Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME

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CO-ORDINATED SCIENCES **0654/43**

Paper 4 Theory (Extended) **October/November 2025**

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.
- Take the weight of 1.0 kg to be 9.8 N (acceleration of free fall = 9.8 m / s^2).

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.

DC (IP/SG) 352887/2

[Turn over

1 **(a)** Plants and bacteria are made of cells.

State **two** ways the plant cells and bacterial cells are similar and **two** ways that they are different.

similar

1 .....

2 .....

different

1 .....

2 .....

[4]

(b) **(i)** Plant cells can divide by mitosis.

Complete the sentence about mitosis.

The exact replication of ..... occurs before mitosis. [1]

(ii) Plants can reproduce by sexual reproduction.

State **one** advantage and **one** disadvantage of sexual reproduction.

advantage .....

disadvantage .....

[2]

(c) (i) In plants, the flower contains both the male and female gametes.

Fig. 1.1 is a diagram of an insect-pollinated flower.

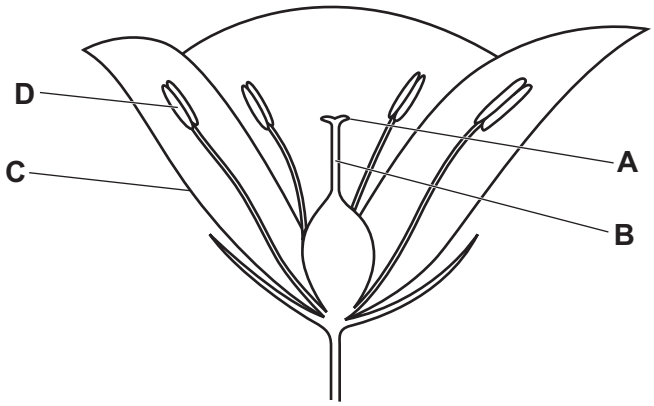

Fig. 1.1

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

A .....

B .....

[2]

(ii) The parts labelled **C** and **D** in Fig. 1.1 would be different in a wind-pollinated flower.

Describe these differences.

C .....

.....

D .....

.....

[2]

(d) State the type of cell division that produces gametes.

..... [1]

[Total: 12]

2 **(a)** Active transport is used in the uptake of mineral ions from the soil into the root hair cells.

(i) Define active transport.

.....

.....

.....

..... [2]

(ii) Magnesium ions and nitrate ions are two mineral ions taken up by active transport.

Explain the importance of magnesium ions and nitrate ions in plants.

magnesium ions .....

.....

nitrate ions .....

.....

[2]

(b) A student investigates the effect of different concentrations of salt solution on plant tissue.

The student cuts pieces of carrot to the same size and mass.

The pieces of carrot are immersed in different concentrations of salt solution for two hours.

After two hours, the student calculates the percentage change in mass of each piece of carrot.

The student's results are shown in Table 2.1.

Table 2.1

concentration of salt solution / mol per dm^3	percentage change in mass
0.0	+20
0.2	+15
0.4	−10
0.6	−28
0.8	−35

(i) Explain the result for the piece of carrot immersed in the **0.0 mol per dm^3** salt solution (pure water).

Use ideas about water potential in your answer.

.....

.....

.....

.....

.....

..... [3]

(ii) Describe the appearance of carrot **cells** immersed in the 0.8 mol per dm^3 salt solution after two hours.

.....

.....

.....

..... [2]

[Total: 9]

3 Fig. 3.1 is a diagram of the heart and associated blood vessels.

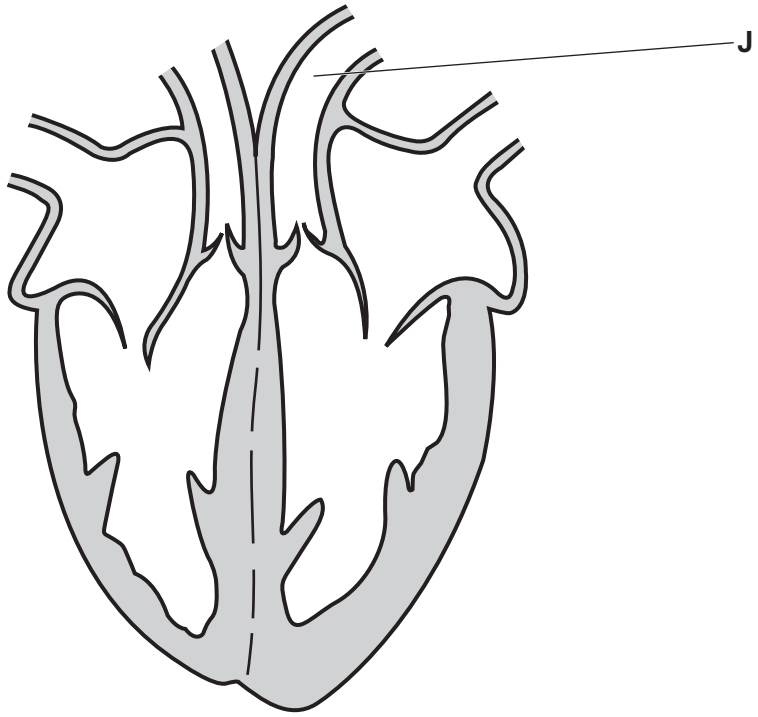

Fig. 3.1

(a) (i) On Fig. 3.1:

- draw a line and the letter **S** to identify the septum
- draw a line and the letter **V** to identify a valve.

[2]

(ii) Explain how blood vessel **J**, an artery, is adapted to its function.

.....

.....

.....

..... [2]

(b) Fig. 3.2 shows some components of the blood.

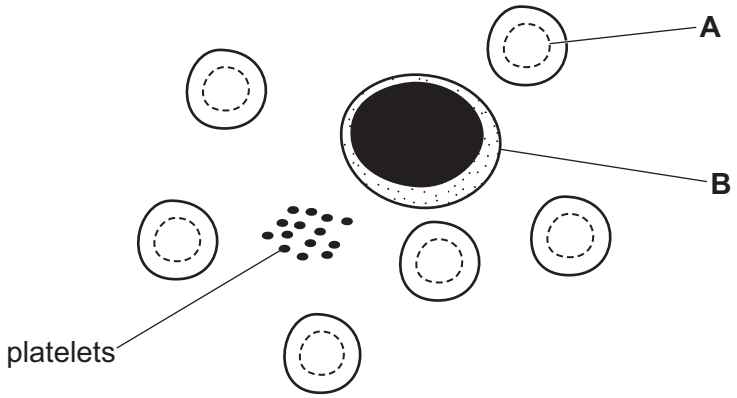

Fig. 3.2

(i) Describe the role of platelets in protecting the body from infection.

.....

.....

..... [2]

(ii) Blood cells and platelets are transported in the plasma of the blood.

State the name of **one other** substance transported by the plasma.

..... [1]

(iii) A person has a very low number of the type of cells labelled **A** in Fig. 3.2.

Explain why this person has difficulty exercising.

.....

.....

.....

.....

..... [3]

(iv) State the function of cell **B** in Fig. 3.2.

.....

..... [1]

[Total: 11]

4 **(a)** Variation occurs in all organisms.

There are two types of variation, continuous variation and discontinuous variation.

Complete Table 4.1 by placing a tick (✓) in each row to show if the description is about continuous or discontinuous variation.

Table 4.1

description	continuous	discontinuous
limited number of phenotypes		
ABO blood groups is one example		
height is one example		

[2]

(b) Antibiotics are used to treat people with bacterial infections.

Some strains of bacteria have become resistant to antibiotics.

Describe how strains of antibiotic-resistant bacteria develop by natural selection.

.....

.....

.....

.....

.....

..... [3]

(c) (i) Many bacteria are decomposers in food chains.

Describe what is meant by a decomposer.

.....

.....

..... [1]

(ii) Energy in food chains is lost through processes such as excretion of urea.

State **two** other ways that energy is lost between one trophic level and the next.

1 .....

.....

2 .....

.....

[2]

[Total: 8]

5 Fig. 5.1 shows the displayed formulas of some organic compounds.

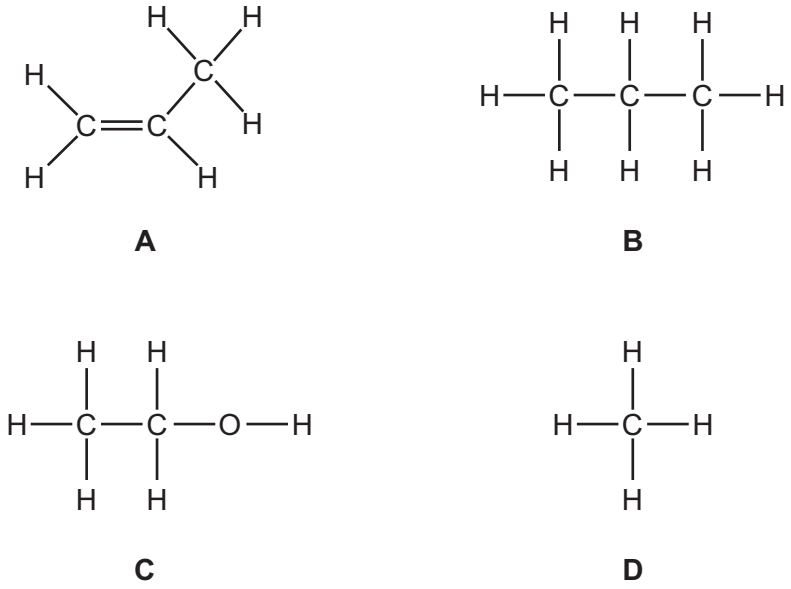

Fig. 5.1

(a) State which compound is **not** a hydrocarbon.

Explain your answer.

compound .....

explanation .....

.....

[2]

(b) Compound **D** is the main constituent of a fossil fuel.

State the name of the fossil fuel.

..... [1]

(c) State the name of compound **B**.

..... [1]

(d) Molecules of compound **A** join together to form a polymer by addition polymerisation.

(i) Complete the structure of the polymer made.

C C

[2]

(ii) Describe **two** differences between addition polymerisation and condensation polymerisation.

1 .....

.....

2 .....

.....

[2]

(e) Compound **B**, C_3H_8, burns in oxygen, O_2.

Carbon dioxide and water are made.

Construct the balanced symbol equation for this reaction.

.....

[2]

[Total: 10]

6 **(a)** Table 6.1 shows some information about the particles in atoms.

Complete Table 6.1.

Table 6.1

particle	relative charge	relative mass
electron	.....	0.0005
neutron	.....	1
proton	+1	.....

[2]

(b) An ion of sodium is shown.

$$^{23}_{11}Na^{+}$$

Complete the sentence about this sodium ion.

This sodium ion contains 11 protons, ... electrons and

..... neutrons.

[2]

(c) Fig. 6.1 shows four symbols.

$$^{32}_{17}Cl \qquad ^{33}_{17}Cl \qquad ^{35}_{18}Cl \qquad ^{37}_{17}Cl$$

Fig. 6.1

State which symbol is **not** an isotope of chlorine.

..... [1]

(d) Chlorine, Cl_2, is a simple molecule.

Draw a dot-and-cross diagram to show the bonding in chlorine.

You only need to show the outer-shell electrons.

[2]

(e) Fig. 6.2 shows a chlorine molecule and a sodium chloride lattice.

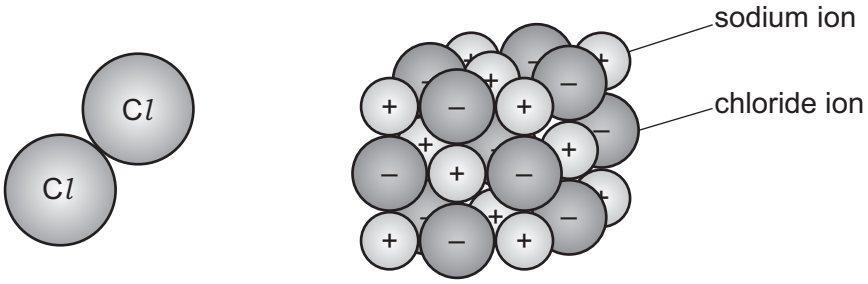

Fig. 6.2

Explain why chlorine is a gas at room temperature but sodium chloride is a solid at room temperature.

Use ideas about:

- the bonding in sodium chloride and in chlorine
- forces.

.....

.....

.....

.....

.....

..... [3]

[Total: 10]

7 A student investigates the decomposition of hydrogen peroxide, H_2O_2.

The equation for the reaction is shown.

$$2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$$

(a) Describe a test and its positive result to identify the gas made in the reaction.

test .....

result .....
[2]

(b) The student uses manganese(IV) oxide as a catalyst in the reaction.

The catalyst speeds up the reaction.

State why the catalyst speeds up the reaction.

.....

.....

..... [1]

(c) The student measures the total volume of gas made every minute.

The student does the experiment using manganese(IV) oxide powder.

The student repeats the experiment using manganese(IV) oxide lumps.

Fig. 7.1 shows a graph of the student's results.

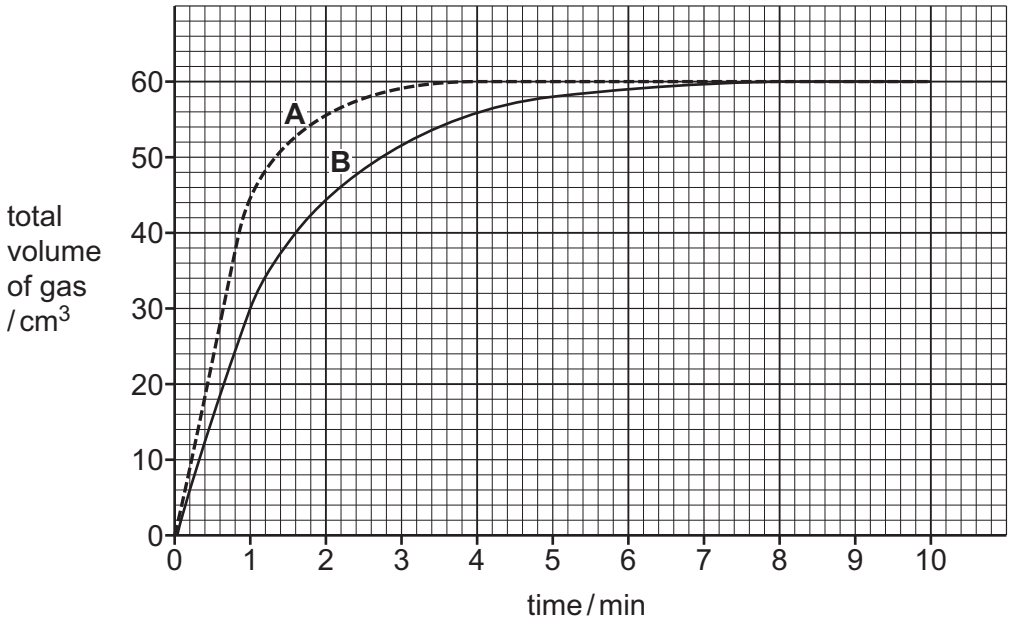

Fig. 7.1

State which line, **A** or **B**, shows the results using manganese(IV) oxide powder.

Use the graph to explain your answer.

line .....

explanation .....

.....

.....

.....

.....

[2]

(d) The decomposition of hydrogen peroxide is **highly exothermic**.

(i) Complete Fig. 7.2 to show an energy level diagram for the reaction.

Label the **activation energy** and the **energy change** (enthalpy change) on your diagram.

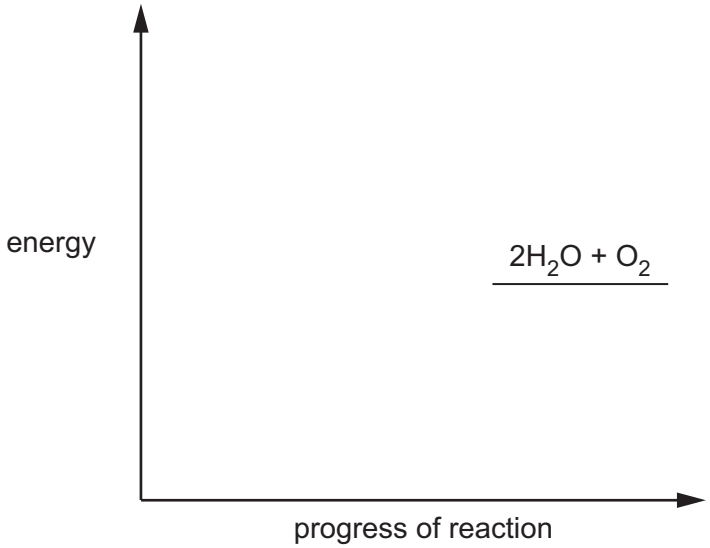

Fig. 7.2

[3]

(ii) Suggest the enthalpy change, ΔH, for the decomposition reaction.

Tick (✓) one box.

+56 kJ / mol ☐

+219 kJ / mol ☐

0 kJ / mol ☐

−196 kJ / mol ☐

[1]

[Total: 9]

8 Iron is extracted from hematite by reduction of iron(III) oxide in a blast furnace.

(a) Iron(III) oxide reacts with carbon monoxide.

Complete the equation for the reduction of iron(III) oxide.

$Fe_2O_3 + 3CO \rightarrow$ ..... + ...

[2]

(b) The iron made in the blast furnace is an alloy containing about 90–95% iron.

Fig. 8.1 shows pure iron and the iron made in the blast furnace.

pure iron

iron made in the blast furnace

Fig. 8.1

(i) Complete the sentences.

Pure iron is an element because .....

..... .

Iron from the blast furnace is a mixture because .....

..... .

[2]

(ii) Iron from the blast furnace is harder than pure iron.

Explain why. Use Fig. 8.1 to help you.

.....

.....

.....

..... [2]

(iii) Pure iron is very malleable.

Explain why. Use Fig. 8.1 to help you.

.....

..... [1]

(c) Calcium carbonate, $CaCO_3$, is added to the blast furnace to remove impurities.

(i) The calcium carbonate is heated to make calcium oxide, CaO.

The equation for the reaction is shown.

$$CaCO_3 \rightarrow CaO + CO_2$$

State the name of the type of reaction that occurs.

..... [1]

(ii) The calcium oxide reacts with silicon dioxide, SiO_2, which is an impurity in the iron ore, to make calcium silicate.

$$CaO + SiO_2 \rightarrow CaSiO_3$$

Calculate the minimum mass of calcium oxide needed to remove 720 tonnes of silicon dioxide.

[A_r: Ca, 40; O, 16; Si, 28]

mass of calcium oxide = ... tonnes [2]

(iii) Fig. 8.2 shows the structure and bonding in silicon dioxide.

The structure and bonding is similar to diamond.

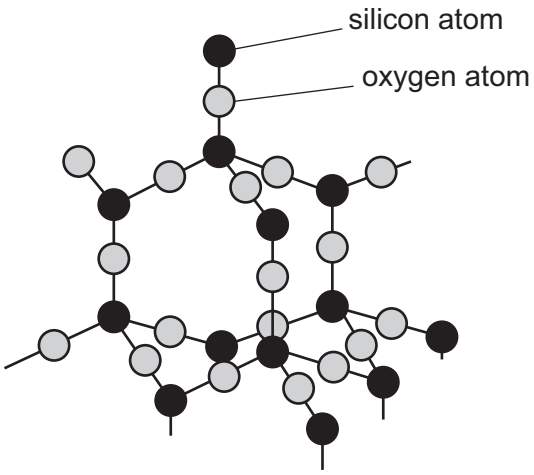

Fig. 8.2

State the type of structure and bonding in silicon dioxide.

Choose from the list.

giant ionic

giant covalent

giant metallic

simple covalent

..... [1]

[Total: 11]

9 **(a)** A simple torch (flashlight) is made from a battery connected to a lamp.

(i) State the name of the energy store in the battery.

..... [1]

(ii) Describe how energy is transferred from this store to the lamp when the lamp is lit.

.....

..... [1]

(b) A ball of mass 0.56 kg is dropped from a height of 9.4 m above the ground.

(i) Calculate the gravitational potential energy transferred by the ball.

gravitational potential energy = ... J [2]

(ii) Calculate the speed at which the ball hits the ground.

Air resistance is negligible.

speed = ... m/s [2]

(c) **(i)** The ball rebounds to a height of 8.2 m.

Air resistance is negligible.

Suggest why the ball does not reach a height of 9.4 m after it bounces.

.....

.....

..... [2]

(ii) Calculate the percentage efficiency of the energy transfer in the bounce.

percentage efficiency = ... % [2]

[Total: 10]

10 (a) A sealed syringe contains a sample of gas as shown in Fig. 10.1.

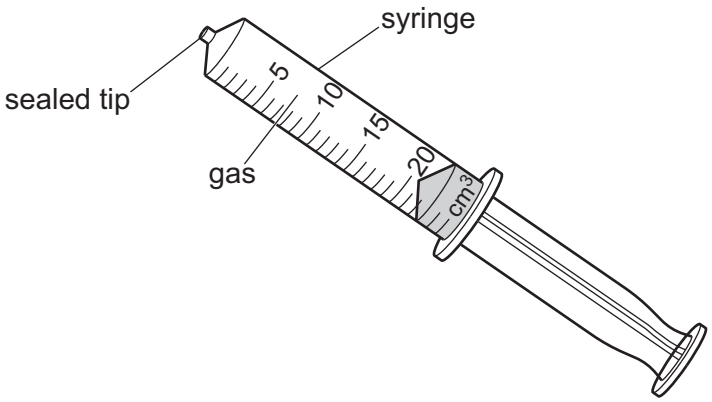

Fig. 10.1

(i) State, in terms of particles, what causes pressure of a gas.

.....

.....

..... [2]

(ii) The gas in the syringe is heated.

State the change, if any, to the average speed of the particles.

..... [1]

(iii) The volume of the gas is kept constant as it is heated.

Explain, in term of particles, why the pressure of the gas increases.

.....

.....

..... [2]

(b) (i) State the name of the state of matter in which sound travels fastest.

..... [1]

(ii) Ultrasound waves can be used to produce images of unborn babies inside the human body, as shown in Fig. 10.2.

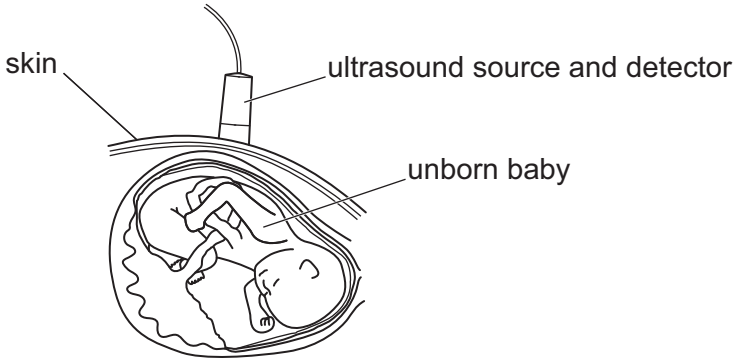

Fig. 10.2

State the lowest frequency of ultrasound waves.

..... [1]

(iii) A pulse of ultrasound is sent into a person from an ultrasound source at the surface of the skin.

Ultrasound travels at 1500 m / s inside human bodies.

A reflection arrives back at the surface of the skin after 8.0×10^{-5} s.

Calculate the depth below the surface at which the reflection was caused.

depth = ... m [3]

[Total: 10]

11 **(a)** **(i)** State the age of the Universe according to the Big Bang Theory.

..... [1]

(ii) State how the Universe began according to the Big Bang Theory.

.....

..... [2]

(b) The distance between Earth and Mars varies between 5.6×10^{10} m and 4.0×10^{11} m.

Calculate the shortest possible time for light to travel from Earth to Mars.

time = ... s [2]

(c) **(i)** New elements form during radioactive decay.

$^{210}_{84}Po$ is radioactive. It decays by emitting an alpha particle.

Complete the equation for this nuclear decay.

$$^{210}_{84}Po \rightarrow \overset{.....}{\underset{.....}{\quad}} Pb + \overset{.....}{\underset{.....}{\quad}} \alpha$$

[2]

(ii) Initially a sample of $^{210}_{84}Po$ has a mass of 560 g.

The half-life of $^{210}_{84}Po$ is 3.1 minutes.

Calculate the mass of $^{210}_{84}Po$ remaining after 12.4 minutes.

mass = ... g [2]

[Total: 9]

12 (a) (i) Describe the construction of a step-up transformer.

You may wish to draw a labelled diagram.

.....

.....

..... [2]

(ii) A step-up transformer reduces the current in an electricity transmission wire from 20 000 A to 500 A.

Calculate the power lost in a wire with resistance 0.60 Ω when the current is 500 A.

power lost = ... W [2]

(b) An electrical current can be either direct or alternating.

State the difference between direct current (d.c.) and alternating current (a.c.).

.....

.....

..... [1]

(c) Fig. 12.1 shows a simple a.c. generator used to produce electricity.

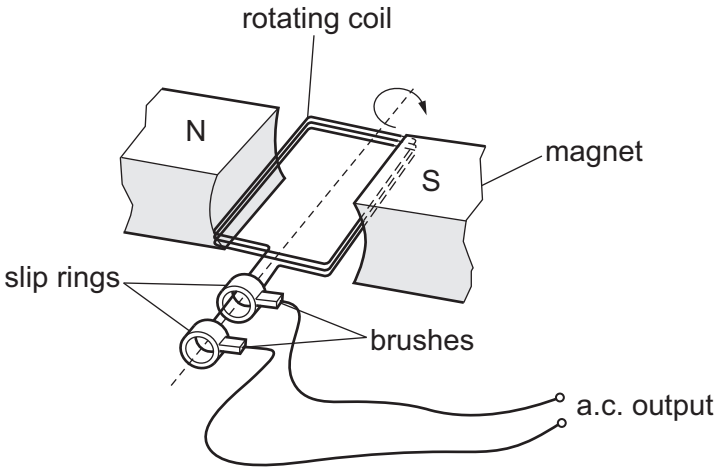

Fig. 12.1

(i) Explain why slip rings are required.

.....

.....

..... [2]

(ii) The coil in the generator is rotated at a constant speed.

On Fig. 12.2 sketch a graph of e.m.f. against time for the output of the a.c. generator.

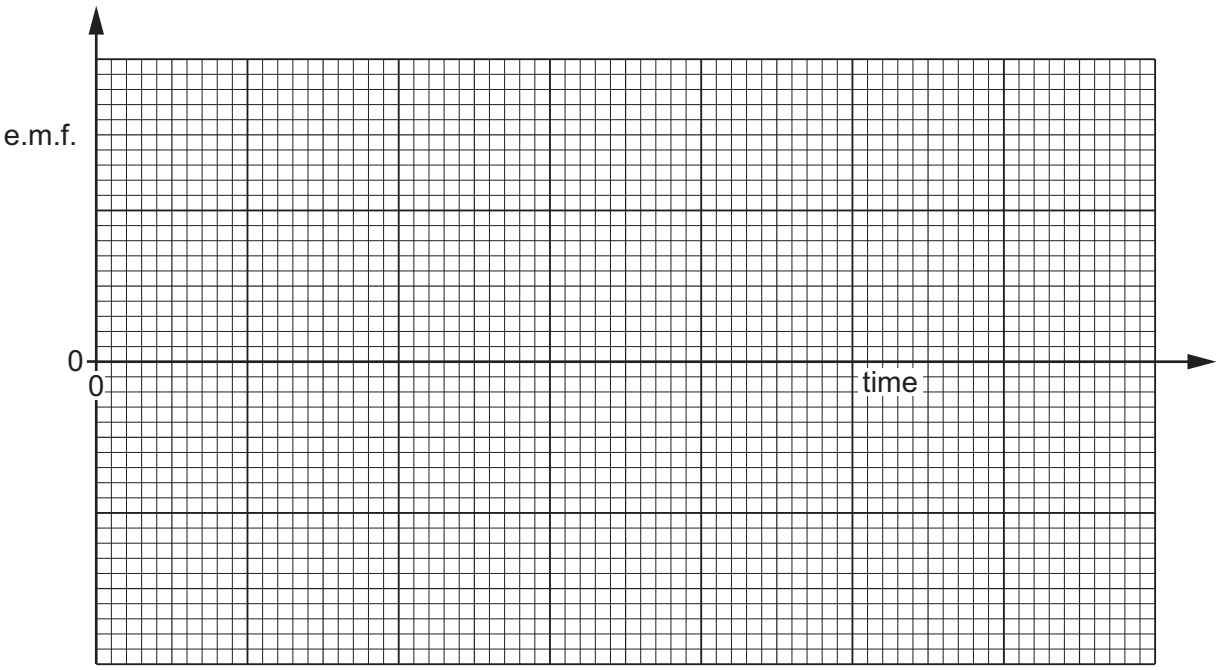

Fig. 12.2

[2]

(iii) The speed of rotation of the coil in the generator is doubled.

Describe how the e.m.f. against time graph changes.

.....

.....

..... [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.).