| 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.

| For Examiner's Use | |
|---|---|
| 1 | |
| 2 | |
| 3 | |
| 4 | |
| 5 | |
| 6 | |
| 7 | |
| 8 | |
| 9 | |
| 10 | |
| Total | |

This document consists of **24** printed pages.

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

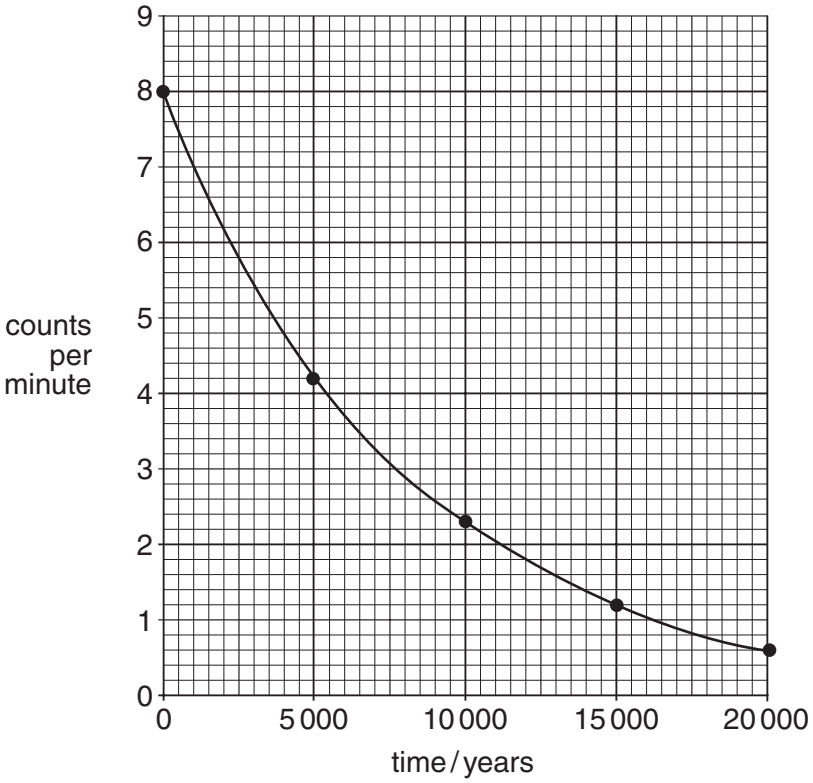



**Fig. 1.1**

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]

**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.

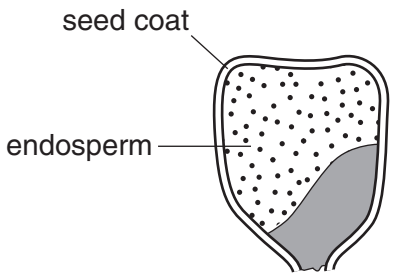



**Fig. 2.1**

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]

**(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.

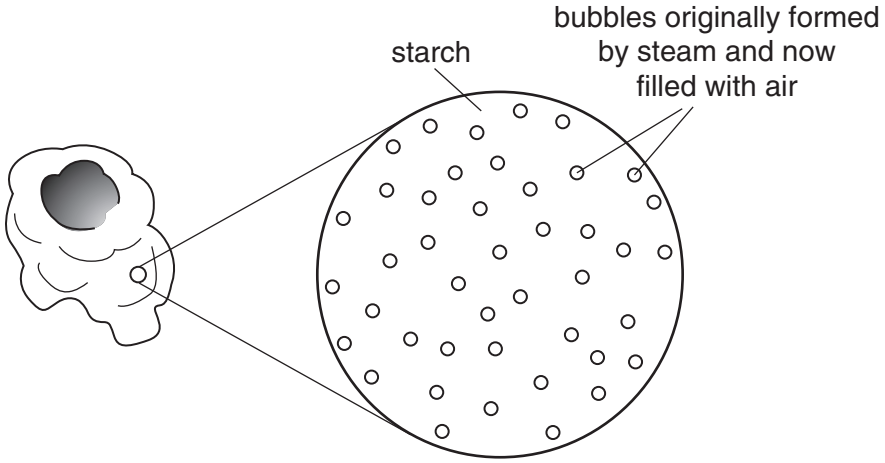



**Fig. 2.3**

**(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.

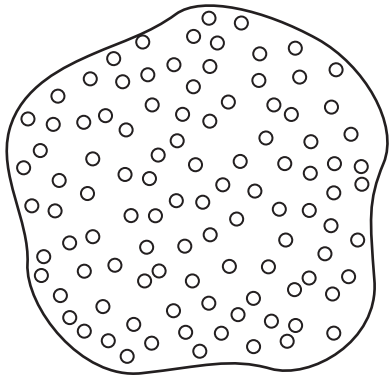


**Fig. 2.4**

.....

.....[2]

**(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]

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

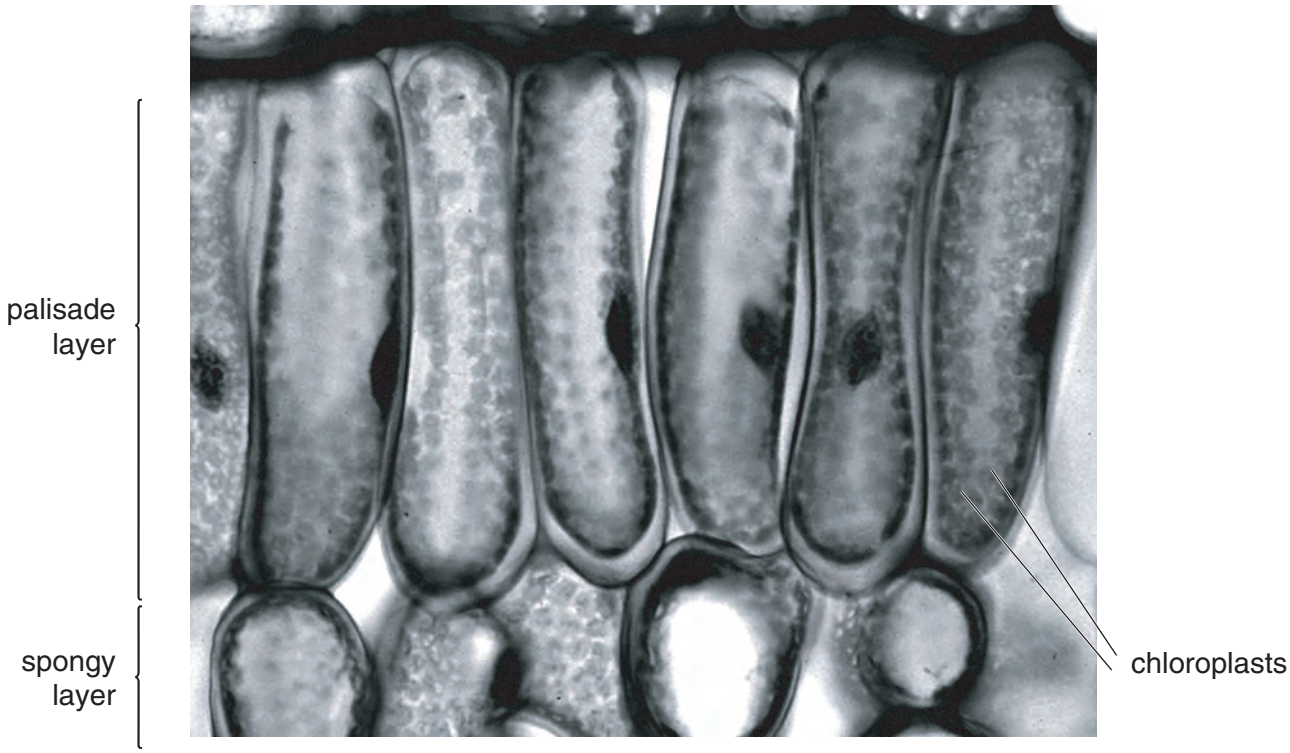



**Fig. 3.1**

**(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]

**(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]

**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]

**(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]

**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.

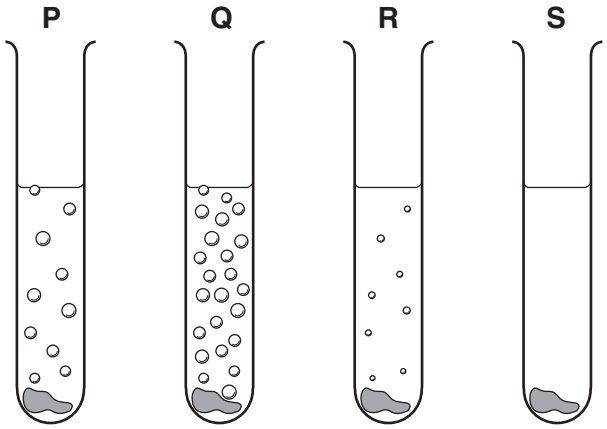



**Fig. 5.1**

**(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]

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

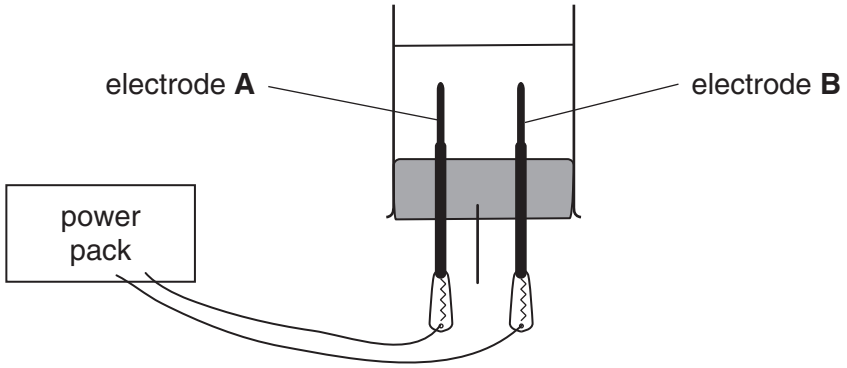



**Fig. 5.2**

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]

**(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.

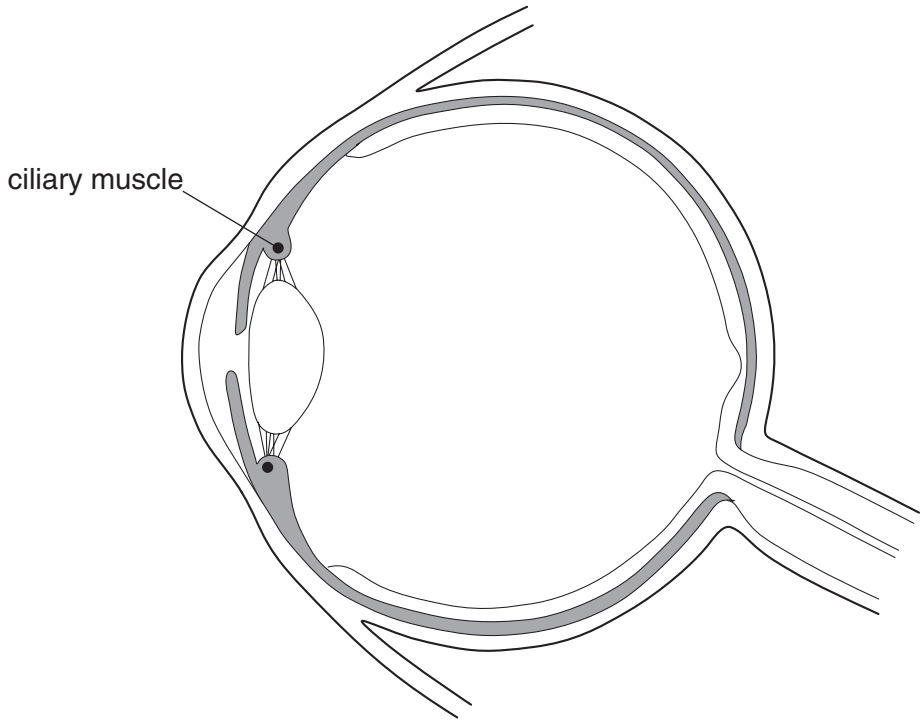



**Fig. 6.1**

**(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]

**(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]

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

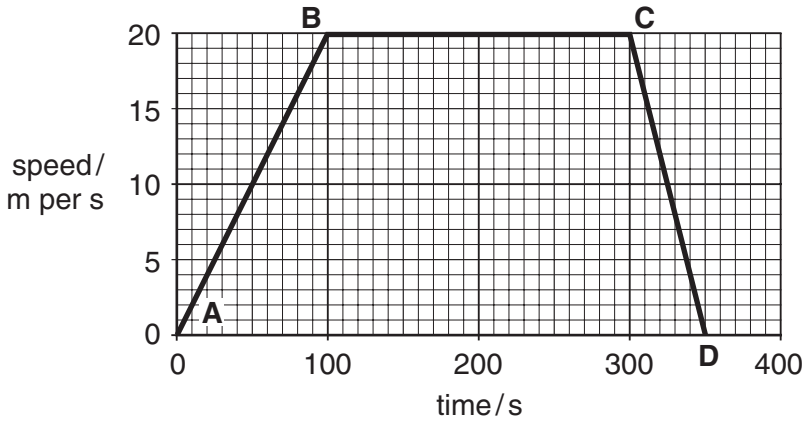



**Fig. 7.1**

**(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]

**(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.

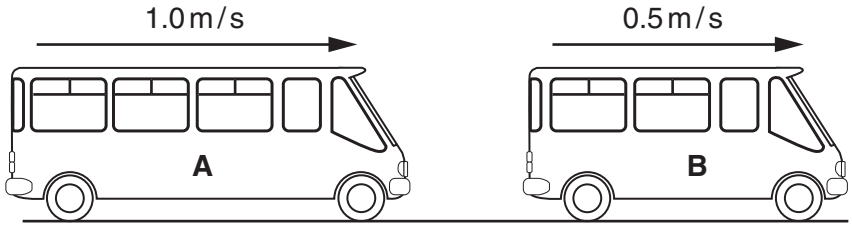



**Fig. 7.2**

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]

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

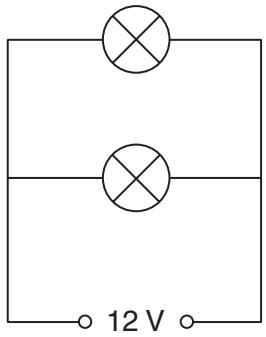



**Fig. 7.3**

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]

**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.

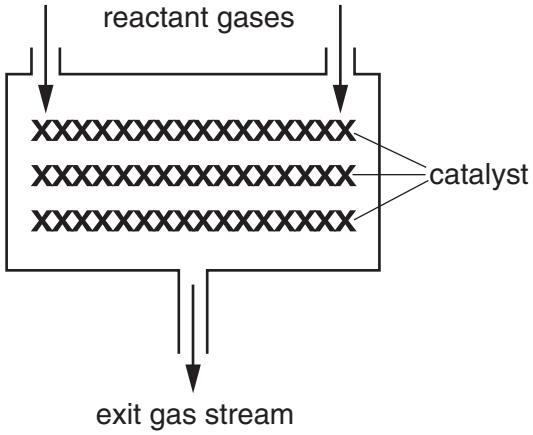



**Fig. 8.1**

**(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]

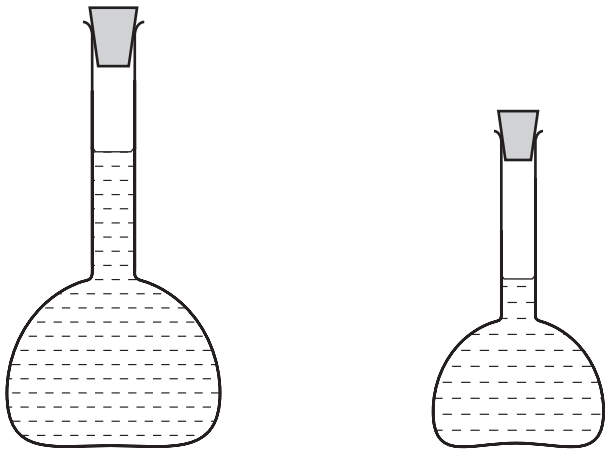
**(b)** Draw a diagram of an ammonia molecule, $NH_3$, showing how the outer electrons are arranged.

[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]

**(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]

**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]

**(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]

**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]

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.

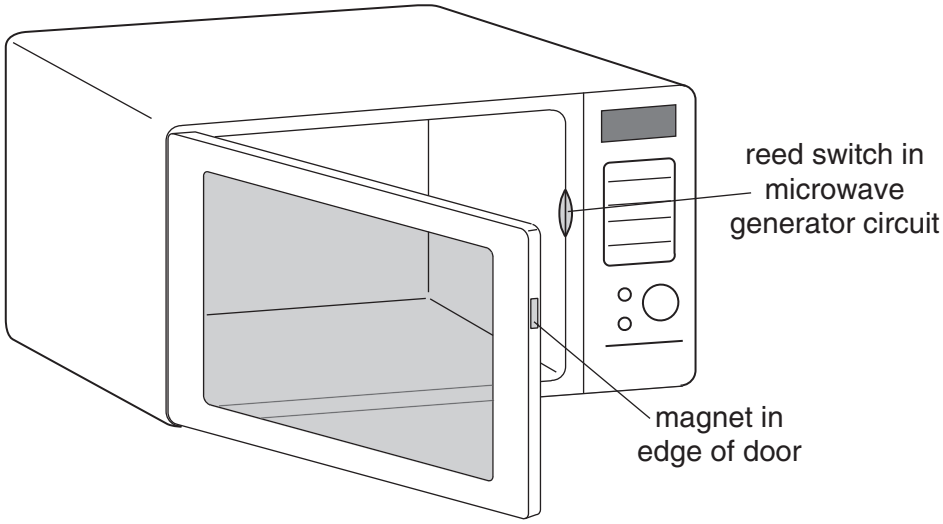



**Fig. 10.1**

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

.....

.....

.....[3]

# 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 Radius 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 |
| 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 | |

Key

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

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