Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CO-ORDINATED SCIENCES **0654/03**

Paper 3

May/June 2005

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 in the spaces provided on the Question Paper.
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.

Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 24.

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

For Examiner's Use	
1	
2	
3	
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7	
8	
9	
Total	

This document consists of **22** printed pages and **2** blank pages.

1 Electricity is a useful form of energy.

(a) Use the information given to help you answer the questions below.

Wind power
Wind can be used as an energy source to produce electrical energy. One wind turbine is able to generate 2 megawatts (MW) of power.

Nuclear power
A nuclear power station uses enriched uranium as a fuel. Radioactive waste materials are produced. A typical nuclear power station can generate 1500 MW.

Electricity demand
Typical demand for electric power in an industrial country is about 50 000 MW.

State one advantage and one disadvantage (apart from cost) of using each energy source to generate electricity in an industrial country.

	using wind power	using nuclear power
advantage		
disadvantage		

[4]

(b) A simple electrical generator is shown in Fig. 1.1.

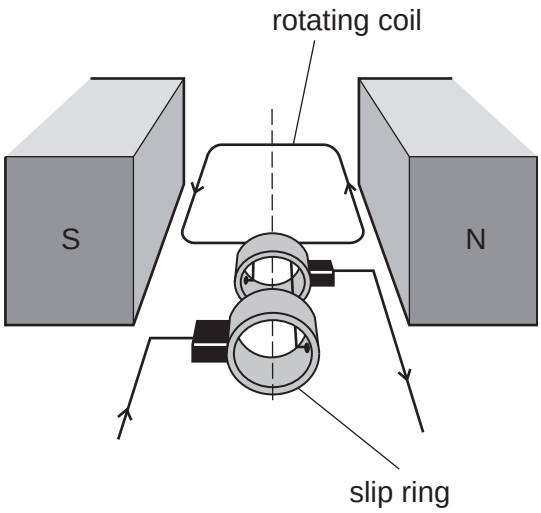

Fig. 1.1

(i) Explain why a voltage is induced in the coil when the coil is turned.

.....

..... [1]

(ii) Explain why this generator produces an alternating current.

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..... [2]

2 Fig. 2.1 shows a villus from the human alimentary canal.

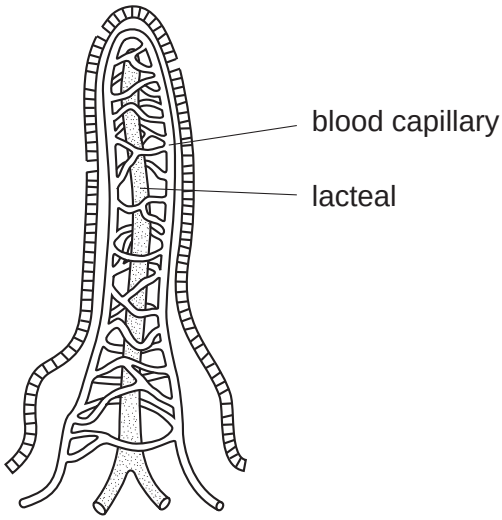

Fig. 2.1

(a) Name **one** part of the alimentary canal in which villi are found.

.....

[1]

(b) The villi help absorption of digested food, such as glucose, to take place quickly. Describe two ways by which the structure of a villus helps this to happen.

1. .....

.....

2. .....

.....

[2]

(c) After it has been absorbed, digested food is taken to the liver. The liver responds to insulin, secreted by the pancreas, by removing excess glucose from the blood.

(i) Name the blood vessel which carries this digested food to the liver.

.....

[1]

(ii) Suggest why it is useful for the digested food to be taken to the liver before it goes on to other parts of the body.

.....

.....

.....

[2]

(d) Glucose is carried to all parts of the body in the blood.

(i) Describe how body cells can obtain energy from glucose when they are well supplied with oxygen.

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..... [3]

(ii) Describe how body cells can obtain energy from glucose when they are short of oxygen.

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.....

..... [2]

(iii) With reference to the effect of cigarette smoke on the body, suggest why the muscles of a smoker are unlikely to be able to work as hard as the muscles of a non-smoker.

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..... [2]

3 Fig. 3.1 shows apparatus which can be used to investigate what happens when sodium chloride solution is electrolysed.

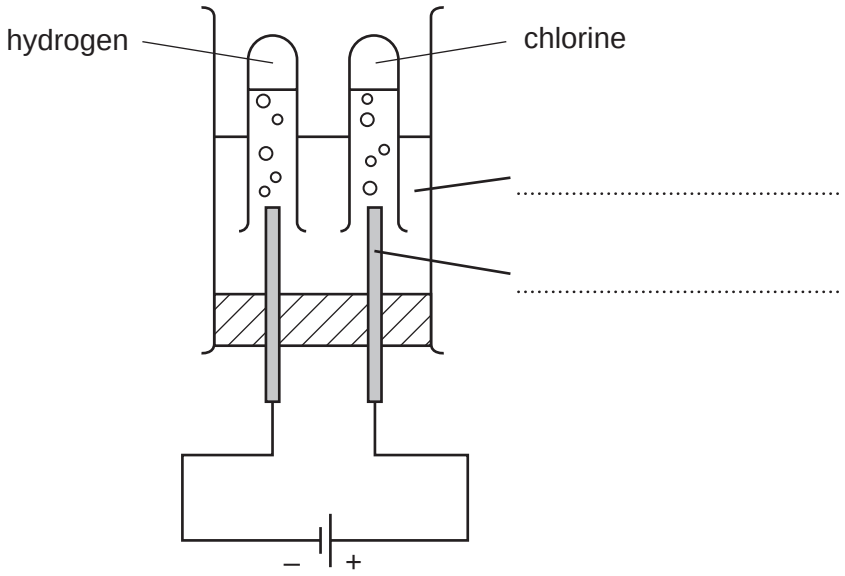


Fig. 3.1

(a) Complete the labelling of the diagram using words from the following list.

anode **cathode** **current** **electrolyte** **ion**

[2]

(b) **(i)** An atom of hydrogen has a nucleon number of 1.

State the type of particle not present in the nucleus of this atom, but which is present in the nucleus of atoms of all other elements.

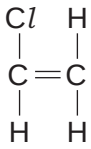
..... [1]

(ii) One atom of hydrogen joins with one atom of chlorine to form a molecule.

Draw a diagram of this molecule showing how the outer electrons in each atom are arranged.

[2]

(c) Chlorine is used to make the unsaturated organic compound chloroethene.
The displayed formula of chloroethene is shown below.



(i) Describe briefly a chemical test to show that this molecule is unsaturated.

.....

.....

..... [2]

Chloroethene is converted into poly(chloroethene) which is a thermoplastic material made of polymer molecules.

(ii) Complete the displayed formula of a short section of a poly(chloroethene) molecule.

—C—C—C—C—C—C—

[1]

(iii) Bakelite is an example of a thermoset material.

Describe and explain briefly the main difference in behaviour between bakelite and poly(chloroethene) when these materials are heated.

.....

.....

.....

.....

..... [3]

4 **(a)** Fig. 4.1 shows an astronaut. He is wearing a space suit designed to protect his body from electromagnetic radiation from the Sun.

Fig. 4.1

Explain how electromagnetic radiation can harm the human body.

.....

.....

..... [2]

(b) Four astronauts are standing on four different planets. One of these planets is Earth, which has a gravitational field strength of 10N / kg.

Table 4.2 shows the mass and weight of each astronaut as they stand on the four planets.

Table 4.2

astronaut	mass / kg	weight / N
A	70	140
B	60	600
C	50	1000
D	80	160

(i) Which astronaut is on Earth? Explain your answer.

.....

..... [1]

(ii) Which two astronauts are standing on planets with the same gravitational field strength?

..... [1]

(iii) Which astronaut would weigh the least on Earth? Explain your answer.

.....

..... [1]

(c) **(i)** Astronauts on the Moon are unable to talk directly to each other, but must use radio signals as the Moon has no atmosphere.

Explain why sound waves need a medium such as air to travel through.

.....

..... [2]

(ii) If an explosion occurred beneath the surface of the Moon, an astronaut would be able to sense this, although he would not hear any sound.

Explain how the astronaut would be able to sense this explosion.

.....

..... [1]

(d) A radio signal sent from Earth to an astronaut on the Moon travels 400 000 kilometres. The speed of radio waves is 300 000 km / s.

(i) Calculate how long it will take the radio signal to travel from Earth to the astronaut on the Moon.

Show your working and state the formula that you use.

formula used

working

..... [2]

(ii) If the wavelength of the radio waves used is 2 m, calculate the frequency of the radio waves.

Show your working and state the formula that you use.

formula used

working

..... [3]

5 Sheep, like most mammals, have skin covered by hair. The hair of sheep is called wool.

(a) For thousands of years, people have kept sheep to provide wool. Wool is made of a protein, keratin, which forms fibres. These fibres have natural elasticity, which makes wool an excellent material for weaving cloth.

Fig. 5.1 shows how the length of wool fibres from a Merino sheep changes as force is applied to them.

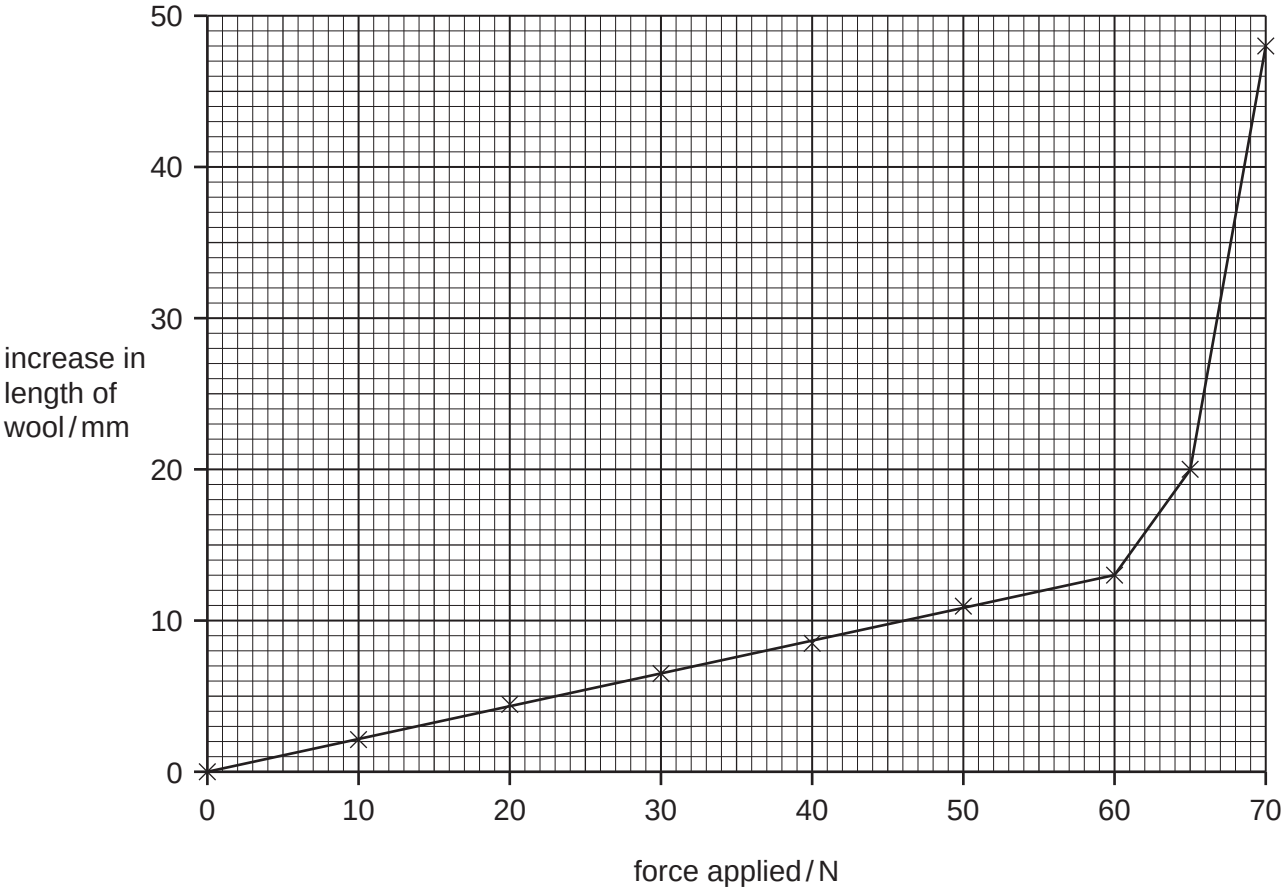


Fig. 5.1

(i) Describe the relationship between the force applied and the increase in the length of the wool fibres up to a force of 60 N.

.....

.....

[2]

(ii) What happens to the wool fibres as forces above 60 N are applied?

.....

.....

[1]

(b) Wool helps sheep to maintain their body temperature in cold conditions. With reference to methods of heat transfer, suggest how wool reduces heat loss from a sheep's body to the air.

.....

.....

..... [2]

(c) The wool from different Merino sheep varies in the diameter of its fibres. An investigation was carried out in Australia to find out whether this variation is caused mainly by the environment, mainly by genes or by both of these factors.

Two groups of sheep were used. Group **A** came from a family in which the wool was especially fine (thin). Group **B** came from a family in which the wool was especially thick. Ten sheep from each flock were kept for eighteen months in a hot, dry area. Another ten sheep from each flock were kept for the same length of time in a cooler, wetter area.

After eighteen months, 100 wool fibres were collected from each of the forty sheep and the fibre diameters were measured. The mean diameter of fibres from each group was calculated. The results are shown in Table 5.2.

Table 5.2

	hot, dry area		cool, wet area	
	group **A**	group **B**	group **A**	group **B**
mean diameter of wool fibres / micrometres	18.55	20.72	16.82	19.06

(i) State one variable which should have been controlled in this investigation, and explain why it was necessary to keep this variable constant.

.....

.....

..... [2]

(ii) Explain how the results in Table 5.2 support the suggestion that the thickness of the wool fibres is affected by a sheep's genes.

.....

.....

..... [1]

(iii) Explain how these results support the suggestion that the thickness of the wool fibres is affected by a sheep's environment.

.....

.....

..... [1]

(iv) Explain how the results in Table 5.2 support the idea that this is an example of *continuous* variation.

.....

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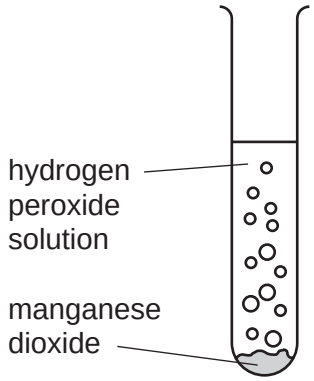
..... [2]

6 Water, H_2O, and hydrogen peroxide, H_2O_2, are colourless, transparent liquids.

(a) Hydrogen peroxide slowly decomposes according to the equation

hydrogen peroxide ⟶ water + oxygen

Manganese dioxide is an insoluble compound which catalyses this reaction.
A student adds 1.0 g of manganese dioxide to an aqueous solution of hydrogen peroxide.



(i) Predict the mass of manganese dioxide that is left in the test-tube when all the hydrogen peroxide has decomposed.
Explain your answer.

.....

.....

..... [2]

(ii) Write a balanced equation for the decomposition of hydrogen peroxide.

..... [2]

(b) Water that contains permanent hardness cannot be softened by boiling.

Describe briefly how the process of ion-exchange removes permanent hardness from water. You may draw a diagram if it helps you to answer this question.

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..... [3]

(c) The amount of hardness in water can be measured by shaking a known volume of the water with soap solution until a permanent lather is formed.

A student carried out a series of experiments to investigate hardness in three samples of water, **A, B** and **C**. His results are shown in Table 6.1.

Table 6.1

sample	volume of soap solution required for lather / cm^3	
	before boiling	after boiling
A	0.5	0.5
B	13.5	0.5
C	8.5	3.5

(i) State and explain which sample, **A, B** or **C**, was the hardest before boiling.

.....

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..... [2]

(ii) Explain the two results for water sample **C**.

.....

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..... [2]

7 **(a)** A student investigated the relationship between the potential difference across a lamp and the current passing through it.

Fig. 7.1 shows the results of this investigation.

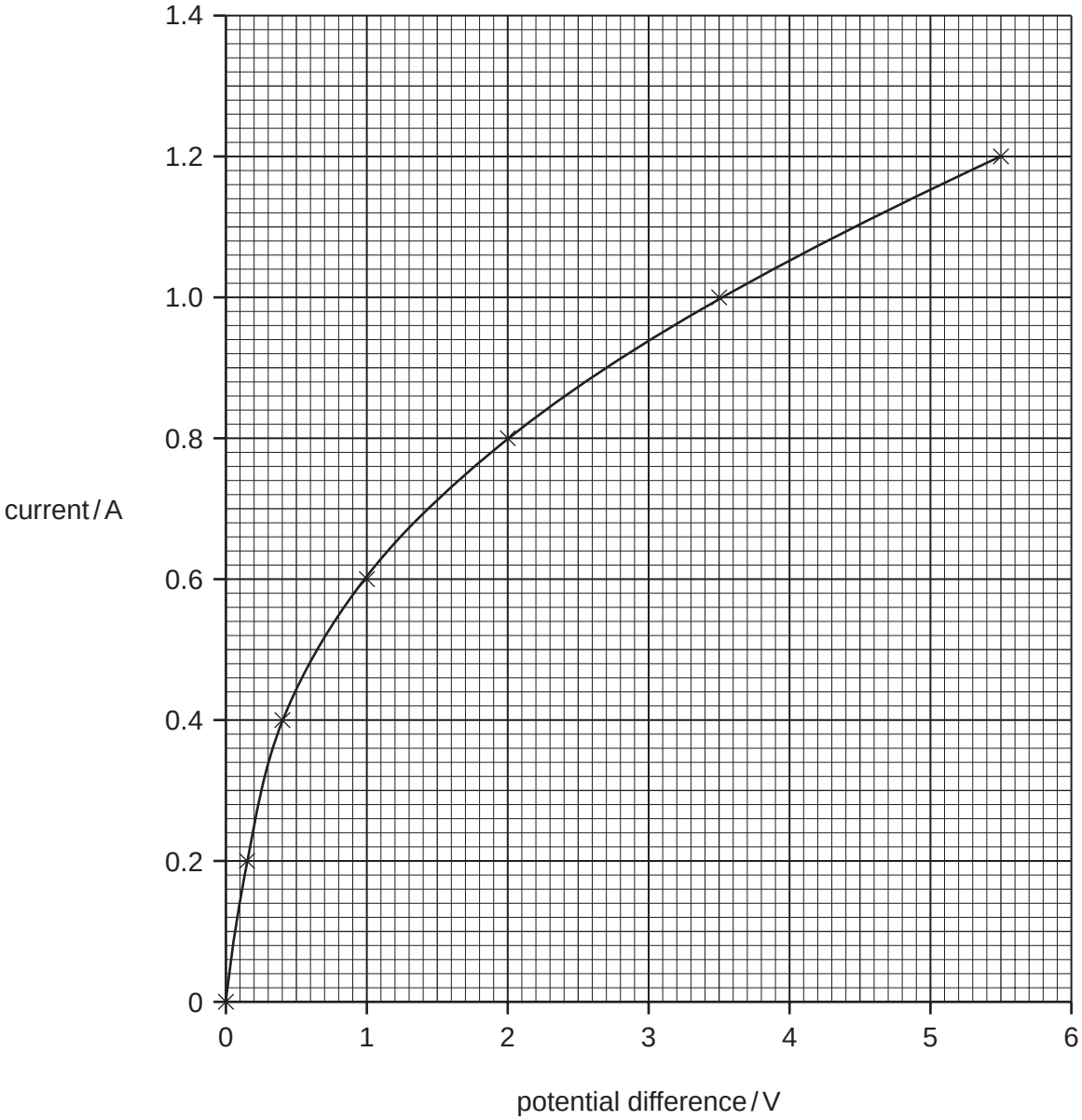

Fig. 7.1

(i) Using data from Fig. 7.1 calculate the resistance of the lamp when the current passing through it was 0.4 A.

Show your working and state the formula that you use.

formula used

working

..... [3]

(ii) From Fig. 7.1, the student concluded that the relationship did not correspond to Ohm's law.
Explain why the relationship between current and potential difference for the lamp did not correspond to Ohm's law.

.....

.....

..... [2]

(iii) On Fig. 7.1, draw the line for the results you would expect if a 5 Ω resistor, which did obey Ohm's law, was used instead of the lamp. [2]

(b) When a poly(ethene) rod is rubbed with a cloth, the rod acquires a negative electrostatic charge. During this process, a very small electric current flows.
Explain what is happening.

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..... [4]

8 Fig. 8.1 shows the structure of a flower.

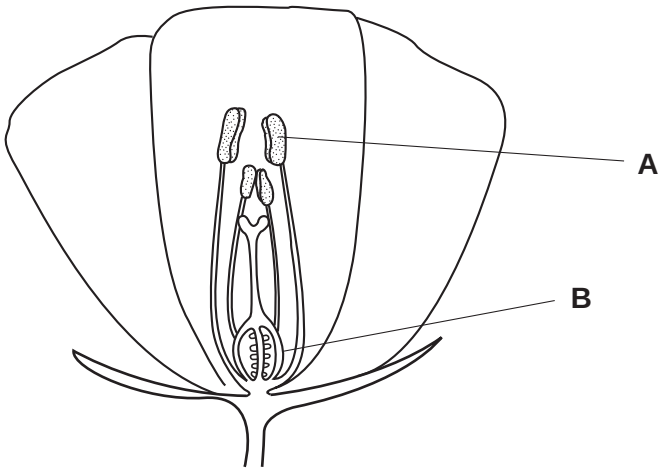

Fig. 8.1

(a) Name the parts labelled **A** and **B**.

A .....

B ..... [2]

(b) Describe how pollination takes place in this flower.

.....

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..... [3]

(c) After pollination, a tube grows from the pollen grain towards an ovule of the flower.

(i) What passes down this tube?

..... [1]

(ii) Describe what happens when the tube reaches the ovule.

.....

.....

..... [2]

(d) A gardener grows bean plants. She enjoys their brightly coloured flowers and harvests the beans to eat.

She is worried that there are too many aphids (greenfly) on the bean plants in her garden. She sprays some of the bean plants with a pesticide to kill the aphids.

She is surprised to find that she actually gets fewer beans from the plants sprayed with pesticide than from the unsprayed plants.

(i) Suggest why spraying with pesticides might reduce the crop of beans that she harvests.

.....

.....

..... [2]

(ii) Suggest and explain **one** other way by which she could try to control the aphids, without affecting the number of beans she gets from the bean plants.

.....

.....

..... [2]

9 Mixtures of raw materials used to make three types of coloured glass are shown below.

blue glass	violet glass	green glass
white sand	white sand	white sand
potassium carbonate	sodium carbonate	sodium carbonate
borax	potassium nitrate	potassium nitrate
lead oxide	calcium carbonate	calcium carbonate
cobalt oxide	manganese dioxide	iron oxide
	iron oxide	copper oxide

(a) Suggest how the mixture of raw materials required for **colourless** glass would differ from that shown above for violet glass.
Explain your answer.

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..... [3]

(b) Iron oxide is an ionic compound having the formula Fe_2O_3.

(i) The formula of an oxide ion is O^{2-}.
Draw a diagram of an oxide ion showing how **all** of the electrons are arranged.

[1]

(ii) Explain, in terms of electronic structure, why oxide ions are less reactive than oxygen atoms.

.....

.....

..... [2]

(iii) Deduce the electrical charge of the ion of iron in the formula Fe_2O_3.
Explain your answer.

.....

[2]

(c) A chemist is investigating a mixture of substances to make an improved type of glass. She wants the finished glass sample to contain 14.0 g of calcium oxide. She plans to add calcium carbonate to the mixture before it is melted.
Calcium carbonate undergoes thermal decomposition according to the equation

$$CaCO_3 \longrightarrow CaO + CO_2$$

Calculate the minimum number of moles of calcium carbonate which the chemist should add to the mixture in order to ensure that the final glass contains 14.0 g of calcium oxide.

Show your working.

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.....

.....

[3]

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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 Sulphur 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 Radius 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	a = relative atomic mass
X	X = atomic symbol
b	b = proton (atomic) number

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