

Centre Number	Candidate Number	Name
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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.

For Examiner's Use	
1	
2	
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7	
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Total	

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.

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.

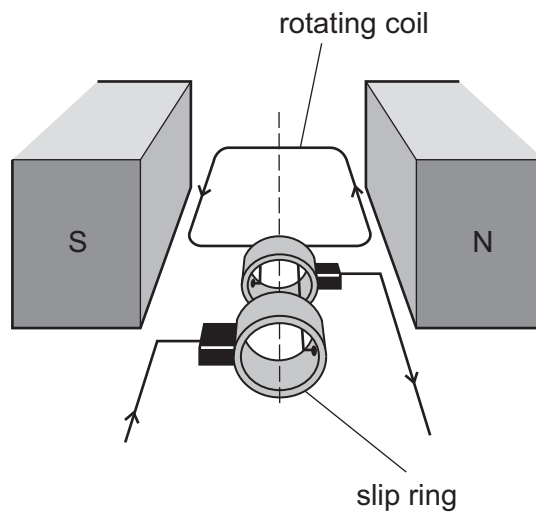


Fig. 1.1

(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.

.....

 [2]

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

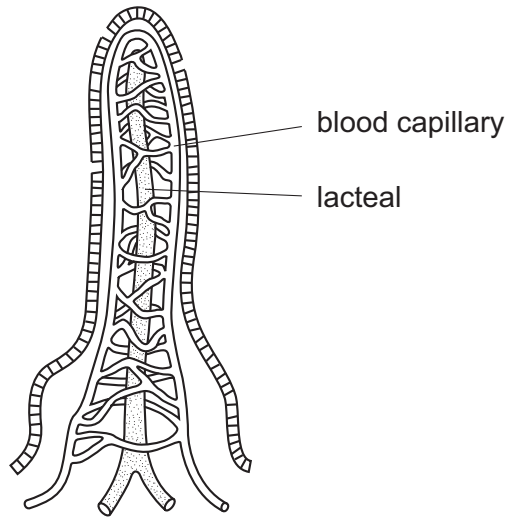


Fig. 2.1

(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.

.....
.....
.....
..... [3]

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

.....
.....
..... [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.

.....
.....
.....
..... [2]

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

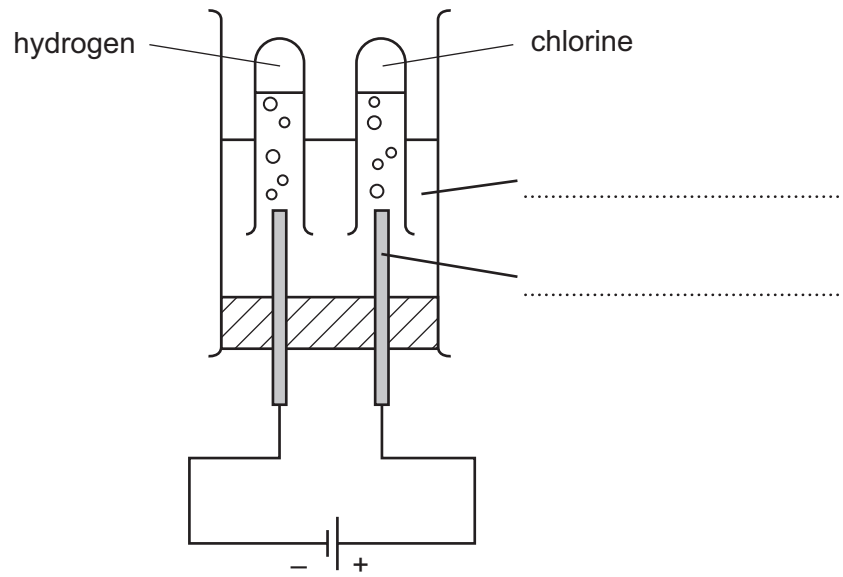


Fig. 3.1

- (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.

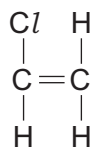
..... [1]

- (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.



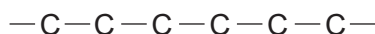
- (i) Describe briefly a chemical test to show that this molecule is unsaturated.

.....

 [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.



[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.

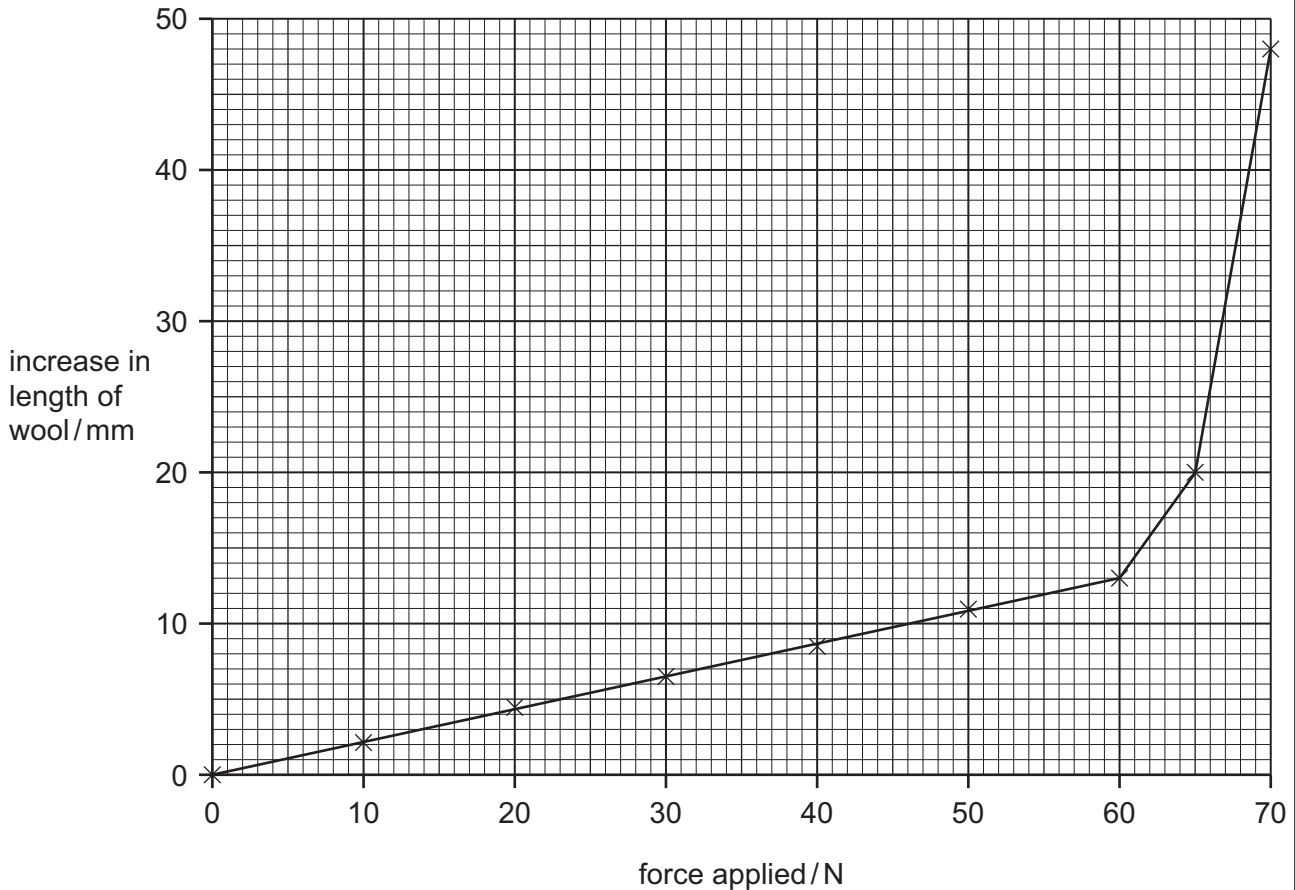


Fig. 5.1

(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.

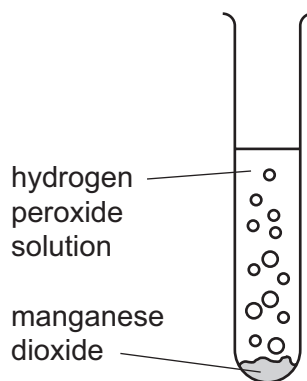
.....
.....
..... [2]

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

(a) Hydrogen peroxide slowly decomposes according to the equation



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.

.....

.....

..... [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.

.....

.....

..... [2]

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

.....

.....

..... [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.

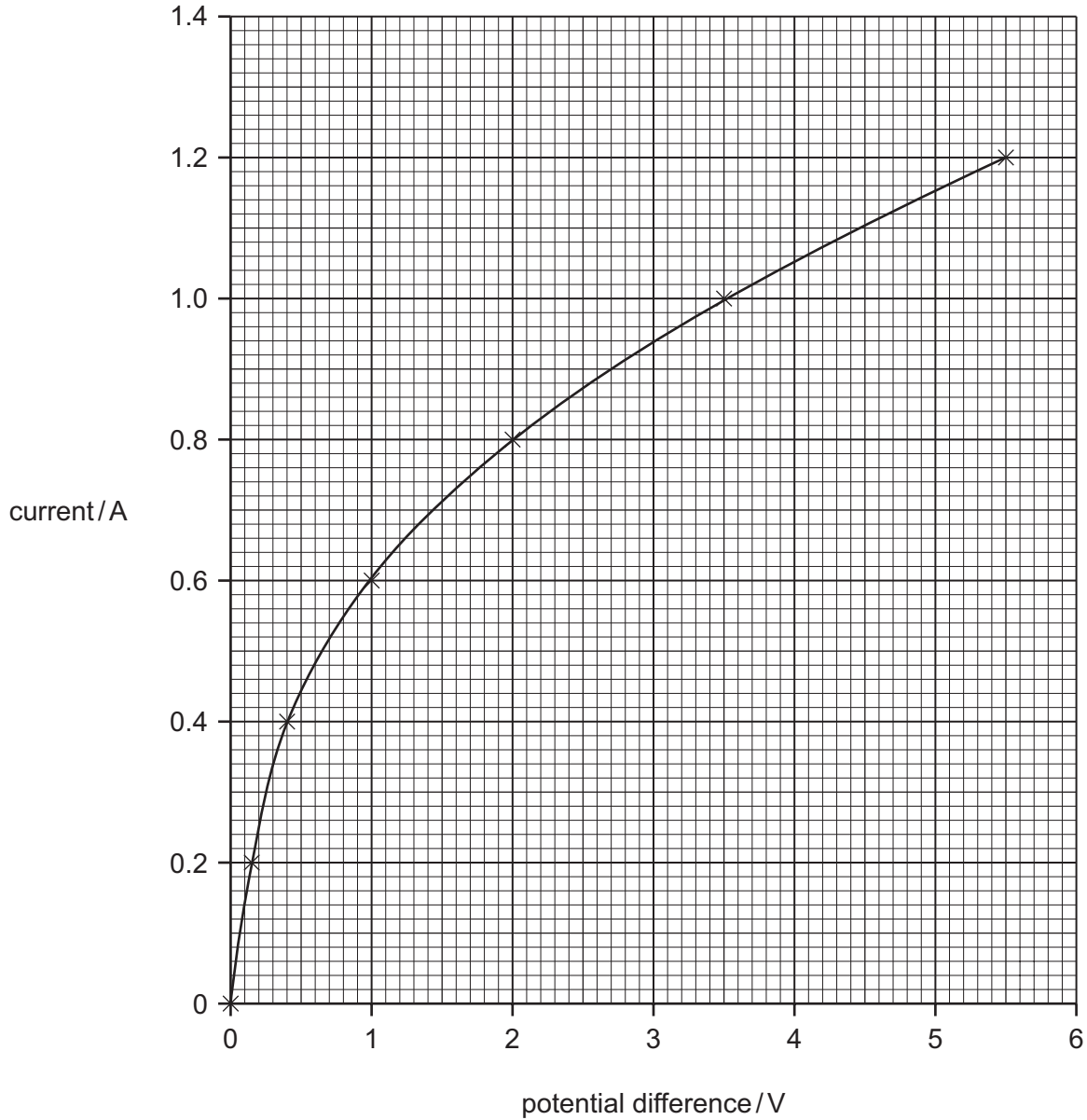


Fig. 7.1

- (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.

.....
.....
.....
.....
.....
..... [4]

8 Fig. 8.1 shows the structure of a flower.

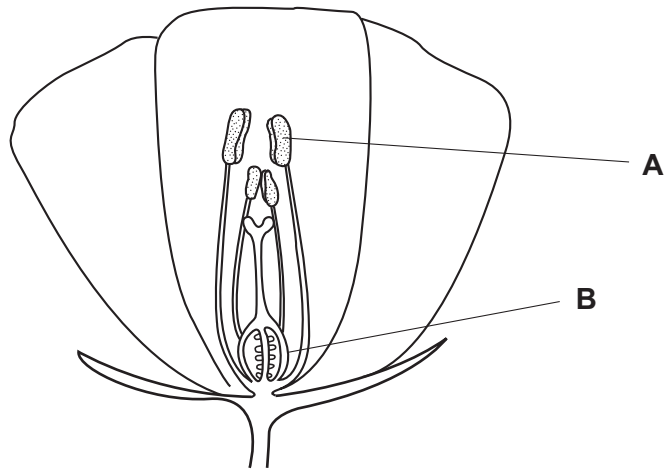


Fig. 8.1

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

A

B [2]

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

.....
.....
.....
..... [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.

.....

.....

.....

..... [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



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.

.....
.....
..... [3]

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DATA SHEET
The Periodic Table of the Elements

		Group										
I	II	III	IV	V	VI	VII	O					
		1 H Hydrogen 1										4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4											20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12	11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	35.5 Cl Chlorine 17	40 Ar Argon 18				
39 K Potassium 19	40 Ca Calcium 20	27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36				
85 Rb Rubidium 37	88 Sr Strontium 38	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	112 Cd Cadmium 48	119 Sn Tin 50	127 I Iodine 53	131 Xe Xenon 54				
133 Cs Caesium 55	137 Ba Barium 56	65 Zn Zinc 30	64 Cu Copper 29	59 Ni Nickel 28	108 Ag Silver 47	204 Pb Lead 82	207 Po Polonium 84	86 Rn Radon 86				
226 Ra Radium 88	227 Ac Actinium 89	56 Fe Iron 26	59 Co Cobalt 27	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77	195 Pt Platinum 78	201 Hg Mercury 80				
		55 Mn Manganese 25	56 Fe Iron 26	101 Ru Ruthenium 44	106 Pd Palladium 46	190 Os Osmium 76						
		52 Cr Chromium 24	55 Mn Manganese 25	101 Ru Ruthenium 44	106 Pd Palladium 46	190 Os Osmium 76						
		51 V Vanadium 23	52 Cr Chromium 24	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		48 Ti Titanium 22	51 V Vanadium 23	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		45 Sc Scandium 21	48 Ti Titanium 22	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		89 Y Yttrium 39	91 Zr Zirconium 40	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		139 La Lanthanum 57	91 Zr Zirconium 40	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		178 Hf Hafnium 72	91 Zr Zirconium 40	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		184 W Tungsten 74	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		186 Re Rhenium 75	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		238 U Uranium 92	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		232 Th Thorium 90	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		140 Ce Cerium 58	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		141 Pr Praseodymium 59	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		144 Nd Neodymium 60	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		150 Sm Samarium 62	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		152 Eu Europium 63	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		157 Gd Gadolinium 64	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		162 Dy Dysprosium 66	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		167 Er Erbium 68	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		169 Tm Thulium 69	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		173 Yb Ytterbium 70	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		175 Lu Lutetium 71	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		102 No Nobelium 102	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		101 Md Mendelevium 101	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		100 Fm Fermium 100	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		99 Es Einsteinium 99	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		98 Cf Californium 98	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		97 Bk Berkelium 97	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		96 Cm Curium 96	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		95 Am Americium 95	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		61 Pm Promethium 61	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		63 Eu Europium 63	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		64 Gd Gadolinium 64	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		66 Dy Dysprosium 66	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		68 Er Erbium 68	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		69 Tm Thulium 69	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		70 Yb Ytterbium 70	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						
		71 Lu Lutetium 71	93 Nb Niobium 41	103 Rh Rhodium 45	106 Pd Palladium 46	192 Ir Iridium 77						

*58-71 Lanthanoid series
90-103 Actinoid series

Key

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

The volume of one mole of any gas is 24 dm³ at room temperature and pressure (r.t.p.).