Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

COMBINED SCIENCE **0653/03**

Paper 3 (Extended)

October/November 2006

1 hour 15 minutes

Candidates answer on the Question Paper.
No Additional Materials are required.

READ THESE INSTRUCTIONS FIRST

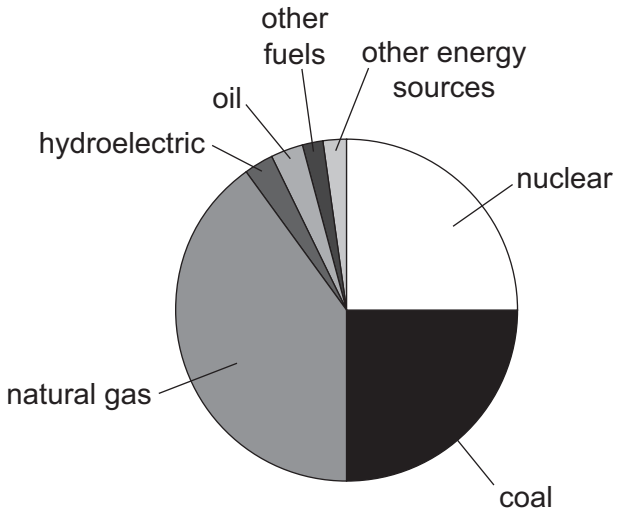
Write your Centre number, candidate number and name on all the work you hand in.
Write in dark blue or black pen.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
A copy of the Periodic Table is printed on page 20.

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	
3	
4	
5	
6	
7	
8	
9	
10	
Total	

1 **(a)** The pie chart in Fig. 1.1 shows the energy sources used to generate the electricity in a European country in one year.



nuclear	25 %
coal	25 %
natural gas	40 %
hydroelectric	3 %
oil	3 %
other fuels	2 %
other energy sources	2 %

Fig. 1.1

(i) Suggest **one** fuel which could have been included in the 'other fuels' section.

.....[1]

(ii) Calculate the percentage of the country's electricity derived from fossil fuels listed in Fig. 1.1.

.....[1]

(b) **(i)** Transformers are used to increase the voltage before electricity is transmitted.

Explain why this is done

.....

.....[1]

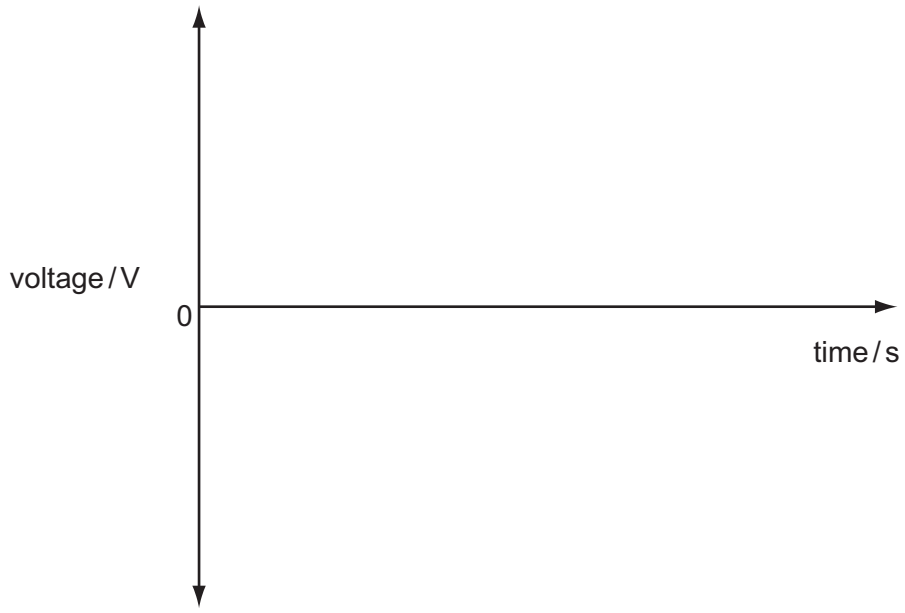
(ii) Explain why the electricity generated in power stations is normally a.c. and not d.c.

.....

.....

.....[2]

(iii) On the grid below sketch a graph to show how the voltage output from an a.c. generator varies with time.



[2]

2 Fig. 2.1 shows a human fetus just before birth.

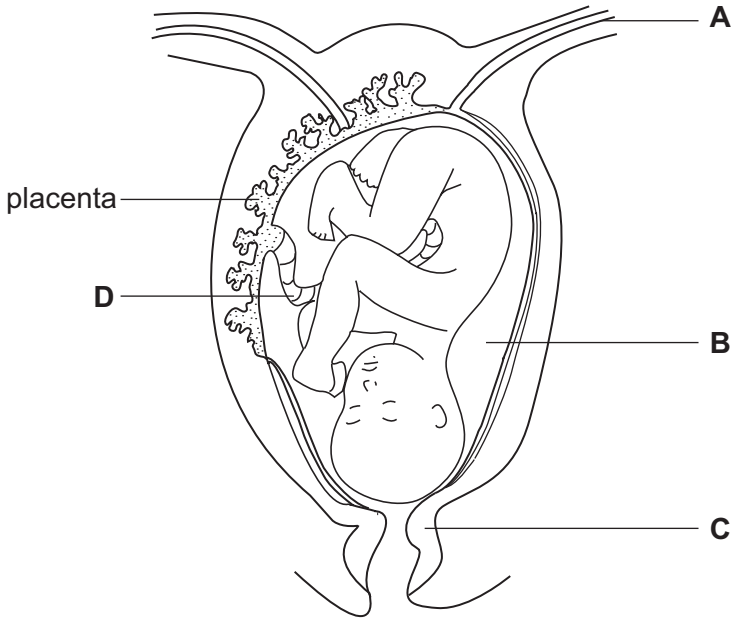


Fig. 2.1

(a) Name structures **A** to **D**.

A .....

B .....

C .....

D ..... [2]

(b) Explain how the developing fetus obtains nutrients while it is in the uterus.

.....

.....

.....

..... [3]

(c) After birth, the baby can be breast fed on milk from its mother, or bottle fed on milk made up from a formula.

Describe **two** advantages, apart from cost, of breast feeding a baby.

.....

.....

.....

..... [2]

(d) If a mother has AIDS, there is a risk that her baby may be born with HIV and develop AIDS.

Explain how this could happen.

.....

.....

.....

..... [2]

3 A student uses the apparatus shown in Fig. 3.1 to investigate several different chemical reactions. In each reaction, a solid reacts with a solution and a gas is produced. The volume of gas produced in each case can be measured using the gas syringe.

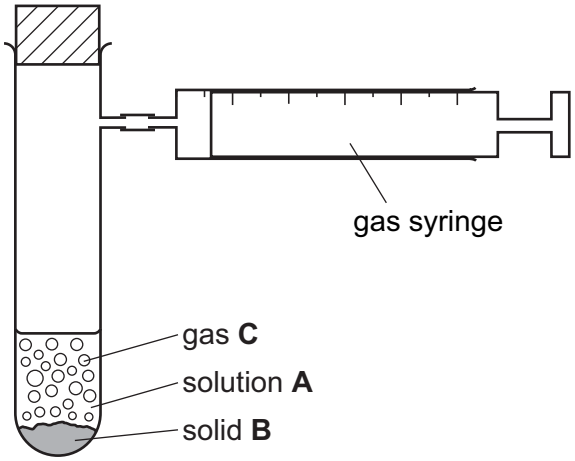


Fig. 3.1

(a) (i) Table 3.1 lists three experiments in which three different solids react with three different solutions.

Complete Table 3.1 by writing in the right hand column the name of the gas **C** produced in each experiment.

Table 3.1

experiment number	solution **A**	pH of solution **A**	solid **B**	gas **C**
1	hydrochloric acid	1.2	calcium carbonate	
2	sulphuric acid	1.5	magnesium	
3	nitric acid	1.1	sodium hydrogencarbonate	

[3]

(ii) Write the chemical formula of nitric acid.

..... [1]

(iii) All aqueous solutions of acids contain hydrogen ions, H^+.

State which acid in Table 3.1 contains the highest concentration of hydrogen ions.

..... [1]

(b) The student then carried out a series of experiments using calcium carbonate and dilute hydrochloric acid. She measured the time taken for 50 cm^3 of gas to collect in the gas syringe shown in Fig. 3.1.

Her results are shown in Table 3.2.

Table 3.2

experiment number	time to collect 50 cm^3 of gas / s
4	40
5	80
6	20

(i) Explain in which reaction, **4**, **5** or **6**, the rate of reaction was the greatest.

.....

..... [2]

(ii) Suggest and explain, in terms of collisions between particles, **one** possible difference in the reaction conditions between experiments **5** and **6** which would explain the difference in reaction rate.

.....

.....

.....

.....

..... [2]

4 A torch contains 3 cells, a switch and a lamp connected in series.

(a) The potential difference across each of the cells in the circuit is 1.5 V.

(i) State the total potential difference across the three cells.

.....

[1]

(ii) State the potential difference across the lamp.

.....

[1]

(b) Fig. 4.1 shows a torch standing on a table. **M** is the position of the centre of mass of the torch.

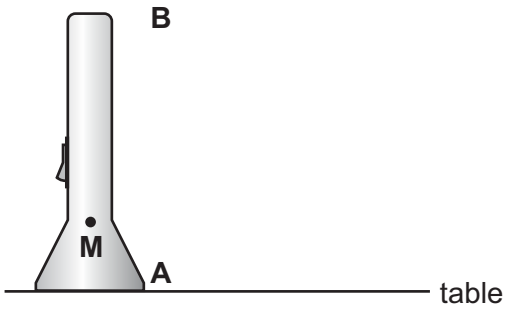


Fig. 4.1

(i) What is meant by the term *centre of mass*?

.....

.....

[1]

(ii) Explain why the torch is more stable if it stands on end **A** rather than on end **B**. Use diagrams in your answer.

.....

.....

[2]

5 An athlete ran on a treadmill on three different days. He ran a different distance on each day. Each time, he ran at a speed that he would use if he was running a race of that particular distance.

The amount of energy that he used and the volume of oxygen that he consumed was measured during each run. The results are shown in Table 5.1.

Table 5.1

distance of run / m	total oxygen consumed / dm^3	total energy used / kJ	mean energy use per metre / kJ
100	10	200	2.0
1500	36	720	0.5
10 000	150	3000	

(a) (i) Explain how the oxygen consumed by the athlete was used to provide the energy that he used in the runs.

.....

.....

.....

..... [3]

(ii) The amount of energy provided by one dm^3 of oxygen was the same in each run. Calculate this value.

..... [1]

(b) (i) Calculate the energy used per metre in the 10 000 metre run, and write the answer in Table 5.1. [1]

(ii) Describe the relationship shown in the table between the mean energy used per metre and the distance of the run. Suggest a reason for this relationship.

.....

.....

..... [2]

(c) At the end of the 100 m run, the athlete carried on breathing very heavily for the next few minutes.
Explain why he did this.

.....

.....

.....

..... [3]

6 Fig. 6.1 shows industrial apparatus used to obtain useful products, **A** to **F**, from petroleum (crude oil).

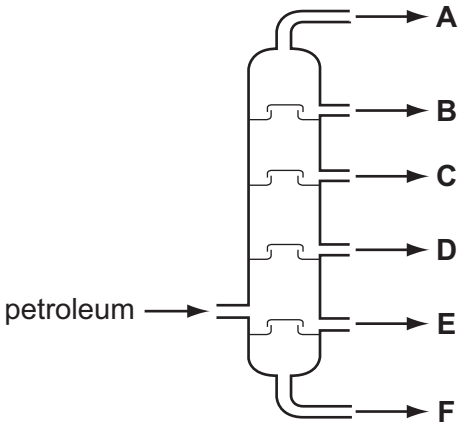


Fig. 6.1

(a) (i) Name the process shown in Fig. 6.1.

..... [1]

(ii) State which of the products, **A** to **F**, is at the highest temperature when it first comes out of the apparatus in Fig. 6.1.

..... [1]

(b) The balanced equation for the complete combustion of methane is shown below.

$$CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$$

(i) Calculate the relative molecular mass of water. The relative atomic masses of hydrogen and oxygen are 1 and 16 respectively.
Show your working.

..... [1]

(ii) When 16 g of methane burn, 44 g of carbon dioxide and 36 g of water are formed.

Calculate the total mass of products when 32 000 g of methane burn.
Show your working.

..... [2]

(c) During the complete combustion of 16 g of methane, some chemical bonds are broken and others are formed. Table 6.2 shows some information about the energy changes involved in this reaction.

Table 6.2

energy absorbed when chemical bonds are broken	energy released when chemical bonds are formed
2632 J	3446 J

(i) Name **one** substance in which bonds are broken during the complete combustion of methane.

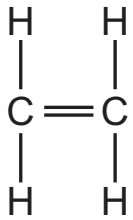
..... [1]

(ii) Use the information in Table 6.2 to explain why the complete combustion of methane is an exothermic reaction.

.....

..... [1]

(d) The displayed formula of ethene is shown below.



Describe what happens when ethene undergoes addition polymerisation to form poly(ethene). You may draw a diagram if it helps you to answer this question.

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.....

..... [2]

7 **(a)** Optical fibres are used to view cavities inside the body. Light is sent down some of the fibres to enable doctors to see what is there.

(i) Fig. 7.1 shows an optical fibre with a ray of light travelling down part of it. Draw the path of the ray of light as it travels down the fibre.

Fig. 7.1

[1]

(ii) Some fibres are used to allow the light to return so that an image can be seen.

Why is it important that light does not leak from one fibre to another?

.....

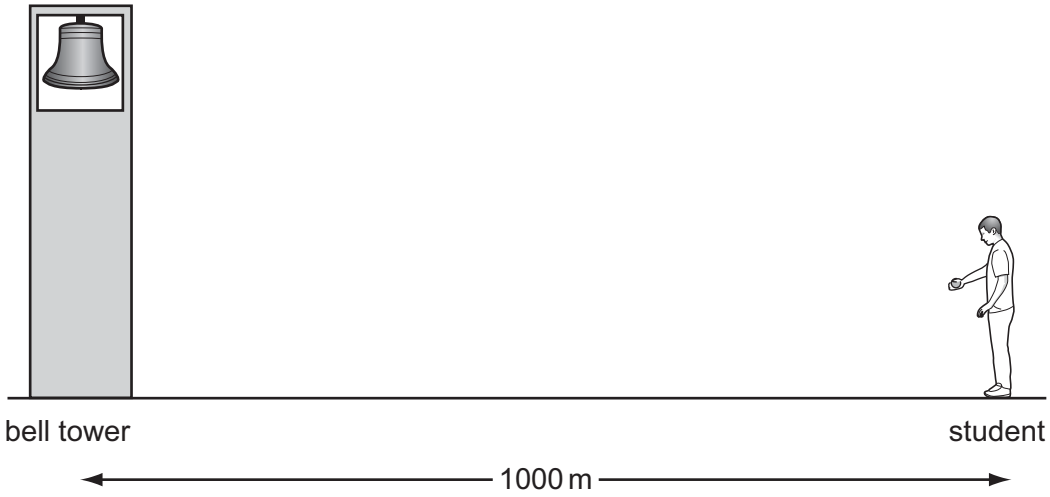
..... [1]

(iii) Suggest why optical fibres are now replacing metal wires as the method by which telephone signals are sent.

.....

..... [1]

(b) A student carried out an experiment to find the speed of sound in air by watching and listening to a bell being rung.
He stood with a timer 1000 m from the bell.



(i) The sound took 3 seconds to travel from the bell to the student.

Calculate the speed of sound.

Show your working and state the formula that you use.

formula used

working

..... [2]

(ii) Describe how the density of an irregular object such as a bell could be determined.

.....

.....

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.....

.....

..... [4]

8 A gardener found that aphids (greenfly) were feeding on his rose plants.

Fig. 8.1 shows an aphid on a rose stem.

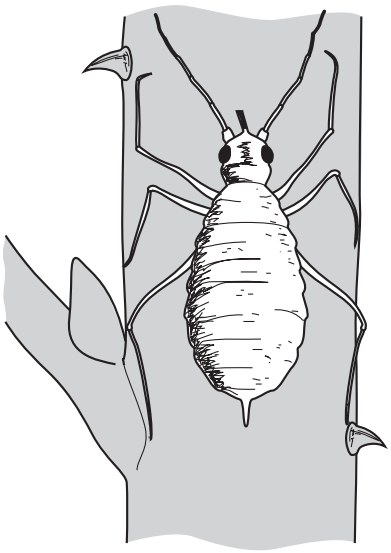

Fig. 8.1

Aphids feed by using their needle-like mouthparts to pierce the plant stems and leaves. They suck out fluid from the plant's phloem tubes.

(a) (i) Explain why even a small insect such as an aphid can reach the fluid in the phloem tubes.

.....

..... [1]

(ii) Explain why the contents of the phloem tubes make a better food source for insects than the contents of the xylem vessels.

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.....

.....

..... [2]

(b) The gardener decided to spray the plants with a systemic insecticide. An insecticide is a pesticide that kills insects. Systemic pesticides are taken into the plant through its leaves and then transported throughout the plant.

(i) Give **two** advantages of systemic pesticides over other kinds of pesticides.

.....

.....

.....

..... [2]

(ii) An alternative method of controlling aphids on rose bushes is to introduce a population of ladybirds to the plants. Ladybirds kill and eat aphids.

Give the name for this kind of pest control.

..... [1]

(c) Phloem is a *tissue*. Explain what is meant by this term.

.....

.....

..... [2]

9 **(a)** Table 9.1 shows some properties of elements.

Write the letter **M** in the right hand column next to properties which are typical of **metallic** elements.

Table 9.1

can be hammered into different shapes	
poor conductor of heat	
is a gas at room temperature (20°C)	
good conductor of electricity	
poor conductor of electricity	

[1]

(b) Aluminium is an important metal in Group III of the Periodic Table.

State the number of protons in one atom of aluminium.

..... [1]

(c) Aluminium is obtained from the compound aluminium oxide by electrolysis.

(i) Fig. 9.2 shows diagrams of an aluminium atom and an oxygen atom.

Complete the diagrams of the aluminium ion and the oxide ion. Include the electrical charges of the ions.

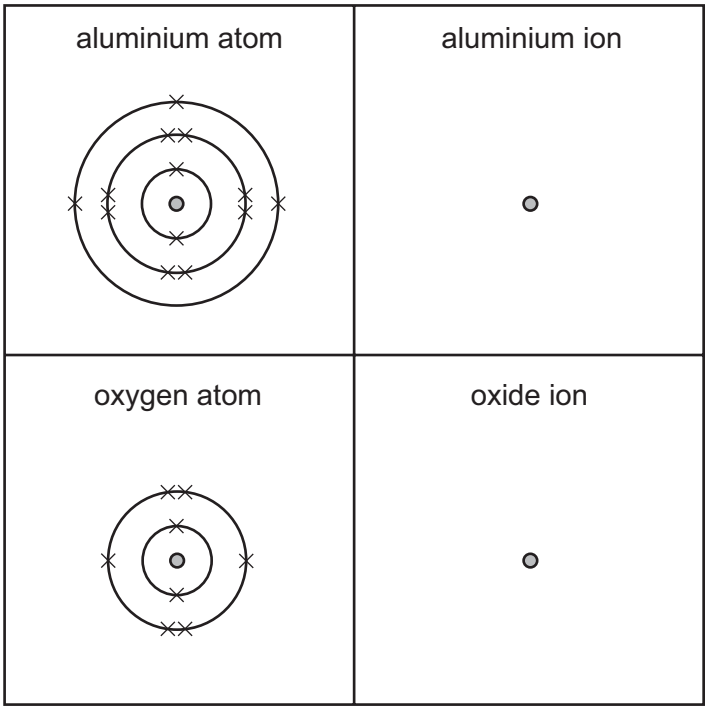

Fig. 9.2

[4]

(ii) Describe what happens to each aluminium ion on the surface of the cathode during electrolysis.

.....

.....

..... [2]

(iii) The symbolic equation below shows the overall chemical change during the electrolysis of aluminium oxide.

Complete the balancing of the equation.

$$Al_2O_3 \longrightarrow 4Al + O_2$$

[1]

10 (a) Explain in terms of particles why, when a gas is compressed, the pressure exerted by the gas on the container increases as its volume decreases.

.....

.....

.....

..... [2]

(b) Explain the difference between speed and velocity.

.....

..... [1]

(c) Explain why a source of alpha radiation is more dangerous if it gets inside the human body than outside the body.

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.....

.....

..... [2]

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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 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 X 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.).