Candidate Name Mark Scheme

Centre Number	Candidate Number

International General Certificate of Secondary Education

UNIVERSITY OF CAMBRIDGE LOCAL EXAMINATIONS SYNDICATE

CO-ORDINATED SCIENCES **0654/3**

PAPER 3

Tuesday **14 NOVEMBER 2000** Morning 2 hours

Candidates answer on the question paper.
No additional materials are required.

Biol ✓
Chem –
Phys ✓

TIME 2 hours

INSTRUCTIONS TO CANDIDATES

Write your name, Centre number and candidate number in the spaces at the top of this page.

Answer **all** questions.

Write your answers in the spaces provided on the question paper.

INFORMATION FOR CANDIDATES

The number of marks is given in brackets [ ] at the end of each question or part question.

A copy of the Periodic Table is printed on page 20.

FOR EXAMINER'S USE	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	
TOTAL	

This question paper consists of 20 printed pages.

SB (SM/DJ) QK07614/4
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[Turn over

For Examiner's Use

1 Fig. 1.1 shows a section through human skin.

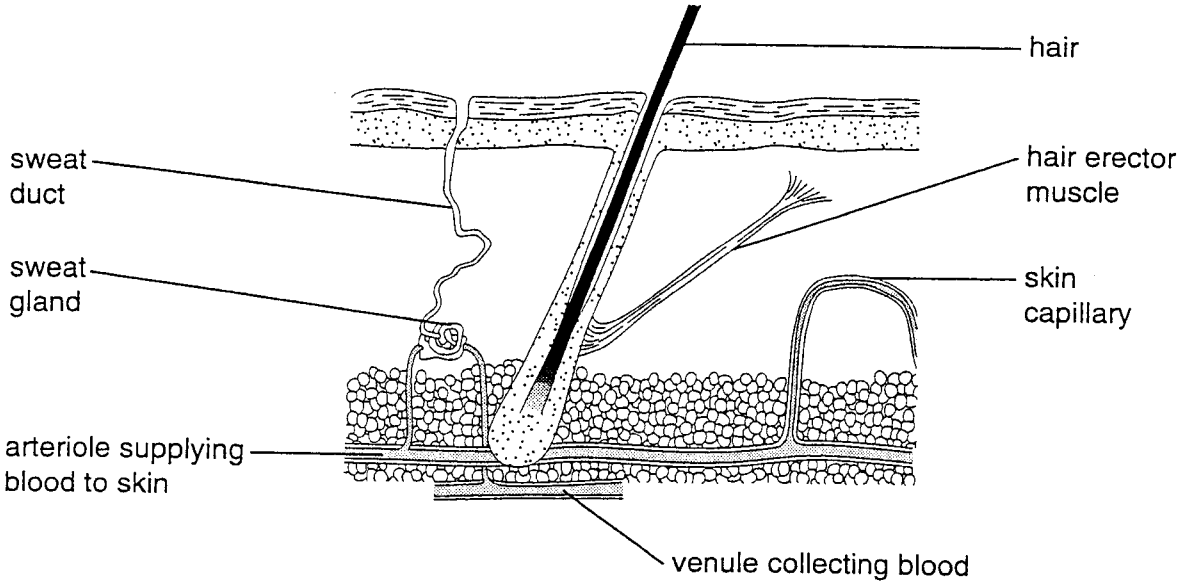


Fig. 1.1

(a) Explain how the sweat glands help to cool the body if it becomes too hot.

Sweat glands secrete more sweat;
Sweat evaporates;
Evaporation needs heat energy;
Heat energy lost from body;

[3]

(b) Describe how the blood vessels respond if the body becomes too cold, and explain how this helps to maintain the body temperature.

Less Blood flows in Skin Capillary;
Blood Carries heat;
Less heat is lost through Skin surface

[3]

(c) Explain why it is useful for mammals to regulate their internal body temperature.

Allows mammals to be more active;
Mammals are not dependent on environmental temp;
Can maintain a body temp above that of the environment;

[3]

For Examiner Use

(d) Mammals also regulate the concentration of glucose in their blood. After a meal containing carbohydrate, the blood glucose concentration may increase.

Describe how this concentration is brought back to normal.

Insulin is released from pancreas
Insulin causes cells to take up Glucose
Excess glucose is converted into glycogen in liver/muscles [2]

2 (a) Aerosol cans which are thrown away with household rubbish can be very dangerous if the rubbish is burned.

Aerosol cans contain gases under pressure. An aerosol can at a temperature of 27 °C has a pressure of 400 kN/m^2. If the pressure rises above 800 kN/m^2, the can will explode.

(i) What is the temperature, in kelvins, of the aerosol can?

273 + 27 = 300K [1]

(ii) Calculate the temperature at which the aerosol can would explode. Show your working and state any formula that you use.

$\frac{T_2}{T_1} = \frac{P_2}{P_1}$ $T_2 = \frac{800}{400} \times 300K = 600K$

600K or 327°C [3]

(b) A balloon is inflated by filling it with helium.

(i) Explain, in terms of particles, how a gas such as helium exerts a pressure.

- Particles constantly move
- Collide with the container [2]

(ii) The balloon is released and rises up into the air. As it rises, its volume increases.

Suggest why the volume of the balloon increases.

Pressure decreases with altitude
OR Temperature decreases. [2]

(iii) As the balloon moves along at a constant height, the Sun sets.

Suggest and explain what happens to the volume of the balloon.

- Decreases
- Temp. decreases. [2]

[Turn over

For Examiner's Use

3 Symbols for some chlorine atoms and bromine atoms are shown in Fig. 3.1.

$^{35}_{17}Cl$ $^{37}_{17}Cl$

$^{79}_{35}Br$ $^{81}_{35}Br$

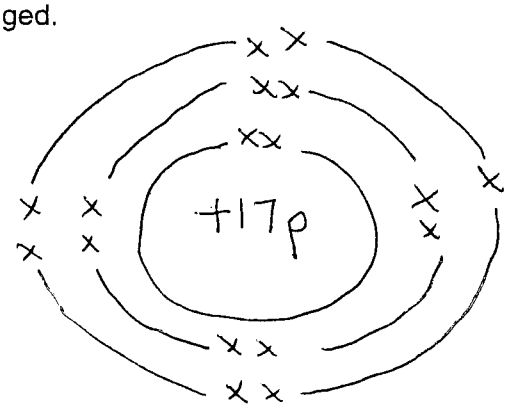
Fig. 3.1

(a) (i) Describe the difference in atomic structure between the two chlorine atoms.

$^{37}_{17}Cl$ has 2 more neutrons than $^{35}_{17}Cl$

.....[2]

(ii) Draw a diagram of a chlorine atom which shows how **all** the electrons are arranged.

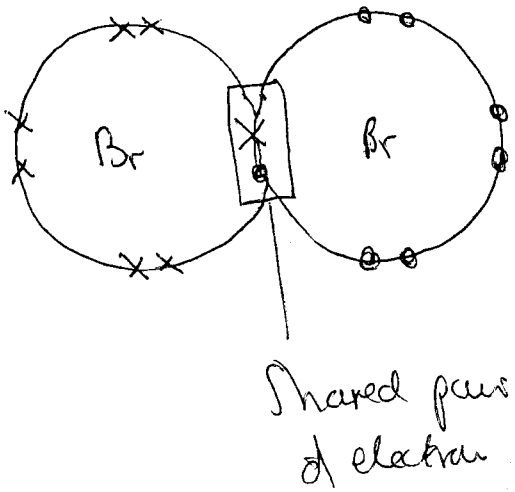


2, 8, 7

17 electrons

[2]

(iii) Draw a diagram of a bromine molecule, Br_2, which shows only the **outer** electrons of each atom.



[2]

For Examiner Use

(b) Chlorine can react with ethene to form chloroethene. The graphical formula of a chloroethene molecule is shown in Fig. 3.2.

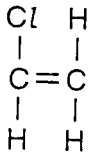


Fig. 3.2

A student shakes a sample of chloroethene with some bromine solution. There is an immediate colour change.

(i) Describe the colour change which the student sees.

from orange/red *to* colourless [1]

(ii) What does the result of this test show about the structure of chloroethene molecules?

unsaturated compound (contains double bonds) [1]

(c) Chloroethene molecules react together in an addition polymerisation reaction to form molecules of poly(chloroethene).

(i) Describe what happens to chloroethene molecules when they undergo addition polymerisation.

Chloroethene double bond breaks (opens up) allowing the units to join together to form a long chain [2]

(ii) Predict and explain the result of shaking bromine solution with poly(chloroethene) molecules.

no result/change because the polymer contains no double bonds (saturated) [2]

[Turn over

For Examiner's Use

4 Fig. 4.1 shows four insects, not drawn to scale.

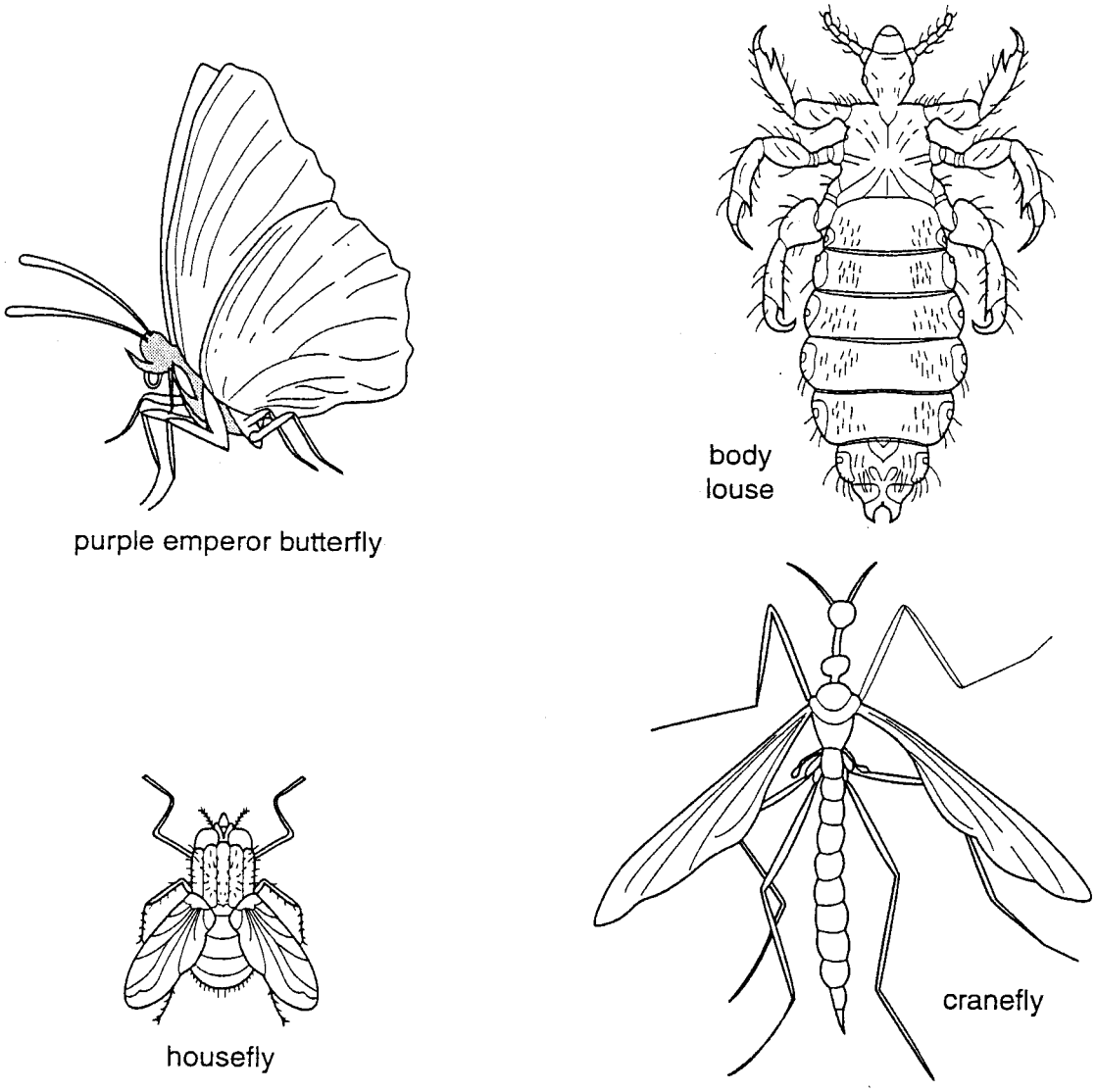


Fig. 4.1

(a) List three features, visible in the diagram of the purple emperor butterfly, which are characteristic of insects and which distinguish insects from other groups of arthropods.

1. 1 Pair antennae;
2. 2 Pairs of wings;
3. 3 Pairs of legs; [3]

(b) Complete the dichotomous key, so that a person could use it to identify each of the four insects. The first step has been done for you.

1	a	wings present	**go to 2**
	b	wings absent	**body louse**

Example

2 a Feathery antennae - housefly

b Antennae Not feathery go to 3

3 a One pair of wings very Small - Cranefly

b 2 Large Pairs of wings - Butterfly

[5]

(c) Insects help many flowering plants to reproduce by pollinating them.

(i) Describe **one** difference you would expect to find between an insect-pollinated flower and a wind-pollinated flower. Explain the reason for this difference.

Insect: Bright Petals, Wind: Petals small/green

: Scented : Not Scented

: Nectaries : No nectaries [2]

For Examiner's Use

(ii) When an insect pollinates a flower, it leaves pollen grains on the stigma.

Describe how the male gamete in a pollen grain travels from the stigma to a female gamete.

Pollen Grain Germinates;
Tube grows down Style;
Tube grows into ovary;
Male Nucleus Moves down tube [3]
Passes into ovule;

5 A woman is driving her car along a straight, level road. **A**, **B** and **C** are three of the forces acting on the car, as shown in Fig. 5.1.

These forces are:

air resistance,
another frictional force,
a driving force.

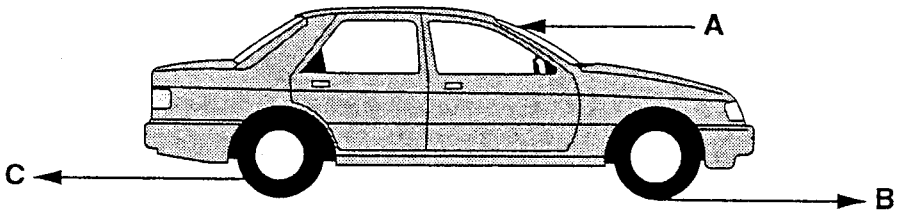


Fig. 5.1

(a) Identify each of the three forces, **A**, **B** and **C**.

A Air resistance

B Driving force

C friction [1]

(b) As the car begins to move, force **B** is much greater than forces **A** and **C** combined.

Describe what happens to the speed of the car. Explain your answer.

Speed increases
there is a resultant forward force [2]

(c) Eventually, force **B** is balanced by forces **A** and **C**.

Describe the speed of the car now.

Constant

.....[1]

(d) The car has a mass of 1500 kg. The driver applies a constant braking force of 5000 N. The car slows down from a speed of 20 m/s and stops.

(i) Calculate the deceleration of the car. Show your working and state any formula that you use.

$a = \frac{F}{m} = \frac{5000}{1500} = 3.3\ m/s^2$

.....[3]

(ii) Calculate how long it takes for the car to stop. Show your working and state any formula that you use.

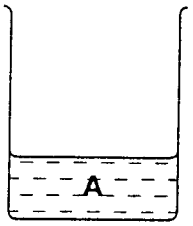
$a = \frac{\Delta V}{t}$ $\quad t = \frac{\Delta V}{a} = \frac{20}{3.3} = 6.\ sec$

.....[3]

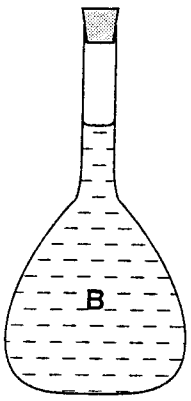
For Examiner's Use

6 (a) Describe how a student could use the materials shown in Fig. 6.1 to make a sample of reasonably pure potassium chloride crystals.

(titration method required for pure crystals)



100 cm^3 of 0.1 mol/dm^3 hydrochloric acid



200 cm^3 of 0.1 mol/dm^3 potassium hydroxide solution

Fig. 6.1

Measure out (using a measuring cylinder) 100 cm^3 of the potassium hydroxide solution and add to the beaker containing hydrochloric acid. Evaporate away about half of the solution by heating.* Pour remaining mixture into evaporating basins and allow to cool. Crystals will appear which can be filtered and dried.

(* to check whether crystals will appear on cooling dip a glass rod into the mixture and spot onto a watch glass or microscope slide) [4]

(b) (i) Write down the symbol and charge of the ion that causes the acidity of all acid solutions.

H^+ [1]

(ii) Write down the symbol and charge of the ion that causes the alkalinity of all alkaline solutions.

OH^- [1]

(iii) Write a **symbol** equation which shows how the ions in (i) and (ii) react together.

$H^+ + OH^- \rightarrow H_2O$ [1]

For Examiner's Use

(c) Calculate how many moles of potassium hydroxide are present in flask **B**. Show your working.

$$\text{moles} = \frac{\text{volume}(cm^3)}{1000} \times \text{molarity}\ (\text{mol/dm}^3)$$

$$= \frac{200}{1000} \times 0.1 = 0.02 \text{ moles}$$

.....[2]

(d) When one mole of potassium hydroxide is neutralised by hydrochloric acid, one mole of potassium chloride, KCl, is formed.

Calculate the mass of potassium chloride crystals which can be obtained when 0.1 mol of potassium hydroxide is neutralised by hydrochloric acid. Show your working.

0.1 mol of KOH produce 0.1 mol of KCl

M_r of KCl = 39+35.5

= 74.5,

$\Rightarrow$ mass of KCl in 0.1 mol = 0.1 × 74.5

= 7.45g .....[3]

For Examine Use

7 A grower wanted to increase the yield of tomatoes from the plants that she grew.

She bought seeds of two different varieties of red-fruiting tomatoes, variety **A** and variety **B**. She sowed equal numbers of seeds from each variety, in the same conditions, and allowed the seedlings to grow into young plants.

She then chose the ten healthiest-looking plants from each variety. She planted five plants of each variety in each of four plots, as shown in Fig. 7.1.

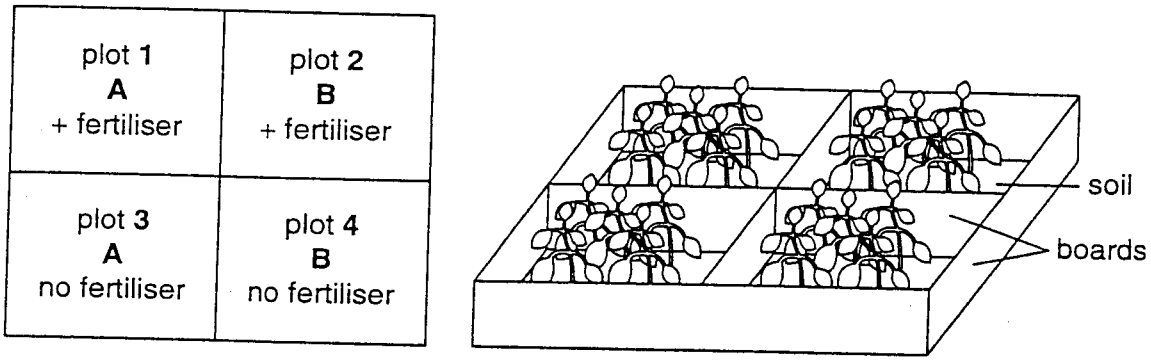


Fig. 7.1

Plots **1** and **2** were given fertiliser, but plots **3** and **4** were not given fertiliser. All other treatments for the four plots were the same.

The grower later collected the tomato fruits from all of the plots and weighed the fruits. The results are shown in the table in Fig. 7.2.

plot	variety	total yield / kg
1	A	50
2	B	65
3	A	42
4	B	38

Fig. 7.2

(a) **(i)** The use of fertiliser increased the total yield of variety **A** by 8 kg.

By how much did the use of fertiliser increase the yield of variety **B**?

27 kg .....[1]

(ii) The average (mean) yield per plant for variety **A** was 9.2 kg.

Calculate the average (mean) yield per plant for variety **B**. Show your working.

(1)
65 + 38 = 103/10 (1) 10.3 kg .....[2]

For Examiner's Use

(b) The fertiliser contained ions which are essential for plant growth.

(i) Name **one ion** which is essential for plant growth.

Mg, NO_3^-; [1]

(ii) Explain how this ion helped to increase the yield of fruit from the tomato plants.

Needed for Chlorophyll; Needed for Amino acids/protein
Chlorophyll absorbs light energy; Protein needed for growth; [2]

(c) The grower wanted to select seeds from this year's plants which would give the best yield next season. She decided

- to collect seeds from variety **B** and not from variety **A**,
- that it did not matter whether she collected the seeds from plot **2** or from plot **4**.

Using your knowledge about variation and inheritance, explain why the grower's two decisions were correct.

Variety B in plot 2 had the greatest yeild when given fertilizer; WTTE Increase in Yeild of plot 2 over plot 4 will be ~~genetic~~ environment variation/not genetic Plot 4 plants will have genes to allow increase in ~~Yield~~ Yeild. [3]

(d) Next season, the grower was surprised to find that one of the plants grown from seeds collected from variety **B** had yellow fruits.

Suggest how this might have happened.

May have been heterozygous Genotypes; eg. Rr [2]

Allele for Red (R) is dominant to allele for Yellow (r)

[Turn over

For Examiner Use

8 Read the passage, then use the information and your own knowledge to answer the questions which follow.

Shock waves can be used to study the rock structure deep under the sea. The shock waves are emitted by a compressed air gun towed behind a ship. The waves travel through the sea water and hit the rocks on the sea bed:

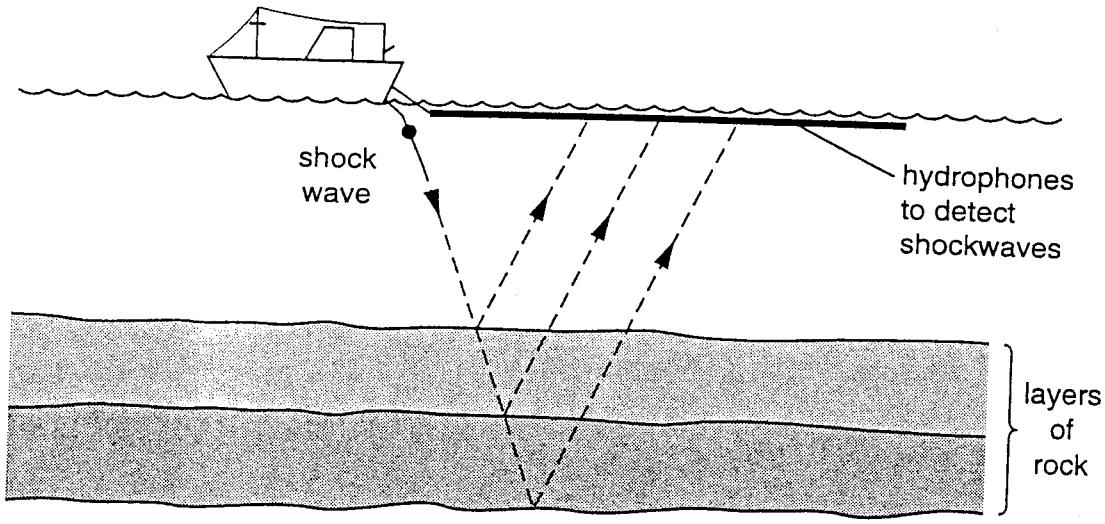


Fig. 8.1

Some of the energy of each wave is reflected back to the surface from each of the rock layers. The reflections are detected by a line of hydrophones towed behind the ship. The rest of the wave carries on until it reaches another rock layer.

The time taken for the wave to travel from the ship to each rock layer and back to the hydrophones is measured. These measurements are used to calculate the distance travelled by the shock wave and therefore the thickness of the rock layers.

As the wave travels through the rock layers, its amplitude decreases. The greater the density of the rock, the more the amplitude decreases.

(a) Explain the meaning of the terms *density* and *amplitude*.

(i) *density* Mass per Unit Volume

[1]

(ii) *amplitude* (You may draw a diagram if it helps you to answer the question.)

Maximum displacement

[1]

For Examiner's Use

(b) The table in Fig. 8.2 shows the speed of shock waves travelling through materials of different density.

material	density / kg per m^3	speed of sound in material / m per s
air	1.3	340
sandstone	2250	2900
sea water	1050	1500

Fig. 8.2

(i) Describe any pattern you can see in the data.

Higher density → higher speed

.....[1]

(ii) The speed of shock waves travelling through an unknown rock was 3000 m/s.

How does the density of this rock compare with that of sandstone?

(slightly) higher

.....[1]

(c) The shock waves have a frequency of 3000 Hz and travel through the sea water at a speed of 1500 m/s.

Calculate the wavelength of the waves. Show your working and state any formula that you use.

$\lambda = \frac{V}{f} = \frac{1500}{3000}$

$= 0.5\ m$

.....[3]

(d) Suggest two reasons why a compressed air gun, rather than explosive charges, is used to make the shock waves.

1. Less harm to marine life

2. More directional

.....[2]

9 Bauxite is a rock containing aluminium oxide from which the reactive metal aluminium is extracted.

(a) Scientists first tried to reduce aluminium oxide by heating it with carbon. These experiments did **not** produce any aluminium.

Suggest a reason for this.

Carbon is unable to reduce aluminium oxide because it is lower than Al in reactivity table [1]

(b) The first successful method of producing aluminium involved reacting aluminium chloride with sodium.

(i) The symbol equation below for this reaction is not balanced.

Balance the equation.

$$AlCl_3 + 3\,Na \rightarrow Al + 3\,NaCl$$ [2]

(ii) Suggest why this reaction to produce aluminium **does** occur.

Sodium is more reactive than aluminium and can displace Al from its chloride [1]

(c) Nowadays, electrolysis is used to produce aluminium.

(i) To which electrode, the anode or the cathode, are aluminium ions attracted during electrolysis? Explain your answer.

Cathode (which is negative) (1) will attract positive (1) Aluminium ions (opposite charges attract) [2]

(ii) Describe how aluminium ions are changed into aluminium atoms at the electrode surface during electrolysis.

Aluminium ions pick up 3 electrons from the cathode to become neutral atoms

$Al^{3+} + 3e^- \rightarrow Al$ [2]

For Examiner's Use

(iii) State which **one** of the arrangements shown in Fig. 9.1, **A**, **B** or **C**, produces aluminium.

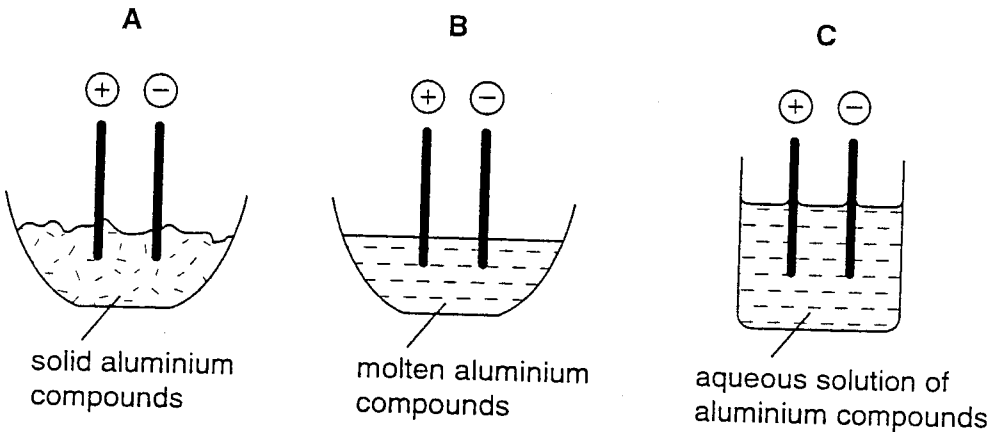


Fig. 9.1

B [1]

(iv) Explain why the other two arrangements shown in **(iii)** do **not** produce aluminium.

arrangement A

reason ions are bonded together in solid | not mobile so are unable to be attracted towards their electrodes

arrangement C

reason Although Al ions are free, they remain in solution. Hydrogen (from the water) is discharged instead as aluminium is more reactive [3]

(d) Bauxite also contains iron compounds. These are converted into iron(III) hydroxide in a precipitation reaction between Fe^{3+} ions and OH^- ions.

Deduce the chemical formula of iron(III) hydroxide. Show your working.

Fe^{3+} requires 3 OH^- ions to balance | neutralise charges

$+3 + (3 \times -1) = 0$ $Fe(OH)_3$ [2]

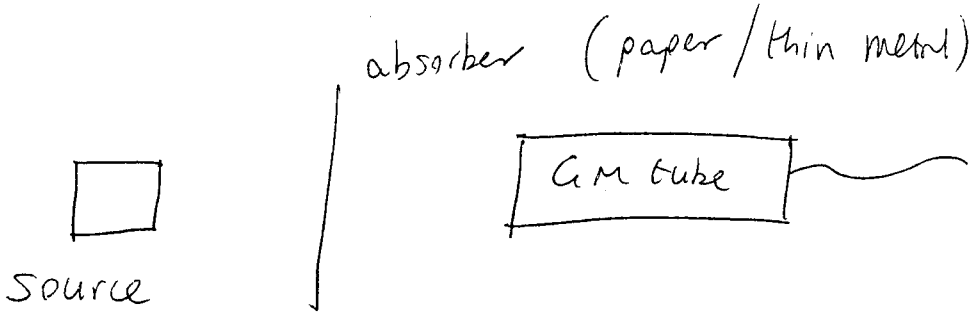
[Turn over

For Examine Use

10 (a) You are provided with two radioactive sources. One source emits only alpha-particles and the other source emits only beta-particles.

Describe an experiment you could carry out to distinguish between the two sources. Your answer should include

- the apparatus you would use,
- the observations you would make to distinguish between the two sources,
- the safety precautions you would need to take during your experiment.



- Source and detector placed close (as α absorbed by air)
- If the absorber makes little or no difference, the source is gamma
- Use gloves / tongs to handle source
- Wear protective apron / overalls
- Stand away

[6]

(b) Alpha-particles and beta-particles are both forms of ionising radiation.

Explain how these particles cause ionisation in the materials through which they pass.

- They knock electrons from the atoms
- Leaving a trail of charged particles (ions and electrons)

[2]

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 Sulphur 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 = 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.).