UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

CANDIDATE NAME									
CENTRE NUMBER						CANDIDATE NUMBER				

7145091241

CO-ORDINATED SCIENCES **0654/33**

Paper 3 (Extended) **May/June 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 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	
10	
11	
12	
Total	

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

For Examiner's Use

1 **(a)** Most atoms of metallic elements found in the Earth's crust exist in compounds called ores which are contained in rocks.

The chemical formulae of some metal compounds found in ores, together with the names of the ores, are shown below.

argentite	Ag_2S
chromite	$FeCr_2O_4$
galena	PbS
scheelite	$CaWO_4$

(i) A binary compound is one that contains only two different elements.

State which of the compounds in the list above are binary compounds.

..... [1]

(ii) State the ore from which the metallic element tungsten could be extracted.

..... [1]

(b) Fig. 1.1 shows an incomplete diagram of an atom of an element **Q** in which only the outer shell electrons are shown.

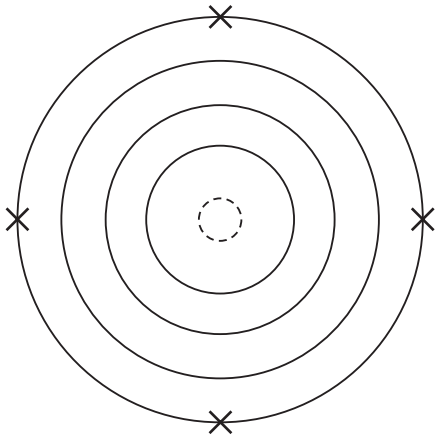

Fig. 1.1

(i) Name element **Q** and explain your answer.

name .....

explanation .....

.....

..... [3]

For Examiner's Use

(ii) One atom of element **Q** combines with hydrogen atoms to form covalent molecules.

Draw a diagram of **one** molecule of this compound to show how the bonding electrons are arranged.

[3]

(iii) Element **Q** may be extracted from its oxide, QO_2, in a reaction with hydrogen, H_2. In this reaction, hydrogen removes the oxygen from the oxide and forms water.

Suggest a balanced symbol equation for this reaction.

..... [2]

For Examiner's Use

2 **(a)** An athlete is training on a bicycle.

He uses the bicycle to turn a generator that lights a lamp as he pedals. Fig. 2.1 shows the simple generator which he uses.

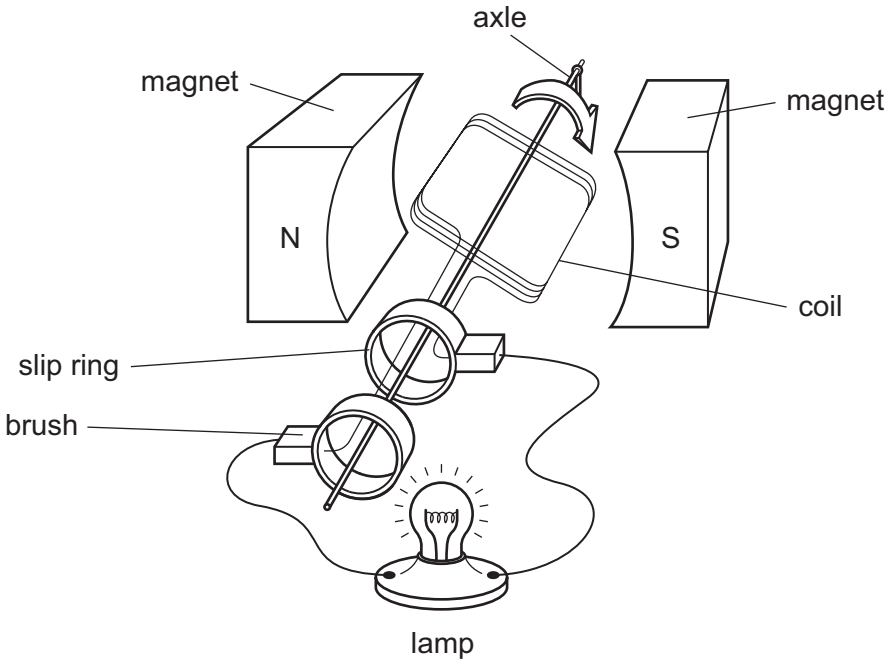

Fig. 2.1

Explain how the rotating coil causes the lamp to light. Include in your explanation a description of what the slip rings and brushes do.

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..... [4]

(b) During his bicycle ride the athlete cools down by sweating.

Describe and explain, in terms of the movement of water molecules, how evaporation cools down the athlete.

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..... [2]

For Examiner's Use

For Examiner's Use

3 **(a)** Fig. 3.1 shows the effect of pH on the activity of an enzyme.

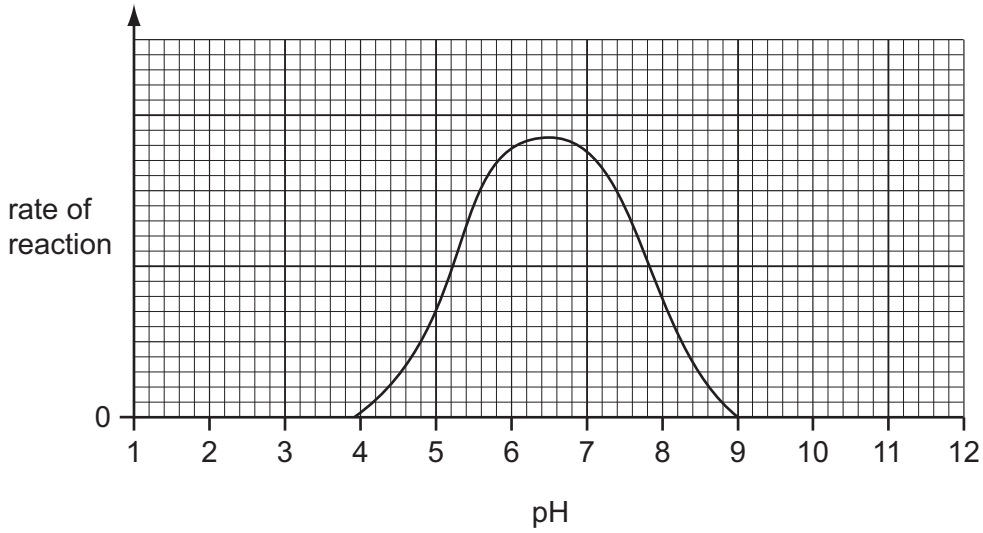

Fig. 3.1

(i) Describe the effect of pH on the activity of this enzyme.

.....

.....

..... [2]

(ii) Explain why pH affects the enzyme in this way.

.....

.....

..... [2]

(iii) A protease enzyme works in the human stomach, where hydrochloric acid is secreted. This enzyme is adapted to work best in these conditions.

On Fig. 3.1, sketch a curve to show how pH affects the activity of this protease enzyme. [1]

(iv) After the food has been in the stomach for a while, it passes into the duodenum. Pancreatic juice, which contains sodium hydrogencarbonate, is mixed with the food in the duodenum.

Explain why the protease enzyme stops working when it enters the duodenum.

.....

.....

..... [2]

(b) Explain how the protease enzyme enables body cells to obtain nutrients.

.....

.....

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..... [3]

(c) Fig. 3.2 shows the structure of a villus.

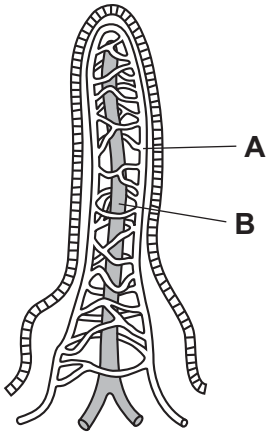


Fig. 3.2

(i) Name the structures labelled **A** and **B**.

A .....

B ..... [2]

(ii) Describe the role of villi in the human alimentary canal.

.....

.....

.....

..... [3]

For Examiner's Use

4 **(a)** A car tyre is inflated using a footpump. The mechanic using the footpump notices that the pump gets hot.

(i) Explain how the air molecules in the tyre exert a pressure on the wall of the tyre.

.....

.....

..... [2]

(ii) The air going into the tyre is warmed up by the pumping.

Describe what happens to the motion of the air molecules as the air warms up.

.....

..... [1]

(iii) When the air in the tyre becomes hotter, the pressure rises.

Explain in terms of the motion of the air molecules why the pressure rises.

.....

.....

.....

..... [2]

(b) Car brake lights (stop lights) light up when the driver presses on the footbrake pedal. The pedal acts as a switch.

Draw a circuit diagram including a battery to show how this works. Design your circuit so that if one brake light fails, the other still lights up.

[2]

For Examiner's Use

(c) A car which is moving has kinetic energy. The faster a car goes, the more kinetic energy it has.

The kinetic energy of the car is 1 120 000 J when the car is travelling at 40 m / s.

Calculate the mass of the car.

State the formula that you use and show your working.

formula used

working

..... [2]

(d) A driver is accompanied by four other passengers and their heavy luggage.

Explain how the addition of the passengers and luggage affects the braking of the car compared to when the driver is alone in the car.

.....

.....

..... [2]

(e) A car is moving along a road. The mass of the car is 1200 kg and the resultant force acting on it is 1500 N.

Calculate the acceleration of the car.

State the formula that you use and show your working.

formula used

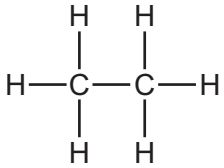
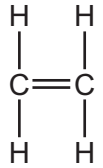
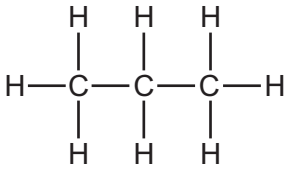
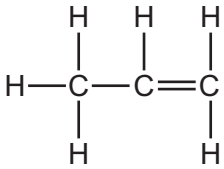
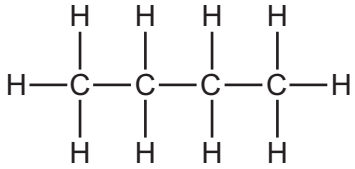
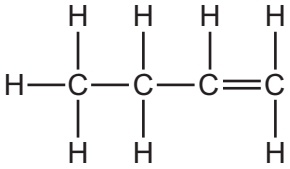
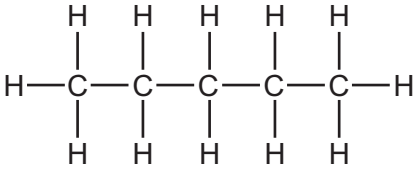
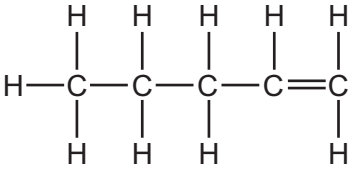
working

..... [2]

5 In hydrocarbons, carbon atoms are joined in chains of various lengths.

Table 5.1 shows information about some hydrocarbons.

Table 5.1

alkanes		alkenes	
molecular structure	**boiling point / °C**	**molecular structure**	**boiling point / °C**
	–87		–104
	–42		–47
	0		–6
	36		30

(a) Table 5.1 contains examples of both saturated and unsaturated hydrocarbons.

(i) State how the bonding in an unsaturated hydrocarbon molecule differs from that in a saturated hydrocarbon molecule.

.....

..... [1]

(ii) Describe a chemical test that is used to show whether a hydrocarbon is saturated or unsaturated.

.....

.....

..... [2]

For Examiner's Use

(b) The alkanes in Table 5.1 occur naturally in deposits of petroleum (crude oil) and natural gas.

Petroleum is brought to an oil refinery where the mixture of alkanes is separated into simpler mixtures by fractional distillation. Some of the simpler mixtures are processed further to produce alkenes.

(i) Fractional distillation relies on differences in the boiling points of hydrocarbons.

State **two** trends shown in the boiling points of the alkanes and alkenes in Table 5.1.

trend 1 .....

.....

trend 2 .....

.....

[2]

(ii) Explain, in terms of forces between molecules, the trend in the boiling points of the alkanes in Table 5.1.

.....

.....

..... [2]

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For Examiner's Use

6 **(a)** Describe how sex is inherited in mammals.

.....

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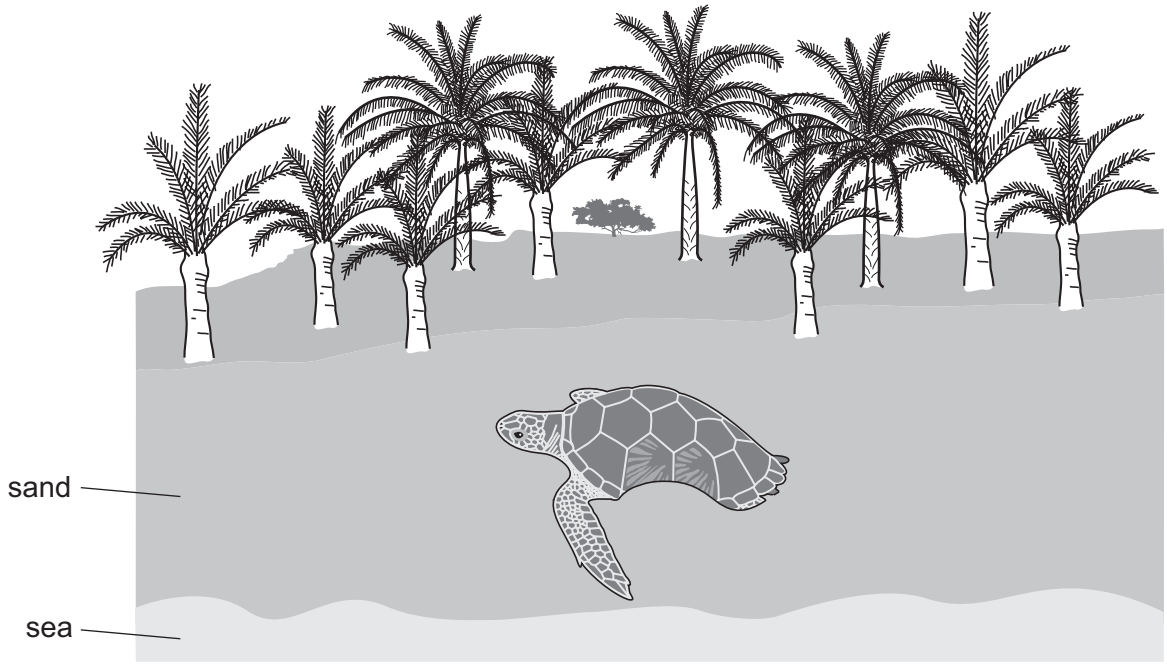
..... [2]

Hawksbill turtles are an endangered species. Adults spend most of their lives at sea, but the females come ashore to lay their eggs. They bury their eggs in nests in the sand, either on a beach or in the vegetation that grows just behind the beach.



Unlike mammals, the sex of hawksbill turtles is determined by the temperature of the sand in which the eggs develop.

- At 29 °C, equal numbers of males and females develop.
- Higher temperatures produce more females.
- Lower temperatures produce more males.

There is concern that in recent years too many female turtles have been produced, and not enough males.

(b) Researchers measured the temperature, at a depth of 30 cm, in four different parts of a beach, on Antigua, where hawksbill turtles lay their eggs. The results are shown in Fig. 6.1. The tops of the bars represent the mean temperatures.

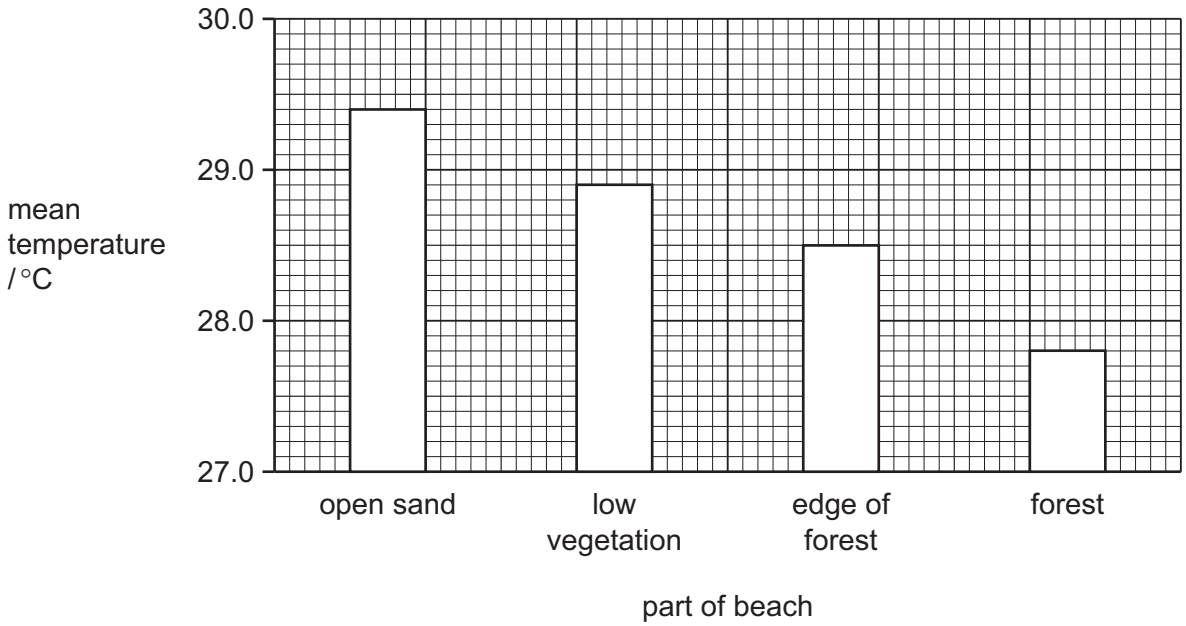


Fig. 6.1

With reference to Fig. 6.1, describe the effect of the presence of trees on the temperature of the sand.

.....

.....

..... [2]

(c) The researchers counted the proportion of male and female turtles hatching from nests in the four different parts of the beach. The results are shown in Table 6.1.

Table 6.1

part of beach	nests producing more males than females	nests producing more females than males	nests producing equal numbers of females and males
open sand	0	16	0
low vegetation	31	24	6
edge of forest	61	0	11
in forest	36	0	0

For Examiner's Use

(i) State the part of the beach in which most female hawksbill turtles chose to lay their eggs.

.....[1]

(ii) Use the information in Fig. 6.1 to explain the results shown in Table 6.1.

.....

.....

.....

.....[2]

(d) Tourism is an important industry in Antigua. The vegetation on many beaches has been cut down to make the beaches more attractive to tourists.

With reference to the results of this research, suggest how deforestation of beaches could affect hawksbill turtle populations.

.....

.....

.....[2]

(e) Describe **two** harmful effects to the environment, other than extinction of species, that may result from deforestation.

1 .....

.....

.....

2 .....

.....

.....

[4]

For Examiner's Use

7 **(a)** The isotope radon-220 is radioactive. A sample was investigated to find its half-life. The activity of the isotope was measured every minute for 6 minutes. The results are shown in Fig. 7.1.

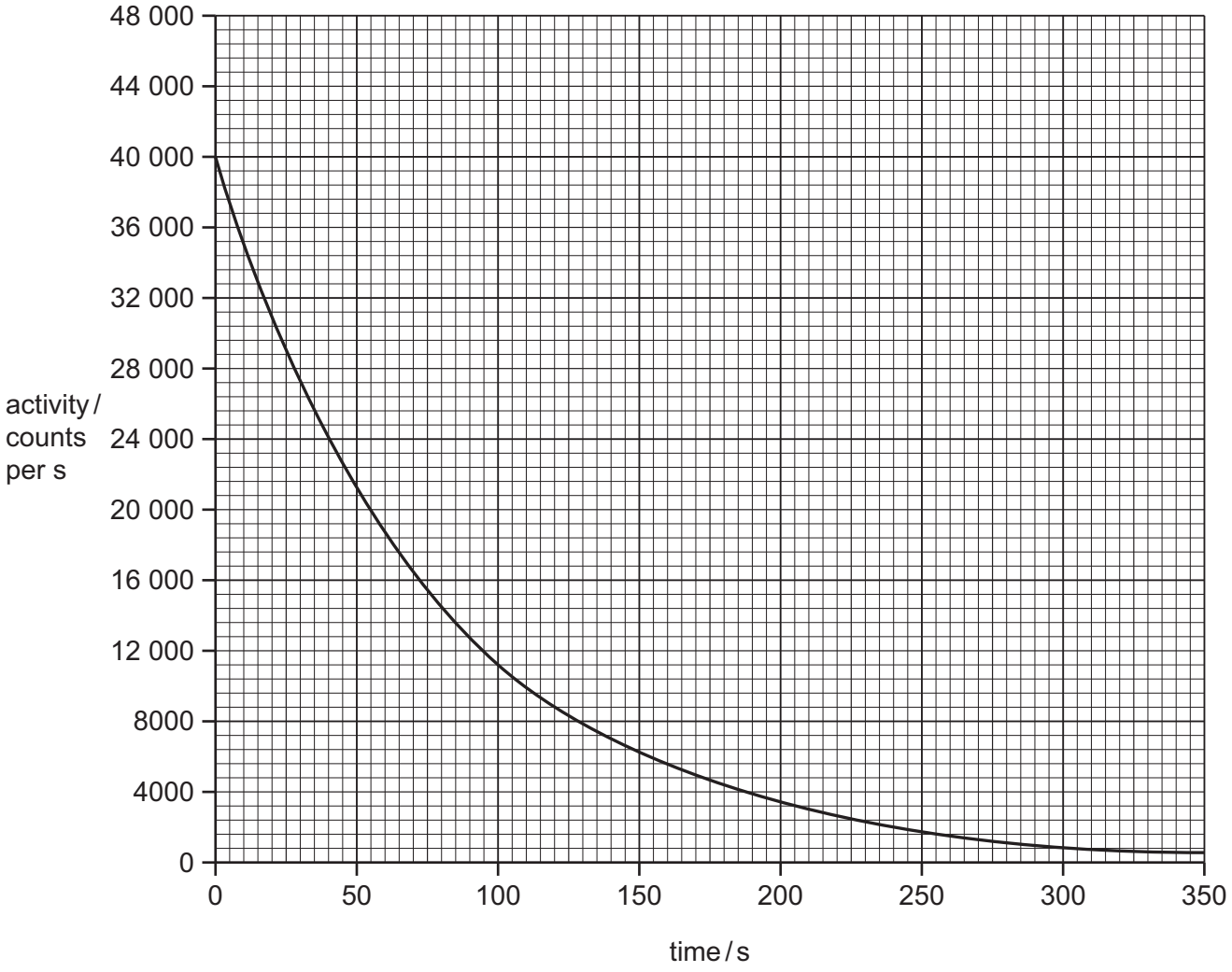


Fig. 7.1

(i) Use Fig. 7.1 to calculate the half-life of the isotope.

Show your working on the graph.

..... [2]

(ii) Describe the differences in the structure of the nucleus of a radon-220 atom before and after the emission of an alpha particle.

.....

.....

..... [2]

For Examiner's Use

(iii) Explain why alpha radiation is affected by an electric field.

.....

.....

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..... [2]

(b) The three types of nuclear radiation are alpha, beta and gamma. They can be identified by their different penetrating powers. Alpha radiation cannot penetrate paper.

(i) Explain how you could identify beta and gamma radiations by their penetrating powers.

beta radiation .....

.....

gamma radiation .....

.....

[2]

(ii) Explain how radiation ionises an atom to make a positive ion.

.....

..... [1]

(c) Gamma radiation is an electromagnetic wave with a short wavelength.

Explain the meaning of the term *wavelength*. You may draw a diagram if it helps you to answer this question.

.....

..... [2]

For Examiner's Use

8 **(a)** Water is a compound which contains the elements hydrogen and oxygen.

Describe **one** difference, other than physical state, between the **compound** water and a **mixture** of the elements hydrogen and oxygen.

.....

.....

..... [2]

(b) Table 8.1 shows information about water and three compounds that can form mixtures with water.

Table 8.1

compound	melting point / °C	boiling point / °C	solubility in water
water	0	100	–
sodium chloride	801	1413	soluble
silicon dioxide	1650	2230	insoluble
hexane	–95	69	insoluble

(i) State which compound in Table 8.1 could be separated from a mixture with water by filtration.

..... [1]

(ii) Explain why the other two compounds **cannot** be separated from a mixture with water by filtration.

.....

.....

.....

..... [2]

(iii) A student looked at a magnified image of some sodium chloride crystals through a microscope.

For Examiner's Use

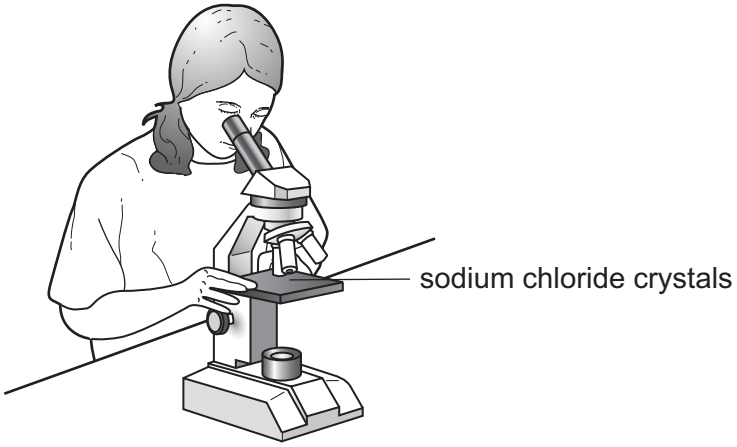

Fig. 8.1 shows what she observed through the microscope.

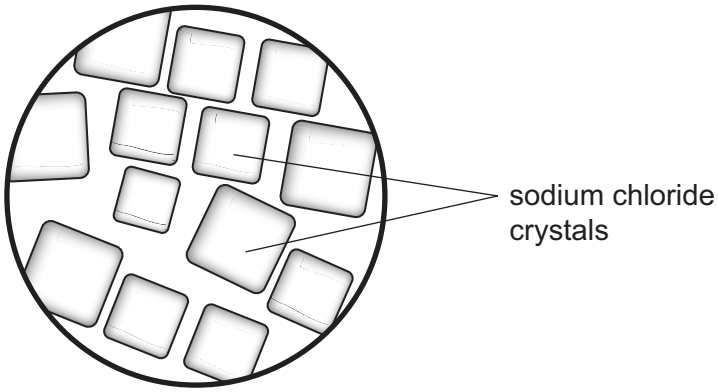

Fig. 8.1

Draw a simple diagram of the structure of sodium chloride.

Your diagram should clearly show the nature and arrangement of the particles involved and should show why the crystals have the shape shown in Fig. 8.1.

[3]

(c) The student is asked to use the reaction between the insoluble compound copper carbonate and dilute sulfuric acid to make some crystals of copper sulfate.

For Examiner's Use

Describe the main steps of a method the student should use to carry out this task.

You may draw labelled diagrams if it helps you to answer this question.

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.....

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.....

..... [4]

For Examiner's Use

9 Fig. 9.1 is a photograph of a cross-section of a leaf, taken through a microscope.

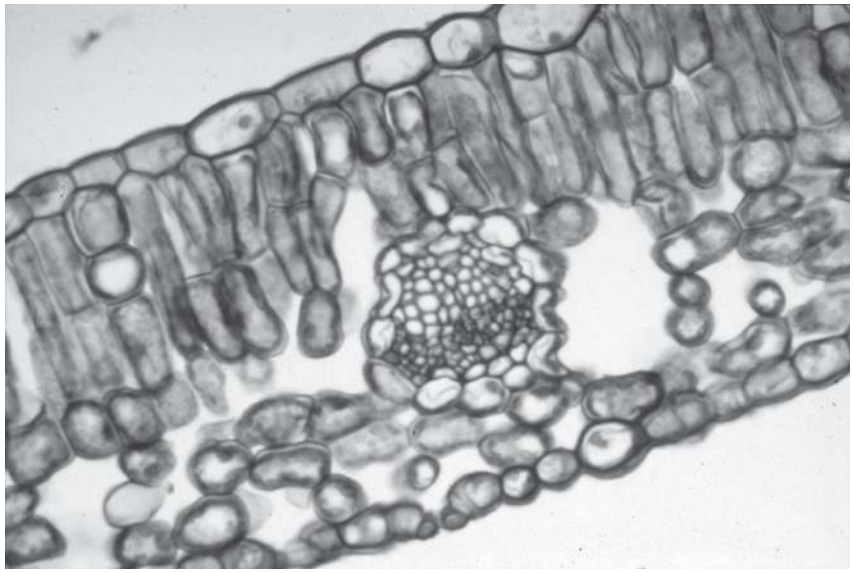


Fig. 9.1

(a) **On Fig. 9.1**, use a label line to label a palisade cell. [1]

(b) There are small gaps in the lower surface of the leaf, called stomata.

Explain the role of stomata in photosynthesis.

.....

.....

..... [2]

(c) If a plant is deficient in magnesium, its leaves lose their green colour.

(i) **On Fig. 9.1**, use a label line and the letter **A** to indicate a part of the leaf that would lose its green colour. [1]

(ii) Explain why the part you have labelled would lose its green colour.

.....

.....

..... [2]

For Examiner's Use

10 (a) Radio waves are electromagnetic waves. Sound waves are not.

State **three** other ways in which radio waves differ from sound waves.

1 .....

.....

2 .....

.....

3 .....

.....

[2]

(b) Visible light is another type of electromagnetic wave.

The frequency of green light is 5×10^{14} Hz.

The wavelength of green light is 6×10^{-7} m.

Calculate the speed of green light.

State the formula that you use and show your working.

formula used

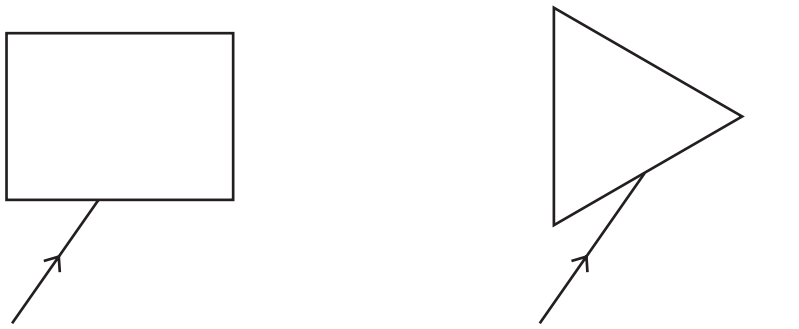
working

..... [2]

(c) A thin beam of **white light** is shone onto two glass blocks.

For Examiner's Use

On Fig. 10.1, complete the diagrams to show what happens to the light passing through each block and after it emerges from the block.



rectangular block

triangular block (prism)

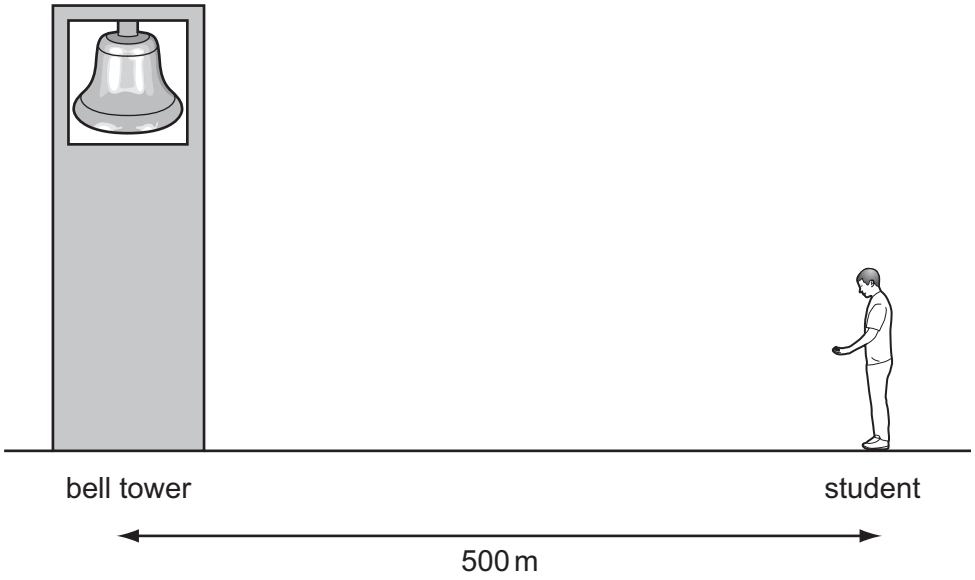
Fig. 10.1

[4]

(d) A student carried out an experiment to find the speed of sound in air by watching and listening to a bell being rung.

For Examiner's Use

He stood 500 m from the bell.



The sound took 1.5 s to travel from the bell to the student.

Calculate the speed of sound.

State the formula used and show your working.

formula used

working

..... [2]

11 Fig. 11.1 shows apparatus a student used to investigate temperature changes that occurred during chemical reactions.

For Examiner's Use

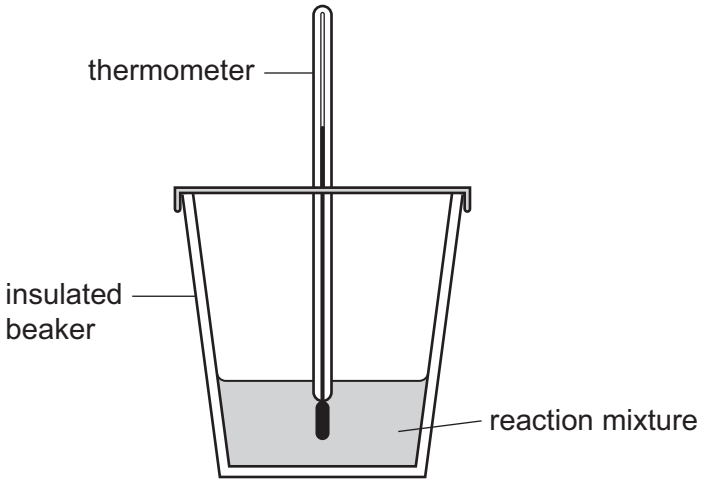


Fig. 11.1

The student added reactants to the insulated beaker and stirred the mixture. She recorded the final temperature of each mixture.

At the start of each experiment, the temperature of the reactants was 22 °C.

Table 11.1 contains the results the student obtained.

Table 11.1

experiment	reactant A	reactant B	final temperature / °C
1	dilute hydrochloric acid	sodium hydrogencarbonate	16
2	dilute hydrochloric acid	potassium hydroxide solution	26
3	magnesium	copper sulfate solution	43
4	copper	magnesium sulfate solution	22

(a) (i) Explain which experiment, **1**, **2**, **3** or **4**, was a reaction involving an alkali.

experiment .....

explanation .....

..... [1]

(ii) State and explain which experiment, **1**, **2**, **3** or **4**, was an endothermic reaction.

experiment .....

explanation .....

..... [1]

For Examiner's Use

(iii) Suggest and explain a reason for the result obtained in experiment **4**.

.....

.....

..... [2]

(b) The student carried out two further experiments, **5** and **6**, to investigate the reaction between zinc and copper sulfate solution.

In experiment **5** the student used 3.25 g of zinc powder, and in experiment **6** she used a single piece of zinc which also had a mass of 3.25 g.

The student observed the readings on the thermometer over five minutes during each experiment.

Predict and explain any difference in the way that the temperature would change between experiments **5** and **6**.

.....

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..... [3]

(c) In the reaction in **(b)**, zinc atoms react with copper ions. This chemical change may be represented by the symbolic equation below.

$$Zn\,(s) + Cu^{2+}\,(aq) \rightarrow Zn^{2+}\,(aq) + Cu\,(s)$$

Explain, in terms of the transfer of electrons, why this reaction is an example of oxidation and reduction (redox).

.....

..... [1]

For Examiner's Use

(d) In both of the experiments in **(b)** the solution at the start of the experiment contained 0.08 moles of copper ions, and the zinc had a mass of 3.25 g.

(i) Calculate the number of moles of zinc that are contained in 3.25 g. The relative atomic mass (A_r) of zinc is 65.

Show your working.

..... [1]

(ii) Use your answer to **(i)** and the equation in **(c)** to explain whether or not the amount of copper ions is sufficient to react with all of the zinc.

.....

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..... [2]

12 (a) Define the term *respiration*.

.....

.....

..... [2]

(b) (i) State the word equation for anaerobic respiration in yeast.

..... [1]

(ii) Describe how anaerobic respiration in yeast is used in bread-making.

.....

.....

.....

.....

..... [3]

DATA SHEET
The Periodic Table of the Elements

Group I	Group II											Group III	Group IV	Group V	Group VI	Group VII	Group 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 above **X** above 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.).