UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS
International General Certificate of Secondary Education

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| CANDIDATE NAME | | | | | | | | | |
| CENTRE NUMBER | | | | | | CANDIDATE NUMBER | | | |



**CHEMISTRY** **0620/23**

Paper 2 **October/November 2013**

**1 hour 15 minutes**

Candidates answer on the Question Paper.

No Additional Materials are required.

**READ THESE INSTRUCTIONS FIRST**

Write your Centre number, candidate number and name in the spaces at the top of this page.
Write in dark blue or black pen.
You may need to use a pencil for any diagrams, graphs or rough working.
Do not use staples, paper clips, highlighters, glue or correction fluid.
DO **NOT** WRITE IN ANY BARCODES.

Answer **all** questions.
Electronic calculators may be used.
A copy of the Periodic Table is printed on page 16.
You may lose marks if you do not show your working or if you do not use appropriate units.

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 **15** printed pages and **1** blank page.

*For Examiner's Use*

**1** **(a)** Choose from the list of metals below to answer the following questions.

**aluminium**
**barium**
**calcium**
**iron**
**lithium**
**silver**

Each metal can be used once, more than once or not at all.

**(i)** Which metal has an atom with three electrons in its outer electron shell?

..... [1]

**(ii)** Which **two** metals are in the same Period of the Periodic Table?

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

**(iii)** Which metal has an atom with three protons in its nucleus?

..... [1]

**(iv)** Which metal has a nitrate which is used to test for halide ions?

..... [1]

**(v)** Which metal is used in food containers because of its resistance to corrosion?

..... [1]

**(b)** Describe **two** chemical properties of iron.

1. .....

2. ..... [2]

**(c)** Describe briefly how iron from the blast furnace is made into steel.

.....

.....

..... [2]

[Total: 9]

*For Examiner's Use*

**2** Helium is in Group 0 of the Periodic Table.

**(a)** Describe the structure of a helium atom. Use your Periodic Table to help you.
In your answer, include

- the type and number of subatomic particles present,
- the position of these particles in the atom,
- the relative charges on the particles.

.....

.....

.....

.....

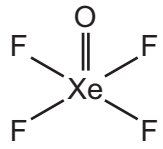
.....

..... [5]

**(b)** Give **one** use of helium.

..... [1]

**(c)** Some elements in Group 0 can form compounds with fluorine and oxygen.
The structure of one of these compounds is shown below.




Calculate the relative molecular mass of this compound.
Use your Periodic Table to help you.
You must show all your working.

[2]

**(d)** Fluorine is a diatomic molecule. It melts at –220 °C and boils at –188 °C.

**(i)** What is the physical state of fluorine

at room temperature, .....

at –200 °C? ..... [2]

**(ii)** What is meant by the term *diatomic*?

..... [1]

[Total: 11]

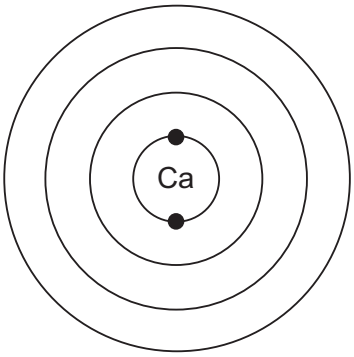


**[Turn over**

*For Examiner's Use*

**3** This question is about calcium and some calcium compounds.

**(a)** Calcium is in Group II of the Periodic Table.
Complete the diagram below to show the electronic structure of calcium.

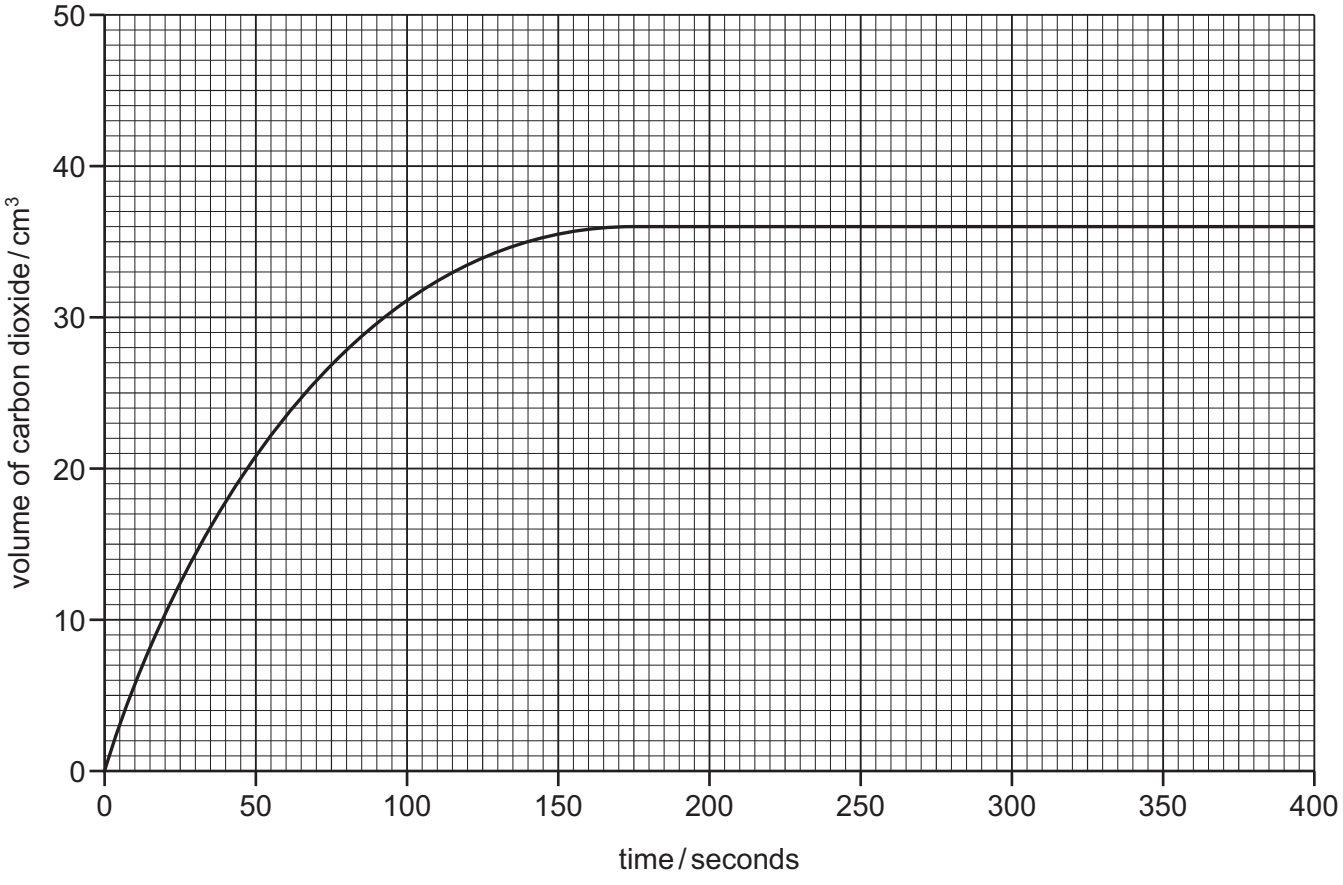



[2]

**(b)** Calcium reacts with hydrochloric acid to form a salt with the formula $CaCl_2$.
State the name of this salt.

..... [1]

**(c)** Calcium carbonate reacts with hydrochloric acid.
The course of this reaction can be followed by measuring the volume of carbon dioxide given off at various time intervals.
The graph below shows the results obtained from an experiment using 0.15 g of calcium carbonate in small pieces.



*For Examiner's Use*

**(i)** What volume of gas is given off in the first 75 seconds of the reaction?

..... [1]

**(ii)** On the grid opposite, sketch the line you would expect for the same reaction using large pieces of calcium carbonate. Assume that the mass of the calcium carbonate and all other conditions remain the same. [2]

**(iii)** What would happen to the rate of this reaction if:

the temperature is increased,

.....

the concentration of hydrochloric acid is decreased?

..... [2]

**(d)** When calcium carbonate is heated at high temperatures, calcium oxide and carbon dioxide are formed.

**(i)** Which **one** of the following words best describes this reaction?
Put a ring around the correct answer.

**combustion** **decomposition** **exothermic** **reduction**

[1]

**(ii)** Describe a test for carbon dioxide.

test .....

result ..... [2]

**(e)** Calcium oxide can be used to neutralise acidic industrial waste.

**(i)** Complete the word equation for the reaction of calcium oxide with nitric acid.

calcium oxide + nitric acid → ..... + .....

..... [2]

**(ii)** State **one** other use of calcium oxide.

..... [1]

**(iii)** When calcium oxide reacts with water, heat is given off.
State the name given to a chemical reaction which gives off heat.

..... [1]

[Total: 15]

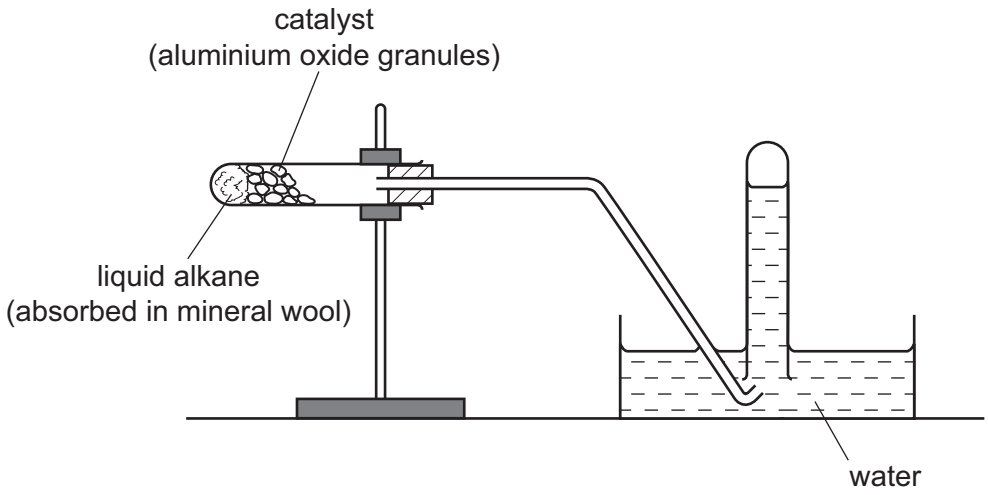




**[Turn over**

*For Examiner's Use*

**4** The diagram shows how a liquid alkane can be cracked in a school laboratory to form a mixture of gaseous and liquid hydrocarbons.




**(a)** What piece of apparatus is missing from the diagram?

..... [1]

**(b)** On the diagram above, put an **X** to show where the gas is collected. [1]

**(c)** What is the purpose of the catalyst?

..... [1]

**(d)** Complete the equation to show the cracking of dodecane, $C_{12}H_{26}$, to form octane and **one** other substance.

$$C_{12}H_{26} \rightarrow C_8H_{18} + .....$$

[1]

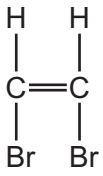
**(e)** Cracking produces a mixture of shorter-chain alkanes and alkenes.

**(i)** Describe what you would observe when a few drops of bromine water are added to an alkene.

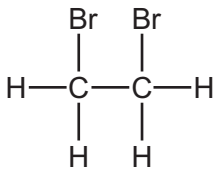
..... [1]

**(ii)** Which one of the following compounds, **A**, **B**, **C** or **D**, is formed when bromine water reacts with ethene?

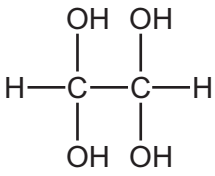
**A**



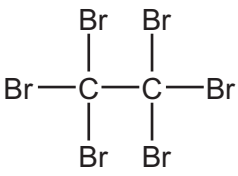
**B**



**C**



**D**



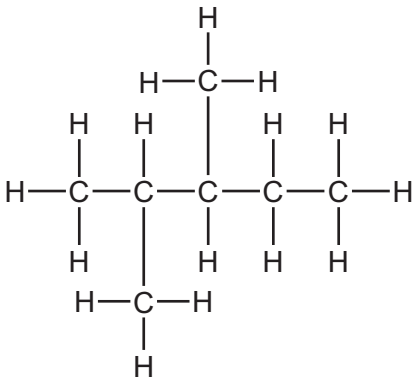
..... [1]

**(iii)** Poly(ethene) is made by combining ethene monomers.
Which one of the following describes this reaction?
Tick **one** box.

| | |
|---|---|
| decomposition | ☐ |
| neutralisation | ☐ |
| oxidation | ☐ |
| polymerisation | ☐ |

[1]

**(f)** Many alkanes found in petrol are branched hydrocarbons.
One example is shown below.



**(i)** Write the molecular formula for this hydrocarbon.

..... [1]

**(ii)** What is meant by the term *hydrocarbon*?

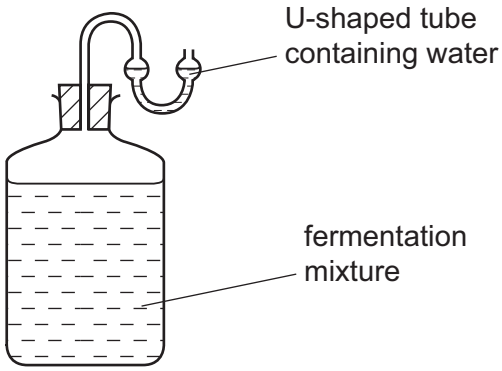
..... [1]

**(g)** State the name of the **two** products formed when a hydrocarbon burns in excess air.

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

[Total: 11]

**5** Ethanol can be made by fermentation.




**(a)** Apart from yeast, what other substances are present in the reaction mixture?
Tick **two** boxes.

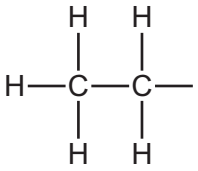
| | |
|---|---|
| copper sulfate | ☐ |
| ethene | ☐ |
| sugar | ☐ |
| methane | ☐ |
| water | ☐ |

[2]

**(b)** What method is used to separate ethanol from the rest of the reaction mixture?

..... [1]

**(c)** Complete the structure of ethanol.



[1]

**(d)** Ethanol belongs to the alcohol homologous series.
Which **one** of the following compounds also belongs to the alcohol homologous series?
Put a ring around the correct answer.

**butene** **hexane** **ethanoic acid** **octanol**

[1]

**(e)** Describe **one** other way, apart from fermentation, by which ethanol can be made on an industrial scale. Include the necessary reaction conditions in your answer.

.....

.....

..... [3]

[Total: 8]

*For Examiner's Use*

**6** **(a)** When hydrated copper(II) sulfate is heated, the following reaction occurs:

$$CuSO_4.5H_2O(s) \rightleftharpoons CuSO_4(s) + 5H_2O(l)$$

hydrated copper(II) sulfate  anhydrous copper(II) sulfate

**(i)** What does the sign $\rightleftharpoons$ mean?

..... [1]

**(ii)** Explain how this reaction is used as a chemical test for water.

.....

..... [2]

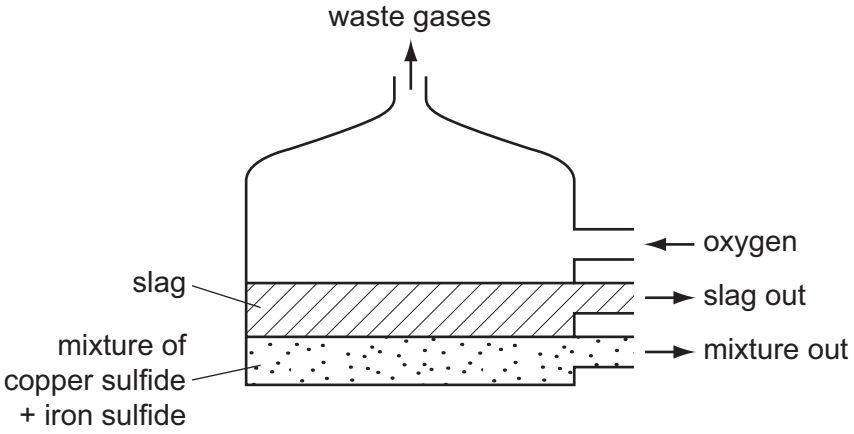
**(iii)** Copper(II) sulfate is a salt.
Sodium chloride is also a salt. Solid sodium chloride does not conduct electricity.
Suggest **two** things you could do to make solid sodium chloride conduct electricity.

1. .....

2. ..... [2]

**(b)** Copper ore contains copper, iron and sulfur.
Copper is extracted by heating copper ore with sand and oxygen.

**(i)** In the first stage of this process, the copper ore is heated in a furnace.
A liquid mixture containing copper sulfide and iron sulfide is formed. The sand reacts with the impurities to form a slag.




What information in the diagram above suggests that the slag is less dense than the mixture of copper and iron sulfides.

..... [1]

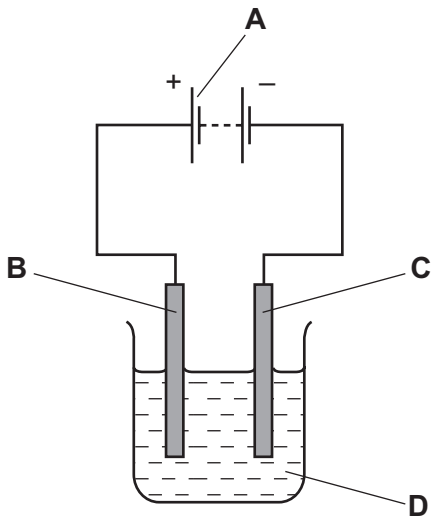
**(ii)** In a later stage, copper sulfide is reacted with more oxygen.

$$Cu_2S + O_2 \rightarrow 2Cu + SO_2$$

How does this equation show that the sulfur in copper sulfide gets oxidised?

..... [1]

**(iii)** Copper is purified by electrolysis using copper electrodes.




Which letter, **A**, **B**, **C** or **D**, in the diagram above represents

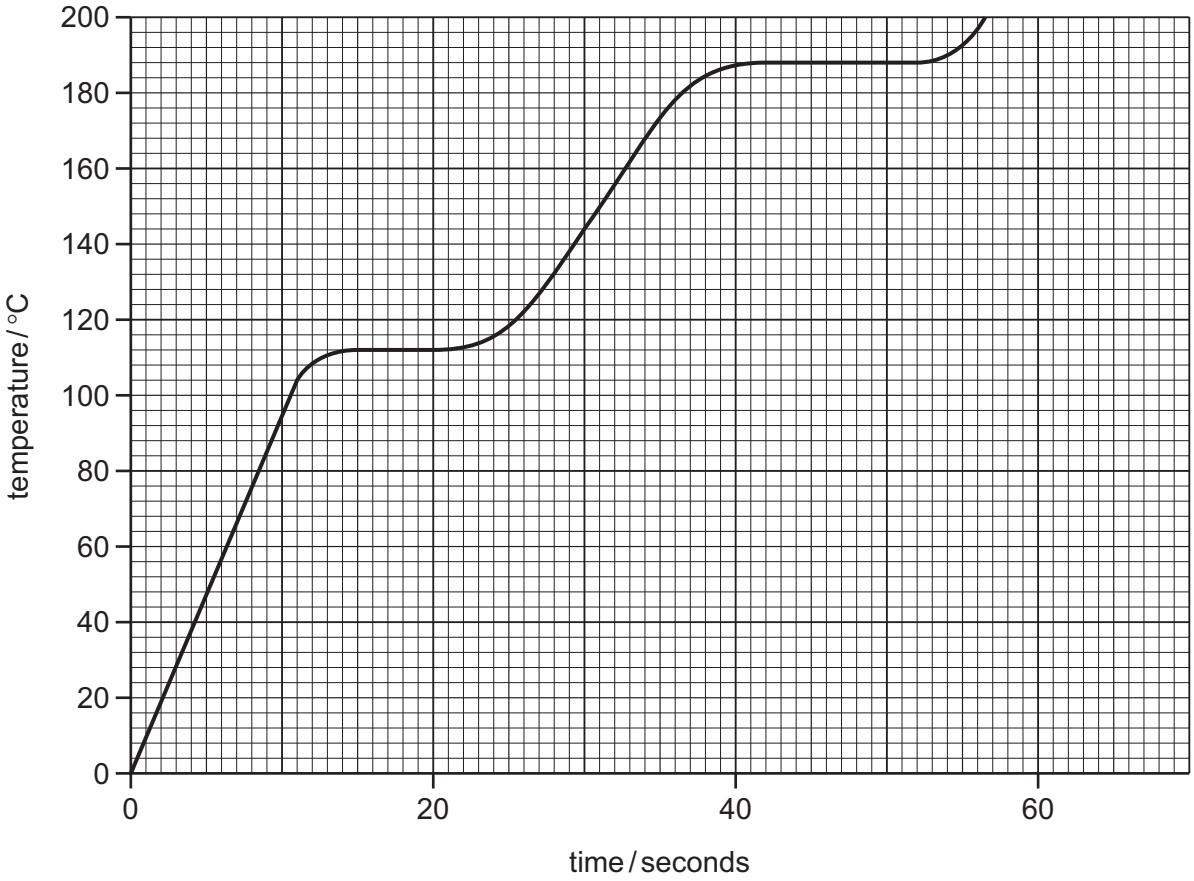
the cathode, .....

the electrolyte? ..... [2]

[Total: 9]

*For Examiner's Use*

**7** The graph below shows how the temperature rises with time when a solid, **P**, is heated steadily and changes to a liquid and then to a gas.




**(a)** Use the information on the graph to deduce

the melting point of **P**, .....

the state of **P** at 160 °C. ..... [2]

**(b)** Explain what happens to the arrangement and motion of the particles when a solid changes to a liquid.

arrangement .....

motion ..... [2]

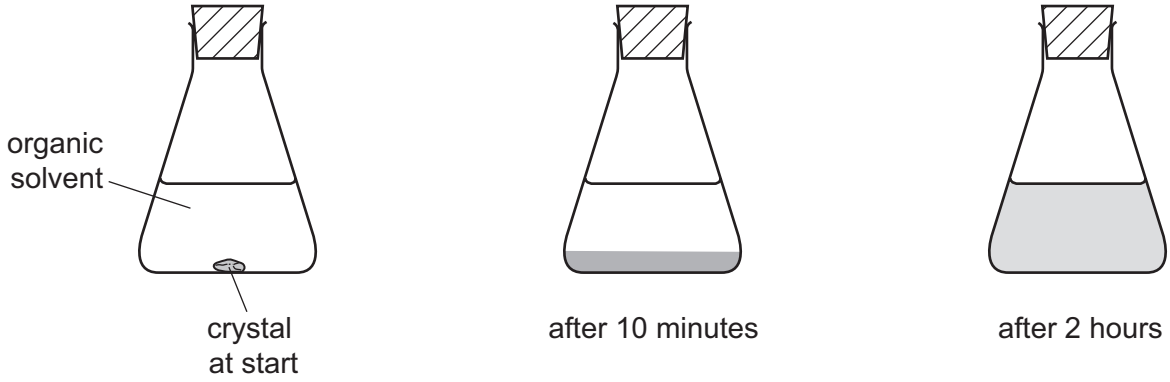




**[Turn over**

For Examiner's Use

**(c)** A student placed a purple crystal in a flask of organic solvent.
After 10 minutes, the crystal had completely disappeared and a dense purple colour was observed at the bottom of the flask.
After 2 hours, the purple colour had spread throughout the solvent.




Use the kinetic particle theory to explain these observations.

.....

.....

.....

..... [3]

[Total: 7]

*For Examiner's Use*

**8** **(a)** State **two** differences between a mixture and a compound.

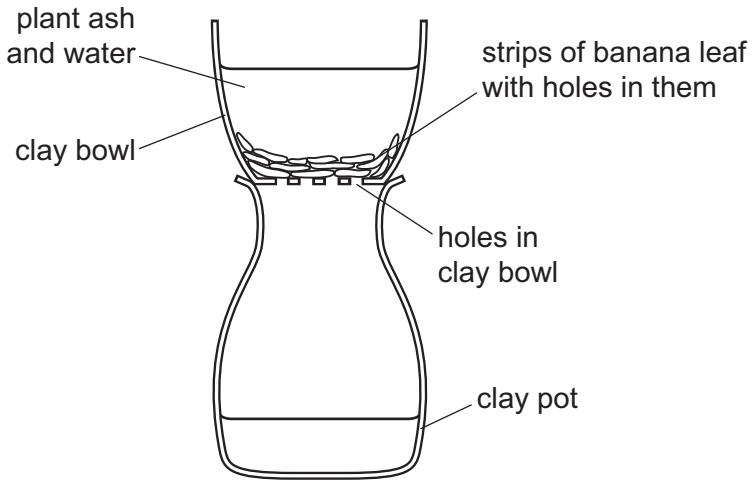
.....

.....

..... [2]

**(b)** Plant ash is a mixture of large insoluble particles and salts which are soluble in water.

In parts of Africa, salts are traditionally obtained from plant ash.
Water is added to the plant ash.
The apparatus shown below is then used to remove the insoluble particles.




Explain how this apparatus separates the salts from the insoluble particles.

.....

.....

.....

..... [2]

For Examiner's Use

**(c)** The composition and solubility of some salts found in the ash from the papyrus plant are shown in the table below.

| salt | ion present in the salt | mass of salt per 100 g of ash / g | solubility of salt in g / $dm^3$ |
|---|---|---|---|
| magnesium sulfate | $Mg^{2+}$ and $SO_4^{2-}$ | 5 | 220 |
| potassium carbonate | $K^+$ and $CO_3^{2-}$ | 10 | 1120 |
| potassium chloride | $K^+$ and $Cl^-$ | 18 | 359 |
| potassium sulfate | | 4 | 122 |
| sodium carbonate | $Na^+$ and $CO_3^{2-}$ | 12 | 70 |
| sodium chloride | $Na^+$ and $Cl^-$ | 40 | 359 |

**(i)** Which salt in the table has the lowest solubility in g / $dm^3$?

..... [1]

**(ii)** Which negatively-charged ion is present in the highest amount in the ash?

..... [1]

**(iii)** Write the symbols for the **two** ions present in potassium sulfate.

..... [2]

**(d)** Sodium chloride reacts with lead(II) nitrate to form sodium nitrate and lead(II) chloride. Complete the symbol equation for this reaction.

$$\text{.....NaCl} + \text{Pb(NO}_3\text{)}_2 \rightarrow 2\text{NaNO}_3 + \text{PbCl}_2$$

[1]

**(e)** Complete the following sentence about the formation of chloride ions.

Chloride ions are formed when chlorine atoms gain ..... . [1]

[Total: 10]

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

| | Group | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | I | II | | | | | | | | | III | IV | V | VI | VII | 0 |
| | | | | | | | | | | | | | | | | 4 He Helium 2 |
| | | | | | 1 H Hydrogen 1 | | | | | | | | | | | |
| | 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 | 98 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 | a = relative atomic mass |
| X | X = atomic symbol |
| b | b = proton (atomic) number |

The volume of one mole of any gas is 24 $dm^3$ at room temperature and pressure (r.t.p.).