



# Cambridge IGCSE™

CANDIDATE  
NAME

CENTRE  
NUMBER

|  |  |  |  |  |
|--|--|--|--|--|
|  |  |  |  |  |
|--|--|--|--|--|

CANDIDATE  
NUMBER

|  |  |  |  |
|--|--|--|--|
|  |  |  |  |
|--|--|--|--|



**CO-ORDINATED SCIENCES**

**0654/32**

Paper 3 Theory (Core)

**February/March 2021**

**2 hours**

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 120.
- 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 **28** pages. Any blank pages are indicated.

## 2

- 1 (a) It is recommended that people eat a balanced diet.

Place a tick (✓) next to the sentence that **best** describes a balanced diet.

|   |  |
|---|--|
| A balanced diet contains all the required nutrients in the correct amounts. |  |
| A balanced diet contains the correct amounts of carbohydrates.              |  |
| A balanced diet contains lots of fruit and vegetables.                      |  |
| A balanced diet contains no fats or salt.                                   |  |

[1]

- (b) The boxes on the left show some nutrients.

The boxes on the right show why the nutrients are needed by the body.

Draw lines to link each nutrient with why it is needed by the body.

| nutrient     | why it is needed           |
|--------------|----------------------------|
| carbohydrate | for bones and teeth        |
| fats         | insulation                 |
| protein      | main source of energy      |
| vitamin D    | used for growth and repair |

[3]

- (c) List the **three** chemical elements that make up carbohydrates.

..... [1]

- (d) Benedict's solution can be used to test for the presence of one type of carbohydrate.

Name the carbohydrate that Benedict's solution is used to test for.

..... [1]

- (e) Name the component of the diet that prevents constipation.

..... [1]

3

(f) Eating less sugar can help prevent tooth decay.

Describe one other way of taking care of teeth.

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

(g) Circle the **two** processes that occur in the mouth.

**ingestion**

**digestion**

**egestion**

**fertilisation**

**photosynthesis**

**pollination**

**transpiration**

[2]

[Total: 10]

- 2 (a) Copper and sodium are metals. Copper is a transition element.

Sodium is not a transition element. It is found in Group I of the Periodic Table.

Some properties of metallic elements are listed.

- A act as a catalyst
- B form coloured compounds
- C good conductor of electricity
- D good conductor of thermal energy
- E malleable
- F non-magnetic

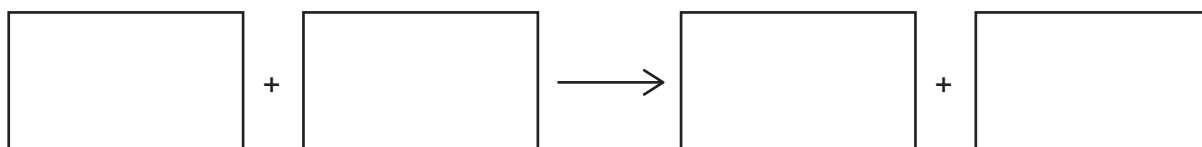
State the letters (A to F) of the **two** properties that describe copper but do **not** describe sodium.

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

- (b) Copper(II) oxide is heated with carbon.

Copper and carbon dioxide are made.

- (i) Construct the word equation for the reaction between copper(II) oxide and carbon.



[1]

- (ii) State the chemical test for carbon dioxide gas and the observation for a positive result.

test .....

observation .....

[2]

- (iii) Explain why copper(II) oxide is described as a basic oxide.

.....

..... [1]

- (c) Metals can be coated with a layer of copper using electroplating.

Electroplating uses the process of electrolysis.

Use words from the list to complete the sentence to define the term electrolysis.

Each word may be used once or not at all.

**covalent**                      **electricity**                      **gas**                      **ionic**                      **molten**  
**solid**                      **solution**                      **time**                      **water**

Electrolysis always involves the breakdown of ..... compounds when  
 ..... or in aqueous ..... by the passage of  
 .....

[2]

- (d) Bronze is a mixture of copper and tin.

- (i) State the term used to describe a mixture of metals.

..... [1]

- (ii) Apart from cost, suggest why bronze is used to make coins but pure copper is **not** used to make coins.

.....

..... [1]

[Total: 10]

**3 (a)** X-rays and  $\gamma$ -radiation are both forms of ionising radiation used in hospitals.

**(i)** State one adverse effect of ionising radiation on the human body.

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

**(ii)** State one use of X-rays in a hospital.

..... [1]

**(iii)** Fig. 3.1 shows an incomplete electromagnetic spectrum.

Write  $\gamma$ -radiation and X-rays in their correct positions in Fig. 3.1.

|  |  |             |  |          |  |             |
|--|--|-------------|--|----------|--|-------------|
|  |  | ultraviolet |  | infrared |  | radio waves |
|--|--|-------------|--|----------|--|-------------|

**Fig. 3.1**

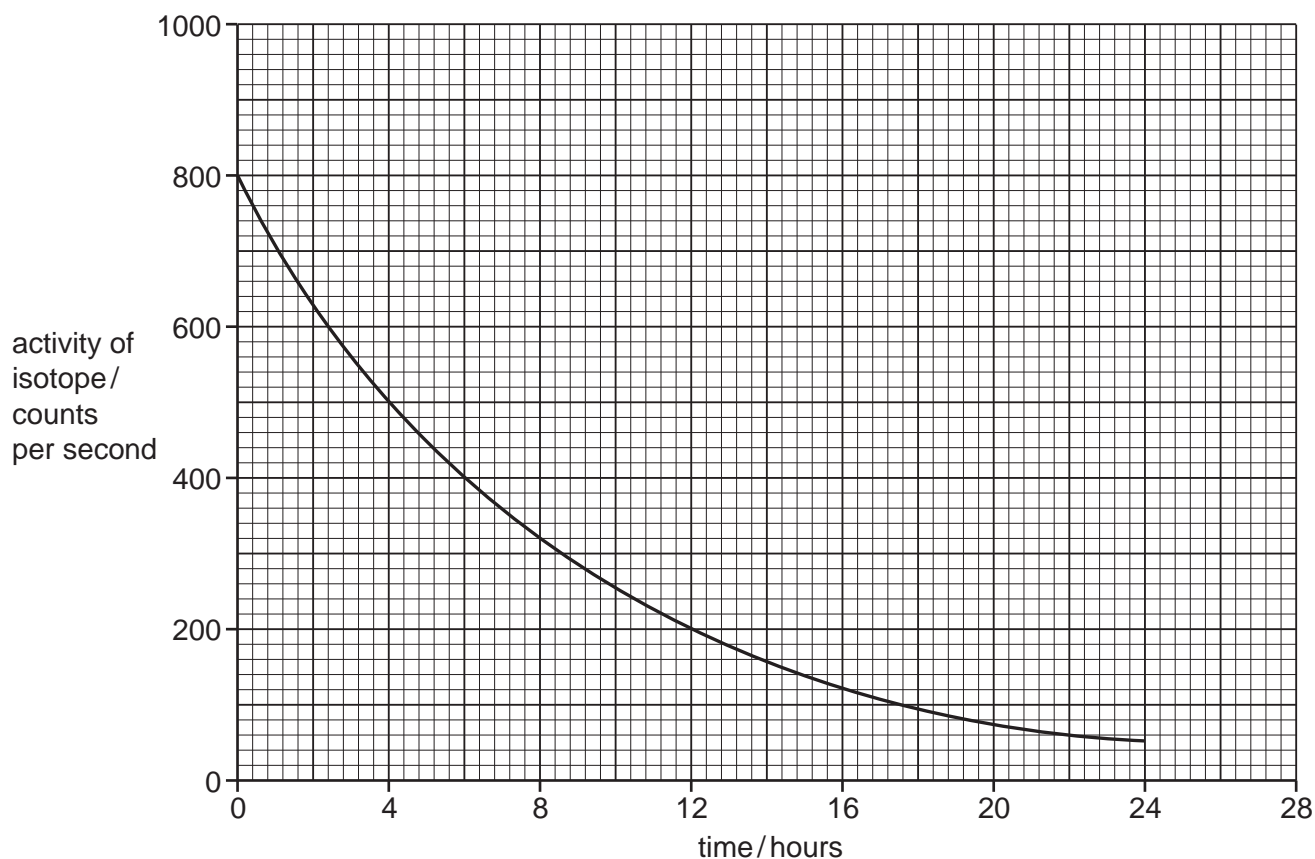
[2]

**(iv)** State one property that is the same for all electromagnetic waves.

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

(b) A radioactive isotope is used in medical tests as a radioactive tracer.

Fig. 3.2 shows the results of an experiment to measure how the radioactivity of the isotope changes with time.



**Fig. 3.2**

Use Fig. 3.2 to determine the half-life of the isotope in hours.

Show your working.

half-life = ..... hours [2]

- (c) Ultrasound waves are also used in hospitals.

Ultrasound waves are sound waves with a frequency greater than the highest audible frequency of a human.

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

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

- (ii) Suggest a frequency for ultrasound waves.

State the unit of your answer.

frequency = ..... unit ..... [2]

- (iii) An ultrasound wave travels 21 cm in 0.00025 s.

Calculate the speed of the ultrasound wave in m/s.

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

[Total: 13]



**BLANK PAGE**

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

The number of new HIV infections in one country was monitored.

The results are shown in Fig. 4.1.

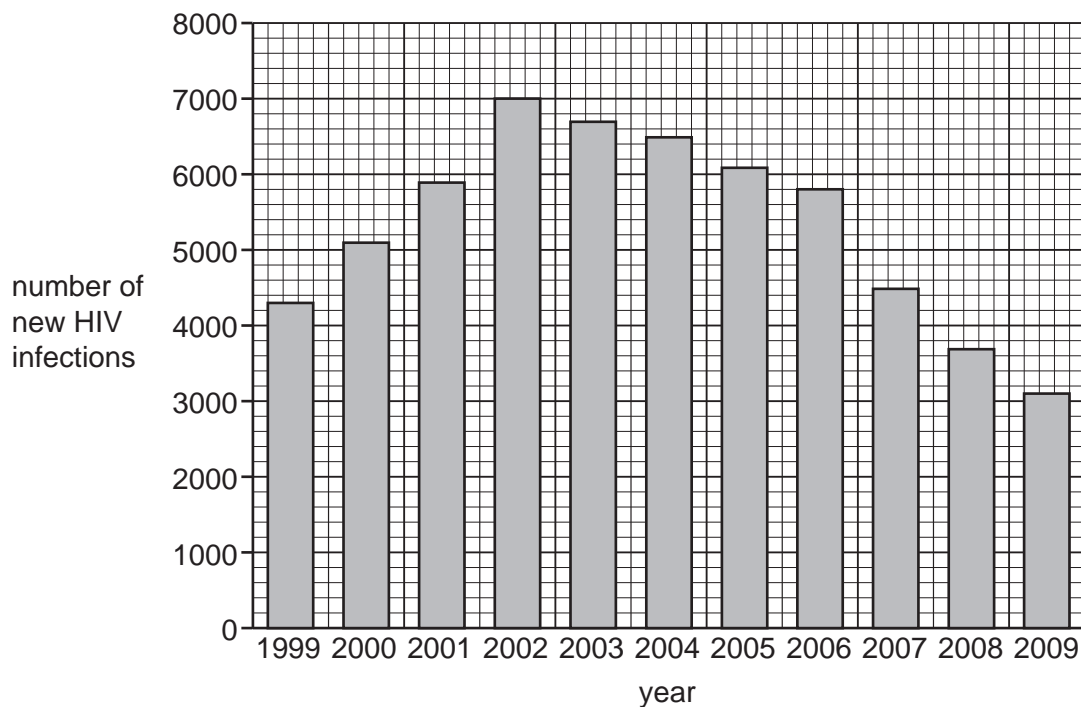


Fig. 4.1

The number of new infections has decreased since 2002.

(i) Calculate the difference in number of new HIV infections between 2002 and 2009.

..... [1]

(ii) Suggest two reasons why the number of new HIV infections has **decreased** since 2002.

1 .....

.....

2 .....

..... [2]

(iii) Place a tick (✓) in the box to show one way HIV can be transmitted.

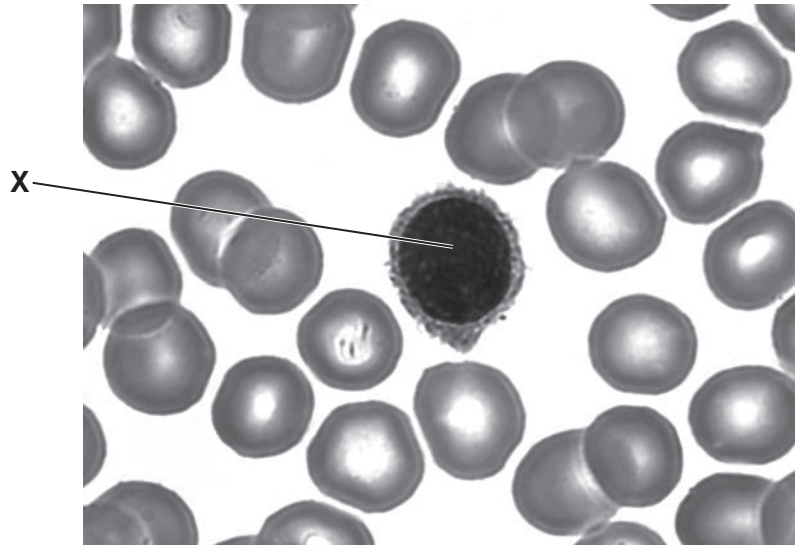
|                          |  |
|--------------------------|--|
| holding hands            |  |
| sharing cooking utensils |  |
| through breast milk      |  |
| genetically inherited    |  |

[1]

(b) HIV infects white blood cells.

Fig. 4.2 shows a photomicrograph of some blood.

A white blood cell can be seen in the centre.



**Fig. 4.2**

(i) Name the part of the white blood cell labelled X in Fig. 4.2.

..... [1]

(ii) Name the other type of cells visible in Fig. 4.2.

..... [1]

(iii) State two functions of white blood cells.

1 .....

2 .....

[2]

(iv) Name the part of the blood that transports hormones.

..... [1]

[Total: 9]

- 5 (a) Lithium, sodium and potassium are alkali metal elements in the Periodic Table.

Table 5.1 shows the melting points of lithium, sodium and potassium.

**Table 5.1**

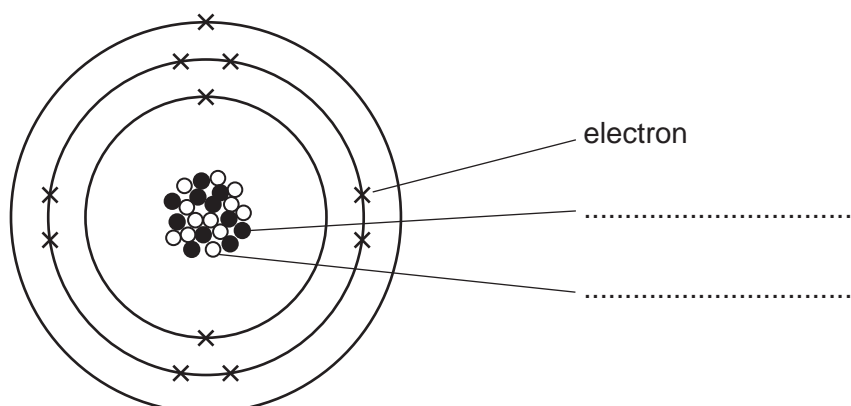
| metal     | melting point/°C |
|-----------|------------------|
| lithium   | 181              |
| sodium    | 98               |
| potassium | 64               |

State the trend in the melting points of the elements from lithium to potassium.

..... [1]

- (b) An atom of sodium has a nucleon number (mass number) of 23 and a proton number (atomic number) of 11.

Fig. 5.1 shows the structure of an atom of sodium.



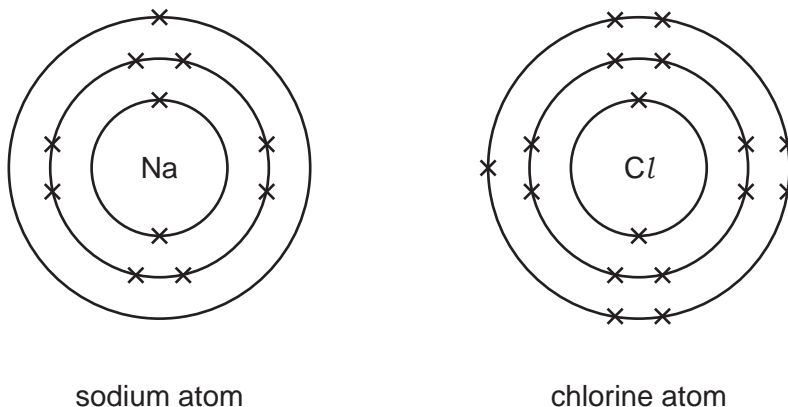
**Fig. 5.1**

- (i) On Fig. 5.1, complete the labels for the sodium atom. [2]
- (ii) State the electronic structure for this sodium atom.

..... [1]

(c) Sodium and chlorine react to form sodium chloride.

Fig. 5.2 shows the electronic structure of a sodium atom and a chlorine atom.



**Fig. 5.2**

Draw diagrams to show the electronic structures of a sodium **ion** and of a chloride **ion** when sodium reacts with chlorine.

Include the charge for each ion.

sodium ion

chloride ion

[3]

(d) Sodium and chlorine are elements. Sodium chloride is a compound.

Describe the difference between an element and a compound.

.....

.....

..... [2]

[Total: 9]

- 6 (a) An information booklet about an electric oven states that the **weight** of the oven is 50 kg.

Explain why this statement is incorrect.

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

- (b) The oven contains two lamps connected in parallel. One lamp has a resistance of  $600\ \Omega$  and the other lamp has a resistance of  $1200\ \Omega$ .

Circle the correct value for the combined resistance of the two lamps connected in parallel.

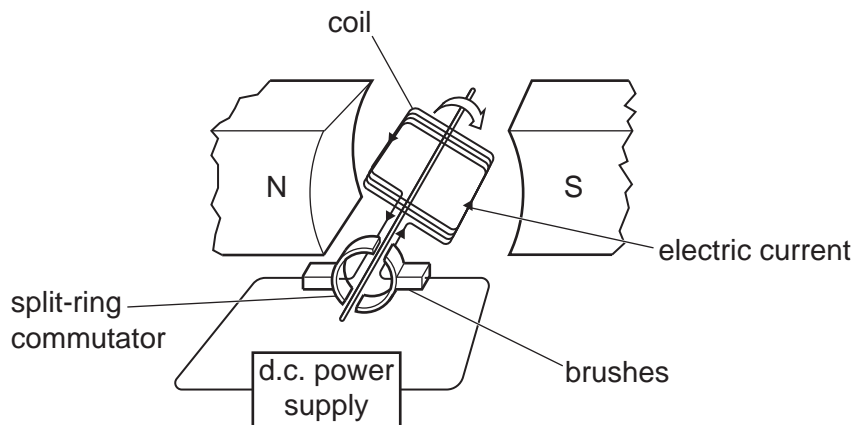
**400  $\Omega$**       **600  $\Omega$**       **900  $\Omega$**       **1200  $\Omega$**       **1800  $\Omega$**

Explain your answer.

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

- (c) The oven contains a fan driven by an electric motor.

Fig. 6.1 shows a simple d.c. electric motor.



**Fig. 6.1**

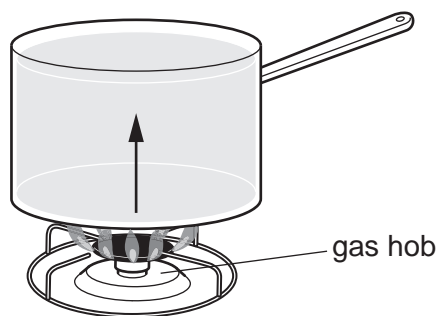
State two ways of increasing the turning effect on the coil.

1 .....

2 .....

[2]

(d) Fig. 6.2 shows a metal saucepan filled with water being heated.



**Fig. 6.2**

(i) The arrow shows the start of a convection current.

Draw more arrows on Fig. 6.2 to show the convection current in water. [2]

(ii) When the base of the metal saucepan is heated, the metal expands.

State one example where the thermal expansion of a metal is a problem.

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

(e) When the water is heated in the saucepan, some of the water evaporates.

Eventually the temperature of the water reaches boiling point.

(i) State the boiling point of water.

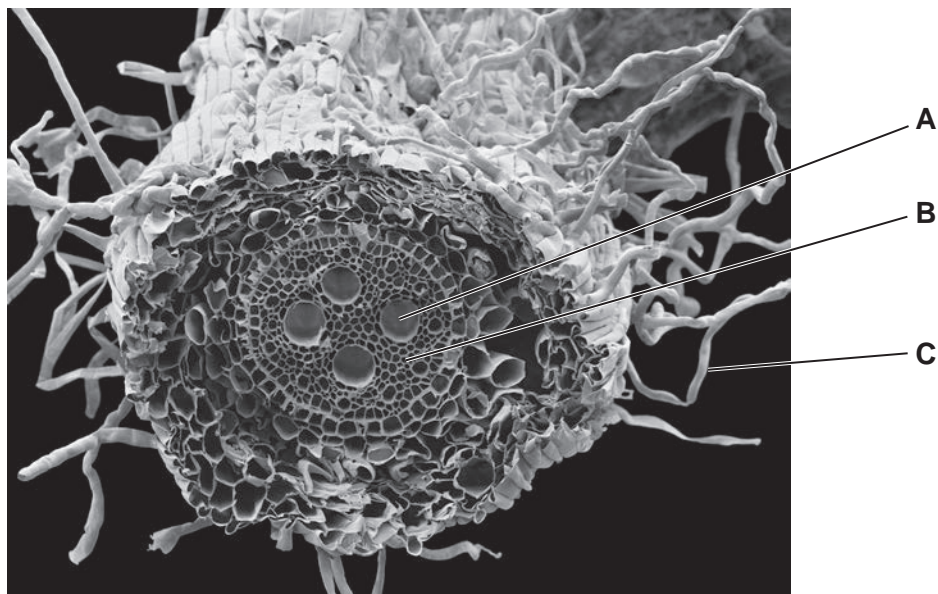
boiling point = ..... °C [1]

(ii) State the meaning of the term *boiling point*.

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

[Total: 10]

7 Fig. 7.1 is a photomicrograph of a cross-section of a root.



**Fig. 7.1**

(a) Identify the parts of the root labelled **A** and **B** in Fig. 7.1.

**A** .....

**B** .....

[2]

(b) The cell labelled **C** absorbs mineral ions from the soil.

(i) Name this cell.

..... [1]

(ii) Name one other substance absorbed by the cell labelled **C** in Fig. 7.1.

..... [1]

(c) Chlorophyll is needed for photosynthesis.

(i) Name the mineral ion needed to make chlorophyll.

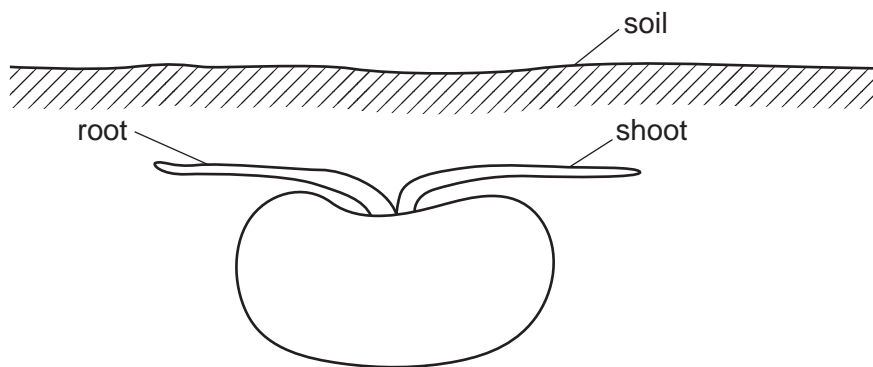
..... [1]

(ii) State the word equation for photosynthesis.

..... [2]



(d) Fig. 7.2 is a diagram of a seed germinating underground.



**Fig. 7.2**

(i) Draw **two** arrows on Fig. 7.2 to show the direction the root and shoot will grow. [1]

(ii) There is no light reaching the seed underground.

Name the stimulus the root would be responding to in Fig. 7.2.

..... [1]

(iii) State two environmental conditions seeds need to germinate.

1 .....

2 .....

[2]

[Total: 11]

- 8 (a) Fig. 8.1 shows three hydrocarbon molecules **X**, **Y** and **Z**.

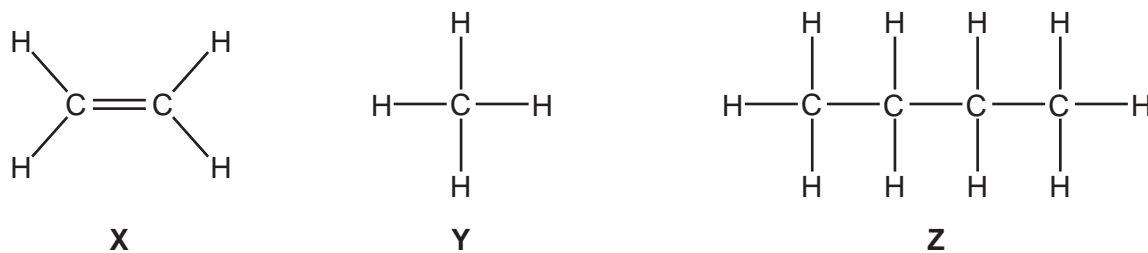


Fig. 8.1

Hydrocarbon molecule **X** is unsaturated.

- (i) Explain why molecule **X** is unsaturated.

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

- (ii) State the name of molecule **X**.

..... [1]

- (iii) An aqueous solution of element **P** is used to test if hydrocarbons **X** and **Y** are saturated or unsaturated.

State the name of element **P**.

..... [1]

- (iv) Describe what, if anything, is observed when an aqueous solution of element **P** is mixed with hydrocarbon molecule **X** and with hydrocarbon molecule **Y**.

with hydrocarbon molecule **X** .....

.....

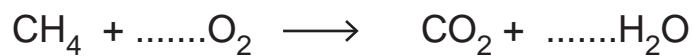
with hydrocarbon molecule **Y** .....

.....

[2]

(b) When hydrocarbon molecule **Y** is completely combusted in oxygen, carbon dioxide and water are made.

(i) Balance the symbol equation for this reaction.



[2]

(ii) This reaction is an exothermic reaction.

State what is meant by an *exothermic* reaction.

.....

..... [1]

(c) Ethanol has the formula  $\text{C}_2\text{H}_5\text{OH}$ .

(i) Explain why ethanol is **not** a hydrocarbon.

.....

..... [1]

(ii) State two methods of producing ethanol.

1 .....

2 .....

[2]

[Total: 11]

- 9 (a) Fig. 9.1 shows an aircraft on a runway.

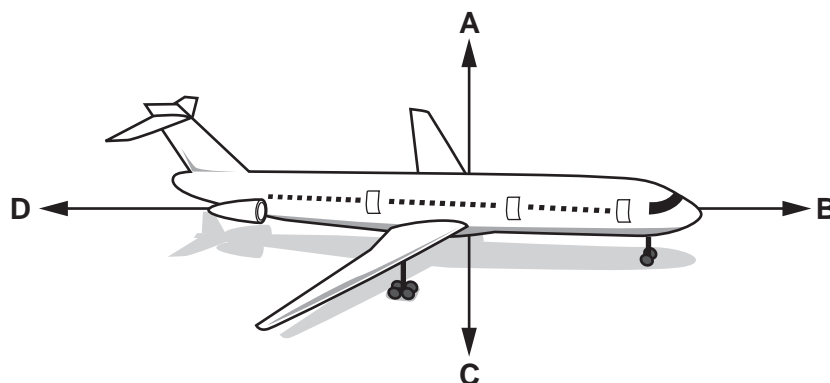


Fig. 9.1

Use the letters **A**, **B**, **C** or **D** to complete the sentences.

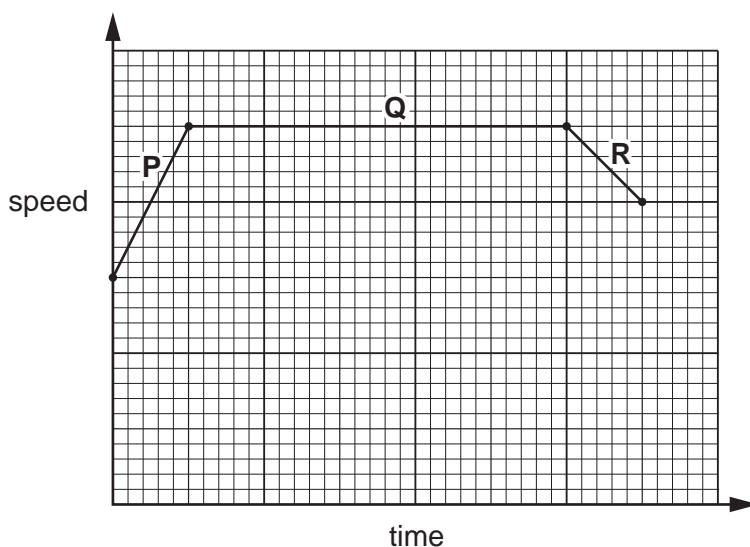
Each letter may be used once, more than once or not at all.

When the aircraft is at rest on the runway, force **A** is equal to force ..... and also force **B** is equal to force .....

When the aircraft starts to accelerate along the runway, forces ..... and ..... are unbalanced.

[2]

(b) Fig. 9.2 shows the speed-time graph for the aircraft during part of its flight when it is travelling at constant height.



**Fig. 9.2**

(i) Label with a cross (X) a part of the flight when the aircraft is accelerating. [1]

(ii) State which section of the graph shows the aircraft travelling with no acceleration.

Explain your answer.

section .....

explanation .....

[1]

(c) The aircraft fuel is a non-renewable energy source obtained from petroleum.

(i) Identify the form of energy stored in aircraft fuel.

..... [1]

(ii) Name two renewable energy sources.

1 .....

2 .....

[2]

[Total: 7]

10 (a) A farmer keeps ponies. The ponies show variation in height. The farmer sells the smaller ponies for more money than the larger ponies.

(i) Name the type of variation shown by differences in height of the ponies.

..... [1]

(ii) Complete the sentences to describe the method the farmer uses to increase the number of smaller ponies on the farm.

The farmer selects the ponies with the desirable feature.

These ponies are then .....

The ..... offspring are then selected and used for .....

This process is then ..... over many generations.

[4]

(iii) State the name of the process the farmer uses.

..... [1]

(b) The inheritance of sex in ponies is the same as in humans.

(i) Complete Table 10.1 to show the inheritance of sex.

**Table 10.1**

|                        |       |                      |       |
|------------------------|-------|----------------------|-------|
|                        |       | male sex chromosomes |       |
|                        |       | X                    | ..... |
| female sex chromosomes | X     | XX                   | XY    |
|                        | ..... | XX                   | XY    |

[1]

(ii) State the ratio of male to female offspring shown in Table 10.1.

..... [1]

(c) Chromosomes contain genes.

Define the term *gene*.

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

[Total: 10]

11 (a) (i) Table 11.1 shows information about three colourless liquids **J**, **K** and **L**.

Complete Table 11.1 by inserting the pH for pure water.

**Table 11.1**

| liquid   | description          | pH |
|----------|----------------------|----|
| <b>J</b> | acid rain            | 4  |
| <b>K</b> | dilute sulfuric acid | 2  |
| <b>L</b> | pure water           |    |

[1]

(ii) Name one gas that causes acid rain.

..... [1]

(iii) Name the indicator used to find the pH of a liquid.

..... [1]

(b) A student reacts dilute sulfuric acid with four metals.

The student's observations are shown in Table 11.2.

**Table 11.2**

| metal     | observation        |
|-----------|--------------------|
| copper    | does not react     |
| iron      | reacts slowly      |
| lithium   | reacts explosively |
| magnesium | reacts rapidly     |

Place the four metals in order of their reactivity from the most reactive to the least reactive.

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

[2]



(c) Table 11.2 shows that magnesium reacts rapidly with sulfuric acid.

(i) State the name of one of the products of this reaction.

..... [1]

(ii) Suggest two ways of **increasing** the rate of reaction between magnesium and dilute sulfuric acid.

1 .....

.....

2 .....

.....

[2]

(iii) The gas formed in this reaction is **not** a greenhouse gas.

State the names of two greenhouse gases.

1 .....

2 .....

[2]

[Total: 10]

12 (a) A bicycle has a front lamp, **X**, and a rear lamp, **Y**, connected in parallel across a battery. Both lamps are controlled by a single switch.

(i) Draw a circuit diagram using standard electrical symbols showing two lamps connected in parallel across a battery. Include the switch in the diagram.

[3]

(ii) When the switch is closed, lamp **X** has a resistance of  $6.0\ \Omega$ .

The potential difference across the lamp is  $3.0\text{ V}$ .

Calculate the current in lamp **X**.

current = ..... A [2]

(b) Bicycle frames can be made from either steel or aluminium.

(i) Suggest and explain a simple way of deciding whether the frame of the bicycle is made from steel or aluminium.

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

(ii) A bicycle frame is made from aluminium.

A block of aluminium has a mass  $8100\text{ g}$  and a volume of  $3000\text{ cm}^3$ .

Calculate the density of aluminium.

density = .....  $\text{g/cm}^3$  [2]

- (c) The bicycle has a mirror to help the cyclist see behind him.

The cyclist sees a police car in his mirror. This is shown in Fig. 12.1.



**Fig. 12.1**

Use Fig. 12.1 to describe two characteristics of an image seen in a plane mirror apart from size.

1 .....

.....

2 .....

.....

[2]

[Total: 10]

---

Permission to reproduce items where third-party owned material protected by copyright is included has been sought and cleared where possible. Every reasonable effort has been made by the publisher (UCLES) to trace copyright holders, but if any items requiring clearance have unwittingly been included, the publisher will be pleased to make amends at the earliest possible opportunity.

To avoid the issue of disclosure of answer-related information to candidates, all copyright acknowledgements are reproduced online in the Cambridge Assessment International Education Copyright Acknowledgements Booklet. This is produced for each series of examinations and is freely available to download at [www.cambridgeinternational.org](http://www.cambridgeinternational.org) after the live examination series.

Cambridge Assessment International Education is part of the Cambridge Assessment Group. Cambridge Assessment is the brand name of the University of Cambridge Local Examinations Syndicate (UCLES), which itself is a department of the University of Cambridge.

## The Periodic Table of Elements

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

lanthanoids

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

actinoids

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