Cambridge IGCSE

Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

1512932308

CO-ORDINATED SCIENCES **0654/42**

Paper 4 (Extended) **October/November 2017**

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.
You may use an HB 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 32.

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 **31** printed pages and **1** blank page.

CAMBRIDGE International Examinations

1 Fig. 1.1 is a photograph of red blood cells in the human body taken with an electron microscope.

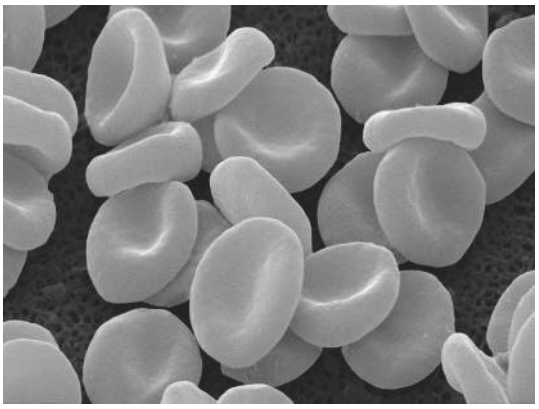

Fig. 1.1

(a) (i) State the main role of red blood cells in the human body.

.....[1]

(ii) Describe **one** way in which red blood cells are adapted for this role.

.....

.....[1]

(b) Red blood cells are one of the components of blood.

Name **two other** main components of blood.

1 .....

2 .....
[1]

(c) Fig. 1.2 shows a photograph of a normal red blood cell, and a red blood cell that has shrunk and changed shape.

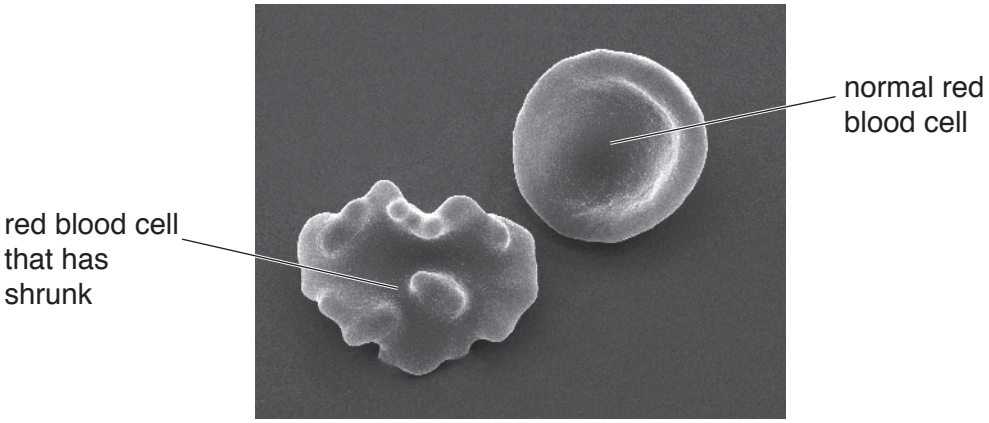

Fig. 1.2

(i) Explain why isolated red blood cells shrink and change shape when placed in a concentrated salt solution.

.....

.....

.....

.....

.....[3]

(ii) Suggest **and** explain what would happen to the appearance of a normal red blood cell if it was placed in water.

.....

.....

.....[2]

2 **(a)** The Periodic Table includes the five metals listed.

copper, Cu
iron, Fe
lithium, Li
potassium, K
sodium, Na

(i) State which **three** of these metals are made of atoms that

have one electron in their outer shell,

..... and ..... and .....

are in the same period of the Periodic Table.

..... and ..... and .....

[2]

(ii) Place the five metals in decreasing order of reactivity.

..... (most reactive)

.....

.....

.....

..... (least reactive) [2]

(b) Fig. 2.1 shows lithium reacting with water.

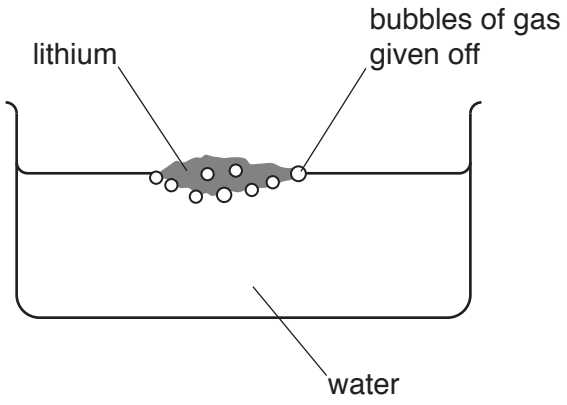

Fig. 2.1

(i) Name the gas given off in this reaction.

.....[1]

(ii) This reaction also produces an alkaline solution of lithium hydroxide.

When lithium hydroxide is neutralised by an acid, the salt lithium sulfate is produced.

Complete the **word** equation for this neutralisation reaction.

lithium hydroxide	+	..... acid	→	lithium sulfate	+	.....

[2]

(c) Chlorine, Cl_2, reacts with sodium bromide solution, NaBr, to form bromine and sodium chloride as shown in Fig. 2.2.

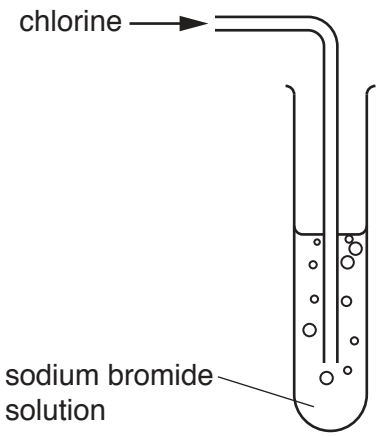

Fig. 2.2

(i) State the change in appearance when chlorine reacts with colourless sodium bromide solution.

.....[1]

(ii) Construct the **balanced symbolic** equation for the reaction between chlorine and sodium bromide.

.....[2]

3 **(a)** A student is listening to music on her computer using headphones.

(i) State the useful energy transformation that happens in the headphones.

from ..... energy to ..... energy [1]

(ii) Fig. 3.1 shows the heat sink on a computer chip.

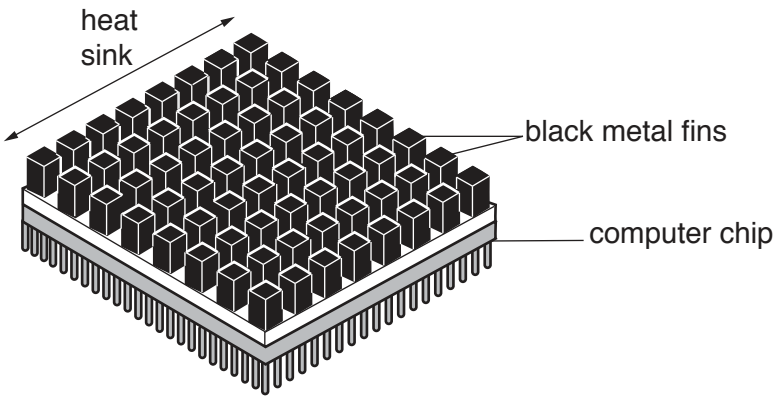

Fig. 3.1

The heat sink allows unwanted thermal energy to be transferred away from the chip.

Suggest **two** features of the heat sink that allow thermal energy to be transferred away from the chip.

Explain why each feature transfers thermal energy efficiently.

feature 1 .....

because .....

.....

feature 2 .....

because .....

.....

[2]

(b) The student watches her teacher set up a radiation detector in the school science laboratory.

A sealed radioactive source, strontium-90, is placed on the bench next to the radiation detector.

Strontium-90 emits β-particles. A small count rate is measured.

(i) When the teacher repeats the experiment a few minutes later, the count rate measured is slightly higher.

Suggest **one** reason for this.

.....

.....[1]

(ii) Strontium-90 decays by beta (β) emission to produce an isotope of yttrium.

Use the correct nuclide notation to complete the symbol equation for this decay process.

$$^{90}_{38}\mathrm{Sr} \longrightarrow {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{Y} + {}^{\cdots\cdots}_{\cdots\cdots}\mathrm{e}$$

[3]

(c) The teacher asks the student to test one of the springs from a chair. Fig. 3.2 shows the chair.

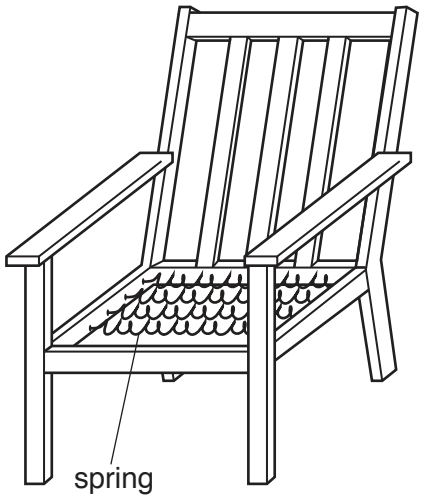

Fig. 3.2

The student measures the extension of the spring for different stretching forces.

She plots the graph shown in Fig. 3.3.

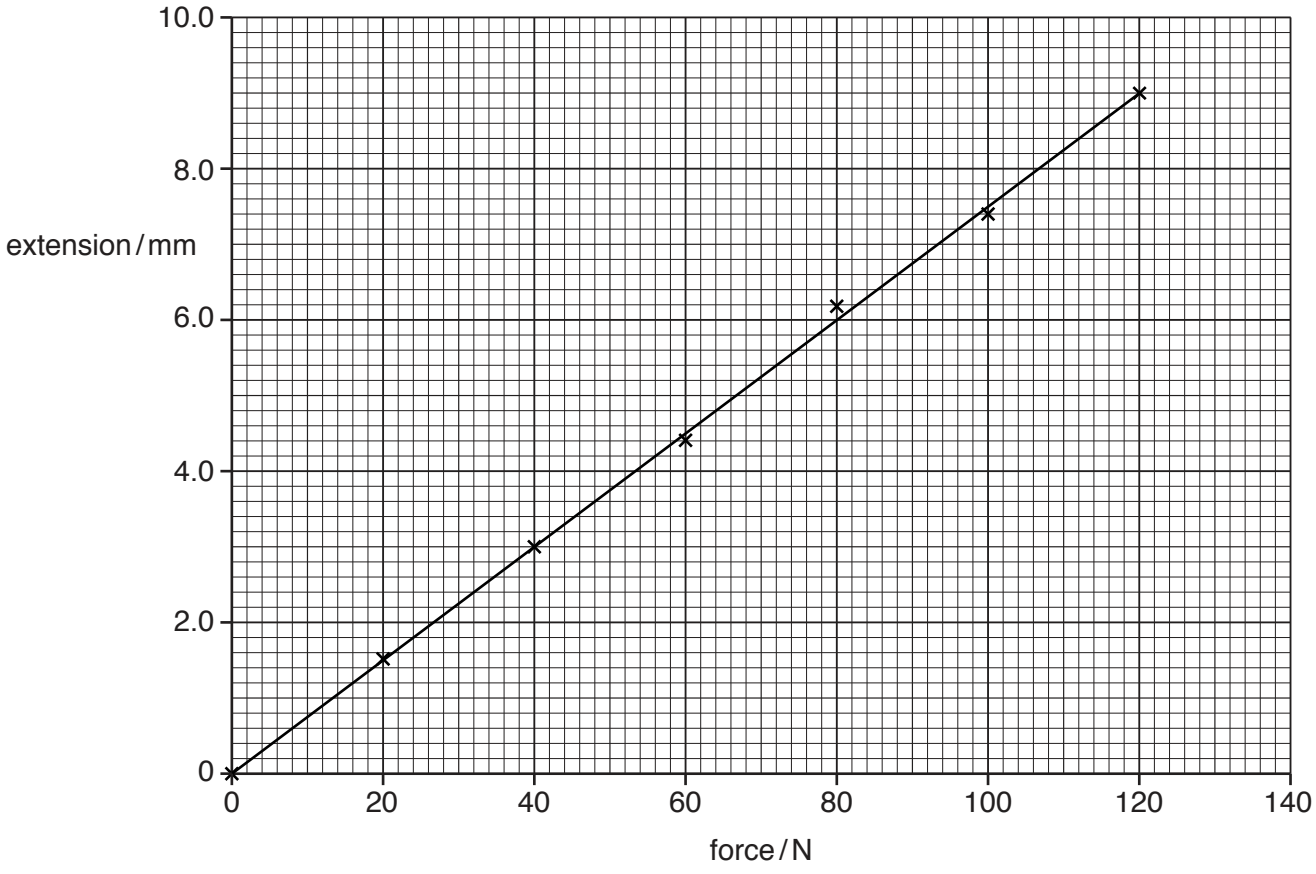

Fig. 3.3

(i) The force changes the shape of the spring.

State **one other** effect that a force can have on a body.

.....[1]

(ii) Use Fig. 3.3 to predict the force needed to give an extension of 10.0 mm.

.....N [1]

(iii) State the assumption you have made to make your prediction in **(ii)**.

.....

.....

.....[1]

4 MRSA is a bacterium that causes infection and has become resistant to many antibiotics.

Samples of MRSA bacteria are tested each year to see what percentage of the bacteria population is resistant to antibiotics.

The results are shown in Fig. 4.1.

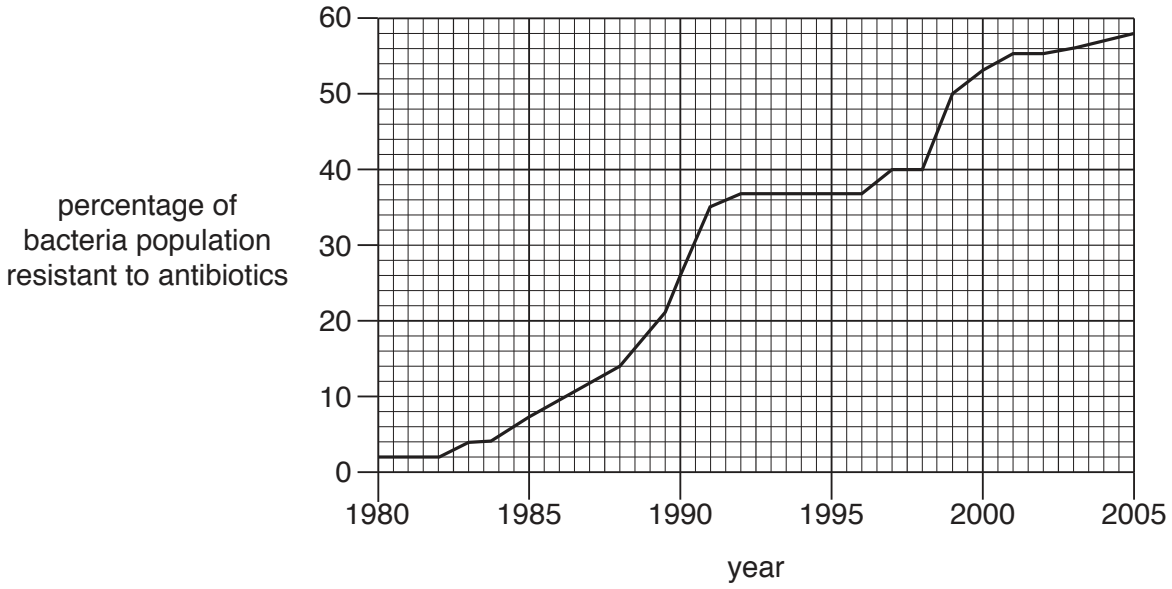

Fig. 4.1

(a) Describe the results shown in Fig. 4.1.

.....

.....

.....[2]

(b) Antibiotic resistance first appeared in strains of bacteria due to a mutation.

Define the term *mutation*.

.....[1]

(c) Eventually, the majority of the population of MRSA bacteria will become resistant to antibiotics.

Explain how the majority of the population will become resistant to antibiotics.

.....

.....

.....

.....

.....[3]

5 **(a)** Fig. 5.1 represents some particles in a mixture of gases.

Atoms of only three elements are shown.

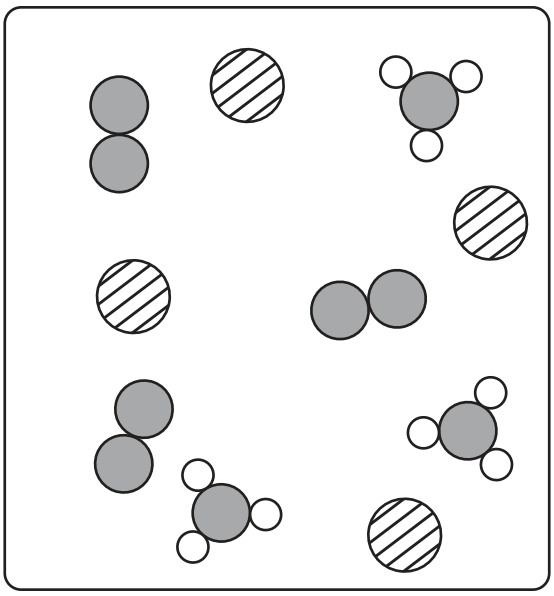

Fig. 5.1

(i) On Fig. 5.1, use a label line and the letter **L** to indicate a particle that could be of an element in Group VIII of the Periodic Table.

Explain your choice of particle.

.....

.....[1]

(ii) On Fig. 5.1, use a label line and the letter **M** to indicate a molecule of a compound.

Explain your choice of particle.

.....

.....[1]

[Turn over

(b) Sulfur reacts with magnesium to form the solid compound magnesium sulfide, MgS.

Fig. 5.2 shows the electronic structure of a sulfur atom.

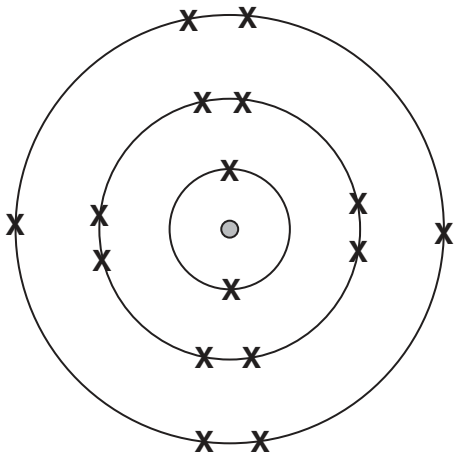

Fig. 5.2

Describe the formation of chemical bonds when magnesium reacts with sulfur to produce magnesium sulfide.

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

.....

.....

.....

.....

.....

.....[3]

(c) Fig. 5.3 shows two industrial processes, **P** and **Q**, that are used in the extraction of metals from their ores.

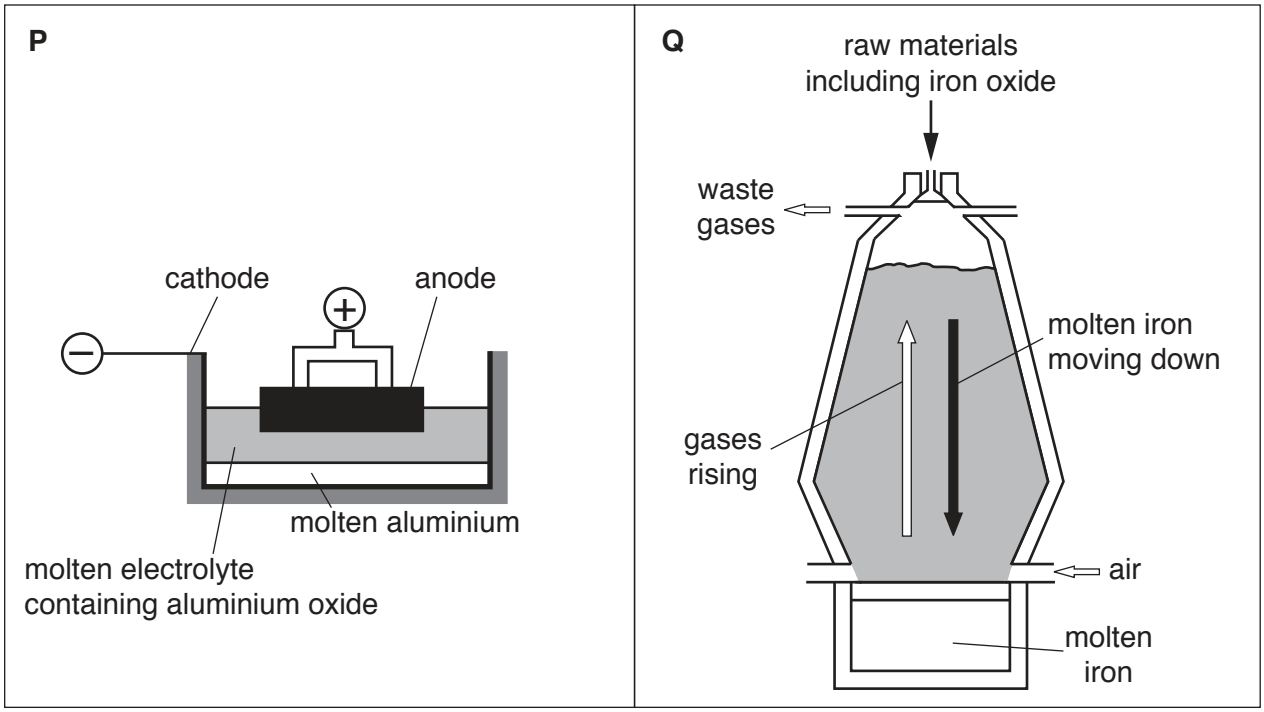

Fig. 5.3

(i) Name process **P**.

.....[1]

(ii) Describe how an aluminium ion, Al^{3+}, is reduced to form an aluminium atom in process **P**.

.....

.....

.....[2]

(iii) In process **Q**, a redox reaction occurs between iron oxide and a gas.

Name this gas.

.....[1]

6 **(a)** Fig. 6.1 shows the information label found on the back of a microwave oven.

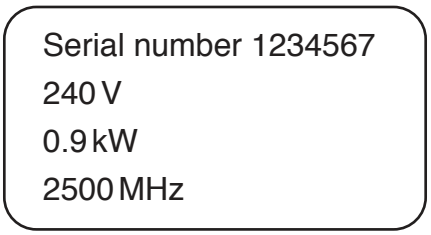

Fig. 6.1

(i) State the frequency of the microwaves used in the oven.

..... [1]

(ii) State the power of the oven.

..... [1]

(b) Infra-red radiation may also be used to heat food.

State whether, compared with microwave radiation, infra-red radiation has a higher, lower or the same value of

wavelength, ...

speed in a vacuum. .....

[1]

(c) Some water is heated in the microwave oven for five minutes.

Fig. 6.2 shows how the temperature of the water changes with time.

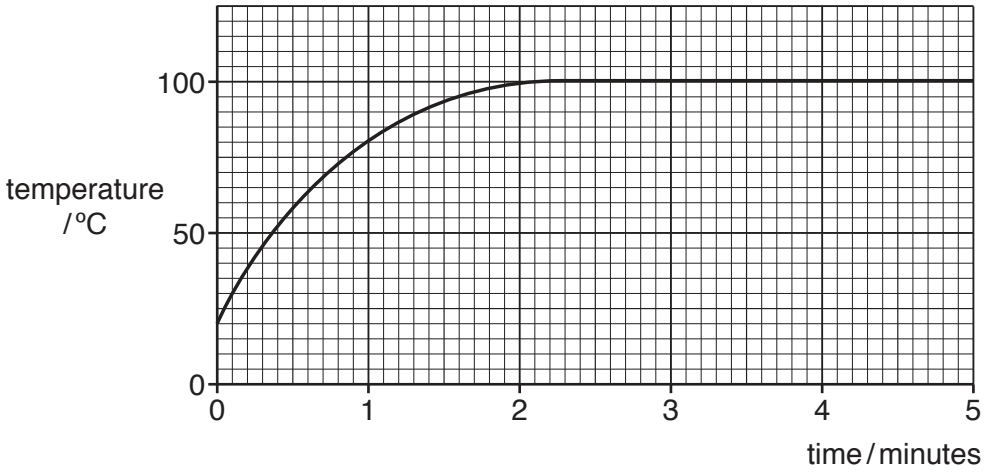

Fig. 6.2

(i) Describe what happens to the water molecules during the first two minutes.

.....

.....[1]

(ii) Explain, in terms of molecules, why the temperature of the water remains unchanged between two and five minutes.

.....

.....

.....[2]

7 The breathing rate of a student at rest is measured by measuring the volume of air in the lungs during inhalation and exhalation.

The results are shown in Fig. 7.1.

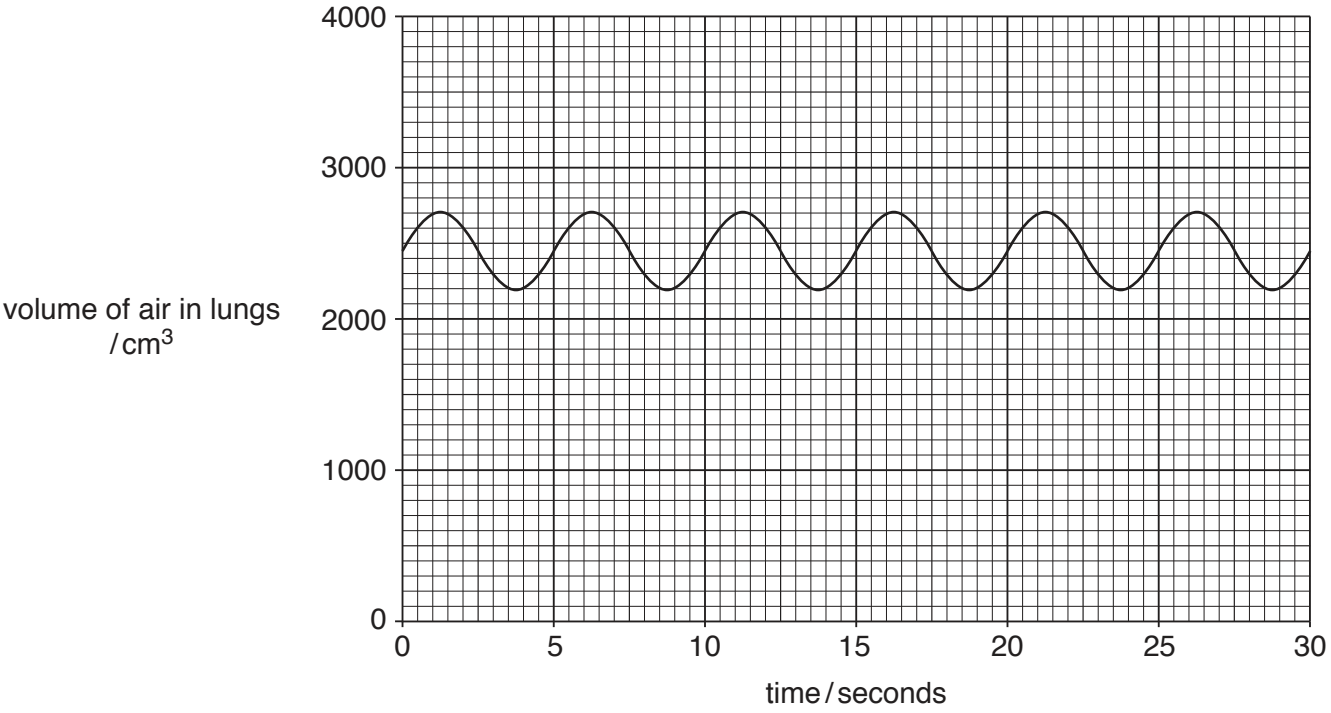

Fig. 7.1

(a) The breathing rate of the student was measured again during intense exercise.

Describe how the graph line differs during intense exercise.

.....

.....

.....[2]

(b) Describe **and** explain the difference in breathing between rest and intense exercise.

.....

.....

.....[2]

(c) Describe **and** explain why the student's pulse rate changes during intense exercise.

.....

.....

.....[2]

(d) After some time of intense exercise the student develops pain, called cramp, in the leg muscles.

(i) Describe what happens to cause cramp.

.....

.....

.....[2]

(ii) Explain why the student's breathing does **not** return to normal immediately after intense exercise.

.....

.....[1]

8 **(a)** For each compound shown, predict whether it reacts with water to produce an acidic, an alkaline or a neutral solution.

potassium oxide, K_2O .....

calcium oxide, CaO .....

carbon dioxide, CO_2 .....

nitrogen dioxide, NO_2 ..... [2]

(b) When magnesium reacts with **excess** dilute hydrochloric acid, hydrogen gas is produced.

Fig. 8.1 shows apparatus a student uses to investigate this reaction.

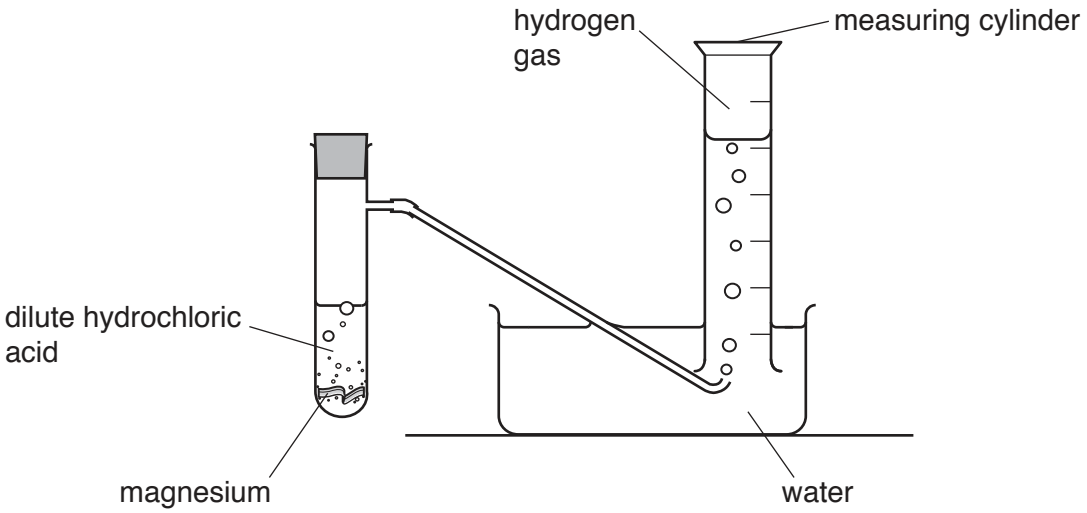

Fig. 8.1

She measures the volume of gas in the measuring cylinder at regular intervals after the start of the reaction.

A sketch graph of her results is shown in Fig. 8.2.

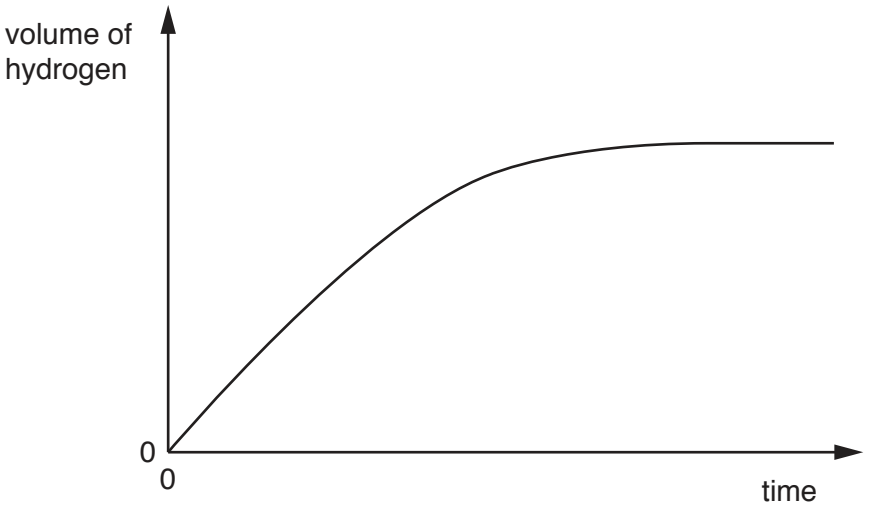

Fig. 8.2

(i) Predict how the concentration of the hydrochloric acid changes, if at all, during the reaction.

.....[1]

(ii) Describe **and** explain the shape of the graph in Fig. 8.2 in terms of the rate of reaction.

.....

.....

.....[2]

(iii) The student repeats the experiment.

She uses hydrochloric acid that has a **higher** concentration.

She keeps all of the other variables the same.

On Fig. 8.2, sketch a graph to show the results that the student obtains from her second experiment. [2]

(c) The balanced equation for the reaction between zinc and dilute hydrochloric acid is shown.

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

Complete the steps in the calculation to find the volume of hydrogen gas that is produced when 2.6 g of zinc reacts completely in excess dilute hydrochloric acid.

Show your working.

Step 1
Calculate the number of moles in 2.6 g of zinc.
[A_r: Zn = 65]

number of moles = ...

Step 2
State the number of moles of hydrogen gas produced.

number of moles = ...

Step 3
Calculate the volume, **in cm^3**, of hydrogen gas produced.
[molar gas volume = 24 dm^3]

volume = ... cm^3
[4]

9 **(a)** A boy riding his bicycle is cooled by sweating.

Describe, in terms of molecules, how sweating cools his body by evaporation.

.....

.....

.....

.....

.....[3]

(b) Fig. 9.1 shows a car behind a bicycle at night.

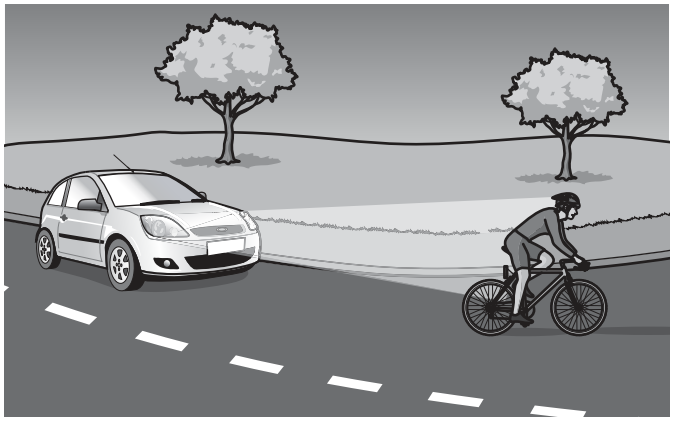

Fig. 9.1

A reflector on the back of the bicycle is made from many small red plastic prisms, one of which is shown in Fig. 9.2.

A ray of light from the headlamp of the car enters the prism.

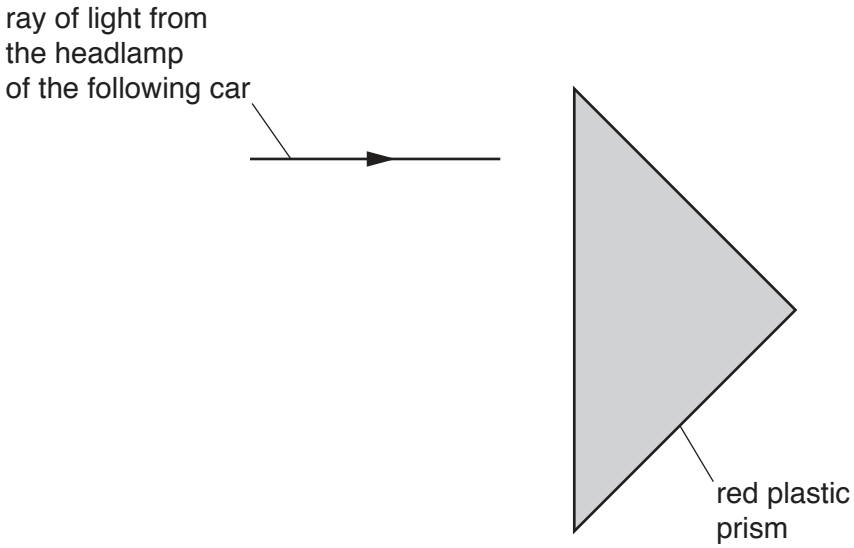

Fig. 9.2

Total internal reflection occurs within the prism.

On Fig. 9.2, complete the path taken by the ray of light until it emerges from the prism. [2]

(c) The bicycle has a lamp powered by a small generator.

The generator turns as the boy pedals and the lamp lights up.

Fig. 9.3 shows a simple version of the generator.

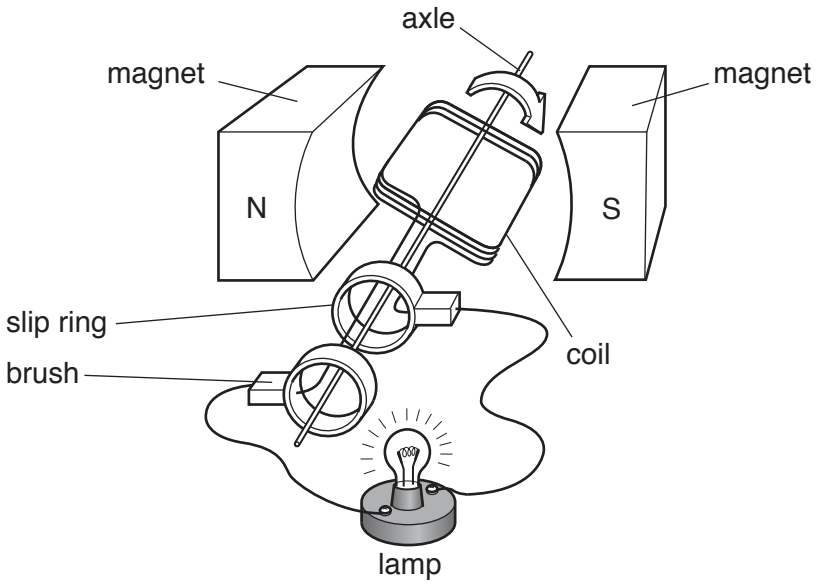

Fig. 9.3

Describe how the rotating coil causes the lamp to light.

.....

.....

.....

.....

.....

.....[3]

(d) The generator produces an alternating voltage.

Fig. 9.4 shows how the output voltage of the bicycle generator changes with time.

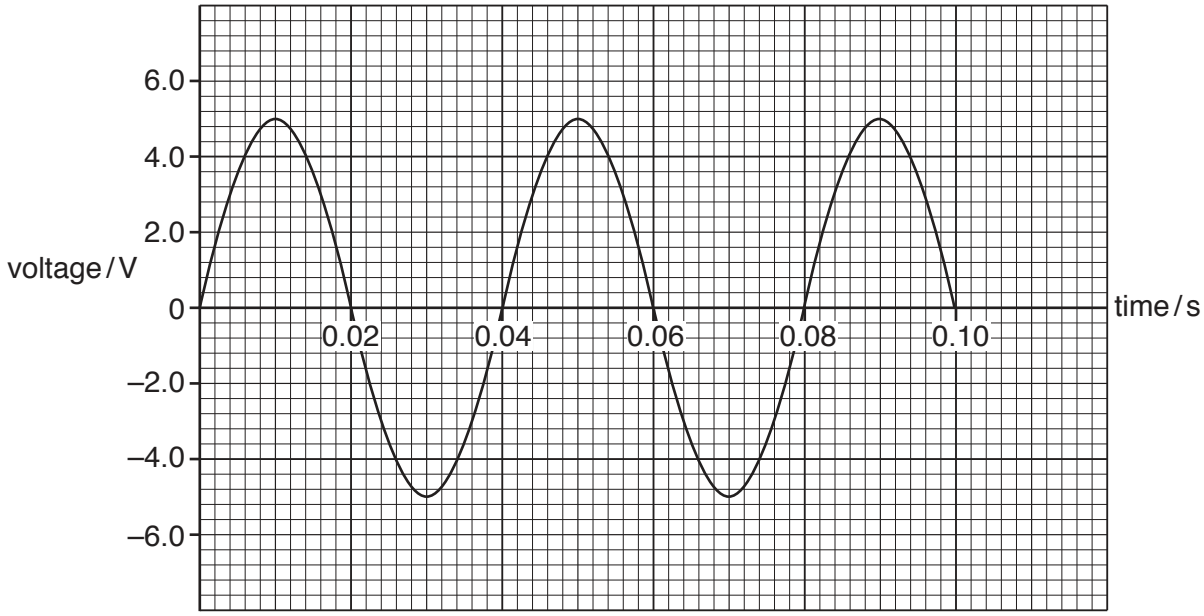

Fig. 9.4

(i) Calculate the frequency of the alternating voltage.

Show your working.

frequency = ... Hz [1]

(ii) State the amplitude of the alternating voltage.

amplitude = ... V [1]

(e) A different bicycle has a front lamp, **A**, and a rear lamp, **B**, powered by the same battery.

Fig. 9.5 shows how the lamps are connected.

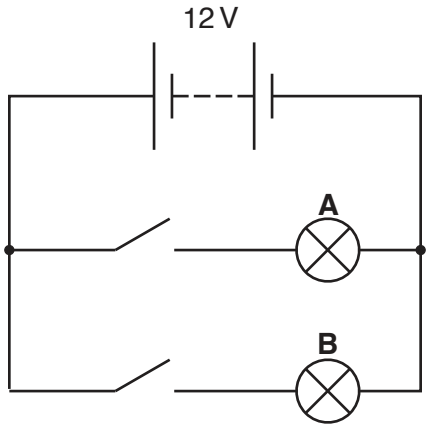

Fig. 9.5

(i) State the name given to this arrangement of lamps in a circuit.

.....[1]

(ii) Lamp **A** has a resistance of 5 Ω.

The battery has a voltage of 12 V.

Calculate the current flowing through lamp **A** when the switch is closed.

State the formula you use and show your working.

formula

working

current = ...A [2]

(iii) Lamp **B** has a resistance of 10 Ω.

Calculate the combined resistance of the two lamps in this circuit.

Show your working.

resistance = ... Ω [2]

[Turn over

10 Fig. 10.1 is a diagram of a human eye.

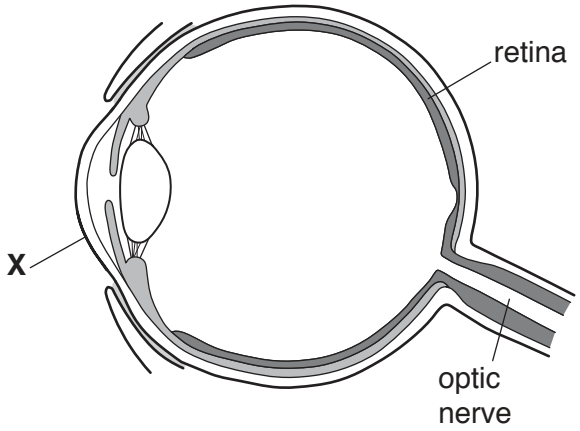

Fig. 10.1

(a) (i) Name the part labelled **X** on Fig. 10.1.

.....[1]

(ii) Draw a label line to identify the iris on Fig. 10.1.

Label this **C**. [1]

(b) The pupil response to light is an example of a reflex action.

(i) Describe the changes that happen in the eye when a person goes from dark to light conditions.

.....

.....

.....[2]

(ii) Explain why the pupil response is described as a reflex action.

.....

.....[1]

(iii) Identify the following parts which are involved during the pupil reflex of the eye.

receptor .....

coordinator .....
[2]

(c) The pupil reflex is an example of nervous control.

Table 10.1 compares hormonal and nervous control systems in the body.

Complete Table 10.1 to show the differences between hormonal control and nervous control.

Table 10.1

feature	hormonal control	nervous control
method of transmission around the body	.....	along neurones
speed of transmission around the body	.....	.....
length of effect	.....	.....

[3]

11 **(a)** Fig. 11.1 shows the structure of a molecule of an alkane.

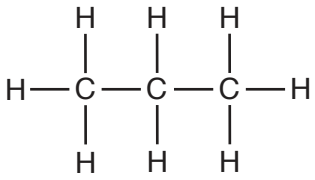

Fig. 11.1

(i) Name this alkane.

.....[1]

(ii) Complete Fig. 11.2 to show the structure of a molecule of the **alkene** that contains only three carbon atoms.

Fig. 11.2 [2]

(b) Fig. 11.3 shows clay pots being heated strongly in a kiln.

The alkane, C_3H_8, is supplied to the gas burner.

Hot gases circulate through the kiln, heating the clay pots and then leaving through the top of the kiln.

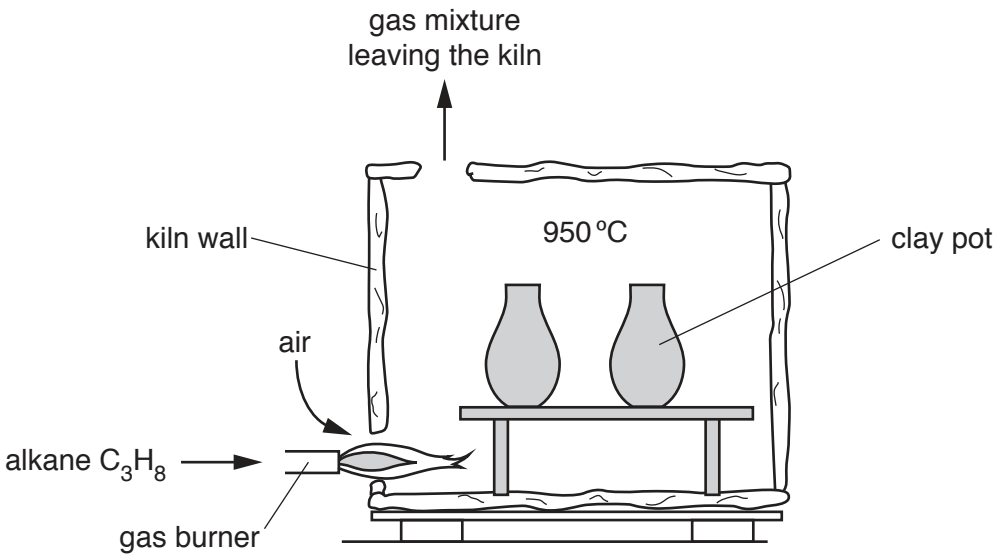

Fig. 11.3

(i) Explain why the gas mixture leaving the kiln contains nitrogen and argon.

.....

.....

.....[2]

(ii) State **two** gases that are produced by the combustion of C_3H_8.

1 .....

2 .....
[1]

(c) Sometimes clay pots are covered with a glaze before they go into the kiln.

Glaze is a mixture of solid compounds that melt at high temperatures. It forms a coloured, shiny layer on the pots as they cool.

Four compounds found in a glaze are listed.

calcium carbonate, $CaCO_3$

cobalt oxide, CoO

copper oxide, CuO

silicon dioxide, SiO_2

(i) Predict which **two** compounds produce colours in the glaze layer.

Explain your prediction.

compounds ..... and .....

explanation .....

.....
[2]

(ii) Explain, in terms of its structure, why silicon dioxide has a high melting point.

.....

.....

.....[2]

[Turn over

12 (a) During car journeys, a car will often become electrostatically charged.

On a warm dry day, the potential difference between the driver and the car increases to 12 000 V.

(i) Explain what happens to cause the car to become charged.

.....

.....

.....[2]

(ii) The driver touches the car door and receives an electric shock.

0.030 J of energy is transferred between the driver and the car. The discharge current lasts for 0.36 milliseconds. The discharge current is the current which flows through the driver.

Calculate the power of the discharge.

State the formula you use and show your working.

formula

working

power = ... W [2]

(iii) Calculate the discharge current.

State the formula you use and show your working.

formula

working

current = ...A [2]

(b) Fig. 12.1 shows a sound wave travelling through the air from the car radio to the driver.

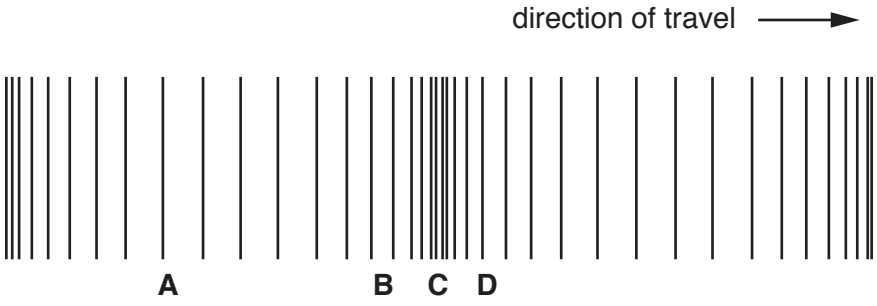

Fig. 12.1

Choose from the letters **A** to **D** to complete the sentences.

A compression in this sound wave is shown by letter ..... .

A rarefaction in this sound wave is shown by letter ..... .

[1]

(c) Car wheels are usually made from steel. Some cars have aluminium alloy wheels.

Suggest a simple way to show that a wheel is **not** made from steel.

Explain your answer.

.....

.....[1]

(d) The driver of the car thinks that he is travelling at 8 m / s.

He is unsure whether this is his speed or his velocity.

Describe the difference between the terms *speed* and *velocity*.

.....

.....

.....[1]

[Turn over

13 Fig. 13.1 is a simplified diagram of the carbon cycle.

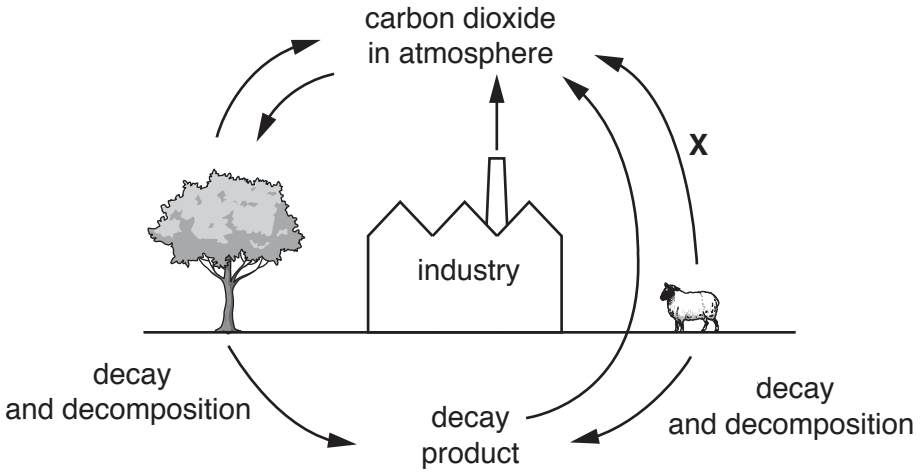

Fig. 13.1

(a) Identify the process that takes place at **X**.

.....[1]

(b) Name the type of organism that gets its energy from decaying matter.

.....[1]

(c) Combustion of fossil fuels increases the carbon dioxide concentration in the atmosphere.

Explain how an increase in atmospheric carbon dioxide leads to global warming.

.....

.....

.....

.....

.....[3]

(d) Deforestation prevents the removal of carbon dioxide from the atmosphere.

List **two other** effects of deforestation.

1 .....

2 .....
[2]

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The Periodic Table of Elements

Group																	
I	II											III	IV	V	VI	VII	VIII
							1 H hydrogen 1										2 He helium 4
3 Li lithium 7	4 Be beryllium 9		**Key** atomic number atomic symbol name relative atomic mass									5 B boron 11	6 C carbon 12	7 N nitrogen 14	8 O oxygen 16	9 F fluorine 19	10 Ne neon 20
11 Na sodium 23	12 Mg magnesium 24											13 Al aluminium 27	14 Si silicon 28	15 P phosphorus 31	16 S sulfur 32	17 Cl chlorine 35.5	18 Ar argon 40
19 K potassium 39	20 Ca calcium 40	21 Sc scandium 45	22 Ti titanium 48	23 V vanadium 51	24 Cr chromium 52	25 Mn manganese 55	26 Fe iron 56	27 Co cobalt 59	28 Ni nickel 59	29 Cu copper 64	30 Zn zinc 65	31 Ga gallium 70	32 Ge germanium 73	33 As arsenic 75	34 Se selenium 79	35 Br bromine 80	36 Kr krypton 84
37 Rb rubidium 85	38 Sr strontium 88	39 Y yttrium 89	40 Zr zirconium 91	41 Nb niobium 93	42 Mo molybdenum 96	43 Tc technetium –	44 Ru ruthenium 101	45 Rh rhodium 103	46 Pd palladium 106	47 Ag silver 108	48 Cd cadmium 112	49 In indium 115	50 Sn tin 119	51 Sb antimony 122	52 Te tellurium 128	53 I iodine 127	54 Xe xenon 131
55 Cs caesium 133	56 Ba barium 137	57–71 lanthanoids	72 Hf hafnium 178	73 Ta tantalum 181	74 W tungsten 184	75 Re rhenium 186	76 Os osmium 190	77 Ir iridium 192	78 Pt platinum 195	79 Au gold 197	80 Hg mercury 201	81 Tl thallium 204	82 Pb lead 207	83 Bi bismuth 209	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –		114 Fl flerovium –		116 Lv livermorium –		

lanthanoids	57 La lanthanum 139	58 Ce cerium 140	59 Pr praseodymium 141	60 Nd neodymium 144	61 Pm promethium –	62 Sm samarium 150	63 Eu europium 152	64 Gd gadolinium 157	65 Tb terbium 159	66 Dy dysprosium 163	67 Ho holmium 165	68 Er erbium 167	69 Tm thulium 169	70 Yb ytterbium 173	71 Lu lutetium 175
actinoids	89 Ac actinium –	90 Th thorium 232	91 Pa protactinium 231	92 U uranium 238	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –

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