



CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/41

May/June 2024

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

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

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

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

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

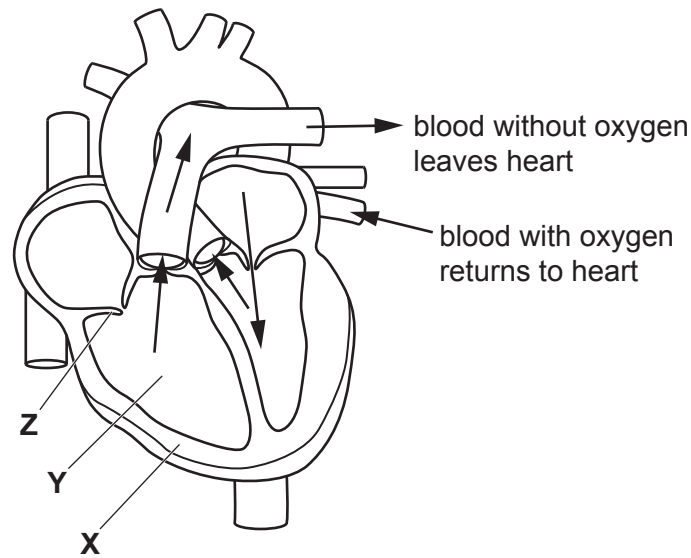


Fig. 1.1

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.

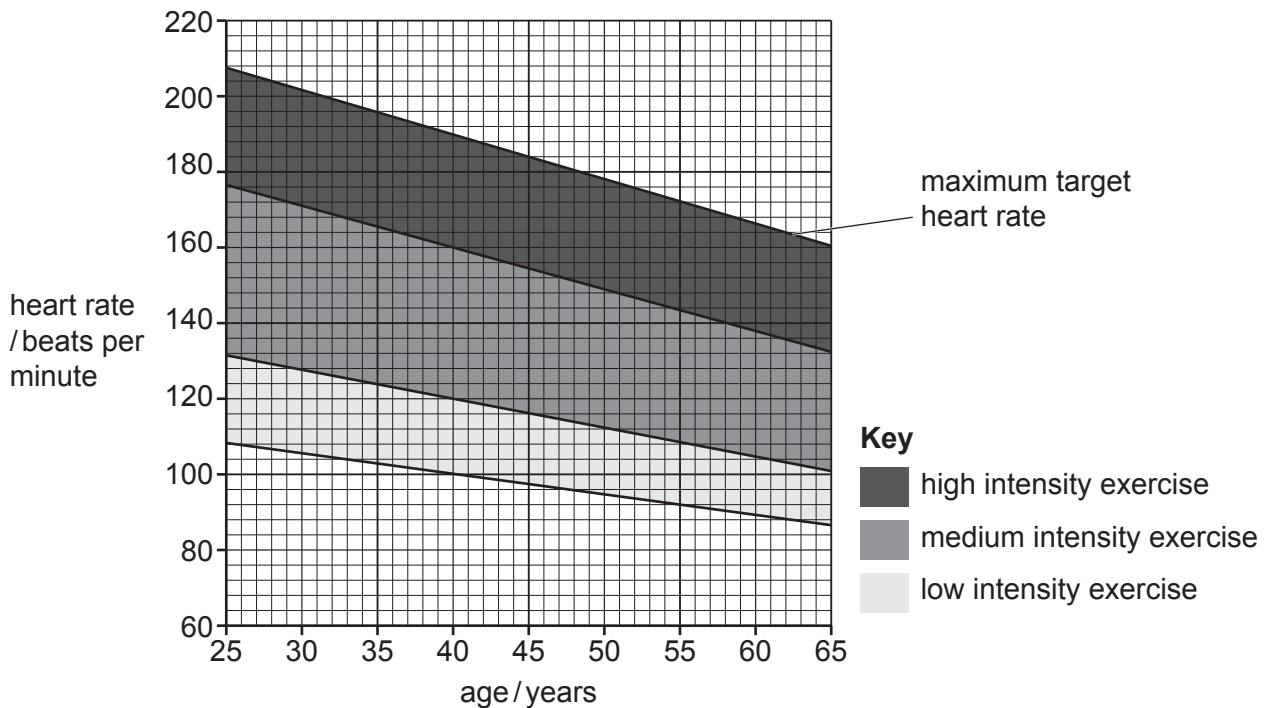


Fig. 1.2

- (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]

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.

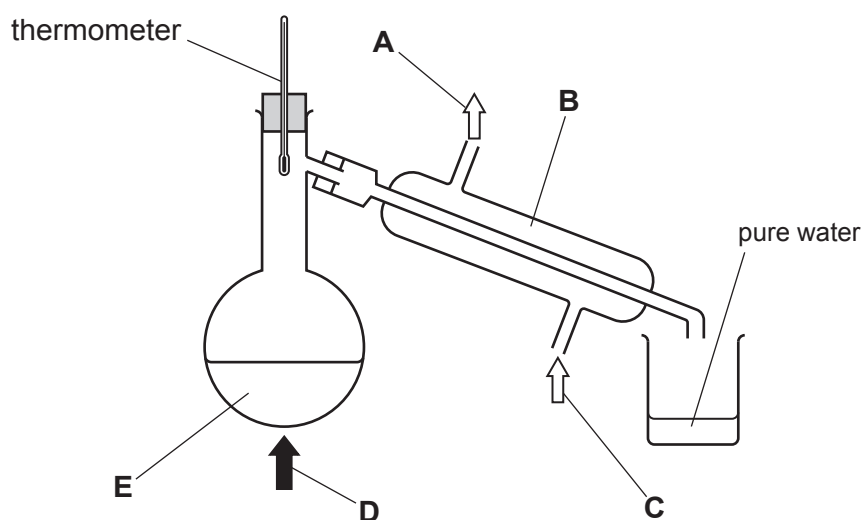


Fig. 2.1

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.

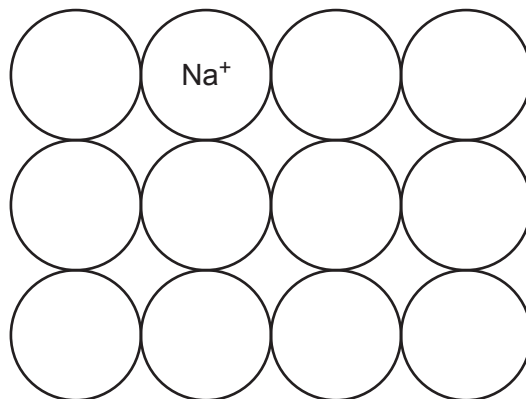


Fig. 2.2

[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.

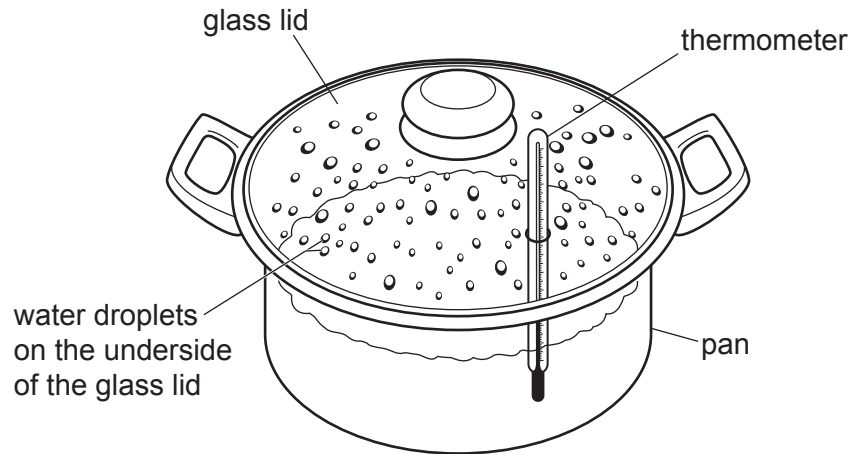


Fig. 3.1

- (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.

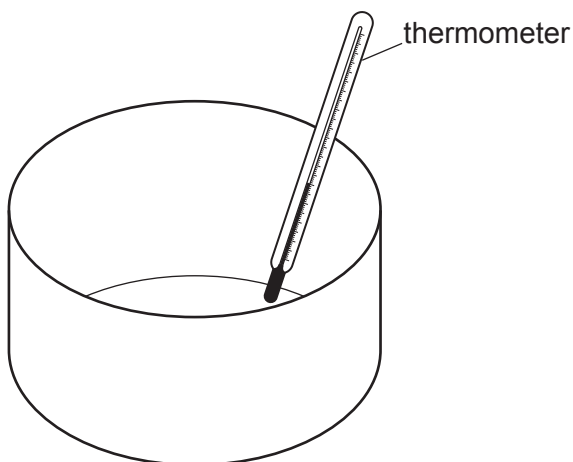


Fig. 3.2

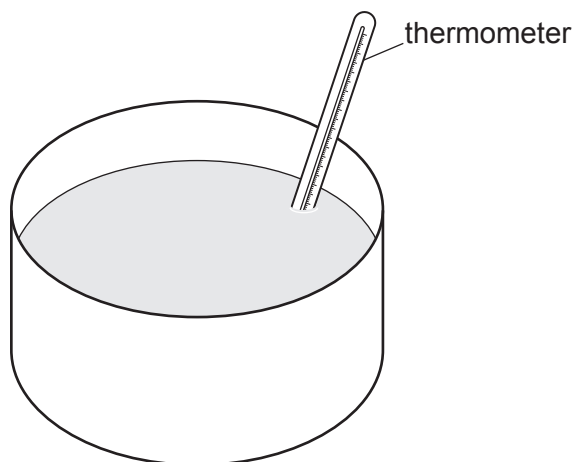


Fig. 3.3

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.

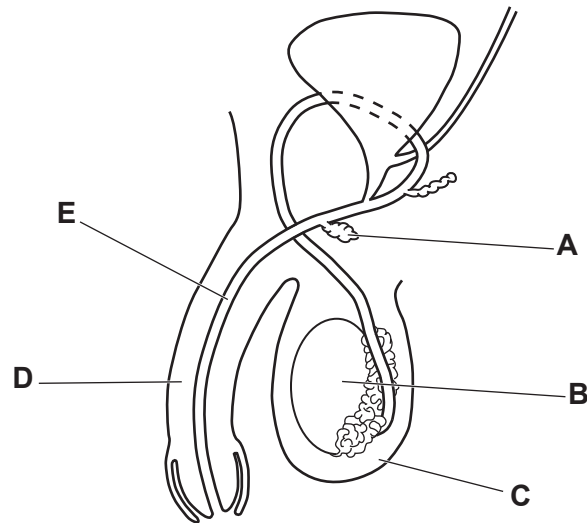


Fig. 4.1

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.

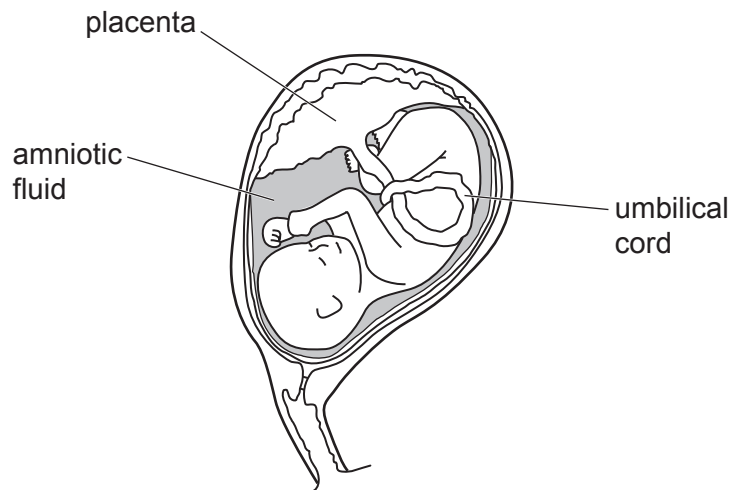


Fig. 4.2

(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.

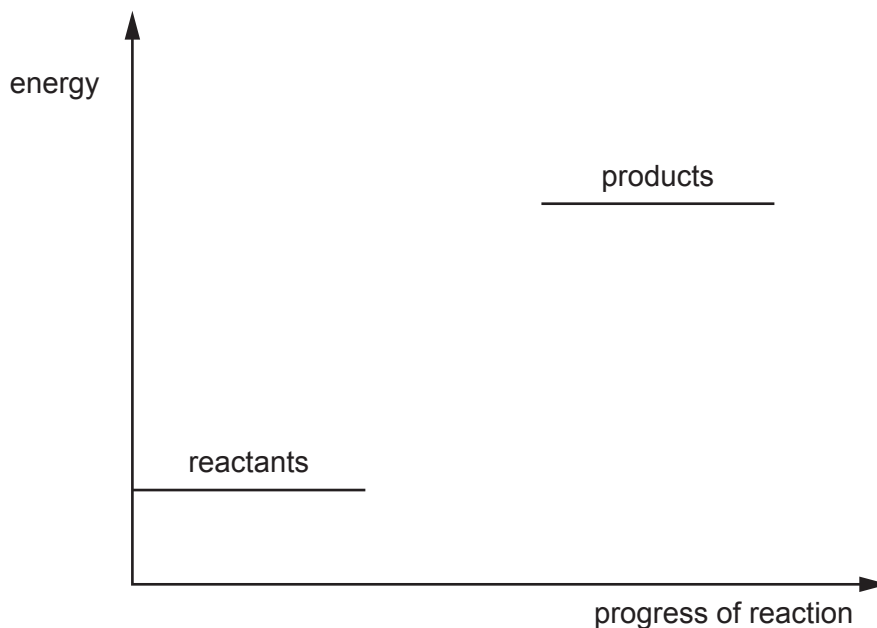


Fig. 5.1

- (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.

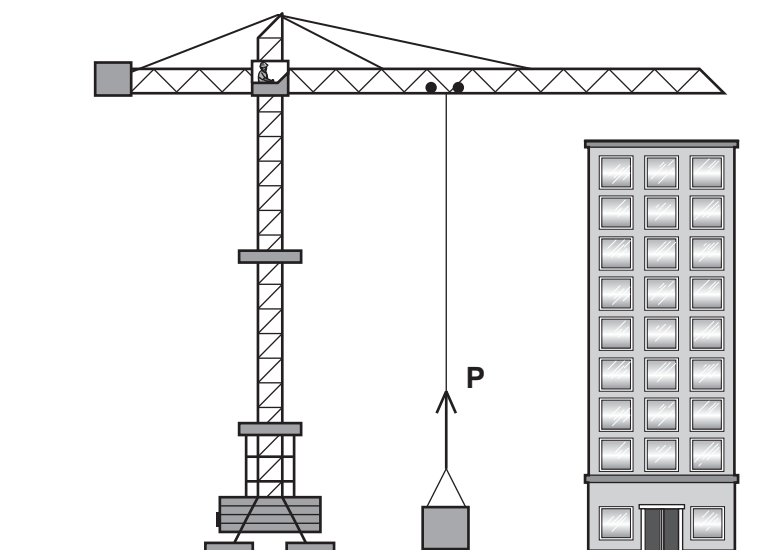


Fig. 6.1

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.

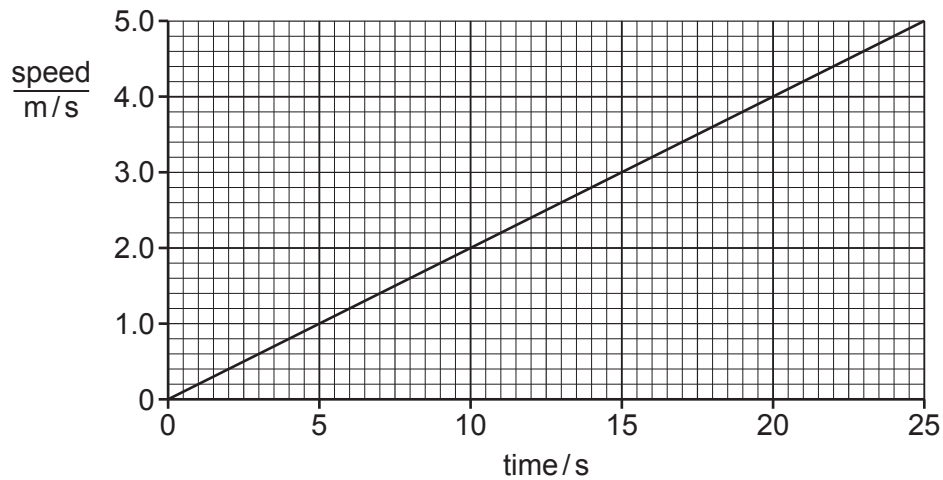


Fig. 6.2

- (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.

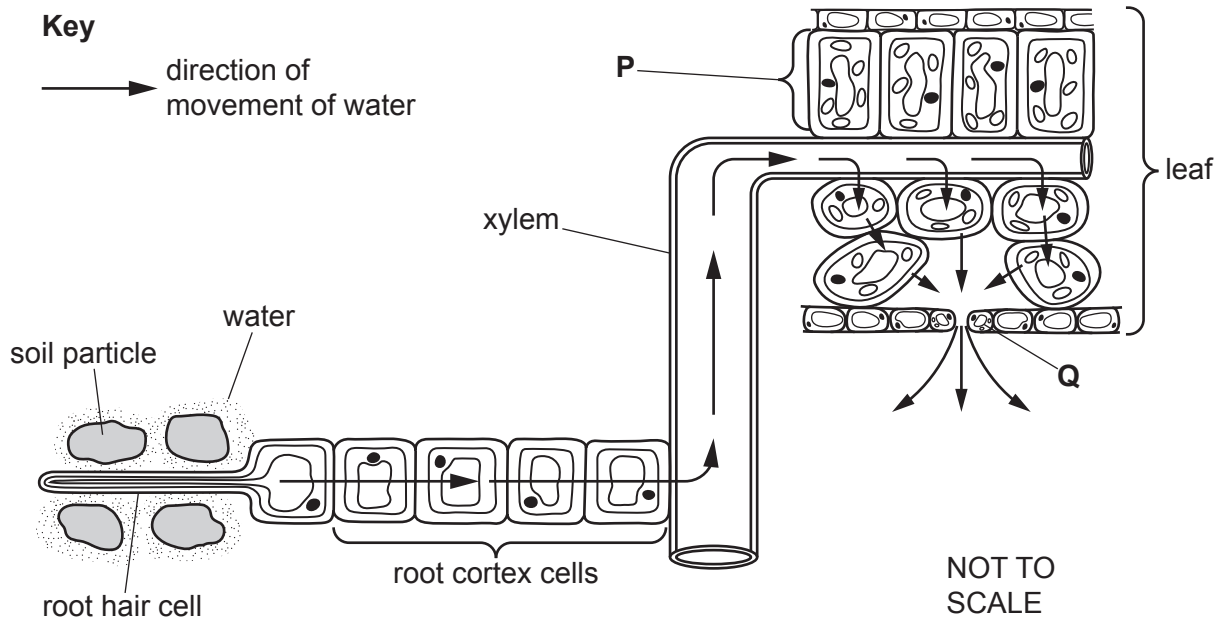


Fig. 7.1

- (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.

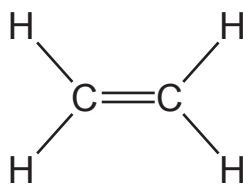


Fig. 8.1

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

Naphtha 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.

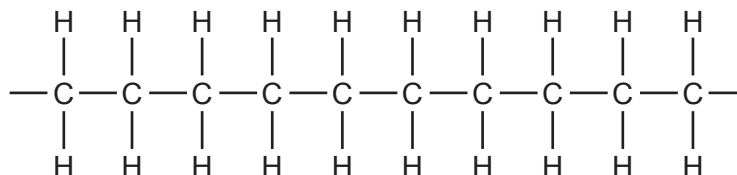


Fig. 8.2

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**.

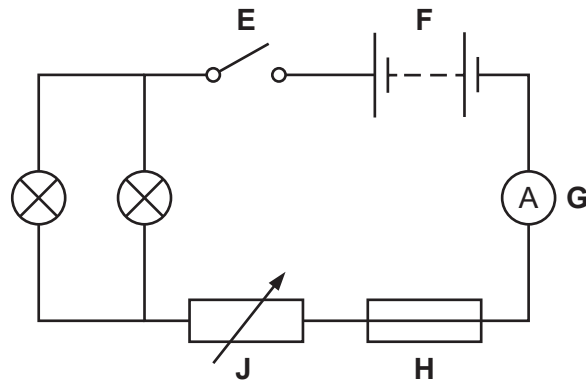


Fig. 9.1

- (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	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										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 oganeson —

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 dm³ at room temperature and pressure (r.t.p.).



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COMBINED SCIENCE**0653/42**

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 **20** pages.

1 (a) Fig. 1.1 shows the alimentary canal and associated organs in humans.

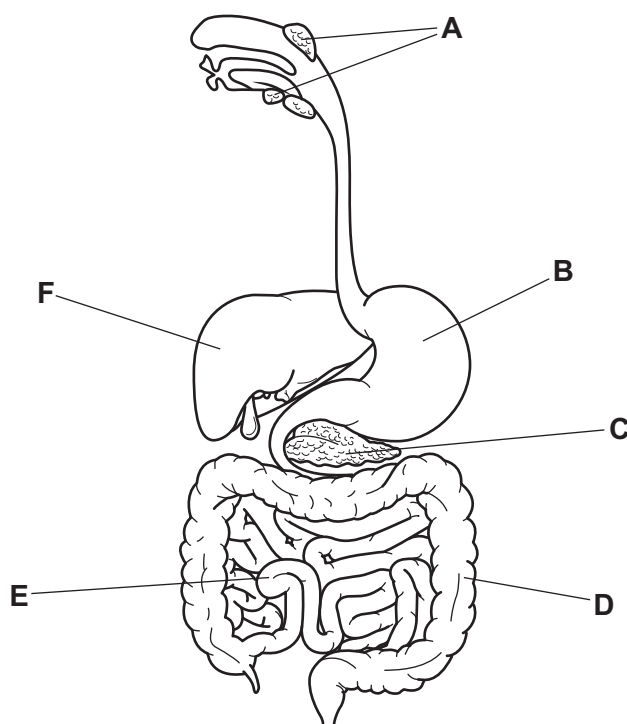


Fig. 1.1

Table 1.1 shows the name and function of some of the parts labelled in Fig. 1.1.

Complete Table 1.1.

Table 1.1

label	name of part	function
.....	stomach	digestion of protein
E		digestion of insoluble molecules and of soluble molecules
C		secretion of lipase

[3]



- (b) **Two** types of digestion occur in the stomach of humans.

Complete these sentences about digestion in the stomach.

Muscles in the stomach wall contract to break down the food into pieces.

This process is called digestion.

The insoluble protein molecules are then converted into soluble molecules by the process of digestion.

The soluble molecules produced from the digestion of protein are called

[4]

- (c) A lipase enzyme is found in the alimentary canal.

Fig. 1.2 shows the activity of this lipase enzyme at different pH values.

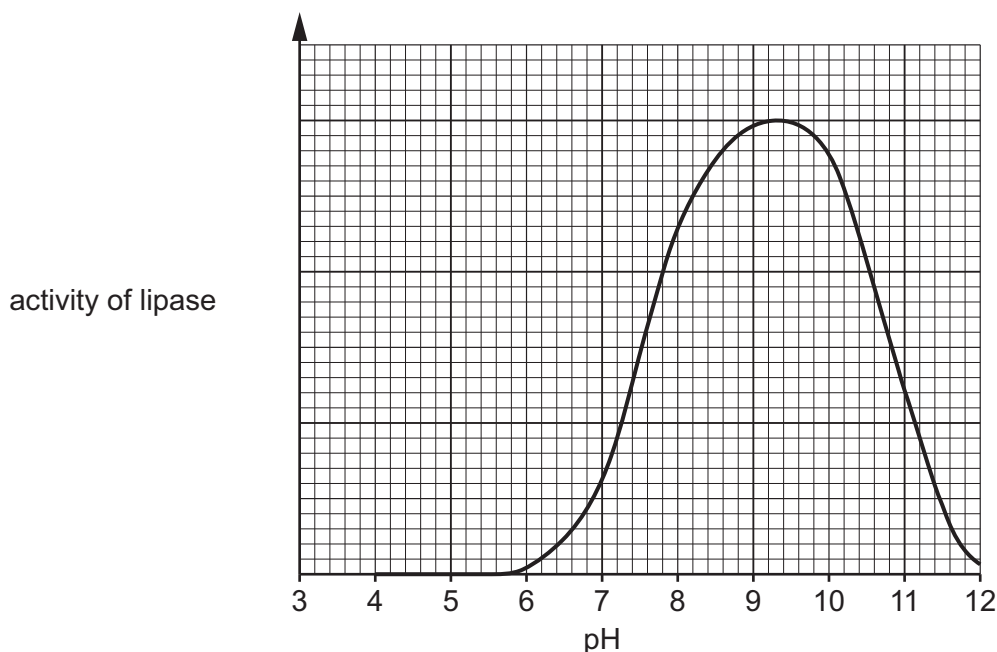


Fig. 1.2

Explain why this lipase enzyme is **not** active in the stomach.

Use data from Fig. 1.2 in your answer.

.....

.....

.....

.....

.....

[3]





- 2 Different types of mixtures need different separation processes to isolate the pure substances from the mixture.

(a) For each separation process, draw **one** straight line to the correct description.

separation process

description

crystallisation

separating an insoluble solid from
a mixture of a solid in water

filtration

separating dyes from a mixture of
dyes in a coloured ink

chromatography

separating a salt from an
aqueous solution

[2]



- (b) Pure water is separated from a mixture of soluble salt and water by distillation. Fig. 2.1 shows the apparatus used.

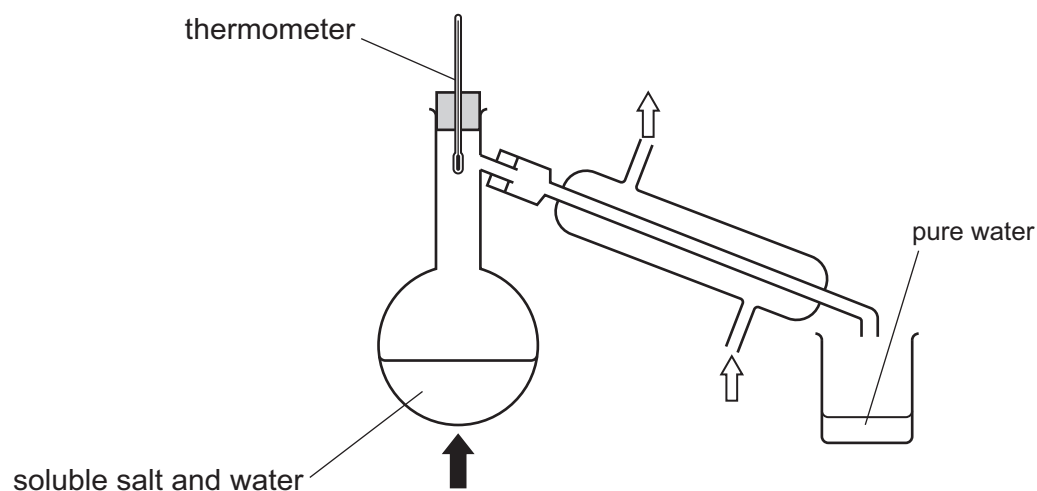


Fig. 2.1

Explain how pure water is separated from this mixture by distillation.

.....

.....

.....

.....

.....

..... [3]





(c) Sodium chloride is a salt.

Table 2.1 shows the melting points and boiling points of sodium chloride and of water.

Table 2.1

	melting point / °C	boiling point / °C
sodium chloride	801	1413
water	0	100

(i) Explain why sodium chloride has a high melting point.

.....

.....

.....

..... [2]

(ii) Explain why the boiling point of water is higher than its melting point.

Use ideas about energy and particles in your answer.

.....

.....

.....

..... [2]





(iii) Fig. 2.2 shows the arrangement of particles in water at $+10^{\circ}\text{C}$.

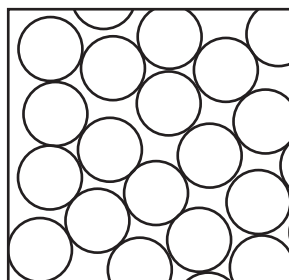
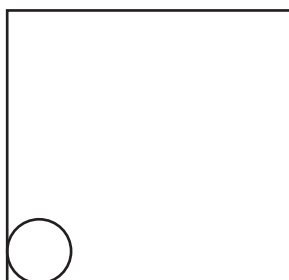


Fig. 2.2

Complete the diagrams in Fig. 2.3 to show the arrangement of particles in water at -10°C and at $+110^{\circ}\text{C}$.

water particles at -10°C



water particles at $+110^{\circ}\text{C}$

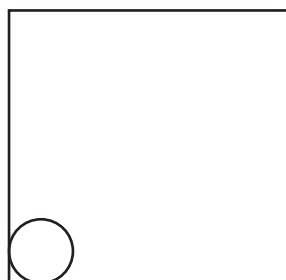


Fig. 2.3

[2]

[Total: 11]





- 3 Fig. 3.1 shows an old-fashioned room heater made of iron. The heater burns oil as a fuel.

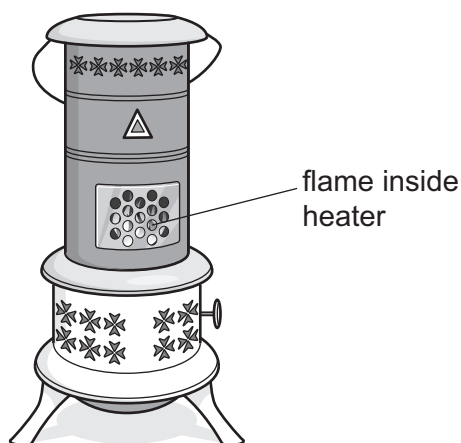


Fig. 3.1

- (a) Complete the sentence to state the energy transfers that occur when the oil burns with a visible flame.

Energy is transferred from potential energy to energy and light.

[2]

- (b) Describe how the process of convection enables the transfer of energy from the flame to the top of the heater.

.....

 [2]

- (c) Fig. 3.2 shows a person warming their hand with radiation from the side of the heater.

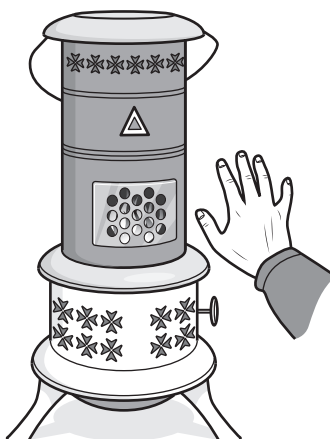


Fig. 3.2





Radiation from the heater is mainly in the infrared region of the electromagnetic spectrum.

The flame emits infrared radiation from the heater with a frequency of 0.95×10^{14} Hz.

(i) State what is meant by frequency.

.....

..... [1]

(ii) State **one** region of the electromagnetic spectrum that has a lower frequency than infrared.

..... [1]

(iii) Calculate the wavelength of radiation with a frequency of 0.95×10^{14} Hz.

The speed of electromagnetic waves = 3.0×10^8 m/s.

wavelength = ... m [2]

[Total: 8]





- 4 (a) A student labels a diagram of a plant cell.

Fig. 4.1 shows the student's diagram.

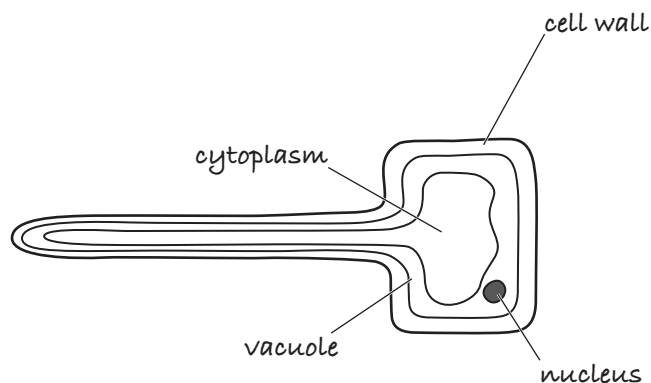


Fig. 4.1

- (i) The student has **not** labelled the diagram correctly.

Circle **all** the labels on Fig. 4.1 that are **not** correct.

[1]

- (ii) Explain how the cell in Fig. 4.1 is adapted to its function.

.....

.....

..... [2]

- (b) Fig. 4.2 shows the effect of carbon dioxide concentration and light intensity on the rate of photosynthesis.

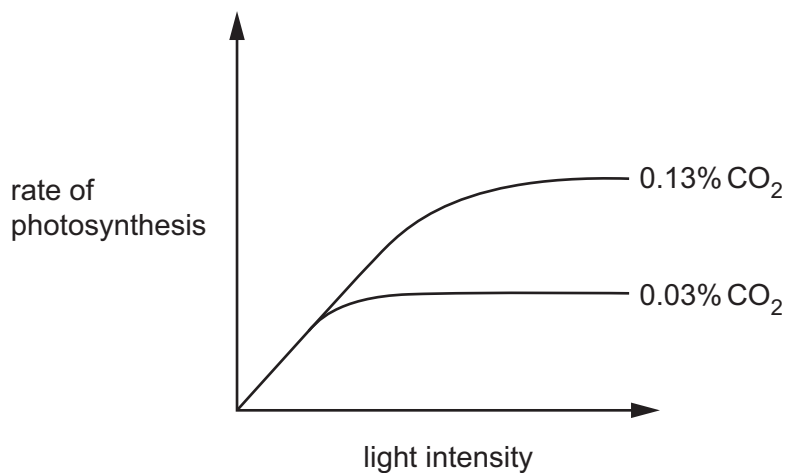


Fig. 4.2





- (i) Describe the effect of increasing **light intensity** on the rate of photosynthesis as shown in Fig. 4.2.

.....

.....

..... [1]

- (ii) Trees in a forest are cut down and burnt where they fall.

Use Fig. 4.2 to suggest why the rate of photosynthesis in the surrounding plants increases.

.....

.....

.....

..... [2]

- (c) Explain why the leaves of plants deficient in magnesium change from green to yellow.

.....

.....

.....

..... [2]

[Total: 8]



5 Nitrogen and oxygen react together at high temperatures in car engines to form oxides of nitrogen.

(a) Nitrogen monoxide, NO, is one of the oxides of nitrogen.

Fig. 5.1 shows the energy level diagram for the reaction of nitrogen and oxygen to form nitrogen monoxide.

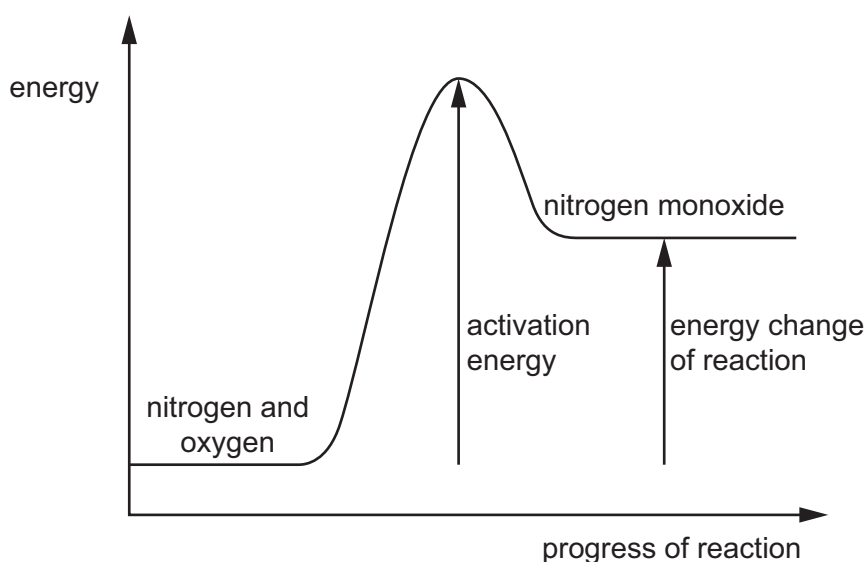


Fig. 5.1

Explain the energy changes shown in Fig. 5.1.

Use ideas about bond breaking and bond forming in your answer.

.....

.....

.....

..... [2]



(b) Nitrogen monoxide, NO, reacts with oxygen to form nitrogen dioxide, NO₂.

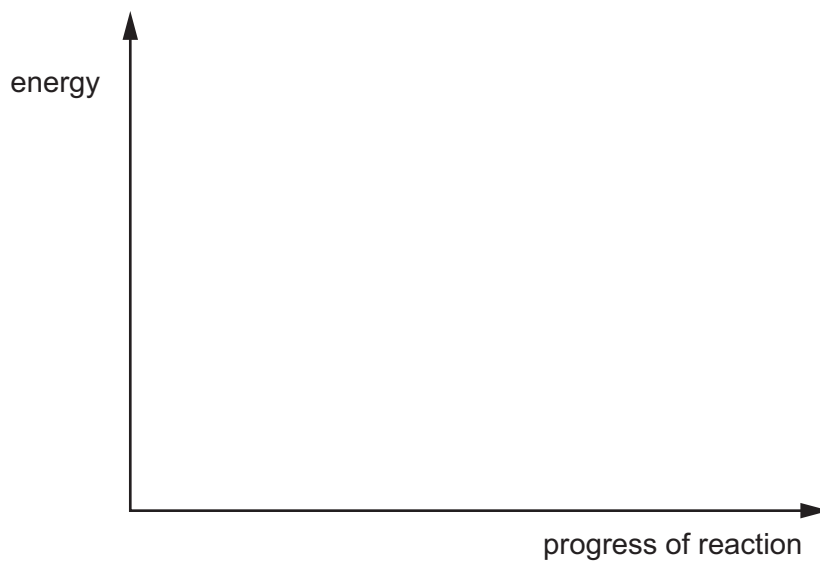
- (i) Write a balanced symbol equation for the reaction between nitrogen monoxide and oxygen.

Include the state symbols.

..... [2]

- (ii) The reaction between nitrogen monoxide and oxygen is exothermic.

Draw a labelled energy level diagram for this reaction. Include labels for the activation energy and the energy change of reaction.



[2]

[Total: 6]





6 Fig. 6.1 shows a rover vehicle on the planet Mars.

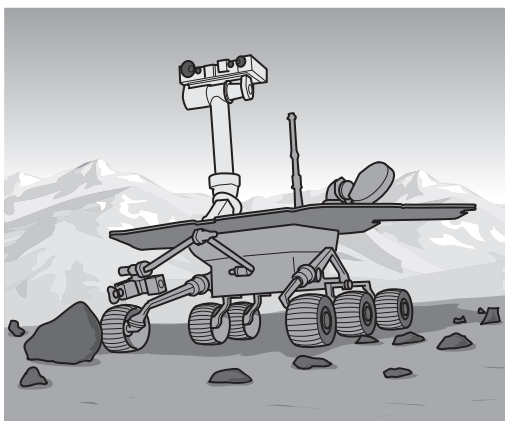


Fig. 6.1

(a) Fig. 6.2 shows a speed–time graph for the vehicle on one of its journeys.

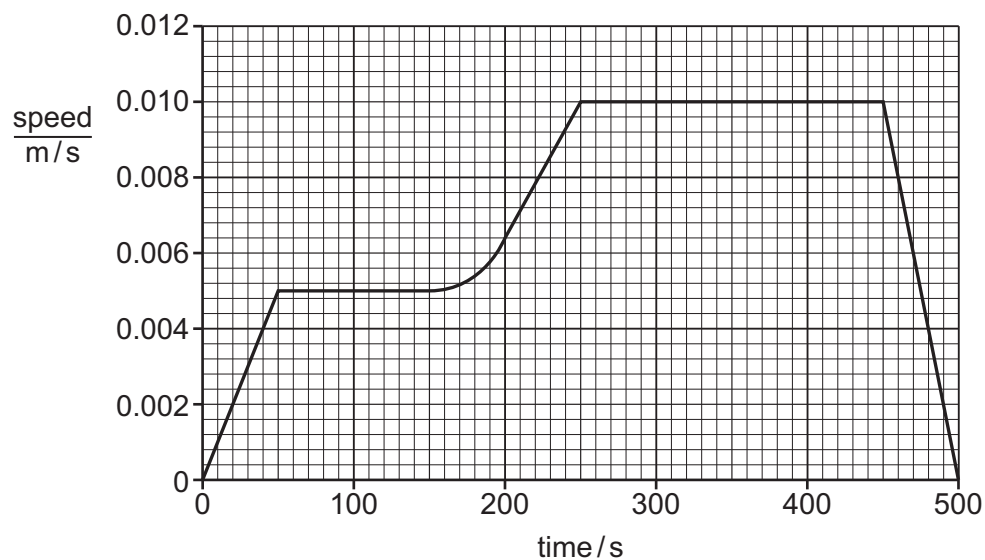


Fig. 6.2

(i) Use Fig. 6.2 to show that the maximum speed of the vehicle on this journey is 0.036 km/h.

[2]





- (ii) Use Fig. 6.2 to calculate the acceleration of the vehicle as it starts its journey.

Give the units of your answer.

acceleration = ... units [3]

- (iii) Describe the motion of the vehicle between 150 s and 200 s.

.....
 [2]

- (b) The mass of the vehicle is 890 kg.

On another journey, the vehicle travels across a rocky terrain at a speed of 0.050 m/s.

- (i) Show that the kinetic energy of the vehicle is approximately 1.1 J.

[2]

- (ii) While travelling at 0.050 m/s, the vehicle's motors switch off.

Assume **no** energy is lost due to friction and that the gravitational field strength on Mars is 3.8 N/kg.

Calculate the height that the vehicle must climb to allow it to stop.

Give your answer in mm.

height = ... mm [3]

[Total: 12]





- 7 (a) Fig. 7.1 shows the double circulatory system in humans.

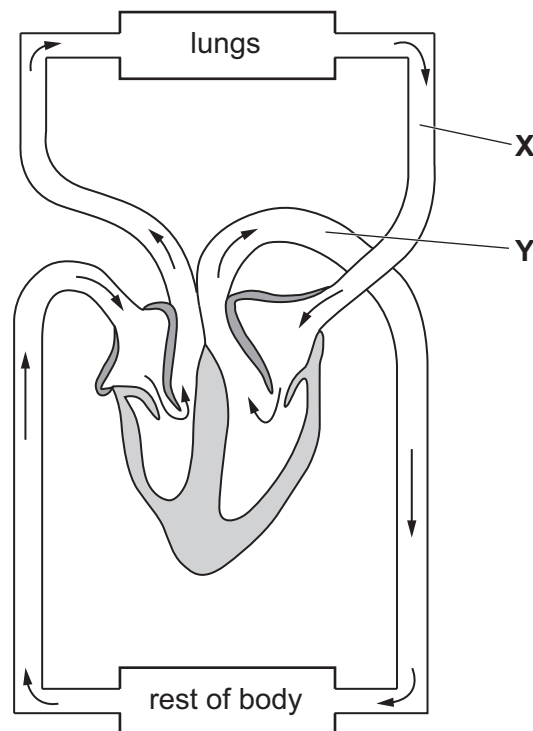


Fig. 7.1

- (i) The arrows show the direction of blood flow.

Identify the blood vessels labelled **X** and **Y** in Fig. 7.1.

X

Y

[2]

- (ii) On Fig. 7.1, draw a label line and the letter **S** to identify the septum.

[1]

- (iii) Explain the advantages of a double circulatory system.

.....

.....

..... [2]





(b) The lungs contain the gas exchange surface in humans.

(i) List **two** features of gas exchange surfaces.

1

2

[2]

(ii) The composition of inspired air is different to expired air.

Tick (✓) **all** the boxes that explain this statement.

Carbon dioxide is a product of respiration.	
Nitrogen is taken into the blood and used in respiration.	
Oxygen is a product of respiration.	
Water is a reactant of respiration.	
Water evaporates from the lining of the alveoli.	

[2]

[Total: 9]





- 8 Solid magnesium and some magnesium compounds react with dilute acids to make salts.

Some of the reactants and products of these reactions are shown in Table 8.1.

Table 8.1

reactants		products	
solid	dilute acid	salt	other product(s)
magnesium	sulfuric acid	magnesium sulfate	
.....	sulfuric acid	magnesium sulfate	water
magnesium carbonate		magnesium chloride	 and

- (a) Complete Table 8.1. [4]

- (b) (i) Identify **one** substance in Table 8.1 that has a pH less than 3.

..... [1]

- (ii) Identify **one** covalent substance in Table 8.1 that has a pH greater than 5.

..... [1]

- (c) Explain how the position of magnesium in the Periodic Table and the electronic structure of magnesium relate to its metallic character.

.....

 [3]

[Total: 9]



- 9 Fig. 9.1 shows a circuit diagram for part of an electric dishwashing machine.

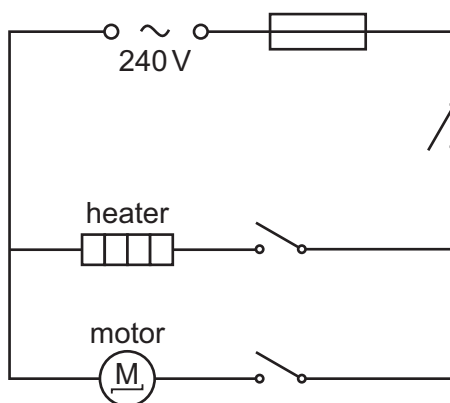


Fig. 9.1

- (a) State the circuit component represented by the symbol $\text{---} \bigcirc \sim \bigcirc \text{---}$.

..... [1]

- (b) The resistance of the heater is $25\ \Omega$.

- (i) Calculate the current in the heater.

current = ... A [2]

- (ii) Use your answer to (b)(i) to calculate the power required by the heater.

power = ... W [2]

- (c) On Fig. 9.1, draw a lamp connected in the circuit that will **only** be on when the heater is switched on but will **not** reduce the current in the heater. [2]

[Total: 7]

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The Periodic Table of Elements

Group																								
I	II											III	IV	V	VI	VII	VIII							
		1 H hydrogen 1																						
		Key atomic number atomic symbol name relative atomic mass																						
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		
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 —						

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			
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 merdelevium —	102 No nobelium —	103 Lr lawrencium —			

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).





CANDIDATE
NAME

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CENTRE
NUMBER

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CANDIDATE
NUMBER

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0653/43

May/June 2024

1 hour 15 minutes

You must answer on the question paper.

No additional materials are needed.

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

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

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

- 1 (a) Fig. 1.1a and Fig. 1.1b are diagrams of different flowers.

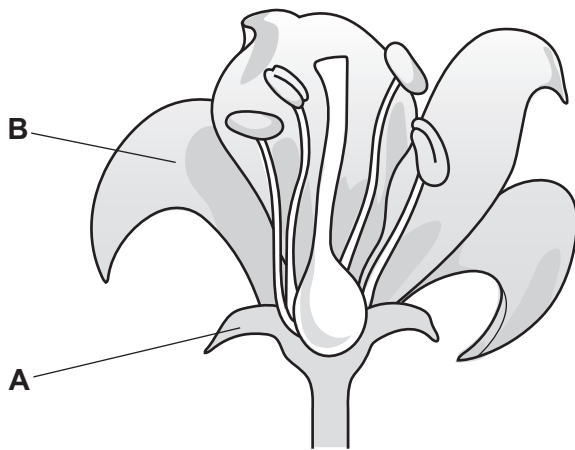


Fig. 1.1a

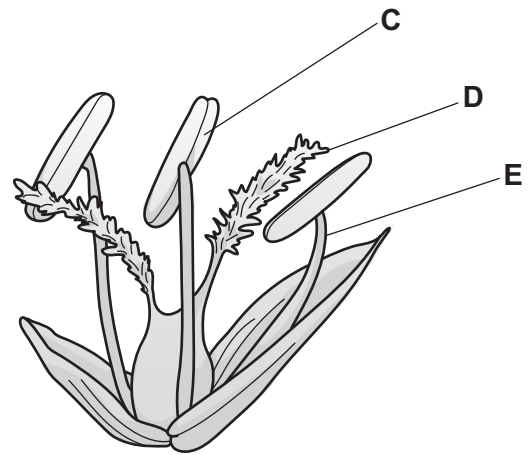


Fig. 1.1b

- (i) Table 1.1 shows some of the labels in Fig. 1.1a and Fig. 1.1b, the name of the part and its function.

Complete Table 1.1.

Table 1.1

label	name	function
.....	sepal	
C		produces
.....		site of pollination

[3]

- (ii) Describe one **visible** feature in Fig. 1.1a that shows the flower is insect-pollinated.

..... [1]

(b) Fig. 1.2 is a diagram of a sperm cell.

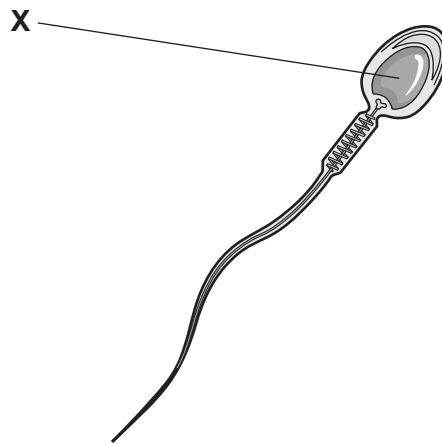


Fig. 1.2

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

1

2 [2]

(ii) Describe what happens during fertilisation to the structure labelled **X** in Fig. 1.2.

.....

..... [2]

[Total: 8]

- 2 Oxides of nitrogen are pollutant gases formed in car engines. Nitrogen monoxide, NO, and nitrogen dioxide, NO₂, are both oxides of nitrogen.

(a) Nitrogen, N₂, and oxygen, O₂, react together in car engines to make nitrogen monoxide, NO.

Nitrogen monoxide reacts with oxygen to form nitrogen dioxide, NO₂.

The energy level diagrams for these reactions are shown in Fig. 2.1 and Fig. 2.2.

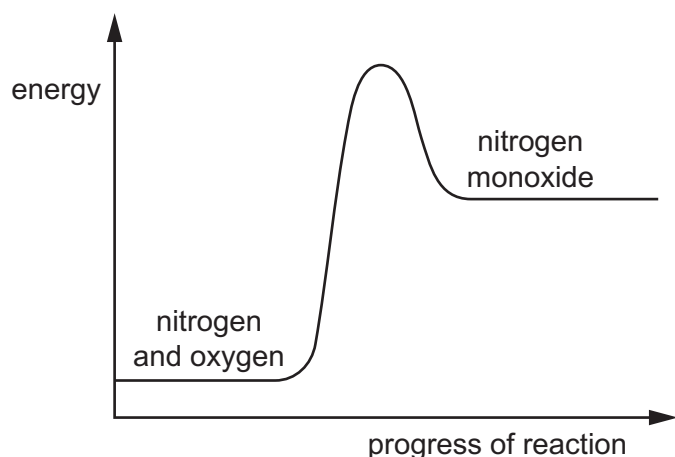


Fig. 2.1

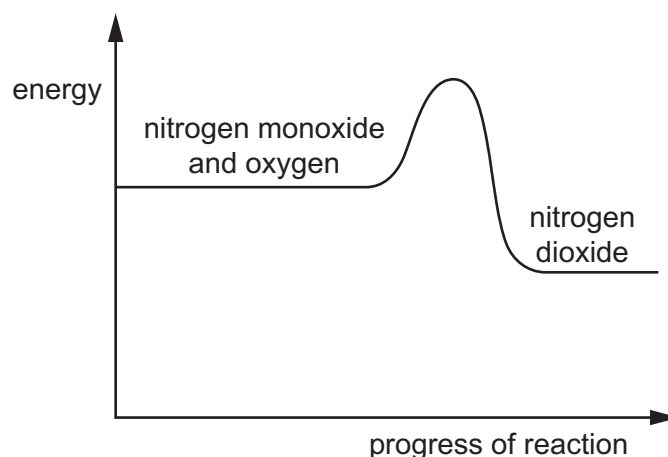


Fig. 2.2

(i) Complete the energy level diagrams shown in Fig. 2.1 and Fig. 2.2 by labelling:

- the activation energy
- the energy change of reaction.

[3]

(ii) The following statements are about the reactions shown in Fig. 2.1 and Fig. 2.2.

Put **one** tick (✓) for each statement to show if it is true or false.

statement	true	false
The reaction between nitrogen and oxygen is exothermic.		
When nitrogen monoxide reacts with oxygen, the energy given out is greater than the energy taken in.		
Both reactions involve breaking bonds.		
Both reactions involve elements reacting together to form compounds.		

[2]

- (iii) Write the balanced symbol equation for the reaction between nitrogen oxide, NO, and oxygen, O₂, to make nitrogen dioxide, NO₂.

..... [1]

- (b) Oxides of nitrogen are simple molecules.

Explain why oxides of nitrogen have low boiling points.

Use ideas about forces and energy in your answer.

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

[Total: 8]

- 3 Fig. 3.1 shows a television (TV) connected to a satellite dish. The satellite dish receives microwave signals from a satellite above the Earth.

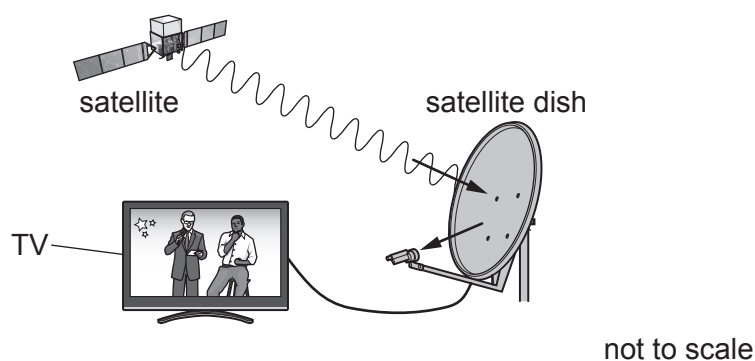


Fig. 3.1

- (a) (i) On Fig. 3.2, write microwaves in the correct place in the electromagnetic spectrum.

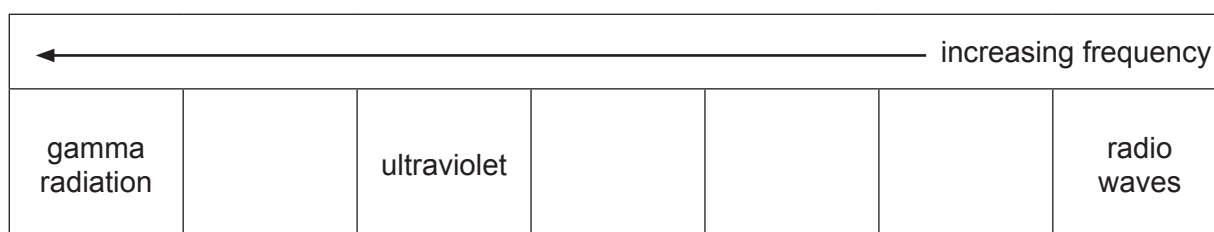


Fig. 3.2

[1]

- (ii) State **one** danger of ultraviolet radiation.

..... [1]

- (b) The microwave signal travels from the satellite to the satellite dish at a speed of 3.0×10^5 km/s.

- (i) The satellite is a distance of 37 000 km from the satellite dish.

Calculate the time taken by the microwave signal to travel from the satellite to the satellite dish.

time = ... s [2]

- (ii) The microwave signal from the satellite has a frequency of $12 \times 10^9 \text{ Hz}$.

Calculate the wavelength in metres of the microwave signal.

wavelength = ... m [3]

[Total: 7]

- 4 (a) Fig. 4.1 shows a model of the alimentary canal and associated organs of humans.

The model is viewed from the back.

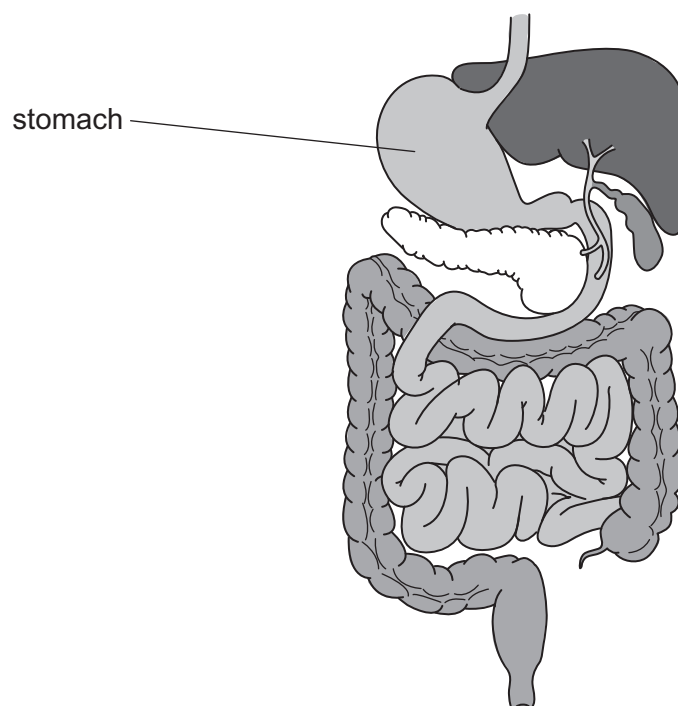


Fig. 4.1

- (i) On Fig. 4.1, draw a label line and the letter **P** to identify the pancreas. [1]

- (ii) Amylase is an enzyme in the alimentary canal.

Explain why amylase does **not** break down proteins.

.....

 [2]

- (iii) State the name of the product when proteins are digested.

..... [1]

(b) Vitamins and minerals are absorbed into blood capillaries in the alimentary canal.

(i) A diet that lacks vitamin D is a cause of vitamin D deficiency in humans.

State **one other** cause of vitamin D deficiency in humans.

..... [1]

(ii) Describe **one** effect of vitamin D deficiency in humans.

..... [1]

(iii) Explain how capillaries are adapted to their function.

.....

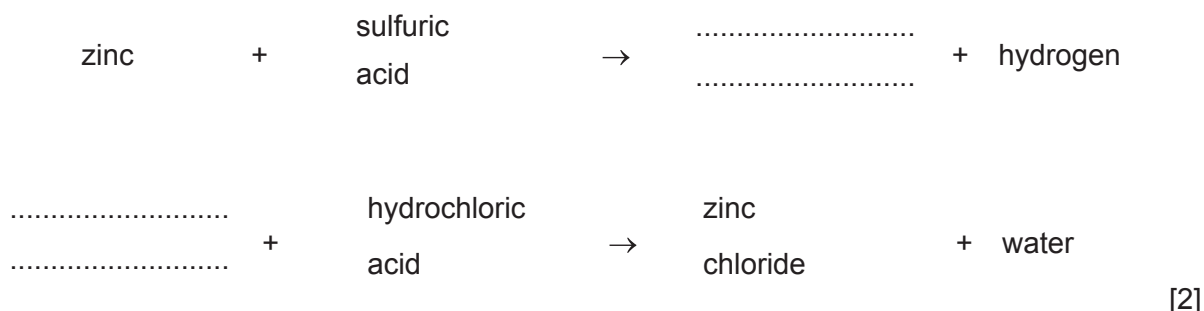
.....

..... [2]

[Total: 8]

5 Zinc and some zinc compounds react with dilute acids to make salts.

(a) (i) Complete the word equations for the following reactions.



(ii) Identify **two** covalent substances shown in the equations in (a)(i).

- 1
- 2 [2]

(b) A metal carbonate reacts with a dilute acid to form a salt and two other products.

Identify the **two other** products formed in the reaction.

- 1
- 2 [2]

(c) Describe how the pH number of a sample of dilute sulfuric acid is determined using an indicator.

.....

.....

..... [2]

(d) Some soils are acidic.

Describe how the acidity in soils is controlled.

.....

..... [1]

[Total: 9]

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- 6 Fig. 6.1 shows three forces, **Q**, **R** and **P**, acting on a bus moving along a level road at constant speed.

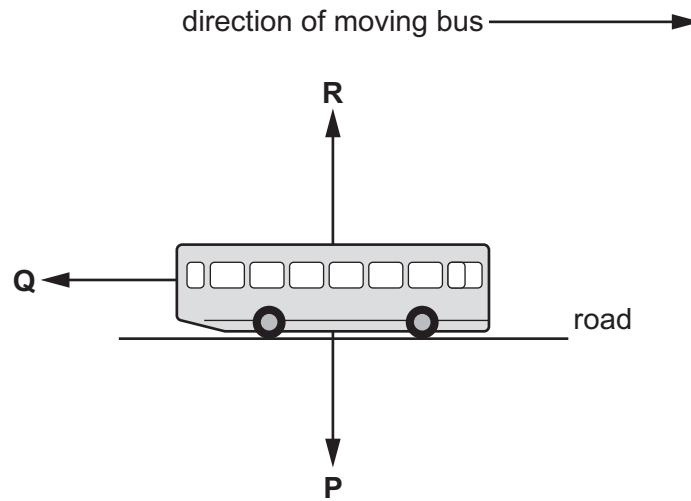


Fig. 6.1

- (a) The driving force acting on the bus is **not** shown on Fig. 6.1.
- (i) On Fig. 6.1, draw an arrow labelled **S** to represent the driving force acting on the bus. [1]
- (ii) State the cause of the force labelled **Q**.

..... [1]

- (b) The mass of the bus is 7500 kg.

The gravitational force on unit mass is 10 N/kg.

Explain why the force labelled **R** must be 75 000 N.

.....

.....

..... [2]

- (c) Fig. 6.2 shows a speed–time graph of the motion of a bus on a journey between two bus stops.

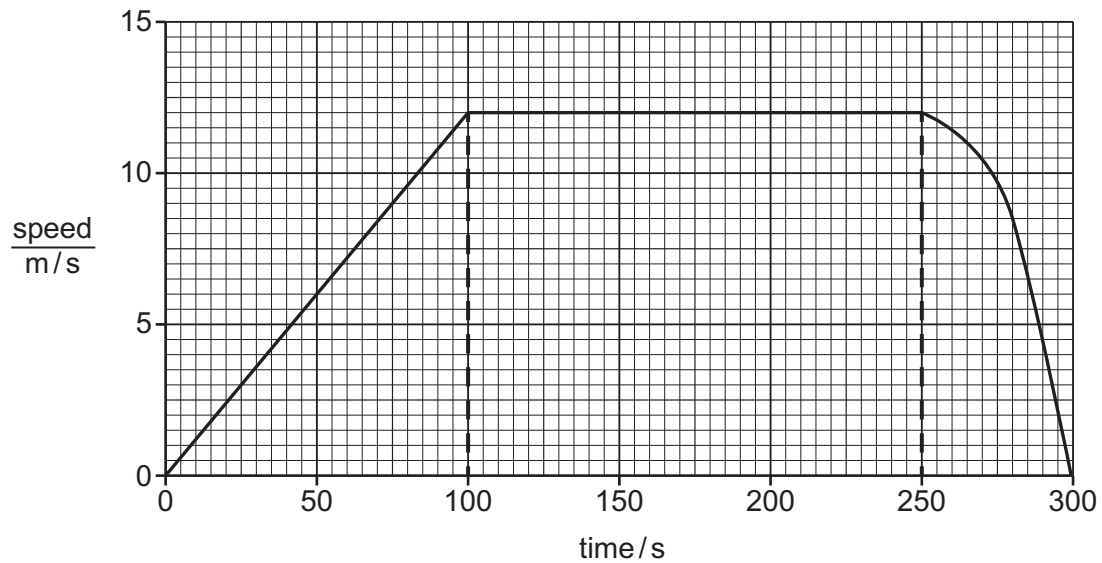


Fig. 6.2

- (i) Calculate the acceleration of the bus as it starts the journey.

Give the units of your answer.

acceleration = ... units [3]

- (ii) Use Fig. 6.2 to calculate the distance in metres travelled by the bus before it begins to slow down.

distance = ... m [3]

- (iii) The total distance between the bus stops is 2.65 km.

Use your answer to (c)(ii) to find the distance in metres travelled by the bus while it is decelerating.

distance = ... m [1]

[Total: 11]

- 7 (a) Fig. 7.1 is a diagram of a cross-section through a leaf.

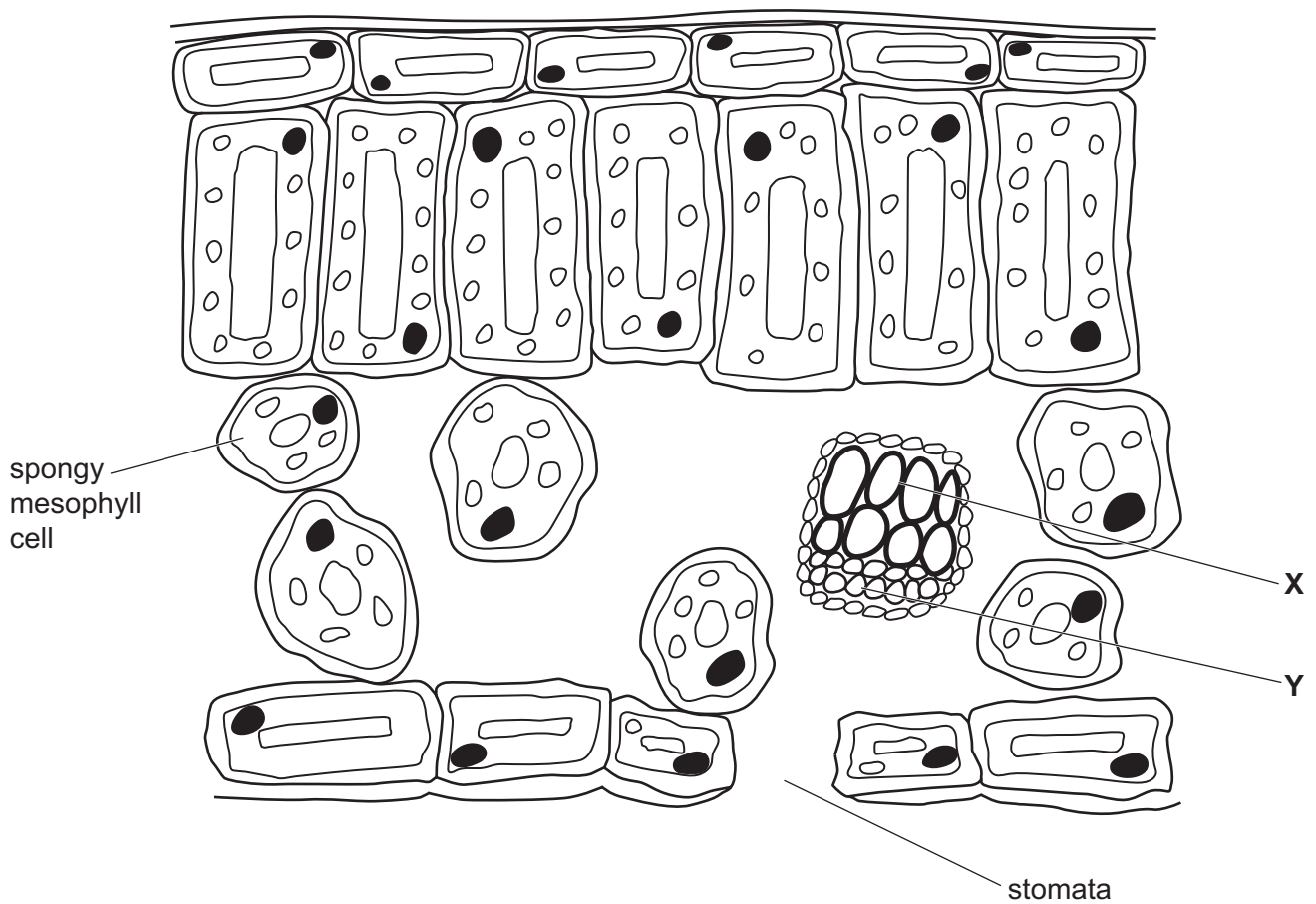


Fig. 7.1

- (i) State **one** way the function of **X** and **Y** in Fig. 7.1 is similar and **one** way their function is different.

similar

.....

different

.....

[2]

- (ii) Describe how water moves from the surface of the spongy mesophyll cells to outside the stomata.

.....

.....

.....

.....

..... [3]

- (b) Plants produce a chemical called auxin.

Complete these sentences about auxin.

Auxin is made in the shoot

Auxin then spreads through the shoot, where it causes growth by stimulating cell

Auxin is unequally distributed in response to and

[3]

- (c) Plants are usually the producer in a food web.

Fig. 7.2 shows a food web with a different producer.

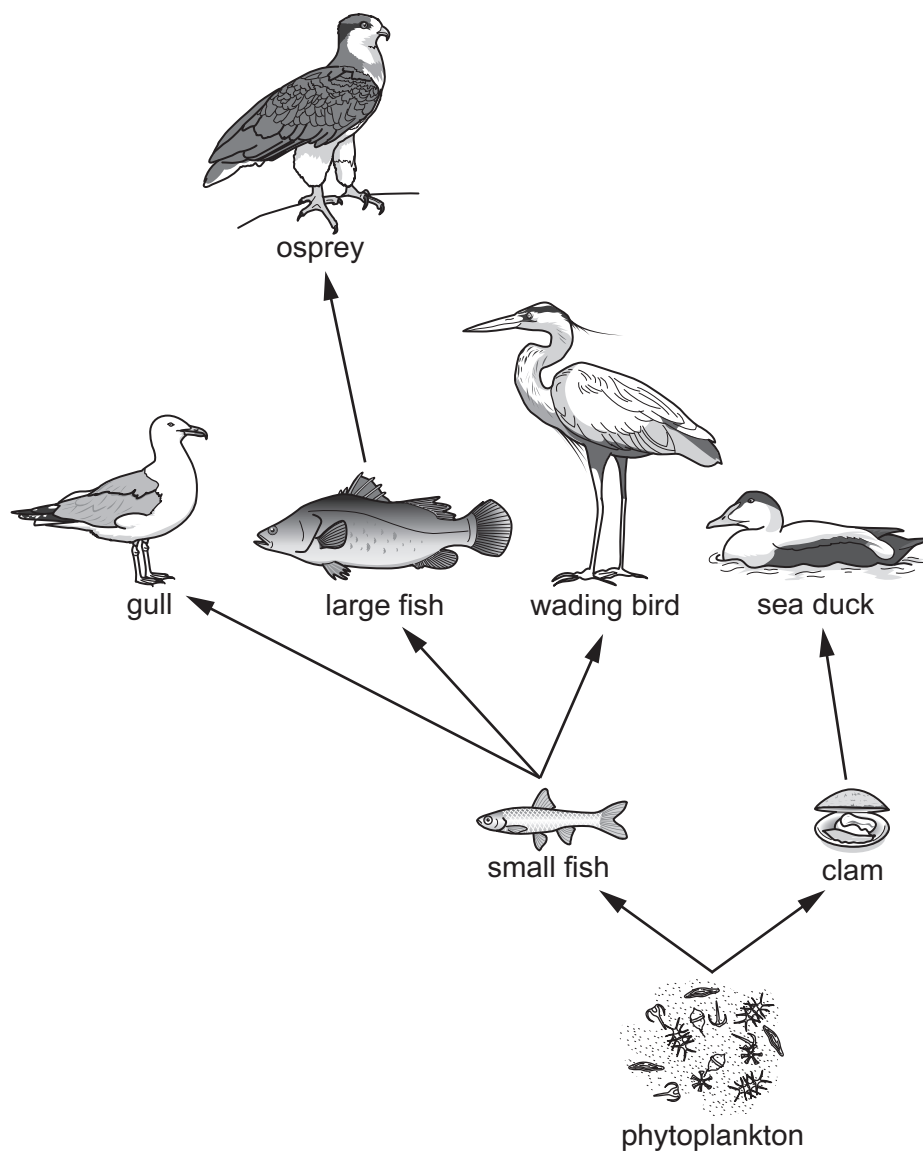


Fig 7.2

- (i) Identify **all** the organisms in Fig 7.2 that occupy trophic level 2.

[1]

- (ii) Circle all the **bold** words in the sentences about the osprey from Fig. 7.2 which make the sentences correct.

The osprey is a **secondary / tertiary** consumer and is a **carnivore / herbivore**.

This is because the osprey eats **large / small** fish.

[2]

[Total: 11]

- 8 The structures of ethene and ethane are shown in Fig. 8.1.

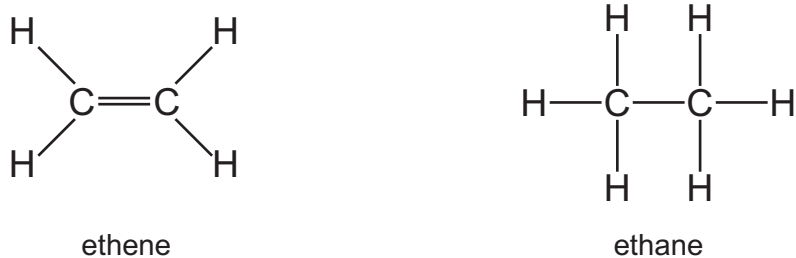


Fig. 8.1

- (a) Ethene is a member of the alkene homologous series.

All alkenes are hydrocarbons with the same general formula.

- (i) State **one other** similarity between all members of the alkene homologous series.

.....
 [1]

- (ii) State the general formula for alkenes and for alkanes.

alkenes

alkanes [2]

- (b) Many ethene monomer units react together in addition polymerisation to form poly(ethene).

Draw the structure of a poly(ethene) molecule to show the part formed from **three** ethene monomer units.

[2]

(c) Cracking produces ethene from larger molecules.

The cracking of molecule **A** forms a molecule of ethene and a molecule of compound **B**, as shown in Fig. 8.2.

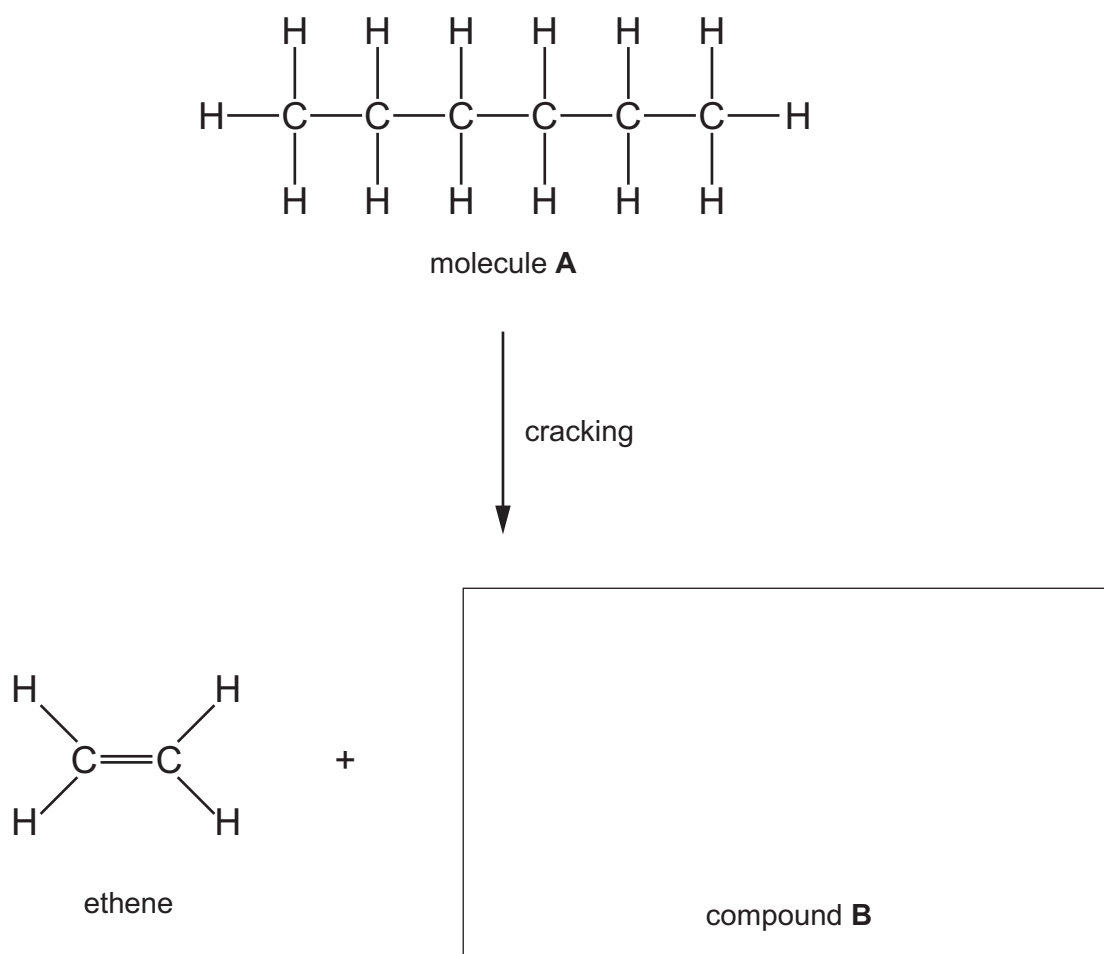


Fig. 8.2

(i) Complete Fig. 8.2 by drawing the structure of compound **B**. [2]

(ii) State the conditions required for cracking.

..... and [2]

[Total: 9]

- 9 Fig. 9.1 shows a simple circuit containing two identical lamps.

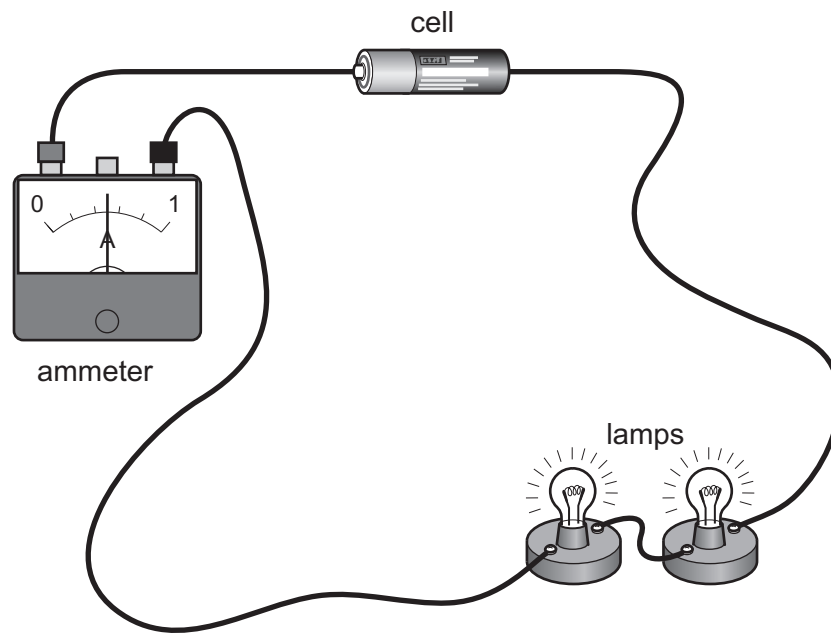


Fig. 9.1

- (a) Complete these sentences.

Potential difference is measured in units called

The current in the circuit is a flow of

[2]

- (b) The cell produces a total e.m.f. of 2.4 V. There is a current of 0.50 A in the circuit.

- (i) Calculate the power supplied by the cell.

power = ... W [2]

- (ii) The cell in Fig. 9.1 has a total charge of 9000 C. Calculate the maximum time in hours for which the cell can produce a current of 0.5 A.

time = ... h [3]

(c) Fig. 9.2 shows the same circuit components connected in a different arrangement.

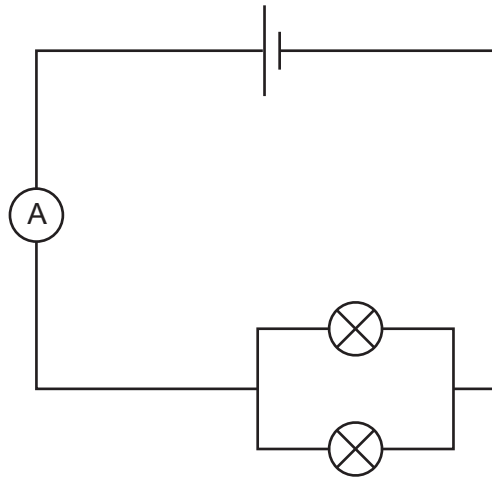


Fig. 9.2

- (i) Describe how the circuit arrangement in Fig. 9.2 differs from that shown in Fig. 9.1.

.....
 [1]

- (ii) Predict whether the reading on the ammeter in Fig. 9.2 will be greater or less than the ammeter reading in Fig. 9.1.

Give a reason for your answer.

.....
 [1]

[Total: 9]

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The Periodic Table of Elements

Group																	
I	II	1 H hydrogen 1										III	IV	V	VI	VII	VIII
3 Li lithium 7	4 Be beryllium 9	Key atomic number atomic symbol name relative atomic mass										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
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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 oganeson —

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 dm³ at room temperature and pressure (r.t.p.).