Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

8578232297

COMBINED SCIENCE **0653/41**

Paper 4 Theory (Extended) **May/June 2024**

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

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

This document has **24** pages. Any blank pages are indicated.

DC (PB/SG) 331075/3

[Turn over

1 **(a)** Fig. 1.1 shows the structure of the human heart.

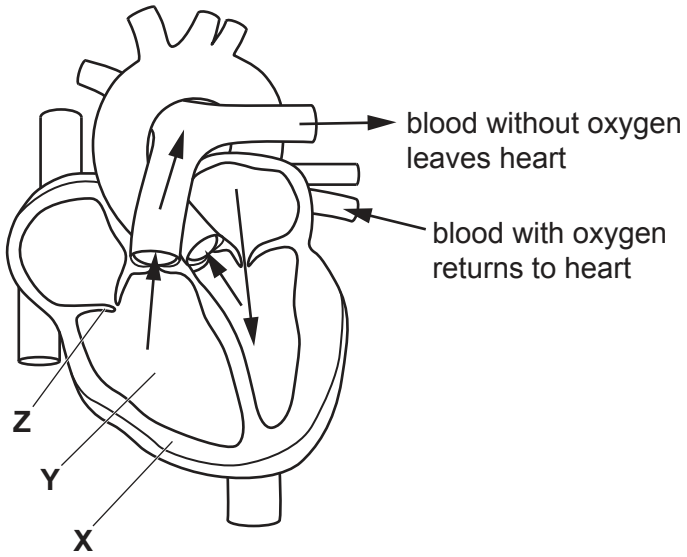

Fig. 1.1

The arrows on Fig. 1.1 show the direction of blood flow.

Complete these sentences.

The part labelled **X** on Fig. 1.1 is the muscular wall of the right ..... .

When the muscles in part **X** contract, blood is pumped into the ..... artery.

The blood from part **Y** is transported to the ..... .

During this contraction the part labelled **Z** ..... to ensure one-way flow of blood.

[4]

(b) During physical activity it is important to keep the heart rate within a target range for effective exercise. This range is dependent on age.

Fig. 1.2 is a chart showing the target range of heart rate for healthy adults of different ages.

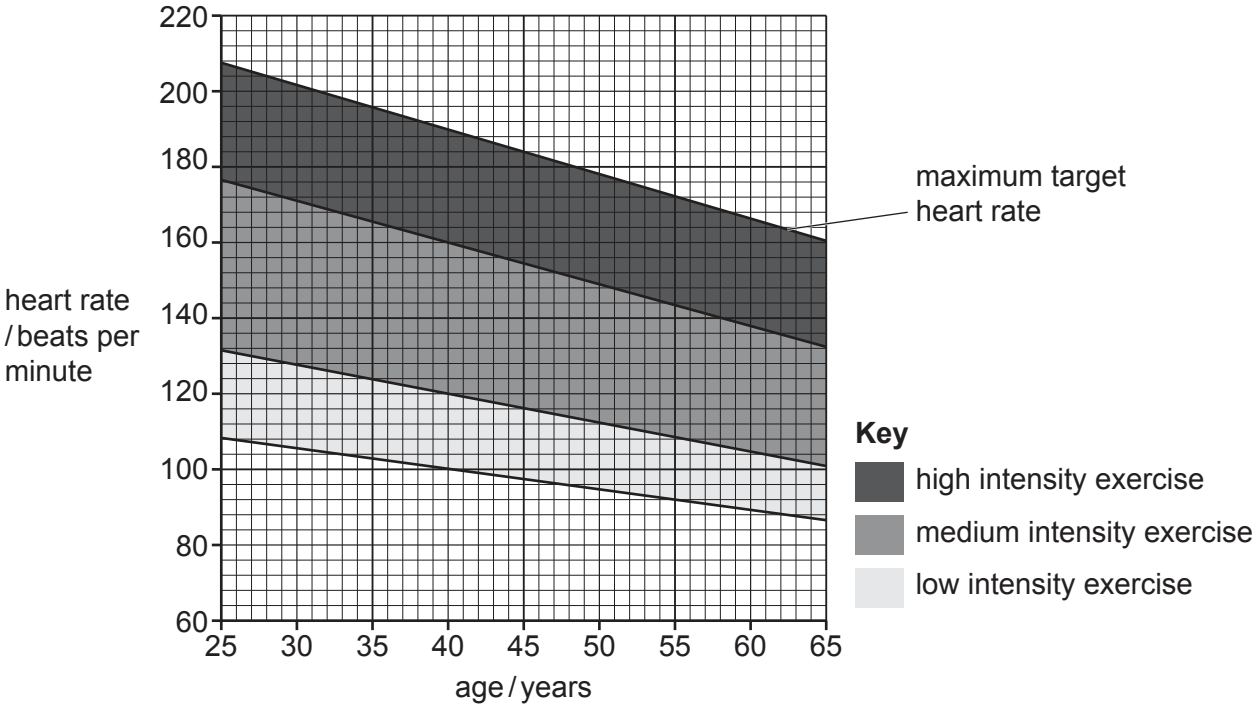

Fig. 1.2

(i) Use Fig. 1.2 to identify the target range of heart rate for a person aged **40** during **medium** intensity exercise.

Tick (✓) the correct answer.

100 – 120 beats per minute	
100 – 190 beats per minute	
120 – 160 beats per minute	
160 – 190 beats per minute	

[1]

(ii) Describe how the maximum target heart rate varies with age.

..... [1]

(iii) Explain why heart rate increases during physical activity.

.....

.....

.....

..... [3]

[Total: 9]

2 Different methods of separation are used for different types of mixtures.

(a) Pure water is separated from a solution of salt and water by distillation.

Fig. 2.1 shows the apparatus used for distillation.

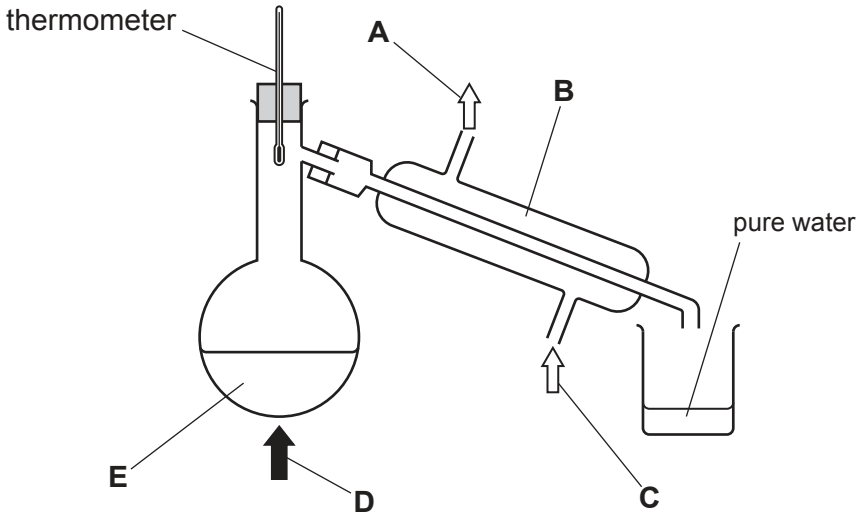

Fig. 2.1

Identify the labels used in Fig. 2.1.

A .....

B .....

C .....

D .....

E .....

[3]

(b) A different method is used to separate the pure, dry salt from a solution of salt dissolved in water.

Describe the method used to produce pure, dry crystals of salt from this solution.

.....

.....

..... [2]

(c) Sodium chloride, NaCl, is a salt. It contains sodium ions, Na^+, and chloride ions, Cl^-.

Fig. 2.2 shows the arrangement of ions in solid sodium chloride.
One sodium ion is labelled.

Label the other ions.

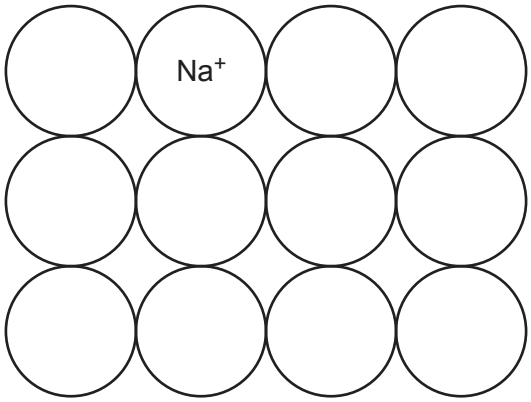

Fig. 2.2

[2]

(d) Explain why sodium ions and chloride ions have different charges.

Use ideas about electrons in your answer.

.....

.....

..... [2]

[Total: 9]

3 Fig. 3.1 shows a pan of water heated on a cooker. There is a glass lid on the pan and a thermometer dips into the water.

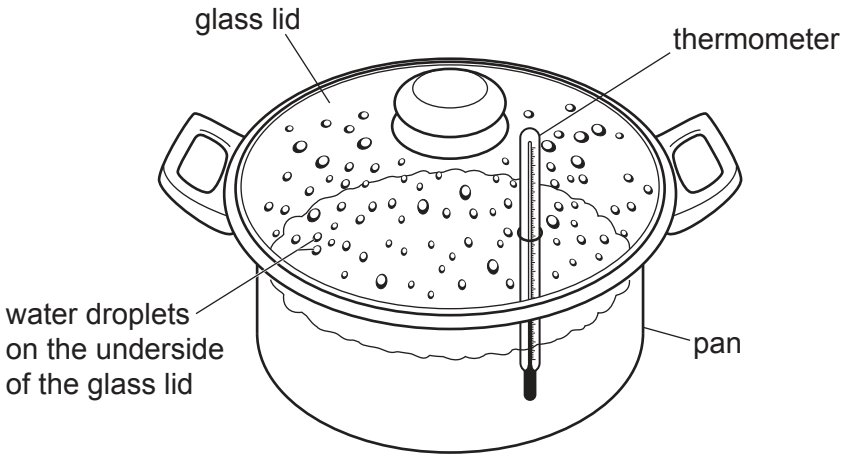

Fig. 3.1

(a) As the pan is heated, the reading on the thermometer increases slowly.

(i) State the process that transfers thermal energy through the water.

..... [1]

(ii) Describe how the process named in **(a)(i)** transfers thermal energy through the water.

.....

.....

..... [2]

(b) The thermometer reads 100 °C. Water droplets condense on the underside of the glass lid.

(i) State the process that happens when the temperature of the water reaches 100 °C.

..... [1]

(ii) Identify where in the pan the water molecules are furthest apart.

.....

..... [1]

(c) Fig. 3.2 shows a thermometer placed in an empty pan as seen by a person looking into the pan.

Fig. 3.3 shows the part of the thermometer that can be seen above the surface when water is added to the pan.

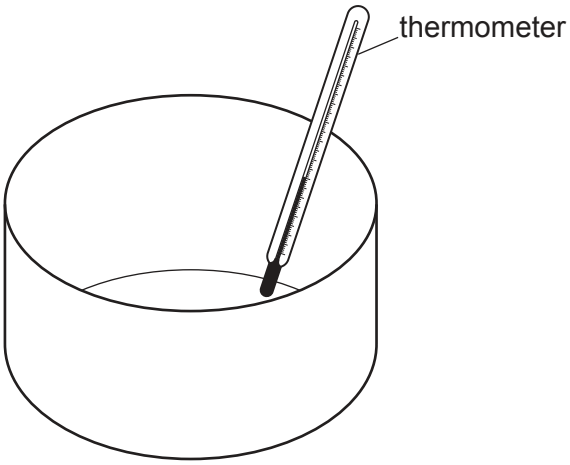

Fig. 3.2

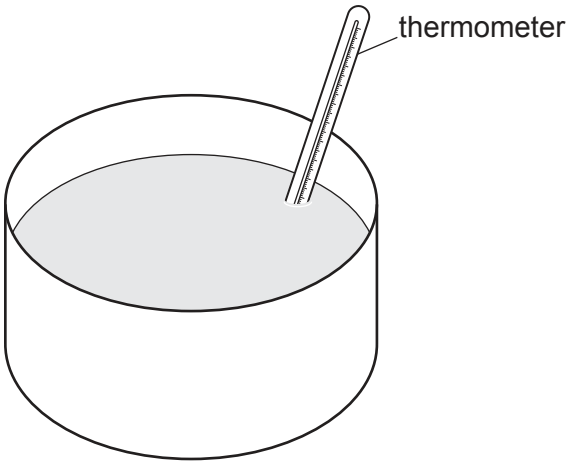

Fig. 3.3

Light rays from the part of the thermometer below the surface are refracted at the water surface.

(i) Complete Fig. 3.3 by drawing the part of the thermometer below the water surface as seen by the person looking into the pan. [1]

(ii) Light is a wave motion.

State the speed of light waves in a vacuum, including the units.

speed of light = ... units ..... [1]

(iii) State a region of the electromagnetic spectrum with waves that travel at the same speed as light waves but with a lower frequency.

..... [1]

(iv) Explain why light rays change direction when they go from water into air.

.....

..... [1]

[Total: 9]

4 **(a)** Fig. 4.1 shows the male reproductive system in humans.

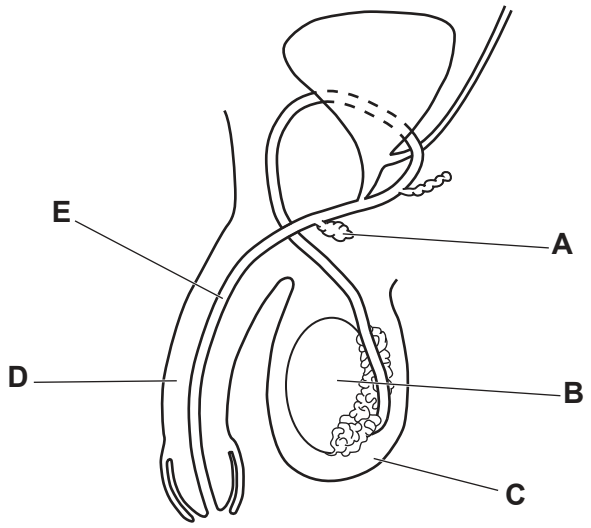

Fig. 4.1

State the letter in Fig. 4.1 that identifies the part that:

produces sperm .....

carries urine out of the body ..... .

[2]

(b) Human gametes are either egg cells or sperm cells.

(i) State **two** adaptive features of egg cells.

1 .....

2 .....

[2]

(ii) State **two** ways the structure of an egg cell is the same as the structure of a sperm cell.

1 .....

2 .....

[2]

(c) Fig. 4.2 shows a human baby inside a uterus just before birth.

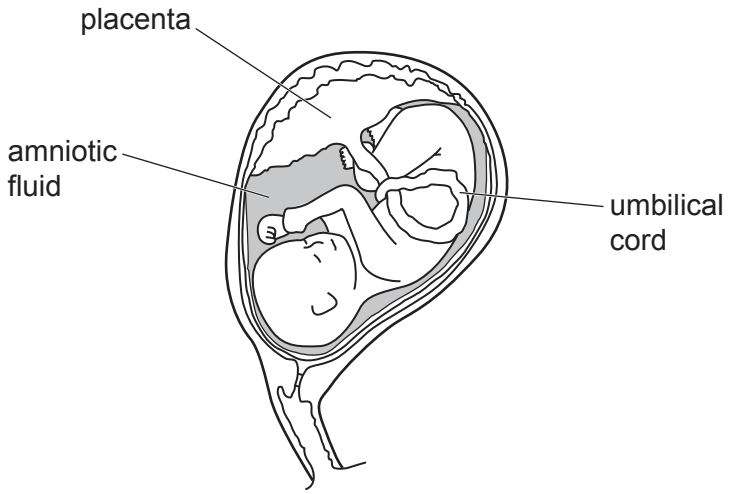

Fig. 4.2

(i) State the function of the amniotic fluid.

.....

..... [1]

(ii) Describe the functions of the placenta and umbilical cord in relation to providing nutrients for the baby.

placenta .....

.....

umbilical cord .....

.....

[2]

[Total: 9]

5 Nitrogen and oxygen react together in a car engine to make nitrogen monoxide, NO.

(a) Fig. 5.1 shows part of the energy level diagram for this reaction.

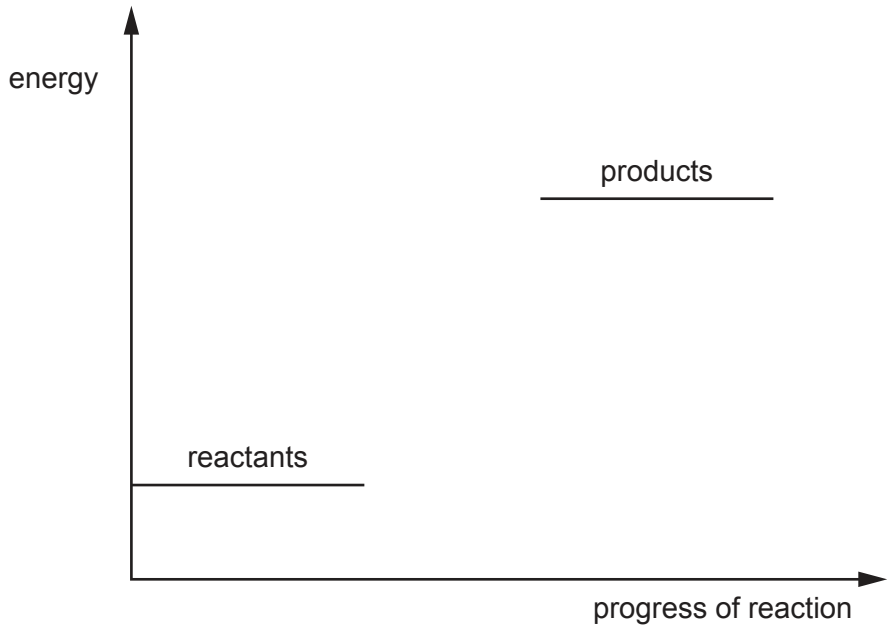

Fig. 5.1

(i) Draw on Fig. 5.1 to complete the energy level diagram. Add labels for the activation energy and the energy change of reaction. [3]

(ii) Describe how Fig. 5.1 shows that this reaction is endothermic.

.....

..... [1]

(iii) Write a balanced symbol equation for the reaction between nitrogen and oxygen to make nitrogen monoxide, NO.

Include the state symbols.

..... [2]

(b) Nitrogen monoxide produced in car engines is an oxide of nitrogen.

Oxides of nitrogen are pollutants when released into the air.

State the adverse effect of oxides of nitrogen on buildings and on human health.

buildings .....

.....

health .....

.....

[2]

[Total: 8]

6 Fig. 6.1 shows a mechanical crane using force **P** to lift a box from the ground to the top of a building.

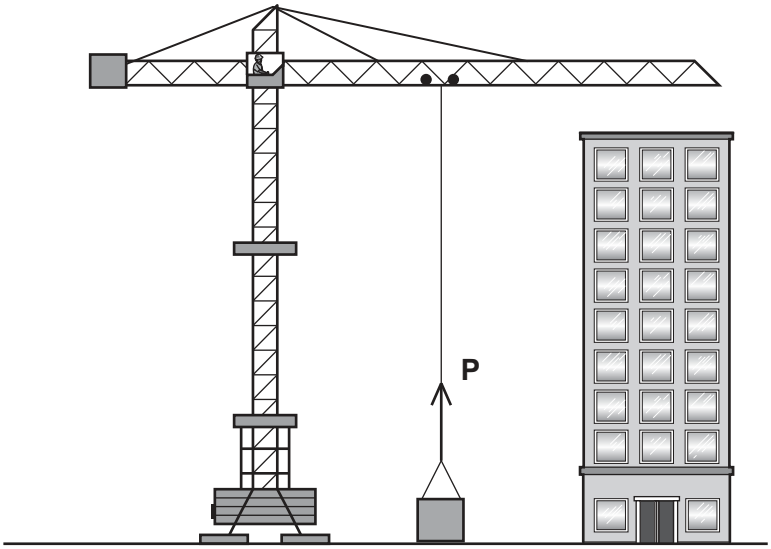

Fig. 6.1

Force **P** is 15 000 N.

The mass of the box is 1475 kg and the weight of the box is 14 750 N.

(a) (i) Complete the sentence:

g is the gravitational force on .... and is measured in N / kg. [1]

(ii) Show that the resultant force on the box is 250 N.

[1]

(b) The crane lifts the box from the ground using force **P** until it reaches the top of the building after 25 s.

Fig. 6.2 shows a graph of the motion of the box as it is lifted.

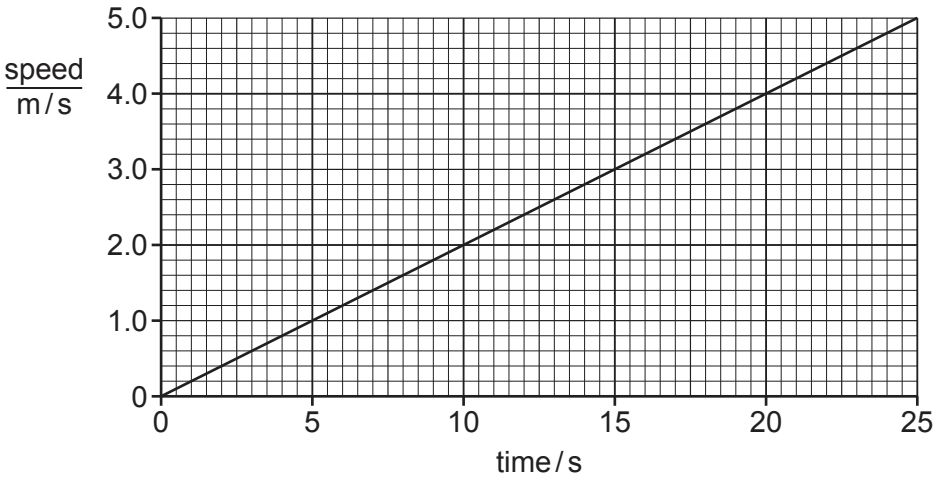

Fig. 6.2

(i) Use Fig. 6.2 to find the speed of the box at 25 s, just before it stops moving upwards.

speed = ... m / s [1]

(ii) Use Fig. 6.2 to calculate the acceleration of the box as it is lifted.

Give the units of your answer.

acceleration = ... units ..... [3]

(iii) Use Fig. 6.2 to show that the height of the building is 62.5 m.

[1]

(iv) Calculate the total energy transferred from the crane to the box when the box reaches the top of the building but **before** the box stops moving.

Use the mass of the box, your answer to **(b)(i)** and the height of the building.

total energy = ... J [4]

[Total: 11]

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7 **(a)** Fig. 7.1 shows the pathway taken by water through a plant.

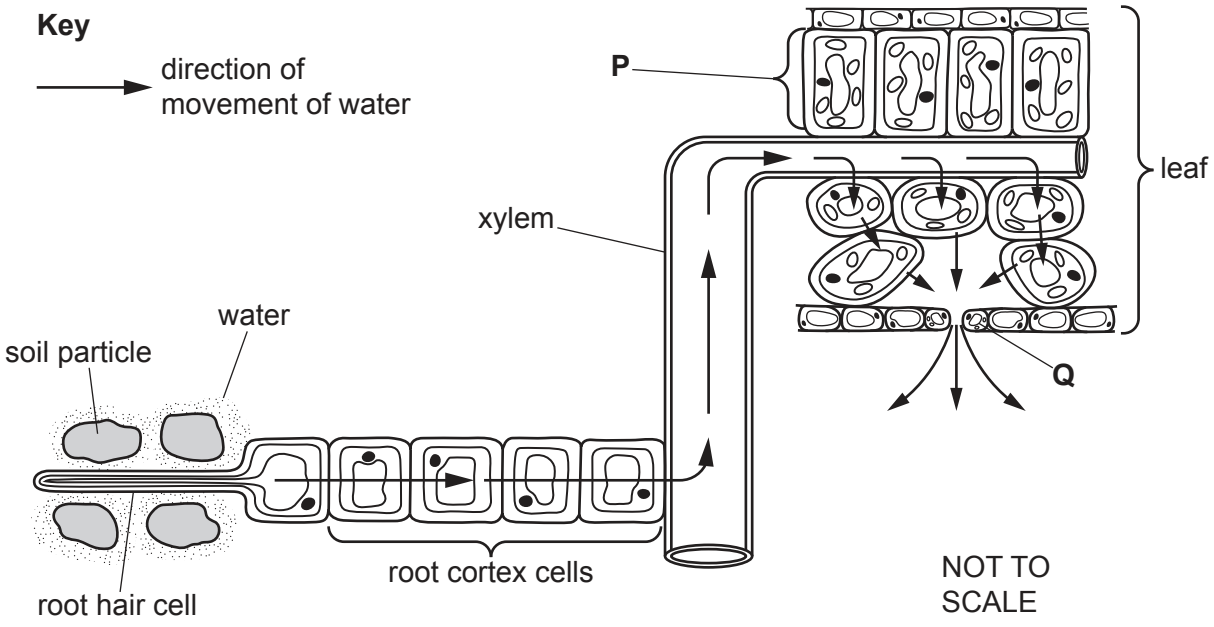

Fig. 7.1

(i) State the function of the cells in the leaf on Fig. 7.1 labelled:

P .....

Q ..... .

[2]

(ii) Complete the sentences to explain how increasing humidity affects the process shown in Fig. 7.1.

Increasing humidity reduces the water concentration .....

between the leaf and the ..... .

Less water vapour is lost by ..... through the stomata.

The rate of water uptake from the soil by root hair cells will

..... .

[3]

(b) Plants are the producers in a food chain.

(i) State the trophic level that plants occupy in a food chain.

..... [1]

(ii) Vultures are birds that are quaternary consumers in some food chains.

Explain why it is **not** usual to have a quaternary consumer in a food chain.

.....

.....

.....

..... [3]

[Total: 9]

8 Ethene, C_2H_4, is an alkene.

Fig. 8.1 shows the structure of an ethene molecule.

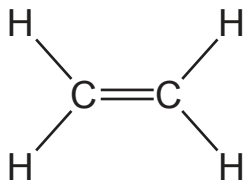

Fig. 8.1

(a) Naphtha is a fraction obtained from the distillation of petroleum.

Naptha undergoes a process to produce ethene.

(i) State the name of the process that produces ethene from naphtha.

..... [1]

(ii) State **two** conditions needed for this process.

1 .....

2 .....
[2]

(b) Ethane, C_2H_6, is an alkane.

(i) Give **one** similarity and **two** differences between a molecule of ethene and a molecule of ethane.

similarity .....

.....

difference 1 .....

.....

difference 2 .....

.....
[3]

(ii) The complete combustion of ethane, C_2H_6, forms two products.

Write a balanced symbol equation for this reaction.

..... [2]

(c) Ethene molecules react together to form poly(ethene).

Part of the structure of poly(ethene) is shown in Fig. 8.2.

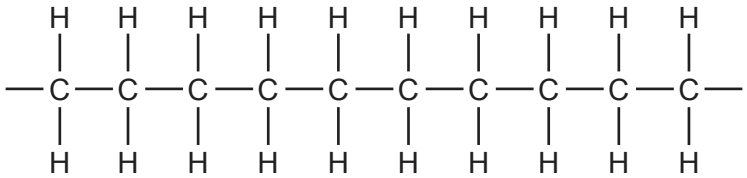

Fig. 8.2

State the number of ethene molecules used to form the part of the poly(ethene) structure shown in Fig. 8.2.

..... [1]

[Total: 9]

9 Fig. 9.1 shows an electrical circuit with components labelled **E, F, G, H** and **J.**

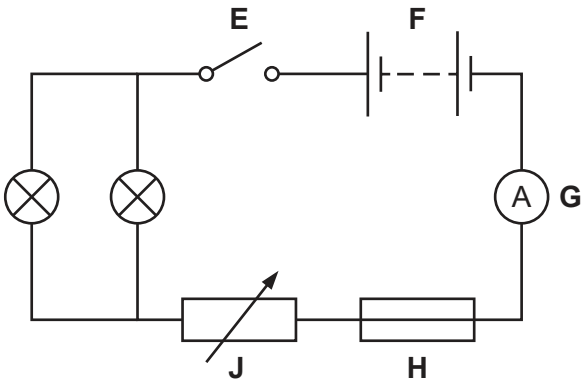

Fig. 9.1

(a) State the letter of the component that:

provides the e.m.f. for the circuit .....

can be used to vary the brightness of the lamps ..... .

[2]

(b) On Fig. 9.1, draw the symbol for the correct meter and show this connected into the circuit to measure the potential difference (p.d.) across the lamps. [2]

(c) The two lamps are identical. The p.d. across the lamps is 3.0 V.

(i) The p.d. across component **F** is 5.5 V.

Assume that components **G** and **H** have **no** resistance.

Find the p.d. across component **J**.

p.d. = ... V [1]

(ii) The ammeter reads 0.6 A.

Calculate the resistance of **one** of the lamps.

resistance = ... Ω [2]

[Total: 7]

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The Periodic Table of Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group VIII
							1 H hydrogen 1										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 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
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	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
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	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
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	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
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 –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

atomic number
atomic symbol
name
relative atomic mass

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.).