UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME	

CENTRE NUMBER							CANDIDATE NUMBER					

4173626436

COMBINED SCIENCE **0653/33**

Paper 3 (Extended) **May/June 2013**

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 pencil for any diagrams or graphs.
Do not use staples, paper clips, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
You may lose marks if you do not show your working or if you do not use appropriate units.
A copy of the Periodic Table is printed on page 28.

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.

This document consists of **26** printed pages and **2** blank pages.

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International Examinations

1 **(a)** Table 1.1 shows the numbers of protons, neutrons and electrons in four atoms, and **D**.

Table 1.1

atom	protons	neutrons	electrons
A	2	2	2
B	3	4	3
C	1	0	1
D	4	5	4

(i) Explain which one of the atoms, **A**, **B**, **C** or **D**, has a nucleon number (mass number) of four.

atom ....

explanation ....

.... [1]

(ii) Explain why all atoms do **not** have an overall electrical charge.

....

....

.... [2]

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(b) Fig. 1.1 shows containers of hydrogen and helium.

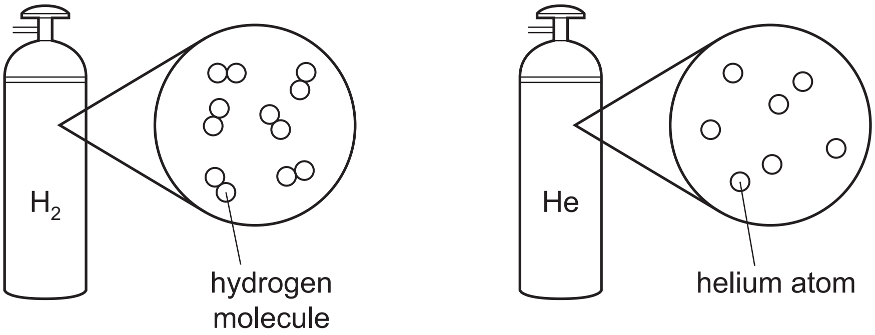
H₂
hydrogen molecule
He
helium atom

Fig. 1.1

(i) Describe, in terms of electrons, how a chemical bond forms between two hydrogen atoms.

You may draw a diagram of a hydrogen molecule if it helps you to answer this question.

....

....

.... [2]

(ii) Explain why helium exists as single atoms and **not** as molecules.

....

.... [1]

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(c) Hydrogen is often included in the reactivity series of metals.

Use the idea of reactivity to explain the observations shown in Fig. 1.2.

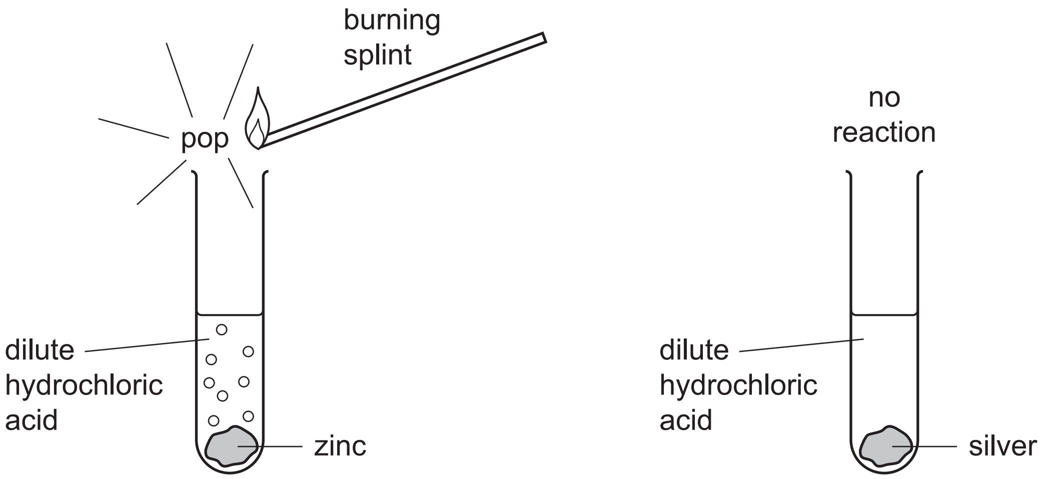
burning
splint
pop
dilute
hydrochloric
acid
zinc
no
reaction
dilute
hydrochloric
acid
silver

Fig. 1.2

....

....

....

....

.... [3]

2 **(a)** A fishing boat uses echo sounding to detect a shoal of fish.

This is shown in Fig. 2.1.

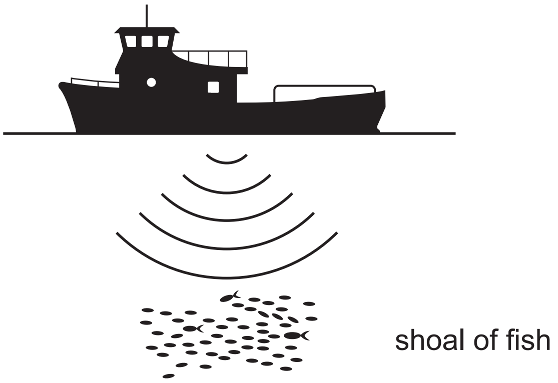

Fig. 2.1

Short pulses of sound are sent out from the boat. The echo from the shoal of fish is detected by a receiver on the boat 0.2 seconds later.

Sound waves travel through water at a speed of 1600 m / s.

(i) Calculate the distance of the shoal of fish below the boat.

State the formula that you use and show your working.

formula

working

.... [2]

(ii) The sound waves have a wavelength of 0.25 m.

Calculate the frequency of the waves.

State the formula that you use and show your working.

formula

working

.... [2]

(b) **(i)** Water waves are a renewable energy resource.

Outline **two** advantages of using renewable energy resources.

1 ....

....

2 ....

.... [2]

(ii) Fig. 2.2 shows how water waves can be used to produce electricity.

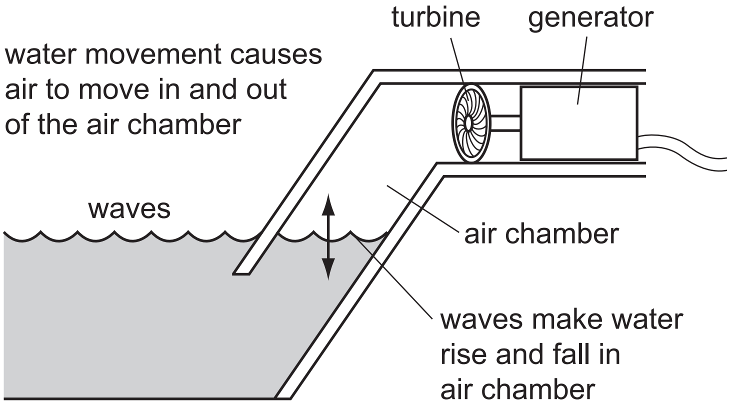
turbine
generator
water movement causes
air to move in and out
of the air chamber
waves
air chamber
waves make water
rise and fall in
air chamber

Fig. 2.2

Using the information in Fig. 2.2, describe **two** of the energy transfers that are involved in changing the kinetic energy of the waves into electrical energy.

....

....

....

....

....

.... [2]

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(c) Fig. 2.3 shows an iceberg floating in the sea.

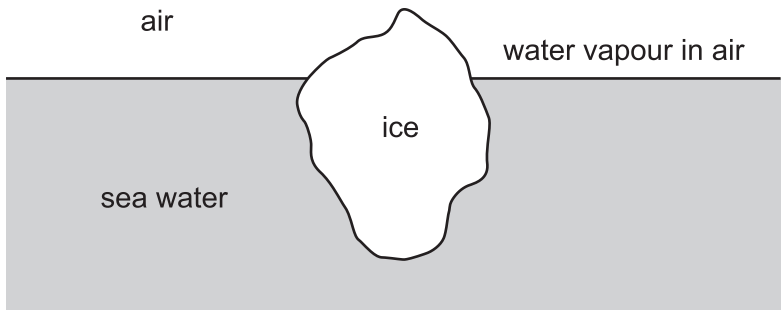
air
water vapour in air
ice
sea water

Fig. 2.3

(i) Which material named on Fig. 2.3 best fits the statement below?

"The particles are able to move, are randomly arranged and are closely packed."

.... [1]

(ii) Name the process by which water molecules in the sea become water molecules in the air.

.... [1]

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3 The addition of a harmful substance to the environment is called pollution. Three exa of pollution caused by human activities are

- acid rain,
- fertilisers entering rivers and lakes,
- the release of too much carbon dioxide into the atmosphere.

(a) Describe how acid rain is caused.

....

....

....

.... [2]

(b) Explain what happens in a lake after large quantities of fertilisers are washed into it.

....

....

....

....

....

.... [3]

(c) Explain how cutting down forests can result in an increase in the carbon dioxide concentration in the atmosphere.

....

....

....

.... [2]

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Please turn over for Question 4.

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[Turn over

4 Petroleum (crude oil) and rock salt occur naturally in the Earth's crust.

(a) Petroleum is a mixture that contains thousands of different compounds. Many of thes compounds are alkanes.

Draw the structure of the alkane molecule that contains eight hydrogen atoms. Use short lines to represent covalent bonds.

[2]

(b) When petroleum is refined, it is separated into simpler mixtures.

Fig. 4.1 shows a simplified diagram of apparatus that is used to refine petroleum.

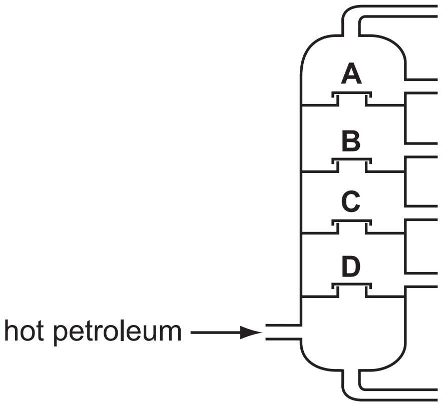

Fig. 4.1

Explain, in terms of intermolecular forces and the size of molecules, why the average boiling point of the fraction at **B** differs from the average boiling point of the fraction at **C**.

....

....

....

....

.... [3]

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(c) Rock salt contains mainly sodium chloride which is a compound of the alkali sodium, and the halogen, chlorine.

(i) Explain why the uncombined elements sodium and chlorine are **not** found in the Earth's crust.

....

.... [1]

(ii) Describe the changes in electron configuration when sodium atoms (2,8,1) react with chlorine atoms (2,8,7) to form sodium chloride.

....

....

.... [2]

5 Milk is a liquid produced by cows, goats and other mammals, on which they fee young.

(a) Table 5.1 shows the mass of some of the substances in 100 g samples of milk from three mammals.

Table 5.1

substance	cow's milk	goat's milk	water-buffalo's milk
protein / g	3.2	3.1	4.5
fat / g	3.9	3.5	8.0
carbohydrate / g	4.8	4.4	4.9
calcium / mg	120	100	195

(i) Which substance shown in Table 5.1 is present in the samples of milk in the smallest quantity?

.... [1]

(ii) Suggest which substance, **not** shown in Table 5.1, is present in the samples of milk in the largest quantity.

.... [1]

(iii) Explain **one** way in which drinking water-buffalo's milk might be better for a person's health than drinking goat's milk.

....

....

.... [2]

(iv) State and explain which substance in Table 5.1 does **not** need to be digested in the human alimentary canal.

....

....

.... [2]

(b) Milk can be used for making yoghurt.

- Bacteria are added to the milk. The milk is kept at a temperature of 40 °C.
- The bacteria convert lactose in the milk to lactic acid.
- When the pH has reached about 4.5, the yoghurt is moved to a refrigerator at a temperature of 3 °C.

(i) Explain why the milk is kept at a temperature of 40 °C after the bacteria have been added to it.

....

....

.... [2]

(ii) Suggest why the yoghurt is kept in a refrigerator at a temperature of 3 °C.

....

.... [1]

(iii) Milk has a pH of about 6.5. Explain why the pH of milk changes during the manufacture of yoghurt.

....

.... [1]

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6 **(a)** In a store, two workers are lifting 5 kg bags of flour onto the shelves. There a
shelves, 0.4 m apart. The lowest shelf is 0.4 m from the floor.

Fig. 6.1 shows the two workers.

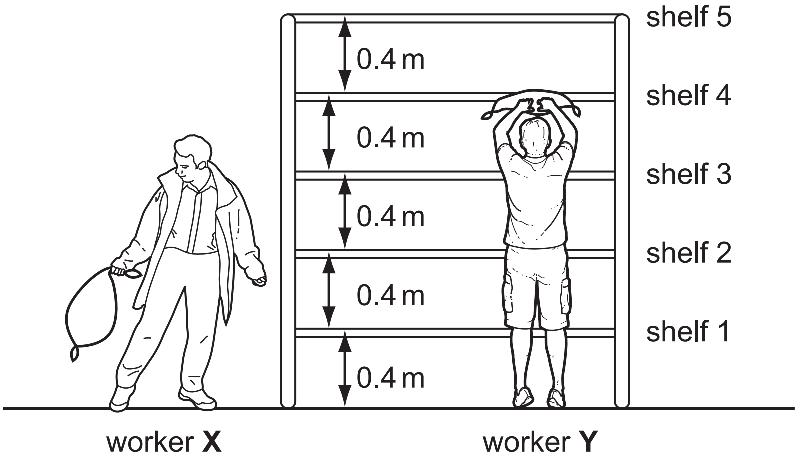
shelf 5
shelf 4
shelf 3
shelf 2
shelf 1
0.4 m
0.4 m
0.4 m
0.4 m
0.4 m
worker **X**
worker **Y**

Fig. 6.1

(i) Worker **X** lifts three bags from the floor to shelf 2. Worker **Y** lifts one bag from the floor to shelf 5.

Worker **X** says that he has done more work than worker **Y**.

Use calculations of the work done to explain whether or not he is correct.

State the formula that you use.

formula

....

.... [2]

(ii) Each worker lifts one bag from the floor to shelf 2. Worker **X** does this more quickly than worker **Y**.

Which worker exerted the higher power during their lift?

Explain your answer.

....

.... [1]

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(iii) Each 5 kg bag of flour has a volume of 5500 cm^3.

Calculate the average density of the bag of flour.

State your answer in g/cm^3.

State the formula that you use and show your working.

formula

working

.... g/cm^3 [2]

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(b) Three boys, **A**, **B** and **C**, walk together from their school to a store. They stay store for a few minutes and then return to school.

When they leave the store,

- one boy walks back to school at a steady pace,
- one boy walks back to school at a slower steady pace,
- one boy slows down gradually as he walks back to school.

The graph in Fig. 6.2 shows how their speeds vary with time during the whole journey to the store and back again.

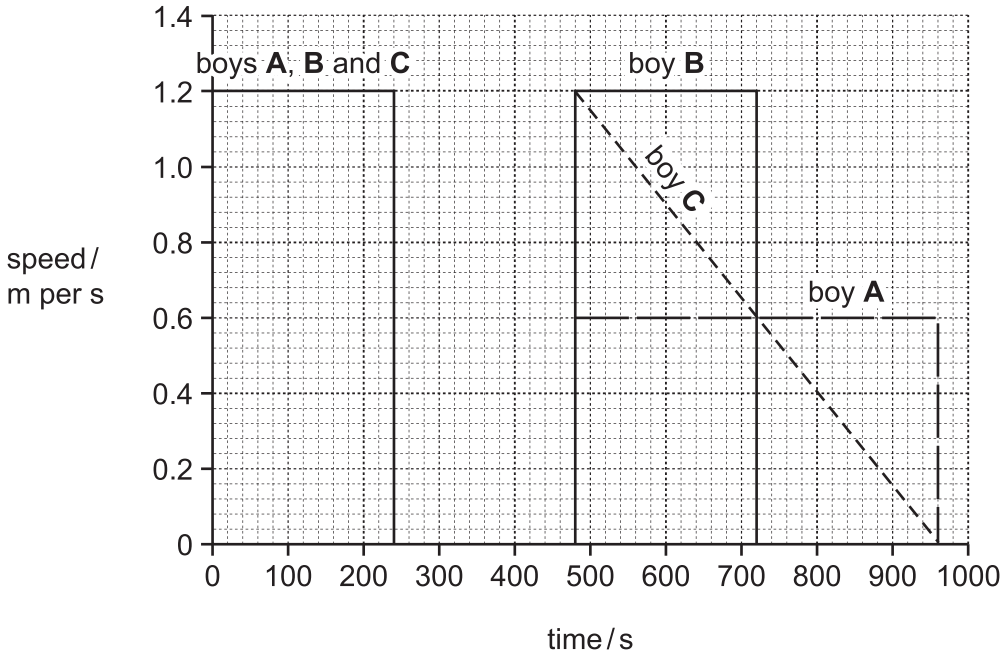

Fig. 6.2

(i) Calculate the distance of the store from the school.

Show your working.

.... [2]

(ii) For how many seconds do the boys stay in the store?

.... s [1]

(iii) Which boy slowed down on his way back to school?

State a reason for your answer.

boy .... because ....

.... [1]

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7 **(a)** Fig. 7.1 shows apparatus a student used to investigate the reaction between a powder and dilute hydrochloric acid.

The student predicted that a gas would be given off in her experiment and chose to test the gas using limewater.

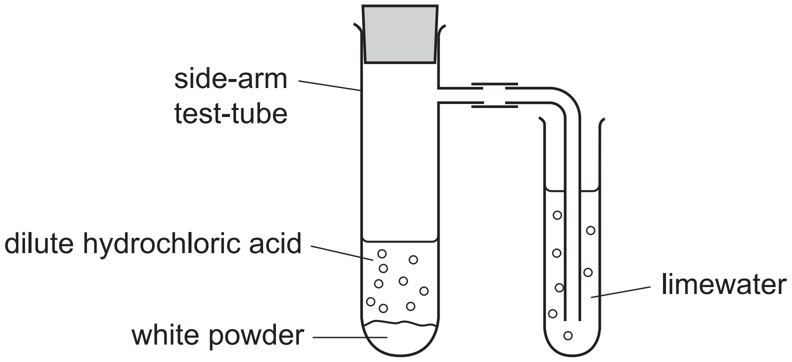
side-arm test-tube
dilute hydrochloric acid
white powder
limewater

Fig. 7.1

State the gas that the student predicted would be given off.

Explain your answer.

name of gas ....

explanation ....

....

.... [2]

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(b) The student investigated the temperature change when sodium hydrogencar was added to excess dilute hydrochloric acid.

Fig. 7.2 shows the apparatus she used.

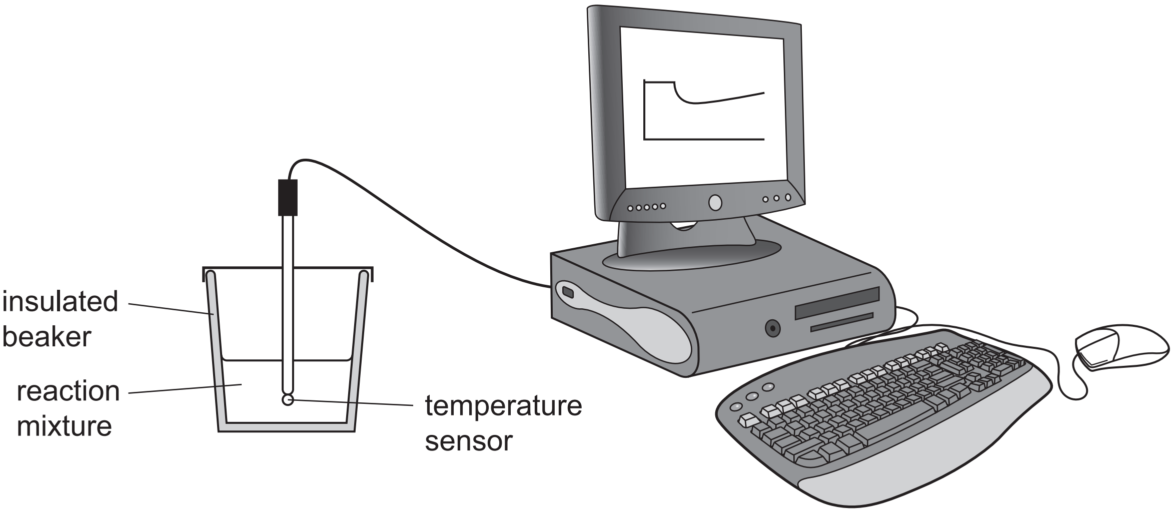
insulated beaker
reaction mixture
temperature sensor

Fig. 7.2

Temperature measurements were displayed on the computer screen as a graph of temperature against time.

This graph is shown in Fig. 7.3.

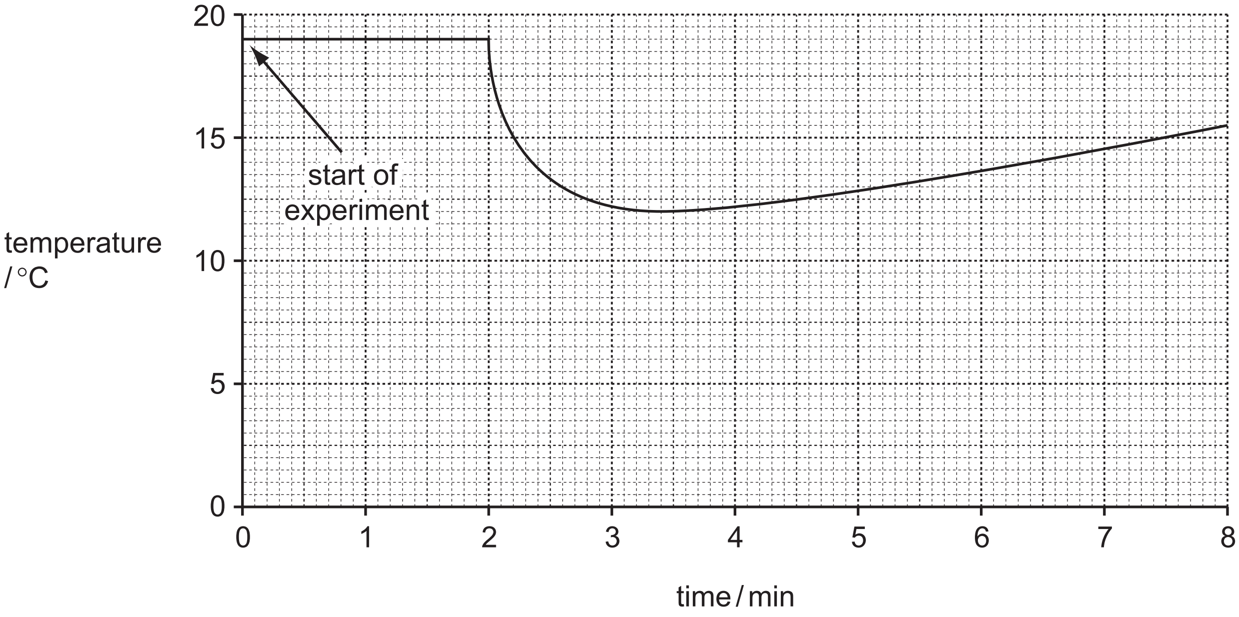

Fig. 7.3

(i) On the graph, mark with an **X** the point where sodium hydrogencarbonate was added to the dilute hydrochloric acid. [1]

(ii) Calculate the temperature change shown in Fig. 7.3 that occurred dur reaction.

.... [2]

(iii) Use the results shown in Fig. 7.3 to explain, in terms of chemical energy and heat energy, the energy transformation that occurred during the reaction.

....

....

.... [2]

(c) Sodium hydrogencarbonate, $NaHCO_3$, is a solid compound made of sodium ions and hydrogencarbonate ions. Sodium is a metal in Group 1 of the Periodic Table.

Deduce the formula and electrical charge of a hydrogencarbonate ion.

Explain your answer.

....

....

.... [3]

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8 Fig. 8.1 shows the human gas exchange system.

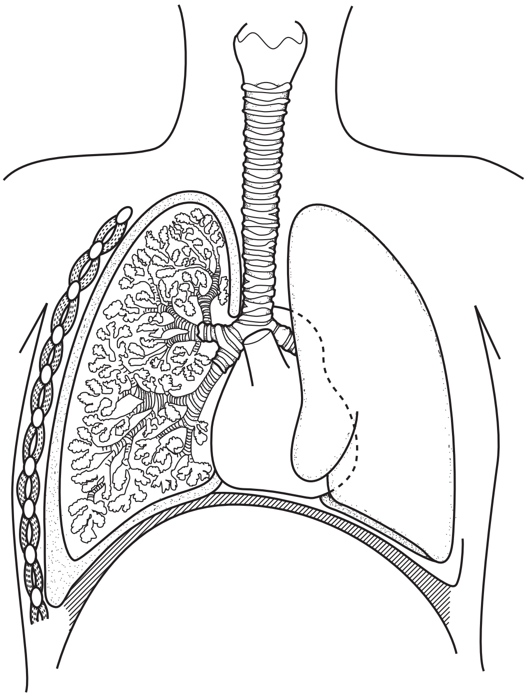

Fig. 8.1

(a) Use label lines to label each of these structures on Fig. 8.1.

trachea

bronchus [2]

(b) Gas exchange takes place across the surface of the alveoli in the lungs.

List **two** features of alveoli that help gas exchange to take place quickly.

1 ....

2 .... [2]

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(c) The gas exchange system is protected from pathogens and harmful substance tissue, containing goblet cells and ciliated cells, that lines the nose, trachea bronchi.

Fig. 8.2 shows part of this tissue inside the nose.

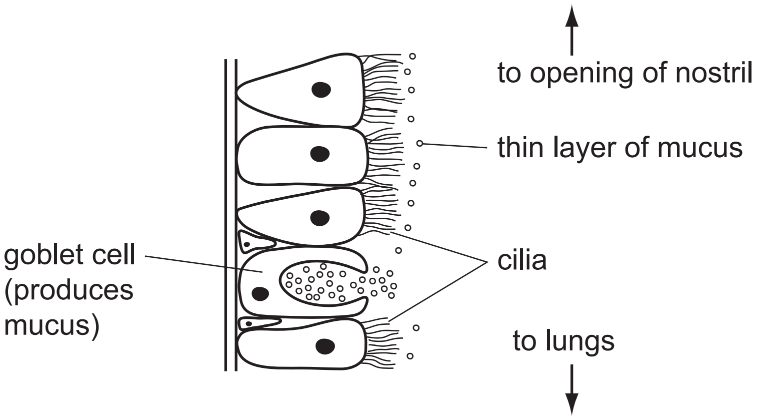
to opening of nostril
thin layer of mucus
goblet cell (produces mucus)
cilia
to lungs

Fig. 8.2

Describe how the tissue shown in Fig. 8.2 helps to stop harmful substances getting into the lungs.

....

....

....

.... [2]

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(d) An experiment was carried out to find out how passive smoking affects the ac the goblet cells and cilia.

Six people sat in a closed room. On day **1**, they breathed normal, clean air. On day **2**, they breathed air containing cigarette smoke.

After one hour, a substance was sprayed into each person's nose. After 40 minutes, the researchers measured the percentage of the substance that remained in each person's nose. This was done on both days.

The faster the cilia and goblet cells were working, the faster the substance was removed from the nose.

Table 8.1 shows the results.

Table 8.1

person	percentage of substance remaining after 40 minutes	
	day **1** after breathing clean air	day **2** after breathing air containing cigarette smoke
1	65	26
2	84	49
3	67	96
4	23	51
5	40	91
6	78	24

(ii) Which three persons' results showed that breathing air containing cigarette smoke slowed down the rate at which their cilia and goblet cells worked?

.... [1]

(ii) Suggest how exposure to cigarette smoke could affect the health of these three people.

....

....

....

....

....

.... [3]

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Please turn over for Question 9.

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9 **(a)** A student investigated how a change in potential difference across a lamp affec
current flowing through the lamp.

She used wires to connect the components shown in Fig. 9.1 to make a circuit.

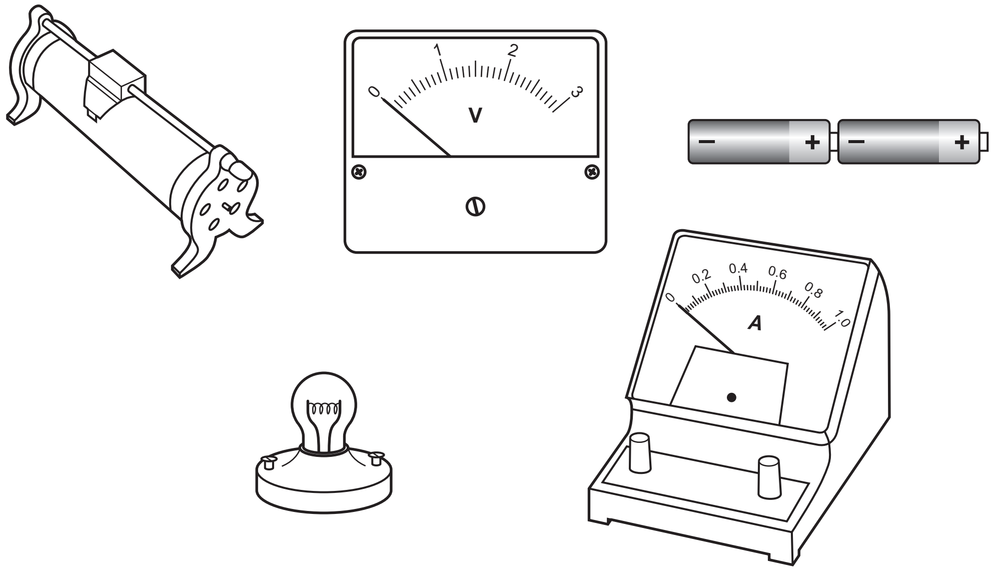

Fig. 9.1

(i) Using the correct circuit symbols, draw a diagram to show the circuit she used.

[3]

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(ii) The student measured the current passing through a wire when a po difference was applied across it.

Calculate the resistance of the wire when a potential difference of 0.3 V is applied and the current measured is 0.5 A.

State the formula that you use and show your working.

formula

working

.... [2]

(b) Electricity is often transmitted through overhead power cables hung from pylons. If these cables are put up on a hot summer day, they are hung loosely from the pylons as shown in Fig. 9.2.

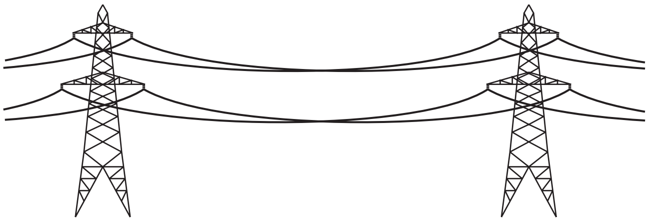

Fig. 9.2

Suggest why the cables are hung loosely.

....

....

.... [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** 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 **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.).

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