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Secondary Three Express

3E

[illegible]

5073

1045-1300

2 hour 15 minutes

Additional Materials:

Optical Marking Sheet, Writing paper & Electronic calculator

READ THESE INSTRUCTIONS FIRST

Write your name and register number in the spaces provided on top of this page.

Write in dark blue/ black pen in the spaces provided on the question paper.

You may use a soft pencil for any diagrams, graphs or rough working.

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

Section A (30 marks)

There are thirty questions in this section. Answer **all** questions.

For each question, there are four possible answers, A, B, C and D.

Choose the **one** you consider correct and record your choice in soft pencil on the OMR sheet.

Section B (40 marks)

Answer all questions in the spaces provided.

Section C (30 marks)

Answer all three questions. Write your answers on the lined paper provided.

At the end of the examination, fasten your answers to Section C together.

You are to submit your answer for each section separately.

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 23.

Seller: Mdm Grace Tan

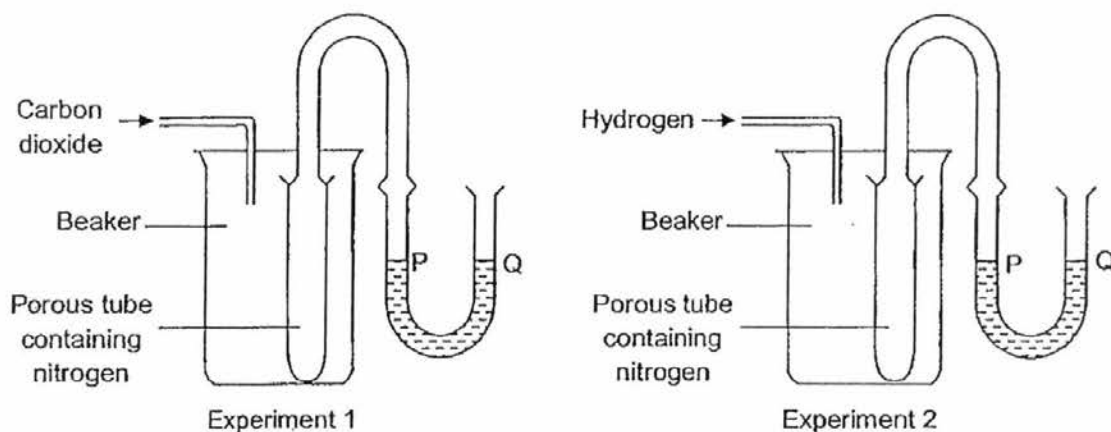
Vetter: Mdm Hia Soo Ching

This question paper consists of 23 printed pages including this page.

Section A: Multiple Choice Questions [30 marks]

Answer all questions and shade your answers on the OMR sheet provided.

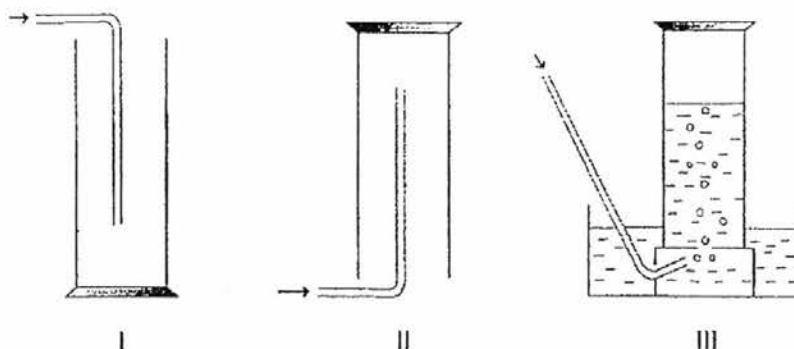
A1 The following experimental set-ups were used to demonstrate diffusion.



What are the changes to the water levels at P and Q that you would expect to see in both experiments?

- | | <u>Experiment 1</u> | <u>Experiment 2</u> |
|----------|---------------------|-------------------------|
| A | P is higher than Q | Q is higher than P |
| B | P is higher than Q | P is higher than Q |
| C | Q is higher than P | P is higher than Q |
| D | Q is higher than P | P and Q remain the same |

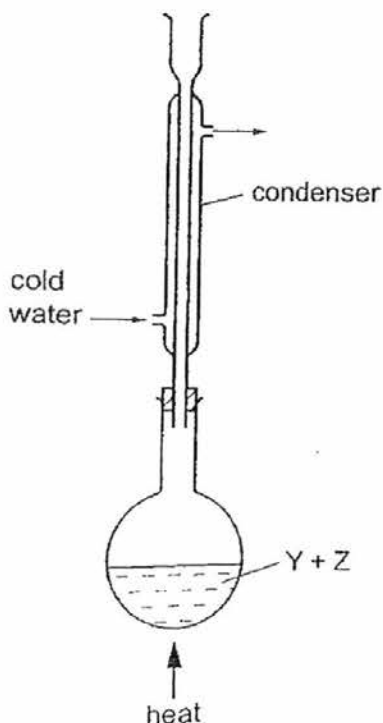
A2 Which of the following methods can be used to collect ammonia gas in the laboratory?



- A** I only
- B** II only
- C** I and III
- D** II and III

A3 The diagram shows the apparatus used to prepare a liquid compound X.

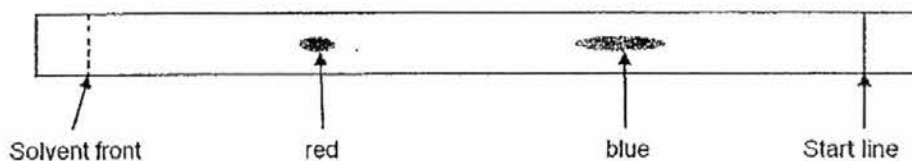
Compound X (boiling point 57°C) is made by heating together two liquids, Y (boiling point 78°C) and Z (boiling point 95°C). The reaction is slow.



What is the purpose of the condenser?

- A To allow liquid X to escape as fast as it is formed
 - B To enable Y and Z to mix more efficiently
 - C To keep air away from the reacting liquids
 - D To prevent Y and Z from escaping before the reaction is complete
- A4** A manufacturer accidentally dropped some tiny industrial diamonds into lead(II) nitrate powder. Which steps could be used to recover the diamonds from the mixture?
- A Shake with dilute hydrochloric acid. Filter the mixture and wash the residue with water.
 - B Shake with dilute sulfuric acid. Filter the mixture and evaporate the filtrate to dryness.
 - C Shake with water. Filter the mixture and evaporate the filtrate to dryness.
 - D Shake with water. Filter the mixture and wash the residue with water.

A5 The chromatogram of a food colouring is shown below.



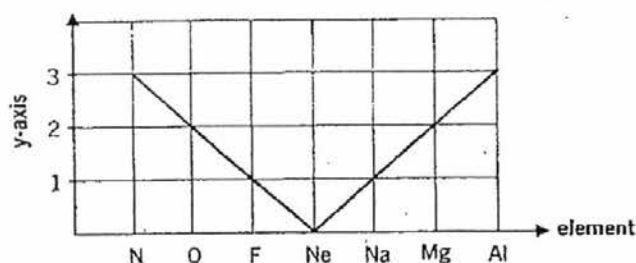
Which of the following statements can be deduced from the chromatogram?

- A The food colouring is blue.
- B The red dye is more soluble than the blue dye.
- C The R_f value of the blue dye is greater than that of the red dye.
- D The molecules of the blue dye are heavier than that of the red dye.

A6 Which one of the substances has been **wrongly** classified as an element or mixture?

	property	classification
A	White solid melts over $56^\circ\text{C} - 58^\circ\text{C}$.	mixture
B	Green powder on heating leaves a black residue and a colourless gas is evolved.	compound
C	Black powder burns in air to form a colourless gas.	element
D	Colourless solution produces two colourless gases when an electric current is passed through it	element

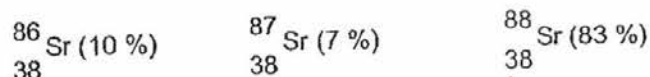
A7 The graph below shows the information of seven elements in the Periodic Table.



What would be a suitable label for the y-axis?

- A valency of element
- B the number of valence electrons
- C the number of electron shells
- D atomic number

- A8** Strontium is used in fireworks to produce crimson flames.
Naturally occurring strontium has three isotopes with the respective percentage abundance.



What is the relative atomic mass of naturally occurring strontium?

- A** 38.0
B 87.0
C 87.7
D 88.0
- A9** The table shows information about particles S and T.

particle	number of protons	number of neutrons	electronic structure
S	8	10	2, 8
T	17	18	2, 8, 8

Both S and T are

- A** atoms of metals.
B atoms of noble gases.
C negatively-charged ions.
D isotopes of the same element.
- A10** How does atom ${}^{238}\text{Y}$ differ from atom ${}^{235}\text{Y}$?
A ${}^{238}\text{Y}$ has 3 more protons and 3 more electrons.
B ${}^{238}\text{Y}$ has 3 more neutrons and 3 more electrons.
C ${}^{238}\text{Y}$ has 3 more protons but the same number of electrons.
D ${}^{238}\text{Y}$ has 3 more neutrons but the same number of electrons.
- A11** Two elements, F and G, have atomic numbers between 11 and 20. The atom F has two electrons less than a noble gas, while the atom G has one electron more than a noble gas. What is the formula for the simplest compound formed between F and G?
A FG
B F₂G₂
C G₂F
D GF₂

A12 Antimony oxide has the formula Sb_2O_3 , while potassium phosphate has the formula K_3PO_4 . What is the formula of antimony phosphate?

- | | |
|-----------------------------------|---------------------------------------|
| A SbPO_4 | C $\text{Sb}_2(\text{PO}_4)_3$ |
| B Sb_2PO_4 | D Sb_3PO_4 |

A13 Which of the following statements about one mole of a metal is always true?

- A** It is liberated by one mole of electrons.
- B** It has the same mass as one mole of hydrogen atoms.
- C** It contains the same number of particles as one twelfth mole of ^{12}C .
- D** It contains the same number of particles as one mole of hydrogen atoms.

A14 In an experiment, 8.0 cm^3 of 0.5 mol/dm^3 aqueous copper(II) sulfate is mixed with 2.0 cm^3 of 2.0 mol/dm^3 of aqueous sodium carbonate.



What would be in the reaction mixture when the reaction ends?

- A** a blue solution only
- B** a colourless solution only
- C** a green precipitate and a blue solution
- D** a green precipitate and a colourless solution

- A15** Phenolphthalein indicator changes colour at pH 9.3. A set of four samples of aqueous potassium hydroxide of different concentrations was prepared, and tested with the indicator phenolphthalein. The results are shown below.

pH	colour with phenolphthalein
8	colourless
9	pale pink
10	violet
11	violet

Two unknown solutions X and Y were then tested with the indicator phenolphthalein.

unknown solution	colour with phenolphthalein
X	pale pink
Y	colourless

Based on the above results, which of the following is the most accurate conclusion about the pH of X and Y?

- A The pH of X is 9, and the pH of Y is 8.
 - B The pH of X is 9, and the pH of Y is 8 or less.
 - C The pH of X is 9 or less, and the pH of Y is 8 or less.
 - D The pH of X is 9, and the pH of Y is between 8 and 9.
- A16** Some dry crystals of citric acid are placed on a piece of dry blue litmus paper. After five minutes, the litmus paper will
- A turn red.
 - B be bleached.
 - C remain unchanged.
 - D turn red then bleached.
- A17** Why is it unwise to add calcium oxide to soil soon after the fertiliser, ammonium sulfate had been added to it?
- A The dry mixture is explosive.
 - B An insoluble salt, calcium sulfate is formed.
 - C When dampened, ammonia gas is produced.
 - D Sulfuric acid is formed.

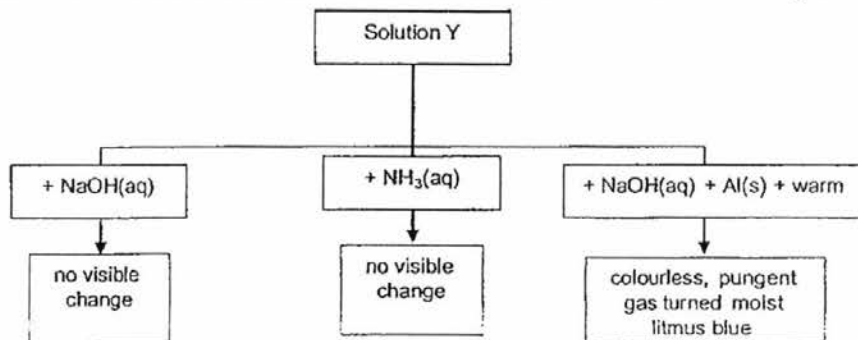
A18 Which one of the following elements forms a neutral oxide?

- A carbon
- B copper
- C silicon
- D sodium

A19 What is the best method to prepare sodium sulfate salt?

- A add dilute nitric acid to sodium hydroxide followed by sulfuric acid
- B add sodium chloride to barium sulfate
- C add sodium hydroxide to sulfuric acid
- D add sodium metal to sulfuric acid

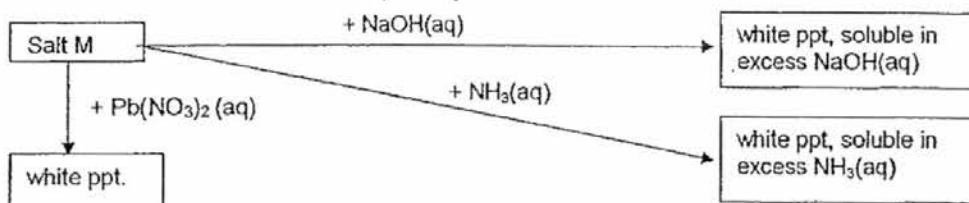
A20 The flow chart below shows the reactions of salt solution Y with three reagents:



Identify the salt present in Y.

- A ammonium sulfate
- B iron(II) nitrate
- C potassium nitrate
- D zinc nitrate

A21 With reference to the flowchart below, identify salt M.



Which of the following is M?

- A zinc chloride
- B zinc iodide
- C aluminium chloride
- D aluminium iodide

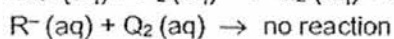
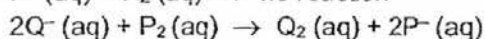
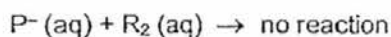
A22 Two elements are in the same group of the Periodic Table.

Which property will be the same for both elements?

- A Their melting points
- B The charge on their ions
- C Their electronic structures
- D Their reactivity with water and with acids

A23 P, Q and R are elements found in Group VII of the Periodic Table. Three experiments were carried out to determine the reactivity of P, Q and R.

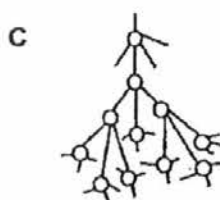
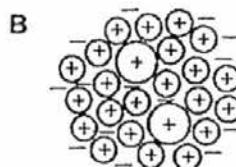
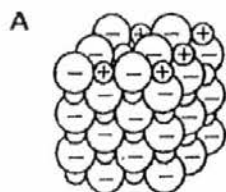
The three reactions are illustrated by the three equations shown below:



What could be the possible identities of P, Q and R?

	<u>element P</u>	<u>element Q</u>	<u>element R</u>
A	chlorine	bromine	iodine
B	chlorine	iodine	bromine
C	bromine	iodine	chlorine
D	iodine	chlorine	bromine

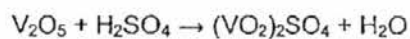
A24 Which of the following diagrams shows the structure of bronze?



A25 When dilute hydrochloric acid is added to brass (an alloy of copper and zinc) until in excess,

- A** a colourless solution is formed.
- B** a grey residue will remain.
- C** a blue solution is formed.
- D** there is no chemical reaction.

A26 Vanadium(V) oxide reacts with dilute sulfuric acid in the reaction shown below.



In this reaction, sulfuric acid is acting as a/an

- A** acid.
- B** oxidising agent.
- C** reducing agent.
- D** drying agent.

A27 The following shows a list of substances and their application.

- Vanadium (V) oxide; a catalyst used in the production of sulfuric acid.
- Nickel; a catalyst used in hydrogenation.
- Iron; a catalyst used in Haber Process.
- Manganese (IV) oxide; a catalyst used in decomposition of hydrogen peroxide.

What do the above substances have in common?

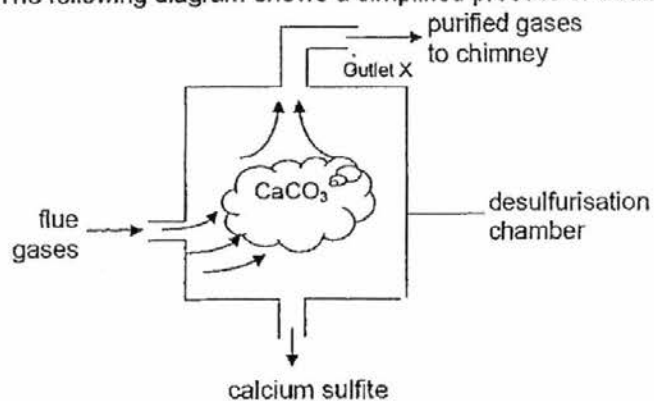
- A All of them are coloured compounds.
- B All of them contain transition elements.
- C All of them are found in Groups II and III of the Periodic Table.
- D All of them are found in Period 4 of the Periodic Table.

A28 A catalytic converter in a car exhaust system changes pollutants into less harmful products.

Which change does **not** occur in a catalytic converter?

- A carbon dioxide → carbon
- B carbon monoxide → carbon dioxide
- C nitrogen oxides → nitrogen
- D unburnt hydrocarbons → carbon dioxide and water

A29 The following diagram shows a simplified process of desulfurisation .



Which of the following observation at the outlet X best describes the nature of the gases released through the chimney?

- A Gases turned damp litmus paper blue.
- B Gases turned acidified potassium manganate (VII) purple.
- C Gases turned acidified potassium iodide brown.
- D Gases formed white precipitate with lime water.

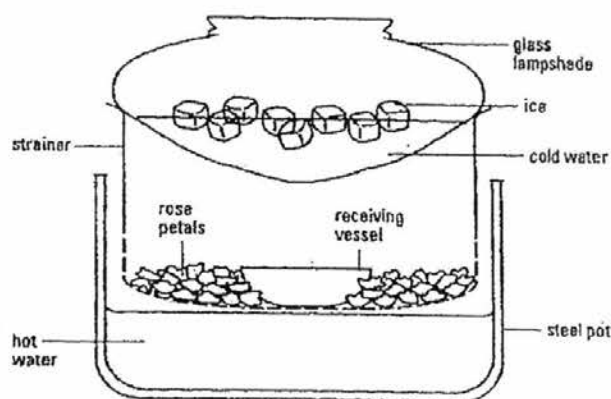
A30 In which pair do **both** pollutants cause damage to buildings?

- A CFCs and carbon monoxide
- B methane and carbon dioxide
- C unburned hydrogen and nitrogen oxides
- D nitrogen dioxide and sulfur dioxide

Section B: Structured Questions [40 marks]

Answer **all** the questions in the spaces provided.

- B1** To obtain the fragrant oils used in perfumes, a method called steam distillation is often used. The diagram below shows the apparatus devised by a student. It can be used to obtain fragrant oils from rose petals at home.



- (a) Explain why the upper container contains ice and cold water.

.....
.....

[1]

- (b) Suggest what happens as steam passes through the rose petals.

.....
.....

[1]

- (c) Two liquids would be collected in the receiving vessel. Suggest and explain a method to separate these two liquids.

.....
.....

[2]

[Total: 4]

B2 The following table shows some physical properties of different substances.

substance	melting point / °C	boiling point / °C	solubility in water
lithium	180	1342	reacts with water
methane	-182	-162	no
kerosene	25 to 40	120 to 150	no
magnesium carbonate	decomposes at 540 °C		no

(a) All the substances in the table are either compounds or mixtures except for lithium.

(i) Explain why lithium is not classified as a compound.

.....
 [1]

(ii) Lithium reacts with water. Name the products formed when lithium reacts with water.

.....
 [1]

(b) How can you tell from the data that kerosene is a mixture?

.....
 [1]

(c) Methane is a pollutant gas.

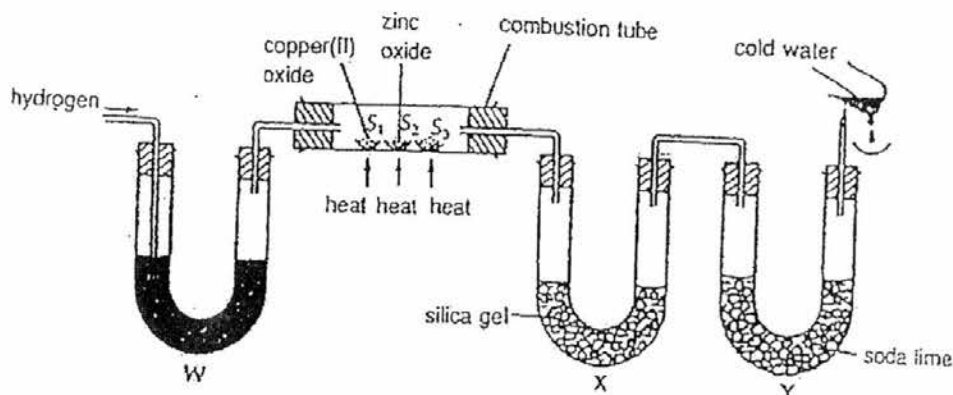
(i) What pollution problem does methane cause?

.....
 [1]

(ii) Draw the dot and cross diagram for methane gas, CH₄. Only valence electrons need to be shown.

[2]
 [Total: 6]

- B3** The apparatus shown below was set up. A steady stream of hydrogen gas was passed through the combustion tube while the substances in it were heated simultaneously until no further changes occurred.



- (a) (i) What changes would be observed taking place in the substances S_1 , copper(II) oxide, and S_2 , zinc oxide, during the course of the experiment?
-
- [1]
- (ii) Substance S_3 is a green powder which finally produced a residue that was the same as the residue left by S_1 . Deduce the name of the substance S_3 .
-
- [1]
- (iii) What is the purpose of the U-tube Y? (Soda lime is a mixture of sodium hydroxide and calcium hydroxide).
-
- [1]
- (b) Another experiment was set up where 21.296 g of magnesium is completely burned in air to form magnesium oxide and magnesium nitride. When the products are treated with water, 2.813 g of gaseous ammonia are generated.

The equations below illustrate the reactions above.

Balance all the chemical equations.

- (i) $\text{Mg (s)} + \text{..... } \text{O}_2 \text{ (g)} \rightarrow \text{..... } \text{MgO (s)}$
- (ii) $\text{Mg (s)} + \text{..... } \text{N}_2 \text{ (g)} \rightarrow \text{..... } \text{Mg}_3\text{N}_2 \text{ (s)}$
- (iii) $\text{Mg}_3\text{N}_2 \text{ (s)} + \text{..... } \text{H}_2\text{O (l)} \rightarrow \text{..... } \text{Mg(OH)}_2 \text{ (s)} + \text{..... } \text{NH}_3 \text{ (g)}$ [3]

(iv) Calculate the number of moles of ammonia generated.

[1]

(v) Using your result in (b)(iv), calculate the mass of magnesium nitride formed.

[1]

(vi) By considering the mass of magnesium in magnesium nitride and magnesium oxide, calculate the mass of magnesium oxide formed.

[1]
[Total: 9]

B4 The table below shows various properties of the chlorides of the elements in Period 3 of the Periodic Table.

formula of the chloride	NaCl	MgCl ₂	Al ₂ Cl ₃	SiCl ₄	PCl ₃	S ₂ Cl ₂	Cl ₂
state of the chloride at r.t.p	solid	solid	solid	liquid	liquid	liquid	gas
boiling point /°C	1465	1418	423	57	74	136	-35

(a) Describe the trend of the boiling points of the chlorides across the period.

.....
.....

[1]

- (b) Explain, using structures and bonding, the difference in boiling point between MgCl_2 and SiCl_4 .

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

[3]
[Total: 4]

B5 Chlorine gas is bubbled into aqueous sodium bromide in an experiment.

- (a) What will be observed when chlorine gas is bubbled into aqueous sodium bromide?

..... [1]

- (b) Write an ionic equation to show the reaction between chlorine gas and aqueous sodium bromide.

..... [2]

- (c) Explain, in terms of electron transfer, which substance has been reduced.

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

- (d) Which of the substances is the reducing agent in the reaction?

..... [1]

- (e) Describe a test to show that the substance named in (d) above is a reducing agent.

.....
.....
..... [2]
[Total: 8]

- B6** The table below shows the results when oxides of copper and three other metals **P**, **Q** and **R** are being heated.

metal oxide	CuO	P ₂ O	QO	RO
observation	no reaction	metal P is formed	no reaction	no reaction

Figures **a**, **b**, **c** and **d** show the observations when the metals copper, **P**, **Q** and **R**, are added separately to copper(II) sulfate solution.



Fig a

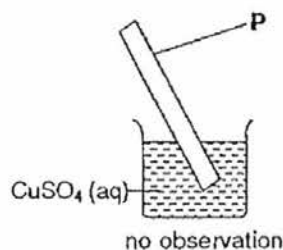


Fig b

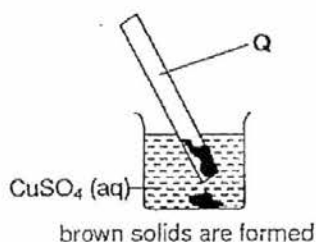


Fig c

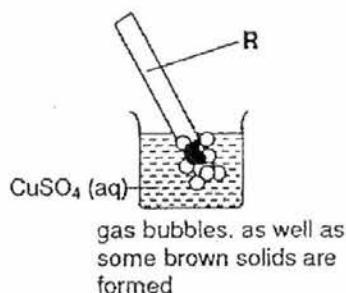


Fig d

- (a) (i) In Figure **c**, state and explain another observation that should be seen for the reaction of **Q** and copper(II) sulfate solution.

.....

 [2]

- (ii) What is the role of copper(II) sulfate solution in the reaction seen in figure **c**? Explain your answer in terms of oxidation state.

.....

 [2]

- (b) (i) With reference to figure d, explain the formation of bubbles of hydrogen gas for the reaction of **R** with copper(II) sulfate solution. Hence, write the chemical equation for this reaction.

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

[2]

- (ii) Describe a test for the hydrogen gas evolved.

.....
.....

[2]

- (c) Arrange the four metals in order of increasing reactivity.

..... [1]
[Total: 9]

Section C [30 marks]

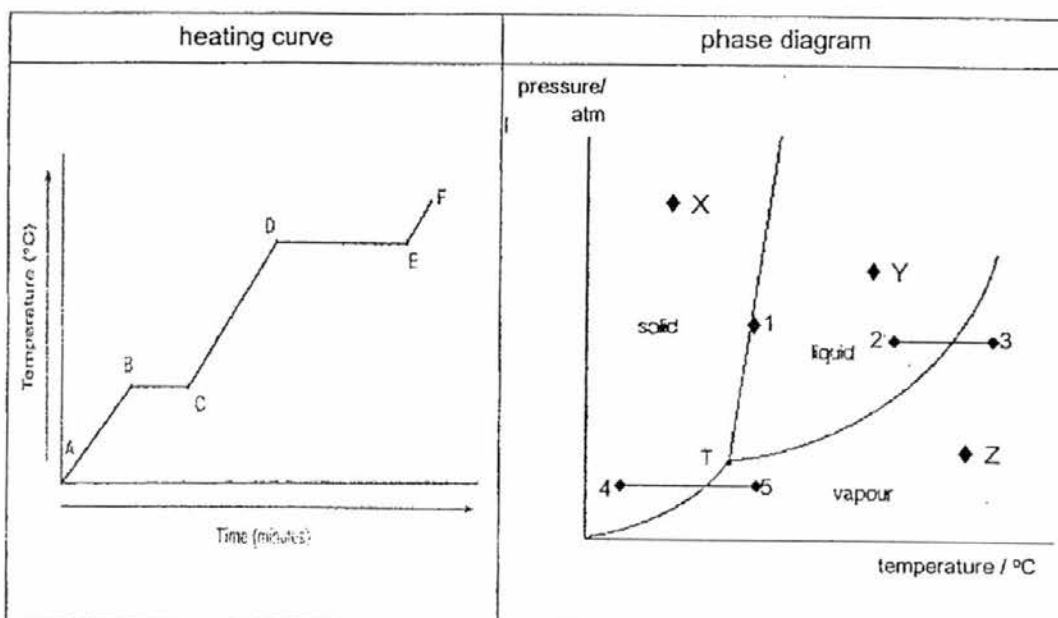
Answer all **three** questions.

Write your answers on the writing papers provided.

- C1** A phase diagram shows the phases (solid, liquid or gaseous states) of a substance at any given temperature and pressure.

At the pressure and temperature at point X in the diagram, the substance would be a solid because it falls into that area of the phase diagram. At Y, it would be a liquid, and at Z it would be a vapour (gas).

The diagrams below show the heating curve and the phase diagram of the same pure substance.



- (a) (i) State what process occurs at point 1 on the phase diagram when temperature is increased. [1]
 (ii) State and explain using kinetic particle theory, if the process in (a)(i) would occur at a higher or lower temperature if pressure is increased. [2]
- (b) State which area(s) on the heating curve is/are
 (i) point 1 on the phase diagram equivalent to?
 (ii) points 2 to 3 on the phase diagram equivalent to? [2]
- (c) Point T on the phase diagram is called the *Triple Point*. Suggest what point T could represent. [1]
- (d) Refer to the phase change from point 4 to 5 on the phase diagram.
 (i) Describe the changes in the movement and arrangement of the particles. [2]
 (ii) State the term used to describe this phase change. [1]
 (iii) Give an example of two substances that will undergo this phase change. [1]

[Total: 10]

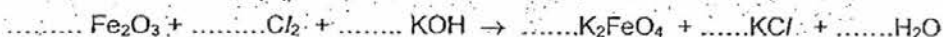
- C2 The space ship, Curiosity rover, landed as an analytical laboratory on Mars in 2012. The laboratory contained equipment which can determine the percentage of elements in a rock sample, Z.

The percentage by mass of compound Z, determined using this type of equipment is given below :

element	percentage by mass /%
potassium	39.4
iron	28.3
oxygen	32.3

- (a) Show that the empirical formula of Z is K_2FeO_4 . [2]

- (b) K_2FeO_4 can be prepared in the laboratory by the reaction between iron(III) oxide, chlorine and potassium hydroxide according to the following equation.



A 2.00 g sample of iron(III) oxide is mixed with 1920 cm³ of chlorine gas and excess potassium hydroxide solution.

- (i) Copy and balance the equation. [1]
- (ii) Determine the limiting reagent for the reaction by means of reasoning or show your working. [2]
- (iii) Find the mass of K_2FeO_4 formed. [1]
- (c) Explain why the above reaction is a redox reaction. [3]
- (d) A few drops of aqueous K_2FeO_4 was added to a test-tube containing 3.0 cm³ of aqueous potassium iodide. The solution in the test-tube changes from colourless to pale brown.

Given this information, what can you deduce about the chemical properties of K_2FeO_4 ? [1]

[Total: 10]

- C3** Aqueous barium hydroxide is considered as a strong alkali that can be used to neutralise dilute sulfuric acid. Different volumes of aqueous barium hydroxide and dilute sulfuric acid are added to six different test tubes. The concentrations and volumes of the two solutions are listed in the following table.

test tube	1	2	3	4	5	6
volume of 0.500 mol/dm ³ aqueous barium hydroxide / cm ³	10.0	10.0	10.0	10.0	10.0	10.0
volume of 1.0 mol/dm ³ dilute sulfuric acid / cm ³	2.0	3.0	4.0	5.0	6.0	7.0

- (a) Write a balanced chemical equation, with state symbols, for the reaction between aqueous barium hydroxide and dilute sulfuric acid. [2]
- (b) (i) Outline how the products in test tube 4 can be separated. [2]
- (ii) Calculate the theoretical yield of the ionic product that is formed in test tube 4. [2]
- (c) The electrical conductivity of the mixture in each test tube is measured.

test tube	1	2	3	4	5	6
electrical conductivity (poor/good)	good					good

- (i) Copy the above table onto your answer script.

Complete the table by predicting the electrical conductivity (poor or good) of the mixture in each of the six test tubes. [1]

- (ii) Explain your predictions in (c)(i) fully. [3]

[Total: 10]

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 Ba barium 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 aluminum 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											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											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 cesium 55	137 Ba barium 56											204 Tl thallium 81	207 Pb lead 82	209 Bi bismuth 83	- Po polonium 84	- At astatine 85	- Rn radon 86	

*58-71 Lanthanoid series
†90-103 Actinoid series

Key

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

140 Ce cerium	141 Pr praseodymium	144 Nd neodymium	150 Sm samarium	152 Eu europium	157 Gd gadolinium	159 Tb terbium	162 Dy dysprosium	165 Ho holmium	167 Er erbium	169 Tm thulium	173 Yb ytterbium	175 Lu lutetium
90 Th thorium	91 Pa protactinium	92 U uranium	94 Pu plutonium	95 Am americium	96 Cm curium	97 Bk berkelium	98 Cf californium	99 Es einsteinium	100 Fm fermium	101 Md mendelevium	102 No nobelium	103 Lr lawrencium

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2016 Fuhua Secondary School Secondary 3E Pure Chemistry EOY Marking Scheme

Section A: Multiple Choice Questions (30 marks)

1 A	11 C	21 A
2 B	12 A	22 B
3 D	13 D	23 B
4 D	14 D	24 B
5 B	15 B	25 A
6 D	16 C	26 A
7 A	17 C	27 B
8 C	18 A	28 A
9 C	19 C	29 D
10 D	20 C	30 D

Section B: Structured Questions (40 marks)

Qn	Suggested solutions	Marks	Remarks
B1(a)	To <u>condense</u> the oil vapour so that the fragrant oils can be collected in the receiving vessel.	[1]	
B1(b)	As steam passes through the rose petals, the oil from the rose petals <u>vapourises</u> .	[1]	
	This question was poorly answered. Candidates need to refer to the purpose of the set-up, which is to collect fragrant oils, while many students focussed on the aroma.		
B1(c)	Use a separating funnel.	[1]	R: Fractional distillation
	Two liquids (Fragrant oils and water) collected are <u>immiscible</u> / Two liquids collected have <u>different density</u> .	[1]	
	Fractional distillation was often given as the wrong answer as candidates neglected that oil and water are immiscible. Large number of candidates also failed to give the explanation for their suggestion.		
		[Total:4]	
B2(a)(i)	Lithium is made up of only one type of atom / it cannot be separated / broken down into simple substances by chemical means / it is an element / it is found in the Periodic Table.	[1]	R: It has a fixed mp/ bp point.
	Note that pure compounds also have fixed mp and bp.		
B2(a)(ii)	Lithium hydroxide and hydrogen.	[1]	
	Common error was lithium oxide instead of hydroxide.		
B2(b)	Kerosene melts and boils over a range of temperature / no fixed melting or boiling points	[1]	
B2(c)(i)	Methane is a greenhouse gas which contributes to global warming	[1]	R: Air is polluted.

B2(c)(ii)		Shared electrons [1] No valence electrons for H [1]	
		[Total:6]	
B3(a)(i)	S ₁ : Black solid turns pink/brown; S ₂ : White solid remained.	[1]	
B3(a)(ii)	Copper(II) carbonate ($\text{CuCO}_3 \rightarrow \text{CuO} + \text{CO}_2$; $\text{CuO} + \text{H}_2 \rightarrow \text{Cu} + \text{H}_2\text{O}$)	[1]	
B3(a)(iii)	To absorb / react away the carbon dioxide that is produced by S ₃ .	[1]	
B3(b)	$2\text{Mg (s)} + 1\text{O}_2 \text{ (g)} \rightarrow 2\text{MgO (s)}$	[1]	
	$3\text{Mg (s)} + 1\text{N}_2 \text{ (g)} \rightarrow 1\text{Mg}_3\text{N}_2 \text{ (s)}$	[1]	
	$1\text{Mg}_3\text{N}_2 \text{ (s)} + 6\text{H}_2\text{O (l)} \rightarrow 3\text{Mg(OH)}_2 \text{ (s)} + 2\text{NH}_3 \text{ (g)}$	[1]	
B3(c)(i)	No of moles of NH ₃ = mass (NH ₃) / M _r (NH ₃) = 2.813g / [14+3(1)] = 0.165 mol	[1]	
B3(c)(ii)	Mole ratio of NH ₃ : Mg ₃ N ₂ = 2:1 No. of moles of Mg ₃ N ₂ = 0.165 ÷ 2 = 0.0827 mol Mass of Mg ₃ N ₂ = no of moles (Mg ₃ N ₂) x M _r (Mg ₃ N ₂) = 0.0827 x [3(24)+2(14)] = 8.27g	[1]	ecf accepted
B3(c)(iii)	$\text{Mass of Mg in Mg}_3\text{N}_2 = \frac{\text{no of atoms x Ar}}{\text{Mr}} \times \text{mass of Mg}_3\text{N}_2$ $= \frac{3 \times 24}{3(24)+2(14)} \times 8.27\text{g} = 5.954\text{ g}$ Mass of Mg present in MgO = 21.296 g - 5.954 g = 15.342 g $\text{Mass of Mg in MgO} = \frac{\text{no of atoms x Ar}}{\text{Mr}} \times \text{mass of MgO}$ $15.342\text{ g} = \frac{1 \times 24}{24+16} \times \text{mass of MgO}$	[1]	ecf accepted

	Mass of MgO = 25.57 g = <u>25.6 g</u> (3sf)		
		[Total:9]	
B4(a)	The boiling points <u>decrease</u> across the period.	[1]	
B4(b)	MgCl ₂ has a <u>giant ionic lattice structure</u> . Large amount of energy is required to overcome the <u>strong electrostatic forces of attraction known as ionic bonds between the positively and negatively charged ions</u> , resulting in high boiling point. SiCl ₄ is a <u>simple covalent molecule</u> . Little amount of energy is required to overcome the <u>weak intermolecular forces of attraction between the molecules</u> , resulting in low boiling point.	[1] [1] [1]	
	Candidates need to pay close attention to terminology used in this question. BOTH <u>structure</u> and <u>bonding</u> should be given. Wrong phrasing such as "Magnesium chloride <u>is a</u> ionic bond" should not be used. Numerous candidates mentioned "molecules" and "atoms" instead of "ions" for the ionic compound, term "intermolecular bonds" was also used loosely for ionic compound.		
		[Total:4]	
B5(a)	The colourless solution turns reddish-brown.	[1]	
	Candidates neglected that question requested for "observation". Colour changes must be given rather than just the final colour.		
B5(b)	$\text{Cl}_2 (\text{g}) + 2\text{Br}^- (\text{aq}) \rightarrow 2\text{Cl}^- (\text{aq}) + \text{Br}_2 (\text{aq/l})$	[1] [1] Balanced, state symbols	
	Common errors included using bromine in gaseous phase, giving chemical equation instead of ionic equation and leaving out state symbols.		
B5(c)	Chlorine gas has been reduced. It has gained electrons to form chloride ions. $\text{Cl}_2 (\text{g}) + 2\text{e}^- \rightarrow 2\text{Cl}^- (\text{aq})$	[1] [1]	
B5(d)	Bromide ions in sodium bromide/ OR sodium bromide.	[1]	
B5(e)	Add acidified aqueous potassium manganate(VII) to aqueous sodium bromide.	[1]	

	If purple potassium manganate(VII) is decolourised, sodium bromide is a reducing agent.	[1]	
	OR acidified potassium dichromate(VI) can be used instead. Colour change is orange to green.		
	Common errors include leaving out "acidified" and providing the wrong oxidation number for the oxidising agents. KI was often used wrongly instead.		
		[Total:8]	
B6(a)(i)	Blue solution (becomes lighter in colour and eventually) becomes colourless.	[1]	R: colour change
	Cu ²⁺ ions which gives the salt solution its blue colour is displaced to form copper metal.	[1]	
	OR Q would reduce in size. Q dissolves as it displaces Cu from an aqueous solution of its salt.	[1]	
		[1]	
B6(a)(ii)	It acts as an oxidising agent.	[1]	
	Copper(II) sulfate solution is being reduced as the oxidation state of Cu decreases from +2 in CuSO ₄ to 0 in Cu.	[1]	
B6(b)(i)	Metal R is a very reactive metal which reacts with water in the copper (II) sulfate solution to produce bubbles of hydrogen gas.	[1]	
	$R(s) + 2H_2O(l) \rightarrow R(OH)_2(aq) + H_2(g)$	[1]	
	Numerous candidates mistook copper(II) sulfate for an acid.		
B6(b)(ii)	Collect the hydrogen gas in a test tube. Insert a <u>lighted splint</u> into the test tube of hydrogen gas. The flame will <u>extinguish</u> with a 'pop' sound.	[1] [1]	
	Wrong terms include "lighted splinter"/ "glowing splint". Credit was not given if candidate failed to mention that the flame would be extinguished.		
B6(c)	$P < Cu < Q < R$	[1]	
		[Total:9]	

Section C: (30 marks)

E.C.F. error carried forward, not meant for within the same part of Q, but across different parts.
B.O.D. Benefit of doubt, given for answers that do not differ much from the answer and "may be accepted" by the Cambridge examiners. However, students should not write such answers as they are not guaranteed of obtaining the full credit for the answer.

C1(a)(i)	The process is melting.	[1]	R: Freezing / boiling
(a)(ii)	If pressure is increased, melting would occur at a <u>higher temperature</u> . At a higher pressure, the particles are pressed closer together. More energy is required to overcome the <u>stronger</u> attractive forces between the particles. OR Increased in pressure, <u>decreases</u> the average kinetic energy of the particles as the forces of attraction are stronger, thus more energy is required to overcome the stronger attractive forces between the particles. OR More heat energy is required to overcome the increased in pressure, to allow the particles to slide over each other. Most students explained that "increased in pressure will result in an increase in kinetic energy, thus lesser energy required to overcome the forces of attraction." Indeed, increase in pressure will result an immediate increase in temperature. However, the question asked about the melting point and not about the instantaneous increase in temperature. Note: In melting process, bonds are not broken.	[1] [1]	R: Bonds are broken
(b)(i)	B to C	[1]	
(b)(ii)	D to E OR D to F OR C to F The optimum answer would have been, a point between C and D to point F. Student must at the minimum recognise that a point on the line in the phase diagram represent a phase change. Therefore, the answer <u>must</u> encompass the phase change from D to E in the heating curve.	[1]	
(c)	It represents the temperature and pressure where all three phases (solid, liquid and gas) exist together / in equilibrium. (or other reasonable answers.)	[1]	B.O.D for three phases. Note: plasma is also a state of matter.
(d)(i)	The particles change from being <u>closely packed in orderly manner</u> to being <u>very far apart</u> , in a <u>disorderly manner</u> . Particles are originally <u>vibrating in fixed positions</u> , and at point 5 they are moving in <u>randomly</u> at fast speed. OR The particles at point 4 are <u>closely packed in orderly manner</u> , <u>vibrating about fixed positions</u> . As temperature increases to point 5, the particles are <u>spaced far apart</u> , <u>moving randomly</u> at fast speed.	[1] [1] [1] [1]	
(d)(ii)	Sublimation	[1]	
(d)(iii)	Carbon dioxide (dry ice), ammonium chloride, iodine, naphthalene (mothballs) (Any 2)	[1]	R: ammonium. ammonia, iodide.

C2(a)																															
	<table border="1"> <thead> <tr> <th></th> <th>K</th> <th>Fe</th> <th>O</th> </tr> </thead> <tbody> <tr> <td>Mass</td> <td>39.4</td> <td>28.3</td> <td>32.3</td> </tr> <tr> <td>Ar</td> <td>39</td> <td>56</td> <td>16</td> </tr> <tr> <td>No of moles</td> <td>$\frac{39.4}{39}$ $= 1.0103$</td> <td>$\frac{28.3}{56}$ $= 0.50536$</td> <td>$\frac{32.3}{16}$ $= 2.0188$</td> </tr> <tr> <td>Divide by smallest no</td> <td>$\frac{1.0103}{0.50536}$</td> <td>$\frac{0.50536}{0.50536}$</td> <td>$\frac{2.0188}{0.50536}$</td> </tr> <tr> <td>ratio</td> <td>1.9992</td> <td>1</td> <td>3.9948</td> </tr> <tr> <td>simplest ratio</td> <td>2</td> <td>1</td> <td>4</td> </tr> </tbody> </table>		K	Fe	O	Mass	39.4	28.3	32.3	Ar	39	56	16	No of moles	$\frac{39.4}{39}$ $= 1.0103$	$\frac{28.3}{56}$ $= 0.50536$	$\frac{32.3}{16}$ $= 2.0188$	Divide by smallest no	$\frac{1.0103}{0.50536}$	$\frac{0.50536}{0.50536}$	$\frac{2.0188}{0.50536}$	ratio	1.9992	1	3.9948	simplest ratio	2	1	4		
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	As this is a proving question, student are reminded of the need for clear working. Without any working, showing 0.5:1:2 is not going to give you any credit as this could be achieved from reverse engineering.																														
(b)(i)	$\text{Fe}_2\text{O}_3 + 3\text{Cl}_2 + 10\text{KOH} \rightarrow 2\text{K}_2\text{FeO}_4 + 6\text{KCl} + 5\text{H}_2\text{O}$	[1]																													
	Students are too obsessed with trying to balanced the equation. They should learn to move on as the rest of the question does not require them to get the correct mole ratio before the marks can be awarded.																														
(b)(ii)	No of moles of $\text{Fe}_2\text{O}_3 = \frac{2}{2(56) + 3(16)}$ $= 0.0125 \text{ mol}$ No of moles of $\text{Cl}_2 = 1920 / 24000$ $= 0.0800 \text{ mol}$ Molar ratio $\text{Fe}_2\text{O}_3 : \text{Cl}_2$ $= 1 : 3$ $= 0.0125 : 0.0375$ Hence, 0.0125 mol of Fe_2O_3 would require 0.0375 mol of Cl_2. However, there is 0.0800 mol of Cl_2 which is more than the 0.0375 mol of Cl_2 that we require, thus, Fe_2O_3 is the limiting reagent.	[1] e.c.f. based on (b)(i). [1] given for no. of moles of Cl_2 [1] Clear explanation and reasoning																													
(b)(iii)	Molar ratio $\text{Fe}_2\text{O}_3 : \text{K}_2\text{FeO}_4$ $= 1 : 2$ $= 0.0125 : 0.0250$ Mass of $\text{K}_2\text{FeO}_4 = 0.0250 \times [2(39) + 56 + 4(16)]$ $= 0.0250 \times 198$ $= 4.95 \text{ g (3 sf)}$	[1]	Accept: didn't round off																												
(c)	Fe_2O_3 is oxidised. The oxidation state of iron increased from +3 in Fe_2O_3 to +6 in K_2FeO_4. Cl_2 is reduced as the oxidation state of chlorine decreased from 0 in Cl_2 to -1 in KCl. Since oxidation and reduction occurs simultaneously, the above reaction is a redox reaction	[3]																													
	1st mark awarded for 1 correct oxidation/reduction with explanation. 2nd mark for both correct. 3rd mark awarded for error free. e.g. oxidation state of which																														

	element is not clearly defined, missing the final statement, missed out which reactant is oxidised/reduced to which product. Marks are not awarded for just writing "Since oxidation and reduction occurs simultaneously, the above reaction is a redox reaction" only,																
(d)	It is an oxidising agent/ It can be reduced by I ⁻ ions	[1]															
C3(a)	$\text{Ba(OH)}_2 (\text{aq}) + \text{H}_2\text{SO}_4 (\text{aq}) \rightarrow \text{BaSO}_4 (\text{s}) + 2\text{H}_2\text{O} (\text{l})$	[2]	Ba ≠ Br														
(b)(i)	<u>Filtration</u> using filter funnel and filter paper. Barium sulfate will be collected as <u>residue</u>. Water will be collected as <u>filtrate</u>.	[1]															
	Majority of students misinterpreted the question as a preparation of salt question. However, question only asked how the products can be separated and obtained. The question also did not mention anything about obtaining a pure and dry sample, thus, there is no need to wash with cold distilled water or dry between pieces of filter paper	[1]															
(b)(ii)	No of moles of barium sulfate formed $= (10/1000) \times 0.5$ $= 0.005\text{mol}$ Mass of barium sulfate formed $= 0.005 \times 233 = 1.17\text{g}$ (3sf)	[1]															
(c)(i)	<table border="1"> <tr> <th>Test tube</th> <th>1</th> <th>2</th> <th>3</th> <th>4</th> <th>5</th> <th>6</th> </tr> <tr> <td>Electrical Conductivity (Poor/Good)</td> <td>Good</td> <td>Good</td> <td>Good</td> <td>Poor</td> <td>Good</td> <td>Good</td> </tr> </table>	Test tube	1	2	3	4	5	6	Electrical Conductivity (Poor/Good)	Good	Good	Good	Poor	Good	Good	[1]	no e.c.f. accepted B.O.D. given for symmetry about test tube 4 i.e. test tube 3 and 5 poor
Test tube	1	2	3	4	5	6											
Electrical Conductivity (Poor/Good)	Good	Good	Good	Poor	Good	Good											
(c)(ii)	The electrical conductivity for test tube 1, 2 and 3 are good as there is <u>excess aqueous barium hydroxide</u>, therefore presence of <u>mobile ions</u> to conduct electricity. In test tube 4, the poor electrical conductivity is due to formation of solid <u>barium sulfate and water</u> which are poor electrical conductors and <u>there is no excess of aqueous barium hydroxide or dilute sulfuric acid</u>, therefore there is <u>absence of mobile ions</u> to conduct electricity. In test tube 5 and 6, the <u>excess dilute sulfuric acid</u> results in <u>presence of mobile ions</u> in the solution to conduct electricity. Students are not specific enough in their answers. Often writing things like "in test tubes 1, 2, 3, 5 and 6, there are mobile ions to conduct electricity". OR "In test tube 4, barium hydroxide completely reacts with dilute sulfuric acid thus there is no electrical conductivity" without mentioning the products.	[1] [1] [1]															

