



UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS  
International General Certificate of Secondary Education

CANDIDATE  
NAME

CENTRE  
NUMBER

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CANDIDATE  
NUMBER

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**CO-ORDINATED SCIENCES**

**0654/33**

Paper 3 (Extended)

**October/November 2013**

**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 pencil for any diagrams or graphs.

Do not use staples, paper clips, glue or correction fluid.

**DO NOT WRITE IN ANY BARCODES.**

Answer **all** questions.

Electronic calculators may be used.

You may lose marks if you do not show your working or if you do not use appropriate units.

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.

This document consists of **30** printed pages and **2** blank pages.



1 Fig. 1.1 shows a root hair cell.

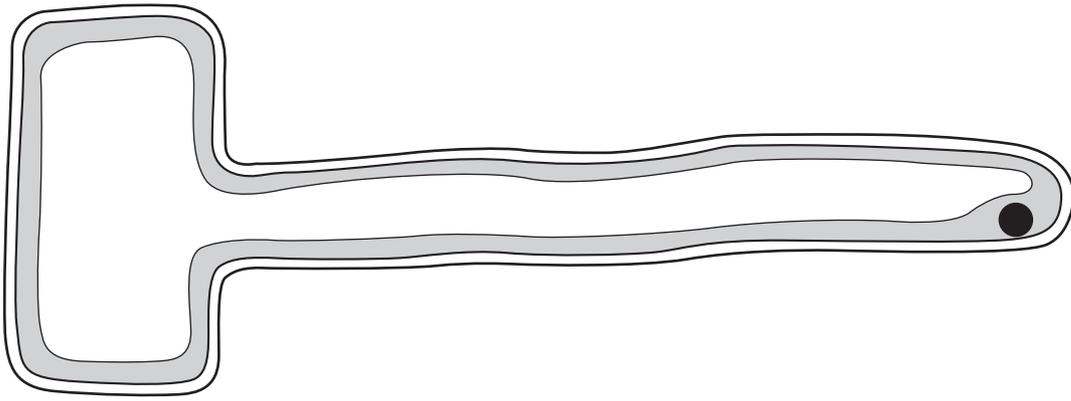


Fig. 1.1

(a) Use the letters **A**, **B** and **C** to label these parts of the root hair cell in Fig. 1.1.

- A** a partially permeable membrane
- B** the part that contains DNA
- C** a structure that is **not** present in animal cells

[3]

(b) Describe how the structure of the root hair cell helps it to carry out its functions.

.....

.....

.....

.....

.....

.....

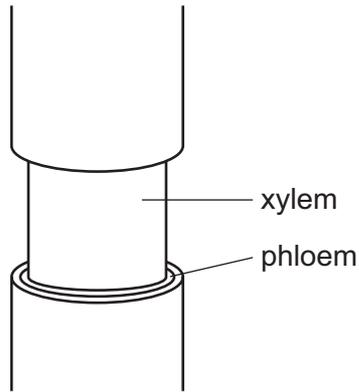
.....

.....

[3]

(c) Fig. 1.2 shows part of a plant stem from which the outer layer has been removed.

*For  
Examiner's  
Use*



**Fig. 1.2**

Explain why this treatment would cause the roots of the plant to die.

.....

.....

.....

.....

.....

.....

..... [3]

- 2 (a) Table 2.1 shows information about some chemical elements and their positions in the Periodic Table.

For  
Examiner's  
Use

**Table 2.1**

element	group number in the Periodic Table
oxygen	6
calcium	2
lithium	1
sulfur	6
fluorine	7

Select **two** elements from Table 2.1 whose atoms form covalent bonds with each other and explain your answer.

..... and .....

explanation .....

.....

..... [2]

(b) Fig. 2.1 shows the electron arrangement in an atom of phosphorus.

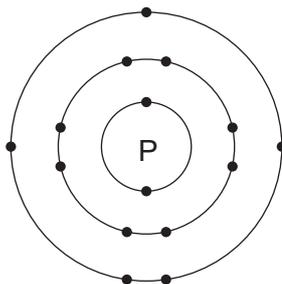


Fig. 2.1

Phosphorus and hydrogen bond together to form the compound phosphine. One molecule of phosphine contains one atom of phosphorus.

Predict and explain the chemical formula of one molecule of phosphine. You may wish to draw a diagram to help you to answer this question.

predicted formula .....

explanation .....

.....

..... [3]

For  
Examiner's  
Use

- (c) A student added **excess** acidified barium chloride solution to a solution of magnesium sulfate.

For  
Examiner's  
Use

Fig. 2.2 shows the procedure followed.

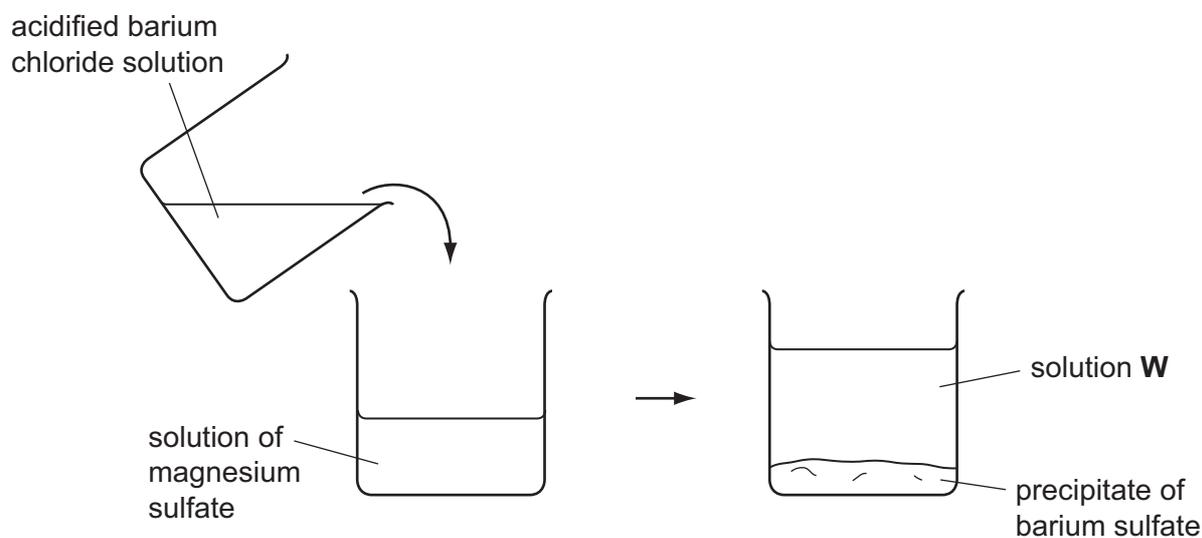


Fig. 2.2

A white precipitate of barium sulfate was produced.

The chemical equation for the reaction is



- (i) State **three** ions that are dissolved in solution **W** in Fig. 2.2.

1 .....

2 .....

3 .....

[1]

- (ii) He used  $50.0 \text{ cm}^3$  of magnesium sulfate solution of concentration  $0.75 \text{ mol/dm}^3$ .

Calculate the number of moles of magnesium sulfate used by the student.

Show your working.

.....moles [2]

- (iii) State the number of moles of barium sulfate precipitate that were produced by the reaction.

.....moles [1]

- (iv) Use the Periodic Table on page 32 to calculate the mass of barium sulfate that formed in the reaction.

Show your working.

.....g [2]

*For  
Examiner's  
Use*

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- 3 (a) Fig. 3.1 shows a circuit used to measure the current passing through a resistor when the voltage across it is changed.

For  
Examiner's  
Use

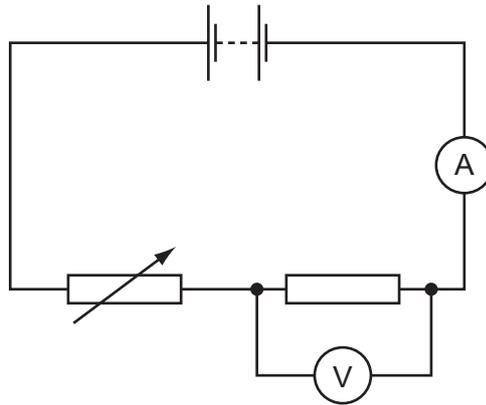


Fig. 3.1

Complete the sentences below using suitable words.

When the voltage across the resistor is reduced, the current through the resistor

.....

When the voltage of the supply is reduced, the voltage across the resistor

.....

[1]

- (b) The resistance of a piece of wire depends on a number of variables such as the temperature of the wire and the material from which it is made.

State **two other** factors which affect the resistance of a piece of wire.

1 .....

2 ..... [2]

(c) Fig. 3.2 shows a circuit used to power a small motor.

For  
Examiner's  
Use

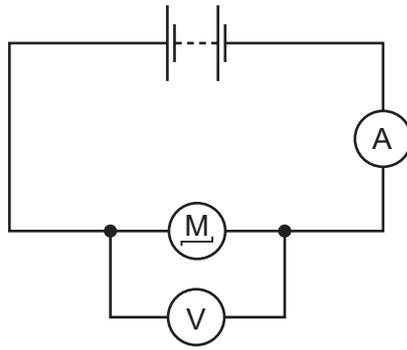


Fig. 3.2

The voltage across the motor is 3 V. The current through the motor is 0.6 A.

(i) Calculate the power input to the motor.

State the formula that you use, show your working and state the unit of your answer.

formula

working

..... unit ..... [2]

(ii) The motor is able to lift a load of 40 N through 1.2 m in 36 seconds.

Calculate the power output of the motor.

State the formula that you use, show your working and state the unit of your answer.

formula

working

..... unit ..... [3]

(iii) Explain why there is a difference between your answers to (i) and (ii).

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

(iv) Calculate the efficiency of the motor.

Show your working.

..... [2]

(d) An electric current in a wire is a flow of electrons.  $\beta$ (beta)-radiation also consists of electrons.

(i) State the name of the sign of the charge on an electron.

..... [1]

(ii)  $\alpha$ (alpha)-radiation moves in the opposite direction to  $\beta$ -radiation in an electrical field.

$\gamma$ (gamma)-radiation passes through an electrical field without deviation.

Explain these two statements.

.....  
.....  
.....  
..... [2]

4 Soya beans are an important crop in Brazil. Soya beans can be used to make soya 'milk', which can be made into yoghurt.

(a) To make yoghurt, microorganisms are added to soya milk. The milk is then kept warm for several hours.

(i) State the type of microorganism that is added to milk to make yoghurt.

..... [1]

(ii) Explain why the milk is kept warm for several hours.

.....  
 .....  
 ..... [2]

(b) Researchers in Brazil investigated whether adding sugar to the soya milk affected the yoghurt that was produced.

They added sugar to one batch of soya milk, but not to another. They measured the percentage of lactic acid in each batch of yoghurt at the start, and after 4, 5, 6 and 7 hours.

Fig. 4.1 shows their results.

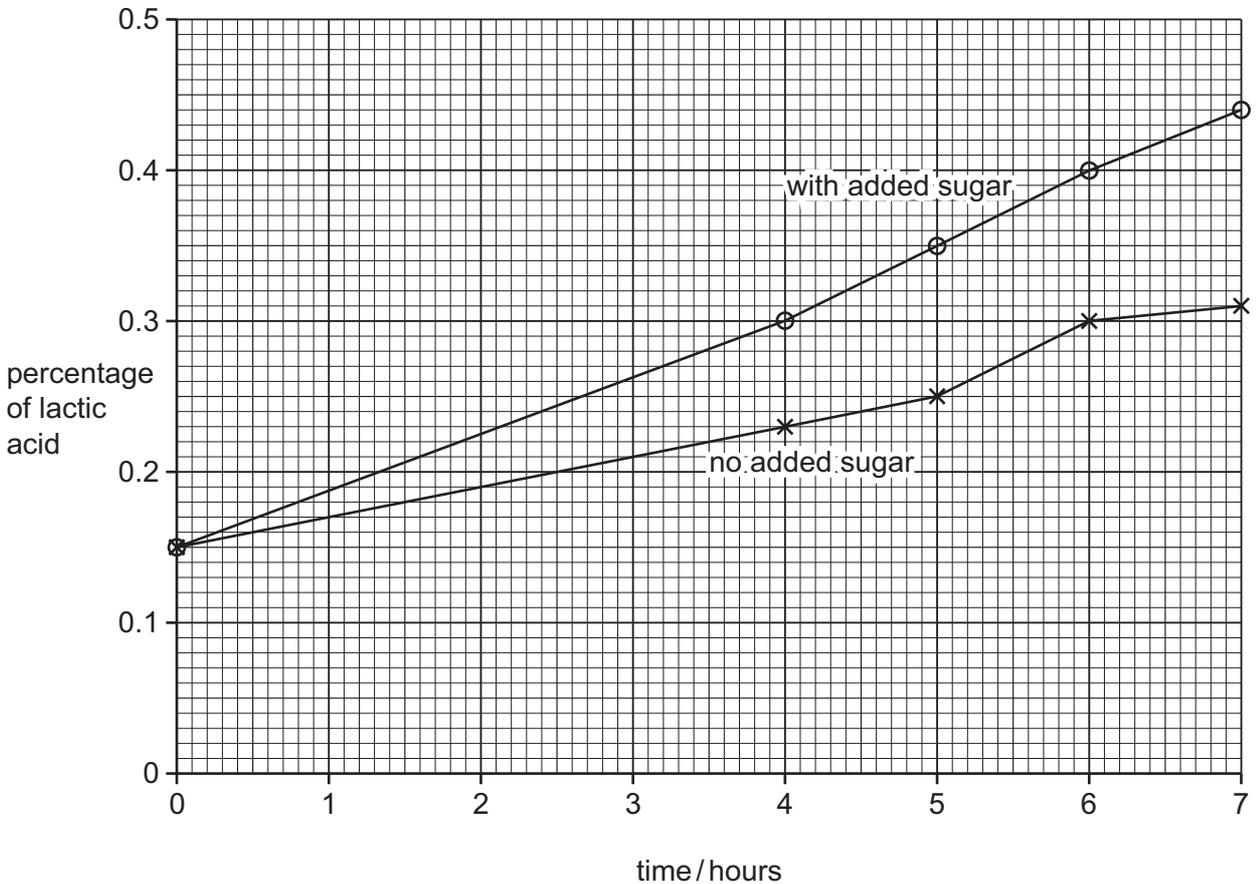


Fig. 4.1

- (i) Describe the change in lactic acid concentration during the fermentation of the yoghurt with no added sugar.

.....  
.....  
..... [2]

- (ii) Compare the concentration of lactic acid when sugar is added with the concentration of lactic acid when no sugar is added.

State the difference and explain it.

.....  
.....  
..... [2]

- (c) Large areas of rainforest have been cleared in Brazil, to provide more land for growing soya beans.

Explain how cutting down the rainforest can harm the environment.

.....  
.....  
.....  
.....  
.....  
.....  
..... [4]

- 5 A student carried out experiments to investigate the differences in reactivity of some elements.

For  
Examiner's  
Use

- (a) Fig. 5.1 shows what the student observed when he removed an iron nail that had been placed into a solution of copper sulfate for a short time.

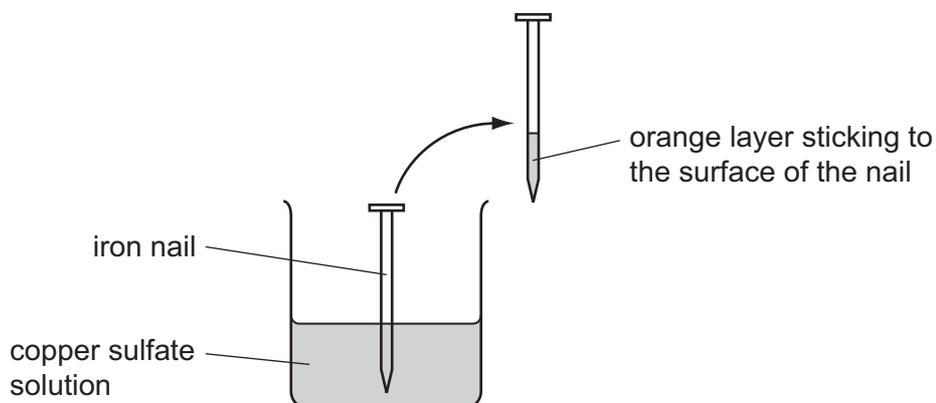


Fig. 5.1

The student correctly concluded that a layer of copper had formed on the surface of the nail.

Explain, in terms of electron transfer, how the reaction is an example of redox (reduction and oxidation).

.....  
 .....  
 ..... [2]

- (b) Fig. 5.2 shows apparatus used by the student to investigate the reaction between different metals and steam,  $\text{H}_2\text{O}(\text{g})$ .

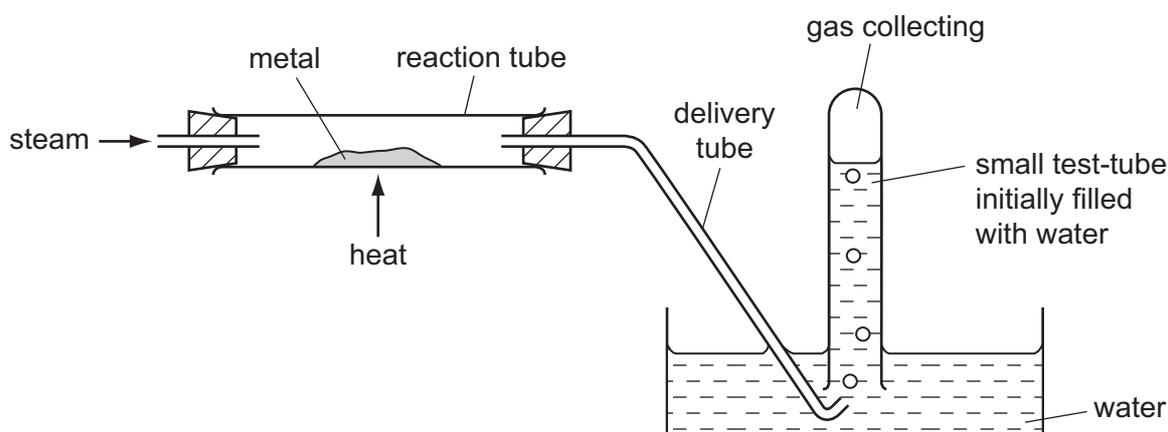


Fig. 5.2

The student carried out experiments using two metals, **P** and **Q**. His observations are shown in Table 5.1.

Table 5.1

metal	observation in reaction tube	observation in small test-tube
<b>P</b>	no reaction	no gas produced
<b>Q</b>	<ul style="list-style-type: none"> <li>• rapid exothermic reaction</li> <li>• white powdery solid produced</li> </ul>	gas <b>G</b> collects

For  
Examiner's  
Use

(i) State the element which combined with metal **Q** to form the white powdery solid.

..... [1]

(ii) Name the gas **G**.

..... [1]

(iii) Use the observations to compare the reactivities of the three elements, **P**, **Q** and gas **G**.

Explain your answer.

most reactive .....

.....

least reactive .....

explanation .....

.....

.....

..... [3]

(c) Mild steel is an alloy that contains mainly iron. Mild steel will rust unless it is protected.

State and explain how a covering of metallic zinc provides sacrificial protection of steel from rusting.

.....

.....

.....

.....

..... [4]

- 6 (a) (i) Fig. 6.1 gives information about the uses of different types of electromagnetic waves and their effects on living tissue.

Draw lines to link each electromagnetic wave with its effect on living tissue and its use.

One has been completed as an example.

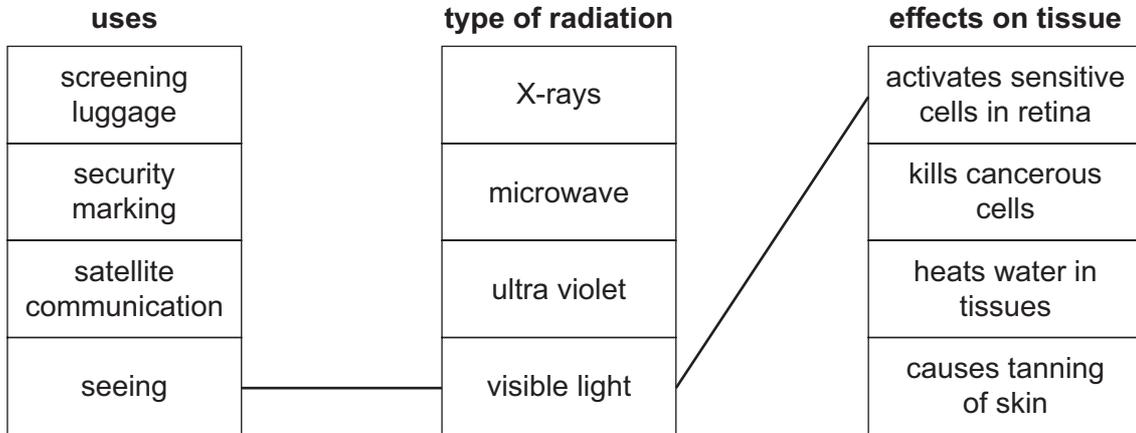


Fig. 6.1

[4]

- (ii) State **one** property that is the same for all electromagnetic waves.

..... [1]

- (b) Infra-red radiation is the part of the electromagnetic spectrum often involved in heat transfer by radiation.

A student carried out an experiment to find out the type of surface that was the best emitter of radiation.

She set up the apparatus shown in Fig. 6.2 and measured the temperature of the water in the flasks every minute for 20 minutes.

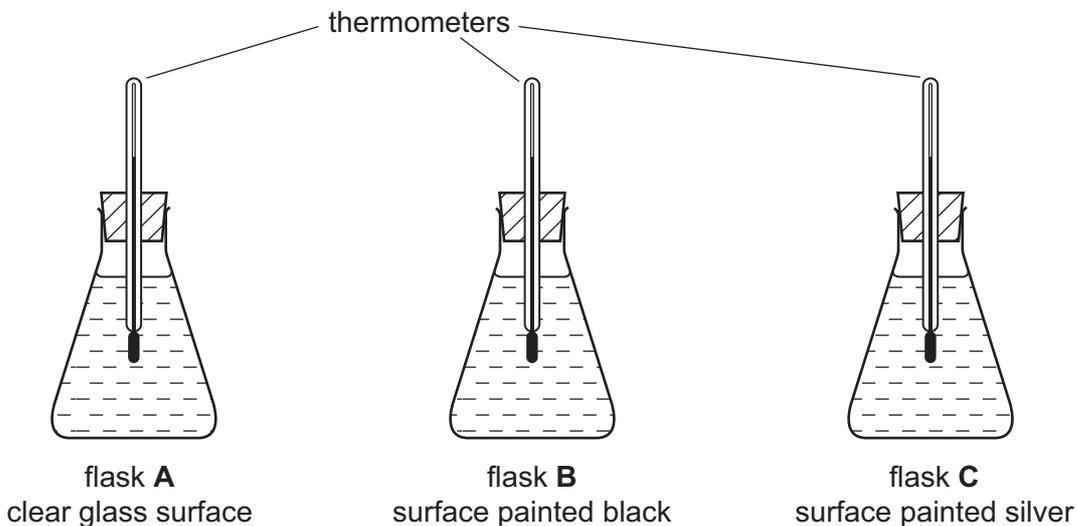
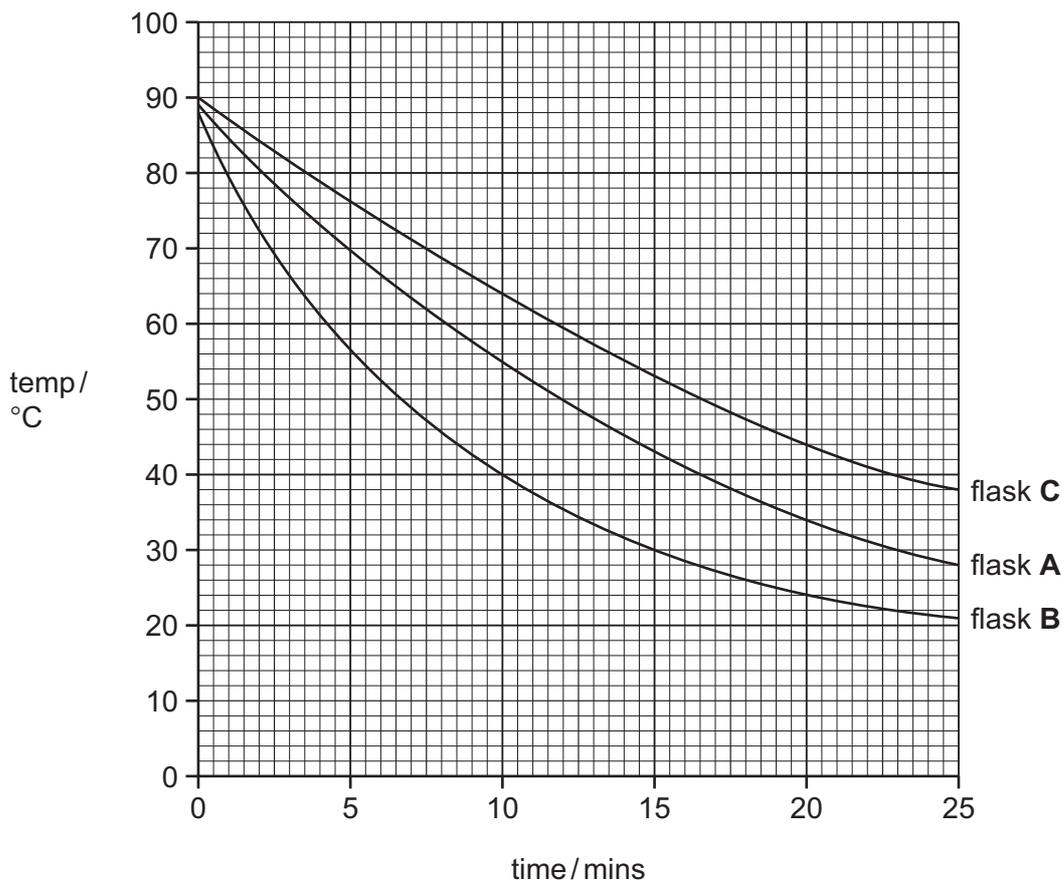


Fig. 6.2

Her results are shown in Fig. 6.3.

For  
Examiner's  
Use



**Fig. 6.3**

(i) From the graphs identify, with a reason, the flask that cools most rapidly.

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

(ii) Suggest why the flask you identified in (i) cooled more rapidly than the others

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

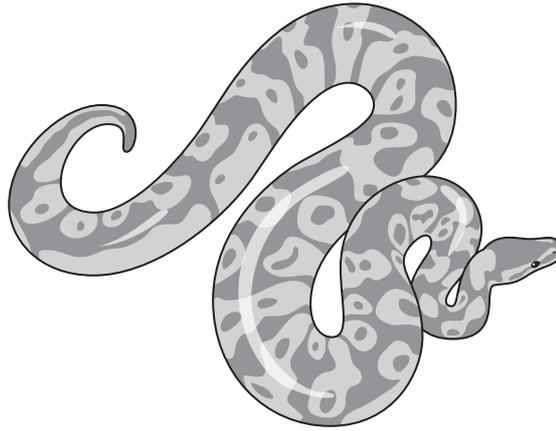
(iii) State **two** variables which the student needed to keep constant during her experiment.

1 .....  
 2 .....

[1]

- 7 Ball pythons (royal pythons) are snakes that are kept as pets in many parts of the world.

For  
Examiner's  
Use



The colour of a ball python is determined by its genes.

Gene **A** has two alleles, **A<sup>N</sup>** and **A<sup>B</sup>**. Neither allele is dominant or recessive.

Table 7.1 shows the three possible genotypes and colours arising from this gene.

**Table 7.1**

genotype	colour
<b>A<sup>N</sup> A<sup>N</sup></b>	normal
<b>A<sup>N</sup> A<sup>B</sup></b>	cinnamon
<b>A<sup>B</sup> A<sup>B</sup></b>	black

- (a) Suggest why the alleles of this gene are **not** shown using a single capital letter and its small letter, e.g. **A** and **a**.

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

- (b) State the correct biological term for the visible appearance produced by the genotype, in this case the colour of the snake.

..... [1]

(c) People try to breed pythons with unusual colours, because they are worth more money.

Use information from Table 7.1 to construct a genetic diagram to explain how a breeder can produce cinnamon offspring from a normal snake and a cinnamon snake.

*For  
Examiner's  
Use*

[4]

(d) A breeder has several normal snakes, no cinnamon snakes and one black snake.

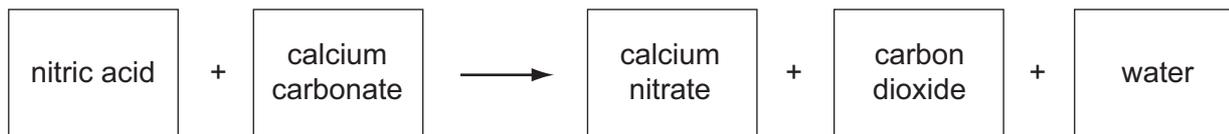
Suggest how she can breed more black snakes.

.....  
.....  
.....  
.....

[2]

8 Dilute nitric acid reacts with calcium carbonate according to the equation.

For  
Examiner's  
Use



(a) Calcium nitrate contains calcium ions and nitrate ions.

Calcium is an element in Group 2 of the Periodic Table and nitrate ions have the formula  $\text{NO}_3^-$ .

Deduce the chemical formula of calcium nitrate.

Show how you obtained your answer.

formula of calcium nitrate ..... [3]

(b) A student carried out an investigation into the way that the rate of the reaction between calcium carbonate and nitric acid changed when he varied the concentration of the nitric acid.

Fig. 8.1 shows the apparatus the student used to measure the rate of reaction.

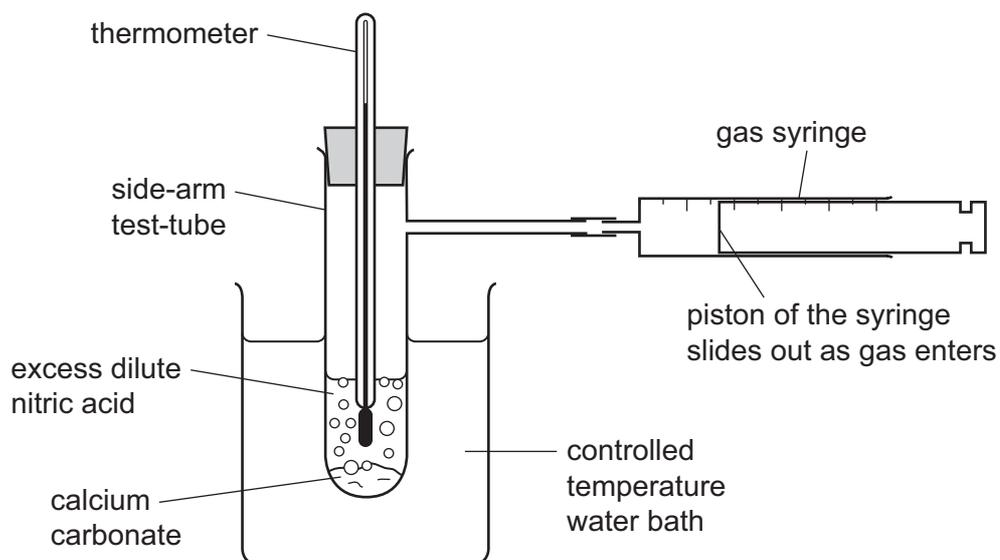
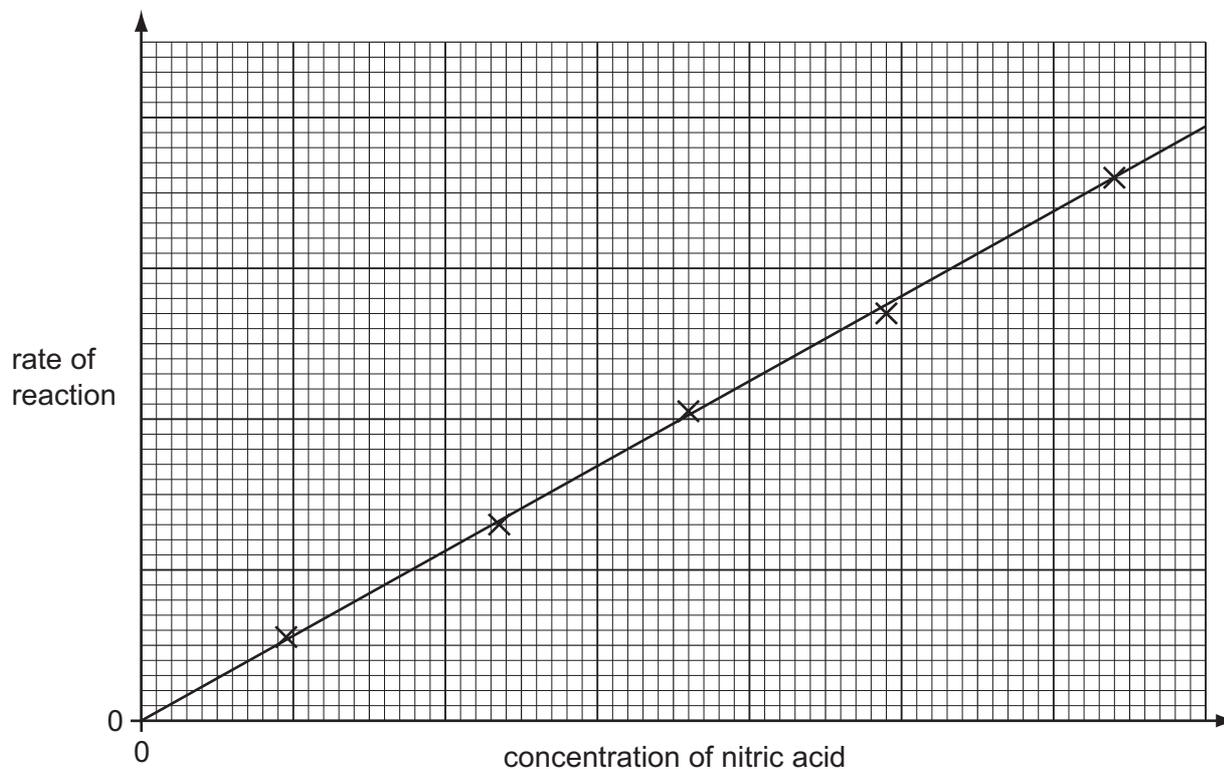


Fig. 8.1

The student measured the rate of reaction by finding the time it took for the gas syringe to fill with gas.

The student measured the rate of reaction using five different concentrations of nitric acid.

Fig. 8.2 shows the student's results as a graph of rate of reaction against acid concentration.



**Fig. 8.2**

- (i) Describe the relationship shown by the graph.

.....  
 .....  
 ..... [2]

- (ii) Explain these results in terms of particle collisions.

.....  
 .....  
 ..... [2]

- (iii) Explain why the temperature of the reacting mixture needs to be kept constant.

.....  
 .....  
 ..... [2]

For  
Examiner's  
Use

- 9 Fig. 9.1 shows a solar-powered golf cart used to carry golfers around a golf course.

For  
Examiner's  
Use

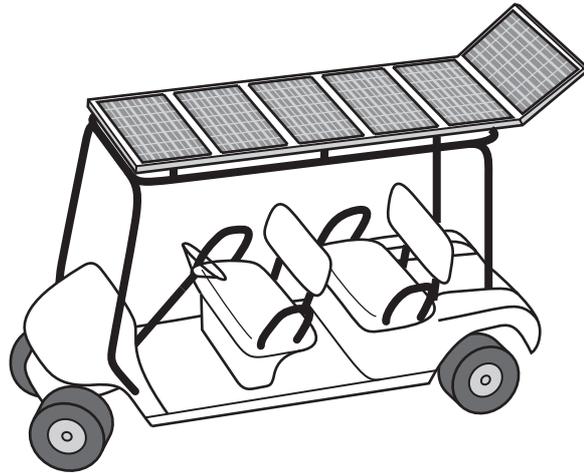


Fig. 9.1

- (a) As the cart moves around the course, the motion of the cart is measured.

Fig. 9.2 shows a distance/time graph for a small part of the journey lasting 60 seconds.

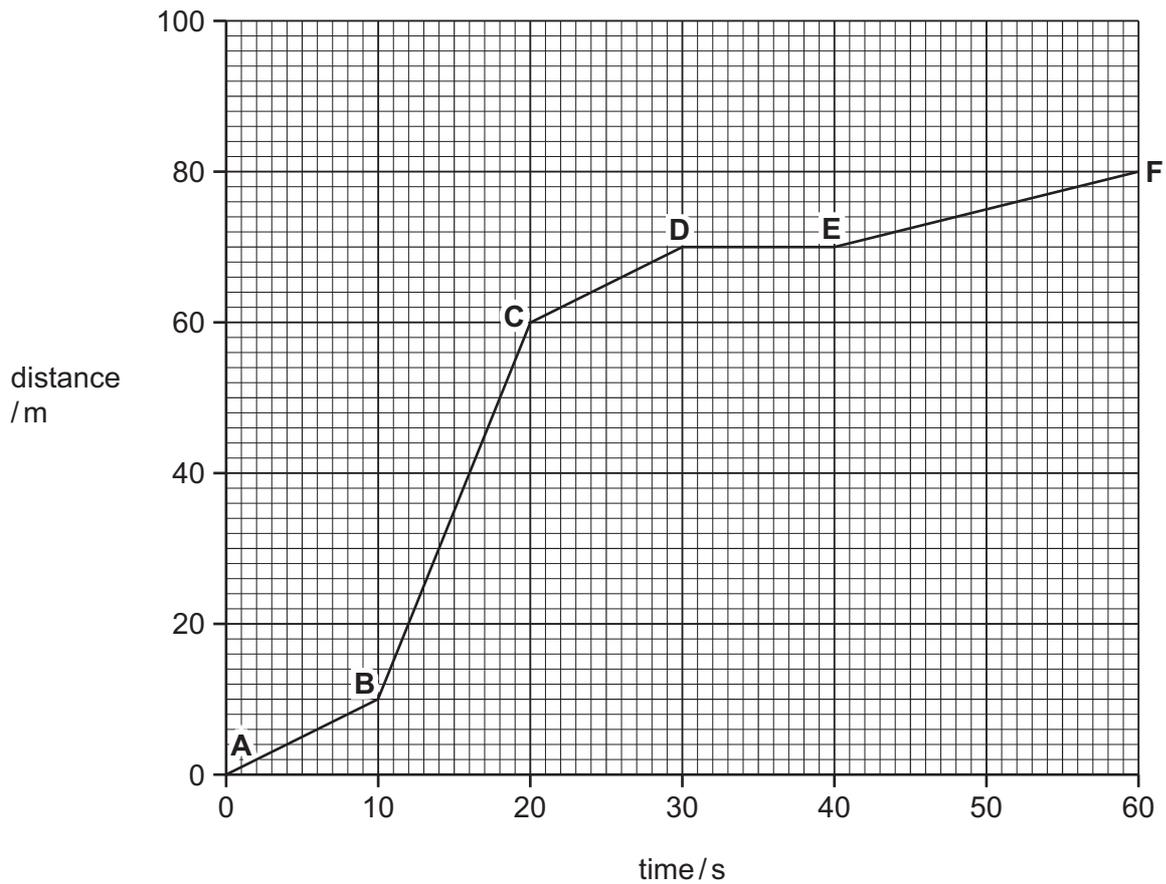


Fig. 9.2

- (i) Show that the speed of the cart between **B** and **C** is 5 m/s.

Show your working in the space.

[1]

- (ii) The mass of the cart is 400 kg.

Calculate the kinetic energy of the cart between **B** and **C**.

State the formula that you use, show your working and state the unit of your answer.

formula

working

..... unit ..... [2]

- (iii) Describe the motion of the cart between **D** and **E**.

..... [1]

- (iv) Later in the journey, the cart accelerates from 1 m/s to 3 m/s in 5 seconds.

Calculate the acceleration of the cart.

State the formula that you use, show your working and state the unit of your answer.

formula

working

..... unit ..... [2]

(b) (i) During the cart's journey, the temperature of the air in the tyres increases by 15 °C.

The volume of the air in the tyre remains the same.

Explain in terms of particles why the **pressure** of the air in the tyre increases when this happens.

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

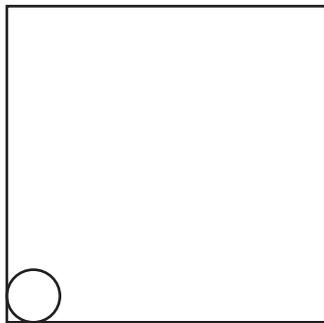
(ii) Sometimes the golfer's hands begin to sweat.

Explain in terms of particles how sweating cools his hands by evaporation.

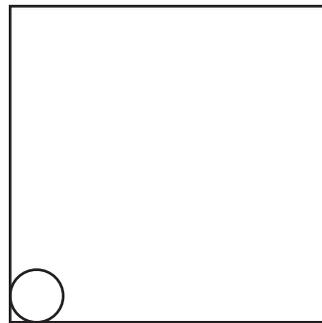
.....  
.....  
..... [2]

(iii) During evaporation, water changes state from liquid to gas.

Complete the diagrams to show the arrangement of particles in a liquid and in a gas.



liquid



gas

[2]

**Please turn over for Question 10.**

10 Fig. 10.1 shows a section through an eye.

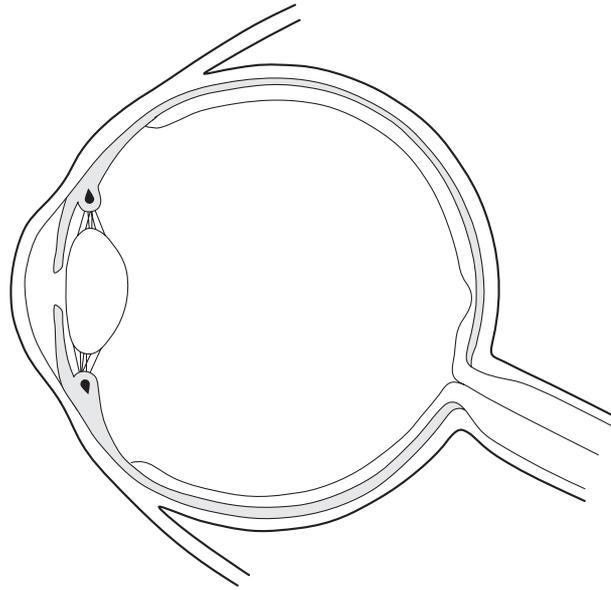


Fig. 10.1

- (a) Complete the sentences to describe how the eye focuses on a nearby object, after it has been looking at a distant object.

Light from a nearby object is diverging ..... than light  
from a distant object. To focus on a nearby object, the .....  
muscles ..... This .....  
the tension on the suspensory ligament, which ..... the  
focal length of the lens. [5]

- (b) On Fig. 10.1, write the letter **F** to show where the rays of light focused by the lens form an image. [1]

(c) When bright light shines onto the eye, the size of the pupil quickly decreases. This is a reflex action.

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

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

(ii) Outline the role of each of the following structures in this reflex action.

sensory neurone .....

.....

motor neurone .....

..... [3]

(d) Most parts of the body are supplied with nutrients and oxygen by blood flowing through capillaries. The cornea and lens of the eye do not contain blood capillaries. They obtain nutrients and oxygen from the aqueous humour and vitreous humour.

(i) Suggest why these parts of the eye do not contain blood capillaries.

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

(ii) Explain why all the living cells in the eye require oxygen.

.....

.....

.....

..... [2]

11 Gasoline and diesel are liquid mixtures of hydrocarbons used as fuels.

Fig. 11.1 shows the structure of a typical molecule in gasoline.

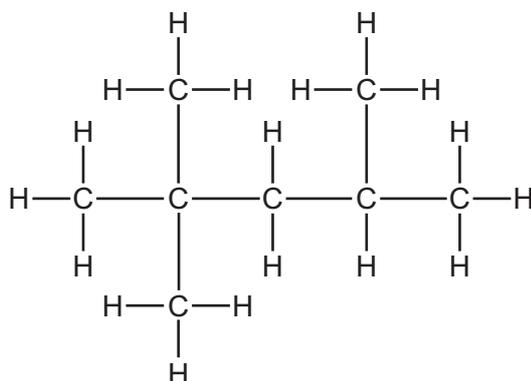


Fig. 11.1

(a) (i) State the chemical formula of the molecule in Fig. 11.1.

..... [1]

(ii) Explain briefly why a molecule like the one in Fig. 11.1 is classified as an *alkane* molecule.

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

(b) Table 11.1 shows some properties of gasoline and diesel.

Table 11.1

fuel	temperature range over which the fuel boils / °C	viscosity (how easily the liquid flows)
gasoline	40 to 205	runny (flows easily)
diesel	250 to 350	less runny

(i) Explain, in terms of molecules and forces, why the properties of these fuels are different.

.....  
 .....  
 .....  
 ..... [2]

- (ii) Decane,  $C_{10}H_{22}$ , boils at a temperature of  $174\text{ }^{\circ}\text{C}$ .

Suggest why gasoline boils over a range of temperatures whereas decane boils at a single temperature.

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

- (c) Ethene,  $C_2H_4$ , is an unsaturated hydrocarbon.

- (i) Describe a chemical test and its result which would show that ethene is unsaturated.

test .....

.....

result ..... [2]

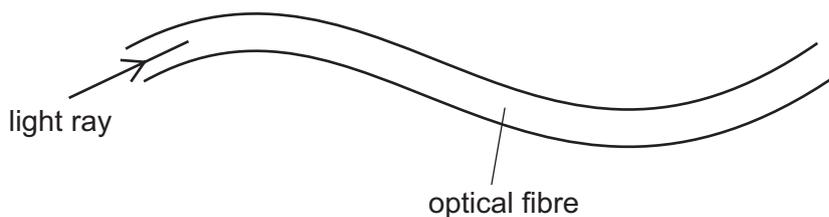
- (ii) Ethene can be made to undergo **complete** combustion in an exothermic reaction with oxygen,  $O_2$ .

Deduce the balanced symbol equation for this reaction.

..... [2]

- 12 (a) Fig. 12.1 shows a light ray entering an optical fibre.

For  
Examiner's  
Use



**Fig. 12.1**

The light ray travels all the way through the optical fibre.

Explain why the light ray is able to stay inside the optical fibre.

You may draw on the diagram if it helps your answer.

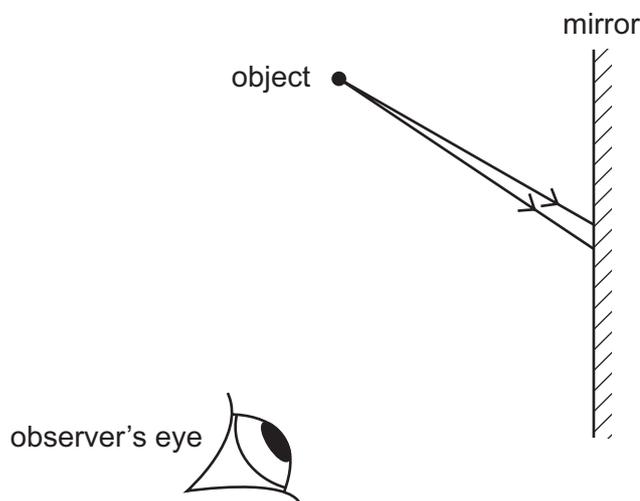
.....

.....

.....

..... [3]

- (b) Fig. 12.2 shows an observer's eye looking at an object in a mirror.



**Fig. 12.2**

- (i) On Fig. 12.2 complete the ray diagram to show how the two rays of light from the object enter the eye of the observer. [1]
- (ii) On Fig. 12.2 show how the observer sees rays of light which appear to come from the image behind the mirror.

Label the position of the image with an **X**.

[2]



**DATA SHEET**  
**The Periodic Table of the Elements**

		Group																			
		I	II	III	IV	V	VI	VII	VIII	IX	X										
		1 <b>H</b> Hydrogen 1																			
7	9	<b>Li</b> Lithium 3	<b>Be</b> Beryllium 4																		
23	24	<b>Na</b> Sodium 11	<b>Mg</b> Magnesium 12																		
39	40	<b>K</b> Potassium 19	<b>Ca</b> Calcium 20	45 <b>Sc</b> Scandium 21	48 <b>Ti</b> Titanium 22	51 <b>V</b> Vanadium 23	52 <b>Cr</b> Chromium 24	55 <b>Mn</b> Manganese 25	56 <b>Fe</b> Iron 26	59 <b>Co</b> Cobalt 27	59 <b>Ni</b> Nickel 28	64 <b>Cu</b> Copper 29	65 <b>Zn</b> Zinc 30	70 <b>Ga</b> Gallium 31	73 <b>Ge</b> Germanium 32	75 <b>As</b> Arsenic 33	79 <b>Se</b> Selenium 34	80 <b>Br</b> Bromine 35	84 <b>Kr</b> Krypton 36		
85	88	<b>Rb</b> Rubidium 37	<b>Sr</b> Strontium 38	89 <b>Y</b> Yttrium 39	91 <b>Zr</b> Zirconium 40	93 <b>Nb</b> Niobium 41	96 <b>Mo</b> Molybdenum 42	101 <b>Ru</b> Ruthenium 44	101 <b>Rh</b> Rhodium 45	106 <b>Pd</b> Palladium 46	108 <b>Ag</b> Silver 47	112 <b>Cd</b> Cadmium 48	115 <b>In</b> Indium 49	119 <b>Sn</b> Tin 50	122 <b>Sb</b> Antimony 51	128 <b>Te</b> Tellurium 52	127 <b>I</b> Iodine 53	131 <b>Xe</b> Xenon 54			
133	137	<b>Cs</b> Caesium 55	<b>Ba</b> Barium 56	139 <b>La</b> Lanthanum 57	178 <b>Hf</b> Hafnium 72	181 <b>Ta</b> Tantalum 73	184 <b>W</b> Tungsten 74	190 <b>Os</b> Osmium 76	192 <b>Ir</b> Iridium 77	195 <b>Pt</b> Platinum 78	197 <b>Au</b> Gold 79	201 <b>Hg</b> Mercury 80	204 <b>Tl</b> Thallium 81	207 <b>Pb</b> Lead 82	209 <b>Bi</b> Bismuth 83	210 <b>Po</b> Polonium 84	210 <b>At</b> Astatine 85	210 <b>Rn</b> Radon 86			
87	88	<b>Fr</b> Francium	<b>Ra</b> Radium	226 <b>Ac</b> Actinium									†								
													*58-71 Lanthanoid series						†90-103 Actinoid series		
		140 <b>Ce</b> Cerium 58	141 <b>Pr</b> Praseodymium 59	144 <b>Nd</b> Neodymium 60	146 <b>Pm</b> Promethium 61	150 <b>Sm</b> Samarium 62	152 <b>Eu</b> Europium 63	157 <b>Gd</b> Gadolinium 64	162 <b>Dy</b> Dysprosium 66	165 <b>Ho</b> Holmium 67	167 <b>Er</b> Erbium 68	169 <b>Tm</b> Thulium 69	173 <b>Yb</b> Ytterbium 70	175 <b>Lu</b> Lutetium 71							
		232 <b>Th</b> Thorium 90	238 <b>Pa</b> Protactinium 91	238 <b>U</b> Uranium 92	238 <b>Np</b> Neptunium 93	244 <b>Pu</b> Plutonium 94	244 <b>Am</b> Americium 95	244 <b>Cm</b> Curium 96	244 <b>Bk</b> Berkelium 97	244 <b>Cf</b> Californium 98	244 <b>Es</b> Einsteinium 99	244 <b>Fm</b> Fermium 100	244 <b>Md</b> Mendelevium 101	244 <b>No</b> Nobelium 102	244 <b>Lr</b> Lawrencium 103						

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

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

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