3.5 CHEMISTRY (233)

Chemistry is examined using three papers. Two papers, 233/1 and 233/2 test theory. Each of the two papers is taken in 2 hours and is marked out of 80 marks. Paper 233/3 tests the practical part of the syllabus. It is taken in 2¼ hours and is marked out of 40 marks. The three papers are thus marked out of a total of 200 marks.

Table 12: Performance of Chemistry in the Years 2009, 2010, 2011 and 2012.

Year	Paper	Candidature	Maximum Score	Mean Score	Standard Deviation
2009	1	**329,730**	80	12.49	9.50
	2		80	14.93	12.04
	3		40	10.86	4.55
	Overall		**200**	**38.23**	**24.53**
2010	1	**347,364**	80	18.78	14.48
	2		80	16.19	13.25
	3		40	14.87	5.60
	Overall		**200**	**49.79**	**31.57**
2011	1	**403,070**	80	18.43	14.86
	2		80	16.99	13.95
	3		40	11.91	6.30
	Overall		**200**	**47.31**	**33.51**
2012	1	427,190	80	22.36	14.17
	2	427,212	80	17.18	14.50
	3	427,167	40	16.34	6.73
	Overall	427,386	**200**	**55.86**	**34.10**

From the table it can be observed that:

(i) The candidature went up from 403,070 in 2011 to 427,386 in 2012. An increment of 6%.

(ii) Performance in all the three papers went up. 233/2 increased marginally by 0.19.

(iii) The means for 233/1 and 233/3 went up by 3.93 and 4.43 respectively.

(iv) Overall performance in chemistry 233 went up from a mean of 47.31 in 2011 to 55.85 in 2012.

The increase in performance is attributed to a change in marking style. Examiners were able to award marks where candidates gave partially correct responses. In the past these partially correct responses were awarded zero marks.

THE QUESTIONS WHICH WERE PERFORMED POORLY ARE BRIEFLY DISCUSSED BELOW

3.5.1 Chemistry Paper 1 (233/1)

Questions 11

The empirical formula of A is CH_2Br. Given that 0.470g of A occupies a volume of $56cm^3$ at 546K and 1 atmospheric pressure, determine its molecular formula.
(H = 1.0, C = 12.0, Br = 80.0, molar gas volume at STP = 22.4 dm^3). (3 marks)

In this question, candidates were required to study the information given and find the molecular mass of the compound whose empirical formula is given then determine the molecular formula of the compound.

Weaknesses

Candidates were not able to calculate correctly the molecular mass of the compound hence they could not determine the correct molecular formula. This weakness could have been caused by lack of enough practice on questions dealing with Gay-Lussac's Law and the molar gas volume. Candidates should be thoroughly drilled on all topics of syllabus. During teaching, different types of questions should be set on these topics. Once the candidates attempt the questions they should be discussed thoroughly. Teachers should arrange for remedial teaching and re-drilling to candidates of low ability so that they are brought to the same level with the average and above average candidates.

Expected Responses

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}$ $(\frac{1}{2})$

$P_2 = 1$ litre
$V_2 = ?$
$T_2 = 273K$

$P_1 = 1$ atm
$V_1 = 56cm^3$
$T_1 = 546K$

$\frac{1 \times V_1}{273} = \frac{56 \times 1}{546}$

$V_1 = \frac{56 \times 1 \times 273}{546}$

$V1 = 28cm^3$ $(\frac{1}{2})$

0.47g of A occupies $28cm^3$ at STP
? $22400cm^3$

$\frac{0.47 \times 22400}{28} = 376$ $(\frac{1}{2})$

$CH_2Br = 12 + 2 + 80 = 94$ $(\frac{1}{2})$

$94n = 376$
$n = 376/94$
$n = 4$ $(\frac{1}{2})$

$(CH_2Br)_4 = C_4H_8Br_4$ $(\frac{1}{2})$

Question 13

A dynamic equilibrium is established when hydrogen and carbon (IV) oxide react as shown below:

$$H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$$

What is the effect of adding powdered iron catalyst on the position of the equilibrium?
Give a reason. (2 marks)

In this question the candidates were expected to state the effect of a catalyst on the position of equilibrium.

Weaknesses

Some candidates stated that the position of equilibrium shifts to the right. Others wrote, it shifts to the left. Yet others left the question unanswered. These kind of weaknesses show that the topic equilibria and effects of catalysts on position of equilibrium is not well understood.

Candidates were supposed to realize that catalysts do not take part in reactions. They only change the speed at which reactants react in a chemical reaction. If the reaction comes to an equilibrium, they only change the rate at which the equilibrium is attained. Thus they have no effect on either forward or backward reactions.

Teachers should ensure that concepts on each topic are thoroughly understood and where possible use the practical approach method to demonstrate effect of a catalyst.

Expected Responses

The catalyst has no effect on the position of equilibrium. (1)
The catalyst will increase the rate of forward and backward reactions to the same extent. (1)

Question 14

Distinguish between ionisation energy and electron affinity of an element. (2 marks)

In this question candidates were expected to show the difference between ionization energy and electron affinity.

Weaknesses

Some candidates had an idea what ionization energy is but the majority had no idea what electron affinity is. In the past, candidates have been tested on ionization energy but not on electron affinity. It should be known that **all** topics can be tested any time and thus they should be thoroughly covered and proper revision made.

Electron affinity is associated with gaining of electrons while ionization energy is associated with electron loss.

Expected Responses

Ionisation energy

This is the energy required to remove an electron from an atom in its gaseous state. (1)

Electron affinity:

This is the energy change that results in the formation of an ion when an atom gains an electron. (1)

Question 23

Describe how the percentage by mass of copper in copper carbonate can be determined.

(3 marks)

In this question candidates were expected to describe in detail the experimental method which could be used to determine the % by mass of copper in copper (II) carbonate.

Weaknesses

Majority of the candidates did not give the experimental details required. Others just left the question unanswered. Candidates should have realized that copper (II) carbonate can be changed to copper (II) oxide by heating it strongly. The copper(II) oxide can be reduced to copper metal by reduction. The weakness stated could be caused by lack of experimental exposure. Teachers are advised to use the practical approach method in teaching of chemistry. Theoretical teaching should be discouraged. Schools should ensure that enough funds are allocated for purchase of chemicals and equipment if performance is to be improved. The weakness stated could also have been cuased by students not taking enough time to read, understand the demands of the question and interpret it correctly.

It is important for candidates to understand the question before they begin to write answers.
Composure, avoiding nervousness gives candidates confidence and this leads to alertness and unblocks the mind. This improves performance.

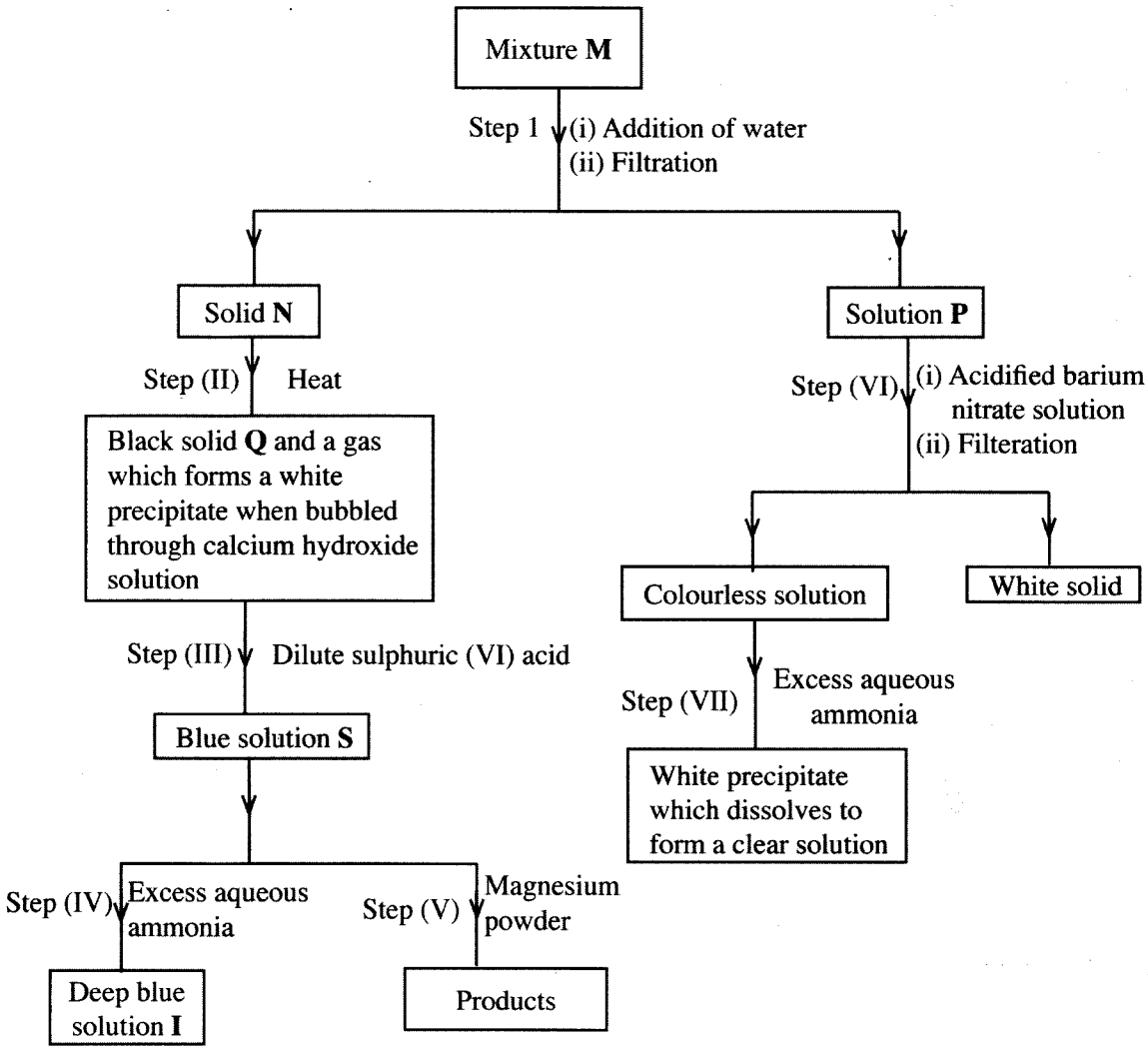
Expected Responses

- Weigh copper carbonate ($\frac{1}{2}$)
- Heat $CuCO_3$ to constant mass in a combustion tube (1)
- Reduce CuO using dry H_2/NH_3 or CO ($\frac{1}{2}$)
- Allow to cool and reweigh to get mass of copper ($\frac{1}{2}$)
- $\% = \frac{Mass\ of\ Cu}{Mass\ of\ CuCO_3} x\ 100$ ($\frac{1}{2}$)

3.5.2 Chemistry Paper 2 (233/2)

Question 6

The flow chart below shows a sequence of reactions involving a mixture of two salts, mixture **M**. Study it and answer the questions that follow.



(a) Write the formula of the following:

(i) anion in solid **Q** (1 mark)

(ii) the two salts present in mixture **M**. (2 marks)

(b) Write an ionic equation for the reaction in step (VI). (1 mark)

(c) State and explain the observations made in step (V). (3 marks)

(d) (i) Starting with Lead (II) oxide, describe how a pure solid sample of lead sulphate can be prepared in the laboratory. (2 marks)

(ii) How can one determine whether the lead sulphate prepared is pure? (2 marks)

In the question, candidates were required to:

1. Read a detailed flow chart on simple experimental processes;
2. Identify anions and cations present in a mixture of two salts.
3. Name the two salts in the mixture;
4. Write ionic equations;
5. Explain some of the observations;
6. Describe how to prepare a salt;
7. State methods of determining purity of a substance.

Weaknesses

Candidates showed weaknesses in:

1. Identifying the anions present in the two salts;
2. naming the salts;
3. writing equations;
4. giving scientific description of some of the observations;
5. describing logically a method of preparing leadsulphate.

This showed serious lack of exposure to experimental processes; students should be exposed to experimental processes. They need to carry out experiments themselves in groups and where it is not possible due to large numbers, class demonstrations should be carried out so that they can see, smell touch and therefore make conclusions.

All practical results should be analysed, discussed thoroughly and logical conclusions made.
Equations should be balanced and have the correct state symbols. Where substances are to be prepared, it is important for candidates to plan first. Decide on how the processes should follow one another starting with the first, second, third etc in a **logical** manner. Remember if the first process is wrong then everything else is wrong.

Expected Responses

(a) (i) Cu^{2+} √1

(ii) $CuCO_3$ √1 / $ZnSO_4$ √1

(b) $Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \longrightarrow BaSO_{4(s)}$ √1

(c) The solution changes from blue to colourless √1 and a brown solid is formed. √1
The magnesium which is above copper in the reactivity series displaces the copper ions √1 from the solution. Apparatus become warm. The reaction is exothermic.

(d) (i) Add nitric (V) acid to √½ lead oxide, filter√½, add a soluble sulphate/ sulphuric acid to the filtrate √½. Filter √½, and wash residue with distilled water √½ to remove traces of the filterate, then dry residue between √½ filter papers /oven.

(ii) Determine the melting √1 point, if it is pure the melting point will be constant. √1

3.5.3 Chemistry Paper 3 (233/3)

Question 2

You are provided with solid **E**. Carry out the experiments below. Write your observations and inferences in the spaces provided.

(a) Place all of solid **E** in a boiling tube. Add about 20 cm^3 of distilled water and shake until all the solid dissolves, label the solution as solution **E**. Use solution **E** for experiments (i) and (ii).

(i) To 2 cm^3 of solution **E**, in a test - tube in each of experiments I, II, III and IV, add:

I. two drops of aqueous sodium sulphate;

Observations	**Inferences**
(1 mark)	(1 mark)

II. five drops of aqueous sodium chloride;

Observations	**Inferences**
(1 mark)	(1 mark)

III. two drops of barium nitrate;

Observations	**Inferences**
(1 mark)	(1 mark)

IV. two drops of lead (II) nitrate;

Observations	**Inferences**
(1 mark)	(1 mark)

(ii) To 2 cm^3 of solution **E**, in a test - tube, add 5 drops of aqueous sodium hydroxide. Add the piece of aluminium foil provided to the mixture and shake. Warm the mixture and test any gas produced with both blue and red litmus papers.

Observations	**Inferences**
(2 marks)	(1 mark)

The question was on qualitative analysis. Candidates were expected to carry out experiments on an unknown compound. Write observations and then draw conclusions.

Weaknesses

- Candidates failed to write correct observations.
- They also failed to use acceptable scientific language in describing the observations.
- Due to lack of correct observations, they could not give the correct conclusions.

Candidates should be encouraged to plan on how to carry out the experiments successfully. They should use **clean** apparatus, use the correct chemicals, distilled water etc. They should write the observations as soon as these are made.

Teachers should give many experiments on qualitative analysis, assist the candidates to write accurate observations and draw conclusions. Candidates can use symbols and where a candidate is not sure of the correct formula or symbol, they can write in words.

Expected Responses

Observation

(a) (i)	(I)	A white precipitate (1)	Presence of Pb^{2+}, Ba^{2+} or Ca^{2+} (1) *1 mark for all the 3 ions* *½ mark for 2 correct ions* *0 mark for one or none*
	(II)	No white precipitate (1)	Absence of Pb^{2+} (1)
	(III)	No white precipitate (1)	SO_4^{2-}, SO_3^{2-}, CO_3^{2-} ions absent (1) *1 mark all the 3* *½ mark for 2 ions correct* *0 mark for one or none*
	(IV)	No white precipitate (1)	Cl^- ions absent (1)
(ii)		Effervescence ½/Bubbles/Fizzing Colourless gas produced ½ Turns red litmus blue ½ Blue litmus remained blue ½ (2 marks)	NO^-_3 present (1)
			(Total 11 marks)

3.7.4 Conclusion

Knowledge in chemistry is mainly used in industrial production of goods e.g. fertilizers, medicines etc. It is important that during teaching that the many benefits of the knowledge is made known to students so that they can build an interest in a chemistry related career in future eg. chemical engineers.

4.4 CHEMISTRY (233)

4.4.1 Chemistry Paper 1 (233/1)

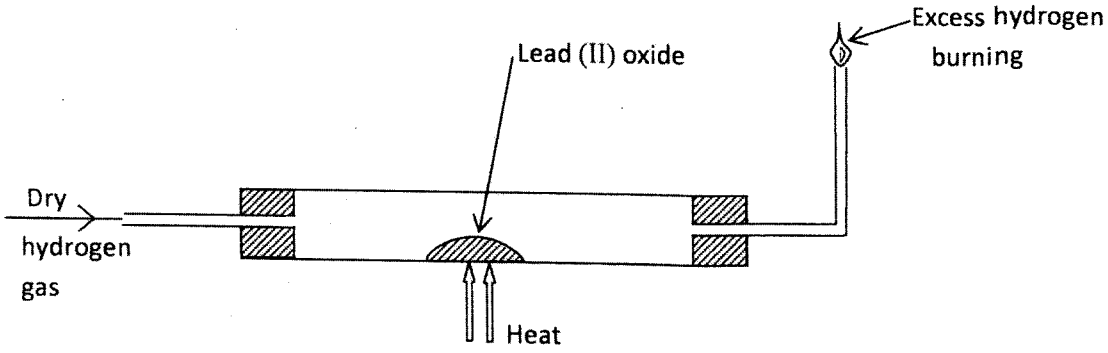
1 Charcoal is a fuel that is commonly used for cooking. When it burns it forms two oxides.

(a) Name the **two** oxides. (2 marks)

(b) State **one** use of any of the two oxides. (1 mark)

2 Iron (III) oxide was found to be contaminated with copper (II) sulphate. Describe how a pure sample of iron (III) oxide can be obtained. (3 marks)

3 In an experiment, dry hydrogen gas was passed over heated Lead (II) Oxide as shown in the diagram below.



State and explain the observations made in the combustion tube. (3 marks)

4 The table below shows properties of some elements **A**, **B**, **C** and **D** which belong to the same period of the periodic table. The letters are not the actual symbols of the elements.

Element	A	B	C	D
Mp (°C)	1410	98	-101	660
Atomic radii (nm)	0.117	0.186	0.099	0.143
Electrical conductivity	Poor	Good	Non conductor	Good

(a) Arrange the elements in the order they would appear in the period. Give a reason. (2 marks)

(b) Select the metallic element which is the better conductor of electricity. Give a reason. (1 mark)

5 A sample of water in a beaker was found to boil at 101.5°C at 1 atmospheric pressure. Assuming that the thermometer was not faulty, explain this observation. (1 mark)

6 Study the information in the table below and answer the questions that follow:

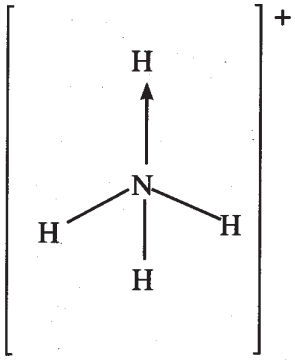
Salt	Solubility (g/100g water)	
	at 40°C	at 60°C
$CuSO_4$	28	38
$Pb(NO_3)_2$	79	98

A mixture containing 35g of $CuSO_4$ and 78g of $Pb(NO_3)_2$ in 100g of water at 60°C was cooled to 40°C.

(a) Which salt crystallised out? Give a reason (2 marks)

(b) Calculate the mass of the salt that crystallised out. (1 mark)

7 Ammonium ion has the following structure:



Label on the structure:

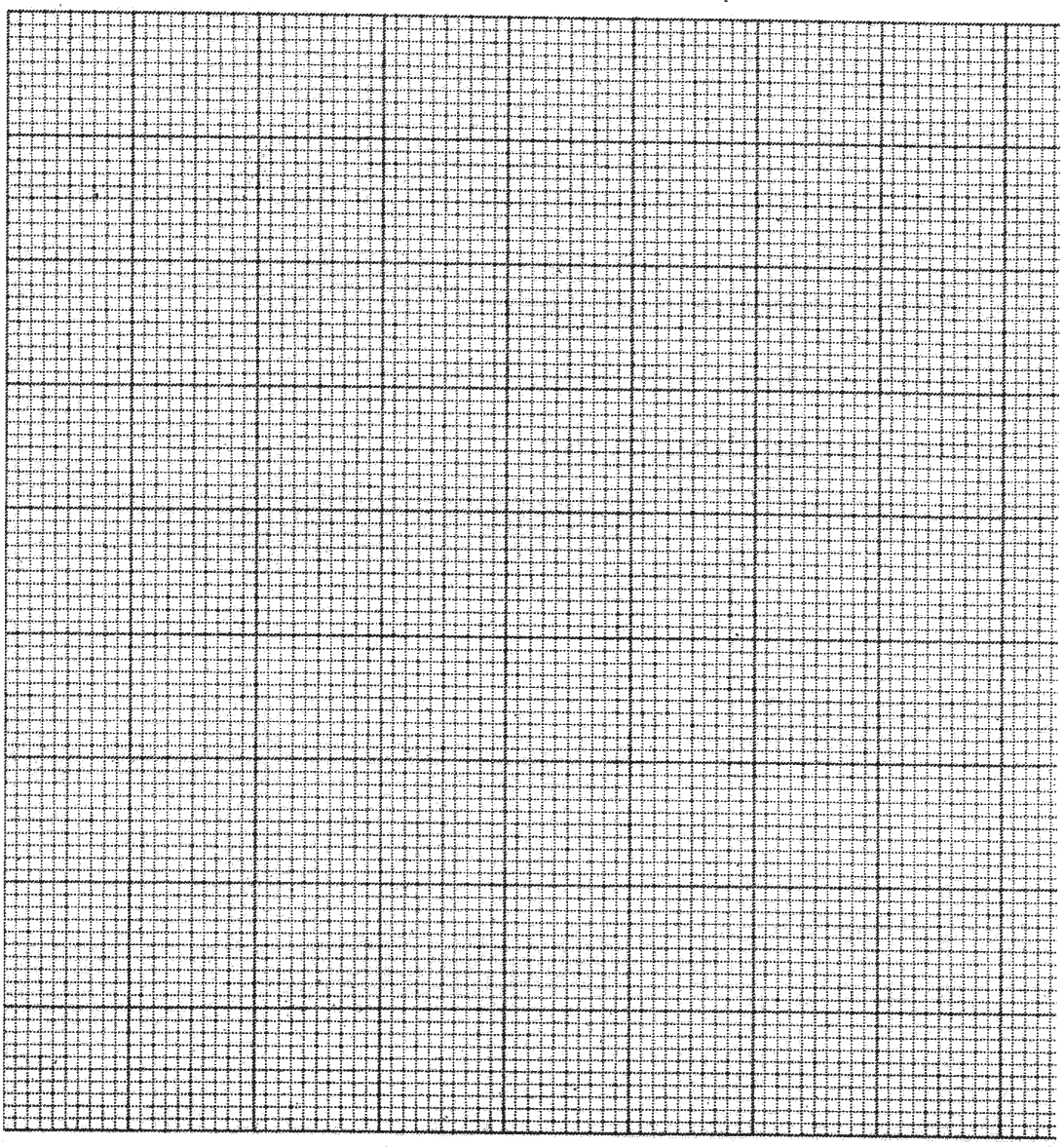
(a) covalent bond; (1 mark)

(b) coordinate (dative) bond. (1 mark)

8 $10cm^3$ of concentrated sulphuric (VI) acid was diluted to $100cm^3$. $10cm^3$ of the resulting solution was neutralised by $36cm^3$ of 0.1M sodium hydroxide solution. Determine the mass of sulphuric (VI) acid that was in the concentrated acid (S = 32.0; H = 1.0; O = 16.0).

(3 marks)

9 120g of iodine - 131 has a half life of 8 days and decays for 32 days. On the grid provided, plot a graph of the mass of iodine - 131 against time. (3 marks)

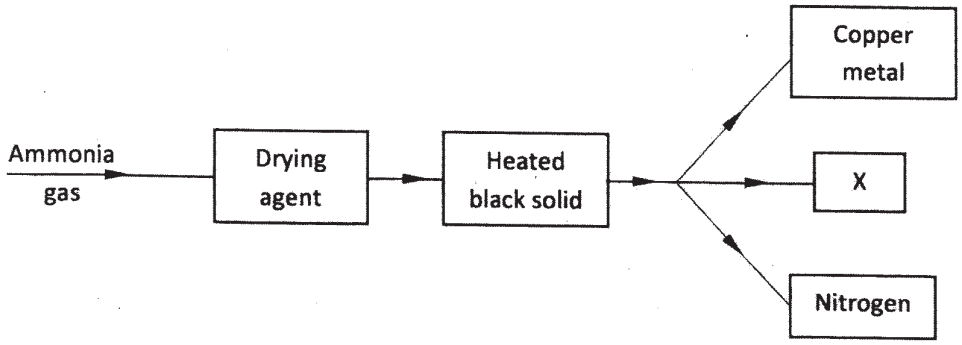


10 (a) Name **two** cations that are present in hard water. (1 mark)

(b) Explain how the ion exchange resin softens hard water. (2 marks)

11 The empirical formula of A is CH_2Br. Given that 0.470g of A occupies a volume of $56cm^3$ at 546K and 1 atmospheric pressure, determine its molecular formula.
(H = 1.0, C = 12.0, Br = 80.0, molar gas volume at STP = 22.4 dm^3). (3 marks)

12 Study the flow chart below and answer the questions that follow.



(a) Name a suitable drying agent for ammonia. (1 mark)

(b) Describe one chemical test for ammonia. (1 mark)

(c) Name X. (1 mark)

13 A dynamic equilibrium is established when hydrogen and carbon (IV) oxide react as shown below:

$$H_2(g) + CO_2(g) \rightleftharpoons H_2O(g) + CO(g)$$

What is the effect of adding powdered iron catalyst on the position of the equilibrium? Give a reason. (2 marks)

14 Distinguish between ionisation energy and electron affinity of an element. (2 marks)

15 Below is a representation of an electrochemical cell.

$$Pb(s) / Pb^{2}(aq) // Ag^{+}(aq) / Ag(s)$$

(a) What does // represent? (1 mark)

(b) Given the following:

	$E^{\theta}V$
$Pb^{2+}_{(aq)} + 2e \longrightarrow Pb(s)$;	-0.13
$Ag^{+}_{(aq)} + e \longrightarrow Ag(s)$;	$+0.80$

Calculate the E.M.F of the electrochemical cell. (2 marks)

16 Use the following information on substances S, T, V and hydrogen to answer the questions that follow:

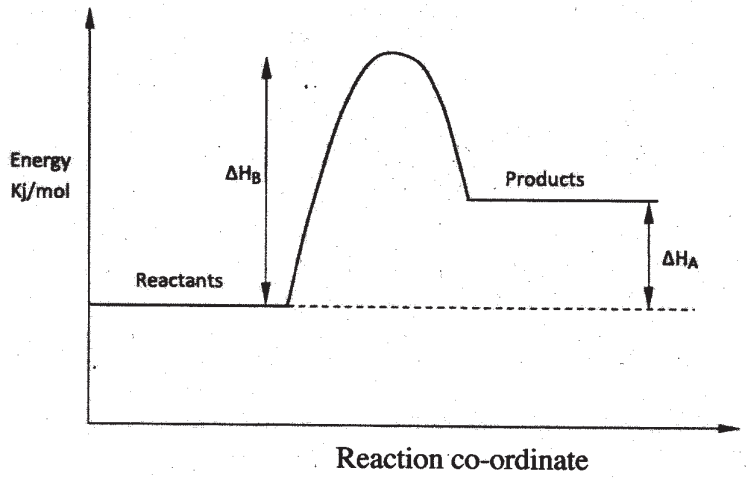
(i) T displaces V from a solution containing V ions.

(ii) Hydrogen reacts with the heated oxide of S but has no effect on heated oxide of V.

(a) Arrange substances S, T, V and hydrogen in the order of increasing reactivity. (2 marks)

(b) If T and V are divalent metals, write an ionic equation for the reaction in (i) above. (1 mark)

17 Study the energy level diagram below and answer the questions that follow.



(a) Give the name of ΔH_A. (1 mark)

(b) How can ΔH_B be reduced? Give a reason. (2 marks)

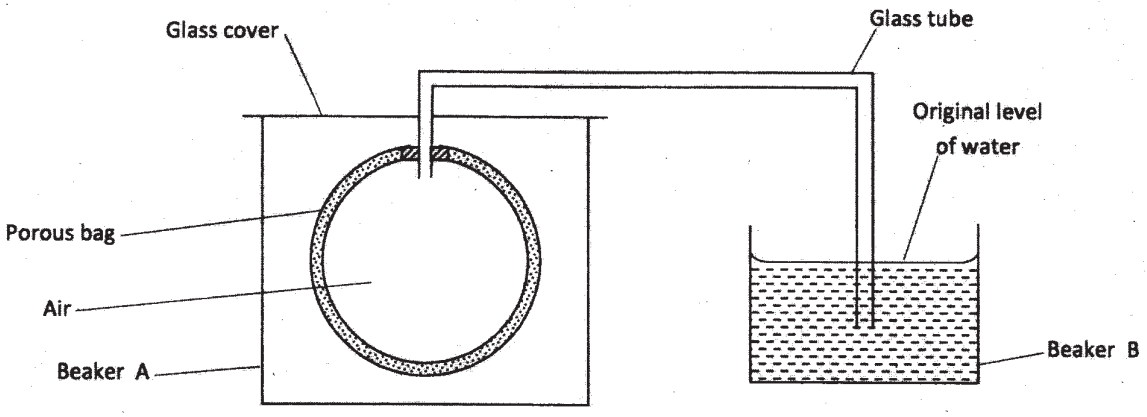
18 Acidified potassium manganate (VII) solution is decolourised when sulplur (IV) oxide is bubbled through it. The equation for the reaction is given below.

$$2H_2O_{(l)} + 5SO_{2(g)} + 2KMnO_{4(aq)} \longrightarrow K_2SO_{4(aq)} + 2MnSO_{4(aq)} + 2H_2SO_{4(aq)}$$

(a) Which reactant is oxidised? Explain. (2 marks)

(b) Other than the manufacture of sulphuric (VI) acid, state one other use of sulphur (IV) oxide. (1 mark)

19 The set up shown below was used to investigate a property of hydrogen gas.



State and explain the observation that would be made in the glass tube if beaker A was filled with hydrogen gas. (3 marks)

20 Draw and name the isomers of pentane. (3 marks)

21 Give **two** uses of the polymer polystyrene. (1 mark)

22 Aluminium is both malleable and ductile.

(a) What is meant by?

(i) malleable; (1 mark)

(ii) ductible. (1 mark

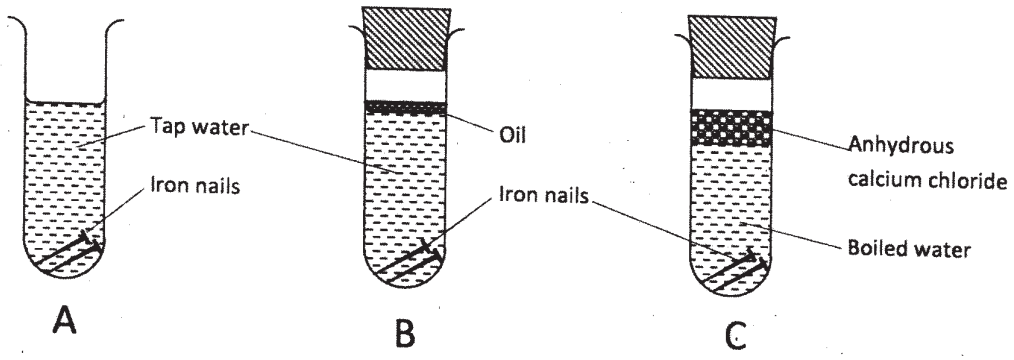
(b) State **one** use of aluminium based on:

(i) malleability ($\frac{1}{2}$ *mark*)

(ii) ductility ($\frac{1}{2}$ *mark*)

23 Describe how the percentage by mass of copper in copper carbonate can be determined. (3 marks)

24 The following set up of three test-tubes was used to investigate rusting of iron. Study it and answer the questions that follow.



(a) Give a reason why rusting did not occur in test-tube C. (1 mark)

(b) Aluminium is used to protect iron sheets from rusting.
Explain **two** ways in which aluminium protects iron from rusting. (2 marks)

25 Describe how a solid sample of potassium sulphate can be prepared starting with $200cm^3$ of 2M potassium hydroxide. (3 marks)

26 Describe **two** chemical tests that can be used to distinguish ethanol from ethanoic acid. (3 marks)

27 (a) The electronic arrangement of the ion of element Q is 2.8.8. If the formula of the ion is Q^{3-}, state the group and period to which Q belongs.

Group. (½ mark)

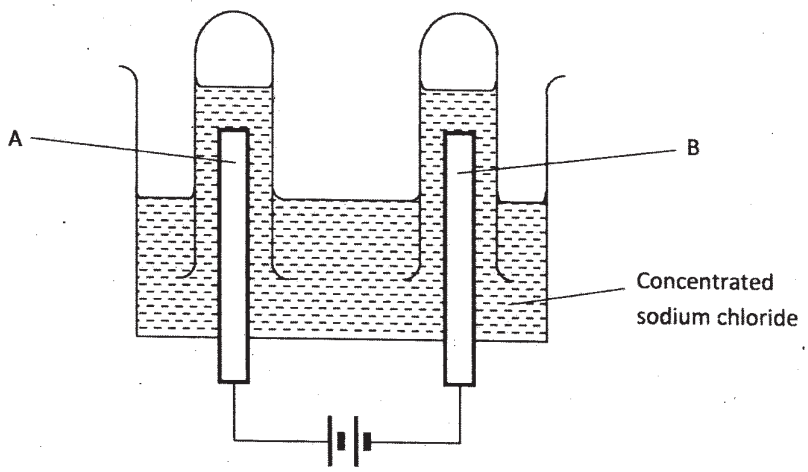
Period. (½ mark)

(b) Helium, neon and argon belong to group 8 of the periodic table. Give:

(i) the general name of these elements, (1 mark)

(ii) one use of these elements. (1 mark)

28 The apparatus shown in the diagram below were used to investigate the products formed when concentrated sodium chloride was electrolysed using inert electrodes.



(a) Write the equation for the reaction that takes place at electrode A. (1 mark)

(b) If the concentrated sodium chloride was replaced with dilute sodium chloride, what product would be formed at electrode A? Explain.

(2 marks)

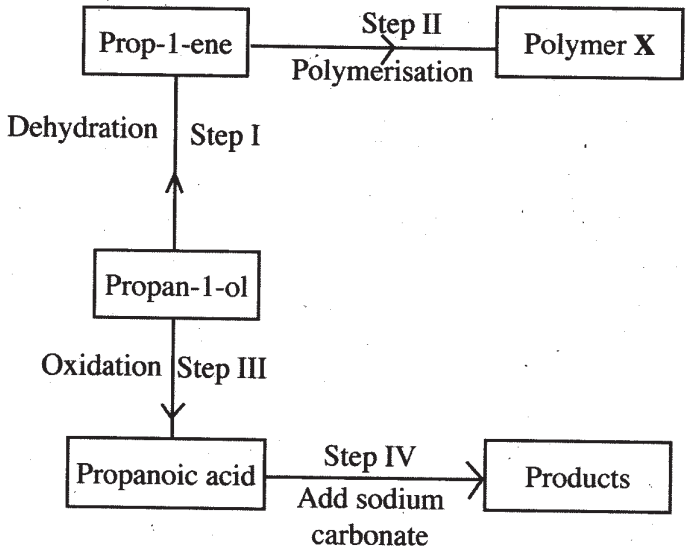
29 (a) State and explain what would happen if a dry blue litmus paper was dropped in a gas jar of chlorine. (1 mark)

(b) By using only dilute hydrochloric acid, describe how a student can distinguish between barium sulphite from barium sulphate. (2 marks)

1 (a) Draw the structural formula for all the isomers of $C_2H_3Cl_3$. (2 marks)

(b) Describe **two** chemical tests that can be used to distinguish between ethene and ethane. (4 marks)

(c) The following scheme represents various reactions starting with propan-1-ol. Use it to answer the questions that follow.



(i) Name one substance that can be used is step I. (1 mark)

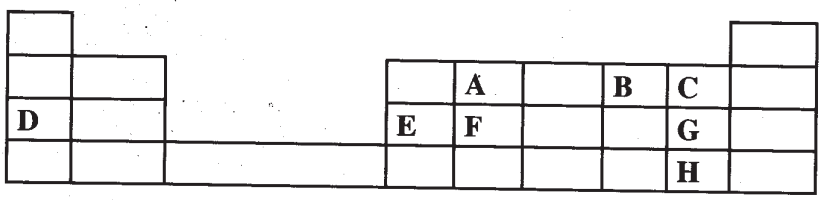
(ii) Give the general formula of **X**. (1 mark)

(iii) Write the equation for the reaction in step IV. (1 mark)

(iv) Calculate the mass of propan-1-ol which when burnt completely in air at room temperature and pressure would produce 18dm^3 of gas. (C = 12.0; O = 16.0; H = 1.0; Molar gas volume = 24 dm^3).

(3 marks)

2 The grid below is part of the periodic table. Use it to answer the questions that follow. (The letters are not the actual symbols of the elements).



(a) Which is the most reactive non-metallic element shown in the table? Explain. (2 marks)

(b) (i) Write the formula of the compound formed when element **A** reacts with element **B**. (1 mark)

(ii) Name the bond type in the compound formed in b(i) above. (1 mark)

(c) (i) What is the name given to the group of elements where **C**, **G** and **H** belong? (1 mark)

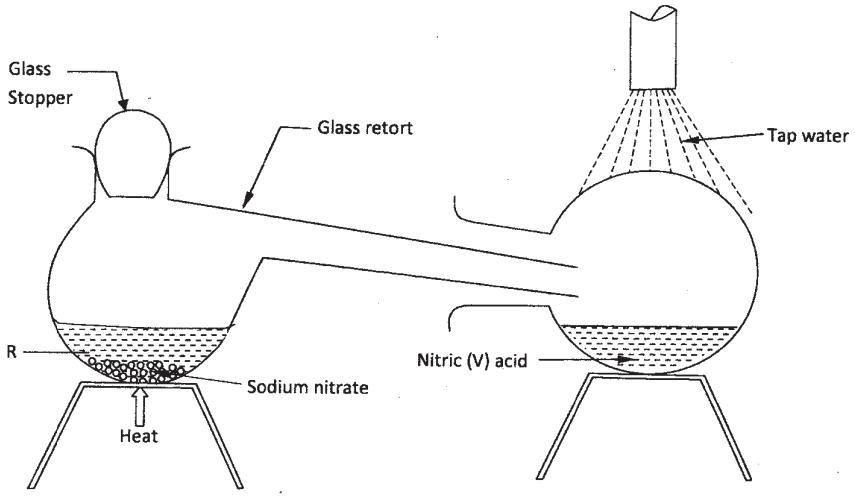
(ii) Write an equation for the reaction that occurs when **C** in gaseous form is passed through a solution containing ions of element **H**. (1 mark)

(d) The melting points of elements **F** and **G** are 1410 °C and -101 °C respectively. In terms of structure and bonding, explain why there is a large difference in the melting points of **F** and **G**. (2 marks)

(e) **D** forms two oxides. Write the formula of each of the two oxides. (1 mark)

(f) **J** is an element that belongs to the 3rd period of the periodic table and is a member of the alkaline earth elements. Show the position of **J** in the grid. (1 mark)

3 In the laboratory, small quantities of nitric (V) acid can be generated using the following set up. Study it and answer the questions that follow.



(a) (i) Give the name of substance R. (1 mark)

(ii) Name one other substance that can be used in place of sodium nitrate. (1 mark)

(iii) What is the purpose of using tap water in the set up above? (1 mark)

(b) Explain the following:

(i) it is **not** advisable to use a stopper made of rubber in the set-up (1 mark)

(ii) the reaction between copper metal with 50% nitric (V) acid in an open test-tube produces brown fumes. (1 mark)

(c) (i) Nitrogen is one of the reactants used in the production of ammonia, name two sources of the other reactant. (2 marks)

(ii) A factory uses nitric (V) acid and ammonia gas in the preparation of a fertilizer. If the daily production of the fertilizer is 4800 kg; calculate the mass of ammonia gas used in kg. (N = 14.0; O = 16.0; H= 1.0) (3 marks)

(iii) State **two** other uses of nitric (V) acid other than the production of fertilizers. (2 marks)

4 The factors which affect the rate of reaction between lead carbonate and dilute nitric (V) acid were investigated by carrying out three experiments:

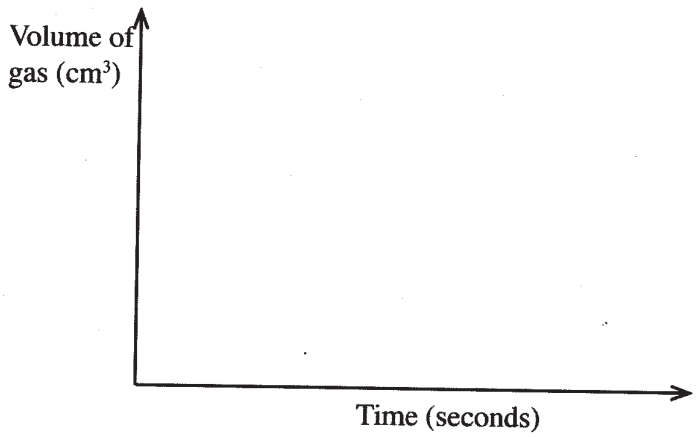
Experiment number	Lead carbonate	Concentration of nitric (V) acid
1	Lumps	4M
2	Powdered	4M
3	Lumps	2M

(a) Other than concentration, name the factor that was investigated in the experiments. (1 mark)

(b) For each experiment, the same volume of acid (excess) and mass of lead carbonate were used and the volume of gas liberated measured with time.

(i) Draw a set up that can be used to investigate the rate of reaction for one of the experiments. (3 marks)

(ii) On the grid provided, sketch the curves obtained when the volume of gas produced was plotted against time for each of the three experiments and label each as 1, 2 or 3.. (4 marks)



(iii) Write an equation for the reaction that took place. (1 mark)

(c) If the experiments were carried out using dilute hydrochloric acid in place of dilute nitric (V) acid, the reaction would start, slow down and eventually stop. Explain these observations.

(2 marks)

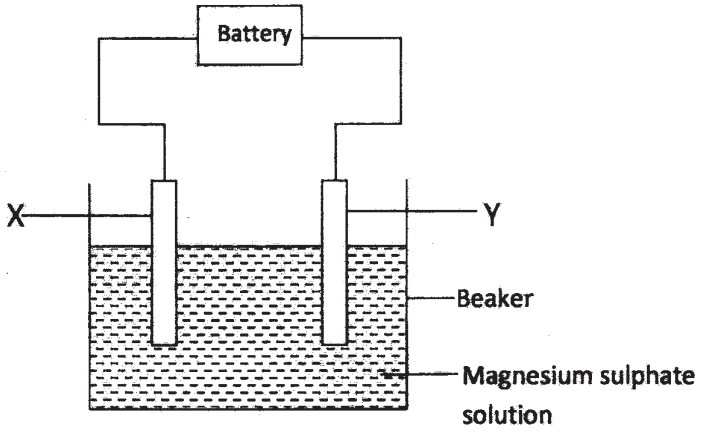
(d) A solution of bromine gas in water is an example of a chemical reaction in a state of balance. The reaction involved is represented by the equation below.

$$Br_{2(g)} + H_2O_{(l)} \rightleftharpoons 2H^+_{(aq)} + Br^-_{(aq)} + OBr^-_{(aq)}$$

Yellow / Orange — Colourless

State and explain the observation made when hydrochloric acid is added to the mixture at equilibrium. (2 marks)

5 (a) The set up below was used to investigate the products formed at the electrodes during electrolysis of aqueous magnesium sulphate using inert electrodes. Use it to answer the questions that follow.



(i) During the electrolysis, hydrogen gas was formed at electrode Y. Identify the anode. Give a reason for your answer. (2 marks)

(ii) Write the equation for the reaction which takes place at electrode X.

(1 mark)

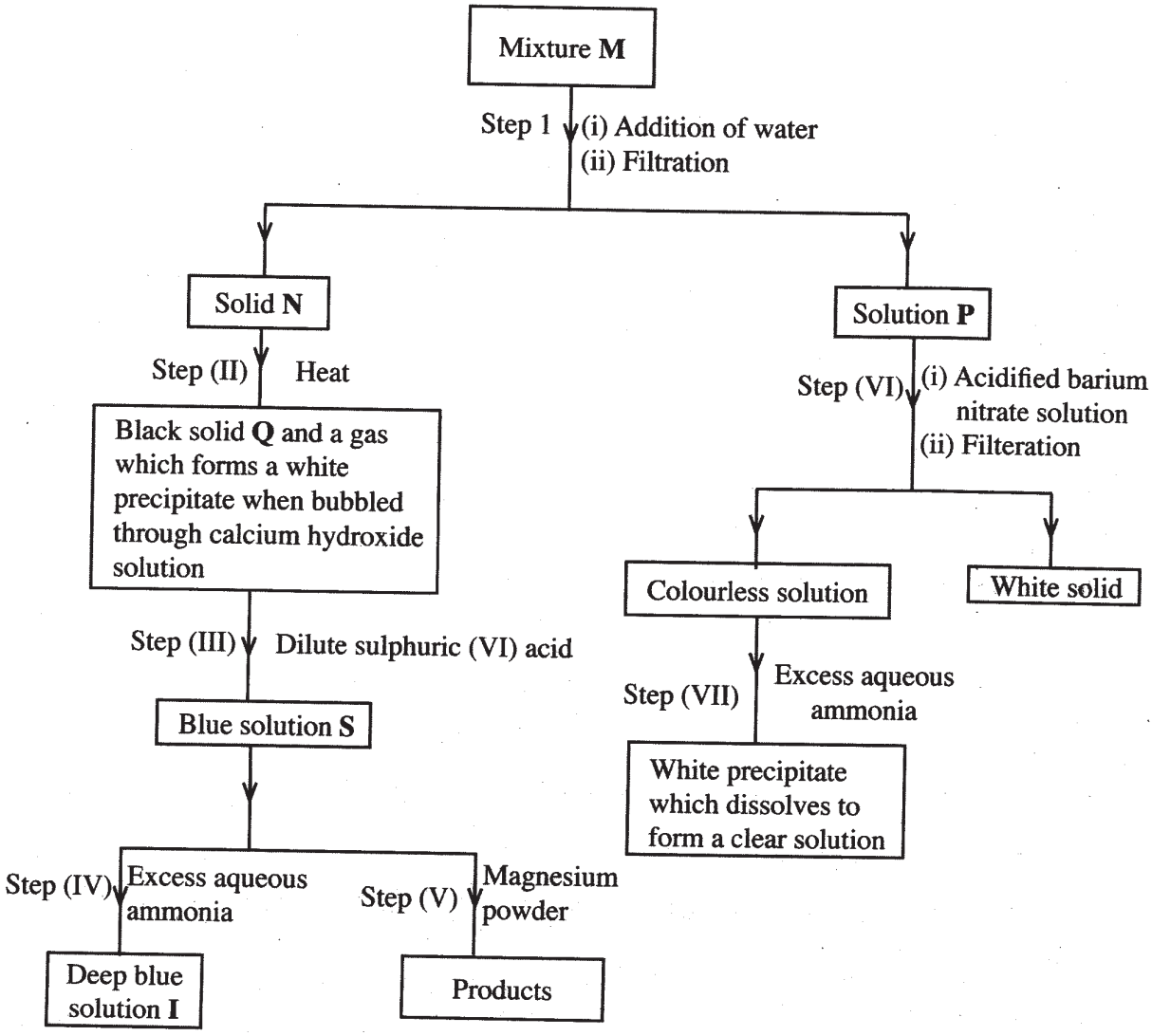
(iii) Why is the concentration of magnesium sulphate expected to increase during electrolysis? (2 mark)

(iv) What will be observed if red and blue litmus papers were dipped into the solution after electrolysis? (2 marks)

(b) During electrolysis of magnesium sulphate, a current of 0.3A was passed for 30 minutes. Calculate the volume of gas produced at the anode
(Molar gas volume = 24dm^3; 1 Faraday = 96,500 C). (3 marks)

(c) State **two** applications of electrolysis. (1 mark)

6 The flow chart below shows a sequence of reactions involving a mixture of two salts, mixture **M**. Study it and answer the questions that follow.



(a) Write the formula of the following:

(i) anion in solid **Q** (1 mark)

(ii) the two salts present in mixture **M**. (2 marks)

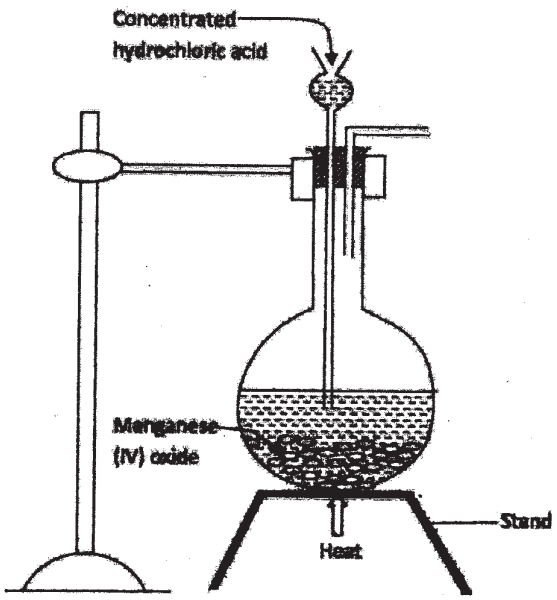
(b) Write an ionic equation for the reaction in step (VI). (1 mark)

(c) State and explain the observations made in step (V). (3 marks)

(d) (i) Starting with Lead (II) oxide, describe how a pure solid sample of lead sulphate can be prepared in the laboratory. (2 marks)

(ii) How can one determine whether the lead sulphate prepared is pure? (2 marks)

7 (a) The diagram below is part of a set up used to prepare and collect dry chlorine gas.



(i) Complete the diagram to show how a dry sample of chlorine gas can be collected. (3 marks)

(ii) Name another substance and condition that can be used instead of manganese (IV) oxide. (1 mark)

(iii) Write an equation for each of the following:

I. chlorine gas reacting with iron (1 mark)

II. chlorine gas reacting with hot concentrated sodium hydroxide solution. (1 mark)

(b) An oxide of chlorine of mass 1.83g was found to contain 1.12g of oxygen. Determine the empirical formula of the oxide (O = 16.0; Cl = 35.5). (3 marks)

(c) Other than the manufacture of weed killers, name **two** other uses of chlorine. (2 marks)

4.4.3 Chemistry Paper 3 (233/3)

1. You are provided with:

   - solution **A** containing an oxidising agent **A**;
   - solution **B**, 0.05 M aqueous sodium thiosulphate;
   - solution **C** containing a reducing agent **C**;
   - aqueous potassium iodide;
   - solution **D**, starch solution.

   You are required to determine the:

   - concentration of solution **A**;
   - rate of reaction between the oxidising agent **A** and the reducing agent **C**.

Procedure 1

1. Using a pipette and **pipette filler**, place 25.0 cm^3 of solution **A** into a 250 ml conical flask.

2. Measure 10 cm^3 of aqueous potassium iodide and add it to solution **A** in the conical flask. Shake the mixture. Add 10 cm^3 of 2 M sulphuric (VI) acid to the mixture and shake.

3. Fill a burette with solution **B** and use it to titrate the mixture in the conical flask until it just turns **orange-yellow**. Add 2 cm^3 of solution **D** to the mixture in the conical flask. Shake thoroughly. Continue titrating until the mixture **just turns colourless**. Record your results in **table 1** below.

4. Repeat the procedure and complete table 1. **Retain the remainder of** solution **A** and solution **D** for use in procedure II.

Table 1	**I**	**II**	**III**
Final burette reading			
Initial burette reading			
Volume of solution **B** used (cm^3)			

(4 marks)

(a) Calculate the:

(i) average volume of solution **B** used; (1 mark)

(ii) number of moles of sodium thiosulphate. (1 mark)

(b) Given that one mole of **A** reacts with six moles of sodium thiosulphate, calculate the:

(i) number of moles of **A** that were used; (1 mark)

(ii) concentration of solution **A** in moles per litre. (2 marks)

Procedure II

1. Label six test - tubes as 1, 2, 3, 4, 5 and 6 and place them in a test - tube rack.

2. Using a clean burette, measure the volumes of distilled water shown in **table 2** into the labelled test - tubes.

3. Using a burette, measure the volumes of solution **A** shown in **table 2** into each of the test - tubes.

4. Clean the burette and rinse it with about 5 cm^3 of solution **C**.

5. Using the burette, measure 5 cm^3 of solution **C** and place it into a 100 ml beaker.

6. Using a 10 ml measuring cylinder, measure 5 cm^3 of solution **D** and add it to the beaker containing solution **C**. Shake the mixture.

7. Pour the contents of test - tube number 1 to the mixture in the beaker and immediately start a stop watch. Swirl the contents of the beaker. Record the time taken for a **blue** colour to appear in **table 2**.

8. Repeat steps 5 to 7 using the contents of test - tube numbers 2, 3, 4, 5 and 6.

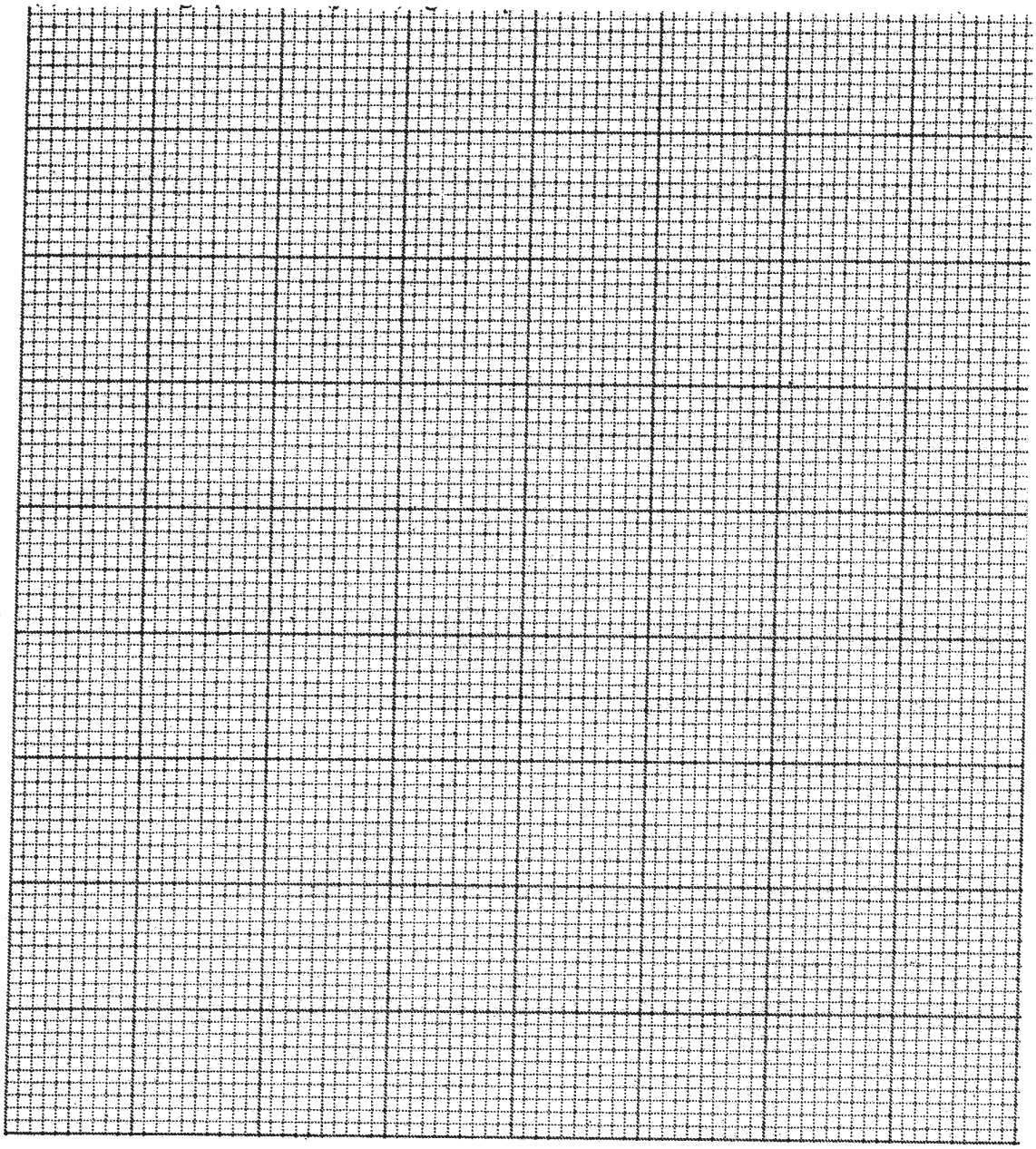
9. Complete **table 2** by computing Rate $= \frac{1}{\text{time}} (S^{-1})$.

Table 2

Test - tube number	1	2	3	4	5	6
Volume of distilled water (cm^3)	0	2	3	5	6	7
Volume of solution **A** (cm^3)	10	8	7	5	4	3
Time (seconds)						
Rate $= \frac{1}{\text{time}} (S^{-1})$						

(6 marks)

(a) Plot a graph of rate (y-axis) against volume of solution **A**. (3 marks)



(b) What time would be taken for the blue colour to appear if the experiment was repeated using 4 cm^3 of distilled water and 6 cm^3 of solution **A**? (2 marks)

2. You are provided with solid **E**. Carry out the experiments below. Write your observations and inferences in the spaces provided.

(a) Place all of solid **E** in a boiling tube. Add about 20 cm^3 of distilled water and shake until all the solid dissolves, label the solution as solution **E**. Use solution **E** for experiments (i) and (ii).

(i) To 2 cm^3 of solution **E**, in a test - tube in each of experiments I, II, III and IV, add:

I. two drops of aqueous sodium sulphate;

Observations	Inferences
(1 mark)	(1 mark)

II. five drops of aqueous sodium chloride;

Observations	Inferences
(1 mark)	(1 mark)

III. two drops of barium nitrate;

Observations	Inferences
(1 mark)	(1 mark)

IV. two drops of lead (II) nitrate;

Observations	Inferences
(1 mark)	(1 mark)

(ii) To 2 cm^3 of solution **E**, in a test - tube, add 5 drops of aqueous sodium hydroxide. Add the piece of aluminium foil provided to the mixture and shake. Warm the mixture and test any gas produced with both blue and red litmus papers.

Observations	Inferences
(2 marks)	(1 mark)

3. You are provided with solid **F**. Carry out the following tests. Write your observations and inferences in the spaces provided.

(a) Place all of solid **F** in a boiling tube. Add about 20 cm^3 of distilled water and shake until all the solid dissolves. Label the solution as solution **F**.

Add about half of the solid sodium hydrogen carbonate provided to 2 cm^3 of solution **F**.

Observations	Inferences
(1 mark)	(1 mark)

(b) (i) Add about 10 cm^3 of dilute hydrochloric acid to the rest of solution **F** in the boiling tube. Filter the mixture. Wash the residue with about 2 cm^3 of distilled water. Dry the residue between filter papers. Place about one third of the dry residue on a **metallic** spatula and burn it in a Bunsen burner flame.

Observations	Inferences
(1 mark)	(1 mark)

(ii) Place all the remaining residue into a boiling tube. Add about 10 cm^3 of distilled water and shake thoroughly. **Retain the mixture for the tests in** (C).

Observations	Inferences
(1 mark)	(1 mark)

(c) Divide the mixture into two portions:

(i) to the first portion, add the rest of the solid sodium hydrogen carbonate.

Observations	Inferences
(1 mark)	(1 mark)

(ii) to the second portion, add two drops of bromine water.

Observations	Inferences
(1 mark)	(1 mark)

5.4 CHEMISTRY (233)

5.6.1 Chemistry Paper 1 (233/1)

1. (a) Carbon (IV) Oxide and Carbon (II) Oxide

   (b) CO_2
   - Fire extinguishers
   - Fizzy drinks
   - Food preservative
   - Solvay process

   Choose 1

   CO
   - Manufacture of fuel (water gas)
   - Reduction in the extraction of metals
   - Manufacture of methanol

   Choose 1

2. Add water to dissolve $CuSO_4$ while Fe_2O_3 does not. Filter out the undissolved Fe_2O_3
   Wash residue with plenty of distilled water to remove traces of the filtrate.
   Dry the residue between filter papers.

3. Grey Solid deposited PbO has been reduced to lead metal. A colourless liquid condenses on the cooler parts of the combustion tube. The hydrogen has been oxidised to water.

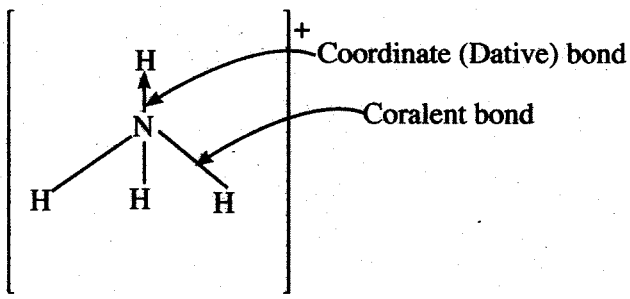
4. (a) BDAC
   Across the period the atomic radius decreases.

   (b) D
   Across the period the conductivity increase due to increase in delocalised electrons.

5. The water must contain impurities. The presence of impurities elevates the boiling point.

6. (i) Copper (II) Sulphate; at 40°C only 28g is soluble leaving undissolved $CuSO_4$
   Pb (NO_3) all dissolves.

   (ii) 35 - 28 = 7g

7. 

8. $H_2SO_{4(aq)} + 2NaOH_{(aq)} \rightarrow Na2SO_{4(aq)} + H_2O(l)$

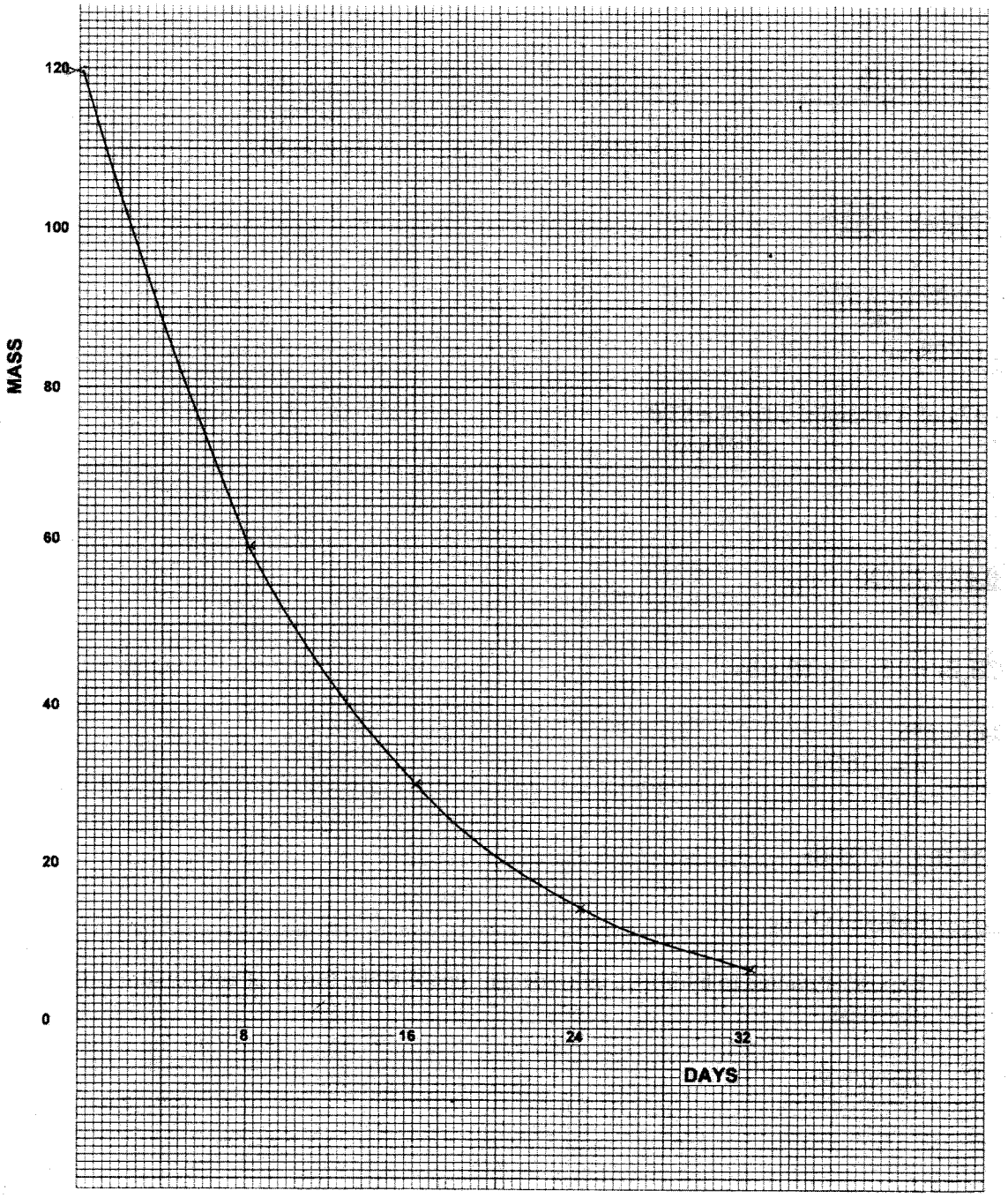
   Moles of NaOH $\frac{36}{1000} \times 0.1 = 0.0036$

Moles of acid in 100 cm^3 = $\frac{100 \times 0.0018}{10} = 0.018$

R.M.M. of $H_2SO_4 = 98^{(\frac{1}{2})}$

$0.0018 \times 98 = 0.1764g^{(\frac{1}{2})}$

9.



10. (a) Mg^{2+}, Ca^{2+}

(b) The Ca^{2+} and Mg^{2+} exchange with Na^{+} on the ions exchange resin.(1)

$2R - Na + Ca^{2+} \longrightarrow R_2 - Ca + Na^{+}$

$2R - Na + Mg^{2+} \longrightarrow R_2 - Mg + Na^{+}$

11. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$P_2 = 1$ litre
$V_2 = ?$
$T_2 = 273K$

$P_1 = 1$ atm
$V_1 = 56cm^3$
$T_1 = 546K$

$\frac{1 \times V_1}{273} = \frac{56 \times 1}{546}$

$V_1 = \frac{56 \times 1 \times 273}{546}$

$V1 = 28cm^3$

0.47g of A occupies $28cm^3$ at STP
? $22400cm^3$

$\frac{0.47 \times 22400}{28} = 376$

$CH_2Br = 12 + 2 + 80 = 94$

$94n = 376$
$n = 376/94$
$n = 4$

$(CH_2Br)_4 = C_4H_8Br_4$

12. (a) Calcium Oxide

(b) Expose ammonia to hydrogen chloride gas, dense white fumes of ammonium chloride are observed.

(c) Steam/water

13. The catalyst has no effect on the position of equilibrium.
The catalyst will increase the rate of forward and backward reactions to the same extent.

14. Ionisation energy

This is the energy required to remove an electron from an atom in its gaseous state.

Electron affinity:

This is the energy change that results in the formation of an ion when an atom gains an electron.

15. (a) Represents salt bridge.

(b) EMF = $E\ominus$ gaining - $E\ominus$ losing

= +0.80 - (-0.13)
= +0.93V

16. (a) S, H, V, T (2) - If only 1st and last letters are correct

(b) $T(s) + V^{2+}(aq) \longrightarrow T^{2+}(aq) + V(s)$

17. (a) Heat of reaction

(b) Using a catalyst
Catalyst reduce activation energy.

18. (a) Sulphur (IV) Oxide is oxidised
The change in Oxidation state for

$SO_2 \longrightarrow H_2SO_4$
$X = +4 \longrightarrow X = +6$

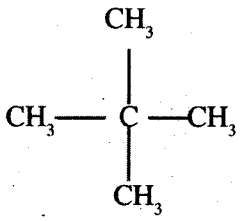
Since it is increasing, this is oxidation.

(b)
- Preservative for Jams and fruits
- Bleaching in the paper industry
- Fumigant
- Disinfectant

19. The level of water in glass tube would go down this is because hydrogen gas being less dense than air diffuses through the porous bag, forcing the level of water in the glass tube to go down while the level of water in the beaker rises slightly.

20. $CH_3 - CH_2 - CH_2 - CH_2 - CH_3$ Pentane

2 - methylbutane



2, 2- dimethylpropane

21. - Plastic bottles
- Packaging of materials
- Tooth brush handles.

Any 1 (1)

22. (a) (i) Maleable - Can be hammed into sheets

(ii) Ductile - Can be drawn into wires

(b) (i) Saucepans

(ii) Electrical transmission lines

23. • Weigh copper carbonate
• Heat $CuCO_3$ to constant mass in a combustion tube
• Reduce CuO using dry H_2/NH_3 or CO
• Allow to cool and reweigh to get mass of copper
• $\% = \frac{Mass\ of\ Cu}{Mass\ of\ CuCO_3} x\ 100$

24. (a) No air due to boiling.

(b) • Aluminium being very reactive forms a layer of Al_2O_3 on the metal making it impervious to moisture.
• Aluminium being more reactive than iron protects the iron through sacrificial protection/ cathodic protection.

25. $2KOH(aq) + H_2SO_{4(aq)} \longrightarrow K_2SO_{4(aq)} + H_2O.$

Moles of KOH $\frac{200}{1000} \times 2 =$ 0.4 moles

$Moles\ of\ H_2SO_4 = \frac{0.4}{2} = 0.2\ moles$

x = $100cm^3$

Mix $200cm^3$ of 2M KOH with $100cm^3$ of 2M H_2SO_4. Concentrate the mixture to drive off excess water, crystallise using a water bath, then dry crystals between filter papers.

26. • Add Na_2CO_3 or $NaHCO_3$ to each, with ethanoic acid there will be effervescence, no reaction with ethanol.

• Add acidified potassium dichromate (VI) or acidified potassium manganate (VII) ethanol will decolarise acidified potasium manganate (VII) and change acidified potasium dichromate (VI) from orange to green. Ethanoic acid has no reaction with the reagent.

27. (a) Group is 5
Period is 3

(b) (i) Noble gases/inert gases

(ii) Used in fluorescence lamps, x-rays tubes

28. (a) $2Cl^-_{(aq)} \longrightarrow Cl_{2(g)} + 2e^-$

(b) Oxygen

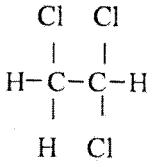
There will be a higher concentration of the hydroxide ion in the dilute solution.
The hydroxide ion being higher in the electromotive series than the chloride ion will then be preferentially discharged.

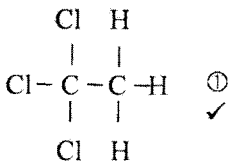
29. (a) No change or no effect
Presence of water is necessary to form H^+ and Ocl^- ions which change the litmus paper

(b) Add dilute hydrochloric acid to each of the salts. $BaSO_3$ gives effervesence and the salt dissolves. There is no effervesence or effect on $BaSO_4$.

5.4.2 Chemistry Paper 2 (233/2)

1. (a)





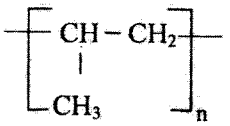
① ✓

(b)
- Bubble each through acidified potassium dichoromate (VI) √1 with ethene the solution changes from orange to green √½ while in ethane the solution remains orange. √½
- Bubble each through acidified Potassium manganate(VII) √1 with ethene the solution changes from purple to √½ colourless while in ethane the solution remains purple. √½
- Add a few drops of bromine water √1 with ethene the solution changes from orange/ brown √½ to colourless, while in ethane the solution remains orange / brown. √½
- Ethene burns with yellow or sooty flame.
  Ethane burns with non-luminous or blue flame.

Choose any 2

(c) (i) Concentrated sulphuric (VI) acid or Al_2O_3 or H_3PO_4. √1

(ii)



① ✓

(iii) $2CH_3CH_2COOH + Na_2CO_3 \longrightarrow 2CH_3CH_2COONa_{(aq)} + CO_{2(g)} + H_2O$ (1)

(iv) $2CH_3CH_2CH_2OH + 9O_2 \longrightarrow 6CO_2 + 8H_2O$ (1)

Moles of $CO_2 = \frac{18}{24}$ (½)

Moles of $CH_3CH_2CH_2OH = \frac{18}{24} \times \frac{1}{3}$ (½)

R.M.M. of $CH_3CH_2CH_2OH = 60$ (½)

$$\text{Mass} = \frac{18}{24} \times \frac{1}{3} \times 60 = 15\text{ g} \quad (½)$$

2. (a) C √ (1) has the smallest atomic radius and is the most electronegative element in the periodic table. √1 / as one traverses the period number of protons increases hence the nuclear attraction increases.

(b) (i) $AB_2/AB/CO_2$ or CO √1
(ii) Covalent bond √1

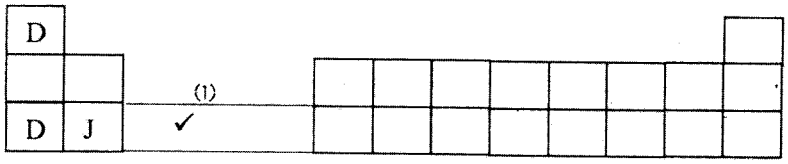
(c) (i) Halogens √1

(ii) $C_{2(g)} + 2H^-_{(aq)} \longrightarrow 2C^-_{(aq)} + H_{2(g)}$ √1

(d) F has a giant atomic √½ structure with strong √½ covalent bond which is strong and difficult to break hence high melting point. While G although it exhibits covalent bond it has simple √½ molecular structure with weak van der waal's forces between its molecules √½ hence the low melting point.

(e) D_2O √½ and D_2O_2 √½

(f)



3. (a) (i) Concentrated √1 sulphuric (VI) acid.

(ii) Potassium nitrate √1

(iii) To condense the fumes or vapour of nitric (V) acid into liquid √1

(b) (i) Nitric acid (V) will corrode the rubber √1

(ii) The reaction produces nitrogen monoxide (colourless) √½ which is oxidised by oxygen from the air to form nitrogen(IV) oxide. √½

(c) (i)
- Water
- Alkanes
- Biogas
- Water gas

√2 } any 2

(ii) $NH_3 + HNO_3 \longrightarrow NH_4NO_3$ √1

Mass of NH_4NO_3 = 80 √½

either

Moles of $NH4NO_3 = \frac{4800}{80} \times 10^3 = 6 \times 10^4$

Moles of NH_3 = 6×10^4 √½

Mass of $NH_3 = \frac{6 \times 17 \times 10^4}{1000}$

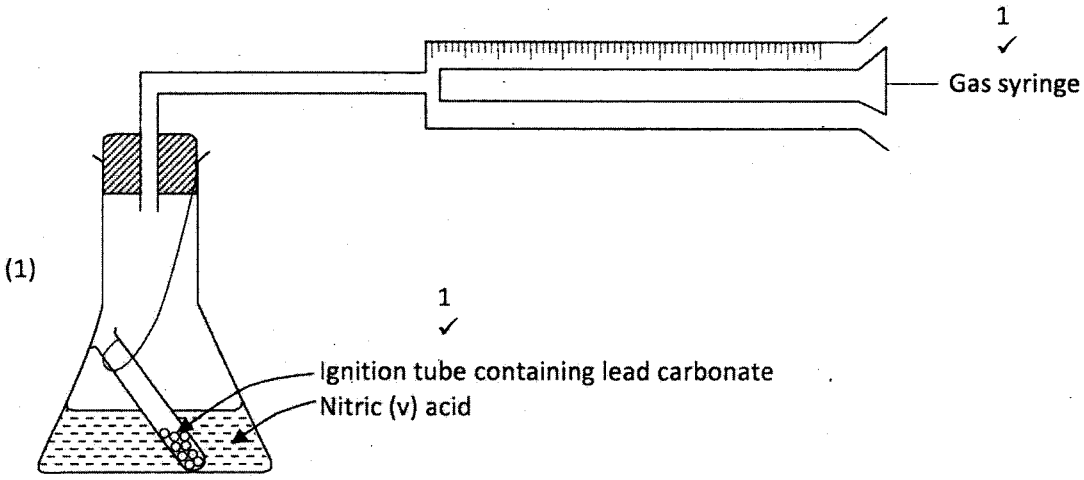
= 1020 kg

(iii) Explosives eg. T.N.T.
Production of polymers (terylene)
Textile dyes.
Manufacture of drugs

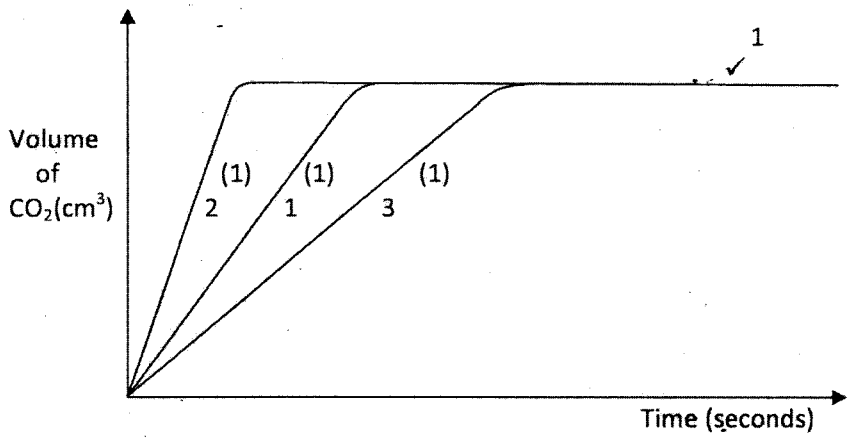
√2 } any 2

4. (a) Surface area/particle size √1.

(b) (i)



(ii)



(iii) $PbCO_{3(s)} + 2HNO_{3(aq)} \longrightarrow Pb(NO_3)_2$√1 $+ CO_{2(g)} + H_2O_{(l)}$

(c) With hydrochloric acid an insoluble lead chloride is formed, √½ which coats the lead carbonate √½ preventing the reaction between the acid and the carbonate from proceeding. √1

(d) The reaction would shift to the left changing the solution from colourless to yellow/ orange √1. Addition of HCl creates excess H^+ which disturbs the equilibrium so it shifts to the left to get rid of the excess H^+ ions. √1

5. (a) (i) The anode is X. √1 Since hydrogen is liberated at the cathode which is Y. √1

(ii) $4OH^-_{(aq)} \longrightarrow 2H_2O_{(l)} + O_{2(g)} + 4e$ √1

(iii) The hydrogen ions and hydroxide ions which form water (1) are discharged at the electrodes leaving $MgSO_4$ concentrated. The amount of water electrolysed is more than the amount of water formed at the anode. √1

(iv) Blue litmus remains √½ blue while the red litmus remains red√½. Indicating that the solution is neutral. √1

(b) Quantity of electricity = 0.3 x 30 x 60
= 540 √1
Oxygen requires 4 Faradays √½ of electricity

$24\ dm^3 = 4 \times 96500$ √½
$? = 540$

$$\frac{24 \times 540}{4 \times 96500} = 0.32\ dm^3$$

(c) Electroplating
Purification of metals

6. (a) (i) Cu^{2+} √1

(ii) $CuCO_3$ √1 / $ZnSO_4$ √1

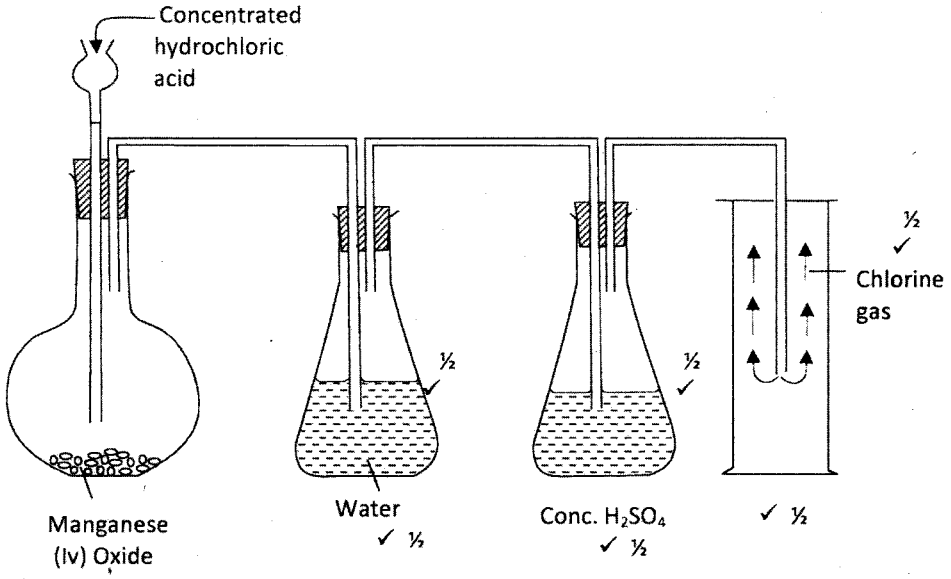
(b) $Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \longrightarrow BaSO_{4(s)}$ √1

(c) The solution changes from blue to colourless √1 and a brown solid is formed. √1
The magnesium which is above copper in the reactivity series displaces the copper ions √1 from the solution. Apparatus become warm. The reaction is exothermic.

(d) (i) Add nitric (V) acid to √½ lead oxide, filter√½, add a soluble sulphate/ sulphuric acid to the filtrate √½. Filter √½, and wash residue with distilled water √½ to remove traces of the filterate, then dry residue between √½ filter papers /oven.

(ii) Determine the melting √1 point, if it is pure the melting point will be constant. √1

7. (a) (i)



(ii) Potassium Manganate (VII) $\surd\frac{1}{2}$ and remove heat $\surd\frac{1}{2}$.

PbO_2 and heat OR $CaOCL_2$ No heating.

(iii) I. $2Fe_{(s)} + 3Cl_{2(g)} \longrightarrow 2FeCl_{3(s)}$ (1)

II. $3Cl_{2(g)} + 6NaOH_{(aq)} \longrightarrow NaCl_{(aq)} + NaClO_{3(aq)} + 3H_2O_{(l)}$ (1)

(b)

	Cl	O
Mass	0.07	1.12
RAM	35.5	16
Moles	$\frac{0.07}{35.5}$	$\frac{1.12}{16}$
	$\frac{0.02}{0.02}$	$\frac{0.07}{0.02}$
	1	$\frac{7}{2}$
	2 :	7

Empirical formula Cl_2O_7 $\surd 1$

(c) Sterilising drinking water supplies $\surd$
Manufacture of hydrochloric acid $\surd$
Manufacture of plastics $\surd$
Manufacture of chloroform $\surd$
Manufacture of bleaching agents $\surd$

(Any 2)

5.4.3 Chemistry Practical Paper 3 (233/3)

1. Table 1

	I	II	III
Final burette reading	17.45	32.90	36.05
Initial burette reading	2.10	17.45	20.60
Volume of solution B used (cm^3)	15.35	15.45	15.45

(4 marks)

(a) (i) Average volume

$$= \frac{15.35 + 15.45 + 15.45}{3}$$

$= 15.42cm^3$ (1 mark)

(ii) Moles of sodium thiosulphate used

$$= \frac{0.05 \times 15.42}{1000} \quad (\frac{1}{2})$$

7.71×10^{-4} moles $(\frac{1}{2})$ (1 mark)

(b) (i) Number of moles of A in $25.0cm^3$

mole ratio A : $Na_2S_2O_3 . 5H_2O$
1 : 6

$7.71 \times 10^{-4}/6 = 1.28 \times 10^{-4}$ moles. (1 mark)

(ii) Concentration of solution A in mol dm^3

1.28×10^{-4} moles in $25cm^3$
? moles in $1000cm^3$

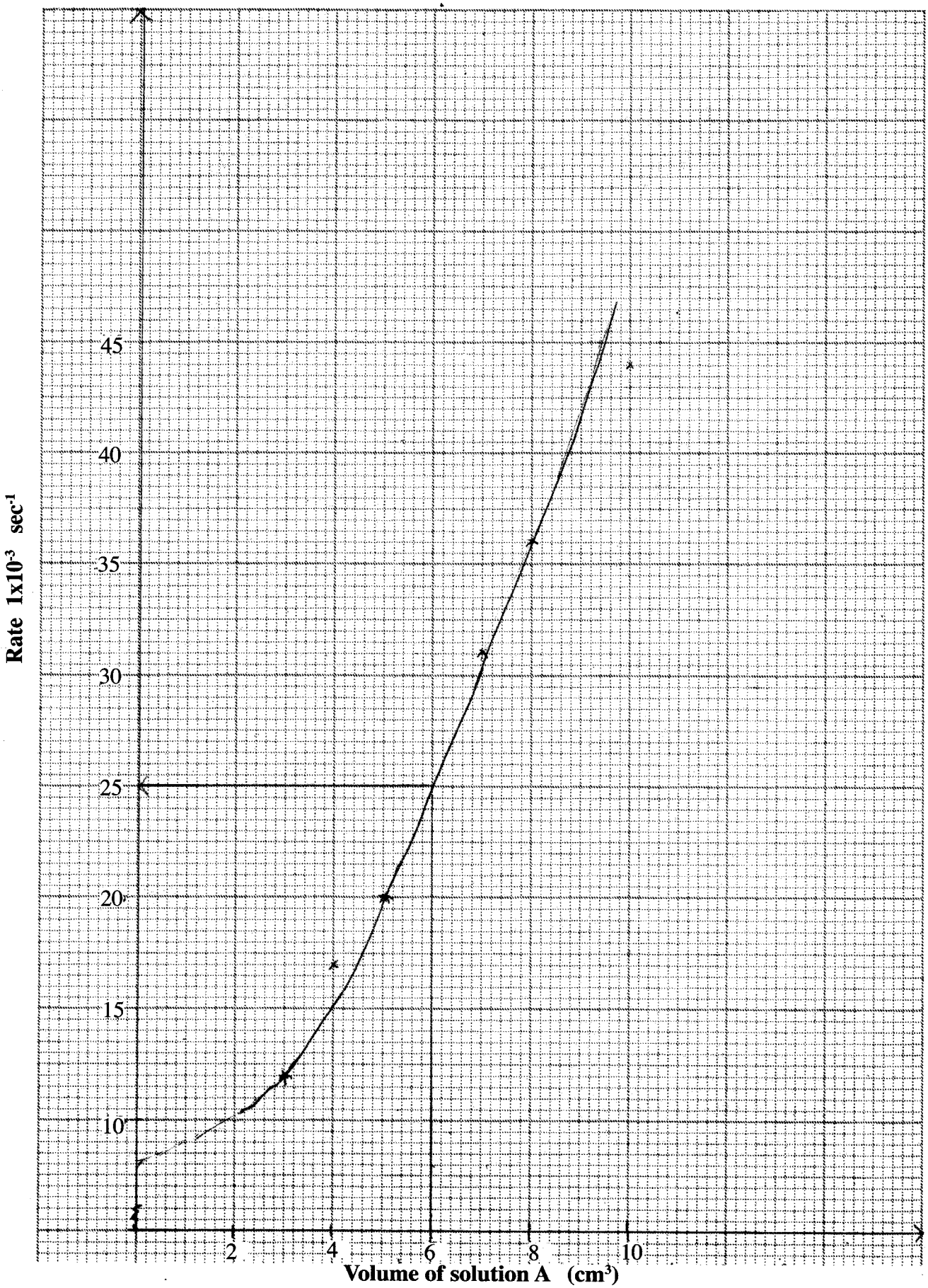
$1.28 \times 10^{-4} \times 1000/25$ (1)
5.12×10^{-3} moles/dm^{-3} (1) (2 marks)

Table 2

Test tube number	1	2	3	4	5	6
Volume of distilled water (cm^3)	0	2	3	5	6	7
Volume of solution A (cm^3)	10	8	7	5	4	3
Time (s)	22.5	28.0	32.0	50.0	57.5	85.0
Rate = $1/Time$ (s^{-1})	0.044	0.036	0.031	0.020	0.017	0.012
	(1)	(1)	(1)	(1)	(1)	(1)

(6 marks)

(a) Graph of Rate (3 marks)



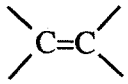
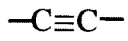
(b) Time taken for $4cm^3$ of distilled water.

$\therefore$ $6cm^3$ of solution A is added.
from the graph = $25x10^{-3}$ sec^{-1} (1)
= 40 seconds (1) (2 marks)

2. Observation

(a) (i)	(I)	A white precipitate (1)	Presence of Pb^{2+}, Ba^{2+} or Ca^{2+} (1) *1 mark for all the 3 ions* *½ mark for 2 correct ions* *0 mark for one or none*
	(II)	No white precipitate (1)	Absence of Pb^{2+} (1)
	(III)	No white precipitate (1)	SO_4^{2-}, SO_3^{2-}, CO_3^{2-} ions absent (1) *1 mark all the 3* *½ mark for 2 ions correct* *0 mark for one or none*
	(IV)	No white precipitate (1)	Cl^- ions absent (1)
(ii)		Effervescence ½/Bubbles/Fizzing Colourless gas produced ½ Turns red litmus blue ½ Blue litmus remained blue ½ (2 marks)	NO^-_3 present (1)
			(Total 11 marks)

3.

	Observations	Inferences
(a)	No effervescence (1)	Compound/solution F **not acidic** H^+ or R-COOH absent. (1)
(b) (i)	Burns with a sooty/smoky ½ luminous/yellow flame ½	Unsaturated cpd (1) $>C=C<$ Long chain hydrocarbon or $-C\equiv C-$
(ii)	Some white suspension/solid remains undissolved ½	Compound slightly/partially soluble in water ½
(c) (i)	Effervescence ½ Colourless gas produced ½	Mixture is acidic (1) RCOOH present
(ii)	Not decolourized (1)	 absent (1)  absent

(Total 9 marks)