Cambridge International Examinations
Cambridge International General Certificate of Secondary Education

CANDIDATE NAME		
CENTRE NUMBER		CANDIDATE NUMBER

CO-ORDINATED SCIENCES **0654/33**

Paper 3 (Extended) **May/June 2015**

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 soft pencil for any diagrams, graphs, tables or rough working.
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 **28** printed pages.

DC (RW/FD) 97580/4

[Turn over

1 Table 1.1 shows some information about three elements **A**, **B** and **C**.

Table 1.1

element	group number in Periodic Table	number of outer electrons in one atom	reactive or unreactive
A	1		
B	7		reactive
C		8	

(a) Add the five missing pieces of information to complete Table 1.1. [3]

(b) The diagrams, **D**, **E** and **F**, in Fig. 1.1 show the structures of three materials.

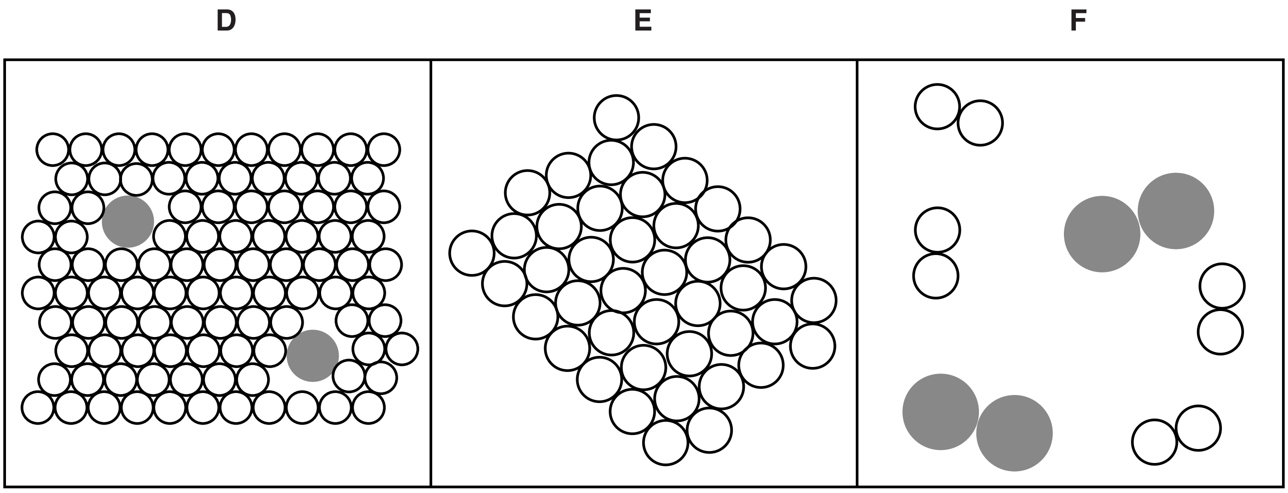

Fig. 1.1

Deduce which diagram shows an alloy and explain why.

diagram showing an alloy ....

explanation ....

....

....[2]

(c) Fig. 1.2 shows a small piece of sodium reacting in ethanol at 25 °C. In this reaction hydrogen gas is given off.

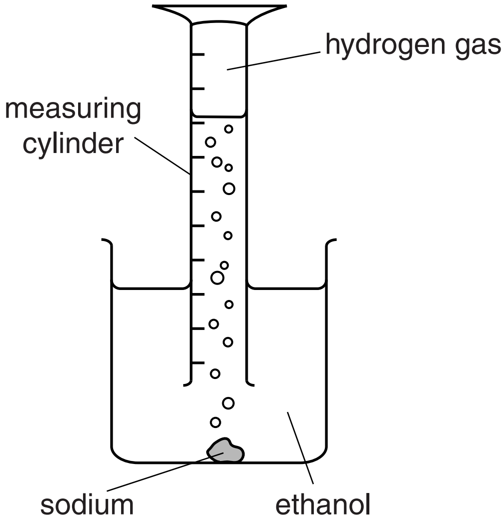

Fig. 1.2

(i) State how the rate of reaction in Fig. 1.2 would be different if the temperature of the ethanol was 10 °C.

Explain your answer in terms of collisions between particles.

....

....

....

....[3]

(ii) The total volume of hydrogen produced by the reaction shown in Fig. 1.2 is 8.4 cm^3.

Calculate the number of moles of hydrogen in 8.4 cm^3.
The molar volume of gas at 25 °C is 24 dm^3.

Show your working.

number of moles = ...[2]

2 **(a)** Fig. 2.1 shows the electrical circuit for a torch (flashlight).

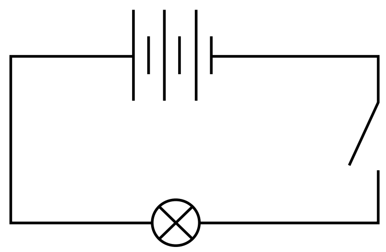

Fig. 2.1

(i) Each cell provides a voltage of 1.5 V.

State the total voltage across the lamp when the switch is closed.

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

(ii) 0.9 A passes through the lamp for one minute. Calculate the charge which passes through the lamp.

State the formula that you use, show your working and state the unit of your answer.

formula

working

charge = ... unit ....[3]

(iii) Two students are discussing the current flowing in the circuit.

Student **A** says that the electrons flow in a clockwise direction. Student **B** says that the conventional current flows in an anti-clockwise direction.

Explain why both students are correct.

....

....

....

....[2]

(b) The lamp from the torch has a resistance of 5 Ω when lit.

Two lamps, identical to the torch lamp, are connected together in a parallel circuit as shown in Fig. 2.2.

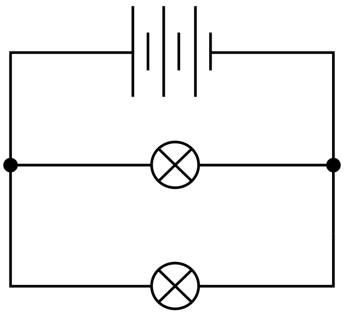

Fig. 2.2

Calculate the combined resistance of the two lamps. State the formula that you use and show your working.

formula

working

resistance = ...Ω [2]

(c) Fig. 2.3 shows a ray of light from the torch that is reflected by a plane mirror.

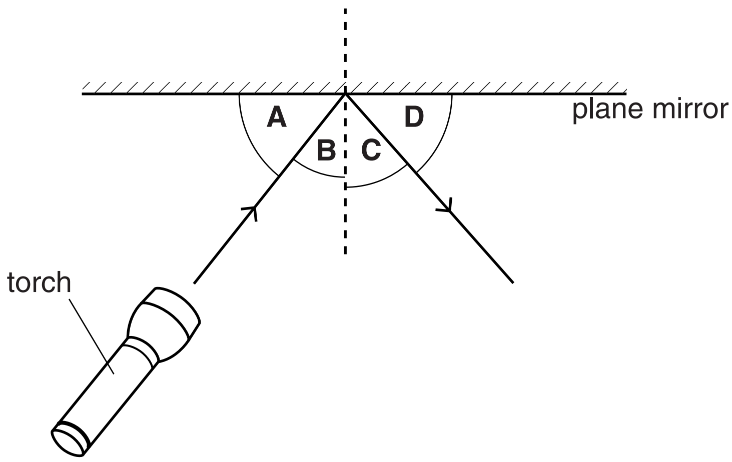

Fig. 2.3

(i) Name angle **B** and angle **C**.

angle **B** ....

angle **C** .... [1]

(ii) State what happens to the value of angle **C** when the value of angle **B** is doubled.

....[1]

3 A person is infected with the human immunodeficiency virus (HIV).

The graph in Fig. 3.1 shows changes over the next ten years in

- the concentration of HIV particles in the person's blood,
- the concentration of white cells in their blood.

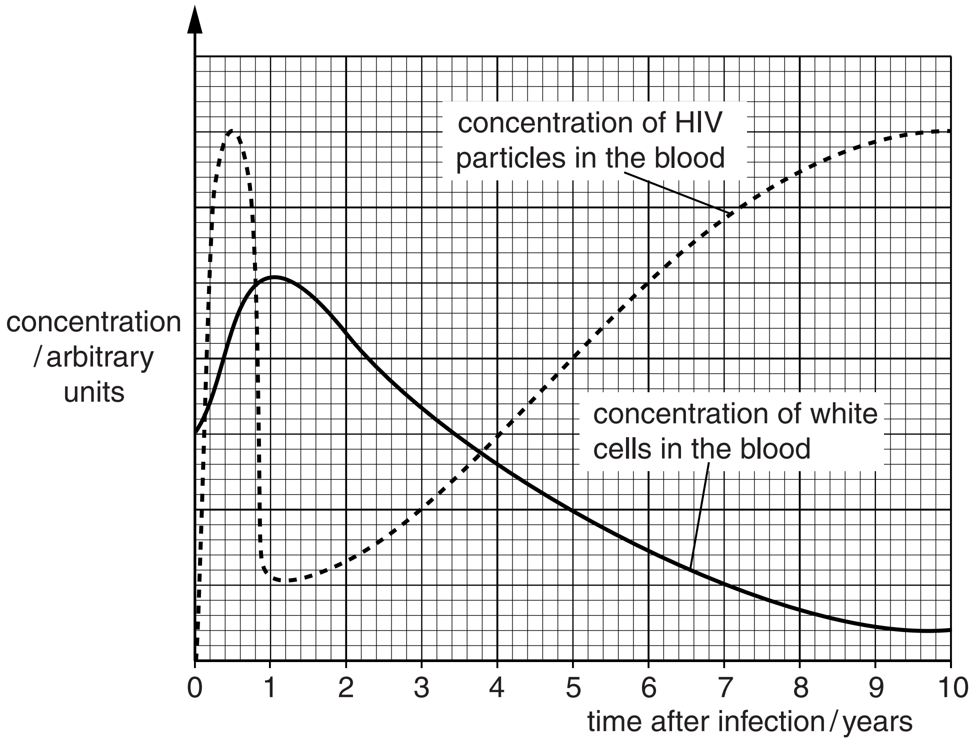

Fig. 3.1

(a) Suggest **two** ways in which this person may have become infected with HIV.

1 ....

2 ....[2]

(b) Describe how the concentration of HIV particles in this person's blood changed

(i) during the first year after infection, ...

....[1]

(ii) over the next nine years. ....

....[1]

(c) Suggest a reason why the concentration of white blood cells

(i) increases during the first year, ...

....[1]

(ii) decreases over the next nine years. ....

....[1]

(d) Describe and explain what effect the decrease in concentration of white blood cells is likely to have on the infected person.

....

....

....[2]

(e) Give **two** ways in which the government of a country can prevent the spread of HIV / AIDS within a population.

1 ....

2 ....[2]

4 **(a)** A student rubs a balloon on his sweater. Charged particles move from the sweater to the balloon which becomes negatively charged.

(i) Name the charged particles.

.... [1]

(ii) The student charges a second balloon in the same way.

Fig. 4.1 shows the two charged balloons next to each other.

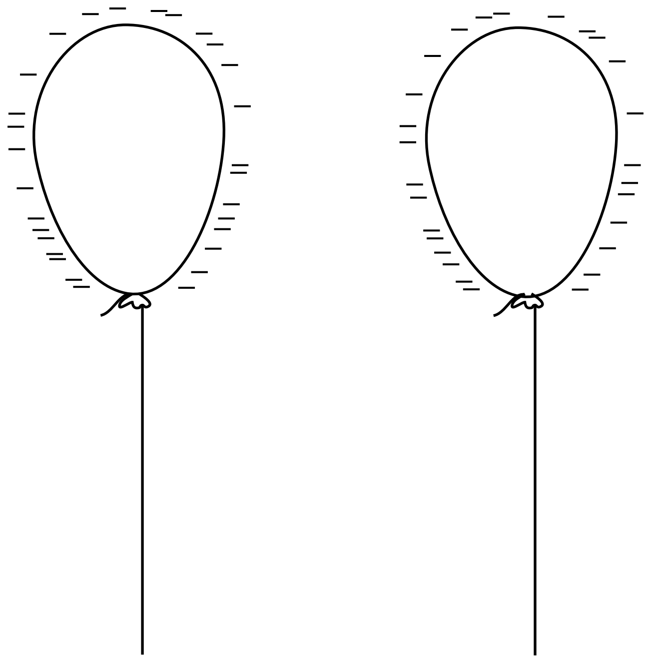

Fig. 4.1

State what happens to the balloons when the student brings the balloons very close together.

Explain your answer.

....

....

....[2]

(b) The student then bursts one of the balloons some distance from a brick wall.

This is shown in Fig. 4.2.

Fig. 4.2

The noise the balloon makes when it bursts travels through the air as a sound wave.

The student hears an echo.

(i) Explain why the student hears an echo.

....

....[1]

(ii) Sound waves move through the air as a series of compressions and rarefactions.

State the difference between a compression and a rarefaction.

....

....

....[1]

(iii) The speed of sound in air is about 330 m/s. In water the speed of sound is about 1500 m/s.

Suggest, using ideas of distances between molecules and the movement of molecules, why the speed of sound is greater in water than in air.

....

....

....

....[2]

(c) Fig. 4.3 shows a large hot air balloon moving upwards.

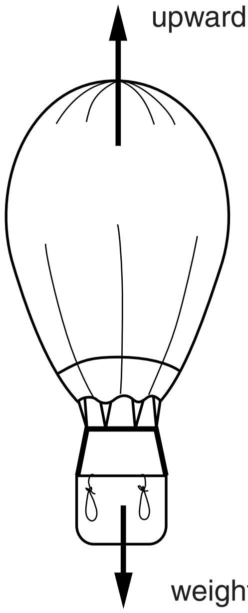

Fig. 4.3

The mass of the hot air balloon is 785 kg.

Calculate the acceleration of the balloon.

State the formula that you use and show your working.

formula

working

acceleration = ... m/s^2 [2]

5 Millions of tonnes of sodium chloride are extracted from the Earth's crust every year.

(a) (i) Name the type of chemical bonding found in sodium chloride.

....[1]

(ii) Fig. 5.1 shows an unlabelled diagram of the structure of sodium chloride.

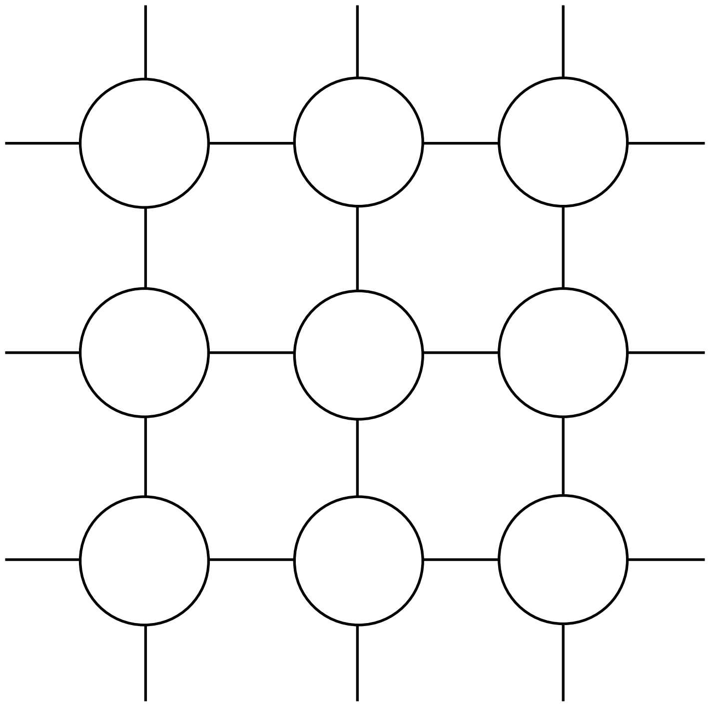

Fig. 5.1

On Fig. 5.1, complete the diagram to show the sodium chloride structure by labelling all of the particles with their chemical symbols and electrical charges. [2]

(b) Pure sodium chloride is used to make chlorine.

Fig. 5.2 shows industrial apparatus used to obtain chlorine.

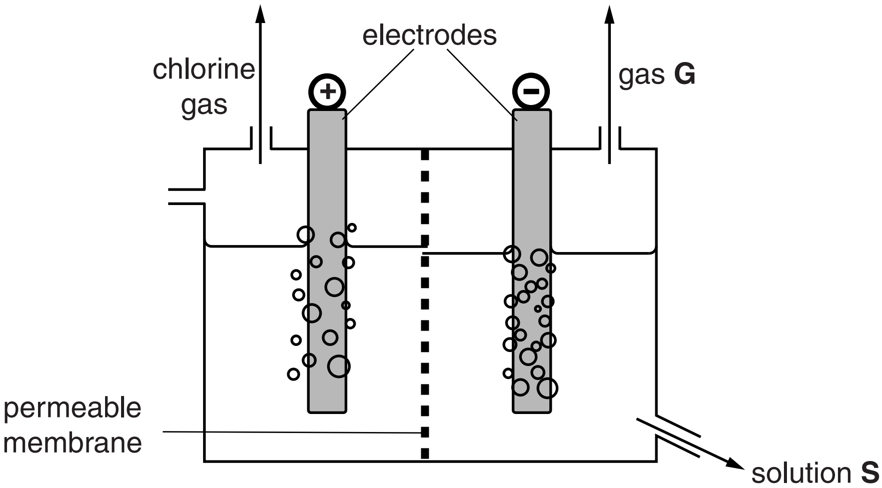

Fig. 5.2

(i) State what must be done to the pure sodium chloride before it can be used in the process shown in Fig. 5.2.

....[1]

(ii) Name gas **G** and solution **S** in Fig. 5.2.

gas **G** ....

solution **S** .... [2]

(iii) Describe in terms of ions, atoms and electrons what happens on the surface of the anode to produce chlorine gas molecules, Cl_2.

....

....

....

....[3]

(c) Phosphorus trichloride, PCl_3, is formed when chlorine gas reacts with phosphorus molecules. The formula for a phosphorus molecule is P_4.

Construct a balanced equation for the formation of phosphorus trichloride.

....[2]

6 **(a)** Fig. 6.1 shows part of a leaf in section, as it appears under a microscope.

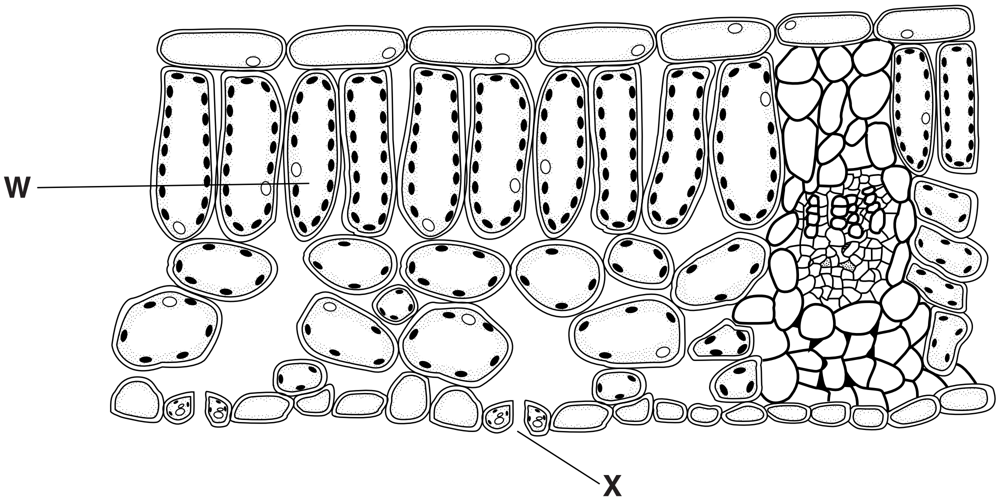

Fig. 6.1

(i) On Fig. 6.1, draw an arrow to show the path taken by water vapour as it goes from the cell labelled **W** to the outside atmosphere. [1]

(ii) Name the pore in the leaf labelled **X**.

....[1]

(b) Another leaf of the same size is similar in structure to Fig. 6.1, has larger air spaces and more pores.

Suggest and explain what effect these features will have on the rate at which this leaf loses water to the atmosphere.

(i) effect of having larger air spaces ....

explanation ....

....[2]

(ii) effect of having more pores ....

explanation ....

....[2]

(c) In very dry environments, such as deserts, plants have leaves that are adapted for the dry conditions.

Use your answers to part **(b)** to suggest **one** way in which a plant's leaves might be adapted for desert conditions.

....

....[1]

7 Oxygen combines with many elements to form oxides.

(a) Fig. 7.1 shows two test-tubes, **J** and **K**, that a student set up to investigate the oxidation of iron.

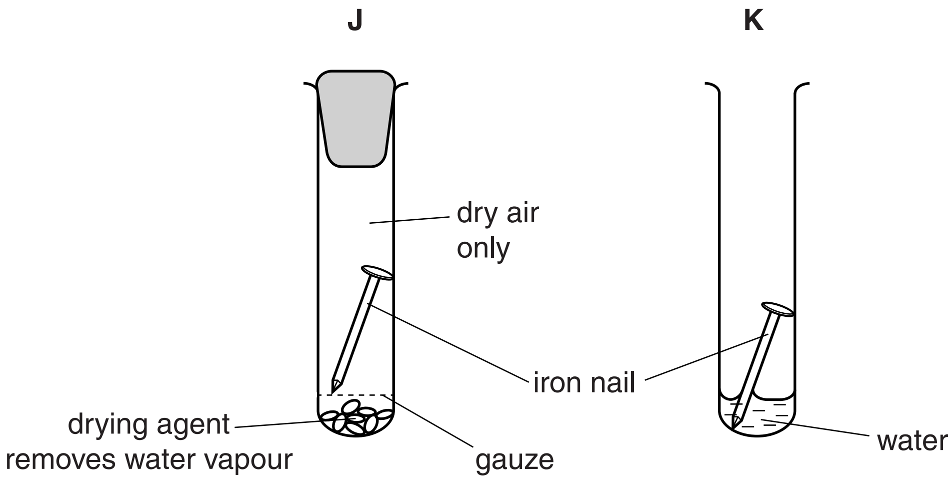

Fig. 7.1

(i) State the common name of the iron oxide that is formed in this experiment.

....[1]

(ii) State and explain whether the oxide in **(i)** is formed in test-tube **J**, in test-tube **K** or in both.

oxide formed in ....

explanation ....

....[1]

(b) Table 7.1 shows some information about six oxides.

Table 7.1

name	formula	physical state at 20 °C	pH after shaking with pure water
aluminium oxide	Al_2O_3	solid	7
copper oxide	CuO	solid	7
nitrous oxide	N_2O	gas	7
potassium oxide	K_2O	solid	13
Q		solid	1
sulfur dioxide	SO_2	gas	2

(i) Name the **elements** that combine with oxygen to form the neutral oxides in Table 7.1.

elements ....

explanation ....

....[2]

(ii) The elements calcium and phosphorus both form white, solid oxides.

Use the information in Table 7.1 to deduce whether oxide **Q** is calcium oxide or phosphorus oxide. Explain your answer.

....

....

....[2]

(c) The word equation for the burning of magnesium in air is shown below.

magnesium	+	oxygen	⟶	magnesium oxide

State and explain whether the chemical potential energy of the product is greater than, less than, or the same as the chemical potential energy of the reactants.

....

....

....[2]

(d) Complete the **word** chemical equation which shows the oxidation of sulfur dioxide during the Contact Process.

	+		⟶	

[2]

(e) Name the substance that reacts with copper oxide to produce a solution containing the salt, copper sulfate.

....[1]

8 **(a)** Coal is burned in a power station to generate electricity.

Fig. 8.1 is a scale diagram to show the energy transformations in a coal-burning power station.

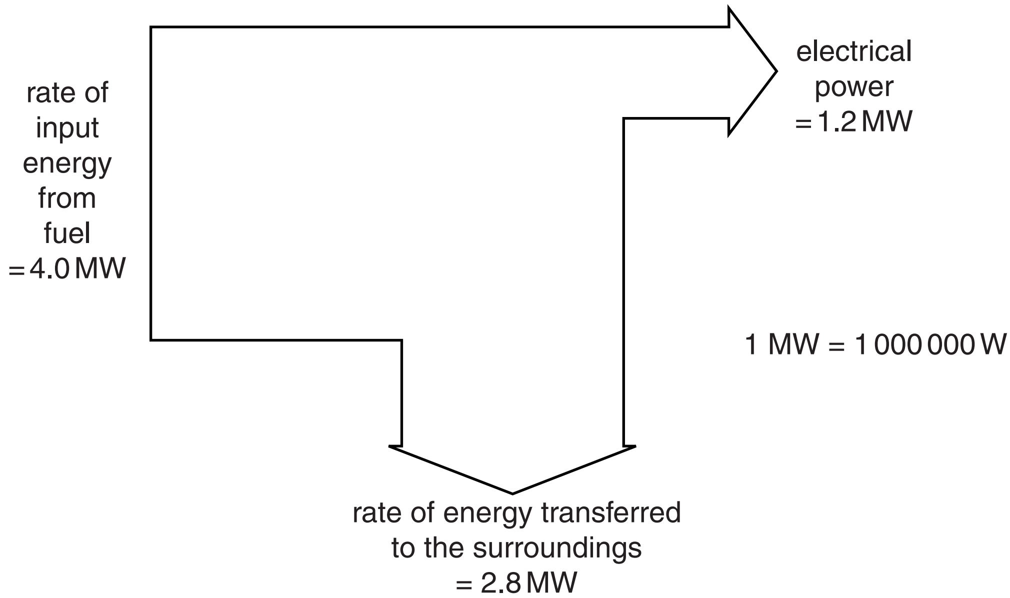

Fig. 8.1

Calculate the efficiency of the power station as a percentage.

Show your working.

efficiency = ...% [2]

(b) Nuclear fuel can also be used in power stations to generate electricity.

In a nuclear power station, nuclear fission of uranium-235 takes place.

(i) State what happens to the uranium-235 during nuclear fission.

....

....[1]

(ii) A different nuclear process takes place in the Sun to release energy from hydrogen.

Name this process and describe what happens to the hydrogen during this process.

name of process ....

description ....

....[2]

(c) When electricity has been generated in a power station, a step-up transformer increases the voltage before the electricity is transmitted through long-distance cables.

(i) Explain why the voltage of the electricity is increased before transmission.

....

....

....[2]

(ii) The power station generates electricity at 33 000 V. The voltage is stepped up by a transformer.

The number of turns on the primary coil of the transformer is 40 000. The number of turns on the secondary coil of the transformer is 500 000.

Calculate the output voltage from the transformer.

State the formula that you use and show your working.

formula

working

output voltage = ... V [2]

The burning of fossil fuels can cause acid rain and may also lead to global warming.

(d) Name a gas produced from burning fossil fuels that can lead to acid rain.

....[1]

(e) Describe why acid rain may kill

plants, ...

....

animals living in lakes. ....

....
[2]

(f) Describe how the gases produced from burning fossil fuels cause global warming.

....

....

....[2]

Please turn over for Question 9.

9 Frederick Hopkins, a scientist, investigated the effect of diet on the growth of mice.

He kept two groups of mice in a laboratory, feeding them on different diets.

- Group **1** had a **basic diet** of purified protein, carbohydrate, fat and mineral ions. They also had plenty of water.
- Group **2** had a **supplemented diet**. This was exactly the same as the basic diet, but with a small amount of milk added.

Hopkins measured the average mass of the mice in each group over a period of 18 days. After 18 days, he reversed the diets.

Fig. 9.1 shows his results.

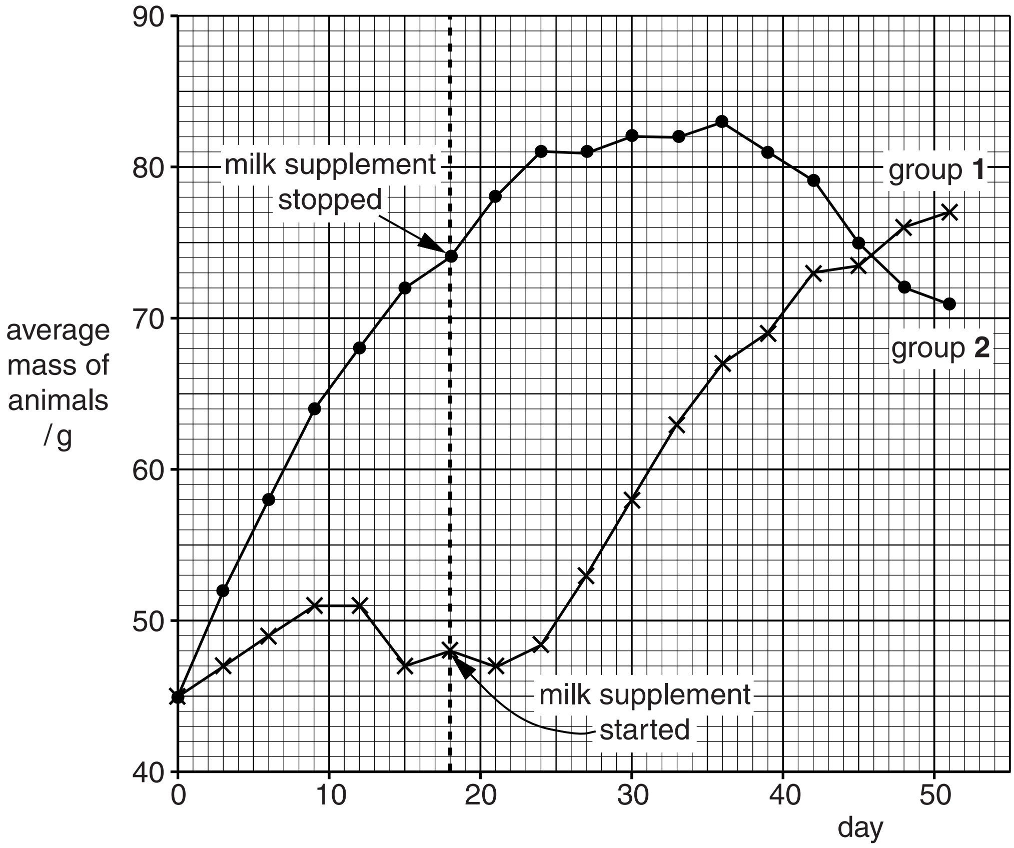

Fig. 9.1

(a) Compare the growth of the group **1** and group **2** animals between day 0 and day 9. Include in your answer how the growth of each group is alike and how the growth of each group is different.

....

....

....[2]

(b) State **one** function, in the diets, of

(i) the protein, ...[1]

(ii) the carbohydrate. ....[1]

(c) Name **one** mineral ion that the mice would need in their diet, and state its function.

mineral ion ....

function ....

....[2]

(d) Suggest **one** nutrient, normally present in a balanced diet, that was present in the milk but absent from the basic diet.

....[1]

(e) In Hopkins's experiment, he used mice from the same litter. Explain why it was important that the group **1** and group **2** mice came from the same litter.

....

....[1]

(f) **(i)** Explain why the diets of the two groups were swapped after 18 days.

....

....

....[1]

(ii) Suggest what would have happened to the mice in group **1** if the diets had been swapped back again after 36 days. Give a reason for your answer.

....

....[1]

(g) Hopkins's experiment was about nutrition. Define *nutrition*.

....

....

....

....[2]

10 The diagrams in Fig. 10.1 represent the structures of four substances **L**, **M**, **N** and **O,** all of which contain carbon.

Some of these substances also contain oxygen or hydrogen.

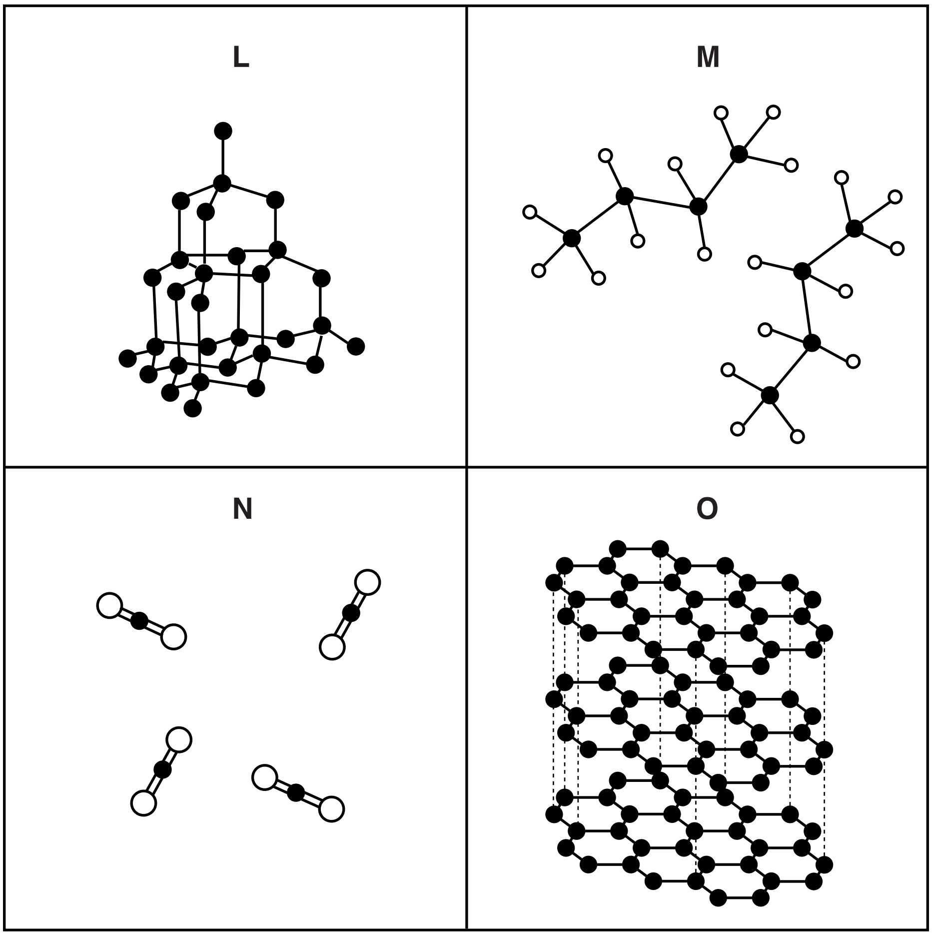

Fig. 10.1

(a) **(i)** State and explain **one** substance in each case, chosen from the structures **L**, **M**, **N** and **O**, that represents

an element, ...

explanation ....

....

a compound. ....

explanation ....

....

[2]

(ii) Deduce which substance **L**, **M**, **N** or **O**, in Fig. 10.1 could be a hydrocarbon.

substance ....

explanation ....

....[1]

(iii) Deduce which substance **L**, **M**, **N** or **O**, in Fig. 10.1 is produced when each of the other three substances undergoes complete combustion.

substance ....

explanation ....

....

....[2]

(b) Fig. 10.2 shows the structure of propane.

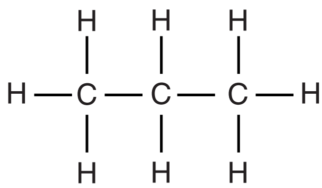

Fig. 10.2

(i) Name the type of chemical bonding that holds the atoms together in this molecule.

....[1]

(ii) State and explain the total number of shared **pairs** of electrons in the molecule shown in Fig. 10.2.

number of pairs of electrons ....

explanation ....

....[2]

11 **(a)** State the balanced chemical equation for aerobic respiration.

....[2]

(b) State how anaerobic respiration differs from aerobic respiration in terms of

(i) substances reacting,

....[1]

(ii) amount of energy released.

....[1]

(c) Explain why anaerobic respiration of yeast is important in the brewing of beer.

....

....

....[2]

12 **(a)** A police car communicates with the police station using radio waves. The police car uses a blue flashing light to alert people.

Radio waves and light waves are both parts of the electromagnetic spectrum.

(i) State **one** property which all electromagnetic waves have in common.

....[1]

(ii) State **one** property which is different for different electromagnetic waves.

....

....[1]

(iii) Blue light waves have a frequency of 6.7×10^{14} Hz. The speed of the waves is 3.0×10^{8} m/s. Calculate the wavelength of blue light waves.

State the formula that you use and show your working.

formula

working

wavelength = ... m [2]

(iv) Fig. 12.1 shows a wave.

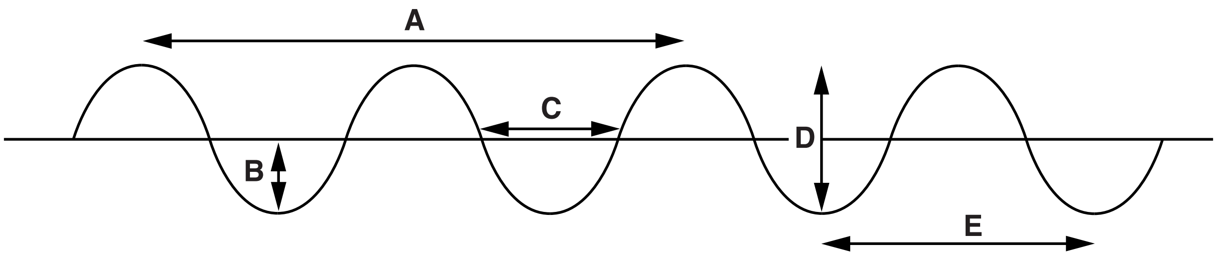

Fig. 12.1

State which measurement, **A**, **B**, **C**, **D** or **E** is

the amplitude of the wave, ...

the wavelength of the wave. .... [1]

(b) Fig. 12.2 shows the motion of the police car over two minutes.

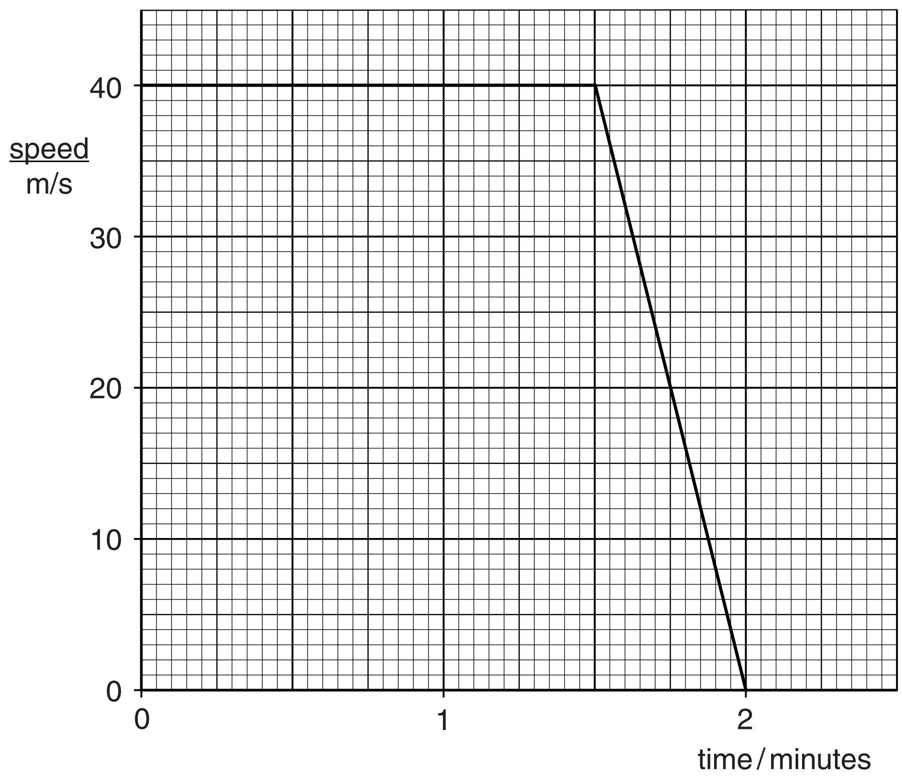

Fig. 12.2

(i) Use the graph to calculate the distance covered by the police car during the two minutes.

Show your working.

distance = ...m [2]

(ii) Label, with a letter **A** and a label line, a point on the graph where the car is accelerating. [1]

(iii) Calculate the acceleration you identified in **(ii)**.

Show your working.

formula

working

acceleration = ...m/s^2 [2]

(iv) The mass of the car is 1200 kg.

Calculate the kinetic energy of the car when it is travelling at the constant speed shown in the graph.

State the formula that you use and show your working.

formula

working

kinetic energy = ... J [2]

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	209 **Po** Polonium 84	210 **At** Astatine 85	222 **Rn** Radon 86
223 **Fr** Francium 87	226 **Ra** Radium 88	227 **Ac** Actinium 89 †															

* 58–71 Lanthanoid series
† 90–103 Actinoid series

140 **Ce** Cerium 58	141 **Pr** Praseodymium 59	144 **Nd** Neodymium 60	147 **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	231 **Pa** Protactinium 91	238 **U** Uranium 92	237 **Np** Neptunium 93	244 **Pu** Plutonium 94	243 **Am** Americium 95	247 **Cm** Curium 96	247 **Bk** Berkelium 97	251 **Cf** Californium 98	252 **Es** Einsteinium 99	257 **Fm** Fermium 100	258 **Md** Mendelevium 101	259 **No** Nobelium 102	260 **Lr** Lawrencium 103

Key

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

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