



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE
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COMBINED SCIENCE

Paper 3 (Extended)

0653/31

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.



- 1 (a) Table 1.1 shows the numbers of protons, neutrons and electrons in four atoms, **A**, **B**, **C** 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]

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

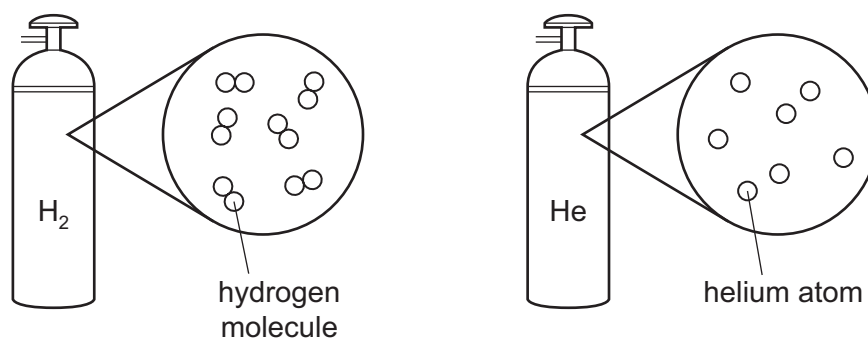


Fig. 1.1

- (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]

(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.

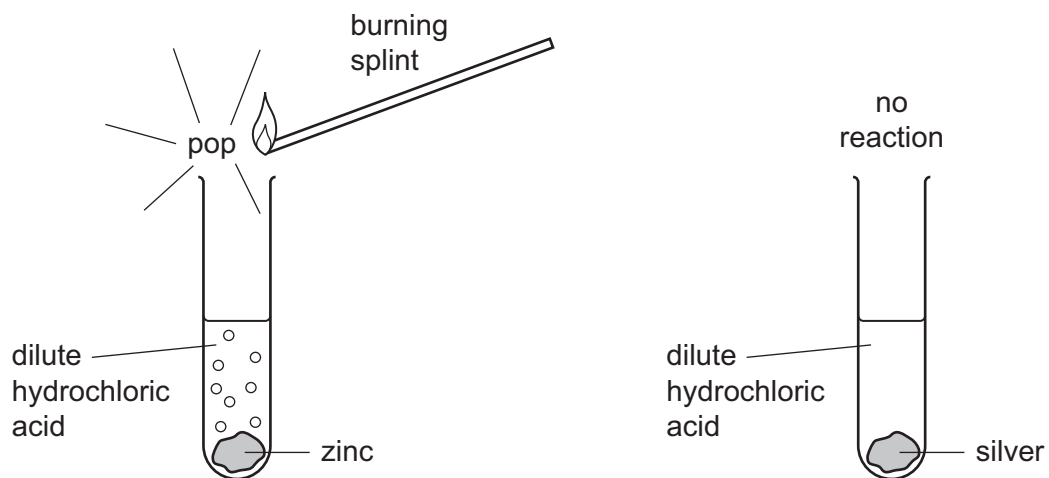


Fig. 1.2

.....

.....

.....

.....

..... [3]

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

This is shown in Fig. 2.1.

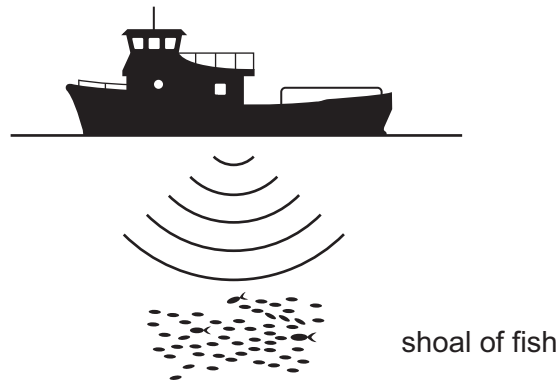


Fig. 2.1

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.

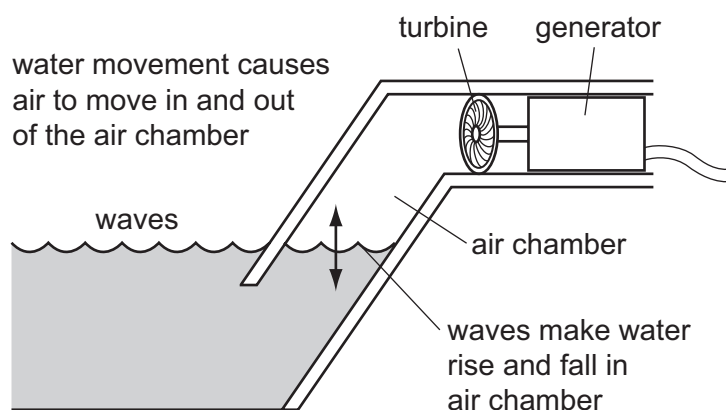


Fig. 2.2

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]

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

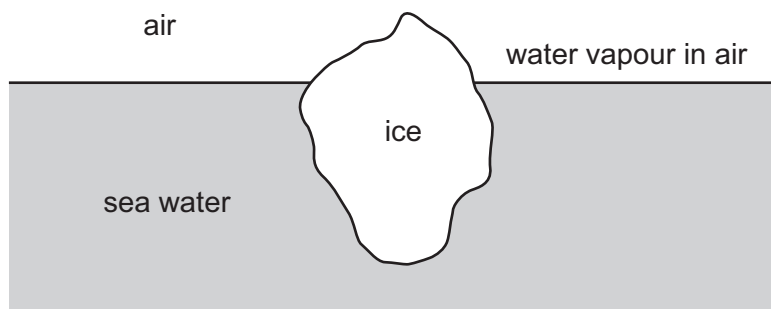


Fig. 2.3

(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]

- 3 The addition of a harmful substance to the environment is called pollution. Three examples 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]

Please turn over for Question 4.

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 these 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.

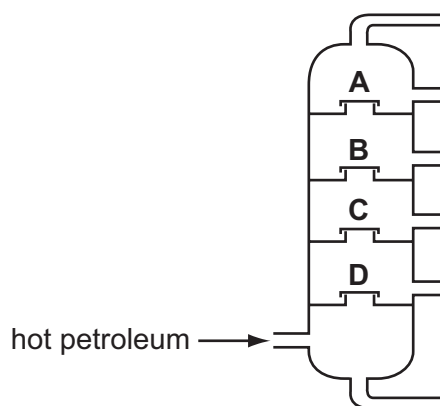


Fig. 4.1

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]

- (c) Rock salt contains mainly sodium chloride which is a compound of the alkali metal, 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 feed their young.

- (a) Table 5.1 shows the mass of some of the substances in 100g 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]

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

Fig. 6.1 shows the two workers.

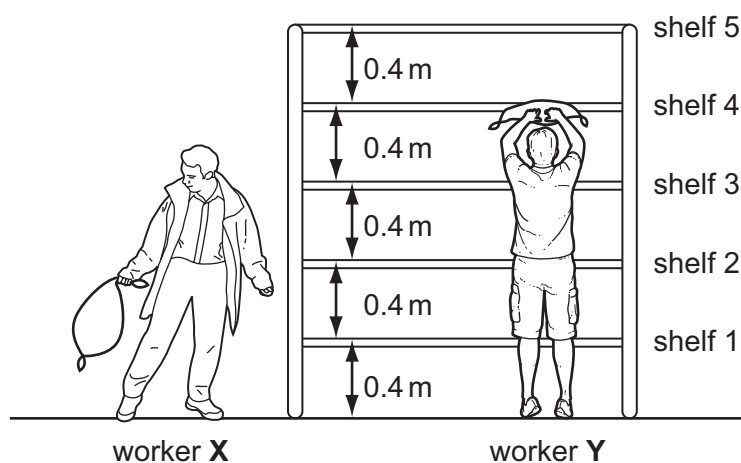


Fig. 6.1

- (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]

- (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]

- (b) Three boys, **A**, **B** and **C**, walk together from their school to a store. They stay in the 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.

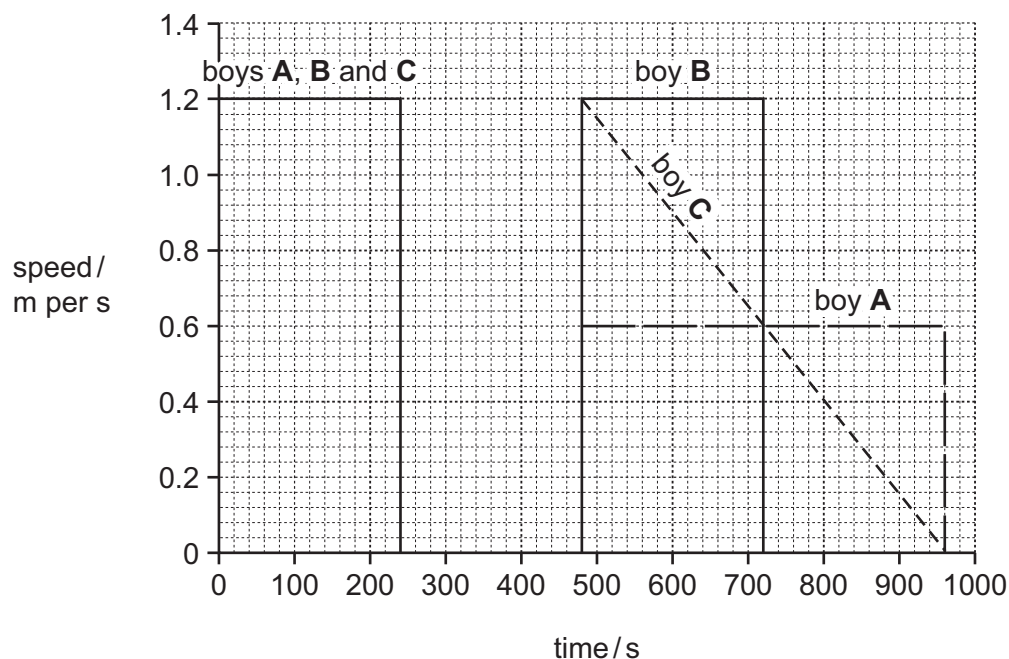


Fig. 6.2

- (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]

- 7 (a) Fig. 7.1 shows apparatus a student used to investigate the reaction between a white 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.

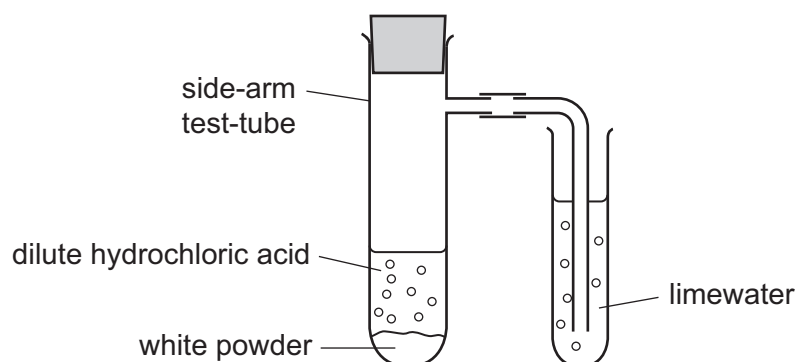


Fig. 7.1

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

Explain your answer.

name of gas

explanation

.....

..... [2]

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

Fig. 7.2 shows the apparatus she used.

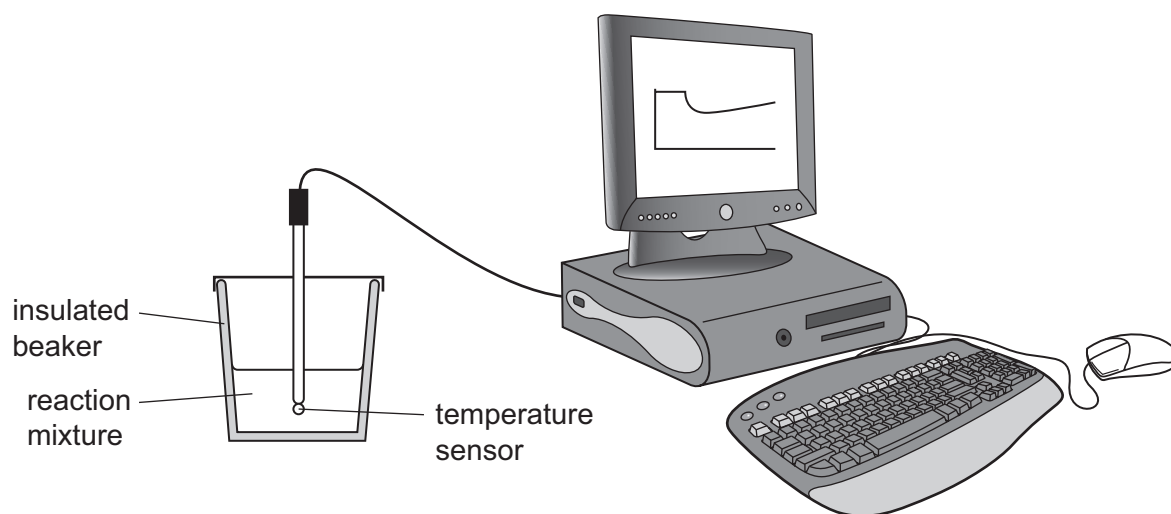


Fig. 7.2

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

This graph is shown in Fig. 7.3.

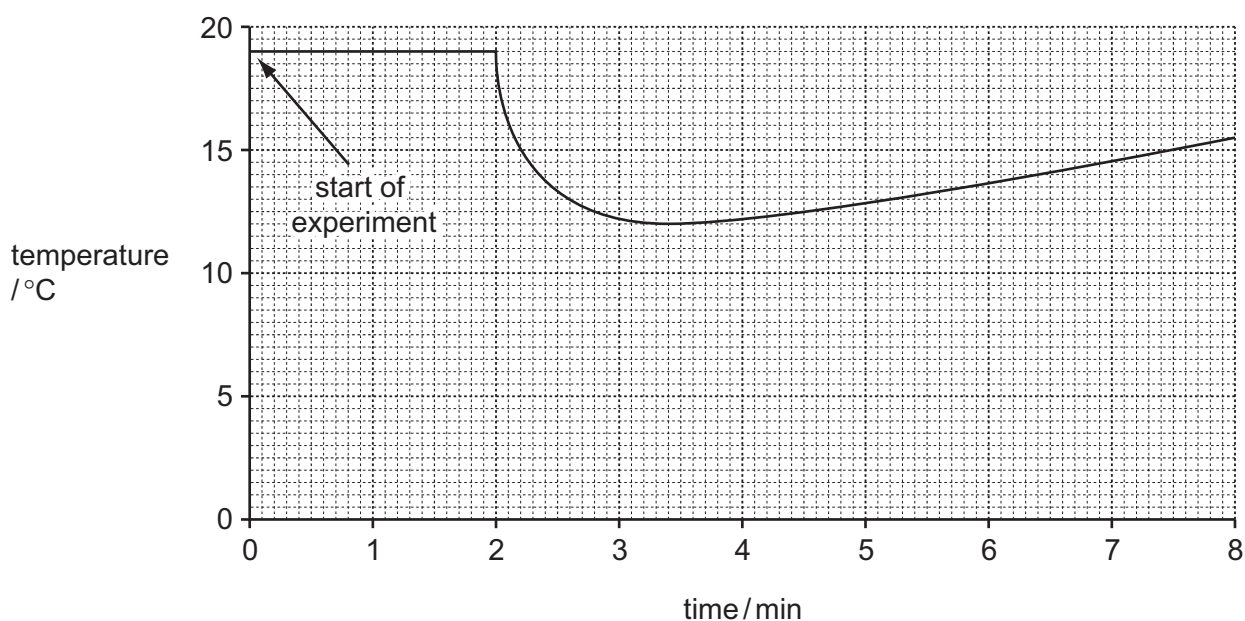


Fig. 7.3

- (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 during the 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]

- 8 Fig. 8.1 shows the human gas exchange system.

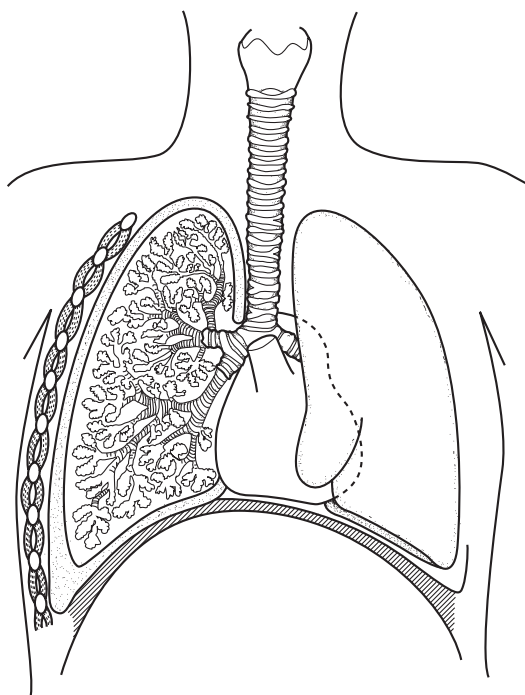


Fig. 8.1

- (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]

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

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

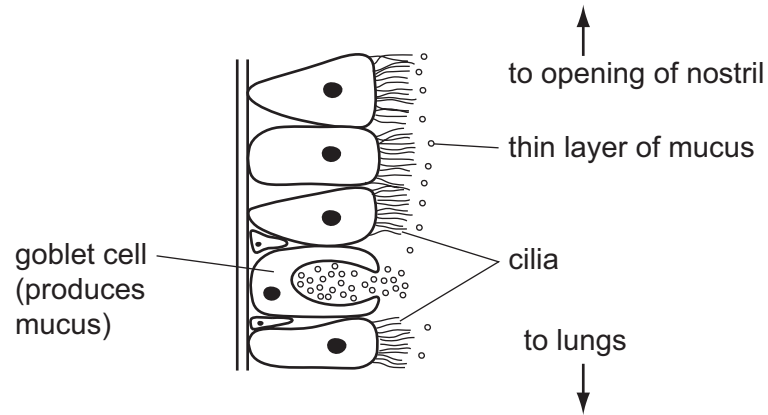


Fig. 8.2

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

.....

.....

.....

..... [2]

- (d) An experiment was carried out to find out how passive smoking affects the action of 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]

Please turn over for Question 9.

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

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

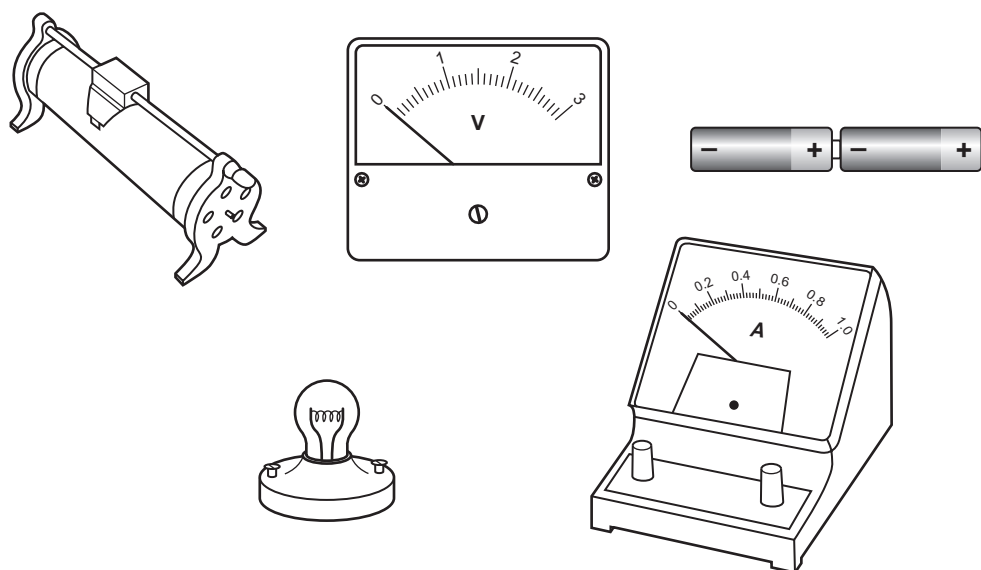


Fig. 9.1

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

[3]

- (ii) The student measured the current passing through a wire when a potential 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.

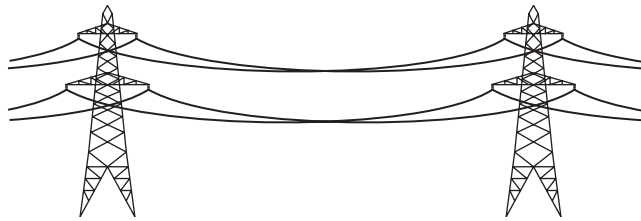


Fig. 9.2

Suggest why the cables are hung loosely.

.....

 [2]

DATA SHEET
The Periodic Table of the Elements

Group																	
I	II											III	IV	V	VI	VII	0
		1 H Hydrogen															
3 Li Lithium	4 Be Beryllium											5 B Boron	6 C Carbon	7 N Nitrogen	8 O Oxygen	9 F Fluorine	10 Ne Neon
11 Na Sodium	12 Mg Magnesium											13 Al Aluminium	14 Si Silicon	15 P Phosphorus	16 S Sulfur	17 Cl Chlorine	18 Ar Argon
19 K Potassium	20 Ca Calcium	21 Sc Scandium	22 Ti Titanium	23 V Vanadium	24 Cr Chromium	25 Mn Manganese	26 Fe Iron	27 Co Cobalt	28 Ni Nickel	29 Cu Copper	30 Zn Zinc	31 Ga Gallium	32 Ge Germanium	33 As Arsenic	34 Se Selenium	35 Br Bromine	36 Kr Krypton
37 Rb Rubidium	38 Sr Strontium	39 Y Yttrium	40 Zr Zirconium	41 Nb Niobium	42 Mo Molybdenum	43 Tc Technetium	44 Ru Ruthenium	45 Rh Rhodium	46 Pd Palladium	47 Ag Silver	48 Cd Cadmium	49 In Indium	50 Sn Tin	51 Sb Antimony	52 Te Tellurium	53 I Iodine	54 Xe Xenon
55 Cs Caesium	56 Ba Barium	57 La Lanthanum	72 Hf Hafnium	73 Ta Tantalum	74 W Tungsten	75 Re Rhenium	76 Os Osmium	77 Ir Iridium	78 Pt Platinum	79 Au Gold	80 Hg Mercury	81 Tl Thallium	82 Pb Lead	83 Bi Bismuth	84 Po Polonium	85 At Astatine	86 Rn Radon
87 Fr Francium	88 Ra Radium	89 Ac Actinium															
58-71 Lanthanoid series																	
90-103 Actinoid series																	
a X Key b X a = relative atomic mass X = atomic symbol b = proton (atomic) number																	
			140 Ce Cerium	141 Pr Praseodymium	144 Nd Neodymium	150 Sm Samarium		152 Eu Europium	157 Gd Gadolinium	159 Tb Terbium	162 Dy Dysprosium	165 Ho Holmium	167 Er Erbium	169 Tm Thulium	173 Yb Ytterbium	175 Lu Lutetium	
			232 Th Thorium	238 Pa Protactinium		238 Pu Plutonium		238 Am Americium		238 Cm Curium		238 Bk Berkelium		238 Cf Californium		238 Es Einsteinium	
			238 Fr Francium		238 Ac Actinium		238 Th Thorium		238 Pa Protactinium		238 U Uranium		238 Np Neptunium		238 Pu Plutonium		
			238 Am Americium		238 Cm Curium		238 Bk Berkelium		238 Cf Californium		238 Es Einsteinium		238 Fm Fermium		238 Md Mendelevium		
			238 No Nobelium		238 Lr Lawrencium		238 Uu Ununium		238 Uub Unbium		238 Uut Untrium		238 Uuq Unquadium		238 Uuh Unhexium		

a	X	b
Key		
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.).



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- 1 Most of the elements in the Periodic Table can be classified as either metals or non-metals.

Fig. 1.1 shows the elements in Group 4 of the Periodic Table.

carbon
silicon
germanium
tin
lead

Fig. 1.1

- (a) (i) Use the classification of metal or non-metal to describe how the Group 4 elements differ from both Group 1 (alkali metals) and Group 7 (halogens).

.....

 [2]

- (ii) Francium and astatine are rare elements which are placed respectively in Group 1 and Group 7 of the Periodic Table.

Predict how the melting points of francium and astatine differ from the other elements in their respective groups.

Explain your predictions briefly.

.....

 [2]

- (b) Fig. 1.2 shows apparatus used to carry out a redox reaction to extract lead from lead oxide, PbO.

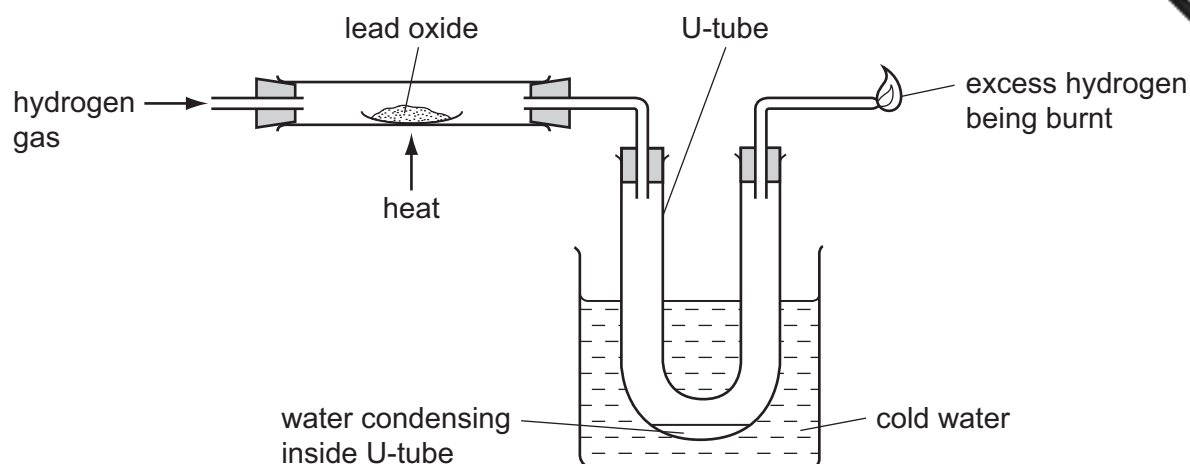
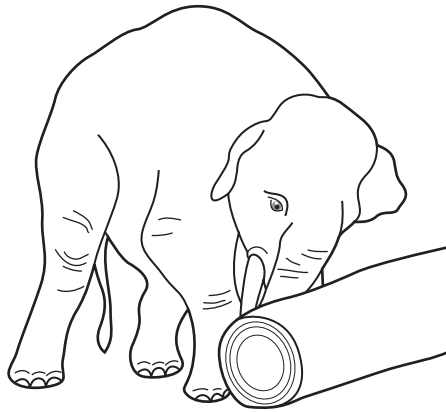


Fig. 1.2

- (i) Describe a chemical test and its result which would confirm that the liquid condensing inside the U-tube is water.
-
-
- [2]
- (ii) Construct a balanced symbolic equation for the reaction between hydrogen and lead oxide.
- [2]
- (iii) Suggest why the method shown in Fig. 1.2 could **not** be used to extract calcium from calcium oxide.
-
-
- [2]

- 2 (a) An elephant of mass 5000 kg exerts a constant force of 1400 N to push a tree trunk along at a steady speed of 1.5 m/s.



- (i) Calculate the work done by the elephant when the tree trunk moves 10 m.

State the formula that you use and show your working.

formula

working

..... [2]

- (ii) Calculate the kinetic energy of the elephant when it is moving at 1.5 m/s.

State the formula that you use and show your working.

formula

working

..... [2]

- (b) The volume of the elephant is 5 m^3 . Its mass is 5000 kg.

Calculate the density of the elephant.

State the formula that you use and show your working.

formula

working

..... [2]

- (c) An elephant can communicate with other elephants using infrasound. This is a very low frequency vibration which it is usually impossible for a human to hear.

- (i) Suggest a possible frequency for this vibration and explain why you chose your answer.

frequency Hz

explanation

..... [2]

- (ii) State the meaning of the term *frequency*.

.....

..... [1]

- (iii) Other animals can communicate using ultrasound.

Suggest how ultrasound differs from infrasound.

.....

..... [1]

- 3 A pea seed was planted in a pot. When the seed had grown into a young plant, the pot was placed on its side, in a room where light was coming from all sides.

Fig. 3.1 shows the young pea plant three days after the pot had been placed on its side.

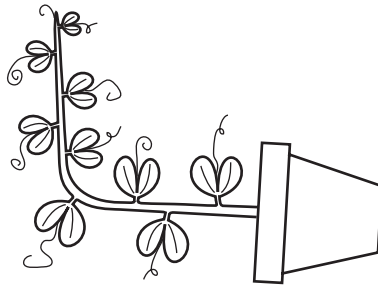


Fig. 3.1

- (a) (i) Name the response shown by the pea plant in Fig. 3.1.

..... [1]

- (ii) Suggest how this response will help the plant to reproduce sexually when it has grown to maturity.

.....

.....

..... [2]

(b) On one of the days when the pot was placed on its side, a scientist measured

- the increase in length of the upper surface and the lower surface of the stem of a pea plant,
- the concentration of auxin in the cells on the upper surface and lower surface of the stem of the pea plant.

His results are shown in Fig. 3.2.

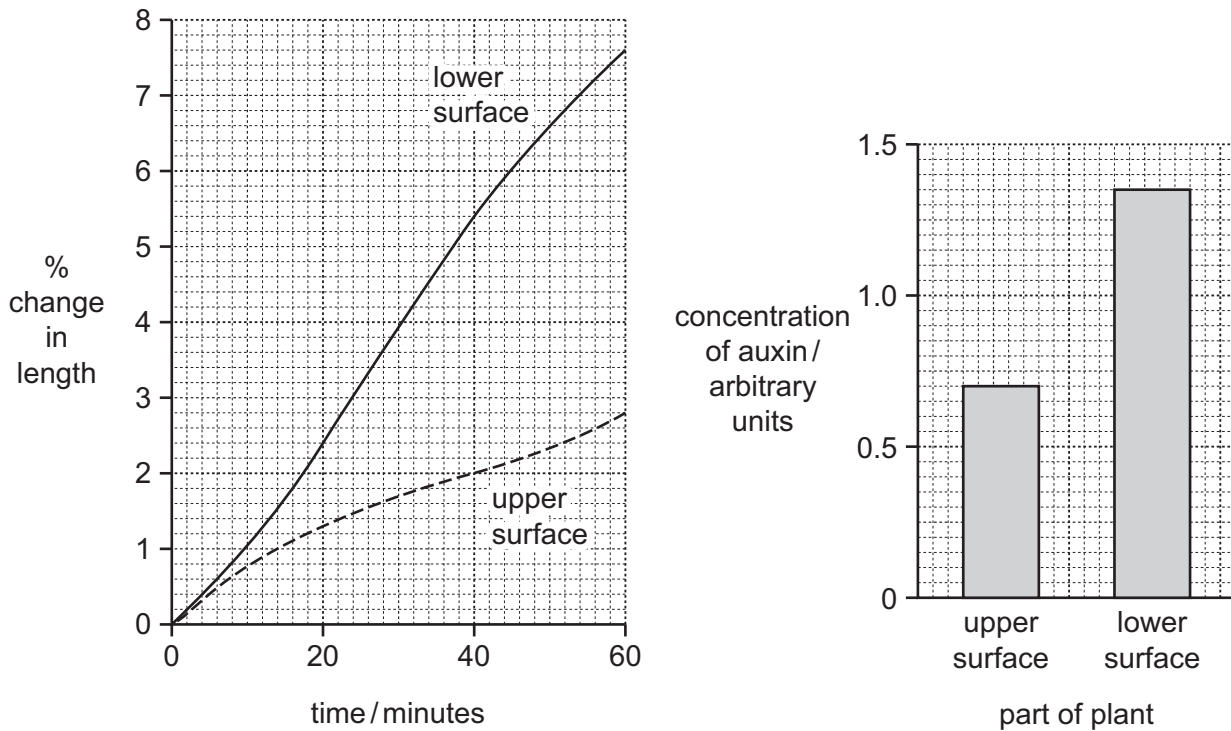


Fig. 3.2

Use the results in Fig. 3.2 to explain what has caused the stem of the pea plant to grow upwards.

.....

.....

.....

.....

.....

.....

.....

[3]

- 4 Fig. 4.1 shows a microwave oven.

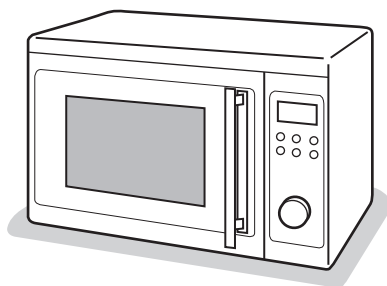


Fig. 4.1

- (a) (i) Microwaves cook food by transferring energy to the food.

Choose words from the list to complete the sentences below. You may use each word once, more than once, or not at all.

chemical	conduction	convection
potential	radiation	thermal

Microwaves are absorbed by the outer layers of food.

The microwave energy is transferred to water and fat molecules in these layers, increasing the energy of these layers.

..... energy is mostly transferred to the centre of solid food by [2]

- (ii) State **one** use for microwaves other than cooking.

..... [1]

- (b) The following label is found on a cooker that combines a microwave oven and a grill.

voltage	220 V
microwave oven power	0.60 kW
grill power	1.20 kW

Some meat is cooked using both the microwave oven and the grill. Both are switched on at full power for 30 minutes.

Calculate the total energy transferred by the cooker.

Show your working.

..... [3]

- (c) Electrical lighting is now being designed so that it is more efficient and can operate using less electrical energy.

Explain why reducing the amount of energy used by electrical lighting could reduce the amount of carbon dioxide emitted into the atmosphere.

.....

.....

.....

..... [2]

- 5 (a) When sodium is burned in air, a mixture of solid products, which contains the compound sodium oxide, is produced.

Fig. 5.1 shows diagrams of a sodium atom and an oxygen atom as they exist just before sodium oxide starts to form.

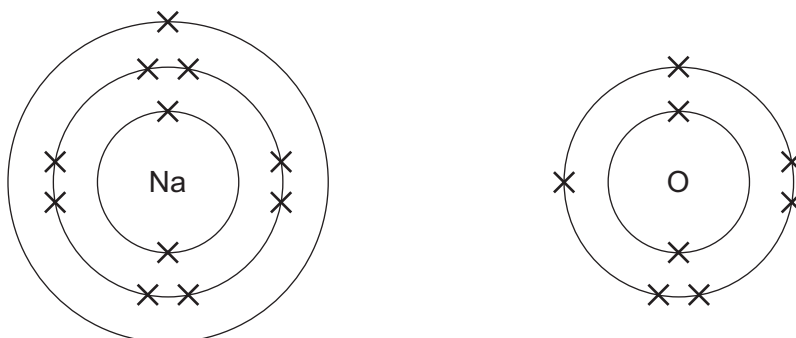


Fig. 5.1

Describe how sodium and oxygen atoms become bonded together. Your answer should explain why the formula of sodium oxide is Na_2O .

.....

.....

.....

.....

..... [3]

- (b) Fig. 5.2 shows apparatus a student used to investigate the electrolysis of dilute sulfuric acid.

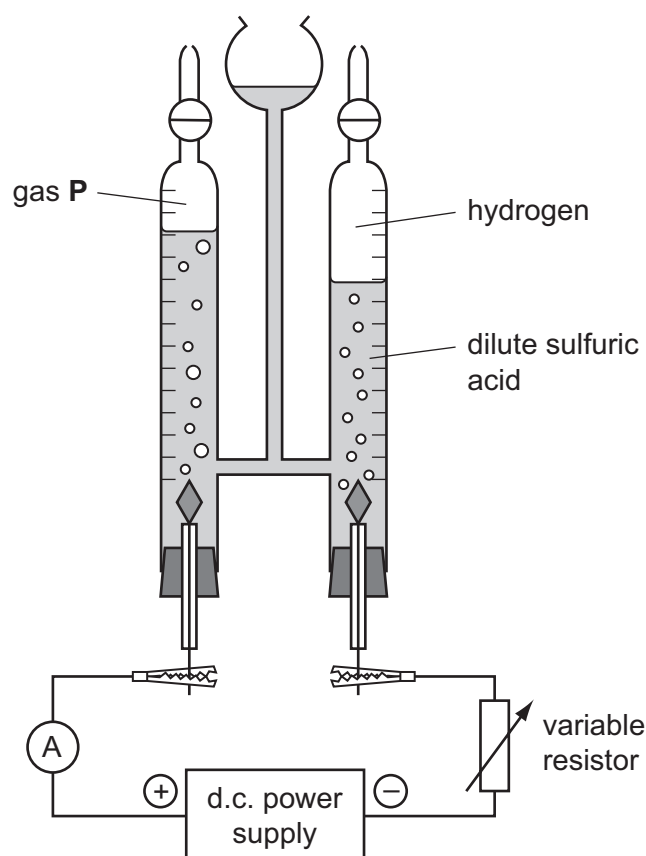


Fig. 5.2

The variable resistor was included in the electrolysis circuit so that the student could alter the current.

Table 5.1 shows some of the measurements the student made in his investigation.

Table 5.1

experiment number	current / A	time current was passed / seconds	volume of hydrogen collected / cm ³
1	0.48	400	24
2	0.24	400	12

- (i) The student thought that gas **P** could be oxygen.

Describe the test that the student should use to find out whether or not gas **P** is oxygen.

.....

..... [1]

- (ii) Calculate the rate at which hydrogen was produced in experiment 1.

Show your working and state the units.

..... [2]

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

Describe, in terms of electrons, ions and atoms, what happens when hydrogen ions collide with the surface of the negative electrode.

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

- (iv) Use your knowledge of electric current to suggest an explanation for the difference in the results for experiments 1 and 2.

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

- 6 Fig. 6.1 shows a food chain. The arrows show how energy flows from one organism to another, along the chain.

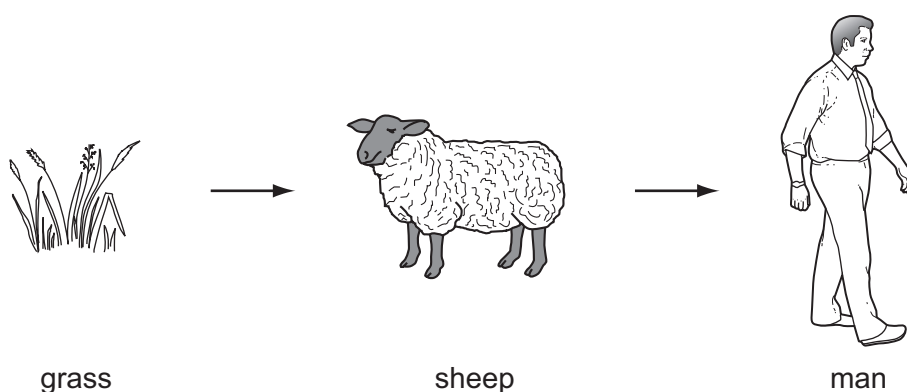


Fig. 6.1

- (a)** The grass is the producer in this food chain.

Explain how plants produce a supply of chemical energy at the start of the food chain.

.....

.....

.....

.....

.....

..... [4]

- (b)** Energy is lost between the trophic levels in a food chain.

Describe **one** way in which energy is lost from this food chain.

.....

.....

..... [2]

- (c) (i)** The cells in the man's body use respiration to release useful energy from nutrients that he has absorbed.

State the balanced equation for aerobic respiration.

..... [2]

- (ii) A person living in a very cold climate generally needs to eat more than a person living in a hot climate.

Explain why.

.....

.....

.....

..... [3]

- 7 (a) A circuit for a torch (flashlight) contains two cells, a lamp and a switch.

Using the correct symbols, draw a circuit diagram for the torch.

[2]

- (b) Torches are usually powered by electrical cells. They can also be powered by energy from the Sun (solar energy).

Solar energy is a renewable energy resource.

Name **one** other renewable energy resource and **one** non-renewable energy resource.

renewable energy resource

non-renewable energy resource [1]

- (c) (i) A resistor of 1200Ω is connected in series with another resistor of 2400Ω .

Calculate the combined resistance of these two resistors.

State the formula that you use and show your working.

formula

working

..... [2]

- (ii) If the two resistors had been connected in parallel, which of the values below would be the combined resistance of the two resistors?

Explain your answer.

800 Ω

1200 Ω

1600 Ω

2400 Ω

3600 Ω

combined resistance

explanation

..... [2]

- 8 (a) A student added a solution of the same dilute acid to each of the test-tubes shown in Fig. 8.1.

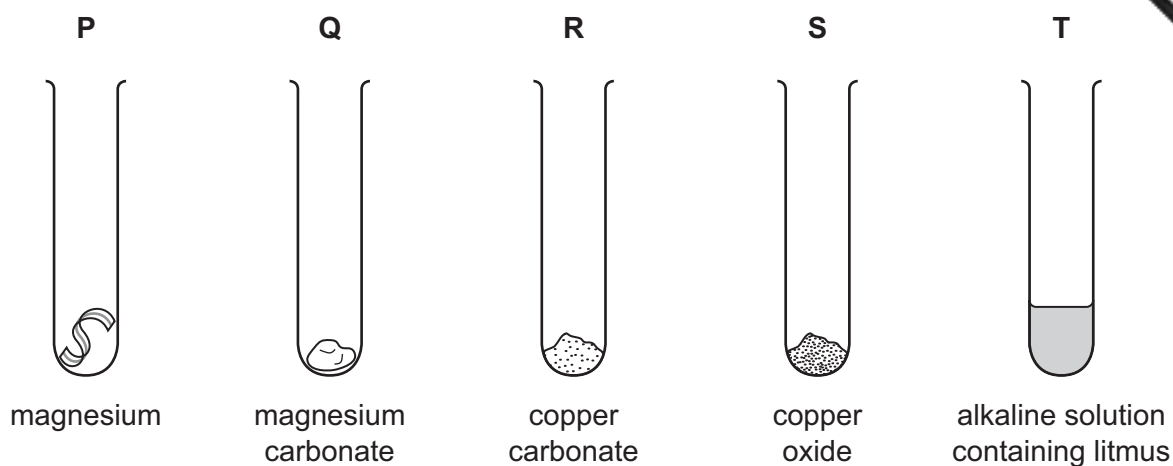


Fig. 8.1

Complete Table 8.1 by matching the test-tubes, **P**, **Q**, **R**, **S** and **T**, with the observations which are made when the dilute acid reacts with the contents.

Some of the observations apply to more than one of the test-tubes. You may use each letter once, more than once or not at all.

Table 8.1

observations	test-tube(s)
The mixture turns red when excess acid has been added.	
A colourless gas is given off.	
A blue solution is formed.	
A colourless gas which pops when ignited is given off.	

[4]

- (b) The student used the apparatus shown in Fig. 8.2 to investigate neutralisation reactions involving two acids, **A** and **B**.

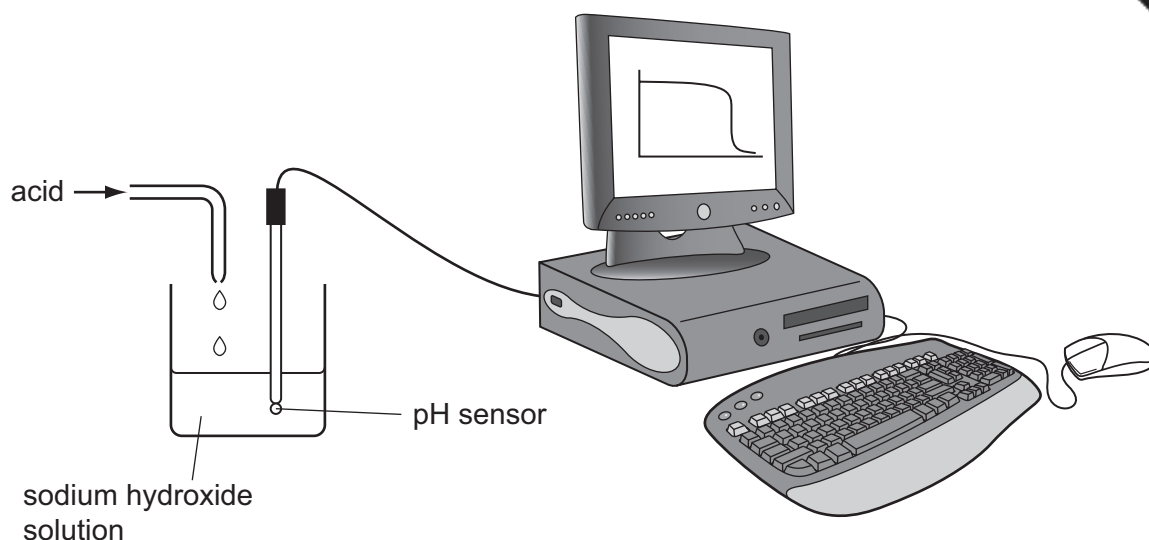


Fig. 8.2

In each experiment, 25.0 cm^3 of the same solution of sodium hydroxide were placed into a beaker. The acid was added at a constant rate until it was in excess.

The measurements were displayed on the computer screen as a graph of pH of the reaction mixture against volume of acid that had been added.

The results for the two acids are shown in Fig. 8.3.

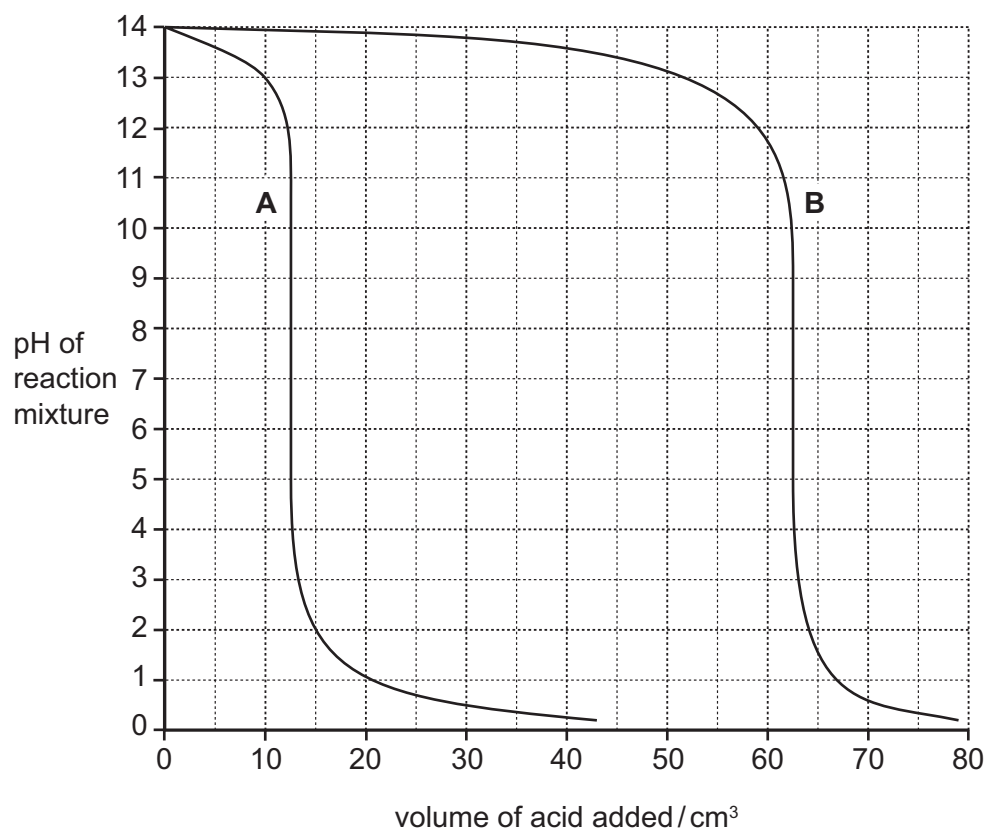


Fig. 8.3

- (i) Describe how the pH of the mixture in the beaker changes as the volume of acid added increases.

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

- (ii) The student found that 12.5 cm^3 of acid **A** and 62.5 cm^3 of acid **B** were needed to neutralise the sodium hydroxide in the beaker.

Explain how the student obtains these results from the graph shown in Fig. 8.3.

.....
..... [1]

- (iii) State and explain briefly which acid, **A** or **B**, was the more concentrated.

acid

explanation
..... [1]

- 9 Fig. 9.1 shows a section through a small blood vessel.

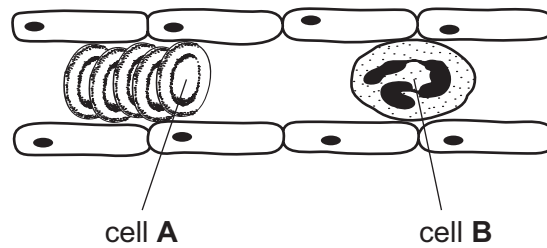


Fig. 9.1

- (a) Cell **A** is a red blood cell.

- (i) Outline **two** ways in which this cell differs from a liver cell.

- 1 [2]
2

- (ii) Describe the function of a red blood cell.

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

- (b) Describe the function of cell **B**.

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

- (c) As people get older, their risk of developing coronary heart disease increases.

- (i) Explain what is meant by *coronary heart disease*.

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

- (ii) List **two** factors, other than getting older, that increase the risk of developing coronary heart disease.

- 1 2 [2]

Group

140	Ce Cerium 58	141	Pr Praseodymium 59	144	Nd Neodymium 60	144	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

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

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UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
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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.



- 1 (a) Table 1.1 shows the numbers of protons, neutrons and electrons in four atoms, **A**, **B**, **C** 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]

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

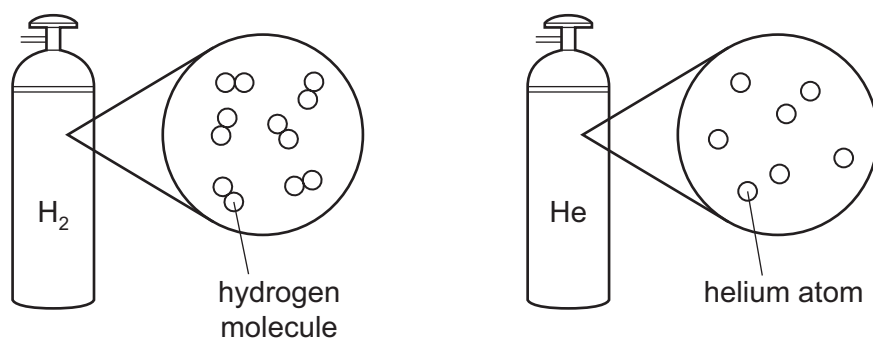


Fig. 1.1

- (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]

(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.

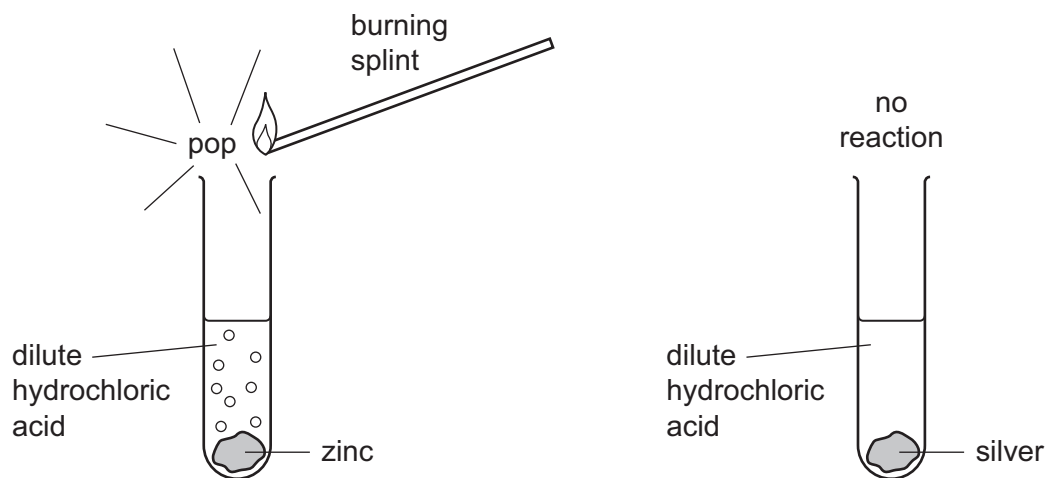


Fig. 1.2

.....

.....

.....

.....

..... [3]

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

This is shown in Fig. 2.1.

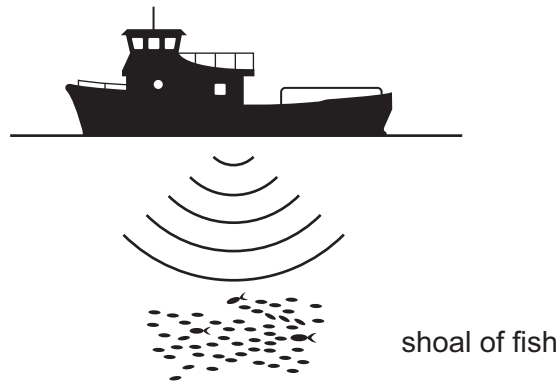


Fig. 2.1

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.

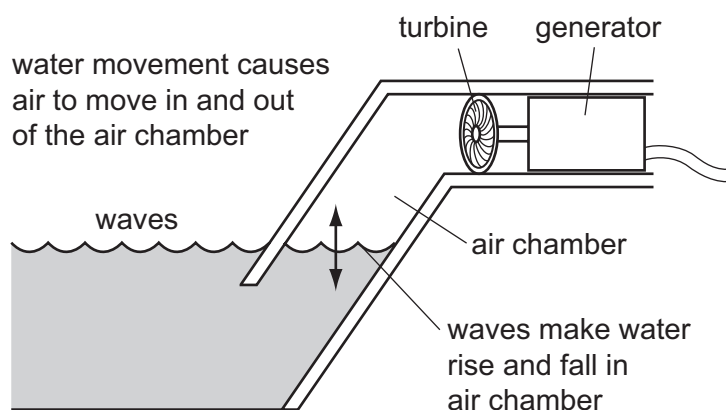


Fig. 2.2

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]

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

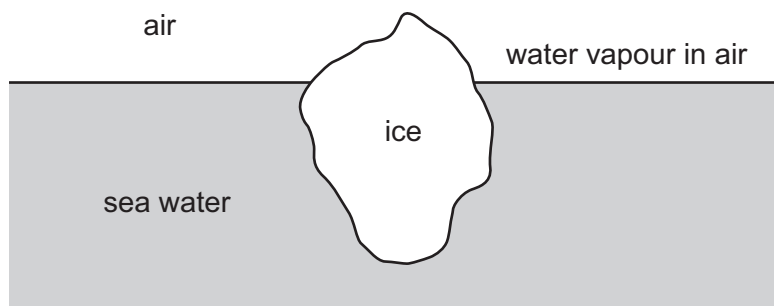


Fig. 2.3

- (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]

3 The addition of a harmful substance to the environment is called pollution. Three examples 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]

Please turn over for Question 4.

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 these 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.

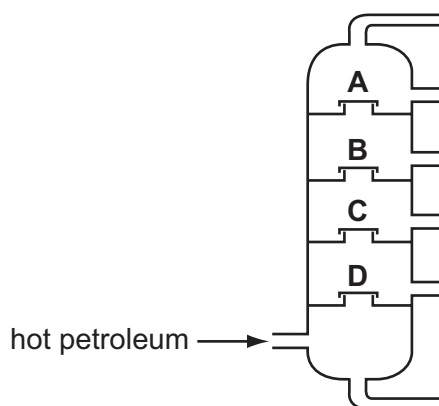


Fig. 4.1

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]

- (c) Rock salt contains mainly sodium chloride which is a compound of the alkali metal, 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 feed their young.

- (a) Table 5.1 shows the mass of some of the substances in 100g 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]

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

Fig. 6.1 shows the two workers.

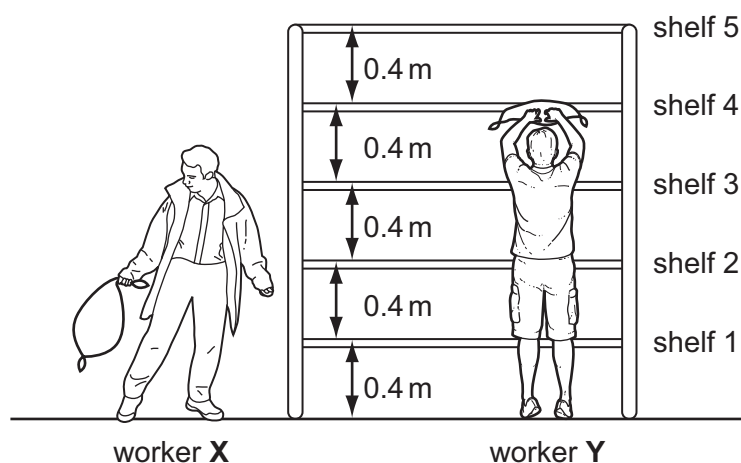


Fig. 6.1

- (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]

- (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]

- (b) Three boys, **A**, **B** and **C**, walk together from their school to a store. They stay in the 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.

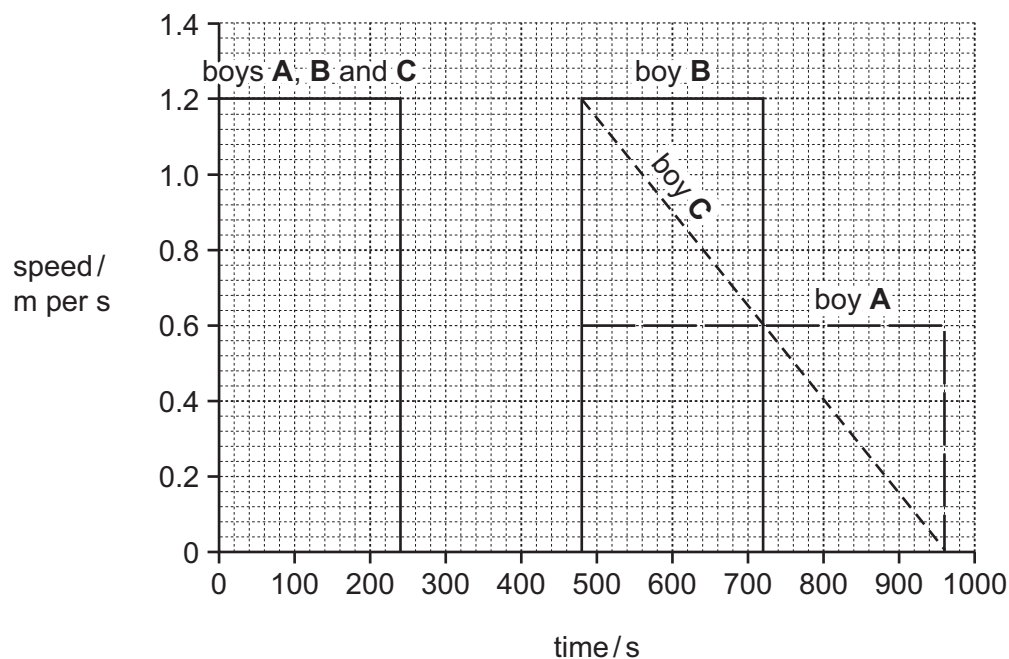


Fig. 6.2

- (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]

- 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.

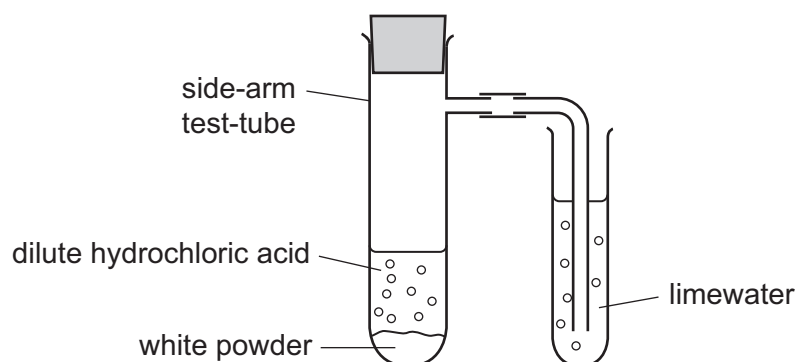


Fig. 7.1

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

Explain your answer.

name of gas

explanation

.....

..... [2]

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

Fig. 7.2 shows the apparatus she used.

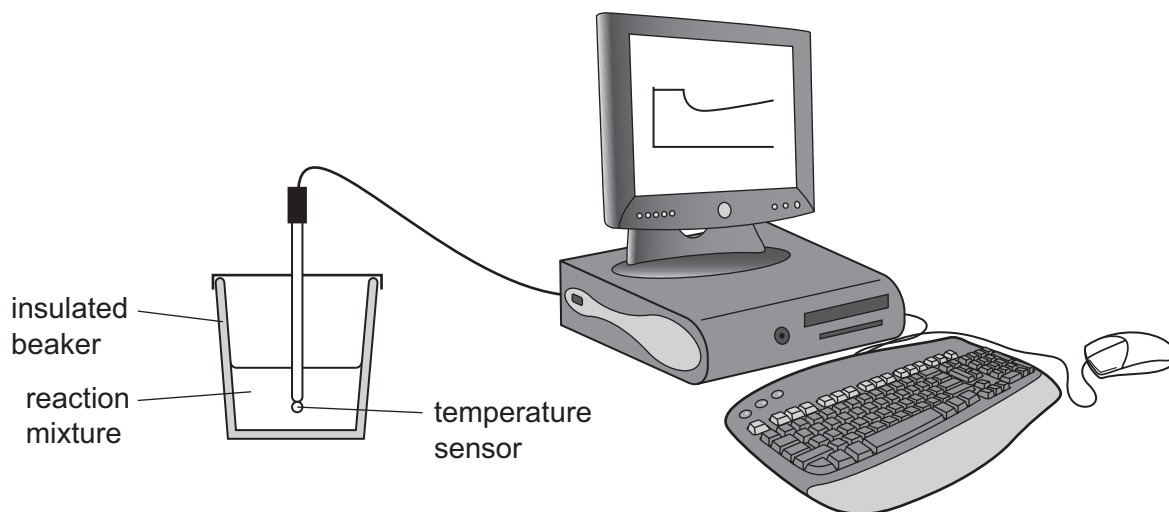


Fig. 7.2

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

This graph is shown in Fig. 7.3.

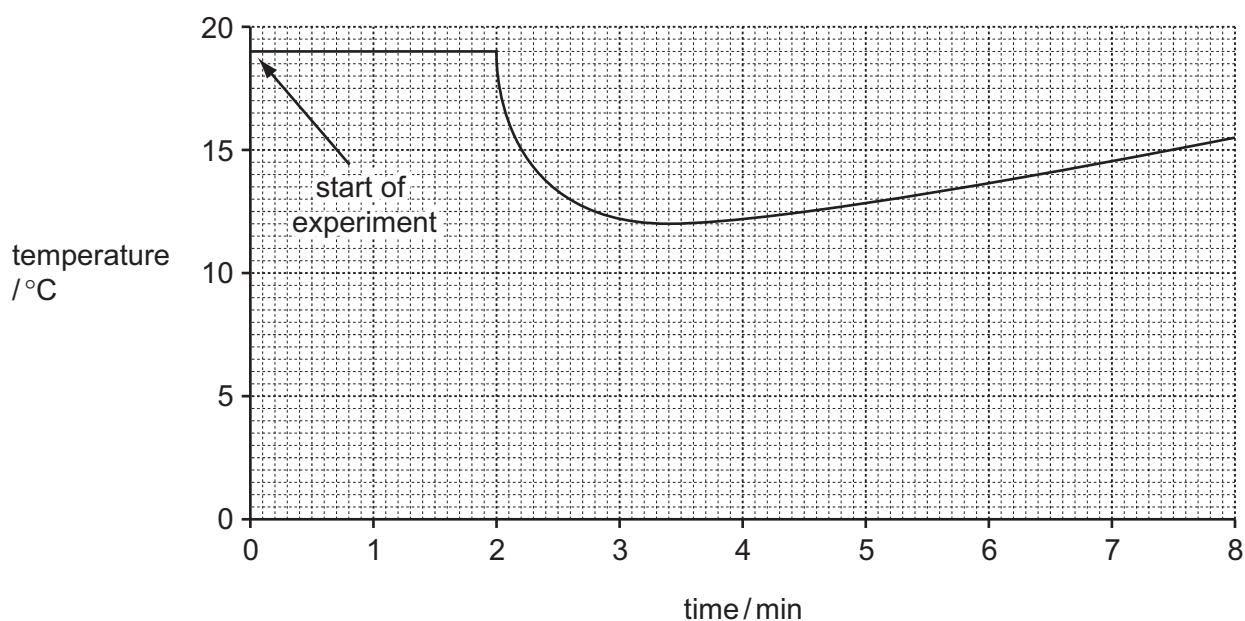


Fig. 7.3

- (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 during the 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]

- 8 Fig. 8.1 shows the human gas exchange system.

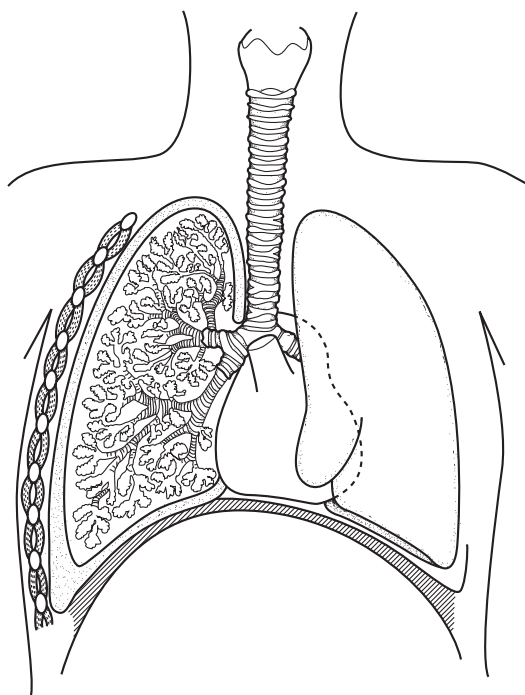


Fig. 8.1

- (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]

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

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

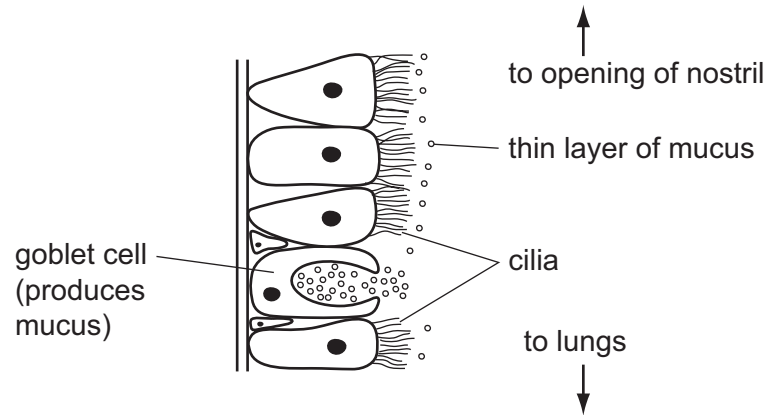


Fig. 8.2

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

.....

.....

.....

..... [2]

- (d) An experiment was carried out to find out how passive smoking affects the action of 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]

Please turn over for Question 9.

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

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

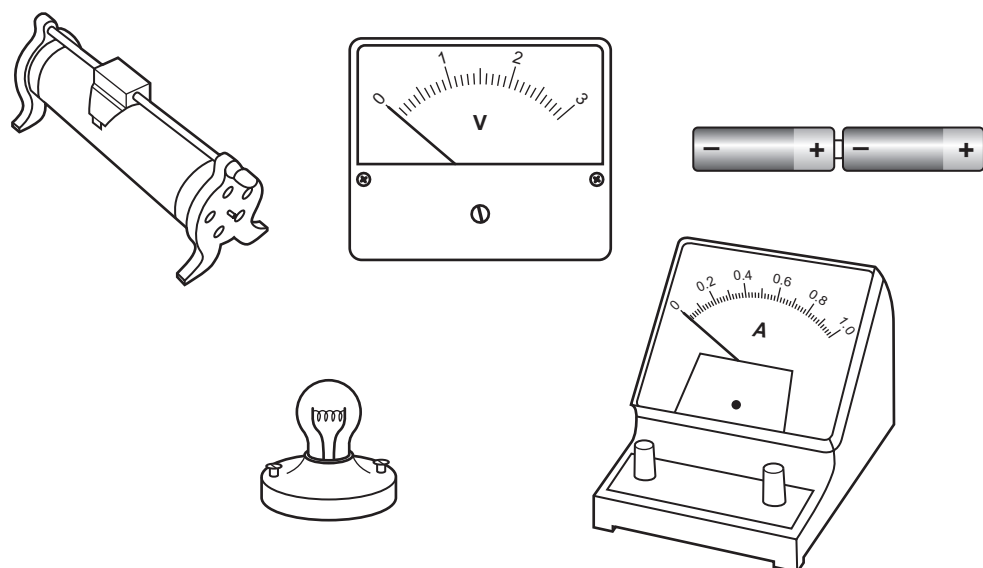


Fig. 9.1

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

[3]

- (ii) The student measured the current passing through a wire when a potential 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.

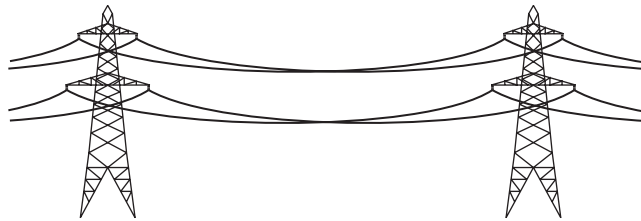


Fig. 9.2

Suggest why the cables are hung loosely.

.....

 [2]

Group

	*58-71 Lanthanoid series	90-103 Actinoid series
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The volume of one mole of any gas is 24 dm^3 at room temperature and pressure (r.t.p.).

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

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