UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER

CANDIDATE NUMBER

8786423411

CO-ORDINATED SCIENCES **0654/32**

Paper 3 (Extended) **October/November 2012**

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 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.

For Examiner's Use	
1	
2	
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7	
8	
9	
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12	
Total	

This document consists of **29** printed pages and **3** blank pages.

1 Fig. 1.1 shows a red blood cell and a root hair cell.

For Examiner's Use

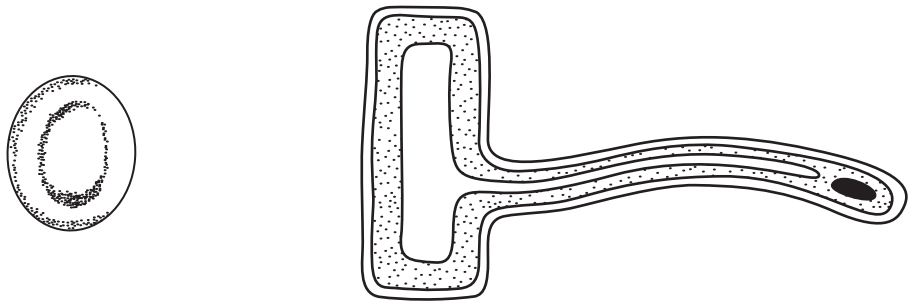

Fig. 1.1

(a) Name the red protein found in the cytoplasm of the red blood cell.

..... [1]

(b) (i) State the function of a root hair cell.

..... [1]

(ii) Explain how the root hair cell is adapted to carry out this function.

.....

.....

.....

..... [2]

(c) Three red blood cells **A**, **B** and **C** were placed in three different solutions. Fig. 1.2 shows their appearance after five minutes.

For Examiner's Use

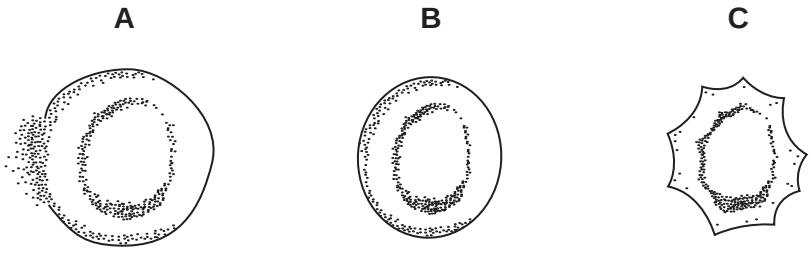

Fig. 1.2

(i) State the **letter** of the cell that was placed in

distilled water, ...

dilute sugar solution, ...

concentrated sugar solution. ..... [1]

(ii) Explain what happened to cell **C** to cause its shape to change.

.....

.....

.....

.....

..... [4]

2 **(a)** In 2002 some research scientists claimed that they had produced a tiny amount of a new element that had a proton number of 118.

The scientists predicted that this element should be placed in Period 7 and Group 0 of the Periodic Table.

(i) State the total number of electrons and the number of electron shells (energy levels) in one atom of this element.

total number of electrons .....

number of electron shells ..... [2]

(ii) Predict and explain, in terms of electron configuration, whether this element would be reactive or unreactive.

.....

.....

..... [2]

(b) The halogens are reactive elements found in Group 7 of the Periodic Table.

Halogens combine vigorously with the alkali metals from Group 1 to form colourless ionic compounds.

The halogens and alkali metals from Periods 2 to 5 are shown in Fig. 2.1.

Li	F
Na	Cl
K	Br
Rb	I

Fig. 2.1

(i) A student has a colourless solution which he knows is either potassium bromide or potassium iodide.

The student adds chlorine solution as shown in Fig. 2.2.

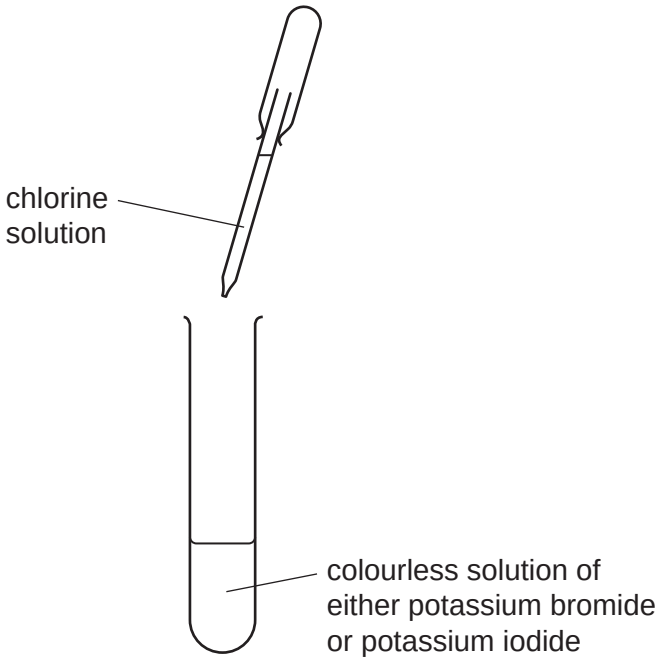

Fig. 2.2

Predict the colour the student would see if the test-tube contained

- potassium bromide, ...
- potassium iodide. .....

Explain your predictions.

.....

.....

.....

..... [3]

(ii) The student is asked to predict which pair of elements, chosen from those shown in Fig. 2.1, would react together most vigorously.

He predicts that the reaction between lithium and fluorine would be the most vigorous.

Explain whether or not the student has made a correct prediction.

.....

.....

..... [2]

(c) Potassium bromide contains potassium ions, K^+ and bromide ions, Br^-.

Construct a balanced symbolic equation for the reaction between potassium and bromine to form potassium bromide.

..... [3]

3 Fig. 3.1 shows four swimmers at the start of a race.

For Examiner's Use

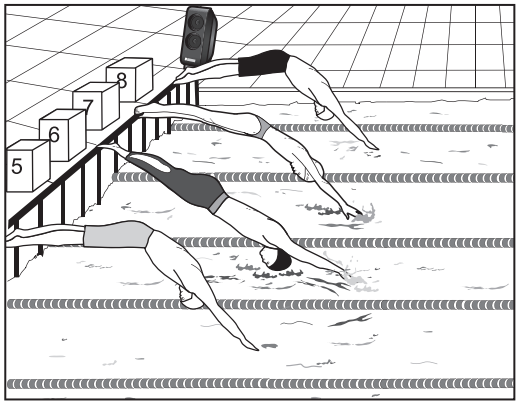

Fig. 3.1

(a) The swimmers start their race when they hear a loud, high-pitched sound from a loudspeaker.

(i) Describe how the loudspeaker causes the sound to travel through the air. Use the idea of compressions and rarefactions in your answer.

You may draw a diagram if it helps your answer.

.....

.....

..... [2]

(ii) Explain why sound travels at a different speed through water than through air.

.....

.....

..... [2]

(b) Fig. 3.2 shows the trace of a sound wave as it appears on an oscilloscope screen.

On Fig. 3.2 draw another trace of a sound wave from a sound that is louder than the one shown, but has the same pitch.

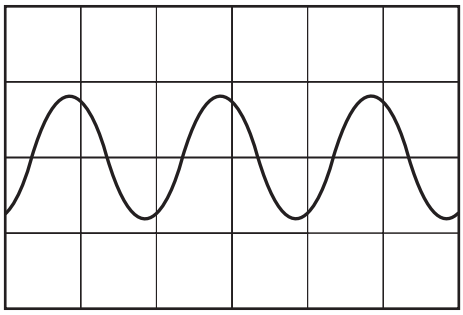

Fig. 3.2

[2]

(c) Sound travels at 330 m / s in air. The loudspeaker produces a sound with a frequency of 2200 Hz.

Calculate the wavelength of this sound.

State the formula that you use and show your working.

formula used

working

..... [2]

(d) The mass of water in the pool is 70 000 kg.

The specific heating capacity of water is 4200 J / kg °C. The water is allowed to cool from 35 °C to 25 °C.

Calculate the energy lost by the water during this cooling.

State your answer in MJ (megajoules).

State the formula that you use and show your working.

formula used

working

..... MJ [3]

For Examiner's Use

4 **(a)** Fig. 4.1 shows part of a food web in the forest ecosystem around Chernobyl, in Ukraine.

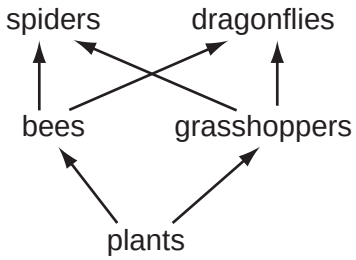

Fig. 4.1

(i) Define the term *ecosystem*.

.....

.....

..... [2]

(ii) What do the arrows in the food web represent?

..... [1]

(iii) State the trophic level at which spiders feed.

..... [1]

(iv) The food web shows that bees depend on plants. Some species of flowering plants also depend on bees and other insects.

Explain how bees help flowering plant species to survive.

.....

.....

.....

.....

.....

..... [3]

(b) In 1986, major errors by operators resulted in a huge explosion at the Chernobyl nuclear reactor. Radioactive substances were released into the environment.

One of the main radioactive substances released was caesium-137. When caesium-137 decays, it forms barium-137.

Table 4.1 shows information about the radioactive decay of caesium-137 and barium-137.

Table 4.1

	caesium-137	**barium-137**
radiation emitted	β (beta)	γ (gamma)
half-life	30 years	2.5 minutes

(i) Explain why the area around Chernobyl still has high levels of both β radiation and γ radiation today, more than 26 years after the explosion.

.....

.....

.....

.....

.....

..... [3]

(ii) Complete the equation to show how caesium-137 decays to form barium-137.

$$^{137}_{55}Cs \longrightarrow \text{.....} + {}^{0}_{-1}e$$

[2]

(iii) In 2009, scientists counted the numbers of spiders at different distances from the Chernobyl reactor. They also measured the radiation levels.

The numbers of spiders counted in areas with different radiation levels are shown in Fig. 4.2.

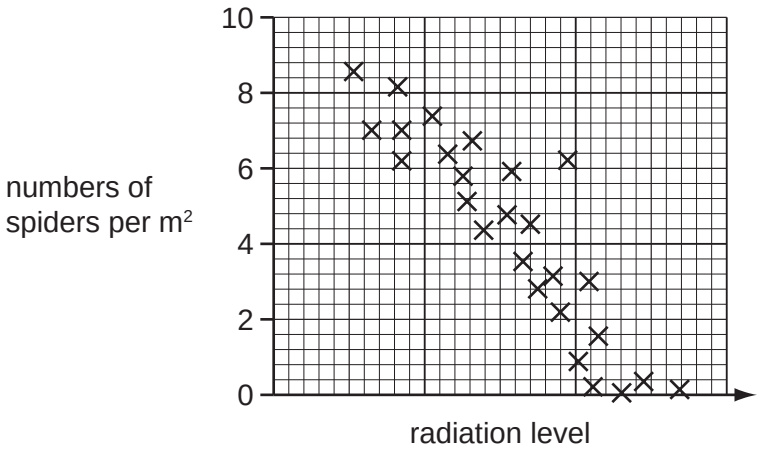

Fig. 4.2

Suggest reasons for the pattern of results shown in Fig. 4.2.

You should use your knowledge of the effects of ionising radiation on living organisms, and the information in the food web in Fig. 4.1.

.....

.....

.....

.....

..... [3]

5 Acid indigestion is caused by unusually high levels of stomach acid. This condition may be treated by taking an antacid tablet.

One type of antacid tablet contains a mixture of sodium hydrogencarbonate, calcium carbonate and magnesium carbonate.

(a) A student investigated the reaction between these antacid tablets and dilute hydrochloric acid.

Fig. 5.1 shows one of the experiments the student carried out.

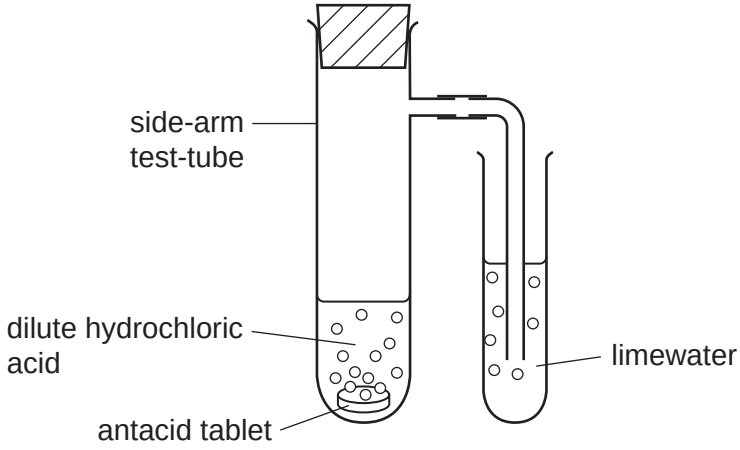

Fig. 5.1

Carbon dioxide gas was given off when the antacid tablet reacted with the dilute hydrochloric acid.

Describe and explain the change in appearance of the limewater during the experiment.

.....

.....

..... [2]

(b) One antacid tablet contains 0.52 g of calcium carbonate, $CaCO_3$.

(i) Calculate the number of moles of calcium carbonate in one antacid tablet.

Show your working.

..... [2]

(ii) The balanced symbolic equation for the reaction between calcium carbonate and dilute hydrochloric acid is

$$2HCl + CaCO_3 \longrightarrow CaCl_2 + CO_2 + H_2O$$

State the number of moles of hydrochloric acid that are neutralised by the calcium carbonate in one antacid tablet.

..... [1]

(iii) Explain briefly why the number of moles of hydrochloric acid that are neutralised by one antacid tablet is greater than your answer to **(ii)**.

.....

..... [1]

For Examiner's Use

6 **(a)** Fig. 6.1 shows a diagram of a small electrical a.c. generator producing an alternating voltage.

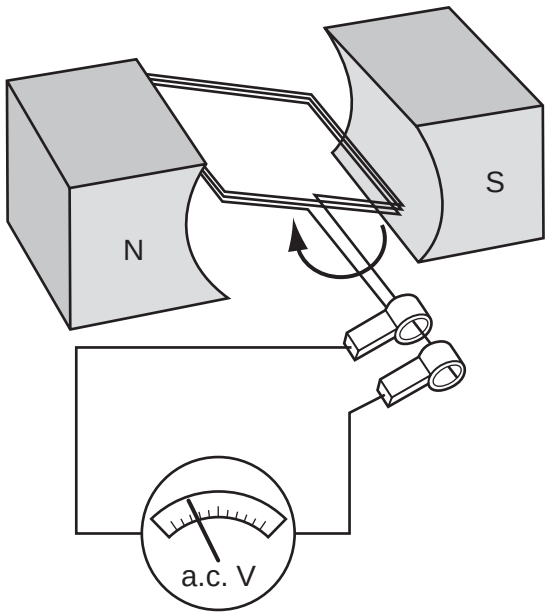

Fig. 6.1

(i) The coil is now made to spin in the opposite direction to the one shown in Fig. 6.1.

What difference, if any, would be shown on the voltmeter reading?

.....

..... [1]

(ii) State **two** ways in which the size of the induced voltage can be increased.

1 .....

2 ..... [2]

(b) In a power station there are several large generators.

Explain why transformers are needed between the power transmission cables from the power station and the cables supplying homes.

.....

.....

.....

..... [2]

7 Fig. 7.1 shows a section through a human eye.

For Examiner's Use

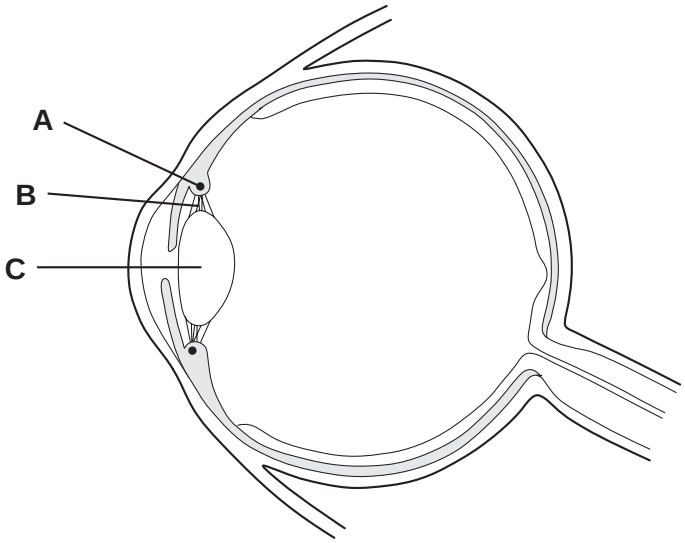

Fig. 7.1

(a) On Fig. 7.1, add label lines and label

- the retina,
- the optic nerve,
- the iris. [3]

(b) The eye in Fig. 7.1 is focused on a distant object.

Explain how structures **A**, **B** and **C** will cause changes to allow the eye to focus on a nearby object.

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.....

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.....

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.....

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..... [4]

(c) When bright light is shone onto the eye, the circular muscles in the iris contract and make the pupil smaller.

(i) In which part of the eye are the receptor cells that sense the bright light?

..... [1]

(ii) Describe how information is transmitted from these receptor cells to the muscles in the iris.

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..... [3]

For Examiner's Use

8 Large amounts of chemical energy are stored in the world's reserves of fossil fuels such as natural gas and petroleum (crude oil).

(a) (i) Name the main compound in natural gas.

.....

Write the **word** chemical equation for the complete combustion of this compound.

..... [3]

(ii) Before it is refined, petroleum contains sulfur compounds.

Describe and explain how water in rivers and lakes could become polluted if sulfur compounds are **not** removed from fossil fuels before they are used.

.....

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.....

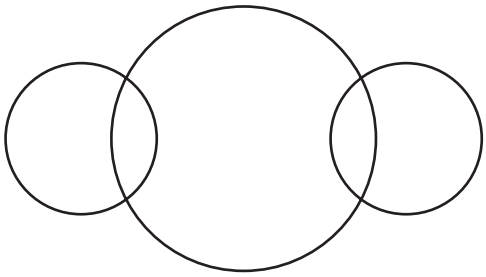
.....

..... [4]

(b) (i) Sulfur is removed from petroleum by combining it with hydrogen to form the gaseous compound hydrogen sulfide, H_2S.

Complete the bonding diagram of one molecule of hydrogen sulfide below to show

- the chemical symbols of the elements,
- how the outer electrons in each element are arranged.



[2]

(ii) Every year, millions of tonnes of sulfur are removed from petroleum, and used as a raw material in the Contact Process.

Name the final product of the Contact Process.

..... [1]

9 Fig. 9.1 shows a toy car of mass 0.5 kg being pushed along a plastic surface.

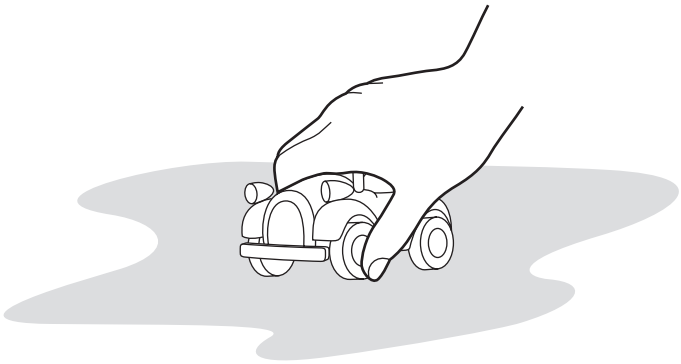


Fig. 9.1

(a) The car is moving at a steady speed of 0.5 m / s.

Calculate the kinetic energy of the car.

State the formula that you use and show your working.

formula used

working

..... [2]

(b) While the car is moving, the wheels are rubbing against the plastic surface. The car becomes electrostatically charged with a positive charge.

Explain how this happens.

.....

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..... [3]

(c) A speed – time graph for the car is shown in Fig. 9.2. It shows the motion of the car over a 25 second period.

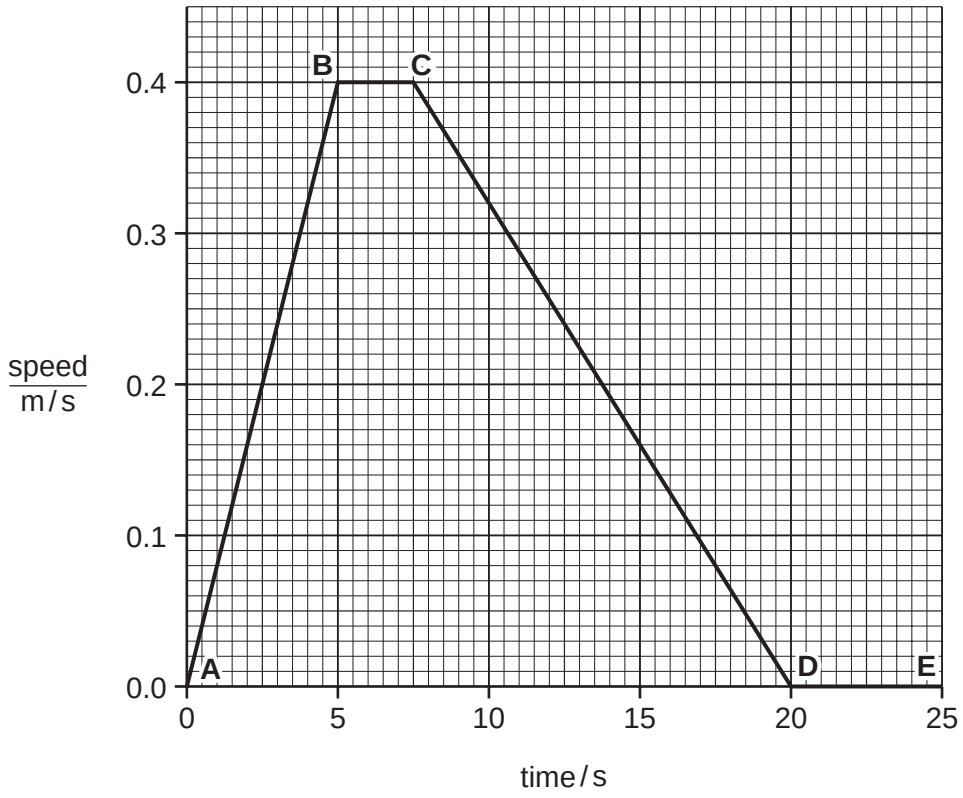

Fig. 9.2

(i) State **one** part of the graph when the car was moving at constant speed and write down the value of this speed.

part of graph .....

speed ..... [1]

(ii) Calculate the distance travelled by the car between **A** and **D**.

Show your working.

..... [3]

10 Lipase is an enzyme that catalyses the breakdown of fats to fatty acids and glycerol.

For Examiner's Use

fat ⟶ fatty acids + glycerol

(a) (i) Name **one** part of the human alimentary canal where this reaction takes place.

..... [1]

(ii) Explain how bile helps this reaction to take place more rapidly.

.....

.....

.....

..... [2]

Question 10 continues over the page.

(b) A student carried out an experiment to investigate the effect of temperature on the rate of the breakdown of fats by lipase. Fig. 10.1 shows how she set up two test-tubes.

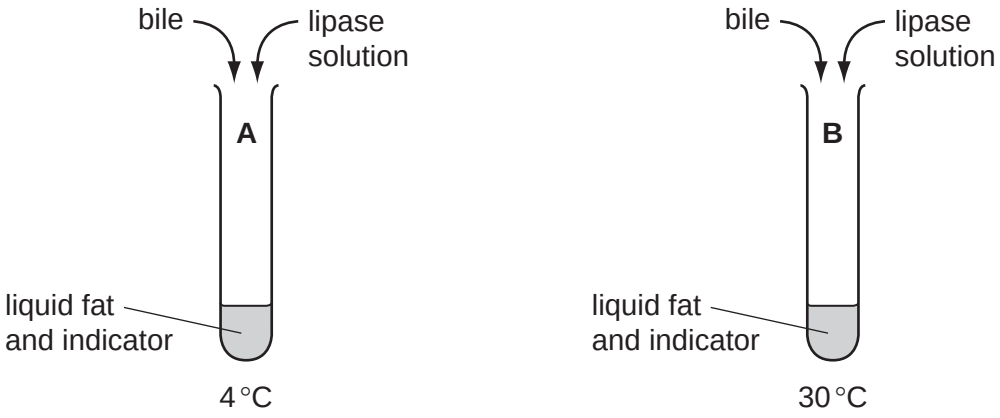

Fig. 10.1

The indicator that the student used changes colour from blue to yellow when the pH falls below 5.

Table 10.1 shows her results.

Table 10.1

time / minutes	tube A (4 °C)	tube B (30 °C)
0	blue	blue
5	blue	yellow
10	blue	yellow
15	yellow	yellow

(i) Using the information in the word equation, explain why the indicator eventually changed to yellow in both tubes.

.....

.....

..... [2]

(ii) Explain the difference between the results for tube **A** and tube **B**.

.....

.....

.....

.....

..... [3]

(iii) The student set up a third tube, tube **C**. This was similar to tubes **A** and **B**, but she added water to the liquid **instead of** bile. She kept the tube at 30 °C.

Complete Table 10.2 to suggest the results she would obtain.

Table 10.2

time / minutes	tube A (4 °C)	tube B (30 °C)	tube C (30 °C)
0	blue	blue	
5	blue	yellow	
10	blue	yellow	
15	yellow	yellow	

[1]

(c) Fat is an important component of a balanced diet.

(i) State **one** role of fat in the human body.

.....

[1]

(ii) Explain why a balanced diet should not contain too much fat.

.....

.....

.....

.....

[2]

11 Large amounts of oxygen are present in the Earth's crust, in the oceans and in the atmosphere.

For Examiner's Use

(a) (i) State the percentage of oxygen gas in the atmosphere near the Earth's surface.

..... [1]

(ii) The oxygen in the atmosphere exists as molecules which have the chemical formula O_2.

Explain why oxygen in the atmosphere is an example of an element and **not** a compound.

.....

.....

..... [2]

(b) Calcium metal reacts with oxygen gas to form the ionic compound calcium oxide.

$$2Ca + O_2 \longrightarrow 2CaO$$

The non-metallic element phosphorus reacts with oxygen gas to form the covalent compound phosphorus oxide.

$$P_4 + 5O_2 \longrightarrow P_4O_{10}$$

(i) State and explain briefly which oxide, calcium oxide or phosphorus oxide, reacts with water to produce a solution which would be neutralised by addition of an alkali.

.....

.....

..... [2]

(ii) The reaction between calcium and oxygen is an example of reduction-oxidation (redox), in which calcium atoms are oxidised.

Explain, in terms of electrons, why oxygen atoms are said to be reduced.

.....

.....

..... [2]

(c) One of the main oxygen compounds in rocks in the Earth's crust is silicon(IV) oxide. The main oxygen compound in the oceans is water.

Both of these compounds are covalent but they have very different physical properties because they have very different structures.

Compare briefly the structures of silicon(IV) oxide and water. You may wish to draw simple diagrams to help you answer this question.

.....

.....

.....

..... [3]

[Turn over

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12 (a) Electrical devices can develop faults and give a user an electric shock.

Explain how a circuit breaker can stop someone who is using a faulty electrical device from receiving an electric shock. You may draw a diagram if it helps your answer.

For Examiner's Use

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.....

.....

.....

..... [3]

Question 12 continues over the page.

(b) Some torches (flashlights) use a filament lamp. Fig. 12.1 shows a circuit for measuring the current through a filament lamp as the potential difference is changed.

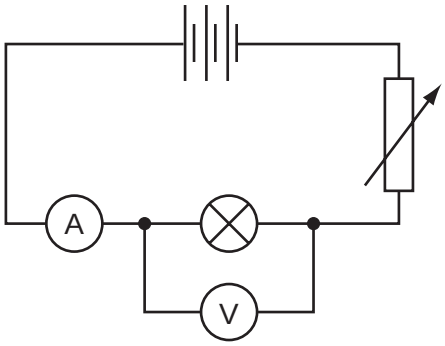

Fig. 12.1

Fig. 12.2 shows a graph of the results from an experiment using this circuit.

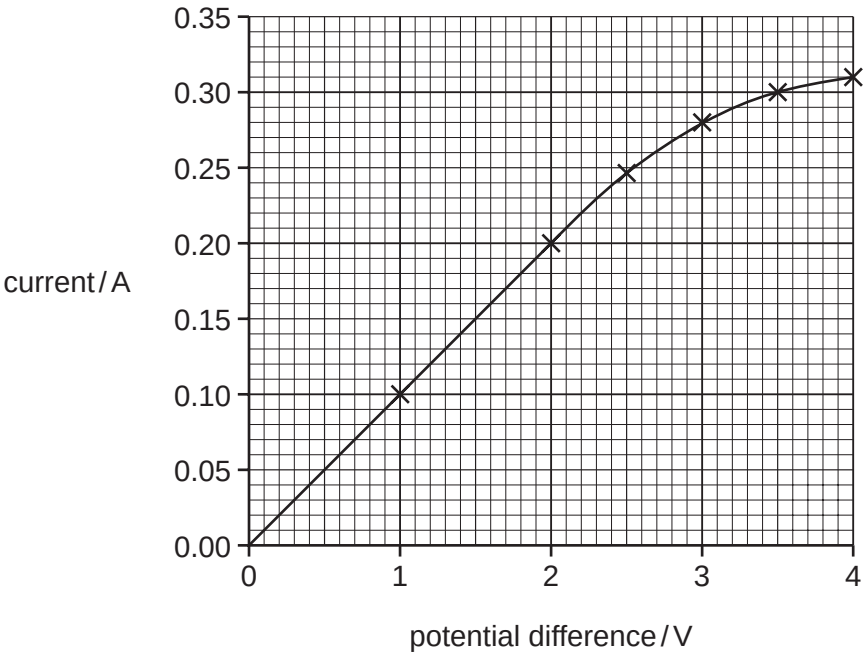

Fig. 12.2

(i) Use the graph to calculate the resistance of the lamp when the potential difference was 2.0 V and when the potential difference was 4.0 V.

State the formula that you use and show your working.

formula used

working

resistance at 2.0 V .....

resistance at 4.0 V ..... [2]

(ii) Describe how the current through the filament lamp changes as the voltage increases above 2.0 V.

.....

..... [1]

(iii) Use your answer to **(i)** to explain why the current changes in this way.

.....

.....

.....

..... [2]

(c) A single ray of light from a torch is shone onto a mirror as shown in Fig. 12.3.

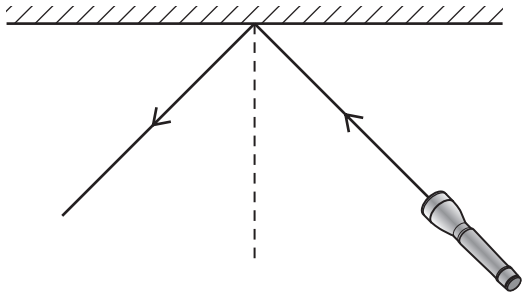

Fig. 12.3

(i) On Fig. 12.3 label the angle of incidence and angle of reflection. [1]

(ii) The angle of incidence = 45°.

Write down the value of the angle of reflection. ..... [1]

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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** 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.).