UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

CO-ORDINATED SCIENCES **0654/33**

Paper 3 (Extended) **October/November 2012**

2 hours

Candidates answer on the Question Paper.

No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
A copy of the Periodic Table is printed on page 36.

At the end of the examination, fasten all your work securely together.
The number of marks is given in brackets [ ] at the end of each question or part question.

For Examiner's Use	
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Total	

This document consists of **34** printed pages and **2** blank pages.

1 Flowers are organs in which sexual reproduction takes place.

(a) Sexual reproduction can be defined as:

"the process involving the fusion of haploid nuclei to form a diploid zygote and the production of genetically dissimilar offspring".

(i) Explain the meaning of the term *diploid*.

.....

..... [1]

(ii) State the scientific term for the fusion of the two haploid nuclei.

..... [1]

(b) Fig. 1.1 shows a section through a flower.

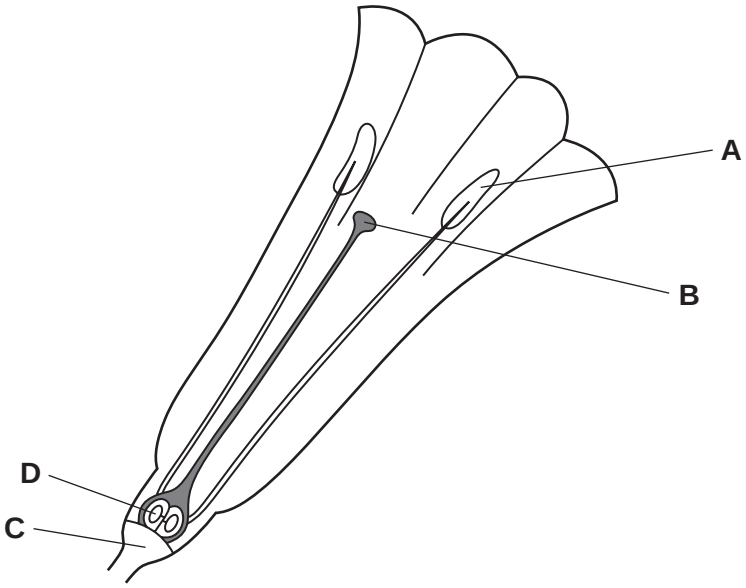

Fig. 1.1

(i) State the **letter** of the part in which

the male gametes are produced, ...

a zygote is produced. ..... [2]

(ii) Explain how the structure of the flower in Fig. 1.1 indicates that it is pollina insects.

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..... [3]

(c) After pollination and seed formation, the ovary of a flower develops into a fruit.

Describe how the structure of a **named** fruit helps it to be dispersed. You may include a labelled diagram if it helps your answer.

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..... [3]

2 **(a)** **(i)** State the percentage of nitrogen in the air.

.....

(ii) Nitrogen can be separated from liquefied air by fractional distillation.

Table 2.1 shows the boiling points of three of the gases found in air.

Table 2.1

gas	boiling point / °C
argon	–186
nitrogen	–196
oxygen	–183

In the process of fractional distillation, very cold liquefied air is allowed to increase in temperature.

Explain briefly how this process is able to separate nitrogen from the other gases shown in Table 2.1.

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..... [2]

(b) Nitrogen is converted into ammonia in the Haber process. Fig. 2.1 shows a simple diagram of the Haber Process.

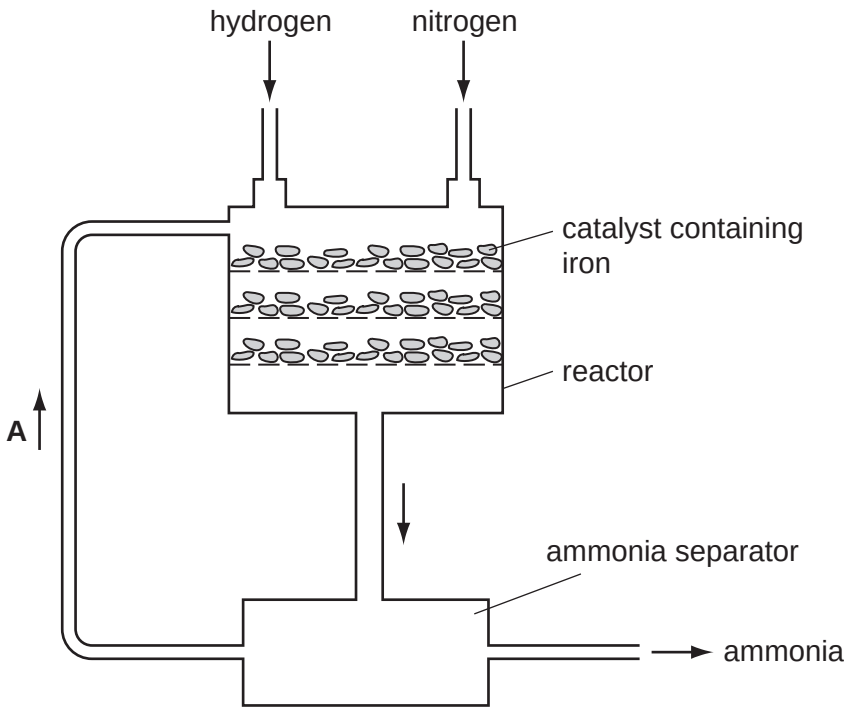

Fig. 2.1

The hydrogen used in this process is produced from reactions involving methane, steam and a catalyst containing nickel.

The reaction that occurs in the reactor in Fig. 2.1 involves a catalyst containing iron.

(i) Name the family of metals to which iron and nickel belong.

.....

[1]

(ii) Suggest why the catalyst inside the reactor in Fig. 2.1 is used in the form of a large number of small pieces.

.....

.....

.....

[2]

(iii) Name the gases that are being re-cycled at point **A** in Fig. 2.1.

.....

[1]

(iv) Explain why the gases you have named in **(iii)** are present at point **A**.

.....

.....

[1]

(c) The diagram in Fig. 2.2 shows the protons and outer shell electrons in a ni molecule.

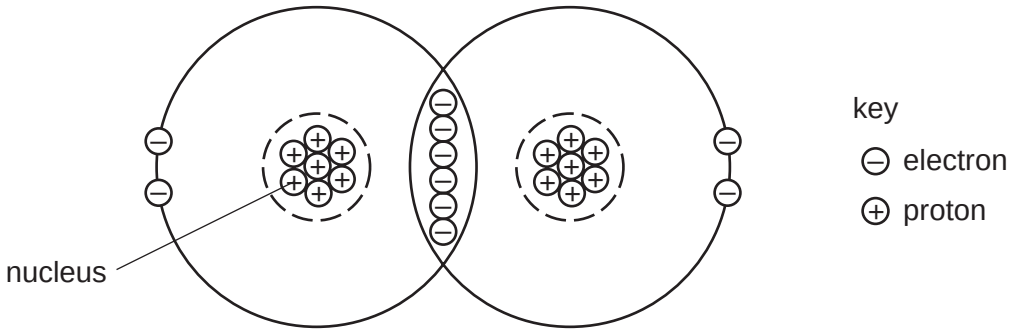

Fig. 2.2

(i) Suggest, in terms of forces between electrically charged particles, why energy is needed to break the covalent bond in a nitrogen molecule.

.....

.....

.....

..... [2]

(ii) Suggest why nitrogen molecules are unreactive.

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..... [2]

Please turn over for Question 3.

3 Fig. 3.1 shows two speed / time graphs for a car.

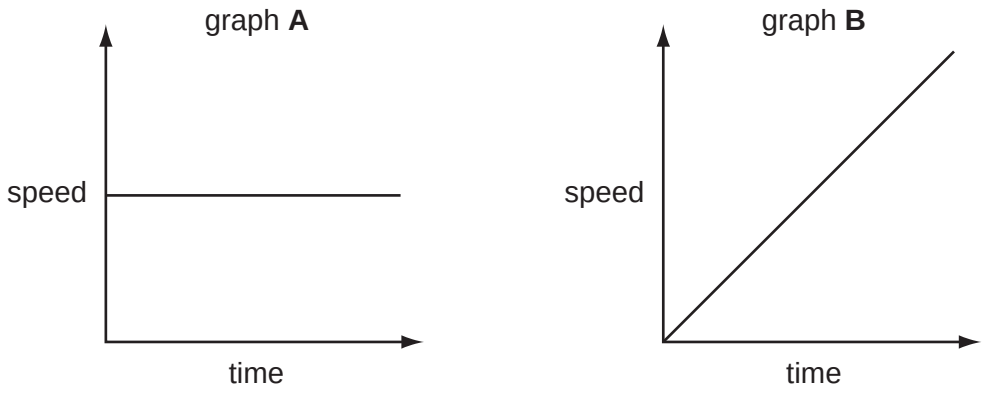

Fig. 3.1

(a) Describe the motion of the car in

graph **A**, ...

graph **B**. ..... [1]

(b) The car travels at 20 m / s for 90 seconds. The total force driving the car forward is 1000 N.

Calculate the work done by this force during this 90 second journey.

State the formulae that you use and show your working.

formulae used

working

..... [3]

(c) The manufacturer of the car gave the following information.

- mass of car 950 kg
- the car will accelerate from 0 to 33 m / s in 11 seconds

(i) Calculate the acceleration of the car during the 11 seconds.

Show your working.

..... [2]

(ii) Calculate the force needed to produce this acceleration.

State the formula that you use and show your working.

formula used

working

..... [2]

(iii) The manufacturer claims the car can reach a maximum speed of 170 km / hr.

Explain, in terms of forces acting on the car, why there is a maximum speed (terminal velocity) that a car can reach.

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..... [2]

4 Bats use echo location to detect objects around them. To do this, they emit ultrasound.

(a) (i) Ultrasound is sound that has a frequency too high for a human to hear.

Suggest a frequency for the ultrasound emitted by bats. ..... [1]

(ii) Underline the word or words that correctly describe an ultrasound wave.

electromagnetic **longitudinal** **transverse** [1]

(b) Most bats drink by flying close to the surface of a pond and taking mouthfuls of water from it.

Researchers thought that bats may be able to tell where water is present because the water has a much smoother surface than the surrounding ground. They put several thirsty bats into a closed room. They placed sheets of two rough materials and two smooth materials on the floor.

rough materials	smooth materials
metal grid	metal sheet
tree bark	smooth wood

The researchers counted the number of times the bats tried to drink from the surface of each material. Their results are shown in Fig. 4.1.

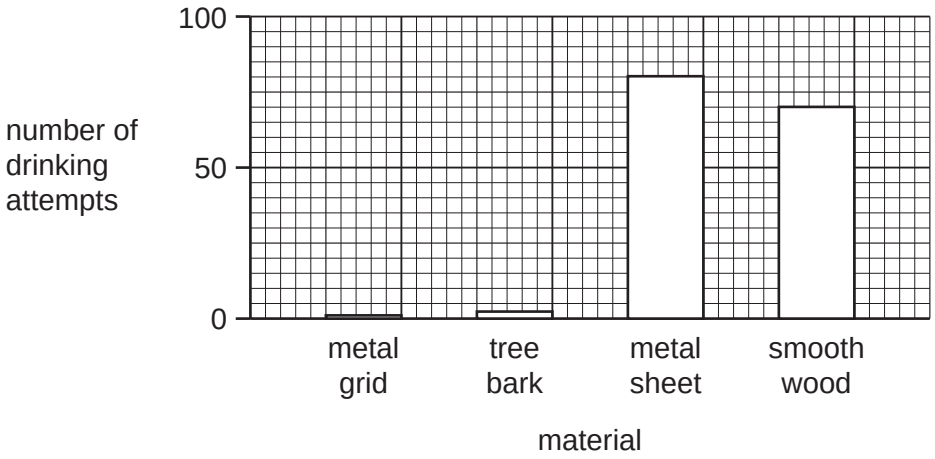

Fig. 4.1

(i) Compare the results for the rough materials and the smooth materials.

.....

.....

..... [2]

(ii) The ultrasound waves reflect from surfaces and are detected by receptors bat's head.

Fig. 4.2 shows how ultrasound waves are reflected from a rough surface and from a smooth surface. The arrows show the direction in which the sound waves travel.

Fig. 4.2

Use the information in Fig. 4.1 and Fig. 4.2 to suggest how bats detect a water surface.

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..... [2]

(c) Many bats feed on moths. Tiger moths have evolved behaviour that helps t
escape from bats. The behaviour is caused by their genes.

A tiger moth has two simple 'ears', each containing a sensory neurone. The sensory neurone produces nerve impulses when it detects ultrasound.

This causes the moth to fly in rapid zig-zags, which makes it more difficult for the bat to catch.

(i) Explain how natural selection could have caused this behaviour to evolve.

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..... [4]

(ii) The response of the tiger moth to ultrasound is a reflex action. The path taken by a nerve impulse in a reflex action in a tiger moth is similar to that in a human.

Suggest what happens to the nerve impulses in the sensory neurone, in order to produce the escape behaviour of the tiger moth.

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..... [3]

5 **(a)** Fig. 5.1 represents what happens when calcium carbonate, an **insoluble** ionic
added to water.

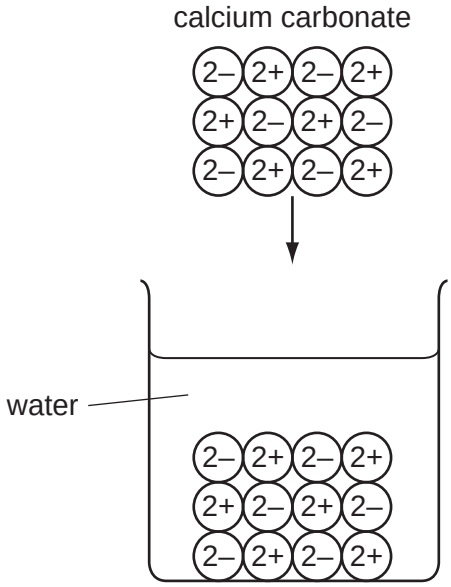

Fig. 5.1

(i) Sodium chloride is a **soluble** ionic salt.

On Fig. 5.2, sketch how the ions from sodium chloride are arranged after it is added to water.

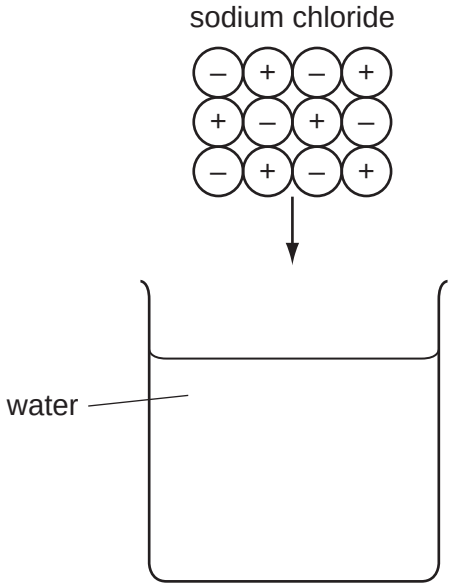

Fig. 5.2

[2]

(ii) Explain, in terms of relative numbers of protons and electrons, why calcium ions have an electrical charge of 2+, but sodium ions have a charge of 1+.

.....

.....

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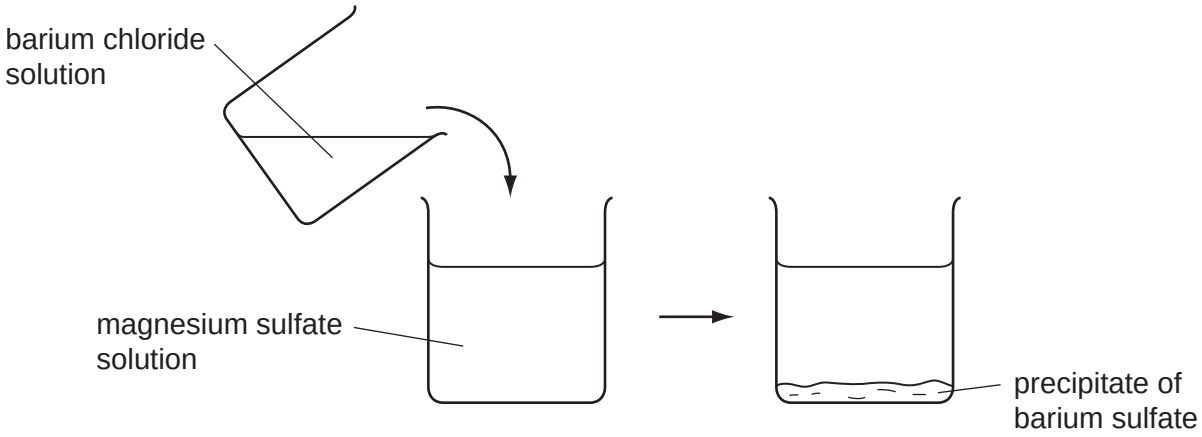
..... [2]

(b) A student is given the task of finding out the mass of magnesium sulfate that is dissolved in an aqueous solution.

She adds excess barium chloride which reacts with all of the magnesium sulfate to produce a white precipitate of barium sulfate.



The student separates and dries the barium sulfate, and finds that it has a mass of 4.66 g.

(i) Calculate the number of moles of barium sulfate, $BaSO_4$, in 4.66 g.

Show your working.

..... [2]

(ii) The balanced equation for the reaction between magnesium sulfate and [illegible] chloride is shown below.

$$MgSO_4\,(aq) + BaCl_2\,(aq) \longrightarrow BaSO_4\,(s) + MgCl_2\,(aq)$$

Use the balanced equation and your answer to **(i)** to calculate the mass of magnesium sulfate in the original solution.

The relative formula mass of magnesium sulfate is 120.

Show your working.

..... [2]

6 Fig. 6.1 shows a washing machine.

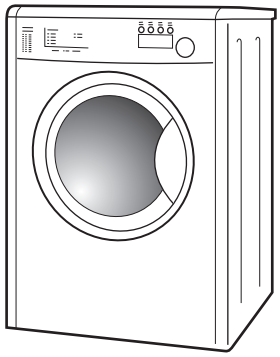


Fig. 6.1

(a) A label on the back of the washing machine shows the following information.

power	2 kW
voltage	250 V
a.c. frequency	50 Hz

(i) Explain what is meant by an a.c. frequency of 50 Hz.

.....

.....

..... [2]

(ii) Calculate the current when the washing machine is using 2 kW of power.

State the formula that you use and show your working.

formula used

working

..... [2]

(b) **(i)** Some of the water inside the washing machine evaporates.

Explain the process of evaporation in terms of particles.

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..... [2]

(ii) Inside the washing machine the water is heated by an electric heater.

Explain how heat energy is able to pass through the metal parts of the heater.

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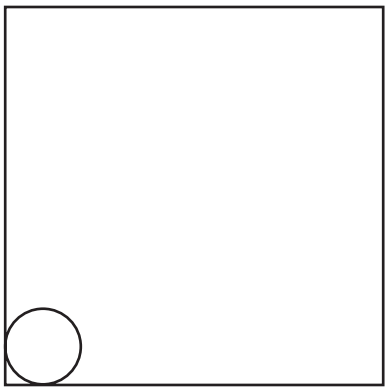
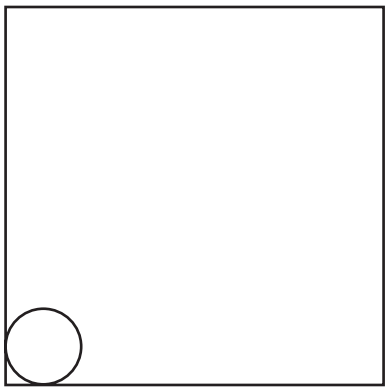
..... [2]

(c) The casing of the washing machine is a solid. The water used in it is a liquid.

Complete the diagrams below to show the arrangement of particles in a solid and in a liquid.



solid



liquid

[2]

(d) 3 kg of water are being heated in the washing machine from 10 °C to 50 °C.

The specific heating capacity of water is 4200 J / kg °C.

Calculate the energy required to heat the water.

Show your working and state the formula that you use.

formula used

working

..... [3]

7 Starch is a carbohydrate found in many foods that come from plants. Starch molecu
very large, and must be broken down into smaller sugar molecules before they ca
absorbed.

(a) (i) Name the enzyme in the human digestive system that breaks down starch molecules.

..... [1]

(ii) State **one** place in the human digestive system where this enzyme is secreted.

..... [1]

(b) Sugar molecules, such as glucose, are absorbed from the alimentary canal through the villi. Fig. 7.1 shows a villus.

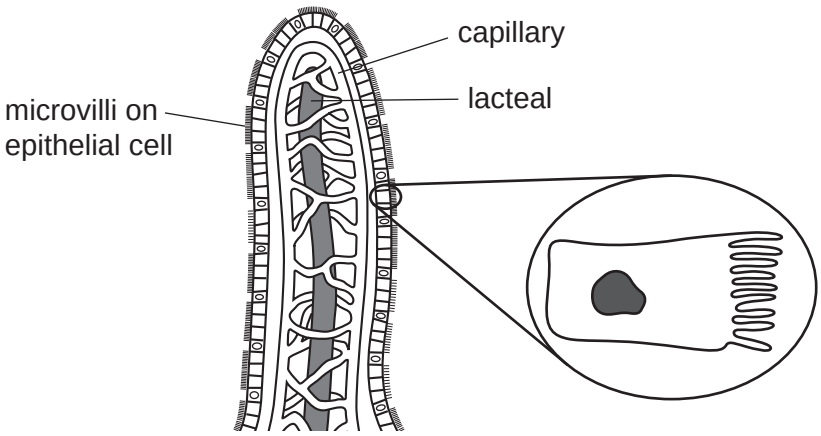


Fig. 7.1

(i) Describe the role of the capillaries in the villus.

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.....

..... [2]

(ii) Describe the role of the lacteals in the villus.

.....

..... [1]

(iii) Suggest the function of the microvilli on the epithelial cells.

.....

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..... [2]

(c) The glucose that is absorbed through the villi is transported to the liver in the blo

Describe what happens to the glucose when it reaches the liver if the concentration glucose in the blood is too high.

.....

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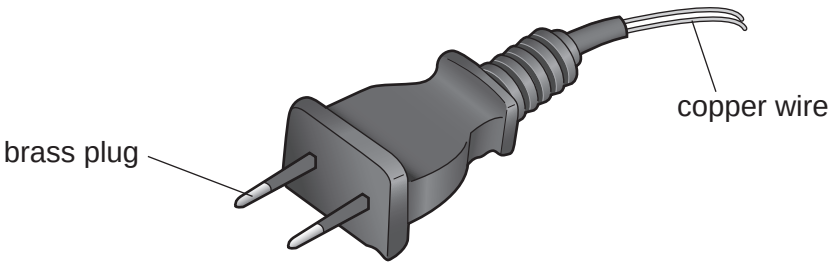
..... [2]

8 Metallic copper is a very important material that has been extracted from compounds for thousands of years.

(a) Copper is used to make electrical wires.

Copper wires are connected to the mains electrical supply using brass plugs. Brass is an alloy of copper and zinc, and is a much less malleable material than pure copper.



Draw a simple diagram of the atoms in brass, and use it to help you explain why brass is less malleable than pure copper.

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.....

..... [3]

(b) One of the processes used in the extraction of copper involves heating co... sulfide, Cu_2S, in air. One of the reactions that occurs is between copper(I) sulfide ... oxygen. This reaction produces copper and sulfur dioxide, SO_2.

Construct a balanced symbolic equation for this reaction.

..... [1]

(c) After further processing, impure copper is extracted from the products of the process in **(b)**.

Most of this copper is purified using electrolysis.

Fig. 8.1 shows the apparatus a student used to investigate this electrolysis reaction.

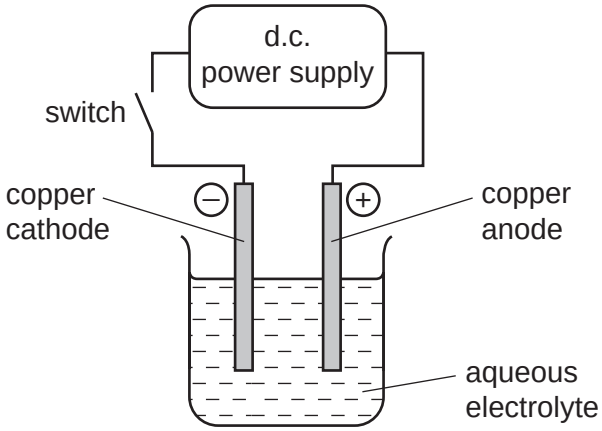

Fig. 8.1

The student investigated what happened to the masses of the anode and cathode during the electrolysis shown in Fig. 8.1.

His results are shown in Table 8.1.

Table 8.1

	mass of anode / g	**mass of cathode / g**
before electrolysis	47.3	49.7
after electrolysis	46.9	50.1

(i) Name the compound that is dissolved in water to make the electrolyte.

..... [1]

(ii) Explain the results shown in Table 8.1.

.....

.....

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..... [2]

(iii) Explain briefly how this electrolysis reaction is used in industry to purify (refine) copper.

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..... [2]

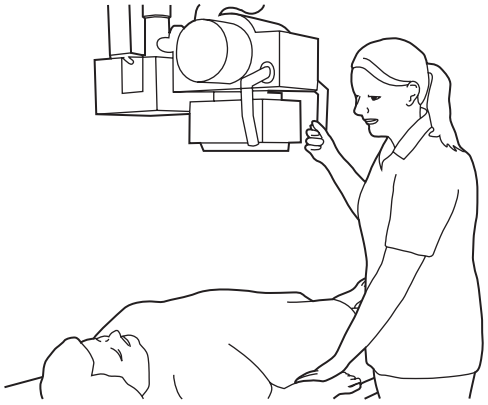
9 **(a)** X-rays and γ (gamma) -rays are two examples of ionising radiation.

Explain the meaning of the term *ionising radiation*.

.....

..... [2]

(b) A radiographer uses X-rays to see the bones in a patient's body. She carries out this procedure many times each day.



The radiographer goes behind a screen before switching on the X-ray machine.

Explain why she does this.

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..... [2]

(c) The speed of X-rays is 3×10^8 m/s. What is the speed of γ-rays?

Explain your answer.

.....

..... [1]

(d) Draw a straight line from each type of radiation in the left hand column to link
property in the right hand column.

α (alpha)	not dangerous
β (beta)	stopped by paper
γ (gamma)	least ionising
	travels up to 1 metre in air

[2]

10 Fig. 10.1 shows a crop plant growing in soil.

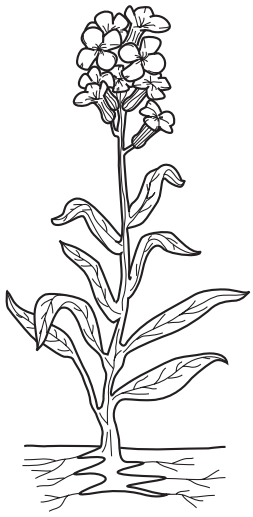

Fig. 10.1

(a) Describe the pathway along which water from the soil travels to the cells in the plant's leaves.

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.....

..... [3]

(b) Farmers often add fertilisers containing nitrate ions to the soil where crop plants are growing.

(i) Explain why plants need nitrate ions.

.....

.....

..... [2]

(ii) If too much fertiliser is added to the soil, the movement of water into the plant's roots will stop.

Explain why.

.....

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..... [2]

(iii) If more fertiliser is added to the soil than the crop plants can absorb, some fertiliser may wash into rivers when it rains.

Explain how this can cause fish to die.

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..... [3]

11 Carbon occurs naturally as the free element and also combined in an extremely number of different compounds.

(a) The most common isotope of carbon has a proton number of 6 and a nucleon number of 12.

Draw a diagram of **one** atom of this isotope of carbon. Label the positions and numbers of the protons, neutrons and electrons.

[2]

(b) As the uncombined element, carbon is found in the forms of diamond and graphi
physical properties of diamond and graphite are very different.

Choose **one** difference in the physical properties of diamond and graphite and explain this difference in terms of structure (the way that the carbon atoms are arranged). You may wish to draw some simple diagrams to help you answer this question.

.....

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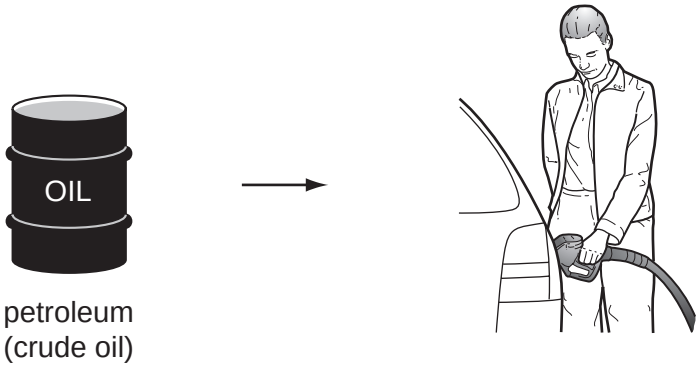
..... [4]

(c) Petroleum (crude oil) is the raw material from which gasoline (car fuel) is obtained.



petroleum
(crude oil)

(i) Fig. 11.1 shows a typical molecule in gasoline.

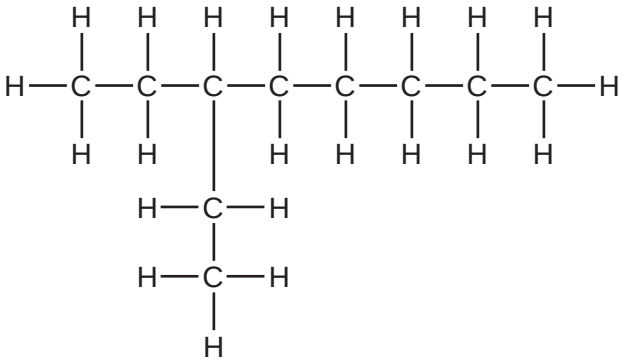


Fig. 11.1

Name the homologous series to which the molecule in Fig. 11.1 belongs.

Explain your answer.

homologous series .....

explanation .....

..... [2]

(ii) Some car manufacturers are researching the use of alternative fuels to r gasoline.

One possible alternative fuel is hydrogen gas, H_2, which is oxidised in the car's engine.

Explain why air pollution caused by car engines would be greatly reduced if hydrogen could be used as the fuel instead of gasoline.

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..... [3]

12 **(a)** Describe how heat energy is used to turn the generator in a power station.

Name the equipment used at each stage of this process.

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..... [2]

(b) Fig. 12.1 shows a simple a.c. generator. When the coil is turned a current is induced in the coil.

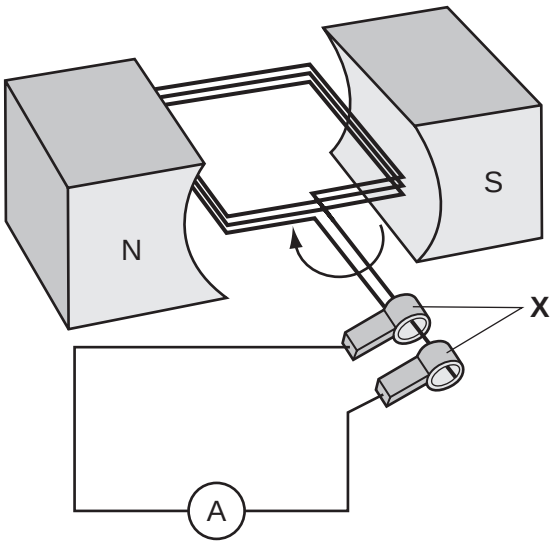

Fig. 12.1

Name the parts labelled **X** and explain their purpose.

part **X** .....

purpose .....

.....

.....

..... [2]

(c) **(i)** The electrical output from a power station is 25 000 V. The voltage is stepped up to 400 000 V by a transformer.

The number of turns on the primary coil of the transformer is 40 000.

Calculate the number of turns on the secondary coil.

Show your working and state the formula that you use.

formula used

working

..... [3]

(ii) Explain why the electrical output from this power station has to be a.c.

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..... [1]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H Hydrogen 1									4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulfur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

*58-71 Lanthanoid series
†90-103 Actinoid series

Key: a = relative atomic mass; X = atomic symbol; b = proton (atomic) number

The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).