UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

3771458015

CO-ORDINATED SCIENCES **0654/33**

Paper 3 (Extended) **October/November 2011**

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 a soft pencil for any diagrams, graphs, tables or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

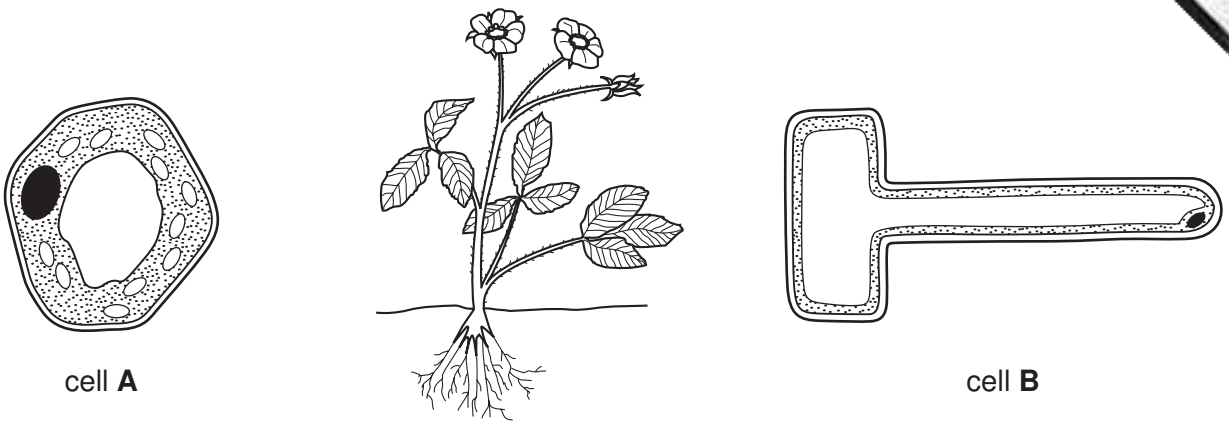
Answer **all** questions.
A copy of the Periodic Table is printed on page 28.

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.

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

This document consists of **27** printed pages and **1** blank page.

1 **(a)** Fig. 1.1 shows a flowering plant, and two cells from the plant.



cell **A** cell **B**

Fig. 1.1

(i) On Fig. 1.1, draw a line from each cell to a part of the plant in which it could be found. [2]

(ii) State **one** difference between the **contents** of cell **A** and cell **B**, and explain the reasons for this difference.

difference .....

explanation .....

.....

..... [3]

(b) A grower has a rare variety of orchid with unusual flowers. She decides to produce new plants from this orchid using tissue culture.

Explain why it is better for the grower to use tissue culture to produce new plants, rather than sowing seeds she has collected from the orchid plant.

.....

.....

.....

..... [3]

(c) Genetic engineering has been used to produce a new variety of maize (corn) plant. This was done by introducing a gene into the maize cells that causes the plant to produce a toxin. The toxin only kills insects that eat parts of the plant.

(i) Suggest **one** possible advantage to a farmer of growing this type of maize.

.....

..... [1]

(ii) Suggest **one** possible problem that could be caused by growing this type of maize.

.....

..... [1]

2 Melamine resin and PTFE are important plastics which have many uses in the hom
industry. Wool consists of fibres which are made of protein molecules.

(a) All of the above substances are made of polymer molecules.

Explain the general meaning of the term *polymer*.

.....

.....

..... [2]

(b) Fig. 2.1 shows the displayed formula of the monomer that reacts to produce PTFE.

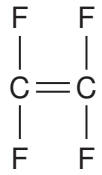


Fig. 2.1

(i) Fig. 2.2 shows the outer shell electrons in a carbon atom and a fluorine atom.

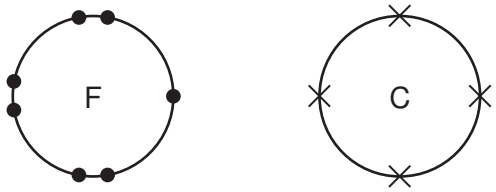
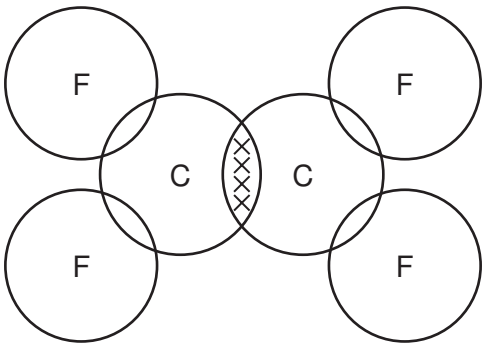


Fig. 2.2

Complete the bonding diagram below to show how the outer electrons are arranged in the molecule whose displayed formula is shown in Fig. 2.1.



[2]

(ii) Explain why the molecule shown in Fig. 2.1 is **not** an example of a hydrocarb

.....

.....

[1]

(iii) Draw the displayed formula of a small section of a PTFE molecule.

The section that you draw must show eight fluorine atoms.

[3]

(c) Melamine resin and PTFE behave differently when they are heated. PTFE becomes softer and may melt, but melamine resin does not melt even when it is heated strongly.

Explain this difference in terms of forces between molecules. You may draw some simple diagrams if it helps you to answer this question.

.....

.....

.....

.....

[3]

(d) Fig. 2.3 shows a magnified section of a wool fibre. The fibre has been washed in hot, temporarily hard water. The fibre is covered with tiny crystals of limescale.

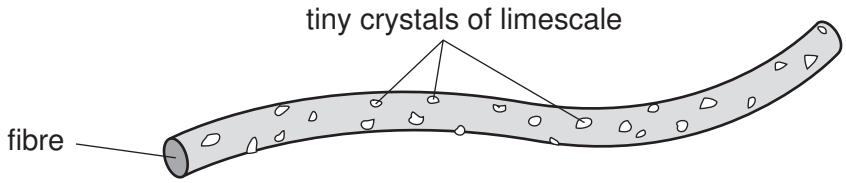


Fig. 2.3

(i) Complete the symbolic equation which represents the chemical reaction which causes limescale to form.

$$Ca(HCO_3)_2 \longrightarrow$$

[1]

(ii) Ion exchange resins are polymers with positive ions attached to the polymer chains.

Describe and explain briefly how the process of ion exchange can be used to soften hard water.

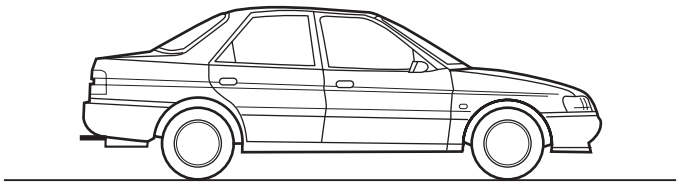
.....

.....

.....

..... [3]

3 A car is being driven on a journey.



(a) (i) State the **two** quantities needed to find the momentum of the car.

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

(ii) The car turns a corner without changing speed.

Explain why the momentum of the car has changed.

.....

.....

..... [2]

(b) Fig 3.1 shows a speed–time graph for part of the car's journey, during which the brakes are used.

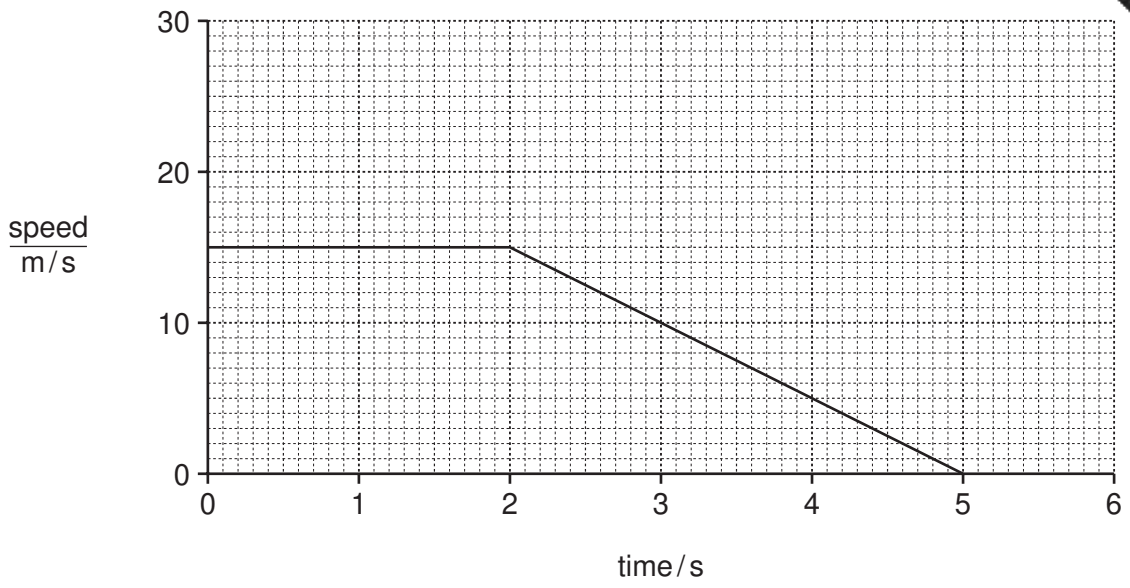


Fig. 3.1

(i) Mark with an **X** the point on the graph at which the brakes are applied. [1]

(ii) Calculate the deceleration of the car.

Show your working.

..... [2]

(iii) Calculate the distance travelled by the car during deceleration.

Show your working.

..... [2]

(c) Fig 3.2 shows the circuit diagram of the parallel circuit used to supply electrical ... to two identical headlamps in the car.

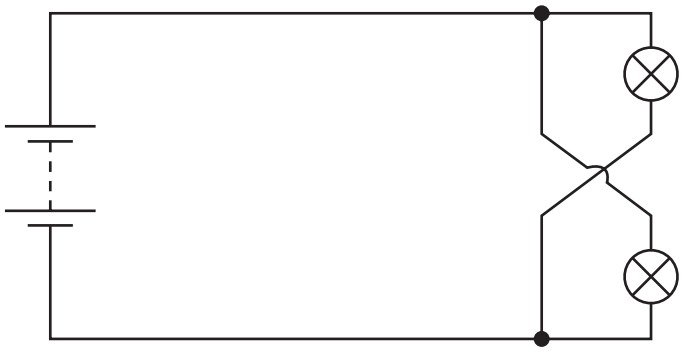


Fig 3.2

The current through the filament of one headlamp is 2.4 A. The potential difference across each of the headlamps is 12 V.

(i) Calculate the resistance of the headlamp filament whilst in use.

State the formula that you use and show your working.

formula used

working

..... [2]

(ii) Calculate the total resistance of the two headlamps in parallel.

State the formula that you use and show your working.

formula used

working

..... [3]

4 **(a)** **(i)** Caffeine is a compound contained in coffee. Many people who consume c
during the day find that they have difficulty in getting to sleep at night.

Explain why it is correct to refer to caffeine as a *drug*.

.....

..... [1]

(ii) Some drugs are analgesics.

Why might a person need to take an analgesic?

..... [1]

(b) Some coffee drinks are sold in self-heating cans.

Fig. 4.1 shows a cross-sectional diagram of one design of self-heating can.

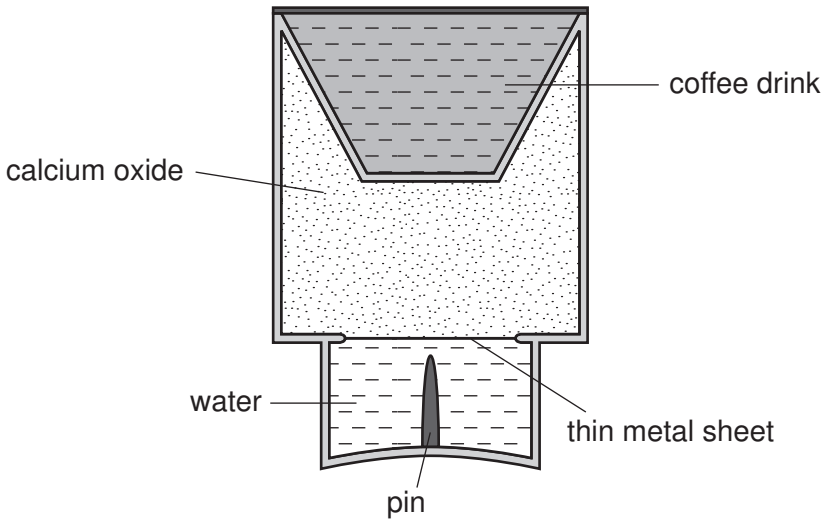


Fig. 4.1

Fig. 4.2 shows the can after it has been turned upside down and the pin p... through the thin metal sheet. This allows the water to fall into the calcium oxide.

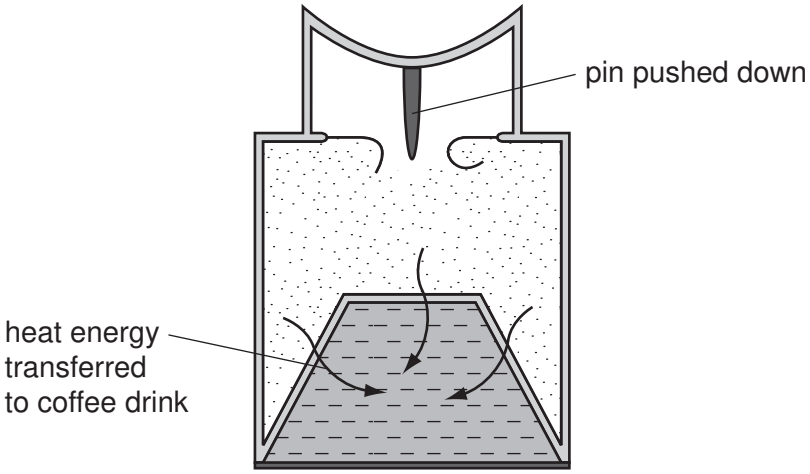


Fig. 4.2

The reaction between calcium oxide and water is highly exothermic and produces the ionic compound calcium hydroxide, $Ca(OH)_2$.

(i) In an internet video to explain how the can works, it is stated that the water mixes with 'limestone'.

State why this information is **incorrect**.

.....

..... [1]

(ii) Use the position of calcium in the Periodic Table to explain why the electrical charge of a calcium ion is +2.

.....

.....

.....

.....

..... [3]

(iii) Deduce the electrical charge of the hydroxide ion.

Show how you obtained your answer.

.....

..... [2]

(c) The balanced equation for the reaction between calcium oxide and water is shown below.

$$CaO + H_2O \longrightarrow Ca(OH)_2$$

This shows that one mole of calcium oxide reacts with one mole of water.

(i) A self-heating can is designed to contain 224 g of calcium oxide.

Calculate the number of moles of calcium oxide in 224 g of the compound.

Show your working.

..... [2]

(ii) Calculate the mass of water which is needed to react with 224 g of calcium o

Show your working.

.....

[2]

5 Cichlid fish live in lakes in east Africa. Fig. 5.1 shows a cichlid fish.

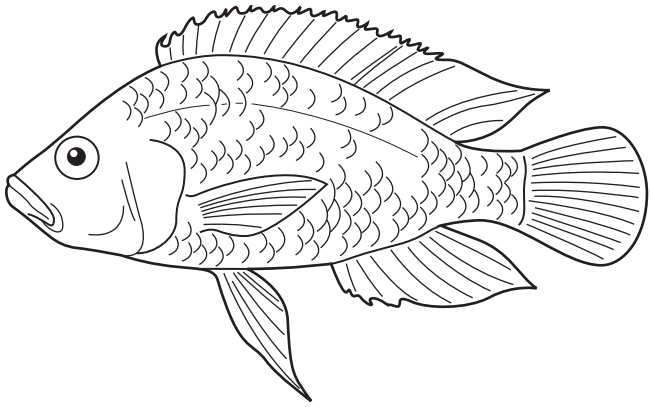


Fig. 5.1

(a) State **two** features, visible on Fig. 5.1, which are characteristic of fish.

1 .....

2 ..... [1]

(b) Most fish have external fertilisation.

(i) Explain what is meant by *external fertilisation*.

.....

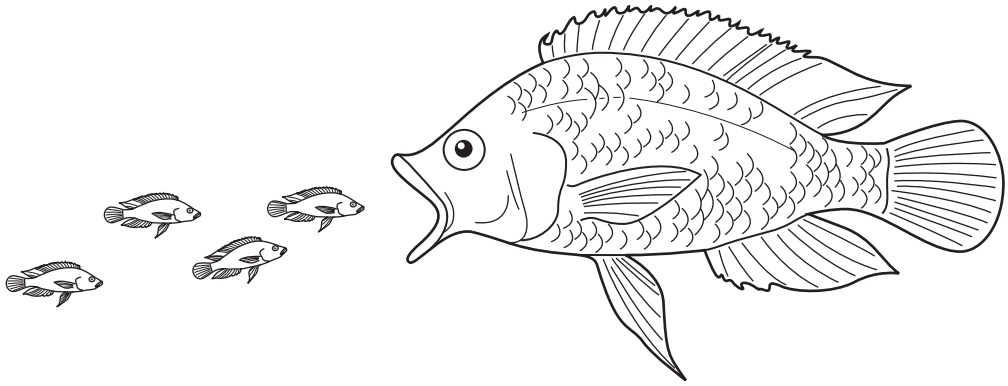
..... [2]

(ii) Explain why animals that live entirely on land cannot use external fertilisation.

.....

..... [1]

(c) Wild cichlid fish are unusual because they care for their eggs and young. The f... keeps the fertilised eggs in her mouth until they hatch. After the young fish h... hatched, she takes them back into her mouth when danger threatens. This behaviour ... caused by the fish's genes, and is inherited.



Suggest how natural selection in an east African lake could have led to the evolution of this behaviour.

.....

.....

.....

..... [3]

(d) Cichlid fish that have been bred in captivity can be bought as pets. Breeders ta young away from the captive mothers after they have hatched because these mot often eat their young.

Research was carried out into the behaviour of mothers in two groups of cichlid fish.

- Group **A** had been bred from a population of fish that had been kept in captivity for more than 30 years.
- Group **B** had recently been caught in the wild.

The researchers used 4 female fish from each group. They allowed each fish to breed as normal with male fish from the same group. They left the young fish with their mothers. All the fish were kept in the same conditions.

Table 5.1 shows the results.

Table 5.1

	group A	**group B**
number of mothers	4	4
number of mothers that ate their young by 1 day after hatching	3	0

(i) Explain how these results suggest that the difference in behaviour between the group **A** and group **B** fish was caused by their genes, and not by their environment.

.....

.....

..... [2]

(ii) The researchers also measured the testosterone levels in the mother fish
groups.

Fig. 5.2 shows the results.

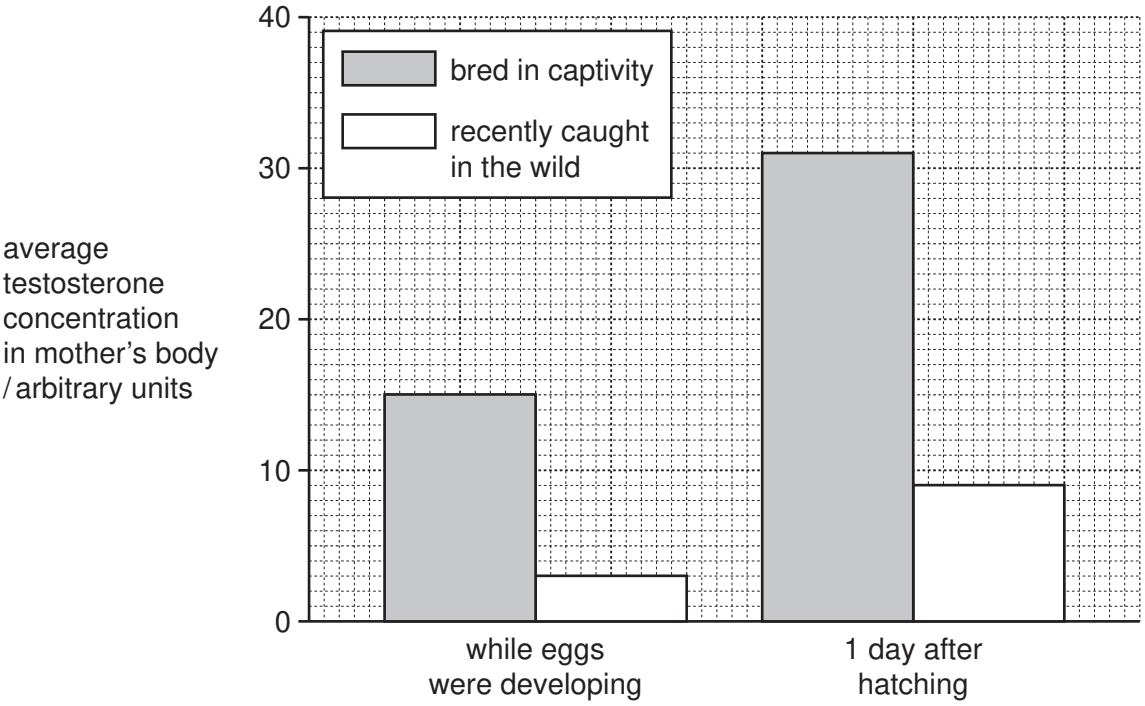


Fig. 5.2

Describe the differences in testosterone concentrations in the two groups of mother fish.

.....

.....

..... [2]

(iii) These results do **not** prove that high testosterone levels in population **A** caused the mothers to eat their young.

Outline **two** reasons why this statement is correct.

1 .....

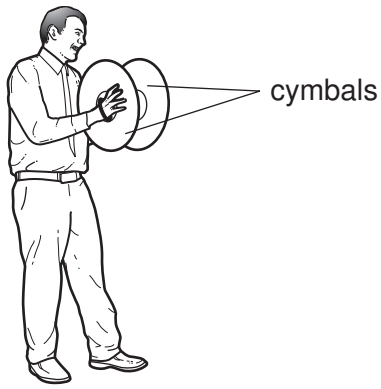
.....

2 .....

..... [2]

6 An orchestra is playing in a theatre.

(a) A musician is playing the cymbals.



(i) Describe how the sound travels through the air from the cymbals to the ear of a man in the audience.

.....

.....

..... [2]

(ii) The man in the audience thought that the sound from the cymbals was loud because of its high frequency. He was wrong.

Explain why the man was wrong.

.....

.....

..... [2]

(b) The theatre has an internal volume of 50 000 m^3. The air inside it has a density of 1.3 kg/m^3.

(i) Show that the mass of the air in the theatre is 65 000 kg.

State the formula that you use and show your working.

formula used

working

..... [2]

(ii) The air is heated by 10 °C. The specific heat capacity of air is 1000 J / kg °C.

Calculate the energy needed to heat up the air in the theatre.

State the formula that you use and show your working.

formula used

working

..... [3]

(c) Coloured light is shone onto the stage. Red light has a wave speed of 3 x 10^8 m / s (300 000 000 m / s) and a wavelength of 7.5 x 10^{-7} m (0.000 000 75 m).

(i) Explain what is meant by the term *wavelength*.

.....

..... [1]

(ii) Calculate the frequency of red light.

State the formula that you use and show your working.

formula used

working

..... [3]

7 **(a)** Table 7.1 shows the electron arrangements of atoms of five elements, **P** to **T**.

Table 7.1

atom	1st shell	2nd shell	3rd shell	4th shell
P	2	1		
Q	2	8	1	
R	2	8	2	
S	2	8	8	1
T	2	8	8	2

(i) Explain how the electron arrangements show that all of the elements, **P** to **T**, are metals.

.....

..... [1]

(ii) An atom of element **P** has a nucleon (mass) number of 7.

State the number of neutrons in this atom.

..... [1]

(b) Fig. 7.1 shows an electrochemical cell which was made by a student in a laboratory.

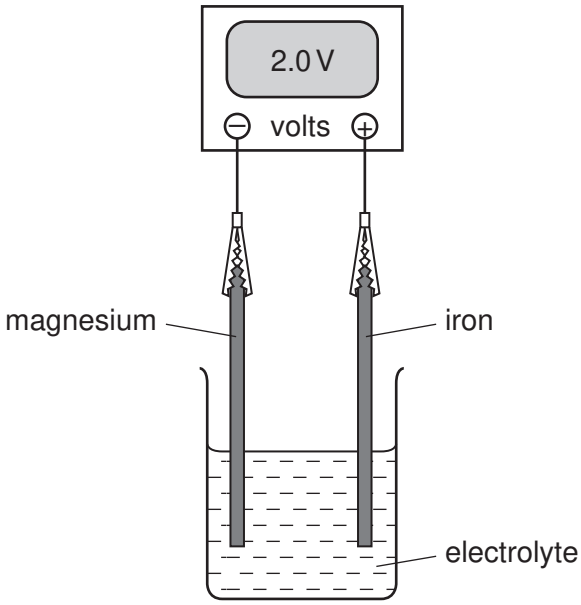


Fig. 7.1

(i) The student was asked to choose one of the liquids shown below as the electrolyte in her cell.

dilute sulfuric acid hexane sodium chloride solution

She correctly chose sodium chloride solution.

Explain briefly why the other two liquids would **not** have been suitable.

.....

.....

.....

..... [2]

(ii) The student used her cell to investigate the relative reactivity of four metals, magnesium, iron and two unknown metals, **X** and **Y**.

The student had learned that the more reactive metal always becomes the negative electrode.

The results of experiments involving all four metals are shown in Table 7.2.

Table 7.2

experiment	negative electrode	positive electrode	cell voltage / volts
1	magnesium	iron	2.0
2	magnesium	**X**	2.7
3	magnesium	**Y**	1.6

Use the results in Table 7.2 to place the four metals in order of reactivity.

most reactive .....

.....

.....

least reactive ..... [2]

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Please turn over for Question 8.

8 **(a)** Fig. 8.1 shows a section through a part of a person's lungs where gas exchange takes place.

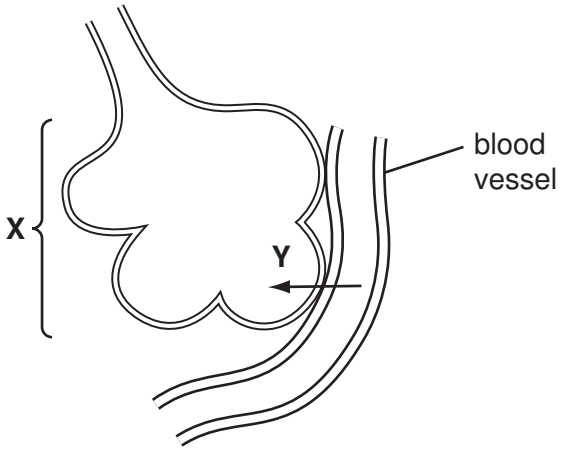

Fig. 8.1

(i) Name the structure labelled **X**. ..... [1]

(ii) Name the type of blood vessel that is shown in Fig. 8.1. ..... [1]

(iii) State what is shown by arrow **Y**, and explain why this process takes place.

.....

.....

.....

..... [3]

(b) Describe how blood travels from the heart to the lungs. Your description should include the role of the heart in this process.

.....

.....

.....

.....

..... [3]

(c) Describe and explain how the actions of the intercostal muscles and diap
muscles cause inhalation (breathing in) to take place.

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..... [3]

9 **(a)** The bar chart in Fig 9.1 shows the electrical power rating of two kettles.

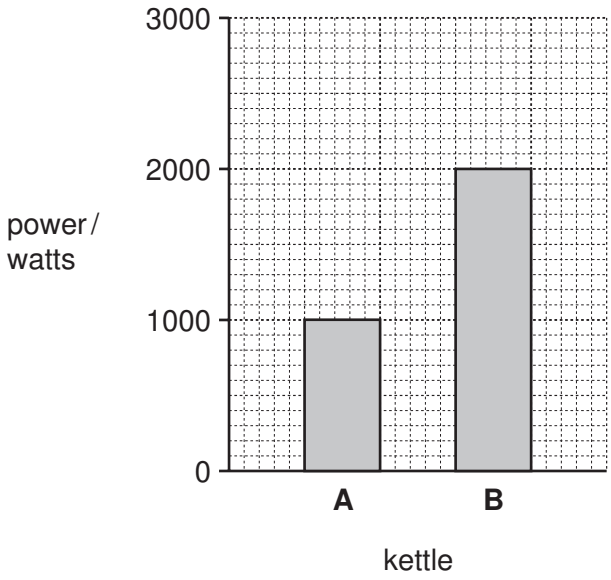

Fig. 9.1

Kettle **A** takes 10 minutes to boil some water.

Predict how long kettle **B** will take to boil the same mass of water.

..... [1]

(b) Kettle **A** has a label underneath it. Fig. 9.2 shows some of the information on this label.

voltage 250 V
power 1000 W

Fig. 9.2

(i) Calculate the maximum current through the kettle.

State the formula that you use and show your working.

formula used

working

..... [2]

(ii) This current passes through the kettle for 2 minutes.

Calculate the charge which passes through the kettle in this time.

State the formula that you use and show your working.

formula used

working

..... [2]

(c) Use the idea of convection to explain why a kettle has the heating element at the bottom.

.....

.....

..... [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	**Po** Polonium 84	**At** Astatine 85	**Rn** Radon 86
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	**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
X
b

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.).