer.

2. the name of the part of the spectrum that enables you to read this question.  
**Do not** circle your answer.

[4]

7 Fig. 7.1 shows the members of a food chain in a habitat.

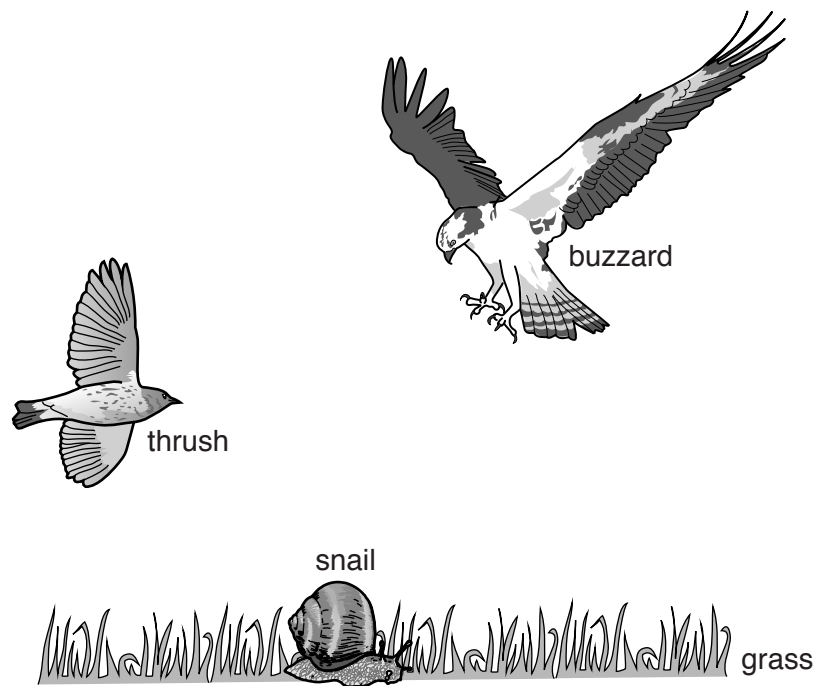


**Fig. 7.1**

The buzzard eats the thrush. The snail eats grass and the thrush is the snail's predator.

- (a) (i) Complete each row of Table 7.1 by ticking the boxes that apply to each organism. One has been done for you.

**Table 7.1**

| organism | producer | consumer | herbivore | carnivore |
|----------|----------|----------|-----------|-----------|
| buzzard  |          |          |           |           |
| grass    |          |          |           |           |
| snail    |          |          |           |           |
| thrush   |          | ✓        |           | ✓         |

[3]

- (ii) Construct a food chain showing **all** of the organisms in Fig. 7.1.

[2]

**(b)** The activities of humans can cause air pollution by gases such as methane.

**(i)** State one large-scale activity of humans that adds methane to the atmosphere.

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

**(ii)** Explain why large amounts of methane in the atmosphere are harmful.

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

- 8 Four metals are added to a dilute acid. Fig. 8.1 shows the pieces of metal before they are added to the acid.

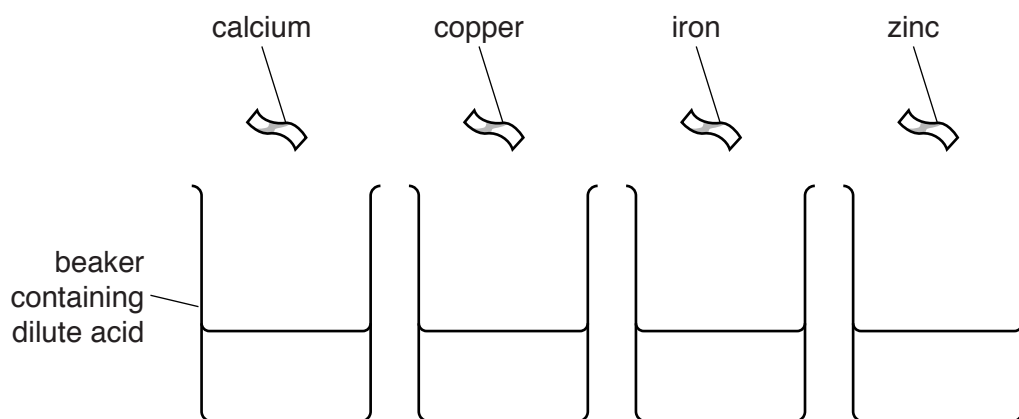


Fig. 8.1

- (a) (i) Place the four metals named in Fig. 8.1 in order of reactivity.

most reactive .....

.....

.....

least reactive .....

[1]

- (ii) The pieces of metal are added to the acid in the beakers.

Describe what is seen in the beakers where a reaction takes place.

.....

..... [1]

- (b) One student thinks that iron reacts to form iron(II) ions. Another student thinks that iron reacts to form iron(III) ions.

Suggest a test for iron(II) ions and iron(III) ions, and state the observations for each.

test .....

iron(II) ions .....

iron(III) ions .....

[3]

(c) Fig. 8.2 shows a piece of sodium added to water in a beaker.

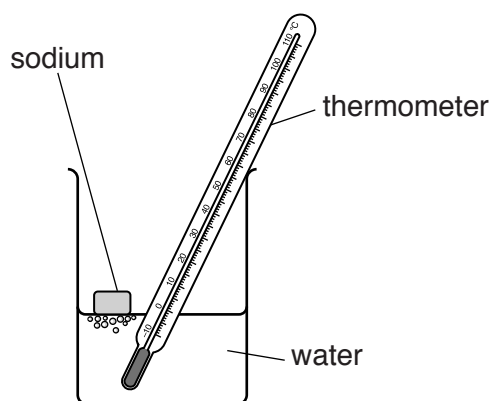


**Fig. 8.2**

The thermometer is used to measure the temperature of the water before and during the reaction.

The temperature of the water increases.

The equation for the reaction is



(i) State the type of chemical reaction that causes an increase in temperature.

..... [1]

(ii) In this reaction sodium atoms turn into sodium ions.

State the charge of a sodium ion.

..... [1]

(iii) Describe how sodium ions are formed from sodium atoms.

.....

..... [1]

- 9 A student investigates the current through an electric buzzer. He designs the circuit in Fig. 9.1 to use in his investigation.

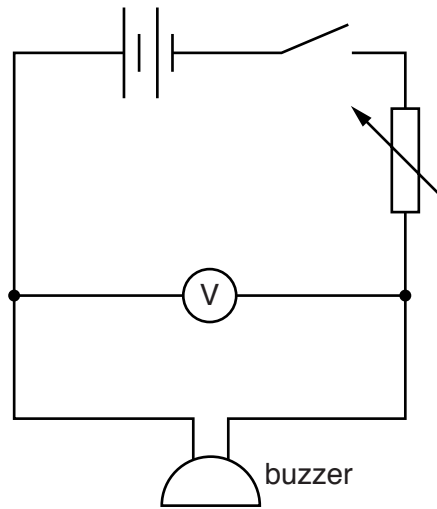
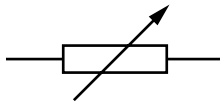


**Fig. 9.1**

- (a) (i) Name the component represented by this symbol.



..... [1]

- (ii) State and explain why the student includes this component in his circuit.

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

- (iii) The student has left out an important component from his circuit that is needed to measure the current.

On Fig. 9.2 complete the circuit diagram and include the symbol for this missing component in its correct place.

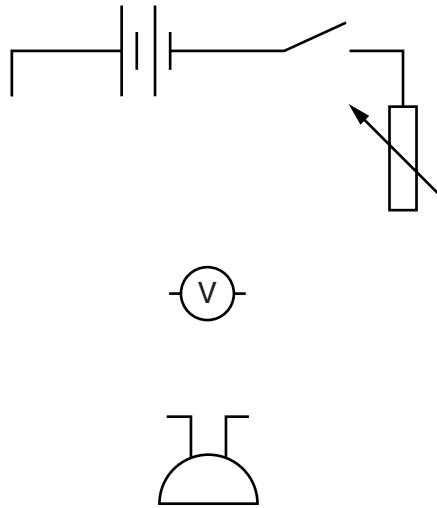


**Fig. 9.2**

[3]

- (b) The student used the correct circuit for his experiment. Fig. 9.3 shows his results plotted as a graph.

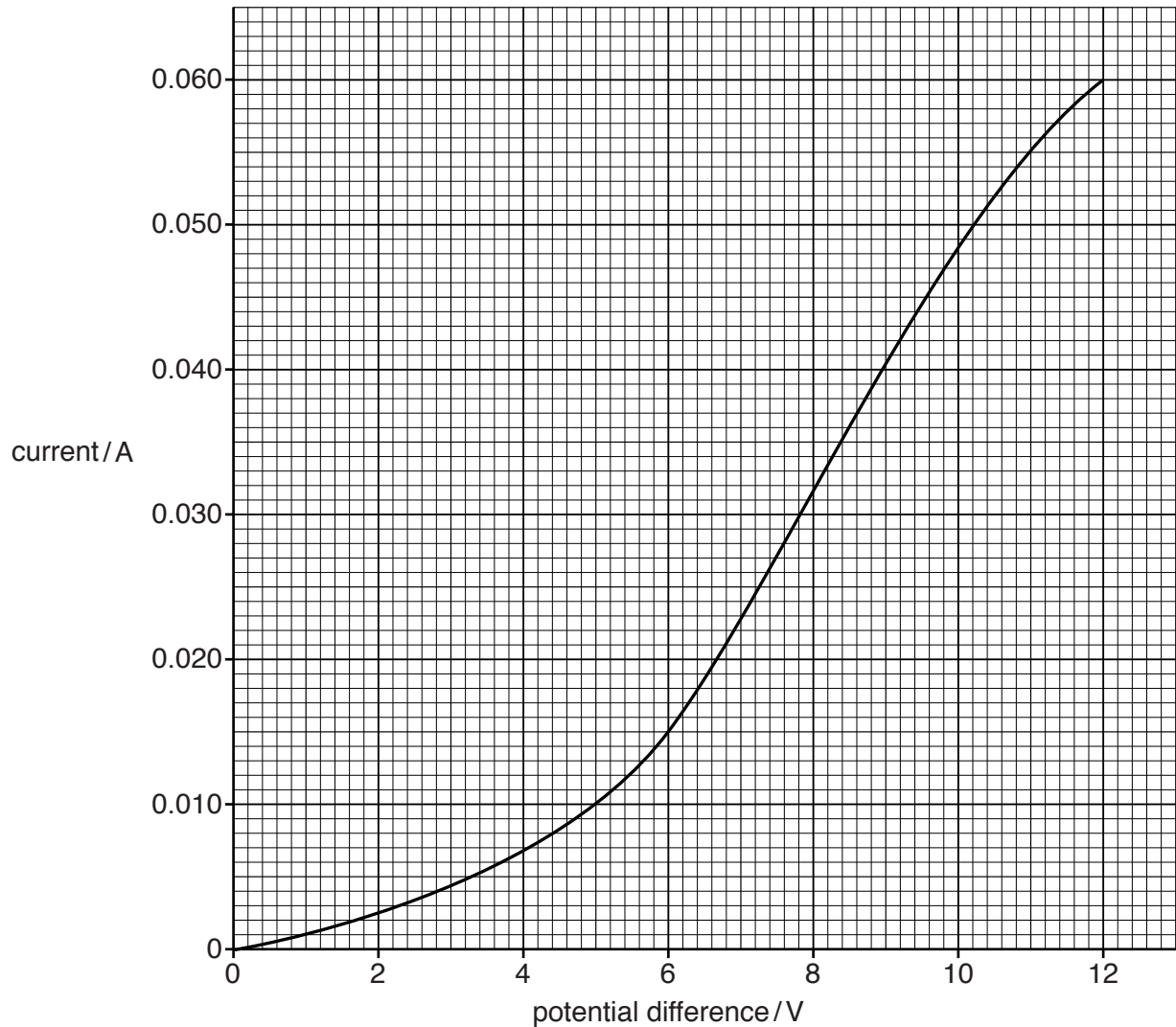


**Fig. 9.3**

The resistance of the buzzer is given by the formula

$$\text{resistance} = \frac{\text{potential difference (p.d.)}}{\text{current}}$$

The student says that the resistance of the buzzer is lower when the p.d. is 12V than when the p.d. is 6V. The resistance at 12V is  $200\,\Omega$ .

Use the graph in Fig. 9.3 to calculate the resistance at 6V to show that he was correct.

resistance at 6V = ..... $\Omega$  [2]

- (c) As the current increases the sound emitted by the buzzer becomes louder but has the same pitch.

State what happens to

the frequency of the sound waves,

.....

the amplitude of the sound waves.

.....

[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   |                                                                              |                                 |                             |                              |                             |                              |                              |                                |                               |                               |                             |                               |                              |                              |                            |                                |
| 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<br>actinoids                                            | 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>Ds<br>darmstadtium<br>— |

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

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