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Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

CENTRE NUMBER | | | | | |

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5352875058

CO-ORDINATED SCIENCES **0654/43**

Paper 4 Theory (Extended) **October/November 2024**

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 **32** pages. Any blank pages are indicated.

[Turn over

1 **(a)** Fig. 1.1 is a diagram of the gas exchange system.

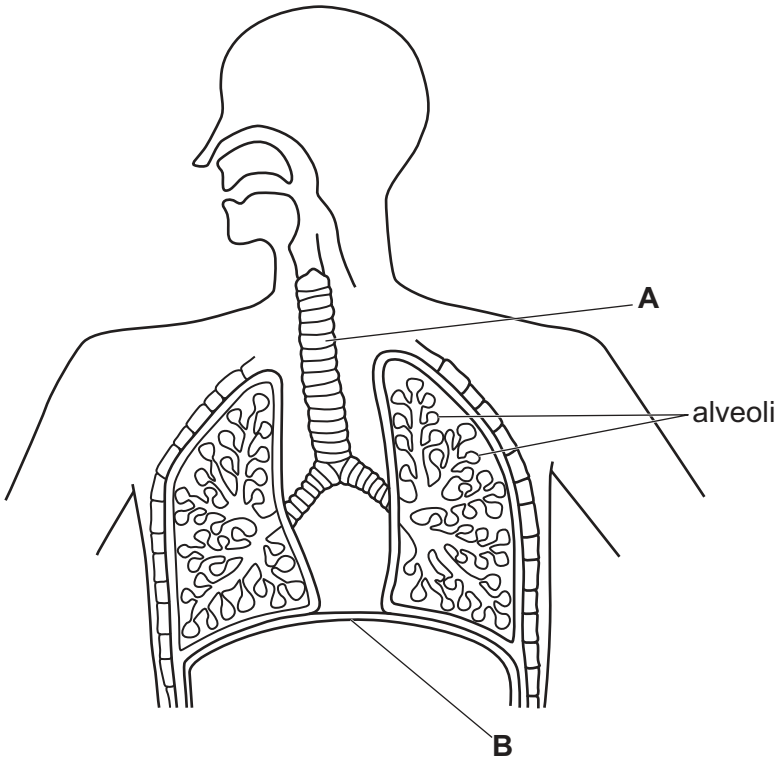


Fig. 1.1

(i) Identify the parts labelled **A** and **B** in Fig. 1.1.

A .....

B .....
[2]

(ii) Alveoli are the gas exchange surface in humans.

State **two** features of an efficient gas exchange surface.

1 .....

2 .....
[2]

(iii) State the name of the cells in the gas exchange system that produce mucus.

..... [1]

(b) A student measures their breathing rate at rest and during exercise.

Table 1.1 shows the results.

Table 1.1

breathing rate at rest / breaths per minute	breathing rate during exercise / breaths per minute
15	40

(i) Calculate the difference in breathing rate between rest and during exercise in Table 1.1.

difference in breathing rate = ... breaths per minute [1]

(ii) Tick (✓) **two** boxes to explain the difference in breathing rate during exercise shown in Table 1.1.

There is a decrease in production of water vapour. ☐

There is a decrease in the use of oxygen by muscles. ☐

There is an increase in carbon dioxide concentration in the blood. ☐

There is an increase in the rate of aerobic respiration. ☐

There is an increase in water intake. ☐

[2]

[Total: 8]

2 Fig. 2.1 shows the displayed formulae of some carbon compounds.

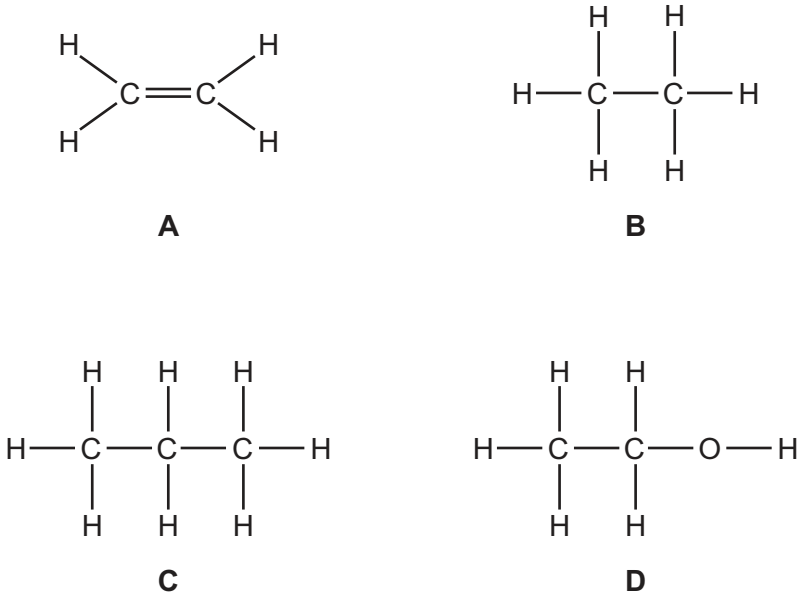


Fig. 2.1

(a) State which compound in Fig. 2.1 is **not** a hydrocarbon.

Explain your answer.

compound .....

explanation .....

.....

..... [2]

(b) State which compound in Fig. 2.1 will decolourise aqueous bromine.

..... [1]

(c) Compound **D** is used as a fuel.

State **one** other use of compound **D**.

..... [1]

(d) Compound **C** is a saturated compound.

State what is meant by saturated.

.....

..... [1]

(e) Compound **C**, C_3H_8, undergoes complete combustion in oxygen.

Construct the balanced symbol equation for this reaction.

..... [2]

(f) Compound **A** is ethene.

Complete Fig. 2.2 to show the displayed formula of the polymer poly(ethene).

C C

Fig. 2.2

[1]

(g) The formation of poly(ethene) from ethene is an example of addition polymerisation.

Explain the differences between addition polymerisation and condensation polymerisation.

.....

.....

.....

..... [2]

[Total: 10]

3 A student investigates an NTC thermistor.

(a) The student connects the thermistor in series with a cell and an ammeter.

The student also connects a voltmeter to measure the potential difference across the thermistor.

Fig. 3.1 shows an incomplete circuit diagram of the circuit used by the student.

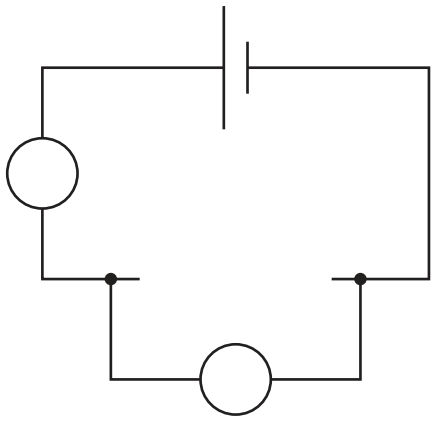


Fig. 3.1

(i) Complete Fig. 3.1. [2]

(ii) When the thermistor is at room temperature, the ammeter reads 3.0 A.

Calculate the charge that flows through the thermistor in 60 s.

State the unit for your answer.

charge = ... unit ..... [3]

(b) The student places the thermistor into hot water.

The student records the values shown by the ammeter and the voltmeter as the temperature of the thermistor increases.

Describe how the power output of the thermistor changes as the temperature of the thermistor increases.

.....

.....

.....

.....

..... [4]

(c) Fig. 3.2 shows the current–voltage characteristic for an ohmic resistor.

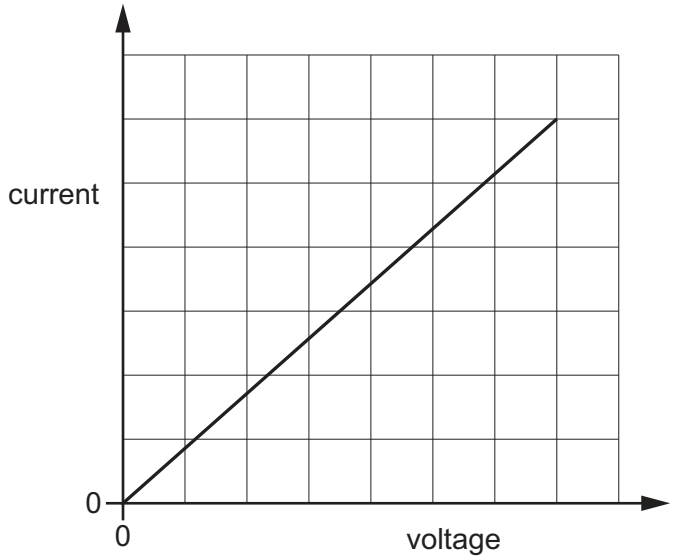


Fig. 3.2

Explain the shape of the graph shown in Fig. 3.2.

.....

.....

.....

..... [2]

[Total: 11]

4 Fig. 4.1 summarises one pathway of water through a plant.

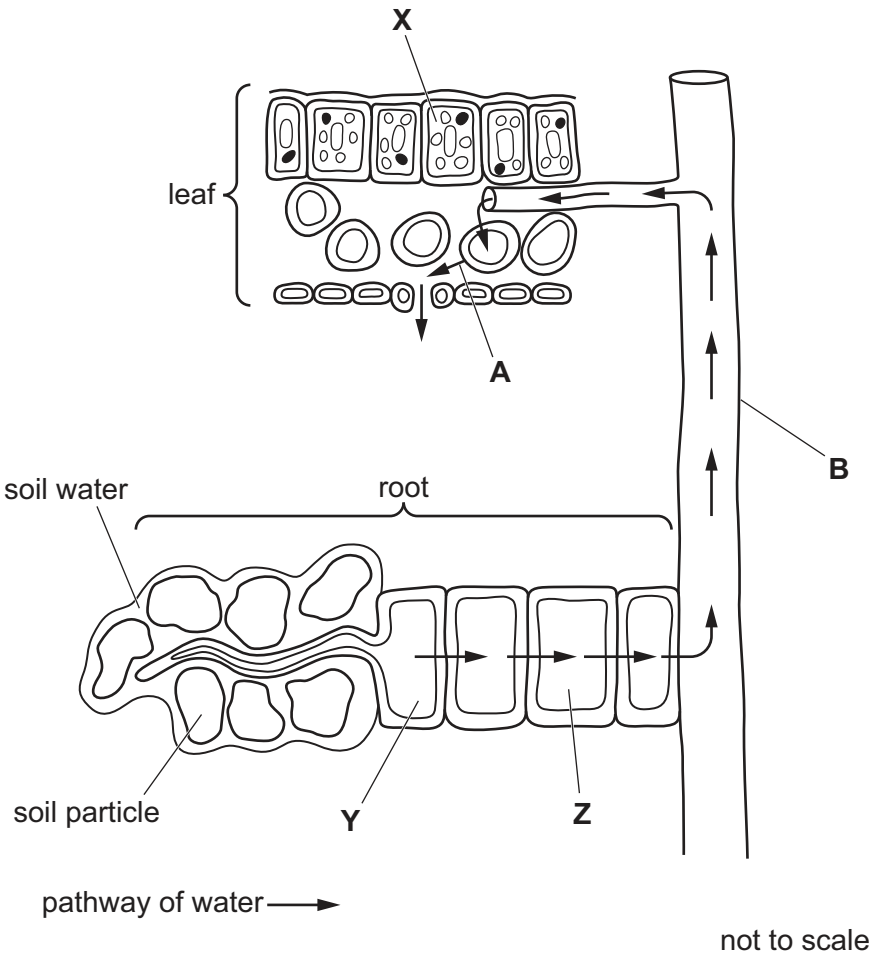


Fig. 4.1

(a) Identify the cells labelled **Y** and **Z** in Fig. 4.1.

Y .....

Z .....

[2]

(b) Describe **two** ways that cell **X** in Fig. 4.1 is adapted for photosynthesis.

1 .....

.....

2 .....

.....

[2]

(c) Explain the effect of an increase in humidity on the process occurring at **A** in Fig. 4.1.

.....

.....

.....

.....

..... [2]

(d) Complete the sentences to explain how water is moved in part **B** in Fig. 4.1.

Water is moved up part **B** by ..... pull.

This creates a ..... gradient, drawing up a column of water molecules that are held together by ..... .

[3]

[Total: 9]

5 A student investigates the reaction between calcium carbonate and dilute hydrochloric acid.

Fig. 5.1 shows the apparatus the student uses.

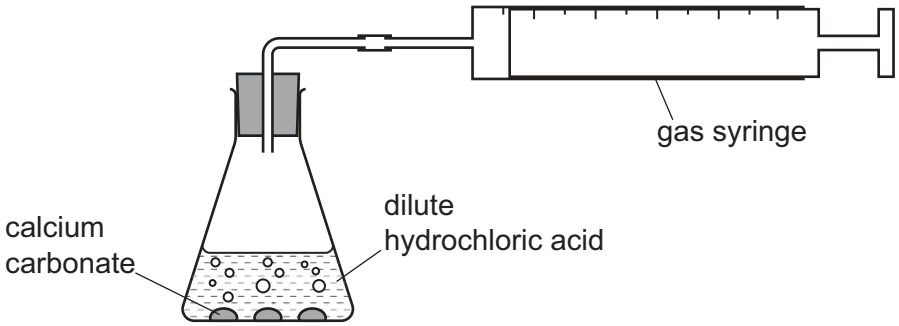


Fig. 5.1

The student measures the volume of gas in the gas syringe every 20 seconds. Fig. 5.2 shows a graph of the student's results.

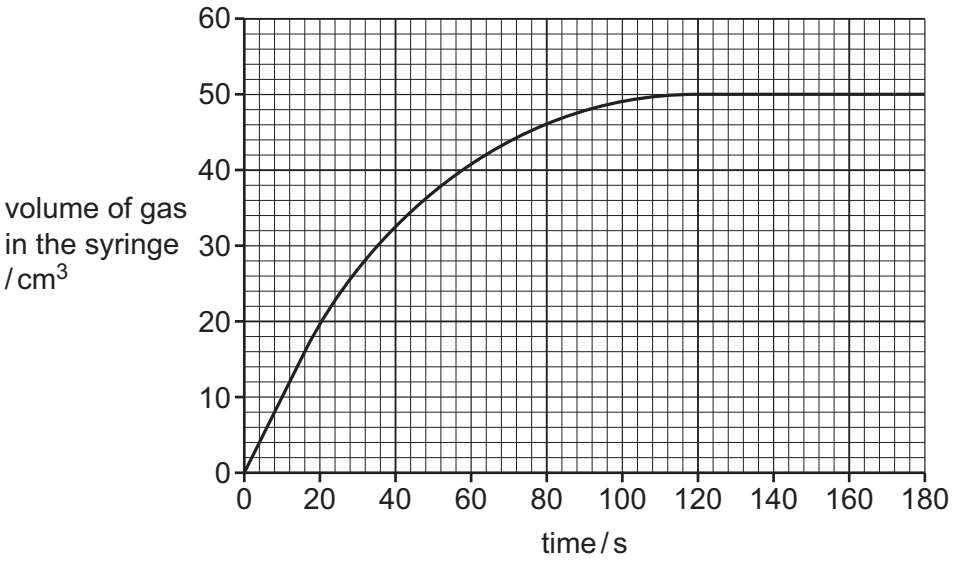


Fig. 5.2

(a) State the name of the gas made in this reaction.

..... [1]

(b) Complete the sentence.

The reaction is fastest between ..... seconds and ..... seconds. [1]

(c) The total volume of gas made in the experiment is 50 cm^3.

Calculate the total number of moles in 50 cm^3 of the gas measured at room temperature and pressure (r.t.p.).

The volume of one mole of any gas is 24 dm^3 at r.t.p.

Show your working.

number of moles in 50 cm^3 of the gas = ... [2]

(d) The student repeats the experiment using dilute hydrochloric acid at a **higher** temperature.

Explain why the reaction is faster.

Use ideas about collisions between particles.

.....

.....

.....

.....

.....

..... [3]

(e) The reaction between calcium carbonate and dilute hydrochloric acid is exothermic.

Complete Fig. 5.3 to show an energy level diagram for an exothermic reaction.

Label the activation energy and the energy change on your diagram.

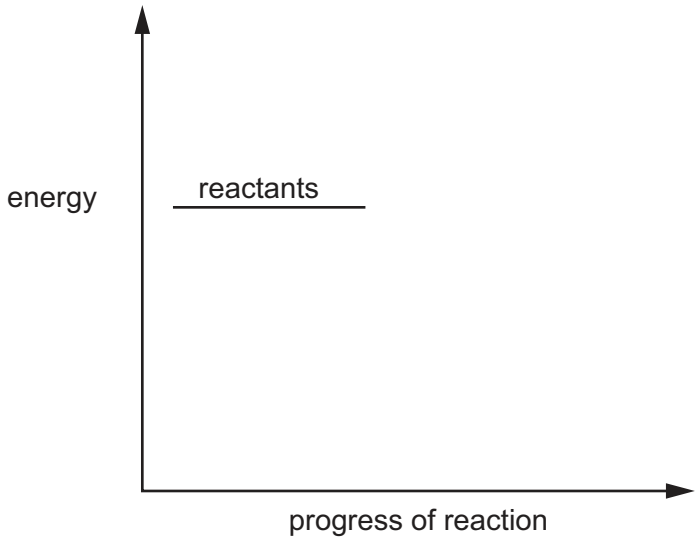


Fig. 5.3

[3]

[Total: 10]

6 Fig. 6.1 shows a car suspension system.

The suspension system uses four identical coil springs.

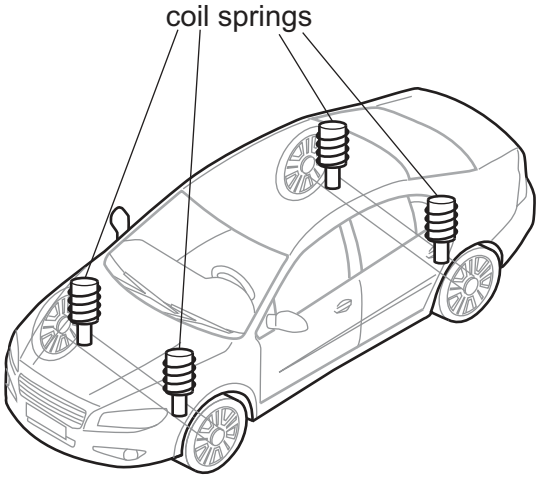


Fig. 6.1

(a) The weight of the car causes compression in the springs. The length of each spring is reduced from its original length.

Hooke's Law can be used for compression as well as extension:

$$F = kx$$

where F = load, k = spring constant and x = compression.

The weight of the car is 17 000 N.

Each spring has a spring constant of 2500 N / cm.

Each spring is reduced to a length of 24 cm.

Calculate the original length of each spring.

original length = ... cm [3]

(b) Ultrasound waves are used to check for cracks in the springs of the car.

Ultrasound waves are high-frequency sound waves.

(i) The frequency of the ultrasound waves is above the audible range of a healthy human ear.

Suggest a frequency for ultrasound waves.

frequency = ... Hz [1]

(ii) Ultrasound waves are longitudinal waves.

Complete the sentences about longitudinal waves.

Longitudinal waves are produced by vibrations which occur ..... to the direction of energy transfer.

Longitudinal waves travel through air in compressions and ..... .
[2]

(iii) A transmitted ultrasound wave travels through the metal of the spring and is reflected by a crack as shown in Fig. 6.2.

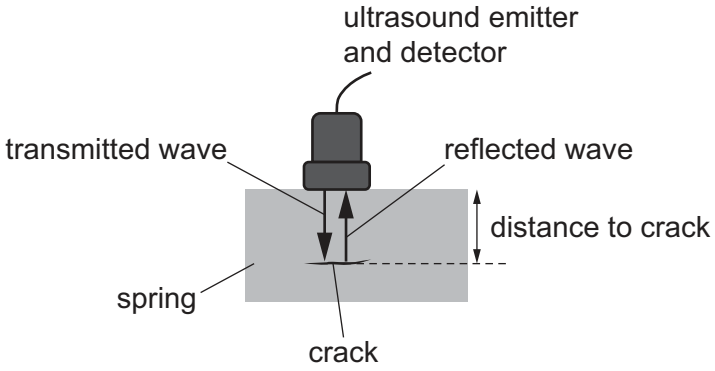


Fig. 6.2

The reflected wave is detected after the transmitted wave is sent, as shown in Fig. 6.3.

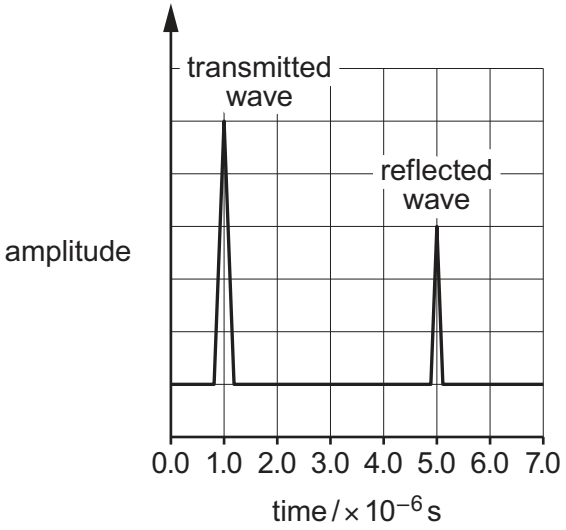


Fig. 6.3

The ultrasound wave travels at 5200 m / s in the metal of the spring.

Use Fig. 6.3 to determine the distance to the crack.

distance = ... m [3]

[Total: 9]

7 **(a)** Fig. 7.1 shows the structure of a villus.

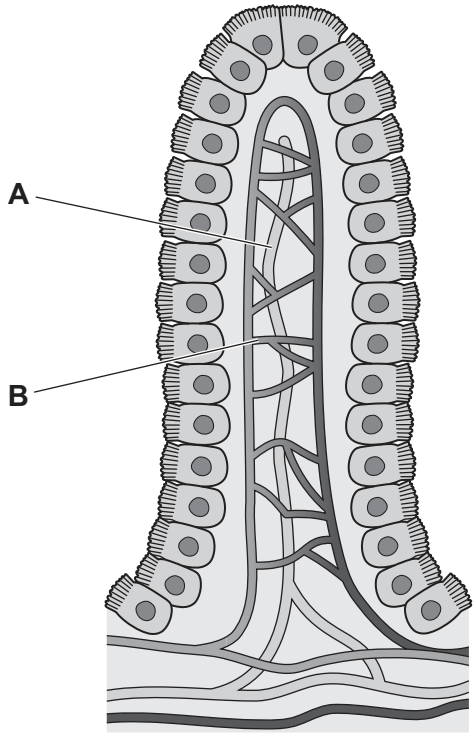


Fig. 7.1

(i) State the name and function of the part labelled **A** in Fig. 7.1.

name .....

function .....

.....

[2]

(ii) Explain how the structure of the part labelled **B** in Fig. 7.1 is adapted for its function.

.....

.....

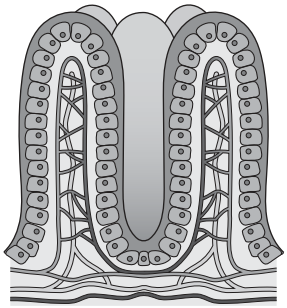
.....

.....

..... [3]

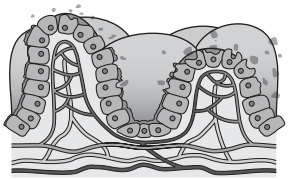
(b) Coeliac disease results in damage to the small intestine when gluten is eaten.

Fig. 7.2 shows villi from a person without coeliac disease and Fig. 7.3 shows villi from a person with coeliac disease.



villi from a person without coeliac disease

Fig. 7.2



villi from a person with coeliac disease

Fig. 7.3

(i) Describe **one** way the shape of the villi in Fig. 7.3 are different from the villi in Fig. 7.2.

.....

..... [1]

(ii) Explain the effect of this difference on villi function in a person with coeliac disease.

.....

.....

.....

..... [2]

(c) Gluten is a type of protein.

(i) State the name of **one** disease caused by protein-energy malnutrition.

..... [1]

(ii) State the chemical test for protein.

..... [1]

(d) Tick (✓) the boxes to show the correct features of mechanical and chemical digestion.

	involves enzymes	occurs in the mouth	produces soluble molecules
mechanical digestion			
chemical digestion			

[2]

[Total: 12]

8 **(a)** Table 8.1 shows some information about the structure of atoms.

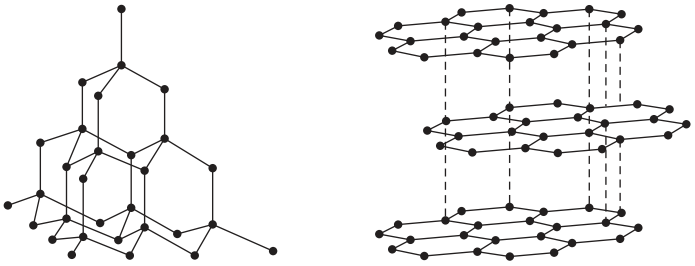
Complete Table 8.1.

Table 8.1

particle	charge	relative mass
electron	–1	.....
neutron	.....	.....
proton	.....	1

[2]

(b) Fig. 8.1 shows two forms of the element carbon, diamond and graphite.



diamond graphite

Fig. 8.1

Put a tick (✓) next to the correct description for the structure of diamond and graphite.

giant covalent ☐

ionic ☐

polymer ☐

metallic ☐

[1]

(c) Graphite is used to make electrodes for electrolysis because it is a good conductor of electricity.

Explain why graphite is a good conductor of electricity.

Use ideas about structure and bonding.

.....

.....

..... [2]

(d) There are different isotopes of the element carbon.

Two of the isotopes are called carbon-12 and carbon-14.

(i) Table 8.2 shows some information about one atom of each of these isotopes of carbon.

Complete Table 8.2.

Table 8.2

	number of protons	number of neutrons	number of electrons
carbon-12	6	.....	6
carbon-14	.....	.....	.....

[2]

(ii) The different isotopes of carbon have the same chemical properties.

Explain why.

.....

..... [1]

(e) Elements are organised in the Periodic Table in groups.

Carbon is in Group IV of the Periodic Table.

Another element, tellurium, is in Group VI of the Periodic Table.

A common compound of tellurium is sodium telluride, Na_2Te.

Put a tick (✓) next to the formula of the tellurium ion in sodium telluride, Na_2Te.

Te^{-} ☐

Te^{+} ☐

Te^{2-} ☐

Te^{2+} ☐

Te^{6-} ☐

[1]

[Total: 9]

9 **(a)** Fig. 9.1 shows distance–time graphs for a car journey and a bicycle journey.

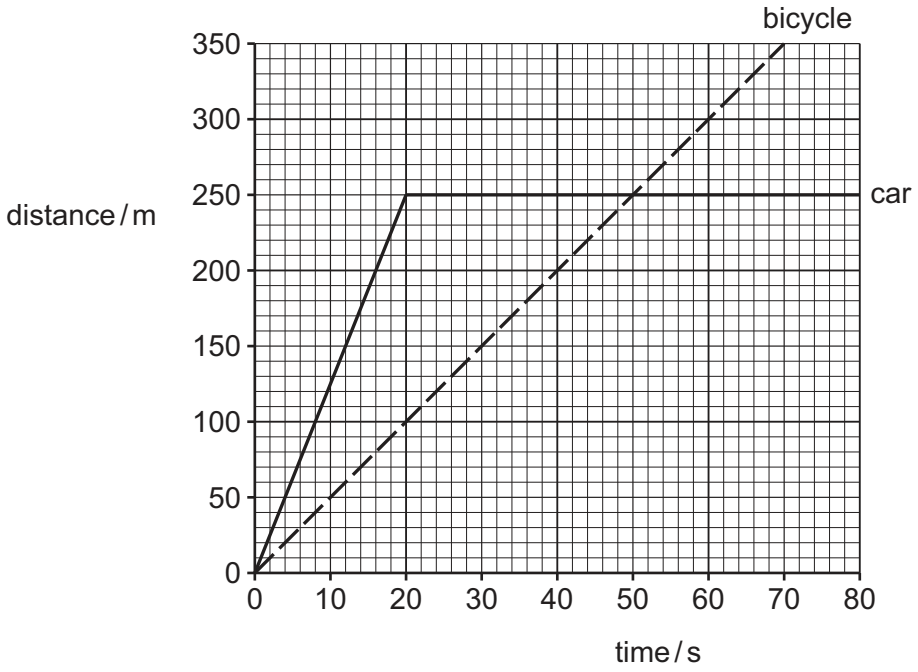


Fig. 9.1

The car and bicycle both start from the same point and travel in the same direction along the same road.

(i) Use Fig. 9.1 to describe the car journey.

.....

.....

..... [2]

(ii) State the time at which the bicycle passes the car.

time = ... s [1]

(iii) The bicycle and rider have a combined mass of 80 kg.

Use Fig. 9.1 to calculate the kinetic energy of the bicycle during this journey.

kinetic energy = ... J [3]

(b) Bicycles are fitted with reflectors which reflect light from car headlights.

Fig. 9.2 shows a diagram of a reflector.

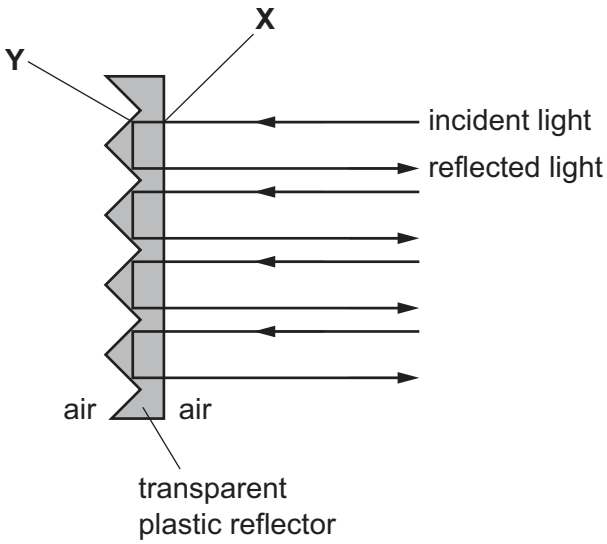


Fig. 9.2

Explain why refraction does **not** occur:

(i) at point **X**.

.....

..... [1]

(ii) at point **Y**.

.....

.....

..... [2]

[Total: 9]

10 A farmer planted some seeds.

(a) Explain why the farmer digs the soil to ensure there are air spaces in the soil before the seeds are planted.

.....

.....

..... [2]

(b) The seeds grow and some of the tips are removed.

Fig. 10.1 shows the shoots after a few days.

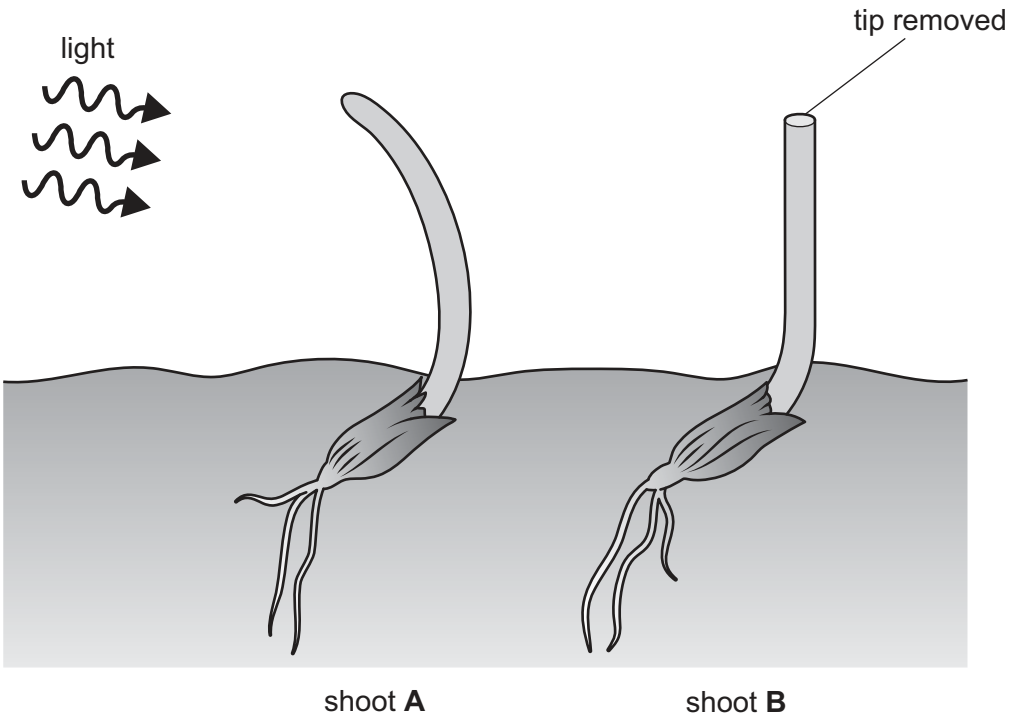


Fig. 10.1

(i) State the name of the tropic response shown by shoot **A** in Fig. 10.1.

..... [1]

(ii) Explain why shoot **B** does **not** grow towards the light in Fig. 10.1.

.....

.....

.....

.....

..... [2]

(c) State the name of the type of selection the farmer could use to improve the quality of crop plants.

..... [1]

(d) The shoots eventually flower.

Fig. 10.2 is a drawing of one of the flowers.

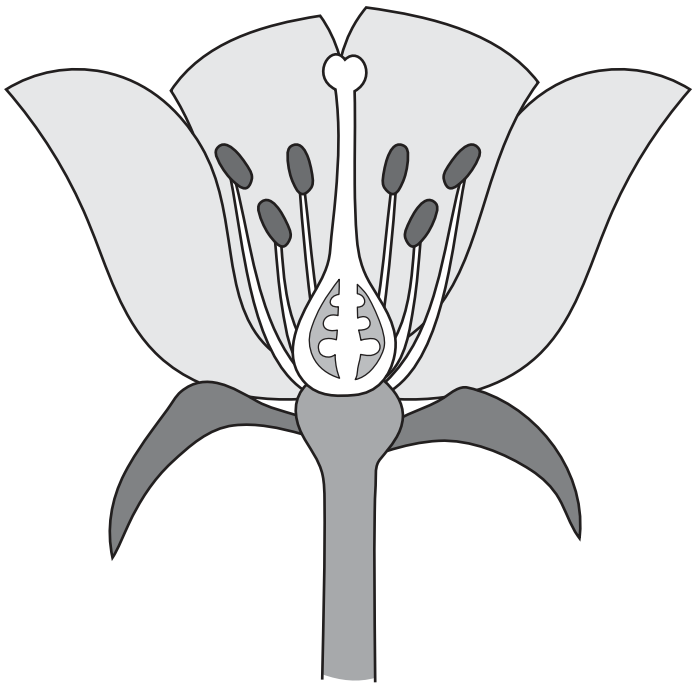


Fig. 10.2

(i) Label the part in Fig. 10.2 that protects the developing flower. Use a label line and the correct name. [2]

(ii) Describe **one** visible feature that shows the flower in Fig. 10.2 is insect-pollinated.

.....

..... [1]

(e) Explain the effect of a magnesium deficiency in the soil on the colour of the plant leaves.

.....

.....

.....

..... [2]

[Total: 11]

11 Fig. 11.1 shows the reactivity series of some metals. The element carbon is also included in the list.

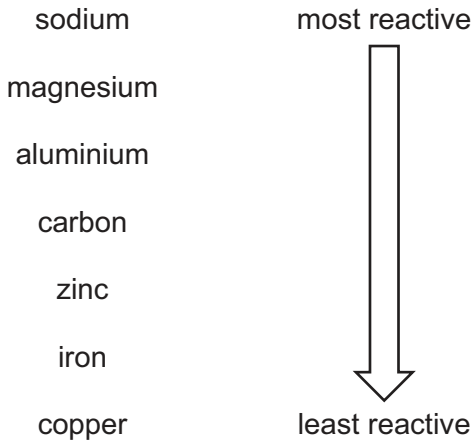


Fig. 11.1

(a) (i) Iron is extracted from the ore hematite by heating with carbon.

Use Fig. 11.1 to state and explain how magnesium is extracted from magnesium ore.

.....

.....

..... [2]

(ii) Sodium is more reactive than magnesium.

Explain why.

.....

..... [1]

(b) Carbon is used to extract an element, **X**, from its oxide.

The equation for the reaction is shown.

$$XO_2 + C \rightarrow X + CO_2$$

The sum of the relative formula masses of the reactants ($XO_2 + C$) is 163.

Calculate the relative atomic mass of **X**.

[A_r: C, 12; O, 16]

relative atomic mass of **X** = ... [2]

(c) Iron is extracted from iron oxide by reacting the iron oxide with aluminium.

The equation for the reaction is shown.

$$2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$$

A mixture contains 162 g of aluminium and 800 g of iron oxide.

Show that aluminium is the limiting reactant.

[A_r: Al, 27; Fe, 56; O, 16]

aluminium is the limiting reactant because .....

.....

..... [3]

(d) Magnesium displaces copper from copper chloride solution.

The ionic equation for the reaction is shown.

$$Mg + Cu^{2+} \rightarrow Mg^{2+} + Cu$$

Explain why the reaction between magnesium atoms and copper ions involves both oxidation and reduction.

.....

.....

..... [2]

(e) Complete the following sentences about oxidising agents and reducing agents.

An oxidising agent is a substance which ..... another substance during a redox reaction.

A reducing agent is a substance which ..... another substance during a redox reaction.

[1]

[Total: 11]

12 Fig. 12.1 shows a diagram of a nuclear power station used to generate electricity.

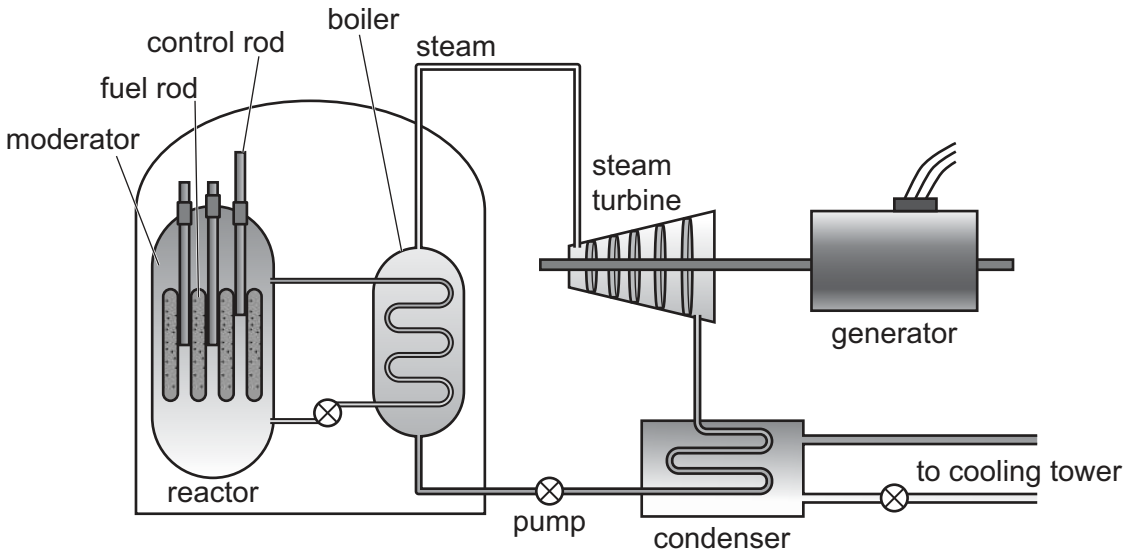


Fig. 12.1

(a) (i) State the process in the reactor that releases energy.

..... [1]

(ii) Complete the sentence about energy resources.

The Sun is the source of energy for all our energy resources except nuclear,

..... and tidal. [1]

(b) (i) Describe, in terms of molecules, how the steam exerts pressure on the walls of the boiler.

.....

.....

.....

..... [2]

(ii) The steam in the boiler has a constant volume.

State what happens to the pressure of the steam if the temperature of the steam is increased.

..... [1]

(c) The power station uses an alternating current (a.c.) generator to generate electricity.

Fig. 12.2 shows a simple a.c. generator.

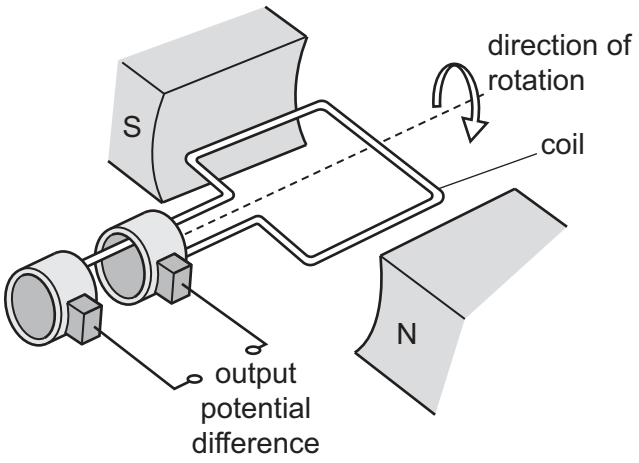


Fig. 12.2

(i) Describe how a simple a.c. generator produces an output potential difference (p.d.).

.....

.....

.....

.....

..... [2]

(ii) The generator converts kinetic energy into electrical energy.

The efficiency of the generator is 75%.

Calculate the kinetic energy required to produce 3600 J of electrical energy.

kinetic energy = ... J [2]

(d) The fuel rod contains uranium-235 ($^{235}_{92}U$).

Uranium-235 decays by alpha emission.

Use correct nuclide notation to complete the decay equation for uranium-235.

$$^{235}_{92}U \rightarrow \text{.....}\,\text{.....}\,Th + \text{.....}\,\text{.....}\,\alpha$$

[2]

[Total: 11]

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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.).