Location Entry Codes

As part of CIE's continual commitment to maintaining best practice in assessment, CIE uses different variants of some question papers for our most popular assessments with large and widespread candidature. The question papers are closely related and the relationships between them have been thoroughly established using our assessment expertise. All versions of the paper give assessment of equal standard.

The content assessed by the examination papers and the type of questions is unchanged.

This change means that for this component there are now two variant Question Papers, Mark Schemes and Principal Examiner's Reports where previously there was only one. For any individual country, it is intended that only one variant is used. This document contains both variants which will give all Centres access to even more past examination material than is usually the case.

The diagram shows the relationship between the Question Papers, Mark Schemes and Principal Examiners' Reports that are available.

Question Paper	**Mark Scheme**	**Principal Examiner's Report**
Introduction	Introduction	Introduction
First variant Question Paper	First variant Mark Scheme	First variant Principal Examiner's Report
Second variant Question Paper	Second variant Mark Scheme	Second variant Principal Examiner's Report

Who can I contact for further information on these changes?
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The titles for the variant items should correspond with the table above, so that at the top of the first page of the relevant part of the document and on the header, it has the words:

- First variant Question Paper / Mark Scheme / Principal Examiner's Report

or

- Second variant Question Paper / Mark Scheme / Principal Examiner's Report

as appropriate.

First Variant Question Paper

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

0622320493

CO-ORDINATED SCIENCES **0654/31**

Paper 3 (Extended) **May/June 2009**

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 **25** printed pages and **3** blank pages.

UNIVERSITY of CAMBRIDGE International Examinations

For Examiner's Use

1 **(a)** A student investigated how a change in potential difference across a lamp affected the current flowing through it.

She used wires to connect the components shown in Fig. 1.1 to make a circuit.

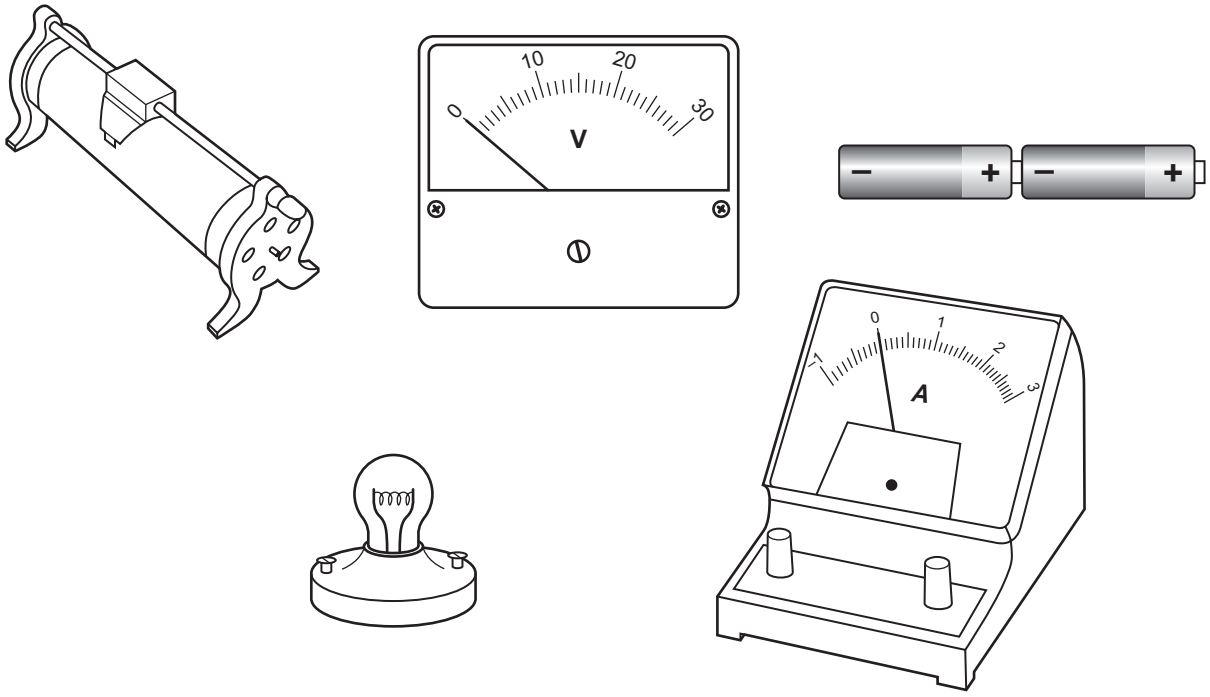

Fig. 1.1

(i) Using the correct symbols, draw a diagram to show the circuit she used.

[2]

(ii) Explain why the variable resistor is included in the circuit.

.....

..... [1]

(iii) Her results are shown in Table 1.1.

Table 1.1

potential difference across lamp / V	current through lamp / A	resistance of lamp filament / Ω
4	1.2	3.3
8	1.5	
12	1.7	7.1

Complete the table by calculating the missing resistance and writing your answer in the empty box.

State the formula that you use and show your working.

formula

working

[2]

(iv) The student concluded that the relationship between potential difference and current did not correspond to Ohm's law.

Explain why the relationship between potential difference and current for the lamp did not correspond to Ohm's law.

.....

.....

..... [2]

For Examiner's Use

(b) Fig. 1.2 shows a wire moving upwards between the poles of two magnets. The ends of the wire are connected to a sensitive ammeter. The ammeter shows the induced current.

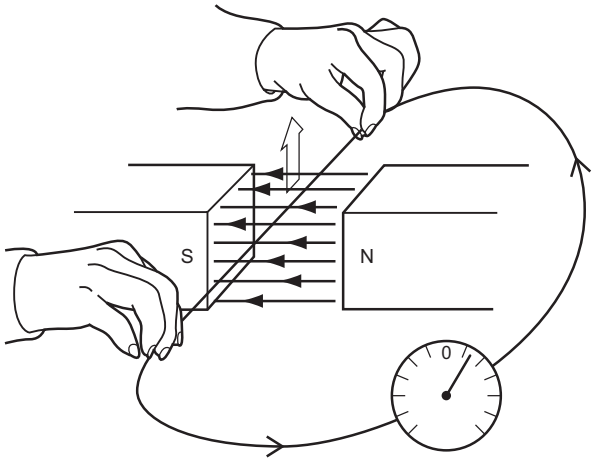

Fig. 1.2

(i) Draw on the ammeter in Fig. 1.3 the reading obtained if the wire was moved twice as quickly in the same direction.

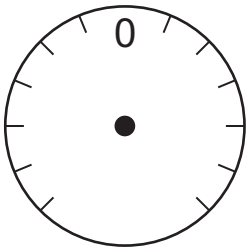

Fig. 1.3

[1]

(ii) Draw on the ammeter in Fig. 1.4 the reading obtained if the wire was moved in the opposite direction.

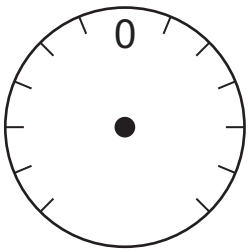

Fig. 1.4

[1]

(iii) Suggest why the ammeter must be a sensitive ammeter.

.....

..... [1]

(iv) Name a device which uses this principle of inducing an electric current when a wire moves in a magnetic field.

..... [1]

2 Fig. 2.1 shows a vertical section through human skin.

For Examiner's Use

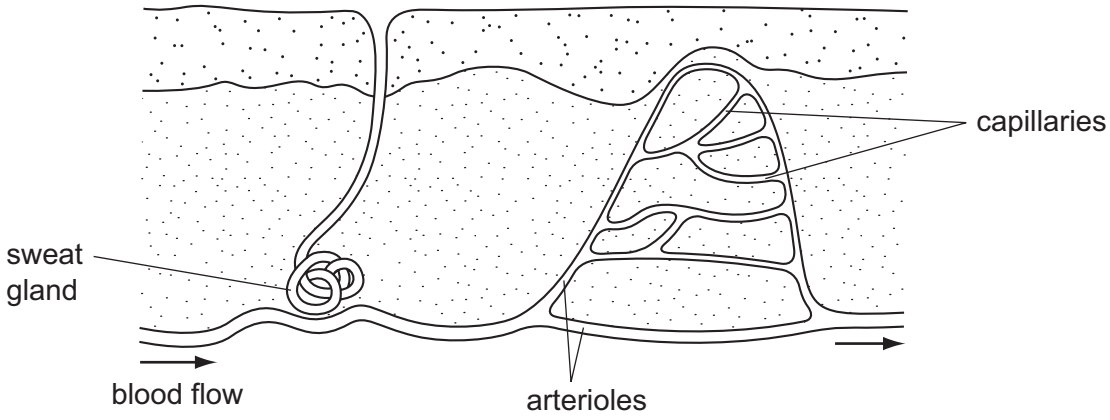

Fig. 2.1

(a) Describe how each of the following structures helps to lower the temperature of the body when it becomes too hot.

(i) sweat gland

.....

.....

..... [2]

(ii) arterioles

.....

.....

.....

..... [3]

For Examiner's Use

(b) A man ran steadily on a running track for 60 minutes. The air temperature was 14 °C.

Fig. 2.2 shows his core temperature (the temperature inside his body) before, during and after the run.

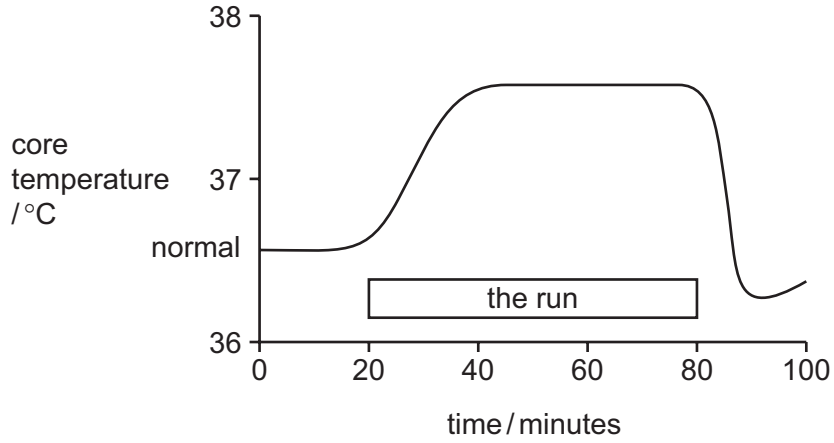

Fig. 2.2

(i) Explain why the man's core temperature increased while he was running.

.....

.....

..... [2]

(ii) Suggest why his core temperature dropped below normal when he stopped running.

.....

.....

..... [2]

(iii) When a runner has finished a marathon, a shiny silver-coloured blanket is often draped over his body. This helps to prevent his body temperature from dropping below normal.

Explain why this type of blanket is used, rather than a non-shiny dark-coloured one.

.....

.....

..... [1]

(c) The skin has an important role in making vitamin D, which it does when sunlight falls onto it.

For Examiner's Use

Explain the importance of vitamin D in the body.

.....

.....

..... [2]

For Examiner's Use

3 Food colourings are natural or synthetic dyes added to make food look more attractive.

(a) Describe the difference between natural and synthetic dyes.

.....

.....

..... [1]

(b) Fig. 3.1 shows a piece of cloth which is stained with food colouring.

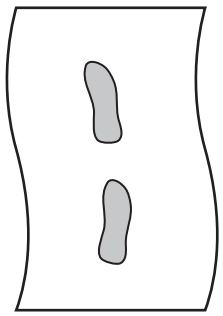

Fig. 3.1

The cloth is washed in water containing soap solution.

Describe how soap molecules help to remove stains from the cloth. You may wish to draw some simple diagrams to help you answer this question.

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.....

.....

..... [3]

For Examiner's Use

(c) Some water supplied to houses contains calcium hydrogencarbonate, $Ca(HCO_3)_2$. When heated, calcium hydrogencarbonate undergoes thermal decomposition.

(i) Complete the symbolic equation below which describes the thermal decomposition of calcium hydrogencarbonate.

$Ca(HCO_3)_2 \rightarrow$

[2]

(ii) The ionic charge of a calcium ion is 2+. Deduce the ionic charge of a hydrogencarbonate ion.

Show how you obtained your answer.

.....

.....

..... [2]

For Examiner's Use

4 (a) Many people have survived accidents where they have been exposed to ionising radiation from radioactive materials. Such exposure can have serious effects on their health.

The table and graph show how the dose (amount) of radiation received is linked to a type of cancer called leukaemia. The radiation dose is measured in units called grays.

Table 4.1

radiation dose / grays	incidences of leukaemia / cases per 10 000 people per year
1.0	1.0
2.5	2.3
5.0	
10.0	10.1
15.0	15.2

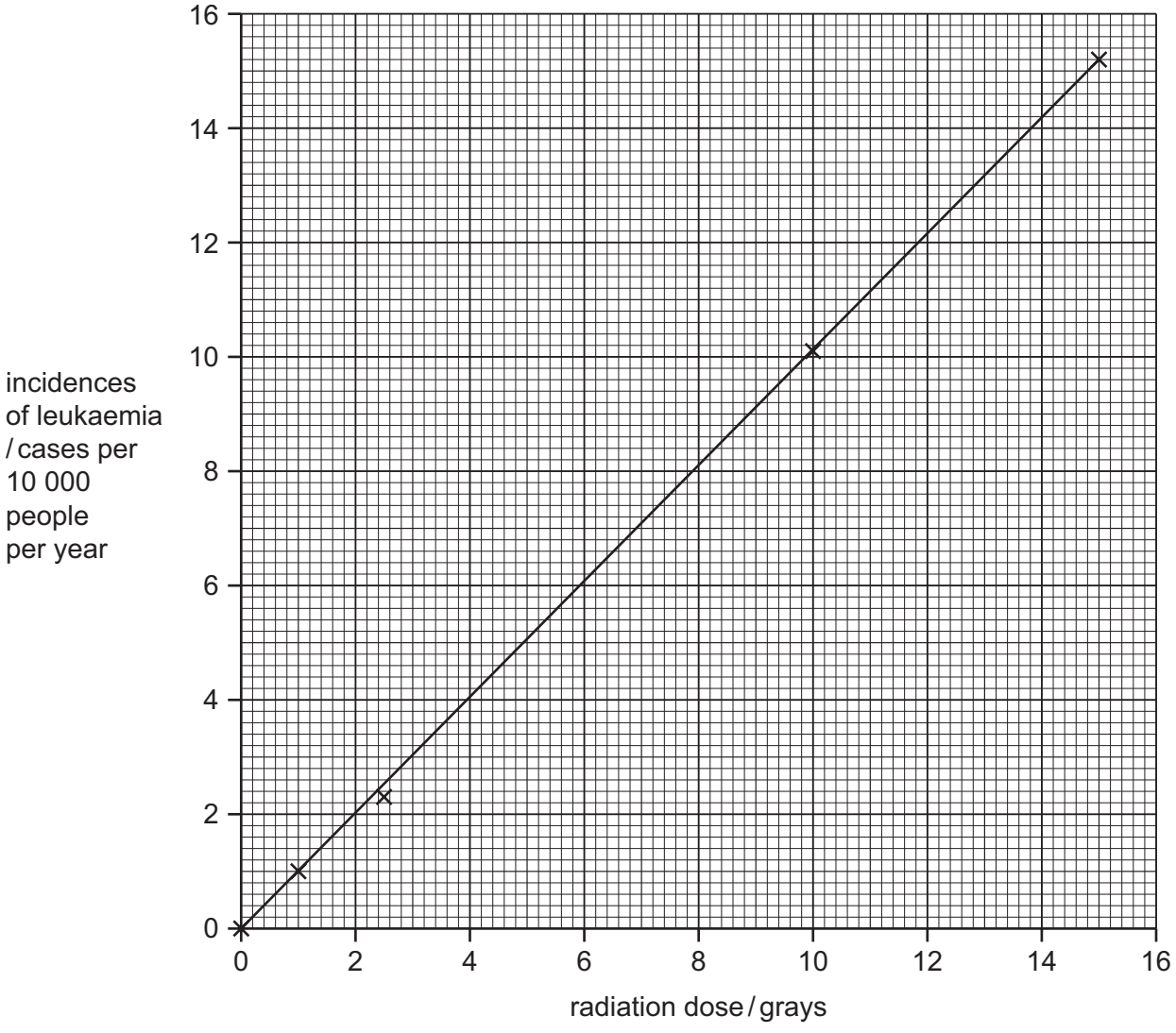

Fig. 4.1

(i) The result for 5.0 grays has been missed out of the table.

Use the graph to help you fill in the missing value in the table. [1]

(ii) What is the relationship between the ionising radiation and the incidence of leukaemia?

.....

..... [1]

(b) Two types of nuclear radiation from naturally occurring sources are alpha and beta. They can be identified by their different penetrating powers.

Describe how you could distinguish between alpha and beta radiation by their penetrating powers.

.....

.....

..... [1]

(c) Radon-222 (^{222}Rn) is a radioactive element. The chart in Fig. 4.2 shows the number of protons and neutrons in the nuclei of the elements formed when radon decays.

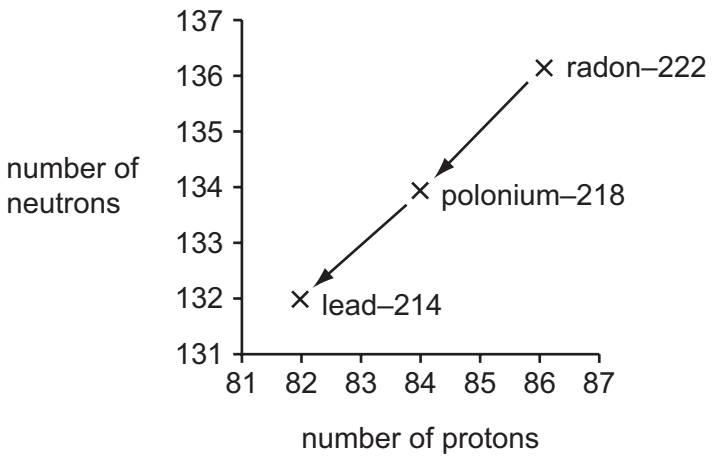

Fig. 4.2

(i) Describe how the graph shows that radon-222 (^{222}Rn) and polonium-218 (^{218}Po) emit alpha particles.

.....

.....

.....

..... [2]

For Examiner's Use

(ii) State why radon and polonium are different elements.

.....

[1]

(iii) Radioactive decay can also produce gamma radiation.

Explain why gamma emission does **not** result in the formation of a new element.

.....

.....

[1]

(iv) Radon-222 has a half-life of 4 days.

Explain what is meant by the term *half-life.*

.....

.....

[1]

(v) 1 mg of radon-222 is allowed to decay.

Calculate after how many days there would be 0.125 mg of radon-222 remaining.

Show your working.

.....

.....

[2]

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Please turn over for Question 5.

For Examiner's Use

5 Fig. 5.1 shows three arthropods.

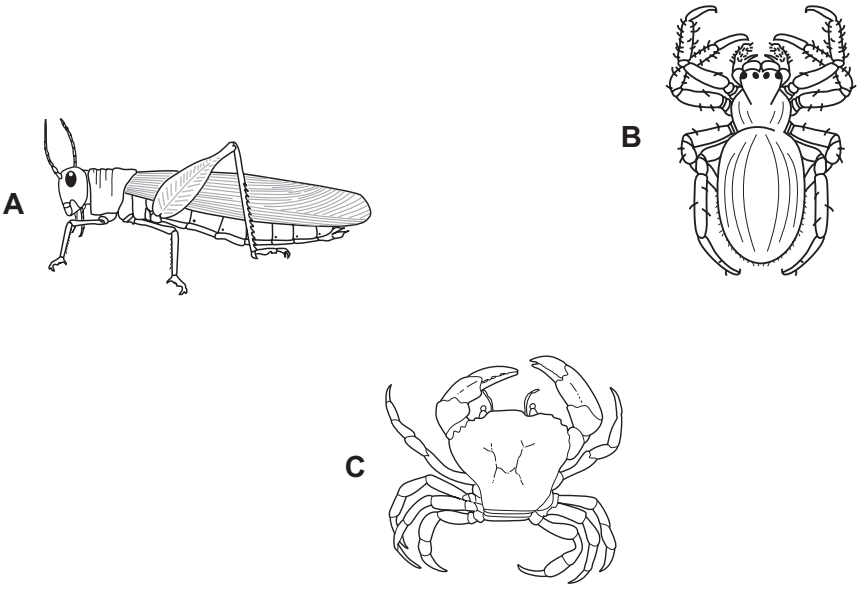


Fig. 5.1

(a) (i) The arthropod **A** is a locust, which belongs to the insect class.

State **two** features, visible on the locust in Fig. 5.1, which are characteristic of insects.

1 .....

2 ..... [2]

(ii) Name the classes to which arthropods **B** and **C** belong.

B .....

C ..... [2]

For Examiner's Use

(b) In one species of locust, the body colour may be brown or green. This is controlled by a gene with two alleles, **G** and **g**. If two locusts with brown bodies are mated, the offspring are always brown. If two locusts with green bodies are mated, some of the offspring may be brown.

(i) Write the possible genotype or genotypes for each of the following phenotypes.

brown body .....

green body ..... [2]

(ii) Use a genetic diagram to explain why some of the offspring of two locusts with green bodies may have brown bodies.

[4]

(c) State whether the variation in body colour in these locusts is an example of *continuous* variation or *discontinuous* variation. Explain your answer.

.....

..... [1]

(d) Locusts sometimes form huge swarms, which can fly long distances, and can eat and completely destroy whole fields of crops. These swarms are sometimes sprayed with pesticides from aeroplanes.

Suggest **two** possible disadvantages of using pesticides in this way.

1 .....

.....

2 .....

..... [2]

6 Fig. 6.1 shows apparatus a student used to investigate electrolysis using concentrated sodium chloride solution as the electrolyte.

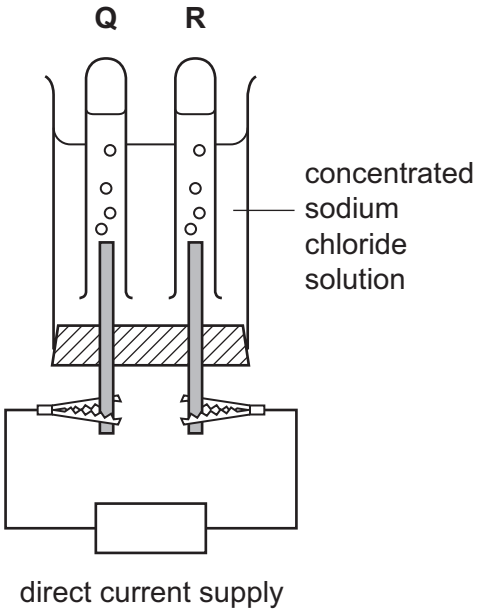


Fig. 6.1

When an electric current flowed through the circuit, chlorine gas collected in tube **Q** and hydrogen gas collected in tube **R**.

The balanced equation below describes the overall chemical change which takes place.

$$2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2 + H_2$$

(a) On Fig. 6.1 label the anode.

Give a reason for your choice.

.....

.....

..... [2]

(b) The student allowed the current to flow through the apparatus until 0.01 moles of hydrogen gas had been produced.

(i) State the number of moles of chlorine which were produced during the experiment.

..... [1]

(ii) Calculate the mass of sodium hydroxide which was produced during the experiment. (Relative atomic masses Na = 23, O = 16, H = 1)

Show your working.

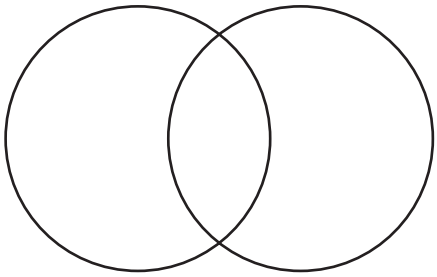
..... [3]

(c) When chlorine gas is bubbled through a colourless solution of potassium bromide, KBr, the solution turns orange because the element bromine is produced.

(i) Write a balanced equation for the reaction between chlorine and potassium bromide.

..... [2]

(ii) Complete the bonding diagram of a bromine molecule to show the arrangement of the outer electrons of each atom.



[2]

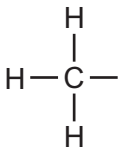
(iii) Describe how bromine is used to test hydrocarbons to find out whether or not they are unsaturated.

.....

.....

..... [2]

(iv) Complete the displayed formula to show the **alkene** which contains four carbon atoms in each of its molecules.



[2]

For Examiner's Use

7 A student carried out an investigation into the response of plant shoots to light.

He grew six maize seedlings and treated them as follows.

- He did nothing to seedlings **A** and **D**.
- He cut the tips off seedlings **B** and **E**.
- He covered the tips of seedlings **C** and **F** with black paper.

He placed one group of seedlings where they received light from all directions. He placed the second group of seedlings in a container where they received light from one side only.

Fig. 7.1 shows the appearance of the six seedlings when the experiment was first set up, and after one day.

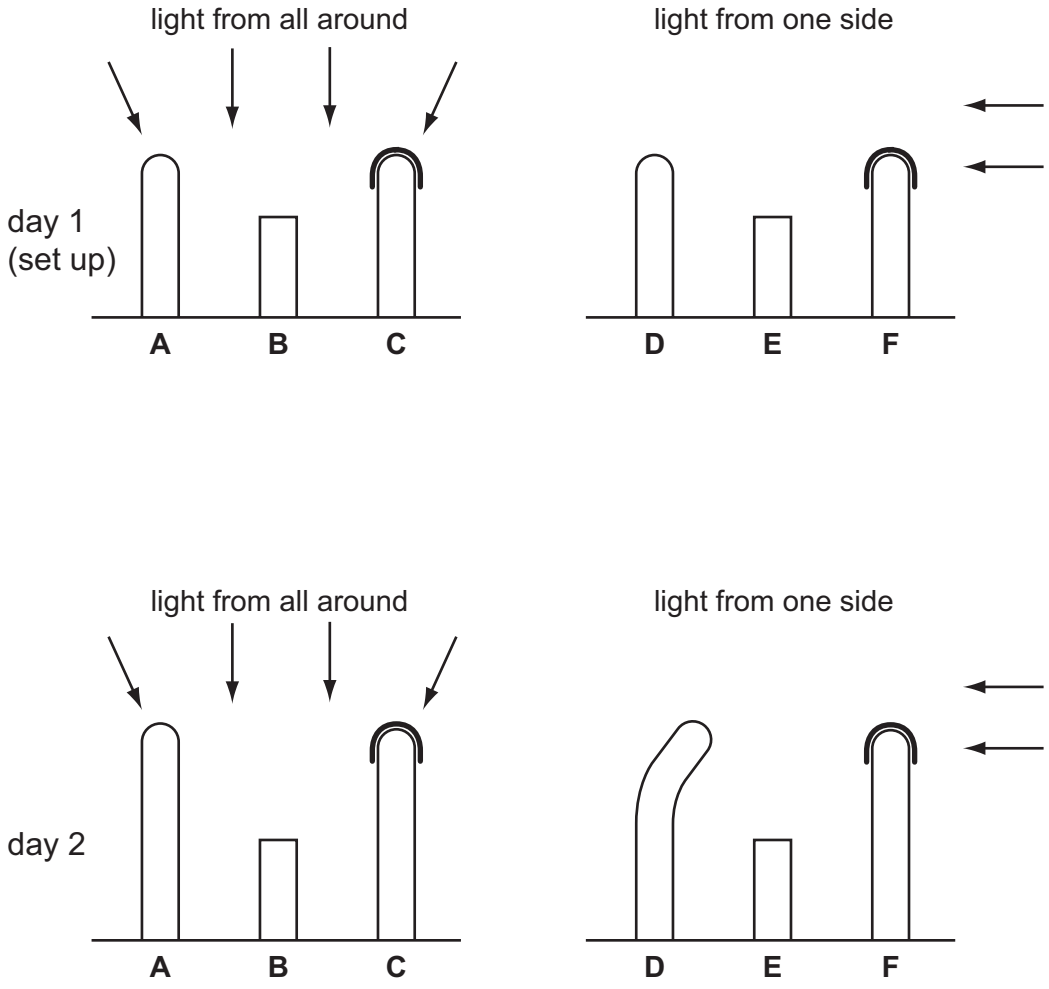


Fig. 7.1

For Examiner's Use

(a) The student concluded that the tip of a shoot is needed for growth. Describe the evidence in Fig. 7.1 that supports this conclusion.

.....

.....

..... [2]

(b) Using the information in Fig. 7.1, deduce the positions of the receptor and the effector that are responsible for the growth response of a seedling towards light.

Explain the evidence for your deductions.

position of receptor .....

evidence .....

.....

position of effector .....

evidence .....

..... [4]

(c) Describe how auxin may be involved in the growth of shoots towards the light. You can use a diagram if it helps your answer.

.....

.....

.....

..... [3]

For Examiner's Use

8 A diver is working under water, wearing a diving suit and helmet.

(a) The diving helmet has a plastic window of area 100 cm^2. The air pressure inside the helmet is the same as the water pressure outside.

(i) At a depth of 40 m, the diver breathes air at a pressure of 50 N/cm^2.

Calculate the force exerted by the air on the helmet window at this depth.

Use the formula

pressure = force / area

Show your working.

..... [1]

(ii) At the surface of the sea, the pressure of the atmosphere is 10 N/cm^2.

Estimate a value for the pressure at a depth of 10 m. Explain your answer.

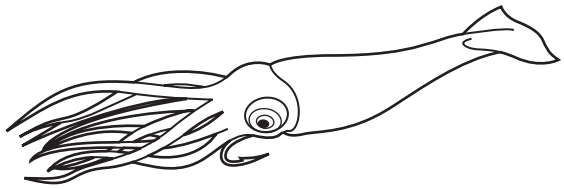
.....

.....

..... [2]

(b) The diver sees a squid. A squid moves by forcing out a jet of water from its body.

For Examiner's Use



This moving water has momentum.

(i) The mass of water forced out is 1.2 kg and has a velocity of 10 m / s.

Show that the momentum of the moving water is 12 kg m / s.

State the formula that you use and show your working.

formula

working

..... [1]

(ii) To conserve momentum, the squid's momentum must equal the momentum of the water jet in the opposite direction.

The mass of the squid is 4 kg.

Calculate the velocity of the squid.

State the formula that you use and show your working.

formula

working

..... [3]

(c) (i) A dolphin near the surface is able to communicate underwater by emitting ultrasonic waves with a frequency of 39 000 Hz.

The speed of these waves in water is 1500 m / s.

Calculate the wavelength of the waves.

State the formula that you use and show your working.

formula

working

..... [2]

(ii) The hearing range for a dolphin is from 1 kHz to 100 kHz. State the hearing range of an average adult human.

..... [1]

(iii) Fig. 8.1 shows the speed of the dolphin travelling through water.

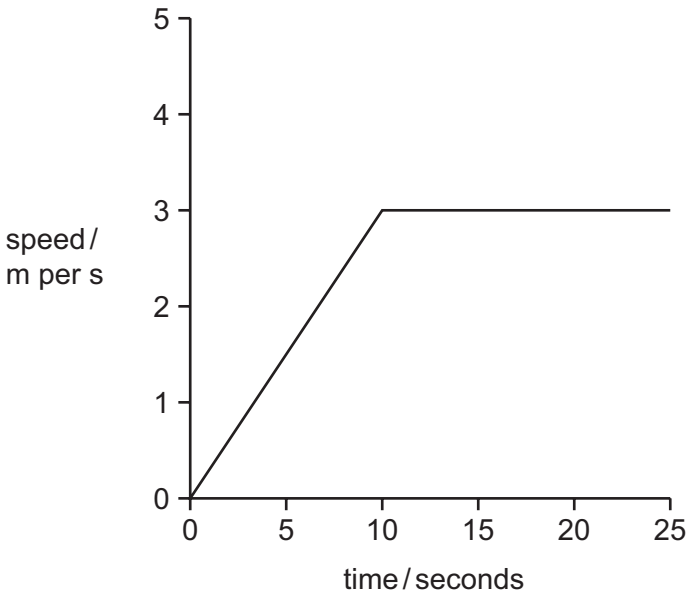


Fig. 8.1

Calculate the distance covered by the dolphin in the first 20 seconds.

Show your working.

..... [2]

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Please turn over for Question 9.

For Examiner's Use

9 Many metals react with dilute acids.

(a) Complete the word equation for the reaction of magnesium with dilute sulfuric acid.

magnesium	+	dilute sulfuric acid	→		+	

[1]

(b) A student used the apparatus shown in Fig. 9.1 to investigate the rate of reaction between sulfuric acid and magnesium.

To start the reaction, she tilted the flask to mix the reactants.

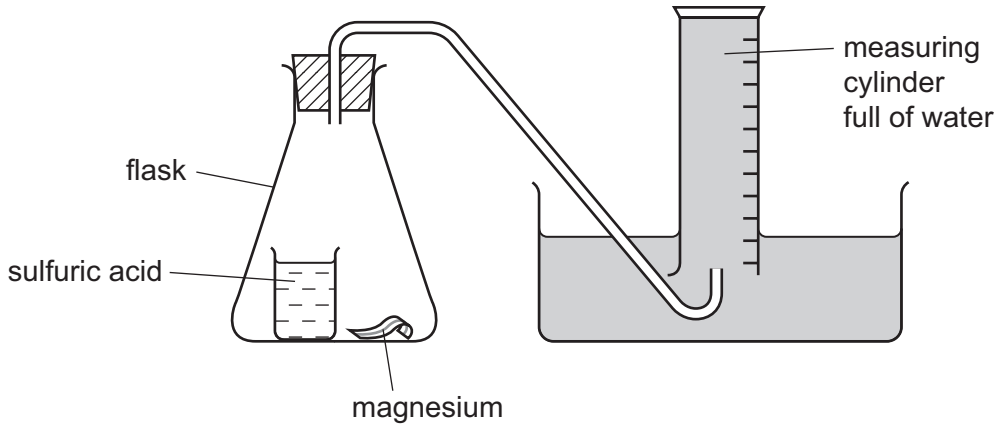

Fig. 9.1

She measured the volume of gas which had collected in the measuring cylinder every minute for several minutes.

Her results are shown in Fig. 9.2.

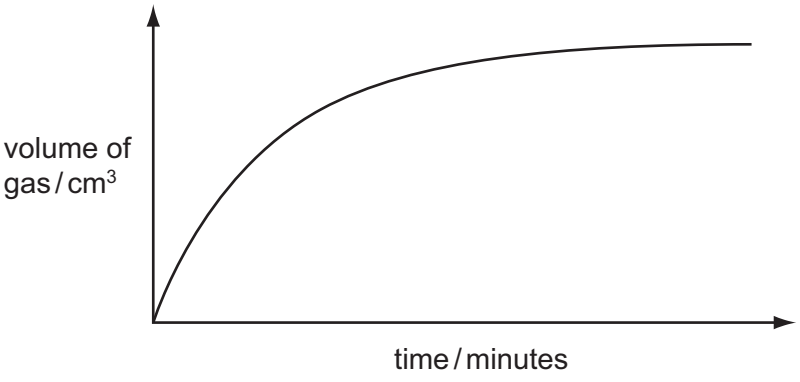

Fig. 9.2

Explain these results in terms of the collisions between particles in the reacting mixture.

For Examiner's Use

.....

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..... [3]

(c) Fig. 9.3 shows a pencil sharpener. Both the case and the blades are made using alloys.

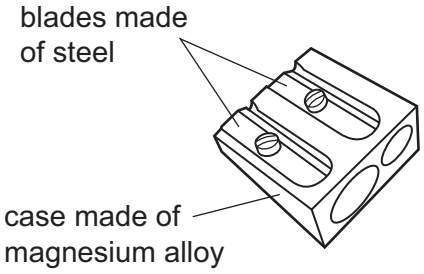

Fig. 9.3

Alloys rather than pure metals are used because they are stronger and less malleable.

Draw diagrams to show part of the giant structures of a pure metal and an alloy.
Use your diagrams to help you to explain why alloys are less malleable than the pure metals they contain.

diagram of the structure of a pure metal

diagram of the structure of an alloy

.....

.....

.....

..... [4]

(d) Table 9.1 shows information about the atomic structures of four particles **W**, **X**, **Y** and **Z**.

Table 9.1

	number of protons	number of neutrons	electrons in 1st shell	electrons in 2nd shell	electrons in 3rd shell
W	11	12	2	8	-
X	9	10	2	8	-
Y	12	12	2	8	2
Z	12	13	2	8	2

Explain which **two** particles from **W**, **X**, **Y** and **Z** in the table would attract one another very strongly.

.....

.....

.....

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.....

..... [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** 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 †															

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	
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.).

Second Variant Question Paper

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME

CENTRE NUMBER | | | | | |

CANDIDATE NUMBER | | | | |

3882206291

CO-ORDINATED SCIENCES **0654/32**

Paper 3 (Extended) **May/June 2009**

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 **23** printed pages and **5** blank pages.

UNIVERSITY of CAMBRIDGE International Examinations

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1 **(**a) A student investigated how a change in potential difference across a lamp affected the current flowing through it.

For Examiner's Use

She used wires to connect the components shown in Fig. 1.1 to make a circuit.

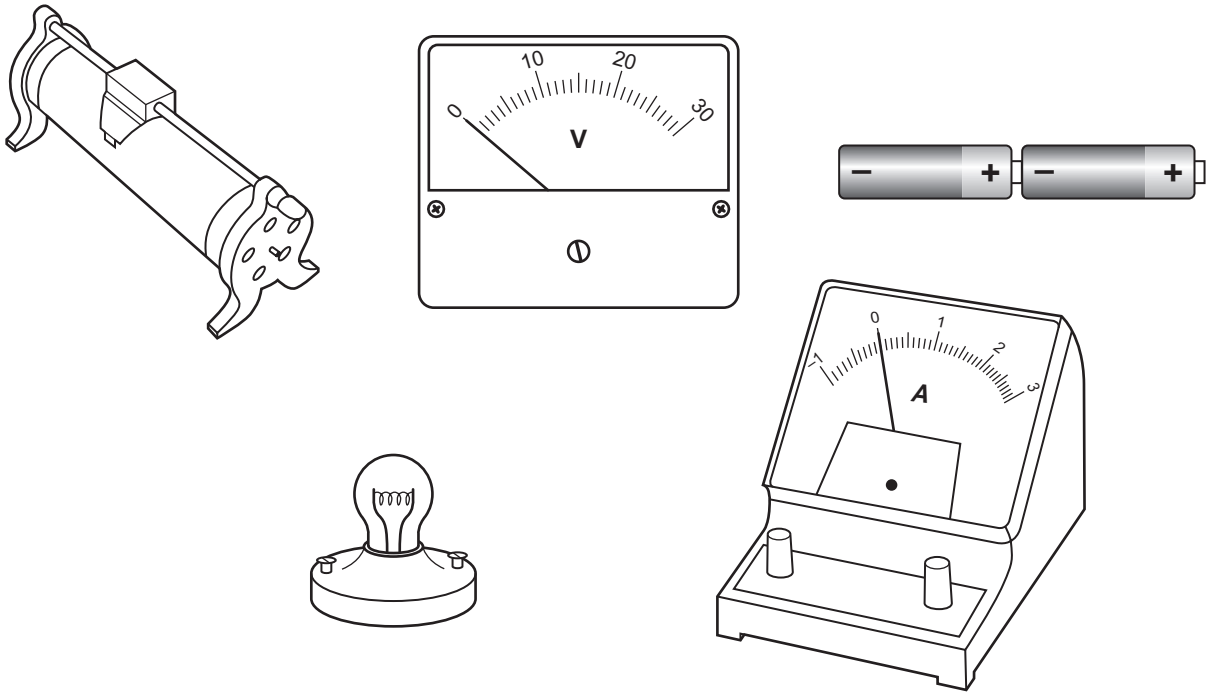

Fig. 1.1

(i) Using the correct symbols, draw a diagram to show the circuit she used.

[2]

(ii) Explain why the variable resistor is included in the circuit.

.....

..... [1]

For Examiner's Use

(iii) Her results are shown in Table 1.1.

Table 1.1

potential difference across lamp / V	current through lamp / A	resistance of lamp filament / Ω
4	1.2	3.3
8	1.5	
12	1.7	7.1

Complete the table by calculating the missing resistance and writing your answer in the empty box.

State the formula that you use and show your working.

formula

working

[2]

(iv) The student concluded that the relationship between potential difference and current did not correspond to Ohm's law.

Explain why the relationship between potential difference and current for the lamp did not correspond to Ohm's law.

.....

.....

..... [2]

For Examiner's Use

(b) Fig. 1.2 shows a wire moving upwards between the poles of two magnets. The ends of the wire are connected to a sensitive ammeter. The ammeter shows the induced current.

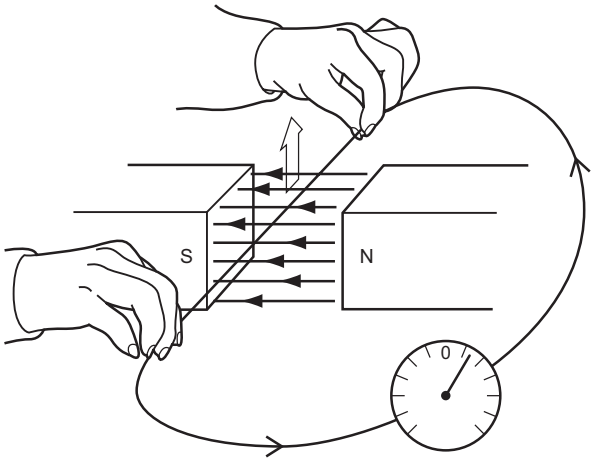

Fig. 1.2

(i) Draw on the ammeter in Fig. 1.3 the reading obtained if the wire was moved twice as quickly in the same direction.

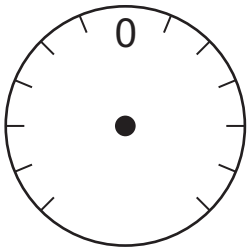

Fig. 1.3

[1]

(ii) Draw on the ammeter in Fig. 1.4 the reading obtained if the wire was moved in the opposite direction.

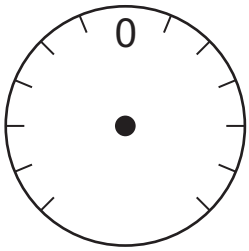

Fig. 1.4

[1]

(iii) Suggest why the ammeter must be a sensitive ammeter.

.....

..... [1]

(iv) Name a device which uses this principle of inducing an electric current when a wire moves in a magnetic field.

..... [1]

For Examiner's Use

2 **(a)** Fig. 2.1 shows a transverse section of an artery.

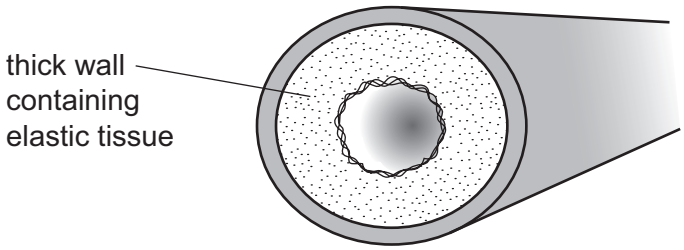

Fig 2.1

(i) Explain why arteries have elastic tissue in their walls.

.....

.....

..... [2]

(ii) Veins contain valves. Explain why arteries do **not** contain valves.

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.....

..... [2]

(b) A man ran steadily on a running track for 10 minutes. Fig. 2.2 shows the rate of oxygen consumption by the muscles of his heart before, during and after the run.

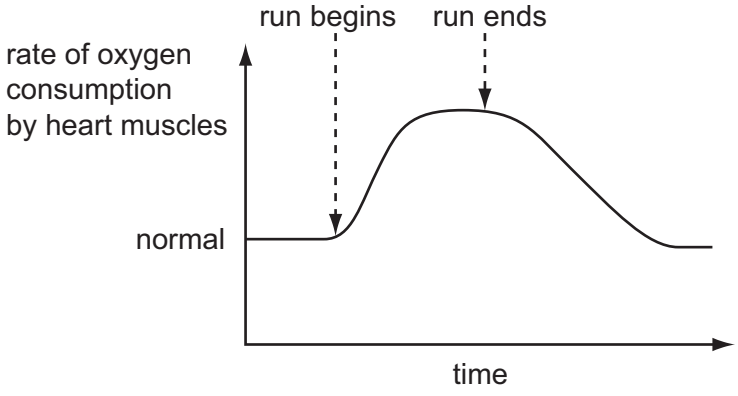

Fig. 2.2

(i) Explain why his heart muscle consumed oxygen at a greater rate during the run than before it.

.....

.....

.....

..... [3]

(ii) Explain why the rate of oxygen consumption by the heart muscle did not return to normal immediately after the run.

.....

.....

.....

..... [2]

(c) In 1968, the Olympic Games were held in Mexico City. This is at a high altitude, and there is less oxygen in the air than at sea level.

Athletes running in 100 m races had no difficulties and times were fast. However, athletes running in long distance races became very tired while they were running and their times were slow.

Suggest an explanation for this.

.....

.....

..... [2]

(d) Competitive athletes need to have plenty of iron in their diet.

Describe the function of iron in the body.

.....

..... [1]

[Turn over

For Examiner's Use

3 Food colourings are natural or synthetic dyes added to make food look more attractive.

(a) Describe the difference between natural and synthetic dyes.

.....

.....

..... [1]

(b) Fig. 3.1 shows a piece of cloth which is stained with food colouring.

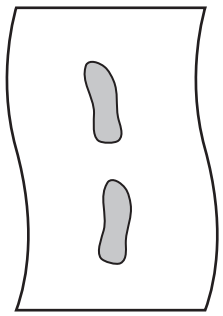

Fig. 3.1

The cloth is washed in water containing soap solution.

Describe how soap molecules help to remove stains from the cloth. You may wish to draw some simple diagrams to help you answer this question.

.....

.....

.....

..... [3]

For Examiner's Use

(c) Some water supplied to houses contains calcium hydrogencarbonate, $Ca(HCO_3)_2$. When heated, calcium hydrogencarbonate undergoes thermal decomposition.

(i) Complete the symbolic equation below which describes the thermal decomposition of calcium hydrogencarbonate.

$Ca(HCO_3)_2 \rightarrow$

[2]

(ii) The ionic charge of a calcium ion is 2+. Deduce the ionic charge of a hydrogencarbonate ion.

Show how you obtained your answer.

.....

.....

..... [2]

For Examiner's Use

4 (a) Many people have survived accidents where they have been exposed to ionising radiation from radioactive materials. Such exposure can have serious effects on their health.

The table and graph show how the dose (amount) of radiation received is linked to a type of cancer called leukaemia. The radiation dose is measured in units called grays.

Table 4.1

radiation dose / grays	incidences of leukaemia / cases per 10 000 people per year
1.0	1.0
2.5	2.3
5.0	
10.0	10.1
15.0	15.2

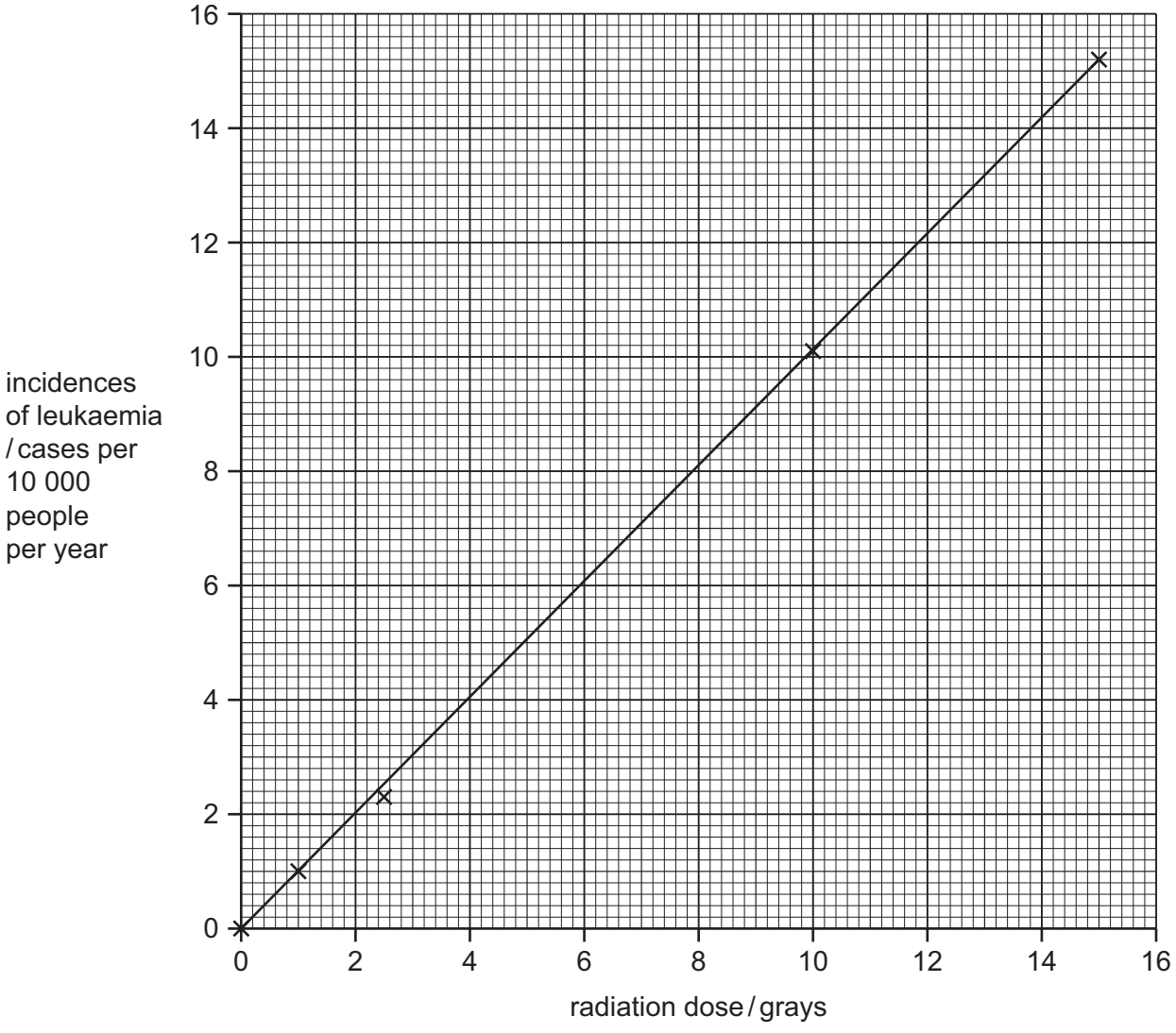

Fig. 4.1

(i) The result for 5.0 grays has been missed out of the table.

Use the graph to help you fill in the missing value in the table. [1]

(ii) What is the relationship between the ionising radiation and the incidence of leukaemia?

.....

..... [1]

(b) Two types of nuclear radiation from naturally occurring sources are alpha and beta. They can be identified by their different penetrating powers.

Describe how you could distinguish between alpha and beta radiation by their penetrating powers.

.....

.....

..... [1]

(c) Radon-222 (^{222}Rn) is a radioactive element. The chart in Fig. 4.2 shows the number of protons and neutrons in the nuclei of the elements formed when radon decays.

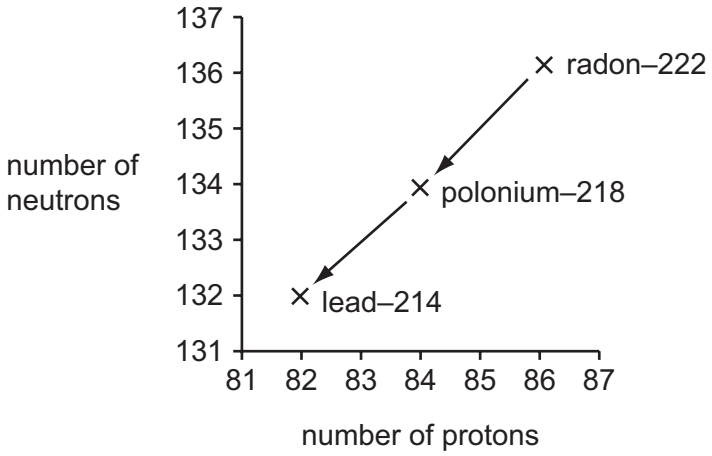

Fig. 4.2

(i) Describe how the graph shows that radon-222 (^{222}Rn) and polonium-218 (^{218}Po) emit alpha particles.

.....

.....

.....

..... [2]

For Examiner's Use

(ii) State why radon and polonium are different elements.

.....

[1]

(iii) Radioactive decay can also produce gamma radiation.

Explain why gamma emission does **not** result in the formation of a new element.

.....

.....

[1]

(iv) Radon-222 has a half-life of 4 days.

Explain what is meant by the term *half-life.*

.....

.....

[1]

(v) 1 mg of radon-222 is allowed to decay.

Calculate after how many days there would be 0.125 mg of radon-222 remaining.

Show your working.

.....

.....

[2]

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Please turn over for Question 5.

5 Fig. 5.1 shows three arthropods.

For Examiner's Use

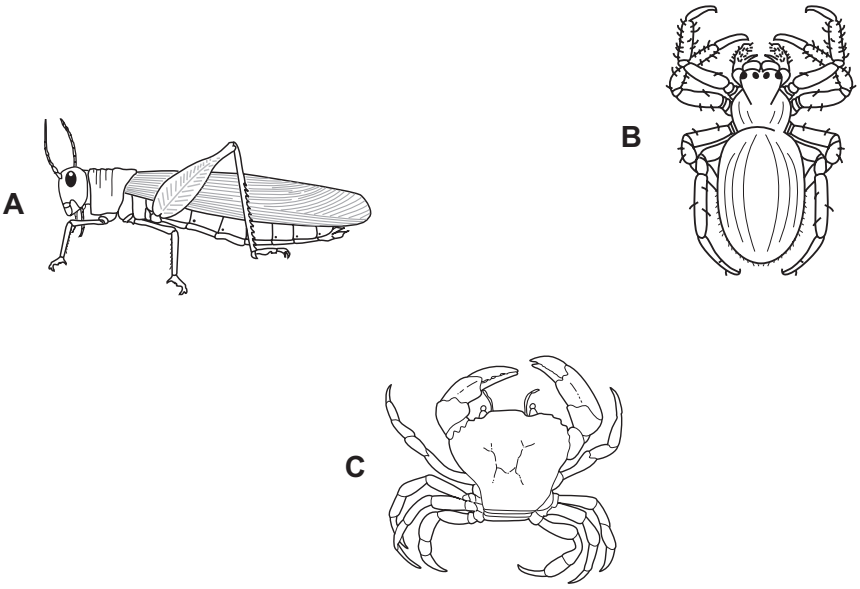


Fig. 5.1

(a) (i) The arthropod **A** is a locust, which belongs to the insect class.

State **two** features, visible on the locust in Fig. 5.1, which are characteristic of insects.

1 .....

2 ..... [2]

(ii) Name the classes to which arthropods **B** and **C** belong.

B .....

C ..... [2]

For Examiner's Use

(b) In one species of locust, the body colour may be brown or green. This is controlled by a gene with two alleles, **G** and **g**. If two locusts with brown bodies are mated, the offspring are always brown. If two locusts with green bodies are mated, some of the offspring may be brown.

(i) Write the possible genotype or genotypes for each of the following phenotypes.

brown body .....

green body ..... [2]

(ii) Use a genetic diagram to explain why some of the offspring of two locusts with green bodies may have brown bodies.

[4]

(c) State whether the variation in body colour in these locusts is an example of *continuous* variation or *discontinuous* variation. Explain your answer.

.....

..... [1]

(d) Locusts sometimes form huge swarms, which can fly long distances, and can eat and completely destroy whole fields of crops. These swarms are sometimes sprayed with pesticides from aeroplanes.

Suggest **two** possible disadvantages of using pesticides in this way.

1 .....

.....

2 .....

..... [2]

6 Fig. 6.1 shows apparatus a student used to investigate electrolysis using concentrated sodium chloride solution as the electrolyte.

For Examiner's Use

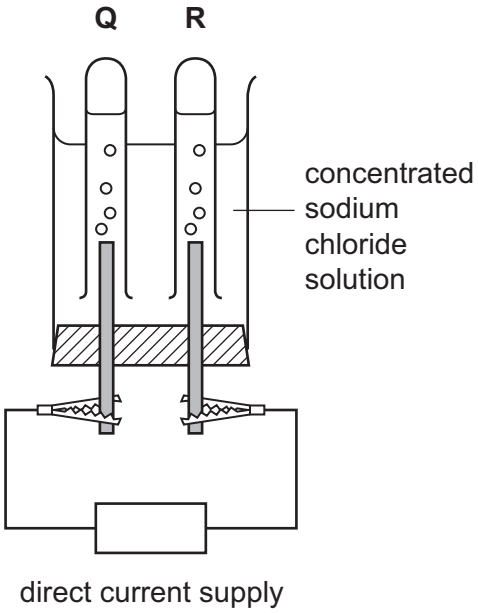


Fig. 6.1

When an electric current flowed through the circuit, chlorine gas collected in tube **Q** and hydrogen gas collected in tube **R**.

The balanced equation below describes the overall chemical change which takes place.

$$2NaCl + 2H_2O \rightarrow 2NaOH + Cl_2 + H_2$$

(a) On Fig. 6.1 label the anode.

Give a reason for your choice.

.....

.....

..... [2]

(b) The student allowed the current to flow through the apparatus until 0.01 moles of hydrogen gas had been produced.

(i) State the number of moles of chlorine which were produced during the experiment.

..... [1]

(ii) Calculate the mass of sodium hydroxide which was produced during the experiment. (Relative atomic masses Na = 23, O = 16, H = 1)

Show your working.

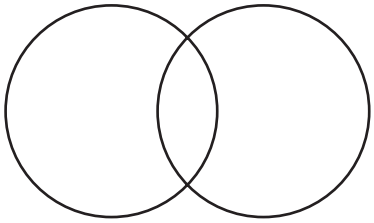
..... [3]

(c) When chlorine gas is bubbled through a colourless solution of potassium bromide, KBr, the solution turns orange because the element bromine is produced.

(i) Write a balanced equation for the reaction between chlorine and potassium bromide.

..... [2]

(ii) Complete the bonding diagram of a bromine molecule to show the arrangement of the outer electrons of each atom.



[2]

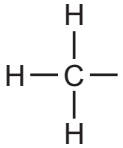
(iii) Describe how bromine is used to test hydrocarbons to find out whether or not they are unsaturated.

.....

.....

..... [2]

(iv) Complete the displayed formula to show the **alkene** which contains four carbon atoms in each of its molecules.



[2]

For Examiner's Use

7 A student carried out an investigation into the response of plant shoots to light.

He grew six maize seedlings and treated them as follows.

- He did nothing to seedlings **A** and **D**.
- He cut the tips off seedlings **B** and **E**.
- He covered the tips of seedlings **C** and **F** with black paper.

He placed one group of seedlings where they received light from all directions. He placed the second group of seedlings in a container where they received light from one side only.

Fig. 7.1 shows the appearance of the six seedlings when the experiment was first set up, and after one day.

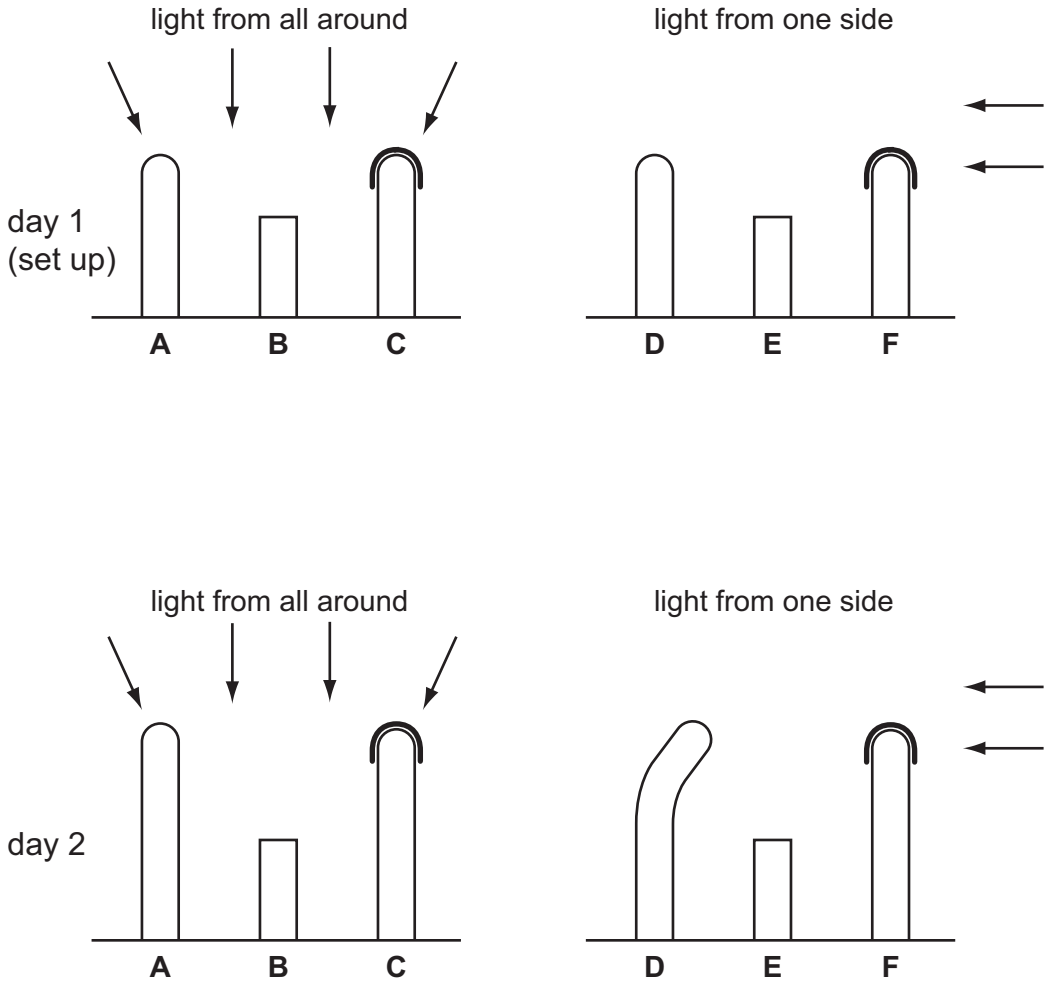


Fig. 7.1

For Examiner's Use

(a) The student concluded that the tip of a shoot is needed for growth. Describe the evidence in Fig. 7.1 that supports this conclusion.

.....

.....

..... [2]

(b) Using the information in Fig. 7.1, deduce the positions of the receptor and the effector that are responsible for the growth response of a seedling towards light.

Explain the evidence for your deductions.

position of receptor .....

evidence .....

.....

position of effector .....

evidence .....

..... [4]

(c) Describe how auxin may be involved in the growth of shoots towards the light. You can use a diagram if it helps your answer.

.....

.....

.....

..... [3]

For Examiner's Use

8 Two skiers **A** and **B** start a straight downhill race.

Fig 8.1 shows how the motion of skier **A** changes during the race. Skier **A** finishes the race after 40 seconds and then slows down and stops after 50 seconds.

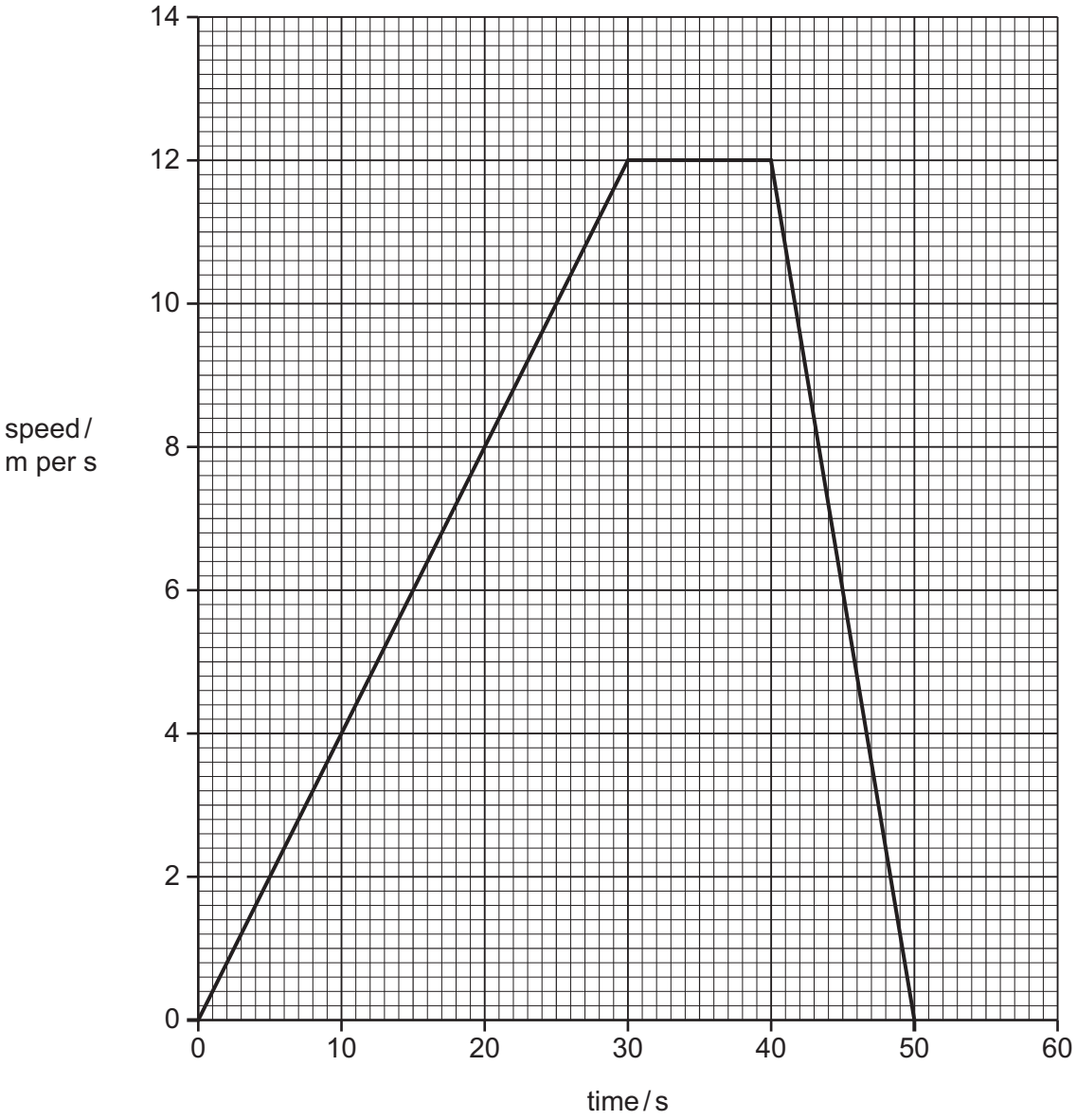


Fig. 8.1

(a) (i) Describe the motion of skier **A** between 0 and 30 seconds.

.....

..... [2]

(ii) Calculate the distance skier **A** travels between 0 and 30 seconds.

Show your working.

..... [2]

For Examiner's Use

(b) The mass of skier **A** is 60 kg. Calculate the kinetic energy of the skier when her speed is 10 m / s.

State the formula that you use and show your working.

formula

working

..... [2]

(c) (i) Calculate the deceleration of skier **A** between 40 and 50 seconds.

State the formula that you use and show your working.

formula

working

..... [2]

(ii) Calculate the force on skier **A** which causes this deceleration.

State the formula that you use and show your working.

formula

working

..... [2]

(d) Skier **B** wins the race. On Fig. 8.1 show how the motion of skier **B** might change during the race.

Explain your answer.

.....

..... [2]

For Examiner's Use

9 Hydrogen peroxide, H_2O_2, is a colourless liquid which slowly decomposes according to the equation below.

hydrogen peroxide → water + oxygen.

If the black solid compound manganese dioxide, MnO_2, is added to a solution of hydrogen peroxide, it acts as a catalyst and the rate of reaction is greatly increased.

(a) Describe the test for oxygen gas.

.....

..... [1]

(b) A student uses the apparatus shown in Fig. 9.1 to study the rate of reaction when hydrogen peroxide solution decomposes.

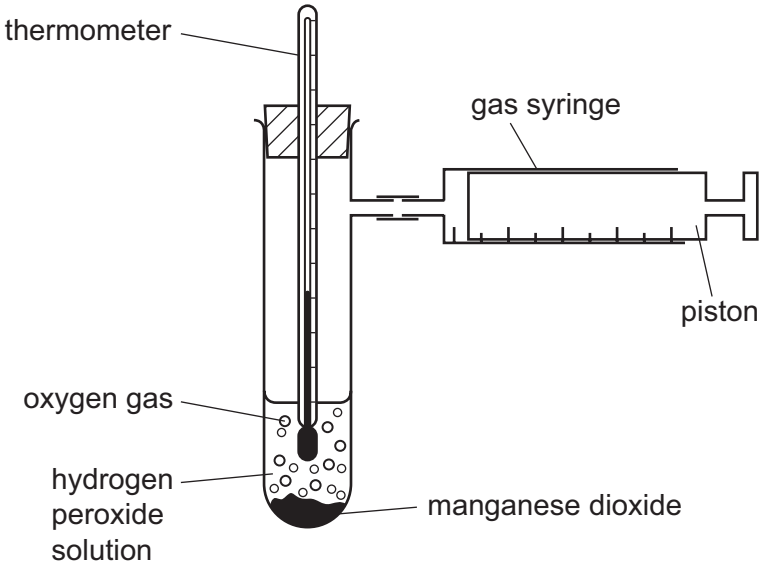


Fig. 9.1

The student carries out three trials to investigate the effect of changing the concentration of the hydrogen peroxide solution. She attempts to keep all other variables the same in each trial.

Her results are shown in Table 9.1.

Table 9.1

For Examiner's Use

trial number	hydrogen peroxide concentration in mol / dm^3	volume of oxygen collected / cm^3	time taken to collect oxygen / s	rate of production of oxygen in cm^3 / s
1	0.4	50	10	5.0
2	0.2	50	20	
3	0.1	50	40	1.25

(i) Calculate the rate of production of oxygen for Trial **2** and write the value in Table 9.1. [1]

(ii) Using the data in Table 9.1, explain in terms of collisions of molecules, the relation between the rate of production of oxygen and the concentration of hydrogen peroxide solution in this experiment.

.....

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.....

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..... [4]

(iii) Describe how the student could show that manganese dioxide is behaving as a catalyst and is therefore not used up or chemically changed.

.....

.....

.....

.....

..... [2]

For Examiner's Use

(c) Table 9.2 shows information about the atomic structure of four particles **P**, **Q**, **R** and **S**.

Table 9.2

	number of protons	number of neutrons	electrons in 1st shell	electrons in 2nd shell	electrons in 3rd shell
P	17	20	2	8	8
Q	10	10	2	8	-
R	9	10	2	8	-
S	17	18	2	8	7

(i) Explain which two particles from **P, Q, R** and **S** are isotopes of the same element.

.....

.....

..... [2]

(ii) State which particle from **P, Q, R** and **S** is an **atom** of a very unreactive element.

..... [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.).