Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CO-ORDINATED SCIENCES **0654/33**

Paper 3 Theory (Core) **October/November 2023**

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.

[Turn over

1 (a) Reproduction is one of the characteristics of living things.

Complete the definition.

Reproduction is the process that makes more of the same kind of .... [1]

(b) Fig. 1.1 is a diagram of the male reproductive system in humans.

Fig. 1.1
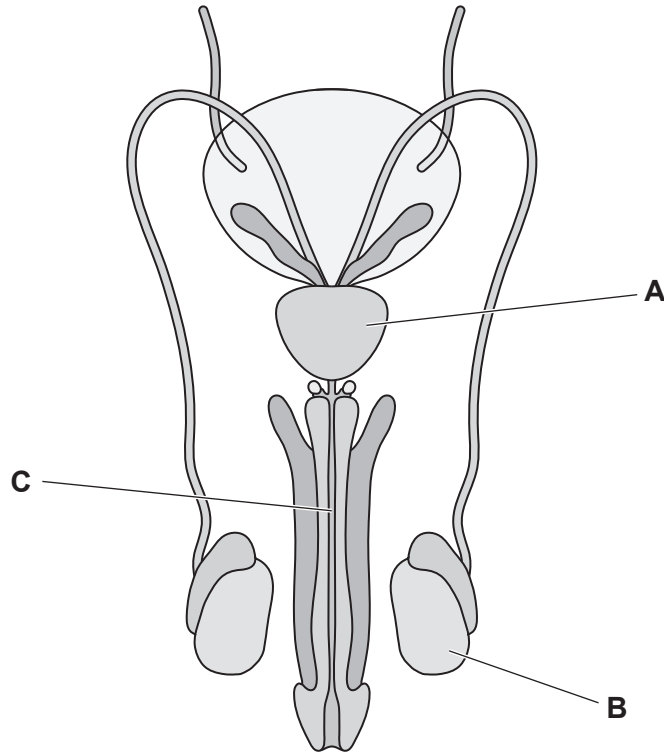
The boxes on the left show the letters labelling some of the parts in Fig. 1.1.

The boxes on the right show functions of some of the parts.

Draw **one** line to link each letter to its function.

	carries semen and urine out of the body
A	
	produces sperm
B	
	secretes fluid for sperm to swim in
C	
	transfers sperm to urethra

[3]

(c) Fig. 1.2 is a drawing of a sperm cell.

Label the cell structure that contains the genetic material with a label line and the correct name.

Fig. 1.2

[2]

(d) State the names of **two** cell structures that are present in plant cells but **not** present in animal cells.

1 ....

2 ....

[2]

[Total: 8]

2 **(a) (i)** There are different methods of separating mixtures.

Fig. 2.1 shows that distillation is used to separate water from aqueous potassium chloride.

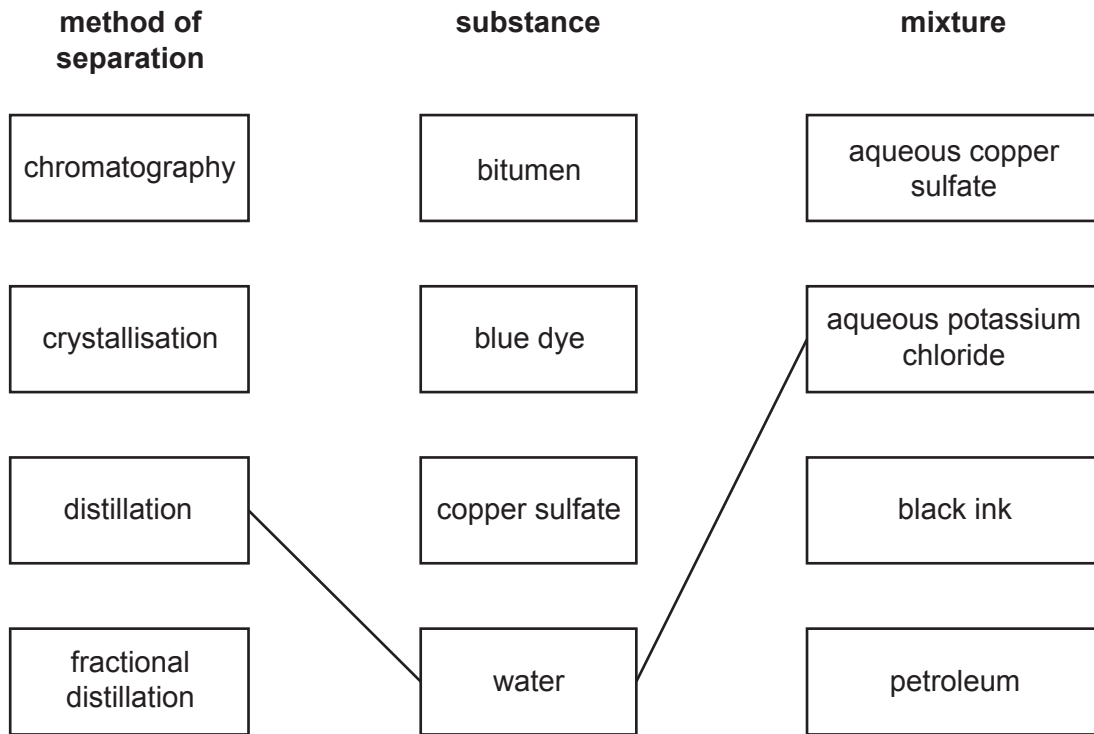Complete Fig. 2.1 to show how the **other three** substances are separated from the mixtures.

method of separation	substance	mixture
chromatography	bitumen	aqueous copper sulfate
crystallisation	blue dye	aqueous potassium chloride
distillation	copper sulfate	black ink
fractional distillation	water	petroleum

Fig. 2.1

[3]

(ii) Name the solvent in aqueous copper sulfate.

.... [1]

(iii) State **one** use for bitumen.

.... [1]

(b) The treatment of a water supply uses filtration and chlorination.

Give a reason for using filtration and chlorination.

filtration ....

....

chlorination ....

....

[2]

(c) Electrolysis is a process which uses electricity to break down a compound.

For example, when molten lead bromide is electrolysed, lead and bromine are made.

Complete the sentences about the electrolysis of lead bromide using words from the list.

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

bromine	**cell**	**electrolyte**	**electrons**	**hydrogen**
ions	**lead**	**molecules**	**negative**	**positive**

Molten lead bromide is called the .... because it contains

.... which are free to move.

The .... electrode is called the cathode

and the .... electrode is called the anode.

.... forms at the anode and ....

forms at the cathode.

[4]

[Total: 11]

3 **(a)** A man is sitting on a beach on a sunny day. The man is out in the Sun for too long and gets sunburned.

    (i) State the name of the electromagnetic radiation that causes sunburn.

       .... [1]

    (ii) Place the electromagnetic radiation named in **3(a)(i)** into the incomplete electromagnetic spectrum shown in Fig. 3.1.

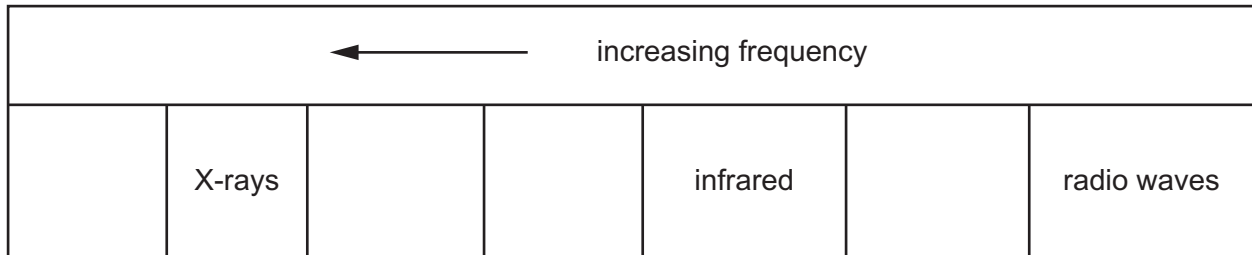|						
	⟵ increasing frequency					
	X-rays			infrared		radio waves

Fig. 3.1

[1]

(b) The man stands up. Pressure from his feet makes footprints in the sand.

State the **two** quantities needed to calculate this pressure.

1 ....

2 ....

[2]

(c) The man catches a beach ball.
The ball has a mass of 0.50 kg and a weight of 4.9 N.

Calculate the value of the gravitational field strength *g*.
State the units of your answer.

g = ... units .... [3]

(d) Fig. 3.2 represents a water wave on the sea.
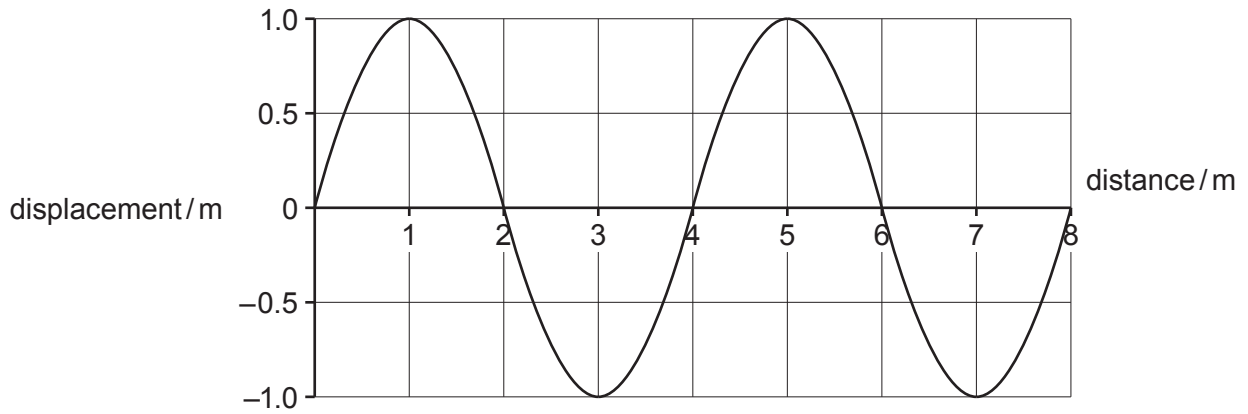
Fig. 3.2

(i) Determine the wavelength of the wave.

wavelength = ... m [1]

(ii) Determine the amplitude of the wave.

amplitude = ... m [1]

 [Turn over

(e) A piece of glass has been left on the sand.
The glass acts as a convex lens focusing the Sun's rays onto a piece of paper lying on the sand.

(i) Complete Fig. 3.3 to show the three rays of light focused on the paper at point **X**.
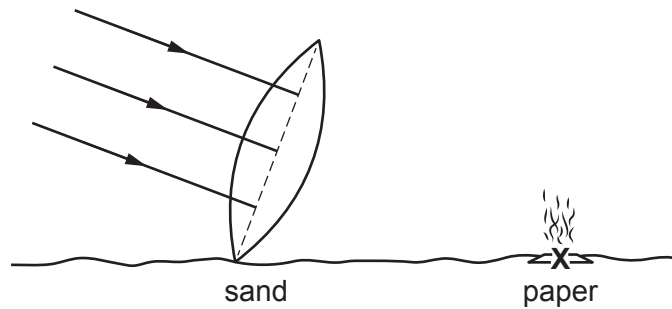

Fig. 3.3

[1]

(ii) The lens has a mass of 5.0 g and a volume of 2.0 cm^3.

Calculate the density of the glass in the lens.

density = ... g / cm^3 [2]

[Total: 12]

4 (a) Scientists record the area of land that is cleared by deforestation every year.

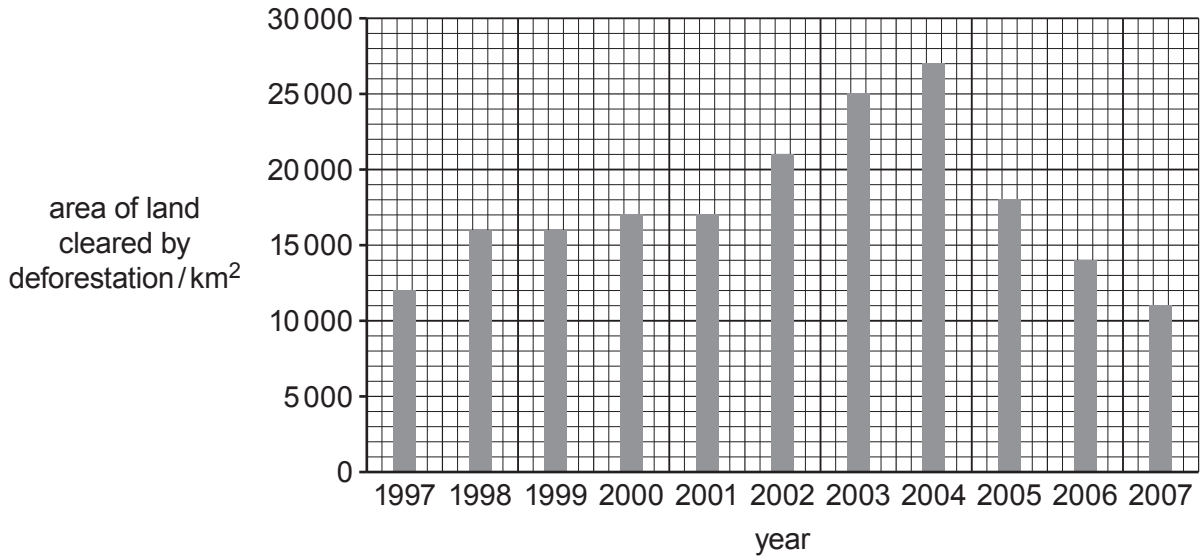Fig. 4.1 shows a bar chart of the results in one country.

Fig. 4.1

(i) Calculate the percentage decrease in area cleared by deforestation between **2004** and **2007**.
Give your answer to the nearest whole number.

area cleared by deforestation in 2004 .... km^2

area cleared by deforestation in 2007 .... km^2

percentage change ....%
[3]

(ii) The change in area cleared by deforestation between **1997** and **2004** affects carbon dioxide concentration in the atmosphere.

Use ideas about the carbon cycle to explain why.

....

....

....

.... [2]

   (iii) Changes to the concentration of gases in the atmosphere is one undesirable effect of deforestation.

     List **three other** undesirable effects of deforestation on the environment.

     1 ....

     2 ....

     3 ....

                        [3]

(b) State **two** ways that living **animals** transfer carbon in the carbon cycle.

     1 ....

     2 ....

                        [2]

[Total: 10]

5 **(a)** Table 5.1 shows some information about three Group VII elements.

Complete Table 5.1.

Table 5.1

element	formula of molecules	colour	metal or non-metal?
bromine		orange	non-metal
chlorine			
iodine	I_2	grey-black	

[3]

(b) State the name given to the Group VII elements in the Periodic Table.

.... [1]

(c) An atom of one of the isotopes of iodine contains 53 protons and 74 neutrons.

Some statements about iodine are shown below.

Place a tick (✓) to show the correct statements about iodine.

All iodine **atoms** contain 53 electrons. ☐

All iodine **molecules** contain 148 neutrons. ☐

The protons are found in the nucleus. ☐

The neutrons are found in the nucleus. ☐

[2]

(d) Describe what is observed when aqueous silver nitrate is added to aqueous potassium chloride and to aqueous potassium bromide.

aqueous potassium chloride ....

....

aqueous potassium bromide ....

....

[2]

(e) A gas jar filled with air is placed on top of a gas jar filled with orange bromine vapour. After several hours, the bromine vapour has mixed with the air.
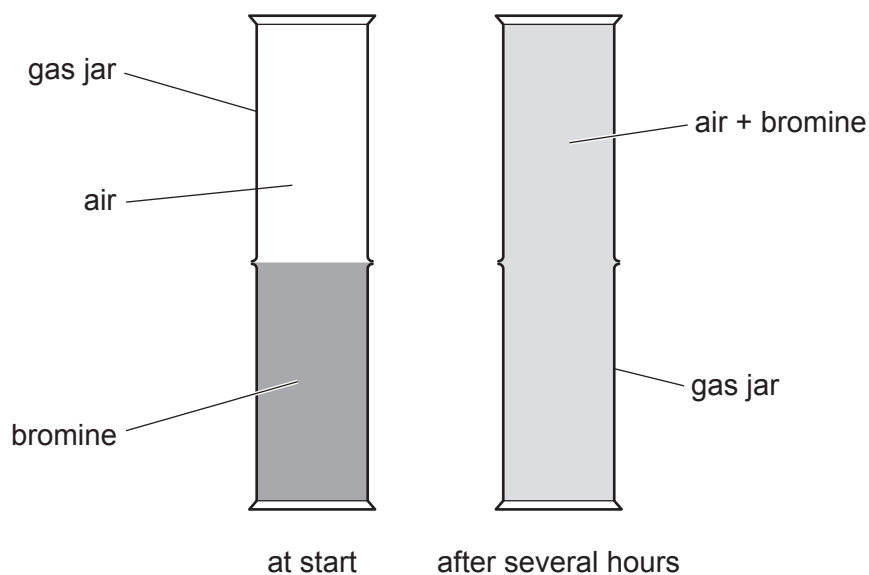
This is shown in Fig. 5.1.

Fig. 5.1

Explain why the bromine mixes with the air.

Use ideas about the movement of molecules in your answer.

....

....

....

.... [2]

[Total: 10]

6 (a) Fig. 6.1 shows a double electric hotplate used to heat food.

hotplate **A**   hotplate **B**

Fig. 6.1
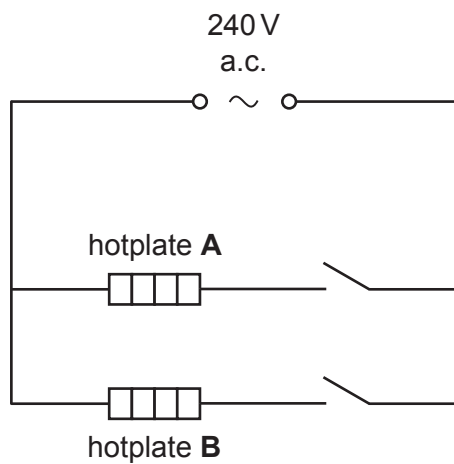
Fig. 6.2 shows the circuit diagram for the hotplates.

Fig. 6.2

Hotplate **A** and hotplate **B** are identical and are connected to a 240 V a.c. supply. Each hotplate has a resistance of 40 Ω.

(i) Calculate the current in hotplate **A**.

current = ... A [2]

(ii) State the term used for the circuit arrangement of the hotplates in Fig. 6.2.

.... [1]

(iii) (Circle) the correct value for the combined resistance of the two hotplates connected as shown in Fig. 6.2.

$$20\,\Omega \qquad 40\,\Omega \qquad 80\,\Omega \qquad 1600\,\Omega$$

Explain your answer.

explanation ....

.... [2]

(b) A steel saucepan containing water is placed on one of the hotplates as shown in Fig. 6.3.

steel saucepan

water

hotplate
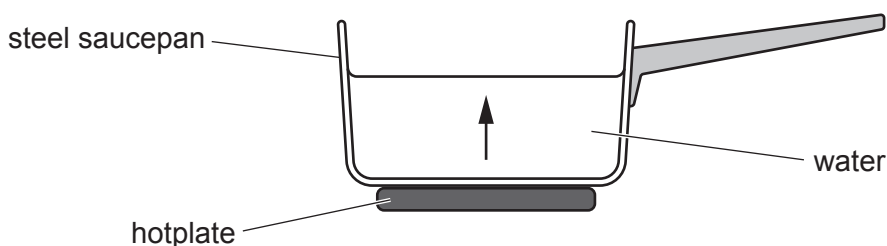
Fig. 6.3

(i) State the method by which thermal energy is transferred through the base of the steel saucepan.

.... [1]

(ii) The water at the bottom of the saucepan is heated.
All the water in the saucepan is warmed by convection.

On Fig. 6.3, draw arrows to show how the heated water circulates around the saucepan.
One arrow has been drawn for you. [1]

(iii) As the water in the saucepan is heated, some of the water evaporates.

Choose words from the list to complete the sentences to describe evaporation.

bottom   density   energy   mass   middle   surface

Water molecules escape from the .... of the liquid.

Only the water molecules with the greatest .... escape.
[2]

(iv) Eventually the water boils as it reaches the boiling point of water.

State the boiling point of water.

boiling point of water = ...°C [1]

(v) While the water boils, the hotplate continues to heat the water in the saucepan.

State what happens to the temperature of the water when it is boiling.

.... [1]

[Total: 11]

7 (a) Enzymes are only active within a specific pH range.
Table 7.1 shows the specific pH range for five different enzymes.

Table 7.1

enzyme	pH range enzyme is active
A	1–5
B	5–9
C	7–12
D	2–3
E	10–12

Identify the enzyme(s) from Table 7.1 that are:

only active in acidic conditions ....

active over the widest range of pH values ....

active at pH 8. ....

[3]

(b) State **one** factor, other than pH, that affects enzyme activity.

.... [1]

(c) Enzymes are proteins.

(Circle) the elements that **all** enzymes contain.

calcium   **carbon**   **chlorine**   **hydrogen**

magnesium   **nitrogen**   **oxygen**

[1]

(d) Table 7.2 lists some large nutrient molecules and the smaller molecules from which they are made.

Complete Table 7.2.

Table 7.2

large nutrient molecule	smaller molecules that nutrients are made from
fats and oils	fatty acids and ....
proteins	....
1. starch 2.	....

[4]

(e) Digested nutrients are absorbed by the body.

Place ticks (✓) in the boxes to show **two** correct statements about absorption.

involves the breakdown of insoluble molecules to soluble molecules	
involves movement of digested food molecules into the blood	
involves movement of insoluble food molecules into cells	
occurs across the wall of the liver	
occurs across the wall of the intestine	

[2]

[Total: 11]

8 (a) Fig. 8.1 shows the apparatus a student uses to investigate the rate of reaction between magnesium and dilute hydrochloric acid.

Hydrogen gas is collected in the measuring cylinder.
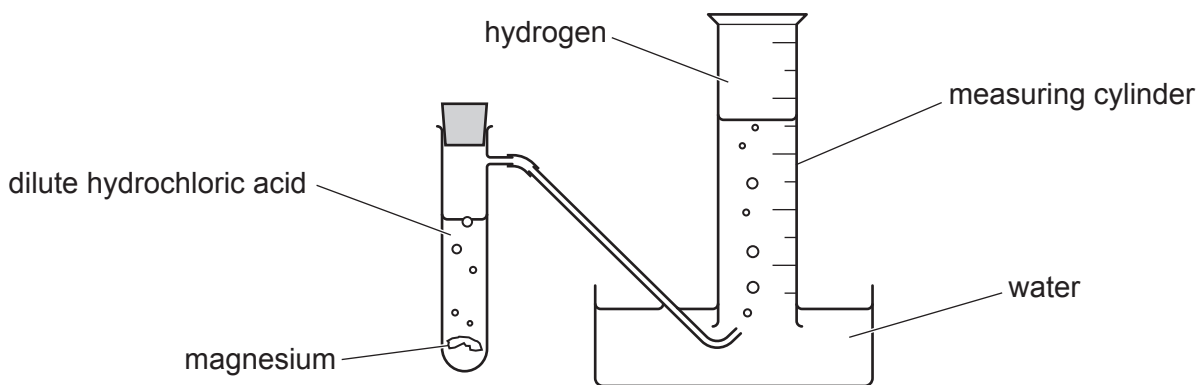The other product is aqueous magnesium chloride.

Fig. 8.1

(i) Construct the word equation for this reaction.

.... + ... $\rightarrow$ .... + ...
[2]

(ii) State **two** changes to the reaction conditions that increase the rate of reaction.

1 ....

2 ....
[2]

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

State the meaning of exothermic.

.... [1]

(iv) The student repeats the experiment using three different metals, copper, iron and calcium.

The observations are shown in Table 8.1.

Table 8.1

metal	observation
copper	does not react
iron	reacts slowly
calcium	reacts rapidly
magnesium	reacts moderately

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

.... most reactive

....

....

.... least reactive
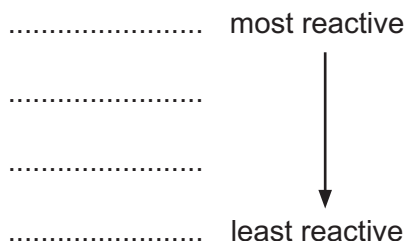
[1]

(b) Table 8.2 shows information about the four metals in a magnesium alloy.

Table 8.2

element	percentage by mass in the alloy / %
aluminium	9.0
magnesium	
manganese	1.0
zinc	1.0

(i) Calculate the percentage of magnesium contained in the alloy.

percentage of magnesium = ... % [1]

(ii) Calculate the mass of aluminium contained in 20 kg of the alloy.

mass of aluminium = ... kg [1]

(iii) Suggest why, apart from cost, this alloy of magnesium is used rather than pure magnesium for making parts for car engines.

....

.... [1]

[Total: 9]

9 (a) Fig. 9.1 shows four energy sources and four descriptions of energy sources.

Draw **one** straight line from **each** energy source to the correct description of the energy source.

energy source	description

geothermal		produces dangerous waste

| hydroelectric (HEP) | | unreliable |

| nuclear | | uses energy from falling water |

| wind | | uses energy from inside the Earth |

Fig. 9.1

[3]

(b) Nuclear fuels are used to generate electricity in a nuclear power station.

State the name of the process by which a nuclear fuel produces heat.

.... [1]

(c) Plutonium-239 is an example of a nuclear fuel.

Plutonium-239 has the nuclide notation $^{239}_{94}$Pu.

Determine the number of neutrons in one atom of plutonium-239.

.... [1]

(d) (i) Plutonium-239 decays by alpha emission.
The decay product is uranium-235.

Write the word equation for this decay process.

.... [1]

(ii) Describe an alpha particle.

.... [1]

(e) α-particles, β-particles, and γ-radiation are three radioactive emissions.

Place the three emissions in order of their ionising ability.

....
most ionising ⟶ least ionising

[1]

[Total: 8]

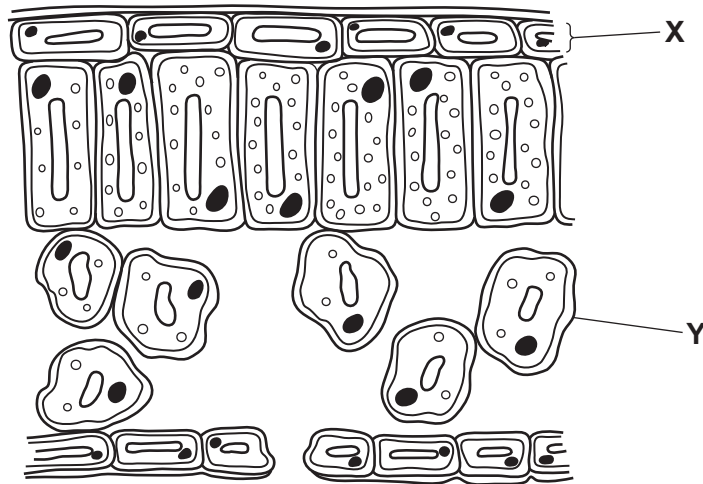**10 (a)** Fig. 10.1 is a diagram of a cross-section through a leaf.

Fig. 10.1

(i) State the name of the **part** labelled **X** and the **cell** labelled **Y** in Fig. 10.1.

part X ....

cell Y ....

[2]

(ii) Draw **one** arrow on Fig. 10.1 to show the pathway of water vapour during transpiration. [1]

(b) Fig. 10.2 is an incomplete sketch graph.

Complete Fig. 10.2 to show the effect of humidity on the rate of transpiration by:

- including axis labels
- drawing a line to show the trend.

Fig. 10.2

[2]

 [Turn over

(c) State the name of the type of plant cell that absorbs water from the soil.

.... [1]

(d) State the name of the plant tissue that transports water from the roots to the leaves.

.... [1]

(e) Suggest **one** reason why not all the water absorbed is lost through transpiration.

....

.... [1]

(f) Blood has several functions including transport in humans.

   (i) State **one** function of white blood cells.

    .... [1]

  (ii) State **two other** main components of blood.

    1 ....

    2 ....

                                                                         [2]

[Total: 11]

11 (a) Sodium forms a basic oxide. Carbon forms acidic oxides.

State why they are different.

....

.... [1]

(b) Carbon is a solid and carbon dioxide is a gas.

Describe the differences between a solid and a gas using ideas about particle separation and particle motion.

particle separation ....

....

particle motion ....

....
[2]

(c) Diamond is one form of carbon.
Fig. 11.1 shows the arrangement of carbon atoms in diamond.
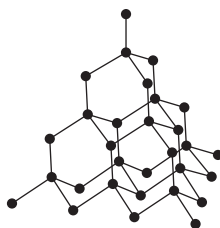
Fig. 11.1

Circle **two** words from the list to describe the structure and bonding in diamond.

simple   giant   metallic   ionic   covalent   polymer
[2]

(d) (i) Sodium metal reacts with chlorine gas to make sodium chloride.

Balance the symbol equation for this reaction.

$$........\text{Na} \quad + \quad Cl_2 \quad \longrightarrow \quad ....\text{Na}Cl$$

[1]

(ii) During the reaction sodium atoms form sodium ions, Na^+, and chlorine atoms form chloride ions, Cl^-.

Fig. 11.2 shows the electronic structure of a sodium ion and a chloride ion.

sodium ion   chloride ion
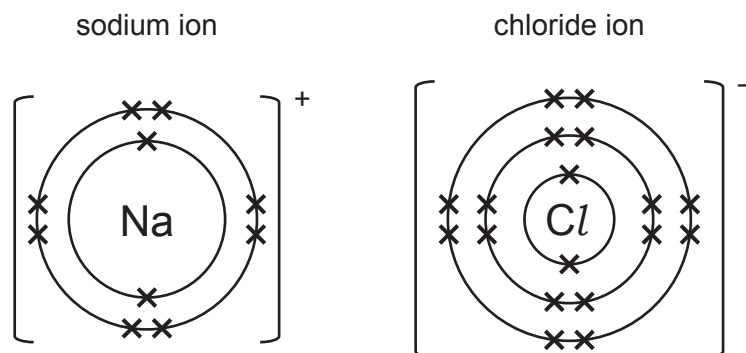
Fig. 11.2

Write down the electronic structure of a sodium **atom** and a chlorine **atom**.

sodium **atom** ....

chlorine **atom** ....

[2]

(iii) Sodium and lithium are both in Group I of the Periodic Table.

Sodium reacts violently with water.

Describe the reaction of lithium with water.

Describe the trend in the reactivity of Group I elements as shown by sodium and lithium.

reaction ....

....

explanation ....

....

[2]

[Total: 10]

12 (a) Fig. 12.1 is a distance–time graph for two cyclists **A** and **B** who are racing for a distance of 1000 m.
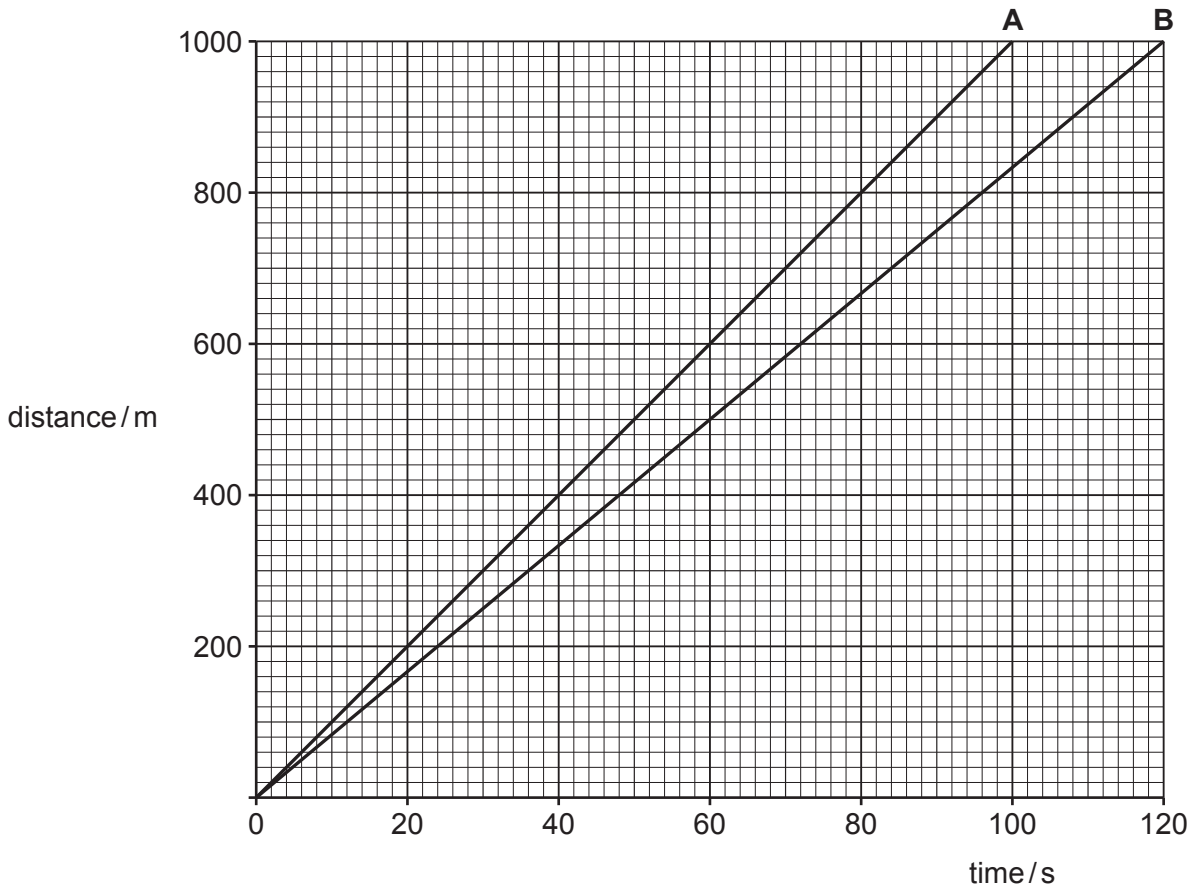
Fig. 12.1

(i) Calculate the time difference over the 1000 m for cyclist **A** compared to cyclist **B**.

time difference = ... s [1]

(ii) Calculate the speed of cyclist **B**.

speed = ... m / s [2]

(iii) Describe how the graph shows that cyclist **B** moves at a constant speed.

....

.... [1]

(b) (i) Fig. 12.2 shows a cyclist moving along a flat road.

Fig. 12.2

Choose words or phrases from the list to complete the sentence.
Each word or phrase may be used once, more than once or not at all.

chemical potential   **elastic potential**   **gravitational potential**   **kinetic**

As the cyclist's speed increases, the .... energy in the

cyclist's body decreases and the .... energy of the cyclist

increases. [2]

(ii) As the cyclist rides along the road, the temperature of the air in the tyres increases.

Describe the change in the motion of the air molecules.

....

.... [1]

(c) The cyclist has a tyre puncture and needs to remove the wheel.
Fig. 12.3 shows the wheel nut that must be unscrewed.
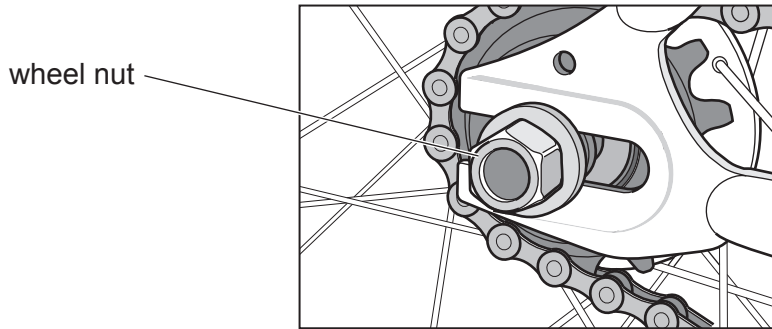
wheel nut

Fig. 12.3

The cyclist has two spanners **X** and **Y** which can be used to unscrew the wheel nut.

X **Y**
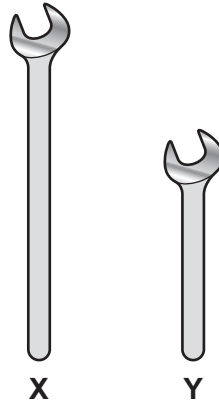
Fig. 12.4

Fig. 12.4 shows the two spanners.

Explain why spanner **X** will unscrew the wheel nut more easily than spanner **Y**.

....

....

.... [2]

[Total: 9]

The Periodic Table of Elements

Group

Key

atomic number
atomic symbol
name
relative atomic mass

I	II		III	IV	V	VI	VII	VIII
								2 He helium 4
3 Li lithium 7	4 Be beryllium 9		5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24		13 A*l* aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 C*l* chlorine 35.5	18 Ar argon 40

1
H
hydrogen
1

19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –

Group III–VI continued:

III	IV	V	VI	VII
31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80
49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127
81 T*l* thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –
	114 F*l* flerovium –		116 Lv livermorium –	86 Rn radon –

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 europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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

0654/33/O/N/23