Cambridge Assessment International Education

Cambridge IGCSE™

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

CO-ORDINATED SCIENCES **0654/43**

Paper 4 Theory (Extended) **October/November 2020**

2 hours

You must answer on the question paper.

No additional materials are needed.

INSTRUCTIONS

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

INFORMATION

- The total mark for this paper is 120.
- The number of marks for each question or part question is shown in brackets [ ].
- The Periodic Table is printed in the question paper.

This document has **28** pages. Blank pages are indicated.

[Turn over

1 A scientist investigates the effect of light intensity, carbon dioxide concentration and temperature on the rate of photosynthesis on the same plant.

Fig. 1.1 is a graph of the results.

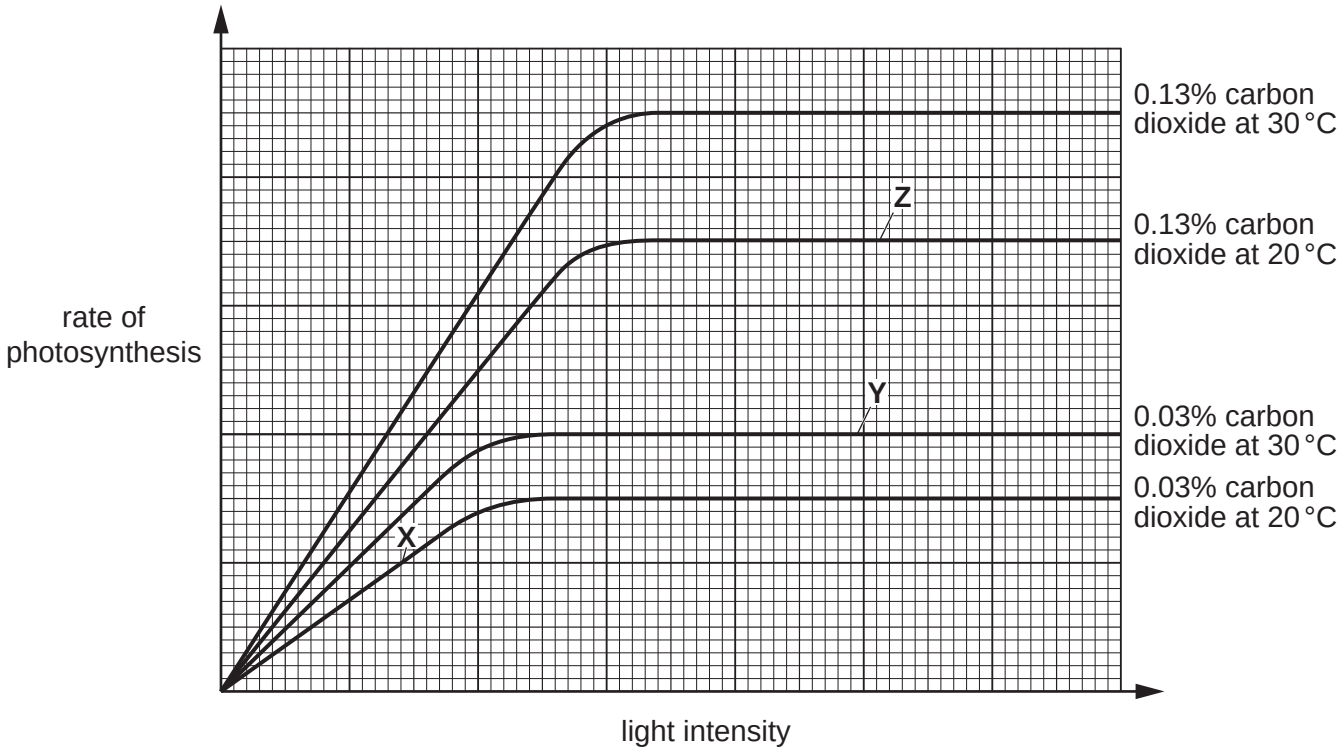

Fig. 1.1

(a) (i) Describe how light intensity affects the rate of photosynthesis as shown in Fig. 1.1.

.....

.....

.....

..... [2]

(ii) State the factor that is limiting the rate of photosynthesis at:

X .....

Y .....

Z. .....
[3]

(b) Photosynthesis is an enzyme-controlled reaction.

The investigation is repeated at a temperature of 80 °C.

State and explain how this will affect the rate of photosynthesis.

.....

.....

.....

.....

.....

..... [3]

(c) State the balanced equation for photosynthesis.

..... [2]

(d) Explain why chlorophyll is needed for photosynthesis.

.....

.....

.....

..... [2]

[Total: 12]

2 Ammonium sulfate is a fertiliser.

The formula of ammonium sulfate is $(NH_4)_2SO_4$.

(a) Calculate the relative formula mass, M_r, of ammonium sulfate.

[A_r: H, 1; N, 14; O, 16; S, 32]

relative formula mass = ... [1]

(b) Ammonium sulfate is made by reacting ammonia with sulfuric acid.

Write a balanced symbol equation for this reaction.

..... [2]

(c) Potassium sulfate, K_2SO_4, is another fertiliser.

In an experiment, 22.4 g of potassium hydroxide, KOH, dissolved in distilled water, reacts with 19.6 g of sulfuric acid to make potassium sulfate.

(i) Calculate the number of moles of potassium hydroxide and the number of moles of sulfuric acid that react.

[A_r: H, 1; K, 39; O, 16; S, 32]

number of moles of potassium hydroxide = ...

number of moles of sulfuric acid = ...
[2]

(ii) Using your answers from part **(c)(i)**, deduce the balanced symbol equation for the reaction.

Show your working.

..... [3]

(d) Ammonia is used in the manufacture of some fertilisers.

Ammonia is made in the Haber process.

$$\text{nitrogen} + \text{hydrogen} \rightleftharpoons \text{ammonia}$$

Fig. 2.1 shows the percentage of ammonia made using different conditions of temperature and pressure.

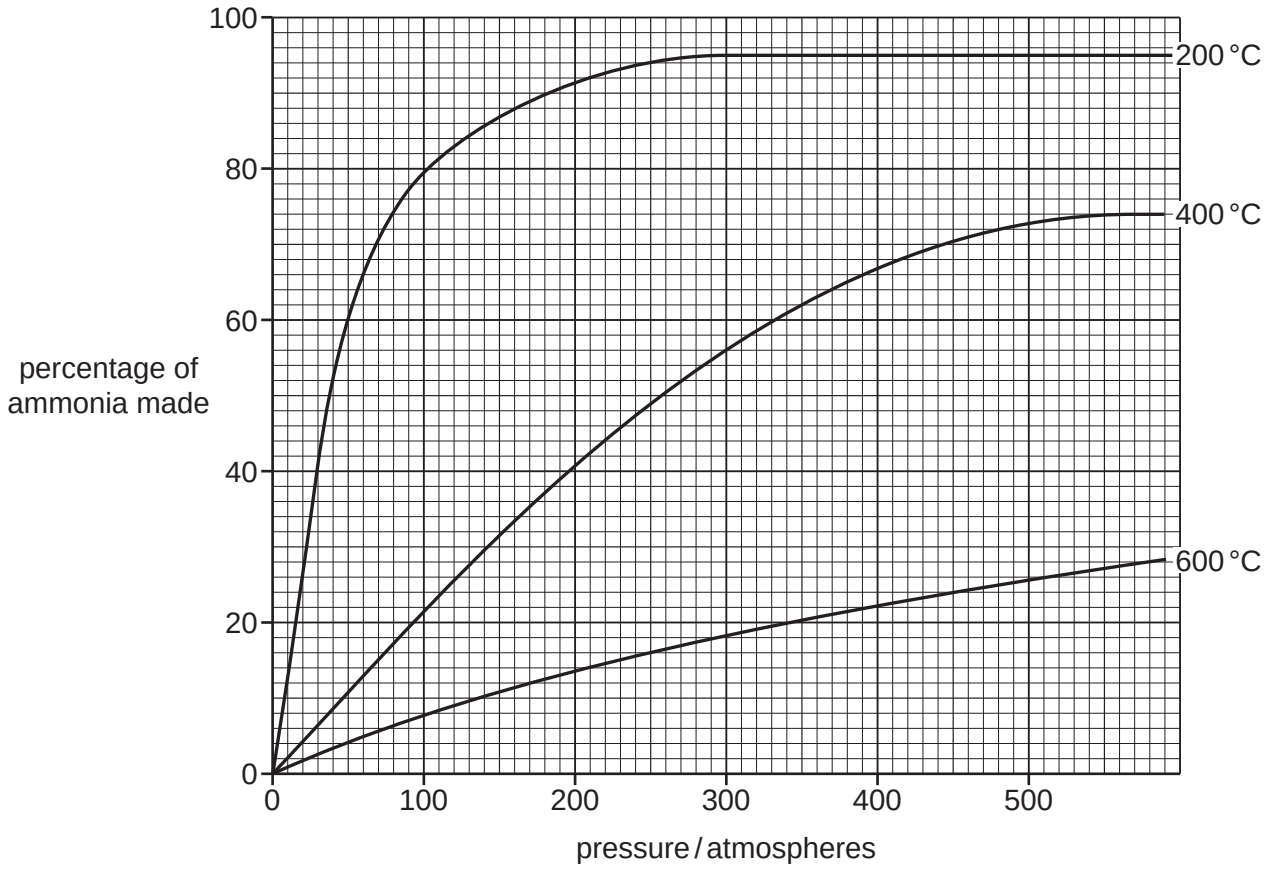

Fig. 2.1

The highest percentage of ammonia is made at 200 °C and 300 atmospheres pressure.

However, in an ammonia factory, a temperature of 450 °C and 200 atmospheres pressure are used.

Explain why.

Use ideas about the percentage of ammonia made and the rate of reaction.

.....

.....

.....

.....

..... [3]

[Total: 11]

3 **(a)** A flea is a small insect.

A student uses a magnifying glass to observe a flea.

The magnifying glass produces a virtual image.

Describe the difference between a real image and a virtual image.

.....

..... [1]

(b) **(i)** The flea jumps upwards from rest. The speed of the flea increases to 1.2 m/s in 0.001 s.

State the difference between the terms *speed* and *velocity*.

.....

.....

..... [1]

(ii) Calculate the acceleration of the flea.

acceleration = ... m/s^2 [2]

(iii) The flea has a mass of 0.0005 g.

Calculate the force causing this acceleration.

force = ... N [3]

[Total: 7]

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4 **(a)** Fig. 4.1 is a diagram of the blood vessels in the placenta of the mother and her fetus.

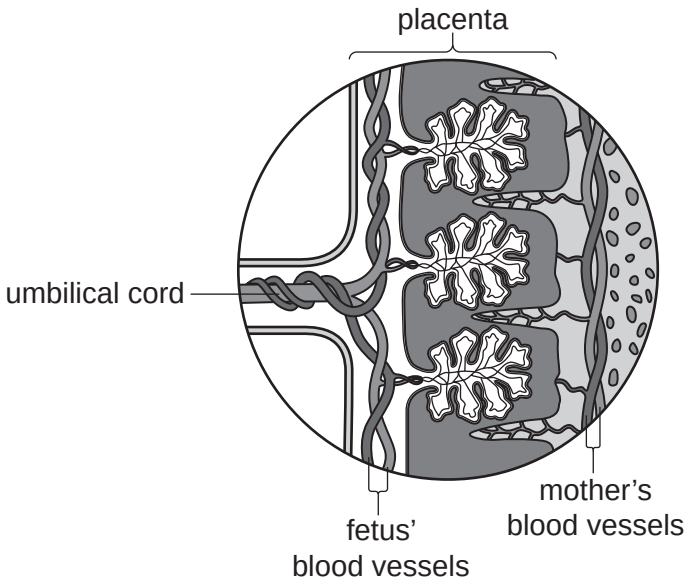


Fig. 4.1

(i) Oxygen moves across the placenta from the mother's blood to the blood of the fetus.

Suggest the name of **one** substance that moves in the opposite direction.

..... [1]

(ii) Oxygen moves across the placenta by diffusion.

Define *diffusion*.

.....

.....

.....

..... [2]

(iii) The placenta is a gas exchange surface.

Suggest **two** features of the placenta that enable efficient gas exchange.

1 .....

2 .....
[2]

(iv) Name the part of the female reproductive system where:

- the fetus develops

  .....

- fertilisation occurs

  .....

- the female gametes are released.

  .....
[3]

(b) The process of mitosis is used for growth.

(i) State **two other** uses of mitosis.

1 .....

2 .....
[2]

(ii) The chromosomes inside the nuclei of cells produced by mitosis are different to those produced by meiosis.

Describe **two** of these differences.

1 .....

.....

2 .....

.....
[2]

[Total: 12]

5 **(a)** Look at the list of atomic symbols.

Br Cu K Mg

N Ne Zn

Answer the following questions choosing from the list of atomic symbols.

Each symbol can be used **once**, **more than once** or **not at all**.

(i) State the symbol for an element with a full outer shell of electrons.

..... [1]

(ii) State the symbol of the element with the electronic structure 2,8,2.

..... [1]

(iii) State the symbols of **two** elements that form basic oxides.

..... and ..... [1]

(b) The symbol of an isotope of oxygen is $^{18}_{8}O$.

Fig. 5.1 shows the nucleus of an atom of $^{18}_{8}O$.

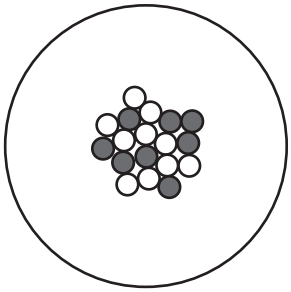


Fig. 5.1

State the name of the particle shown by

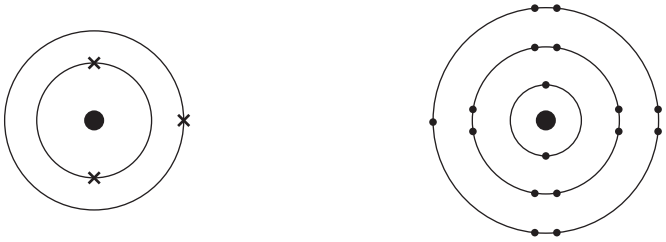
(i) ● ..... [1]

(ii) ○ ..... [1]

(iii) Draw a similar diagram to Fig. 5.1 to show a **different** isotope of oxygen.

[1]

(c) Fig. 5.2 shows the electronic structures of a lithium atom and of a chlorine atom.



lithium atom chlorine atom

Fig. 5.2

When lithium reacts with chlorine a lithium ion and a chloride ion are made.

Draw dot-and-cross diagrams to show the electronic structures of a lithium ion and of a chloride ion.

Include the charge on each ion.

lithium ion chloride ion [2]

[Total: 8]

6 **(a)** A boat has a mass of 2000 kg.

(i) State the kinetic energy of the boat when the boat is not moving.

kinetic energy = ... J [1]

(ii) Calculate the kinetic energy of the boat when it moves at a constant speed of 11 m/s.

kinetic energy = ... J [2]

(b) The boat reaches the entrance to a harbour.

Fig. 6.1 shows five wavefronts approaching the narrow harbour entrance.

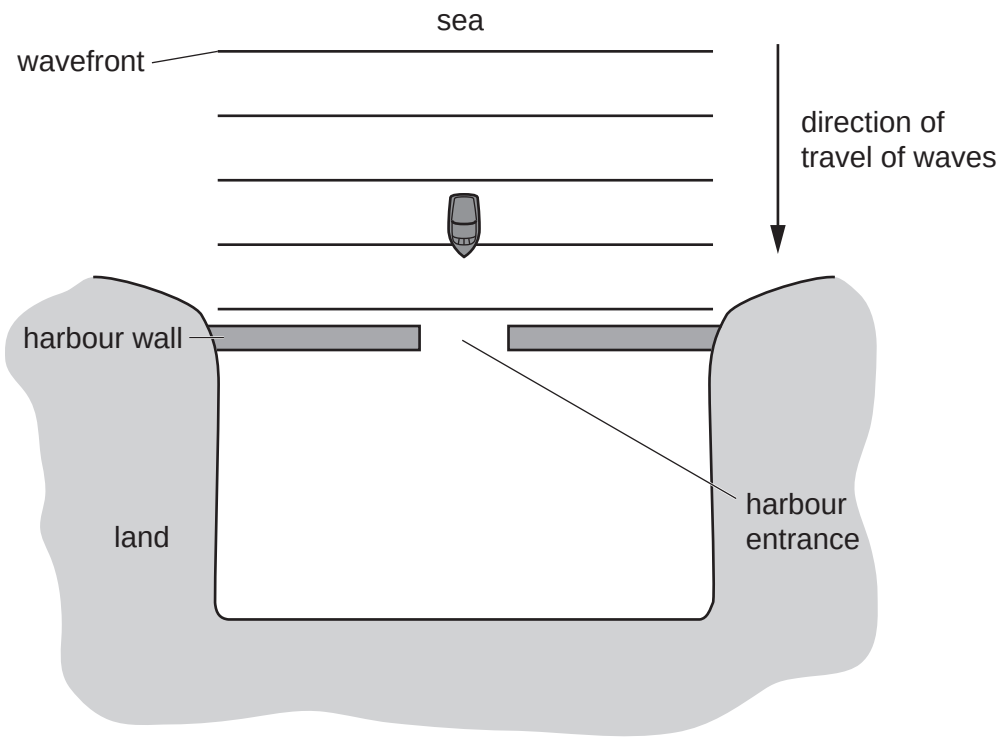


Fig. 6.1

On Fig. 6.1, draw **two** wavefronts after they pass through the harbour entrance. [2]

(c) There is water on the deck of the boat.

The water slowly evaporates.

State **two** conditions that could change so that the water evaporates faster.

1 .....

2 .....
[2]

(d) A seabird of mass 1.2 kg lands on the deck of the boat. The total area of the seabird's two feet in contact with the deck is 5.4 cm^2.

Calculate the pressure exerted by the seabird on the deck when it is standing on two feet.

The gravitational field strength g is 10 N / kg.

pressure = ... N / cm^2 [3]

[Total: 10]

7 **(a)** Table 7.1 shows the deficiency diseases of children of different ages admitted to a hospital.

Table 7.1

	number of children				
deficiency disease	0–12 months	13–24 months	25–36 months	37–48 months	49–60 months
kwashiorkor	19	16	3	1	1
marasmus	48	24	2	0	0

(i) Describe the general trends seen in Table 7.1.

.....

.....

.....

..... [2]

(ii) A total of 212 children were admitted to the hospital.

Calculate the percentage of these children with kwashiorkor.

.....% [2]

(b) Treatment of kwashiorkor and marasmus includes an increase of **one** particular nutrient in the diet.

State the name of this nutrient.

..... [1]

(c) Fig. 7.1 is a photograph of a person with a deficiency disease called rickets.

Fig. 7.1

State and explain the cause of the appearance of the person shown in Fig. 7.1.

.....

.....

.....

..... [2]

(d) Describe the importance of fibre in the diet.

.....

..... [1]

(e) A diet containing too much fat can cause coronary heart disease.

State **two other** risk factors for coronary heart disease.

1 .....

2 .....

[2]

[Total: 10]

8 Fig. 8.1 shows the structures of ethene and of ethanol.

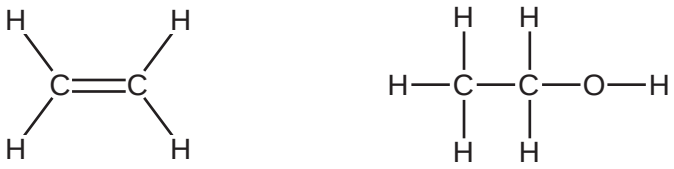


Fig. 8.1

(a) Ethene is an unsaturated hydrocarbon.

Explain the meanings of the underlined words.

unsaturated .....

.....

hydrocarbon .....

.....

[2]

(b) Ethene has a simple molecular structure.

Ethene does **not** dissolve in water.

State **one other** physical property of substances with a simple molecular structure.

..... [1]

(c) Ethanol is an alcohol made by fermentation.

(i) Ethanol is used in alcoholic drinks.

State another **use** for ethanol.

..... [1]

(ii) Describe how ethanol is made by fermentation.

.....

.....

.....

.....

..... [4]

[Total: 8]

9 **(a)** Fig. 9.1 shows a bicycle with a front lamp **F** and a rear lamp **R**, powered by a 9 V generator (dynamo).

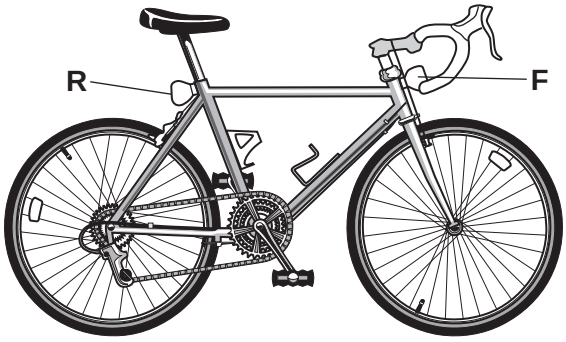


Fig. 9.1

Fig. 9.2 shows the circuit diagram for the lamps.

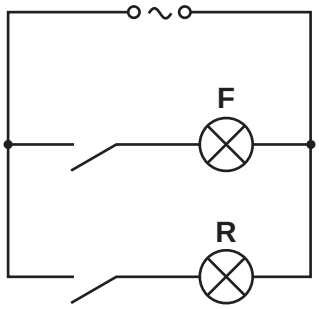


Fig. 9.2

Lamp **F** has a resistance of 12 Ω and lamp **R** has a resistance of 6 Ω.

(i) Calculate the combined resistance of the **two** lamps in this circuit.

resistance = ... Ω [2]

(ii) Lamp **R** is switched on.

Show that the current in lamp **R** is 1.5 A.

[2]

(iii) Calculate the charge that passes through lamp **R** in 300 seconds.

State the unit of your answer.

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

(iv) The generator supplies an alternating current to light the lamps.

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

.....

.....

..... [1]

(v) State the useful energy transformation that occurs in the generator.

from ..... energy to .....energy [1]

(vi) State the useful energy transformation that occurs in the lamp.

from ..... energy to .....energy [1]

(b) The generator is noisy and emits sound waves that pass through the air.

Sound waves are longitudinal waves and visible light waves are transverse waves.

(i) Give **one** other example of a transverse wave.

..... [1]

(ii) The sound waves pass through the air as a series of compressions (**C**) and rarefactions (**R**).

Fig. 9.3 shows the positions of the compressions and rarefactions as the sound wave passes through the air.

Fig. 9.3

On Fig. 9.3, mark **one** wavelength with a double headed arrow (◄——►). [1]

(iii) Describe how the distance between two compressions changes if the frequency of the sound wave increases.

.....

..... [1]

[Total: 13]

10 Increasing the concentration of nitrate ions in freshwater can cause eutrophication.

(a) State **two** sources of nitrate ions which cause water pollution.

1 .....

2 .....
[2]

(b) Complete the sentences to explain how an increase in nitrate ions in water causes eutrophication.

The increased availability of nitrate ions increases the growth of ..... on the surface of the water.

Underwater plants cannot receive light and so cannot photosynthesise.

Underwater plants die and are broken down by ..... .

This causes an increase in ..... respiration.

Dissolved ..... concentration in the water decreases, which causes aquatic organisms to die.
[4]

[Total: 6]

11 **(a)** The equations **A**, **B**, **C** and **D** represent four possible reactions.

equation **A** $Zn + Cu^{2+} \rightarrow Zn^{2+} + Cu$

equation **B** $Cu - 2e^{-} \rightarrow Cu^{2+}$

equation **C** $Cu^{2+} + 2e^{-} \rightarrow Cu$

equation **D** $Cu^{2+} + 2OH^{-} \rightarrow Cu(OH)_2$

(i) State which equation **A**, **B**, **C** or **D** represents **only** oxidation.

..... [1]

(ii) State which equation **A**, **B**, **C** or **D** represents **both** oxidation **and** reduction.

..... [1]

(iii) Copper is purified by using electrolysis of copper sulfate solution.

Fig. 11.1 shows the apparatus used.

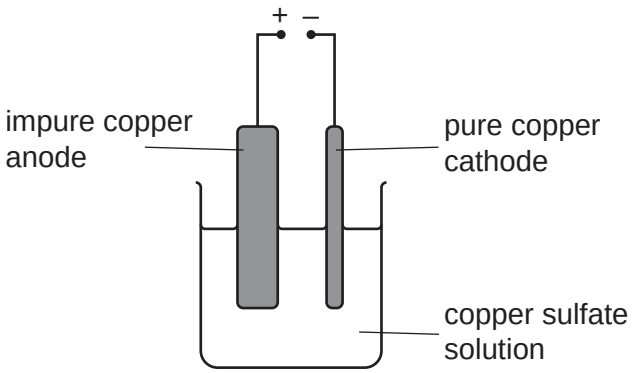


Fig. 11.1

State which equation **A**, **B**, **C** or **D** represents the reaction that takes place at the cathode.

..... [1]

(b) Copper is extracted from copper oxide by heating copper oxide with carbon.

$$2CuO + C \rightarrow 2Cu + CO_2$$

CuO acts as an oxidising agent in this reaction.

Define the term *oxidising agent*.

.....

..... [1]

(c) Aluminium is extracted from its purified ore by electrolysis.

Fig. 11.2 shows the equipment that is used.

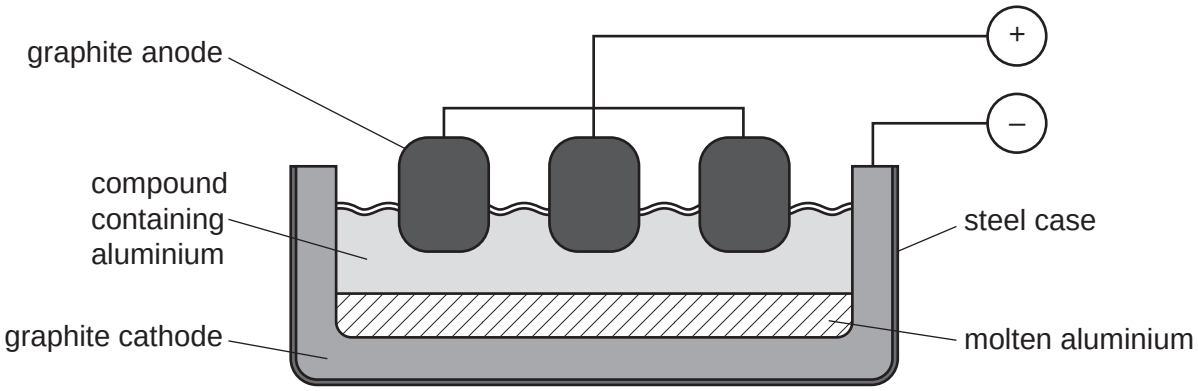


Fig. 11.2

Describe how aluminium is extracted from its purified ore.

Include in your answer:

- the name of the compound containing aluminium
- what is made at each electrode.

.....

.....

.....

..... [3]

[Total: 7]

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12 **(a)** Fig. 12.1 shows a hot water storage tank in a house.

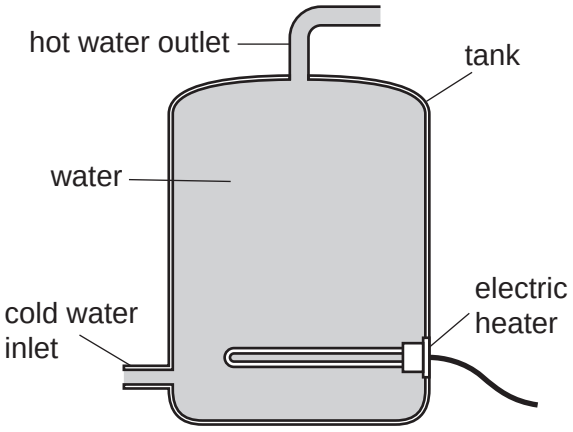


Fig. 12.1

The water is heated by an electric heater placed near the bottom of the tank. Cold water enters at the bottom of the tank and hot water leaves at the top of the tank.

Explain why all the water in the tank is heated by convection.

.....

.....

.....

..... [3]

(b) The house is fitted with a smoke detector. The smoke detector contains a radioactive isotope of americium-241.

Americium-241 decays by α-particle emission.

(i) Explain why it is safe to use this isotope of americium near people in the house.

.....

..... [1]

(ii) Use nuclide notation to complete the symbol equation for the α-decay process.

$$^{241}_{95}\text{Am} \longrightarrow {}^{\text{.....}}_{\text{.....}}\text{Np} + {}^{\text{.....}}_{\text{.....}}\text{.....}$$

[4]

(c) There is a rechargeable electric toothbrush in the bathroom of the house.

Fig. 12.2 shows the electric toothbrush and the charger.

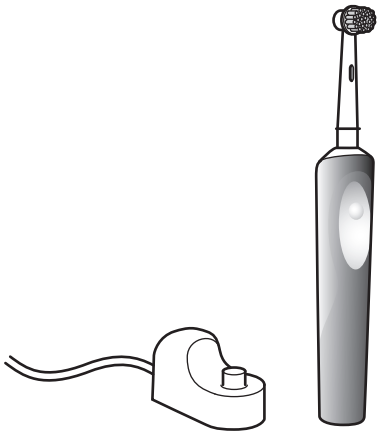


Fig. 12.2

In the charger, there is a transformer that steps down the voltage from 220 V to 2.4 V.

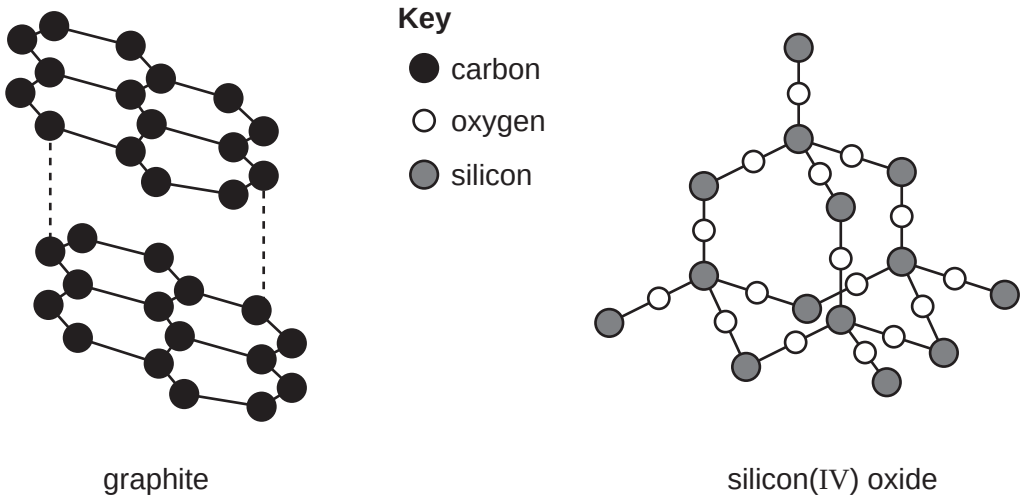
The primary coil of the transformer has 5000 turns.

Calculate the number of turns on the secondary coil.

number of turns = ... [2]

[Total: 10]

13 Fig. 13.1 shows the structures of graphite and of silicon(IV) oxide.



graphite

silicon(IV) oxide

Fig. 13.1

(a) Graphite is used as a lubricant.

Explain why.

Use ideas about the structure and bonding in graphite.

.....

.....

..... [2]

(b) State **one similarity** between the structure of graphite and the structure of silicon(IV) oxide.

.....

..... [1]

(c) Look at Fig. 13.2.

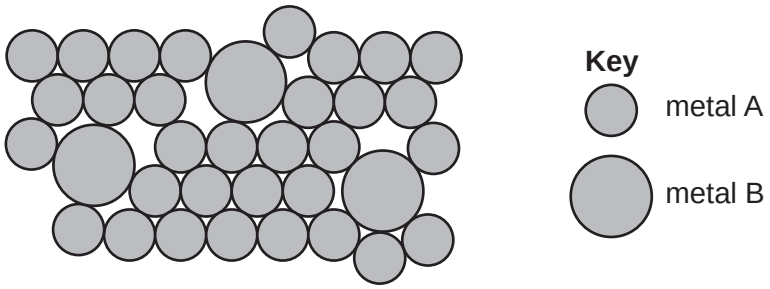


Fig. 13.2

State the type of mixture shown by Fig. 13.2.

..... [1]

(d) Galvanised steel is made of steel which is coated in a layer of zinc.

Explain why a galvanised steel gate does **not** rust.

.....

.....

..... [2]

[Total: 6]

The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
				Key			1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9			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 –		114 Fl flerovium –		116 Lv livermorium –		

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.).