Centre Number	Candidate Number	Name

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CO-ORDINATED SCIENCES **0654/03**

Paper 3

October/November 2004

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 in the spaces provided on the Question Paper.
You may use a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.

Answer **all** questions.
The number of marks is given in brackets [ ] at the end of each question or part question.
A copy of the Periodic Table is printed on page 24.

If you have been given a label, look at the details. If any details are incorrect or missing, please fill in your correct details in the space given at the top of this page.

Stick your personal label here, if provided.

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10	
Total	

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1 **(a)** Fig. 1.1 shows how the radiation detected from a sample of carbon-14 would change with time.

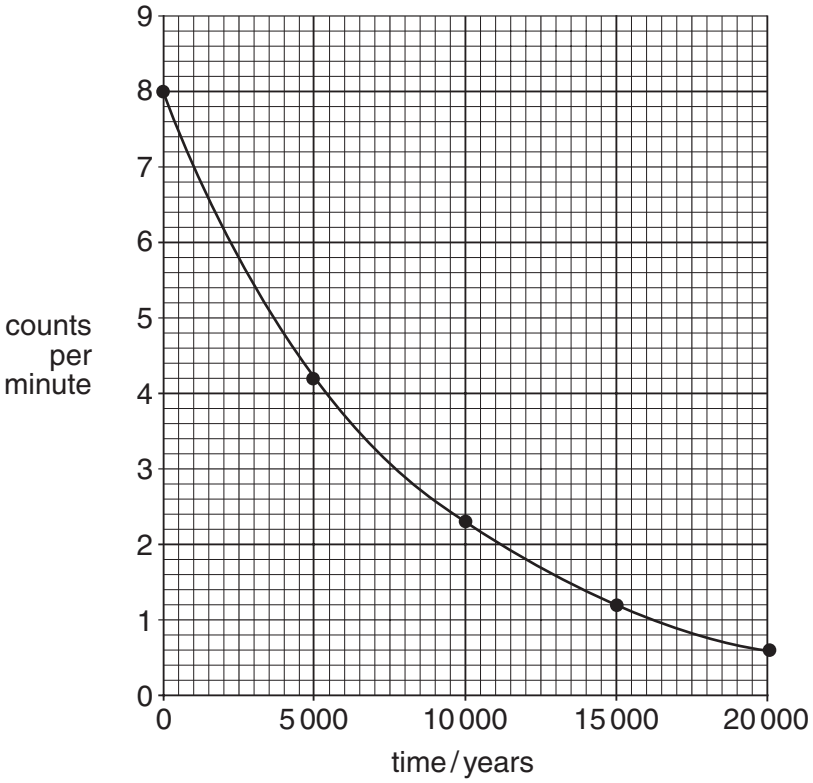

Fig. 1.1

Use the graph to calculate the half life of carbon-14. Show your working on the graph.

..... years [2]

(b) When a carbon-14 atom ($^{14}_{6}C$) emits radiation it changes into a nitrogen atom ($^{14}_{7}N$).

Using this information, suggest the type of radiation emitted by carbon-14. Explain your answer.

.....

.....[2]

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2 Popcorn is a popular food. It is made by heating grains of the maize plant. Fig. 2.1 shows a cross section through a typical maize grain.

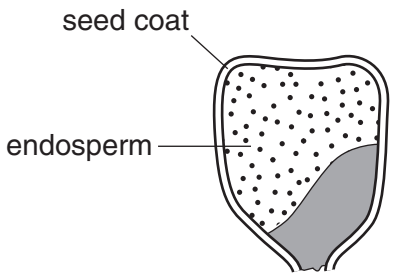

Fig. 2.1

When the grain is heated, water in the endosperm vaporises and turns to steam. As the temperature increases, the pressure of the steam increases, and the starch in the endosperm softens and becomes fluid (more like a liquid than a solid). When the pressure inside the grain is high enough, the steam and fluid starch break through the seed coat. Fig. 2.2 shows the popped maize grain.

Fig. 2.2

(a) Starch and glucose are carbohydrates. Starch is made of polymer molecules which can be broken down into glucose molecules.

(i) Name the **three** elements in all carbohydrates.

.....[1]

(ii) Using starch and glucose as examples, explain briefly the meanings of the terms *monomer* and *polymer*.

.....

.....

.....[2]

(iii) Proteins are another very important group of substances made of polymer molecules. Name the element found in all proteins but not in carbohydrates.

.....[1]

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(b) Explain in terms of the motion of molecules why the steam pressure inside the maize grain increases when the temperature increases.

.....

.....[2]

(c) The starch, which bursts through the seed coat when the maize grain pops, cools quickly to form a solid foam. Fig. 2.3 shows a magnified view of the inside of the solid foam.

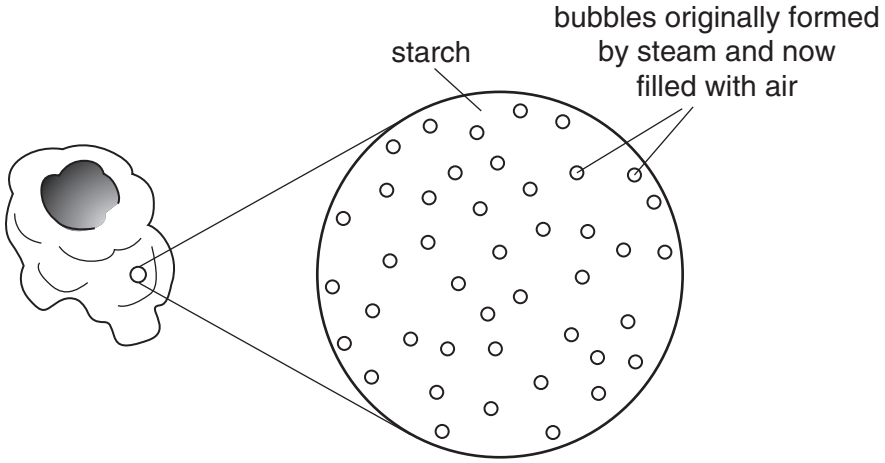

Fig. 2.3

(i) What general name is given to a mixture in which one substance is dispersed in another?

.....[1]

(ii) An emulsion, such as milk, is an example of a mixture in which one substance is dispersed in another.

Explain why it is not possible to see through emulsions like milk. Draw some light rays on the diagram in Fig. 2.4 to help you to answer this question.

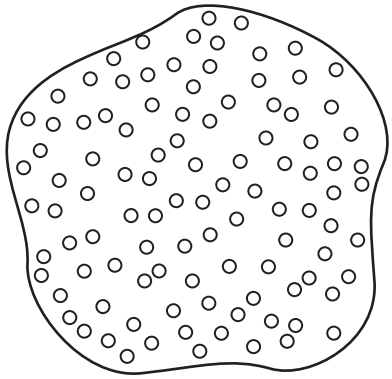

Fig. 2.4

.....

.....[2]

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(d) Popcorn is often made by heating the maize grains in a cooking pot made from an aluminium alloy.

In the boxes below, draw labelled sketches to show how the atoms are arranged in a piece of pure aluminium and in a piece of an aluminium alloy. One aluminium atom has been drawn in each box.

O	O
pure aluminium	aluminium alloy

[4]

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3 Fig. 3.1 is a photograph of part of a leaf, taken using a light microscope.

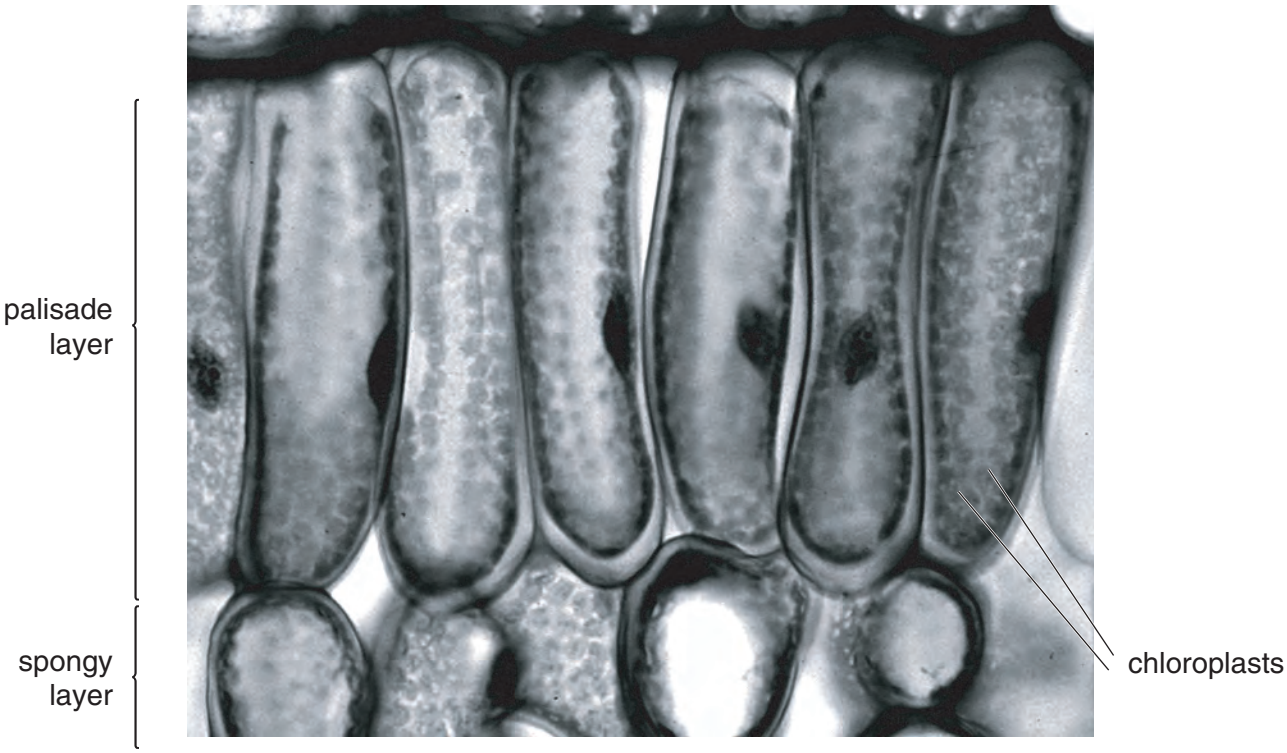

Fig. 3.1

(a) The presence of chloroplasts shows that these are plant cells, and not animal cells.

(i) On the photograph, label **one** feature, other than chloroplasts, which is present in plant cells but **not** in animal cells. [1]

(ii) Describe the function of the feature you have labelled.

.....

.....

.....[2]

(b) Explain how the **structure** of these cells enables photosynthesis to be carried out effectively.

.....

.....

.....

.....

.....[2]

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(c) Explain how the **position** of these cells in the leaf enables them to obtain each of the following requirements for photosynthesis.

(i) light .....

.....

.....[2]

(ii) carbon dioxide .....

.....

.....[2]

(d) What name is given to a group of similar cells such as the palisade layer in a leaf?

.....[1]

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4 **(a)** Fig. 4.1 shows an athlete running a race.

Fig. 4.1

Some forces acting on the athlete are

- a support force, **A**, from the ground pushing on the athlete,
- a friction force, **B**, from the ground helping the athlete to move,
- the weight, **C**, of the athlete,
- the force of air resistance, **D**, which slows the athlete.

Draw arrows on Fig. 4.1 to show the direction of each of these forces. Label each force clearly using the letters **B** – **D**. The direction of force **A** has been drawn for you. [2]

(b) Good sprinters are said to need strong leg muscles and small body mass. Explain why these characteristics may be useful to a sprinter as he accelerates from the starting blocks.

.....

.....

.....

.....[3]

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(c) A spectator is sitting 85 m from the starting gun. When the race is started, the spectator sees the athletes run off and a little later hears the bang from the starting gun. The spectator thinks that there was a false start, when the athletes started running before the starting gun was fired.

The speed of sound is 340 m / s. Explain why the athletes did not have a false start.

.....

.....

.....[2]

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5 A student investigated the reaction of four metals, **P**, **Q**, **R** and **S**, with dilute hydrochloric acid. Fig. 5.1 shows what the student observed during the experiment.

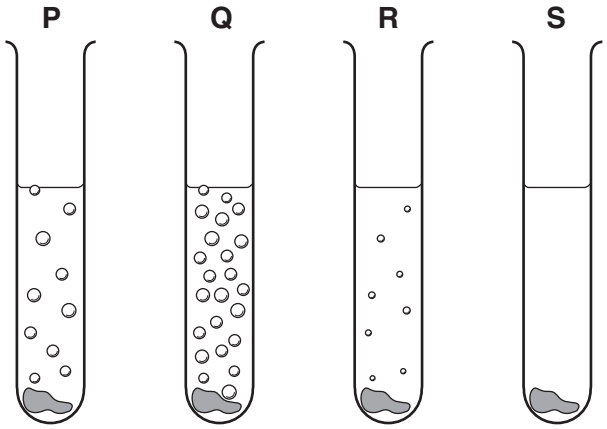

Fig. 5.1

(a) Name the gas given off in these reactions.

.....[1]

(b) The student thought that the results clearly showed the reactivity order of the metals.

(i) List the metals in reactivity order suggested by the observations.

……. (most reactive)

…….

…….

……. (least reactive) [1]

(ii) State three conditions that would need to be kept the same for each reaction if the observations are to be a reliable indication of the reactivity of the metals.

1 .....

2 .....

3 .....[3]

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(c) The student then investigated the electrolysis of seven aqueous solutions, using the apparatus shown in Fig. 5.2.

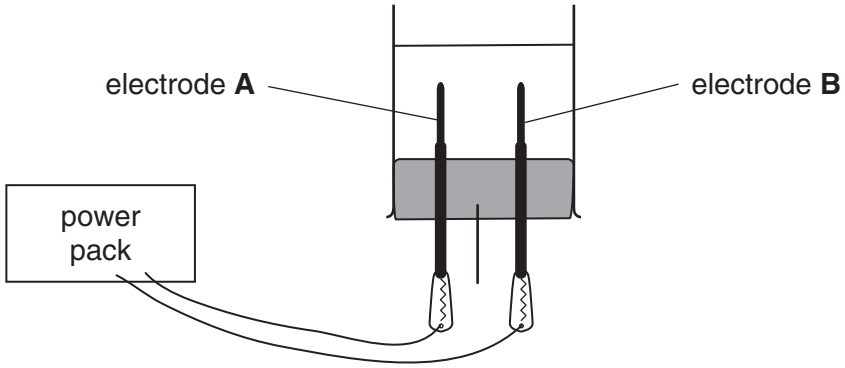

Fig. 5.2

His results are shown in Table 5.1.

Table 5.1

solution	product at electrode **A**	product at electrode **B**
potassium sulphate	hydrogen gas	oxygen gas
magnesium nitrate	hydrogen gas	oxygen gas
copper sulphate	copper metal	oxygen gas
silver nitrate	silver metal	oxygen gas
potassium chloride	hydrogen gas	chlorine gas
magnesium chloride	hydrogen gas	chlorine gas
copper chloride	copper metal	chlorine gas

Part of the reactivity series is shown below.

potassium (most reactive)
magnesium
(hydrogen)
copper
silver (least reactive)

(i) Use the patterns in the results shown in Table 5.1 to predict the electrode products in the examples below.

solution	product at electrode **A**	product at electrode **B**
copper nitrate		
magnesium sulphate		

[2]

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(ii) Suggest a general rule for predicting the product at electrode A from the reactivity series.

.....

.....

.....[2]

6 Fig. 6.1 is a transverse section through a human eye.

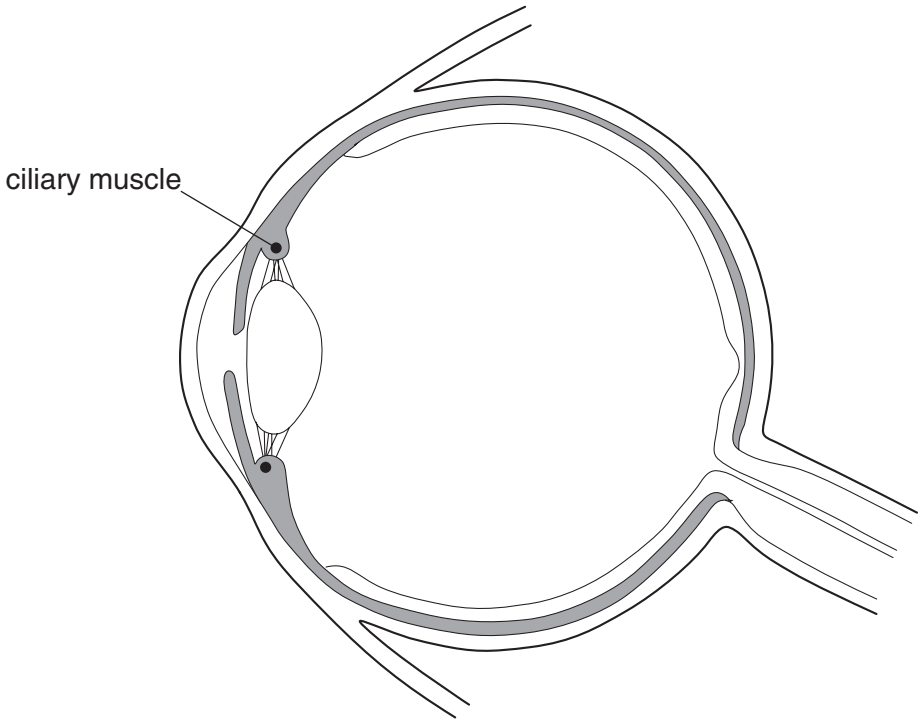

Fig. 6.1

(a) On the diagram, draw label lines to

(i) the area where an image is focused, and label it **F**, [1]

(ii) a part of the eye that prevents too much light from reaching the retina, and label it **P**. [1]

(b) Describe how information from the eye is transmitted to the brain.

.....

.....

.....[2]

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(c) Explain how the contraction of the ciliary muscle helps the eye to focus on a nearby object.

.....

.....

.....

.....[3]

(d) The eyes of snakes contain only cones, with no rods.

Use this information to make two statements about the vision of snakes.

1 .....

.....

2 .....

.....[2]

(e) Many snakes hunt for prey, such as small mammals, at night. They have structures in their heads called pit organs, which can sense infra-red radiation. This helps them to locate their prey even when it is completely dark, because small mammals emit much more infra-red radiation than their surroundings.

(i) State **one** way in which infra-red radiation differs from light.

.....[1]

(ii) Suggest why mammals emit much more infra-red radiation than their surroundings.

.....

.....

.....[2]

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7 Fig. 7.1 shows the motion of a bus from one stop to the next.

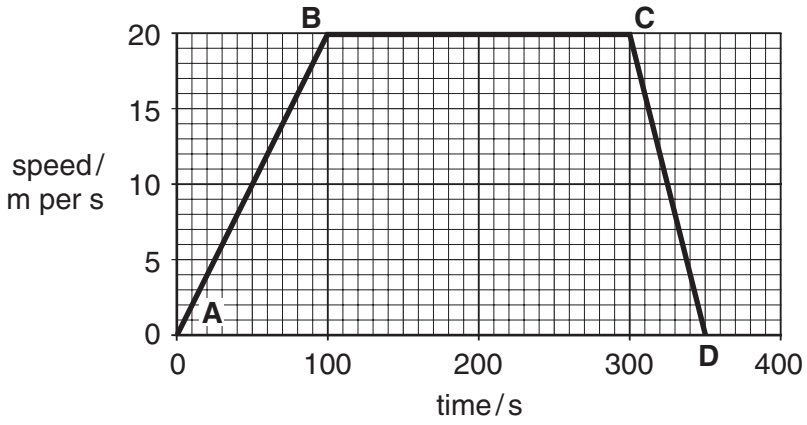

Fig. 7.1

(a) Describe the motion of the bus during **BC** and during **CD**.

BC .....

.....

CD .....

.....[2]

(b) Calculate the distance covered by the bus from **A** to **D**. Show your working.

.....[3]

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(c) Fig. 7.2 shows two toy buses. Bus **A** has a mass of 0.5 kg and bus **B** has a mass of 0.3 kg. Both buses are moving in the same direction.

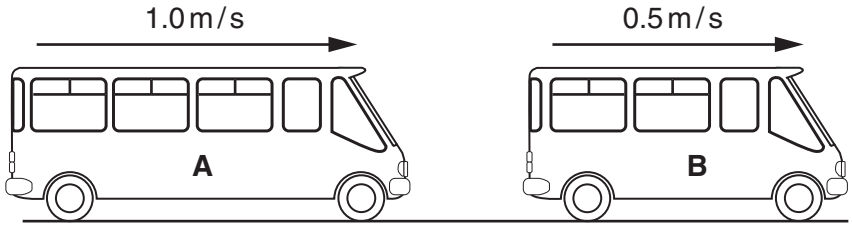

Fig. 7.2

Bus **A** is travelling at 1.0 m/s and bus **B** is travelling at 0.5 m/s. When they collide, bus **A** and bus **B** join together and move in the same direction.

Calculate the speed at which they continue to move.

Show your working and state the formula that you use.

formula used

working

.....[3]

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(d) The headlamps on a bus are connected in parallel as shown in Fig. 7.3.

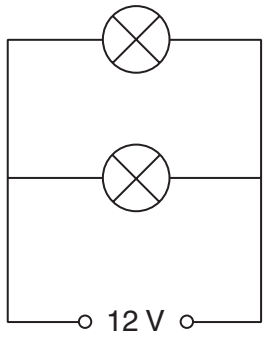

Fig. 7.3

Each headlamp has a resistance of 4 ohms.
Calculate the combined resistance of the two headlamps.

Show your working and state the formula that you use.

formula used

working

.....[2]

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8 The manufacture of ammonia and of sulphuric acid are two important industrial processes.

Fig. 8.1 is a simplified diagram of the type of reaction vessel which is used in both processes.

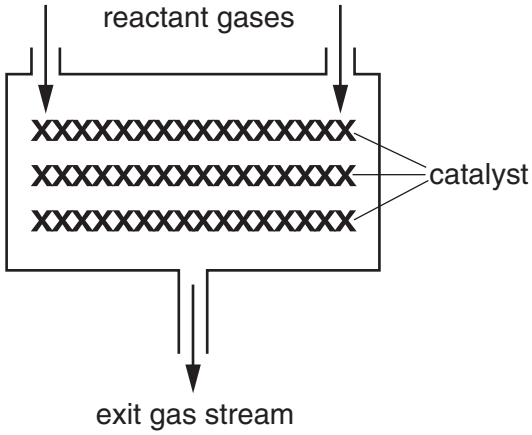

Fig. 8.1

(a) The manufacture of ammonia and of sulphuric acid both involve reversible, redox reactions which require a catalyst.

(i) State the purpose of a catalyst.

.....[1]

(ii) The reactant gases required to make ammonia are nitrogen and hydrogen.

Explain why the exit gas stream contains all three of these gases.

.....

.....

.....[2]

(iii) The equation below shows one of the reactions involved in the manufacture of sulphuric acid. The equation is not balanced.

Balance the equation.

$$SO_2 + O_2 \rightleftharpoons SO_3$$

[1]

(iv) Name the substance that is oxidised in this reaction.

.....[1]

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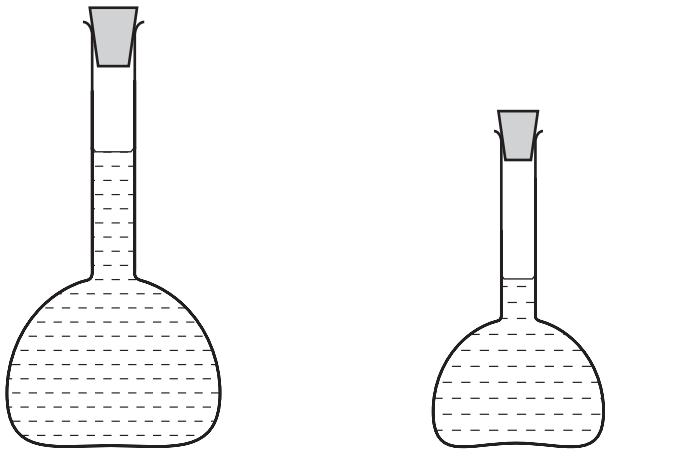
(b) Draw a diagram of an ammonia molecule, NH_3, showing how the outer electrons are arranged.

[2]

(c) Ammonia reacts with dilute nitric acid to make the salt ammonium nitrate.

$$NH_3 + HNO_3 \longrightarrow NH_4NO_3$$

A student makes a solution of ammonium nitrate by mixing the solutions shown in Fig. 8.2.



100 cm^3 of 0.1 mol / dm^3 nitric acid

50 cm^3 of 0.2 mol / dm^3 aqueous ammonia

Fig. 8.2

(i) Show that the number of moles of ammonia and the number of moles of nitric acid that the student uses are both 0.01.

.....[3]

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(ii) The student leaves the mixture to evaporate.
Calculate the mass of ammonium nitrate crystals that she will obtain.
(relative atomic masses N = 14; O = 16; H = 1.)

.....[3]

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9 Hog deer (Fig. 9.1) are herbivores which live in regions of Pakistan and India. They feed on grass. Hog deer are killed and eaten by tigers.

Fig. 9.1

(a) (i) Construct a food chain using the information above.

[1]

(ii) What do the arrows in your food chain represent?

.....[1]

(iii) Sketch a pyramid of biomass representing this food chain. Label each part of the pyramid using the correct terms for the feeding levels.

[3]

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(b) Hog deer are normally brown, but occasionally an albino (pure white) hog deer is born.

(i) Suggest how this might occur.

.....

.....

.....[2]

(ii) Explain how natural selection is likely to ensure that very few albinos are present in a population of hog deer.

.....

.....

.....

.....

.....[4]

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10 **(a)** Microwaves travel at 300 000 000 m / s. Calculate the frequency of a microwave of wavelength 6 cm.

Show your working and state the formula that you use.

formula used

working

……[3]

(b) A microwave oven was used to heat 0.5 kg of milk contained in a plastic cup. The temperature of the milk was 15 °C when it was placed in the microwave oven and 95 °C when it was taken out.
The specific heating capacity for milk is 4500 J / kg °C.

(i) Calculate the amount of energy transferred from the microwave oven to the milk.

Show your working and state the formula that you use.

formula used

working

……[3]

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To heat the milk, 240 000 J of electrical energy was transferred to the microwave oven.

(ii) Use your answer to part **(i)** to calculate the efficiency of the energy transfer.

.....[1]

(iii) Suggest why the energy transfer is not 100% efficient.

.....

.....[1]

(c) Fig. 10.1 shows a reed switch used as a safety device in a microwave oven.

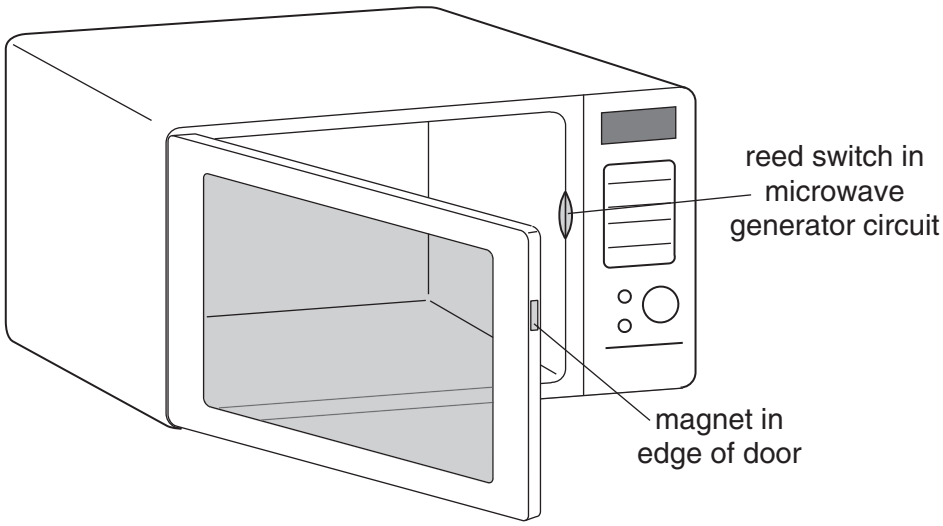

Fig. 10.1

Suggest what the reed switch contains and how this ensures that the microwave oven only operates when the oven door is shut.

.....

.....

.....[3]

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DATA SHEET
The Periodic Table of the Elements

Group																	
I	II										III	IV	V	VI	VII	0
							1 H Hydrogen 1									4 He Helium 2
7 Li Lithium 3	9 Be Beryllium 4										11 B Boron 5	12 C Carbon 6	14 N Nitrogen 7	16 O Oxygen 8	19 F Fluorine 9	20 Ne Neon 10
23 Na Sodium 11	24 Mg Magnesium 12										27 Al Aluminium 13	28 Si Silicon 14	31 P Phosphorus 15	32 S Sulphur 16	35.5 Cl Chlorine 17	40 Ar Argon 18
39 K Potassium 19	40 Ca Calcium 20	45 Sc Scandium 21	48 Ti Titanium 22	51 V Vanadium 23	52 Cr Chromium 24	55 Mn Manganese 25	56 Fe Iron 26	59 Co Cobalt 27	59 Ni Nickel 28	64 Cu Copper 29	65 Zn Zinc 30	70 Ga Gallium 31	73 Ge Germanium 32	75 As Arsenic 33	79 Se Selenium 34	80 Br Bromine 35	84 Kr Krypton 36
85 Rb Rubidium 37	88 Sr Strontium 38	89 Y Yttrium 39	91 Zr Zirconium 40	93 Nb Niobium 41	96 Mo Molybdenum 42	Tc Technetium 43	101 Ru Ruthenium 44	103 Rh Rhodium 45	106 Pd Palladium 46	108 Ag Silver 47	112 Cd Cadmium 48	115 In Indium 49	119 Sn Tin 50	122 Sb Antimony 51	128 Te Tellurium 52	127 I Iodine 53	131 Xe Xenon 54
133 Cs Caesium 55	137 Ba Barium 56	139 La Lanthanum 57 *	178 Hf Hafnium 72	181 Ta Tantalum 73	184 W Tungsten 74	186 Re Rhenium 75	190 Os Osmium 76	192 Ir Iridium 77	195 Pt Platinum 78	197 Au Gold 79	201 Hg Mercury 80	204 Tl Thallium 81	207 Pb Lead 82	209 Bi Bismuth 83	Po Polonium 84	At Astatine 85	Rn Radon 86
Fr Francium 87	226 Ra Radium 88	227 Ac Actinium 89 †															

140 Ce Cerium 58	141 Pr Praseodymium 59	144 Nd Neodymium 60	Pm Promethium 61	150 Sm Samarium 62	152 Eu Europium 63	157 Gd Gadolinium 64	159 Tb Terbium 65	162 Dy Dysprosium 66	165 Ho Holmium 67	167 Er Erbium 68	169 Tm Thulium 69	173 Yb Ytterbium 70	175 Lu Lutetium 71
232 Th Thorium 90	Pa Protactinium 91	238 U Uranium 92	Np Neptunium 93	Pu Plutonium 94	Am Americium 95	Cm Curium 96	Bk Berkelium 97	Cf Californium 98	Es Einsteinium 99	Fm Fermium 100	Md Mendelevium 101	No Nobelium 102	Lr Lawrencium 103

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

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

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

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