UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

1795973320

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	
1	
2	
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9	
10	
11	
12	
Total	

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

For Examiner's Use

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.

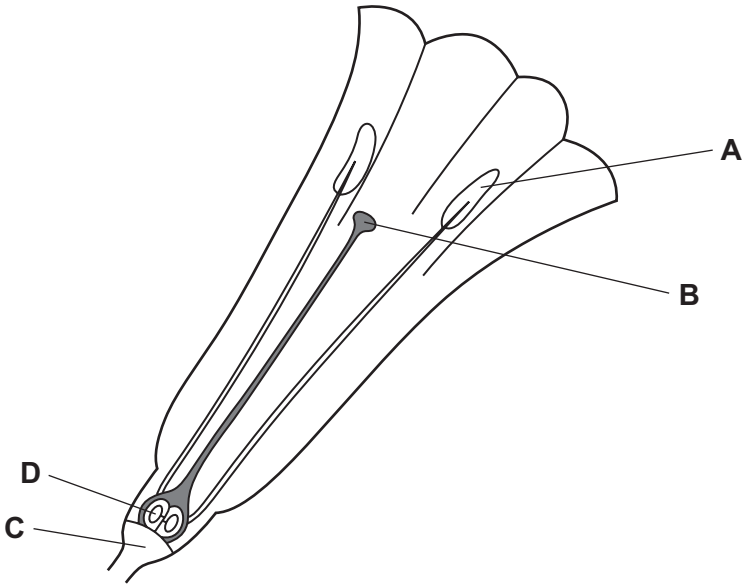

Fig. 1.1

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

the male gametes are produced, ...

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

For Examiner's Use

(ii) Explain how the structure of the flower in Fig. 1.1 indicates that it is pollinated by 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. ..... [1]

For Examiner's Use

(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 simplified diagram of the Haber Process.

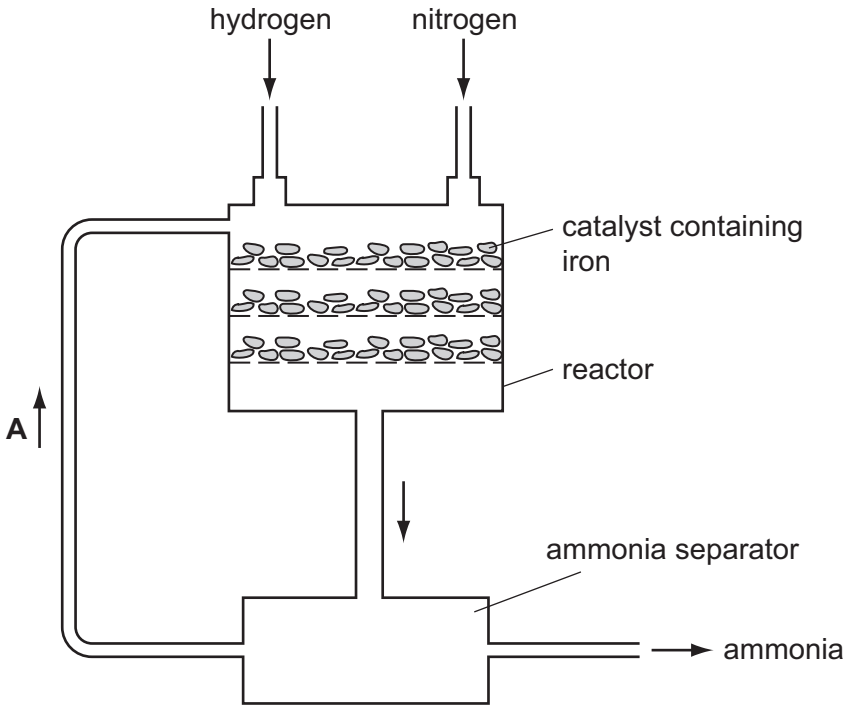

Fig. 2.1

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]

[Turn over

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

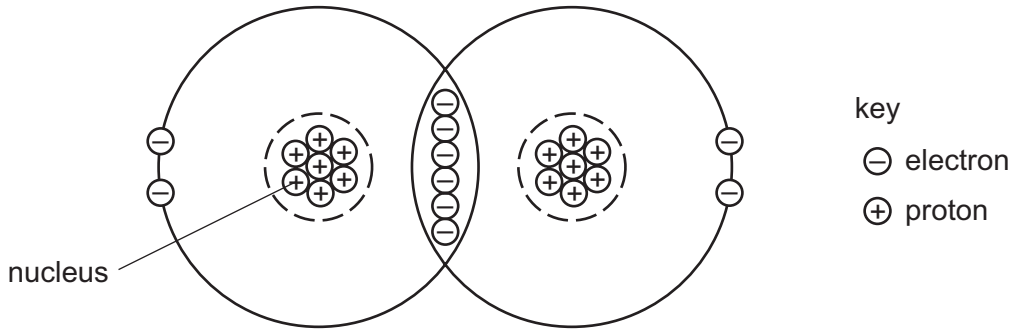

Fig. 2.2

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

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..... [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.

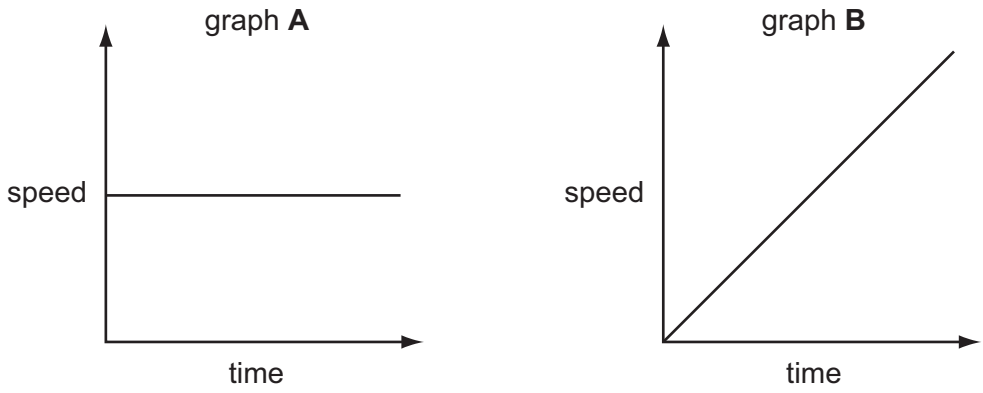

Fig. 3.1

(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]

For Examiner's Use

(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.

.....

.....

..... [2]

For Examiner's Use

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.

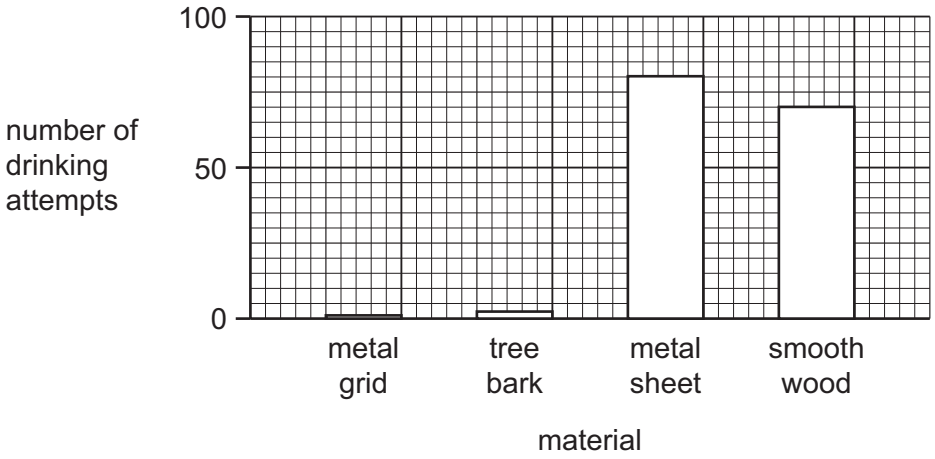

Fig. 4.1

(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 in the 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.

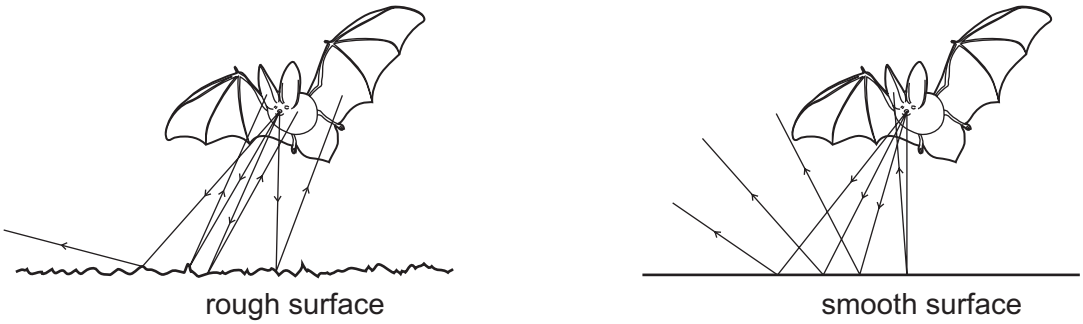

Fig. 4.2

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

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..... [2]

For Examiner's Use

(c) Many bats feed on moths. Tiger moths have evolved behaviour that helps them to 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]

For Examiner's Use

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

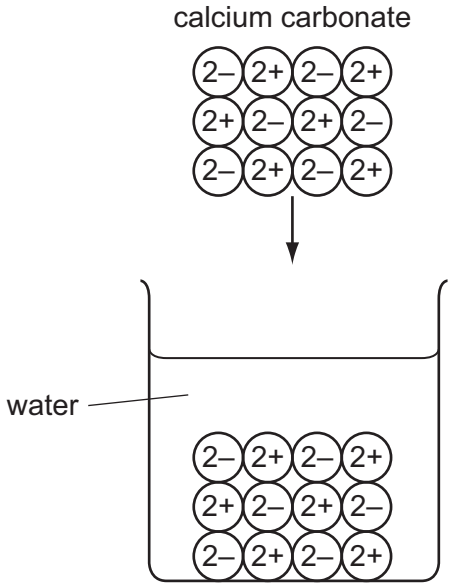

Fig. 5.1

(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.

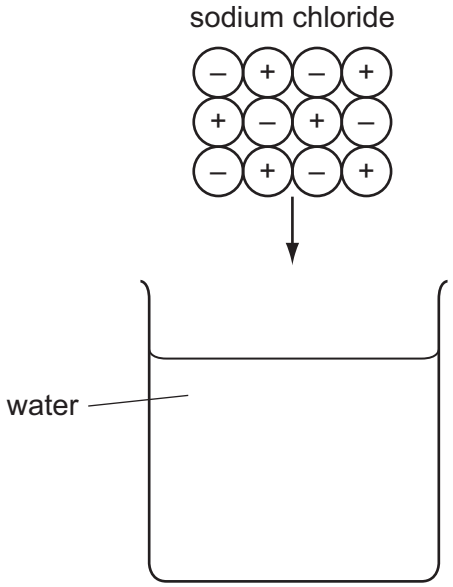

Fig. 5.2

[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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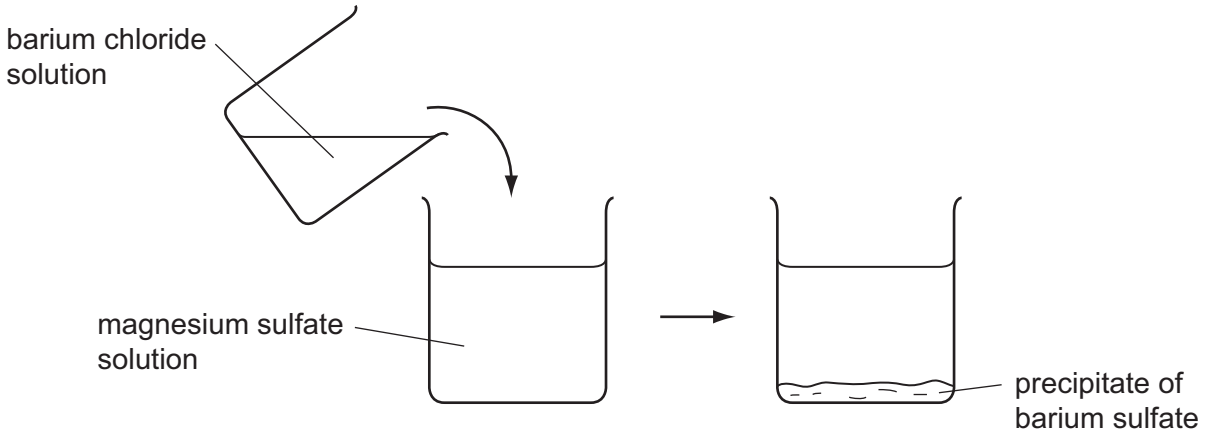
..... [2]

(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]

For Examiner's Use

(ii) The balanced equation for the reaction between magnesium sulfate and barium 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]

For Examiner's Use

6 Fig. 6.1 shows a washing machine.

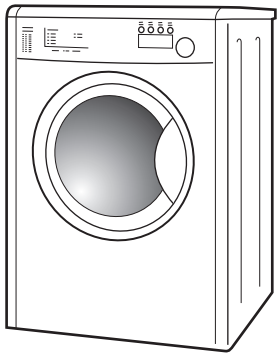


Fig. 6.1

(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]

For Examiner's Use

(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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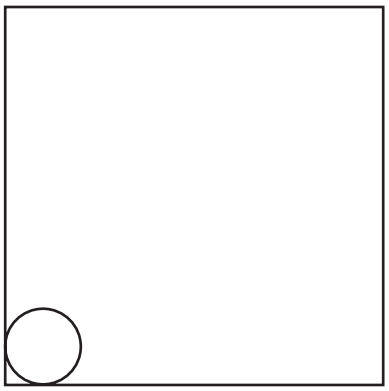
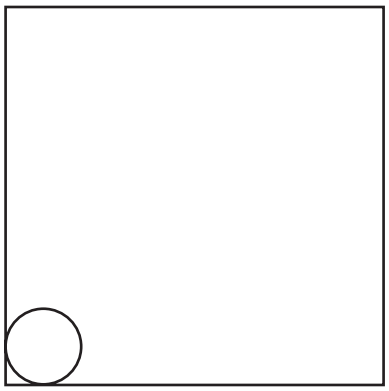
..... [2]

(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]

For Examiner's Use

For Examiner's Use

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

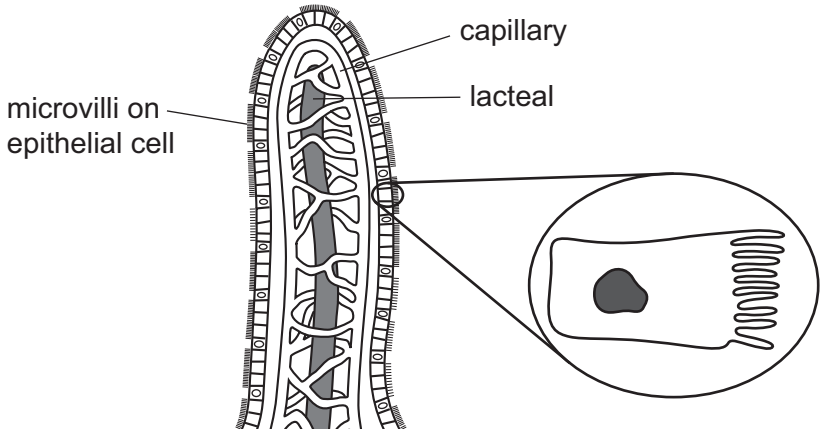


Fig. 7.1

(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 blood.

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

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..... [2]

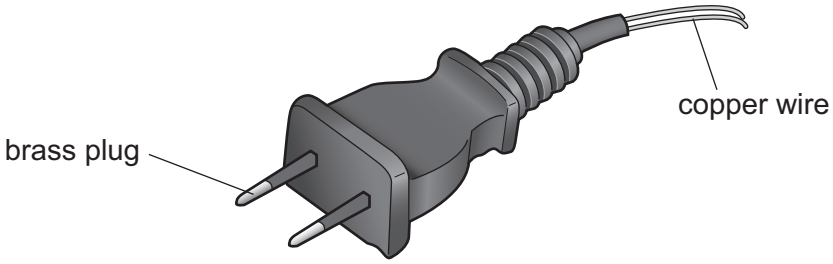
For Examiner's Use

For Examiner's Use

8 Metallic copper is a very important material that has been extracted from copper 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 copper(I) sulfide, Cu_2S, in air. One of the reactions that occurs is between copper(I) sulfide and 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.

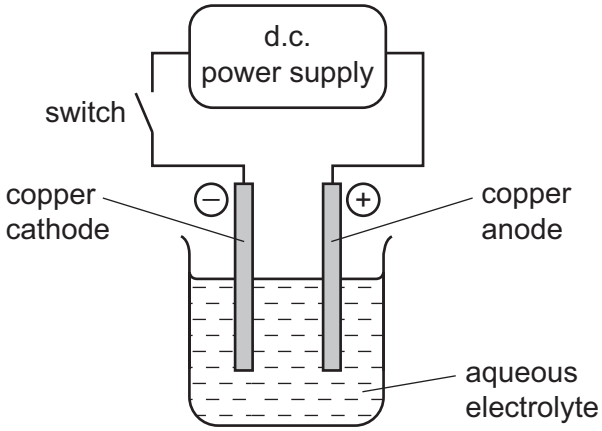

Fig. 8.1

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.

For Examiner's Use

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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]

For Examiner's Use

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

Explain the meaning of the term *ionising radiation*.

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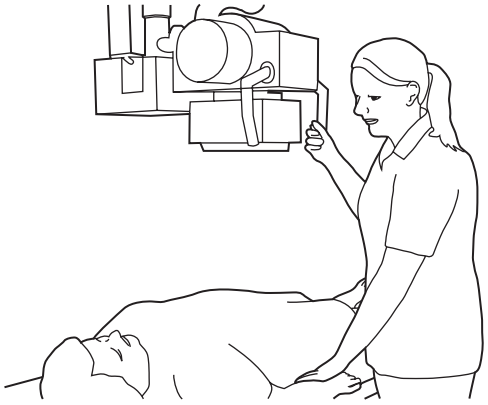
..... [2]

(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 with its property in the right hand column.

For Examiner's Use

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

[2]

For Examiner's Use

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

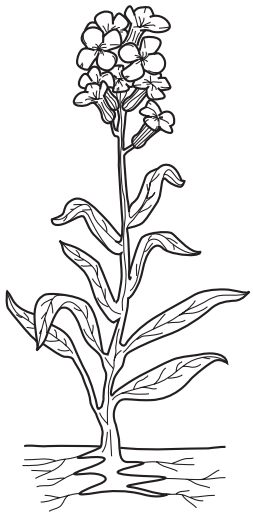

Fig. 10.1

(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.

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..... [2]

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

Explain why.

.....

.....

..... [2]

For Examiner's Use

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

Explain how this can cause fish to die.

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..... [3]

For Examiner's Use

11 Carbon occurs naturally as the free element and also combined in an extremely large 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 graphite. The physical properties of diamond and graphite are very different.

For Examiner's Use

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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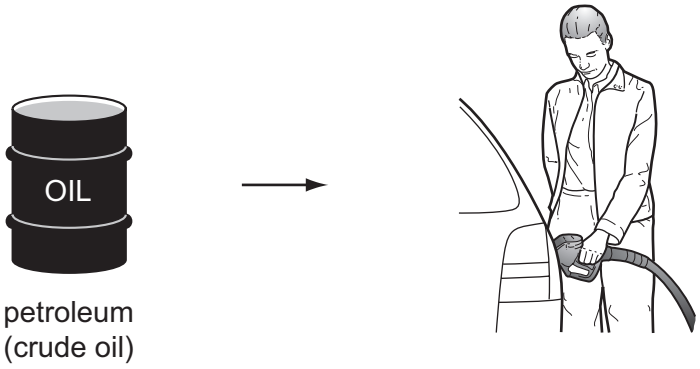
..... [4]

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

For Examiner's Use



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

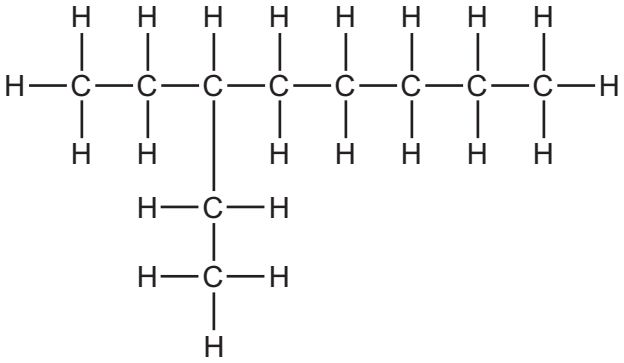


Fig. 11.1

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

Explain your answer.

homologous series .....

explanation .....

..... [2]

For Examiner's Use

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

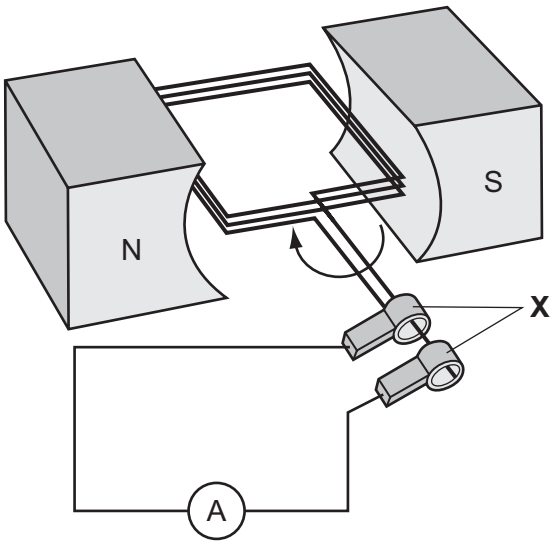

Fig. 12.1

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

part **X** .....

purpose .....

.....

.....

..... [2]

For Examiner's Use

(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 over X over b

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.).