ACID AND BASES

1. An acid is a chemical compound that produce hydrogen ion, H^+ or **hydroxonium**, $\mathbf{H_3O^+}$ when dissolves in water.

$HCl + H_2O \rightarrow H_3O^+ + Cl^-$
H_2O $HCl \rightarrow H^+ + Cl^-$

2. An acid shows its **acidic properties** only in the presence of **water.**

3. A base is defines as a chemical substance that can neutralise an acid to produce a salt and water.
Example:

$$CuO + 2HCl \rightarrow CuCl_2 + H_2O$$

4. An alkali is defined as a chemical compound that dissolves in water to produce hydroxide ions, OH^-.
Example:

$$KOH \xrightarrow{H_2O} K^+ + OH^-$$

5. Define weak acid :

.....

6. Define strong acid :

.....

7. Define strong alkali :

.....

8. Define weak alkali:

.....

9. Define basicity : the number of ionisable ..... atoms per molecule of an acid.

10. Using a suitable examples explain what is meant by
   a) Monoprotic acid :

   .....

   b) Diprotic acid :

   .....

   c) Triprotic acid :

   .....

11. Write an equation of dissociation for the following acid.

a) Nitric acid :

.....

b) Ethanoic acid :

.....

c) Carbonic acid :

.....

d) Sulphuric acid :

.....

e) Chemical properties of acid.

Reaction	Product	Example and Chemical equation
With reactive metal	Salt and hydrogen gas	$Zn + 2HCl \rightarrow ZnCl_2 + H_2$

PAPER 2 : STRUCTURE

1. An experiment is carried out in the laboratory to determine the end point of the reaction between 25.0 cm^3 of potassium hydroxide solution and 1.0 $moldm^{-3}$ of sulphuric acid. Phenolphthalein is used in the titration to detect the end point of the reaction. diagram 1 shows the set-up of apparatus for the titration.

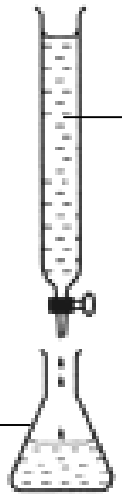


Diagram 1

The volume of sulphuric acid added and the change of the colour of potassium hydroxide solution shown in the Table 1 below.

Volume of sulphuric acid (cm^3)	4,5	4.6	4.7	4.8	4.9	5.0	5.1	5.2	5.3
Colour of potassium hydroxide solution	Pink					Colourless			

Table 1

(a) Name the chemical reaction between potassium hydroxide solution and sulphuric acid.

……

[1 mark]

(b) Write a chemical equation for the reaction.

……

[1 mark]

(c) Write the formula of ions which are present in the conical flask when the volume of sulphuric acid added is:

(i) 4.5 cm^3

.....

(ii) 5.0 cm^3

.....

[2 marks]

(d) What is the volume of sulphuric acid needed to neutralise 25 cm^3 potassium hydroxide solution?

….....

[1 mark]

(e) Calculate the concentration of potassium hydroxide solution in this experiment.

[2 marks]

(f) If sulphuric acid is replaced with nitric acid with the same molarity, predict the volume of nitric acid require to neutralise 25.0 cm^3 of the potassium hydroxide solution. Explain why.

.....

.....

[2 marks]

2. Hydrogen chloride gas is dissolved in two different solvent, producing solutions X and Y.

Experiment I and II are carried out.
Table 2 below shows the results of the experiment.

Experiment		Observations	
		Solution X	Solution Y
I	Marble chips added into solutions	Gas bubbles	No changes
II	Electrical conductivity	Deflection of ammeter reading	No deflection of ammeter reading

Table 2

a) Name a suitable solvent to produce
(i) Solution X

.....

(ii) Solution Y

.....

[2 marks]

b) (i) Which solution shows acidic properties

.....

(ii) What is the role of the solvent used to produce the acid in (b)(i)

.....

.....

[2 marks]

c) (i) Name the gas produce in Experiment I

.....

(ii) Describe a chemical test to verify the gas in (c)(i).

.....

.....

[3 marks]

d) Solution X can conduct electricity but solution Y cannot. Explain this statement.

.....

.....

[2 marks]

3. Table 3, below shows the pH value of four solutions. The solutions are of the same concentration

Solution	W	X	Y	Z
pH	1	5	7	14

Table 3

a) (i) Name one example of solution Z.

.....

(ii) Write a chemical equation for the reaction of Z in a(i) with sulphuric acid.

.....

(iii) Name the chemical reaction occur in a(ii).

.....

[3 marks]

b) Which solution possibly can be sodium sulphate?

.....

[1 mark]

c) (i) Which solution can change a blue litmus paper to red?

.....

(ii) State one test to prove the chemical property of c(i) without using an indicator.

.....

.....

.....

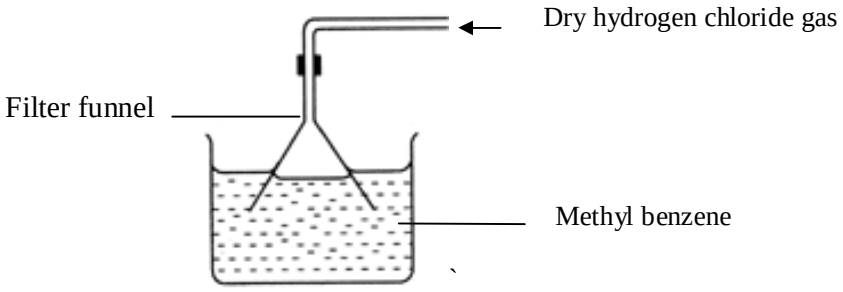
[3 marks]

d) Explain why solution W and Solution and solution X have different pH values.

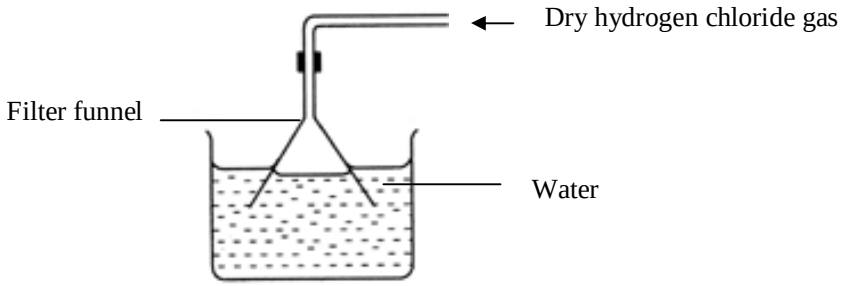
.....

.....

[2 marks]



Beaker A



Beaker B

4. Figure above shows the arrangement of apparatus used to prepare hydrogen chloride in methyl benzene and in water respectively.

a) What is the purpose of using filter funnels in this experiment ?

.....

[1 mark]

b) (i) What is observed when a piece of magnesium ribbon is placed in Beaker A and Beaker B respectively.

Beaker A : .....

Beaker B :.....

(ii) State the reason for your answer in b(i)

.....

.....

[3 marks]

c) Name the types of particles present in

Beaker A ; .....

Beaker B : .....

[2 marks]

d) Water is added to the solution in Beaker A and the mixture is then shaken. When sodium carbonate solution is added, effervesence occurs.

(i) Name the gas and suggest a suitable test to identify the gas evolved.

.....

(ii) State the role of water that caused the liberation of the gas.

.....

(iii) Write the ionic equation for the reaction involving the liberation of the gas.

.....

[3 marks]

5. Diagram 5 shows four test tubes contain dry glacial ethanoic acid, aqueous solution of ethanoic acid, dilute hydrochloric acid and aqueous solution of X.

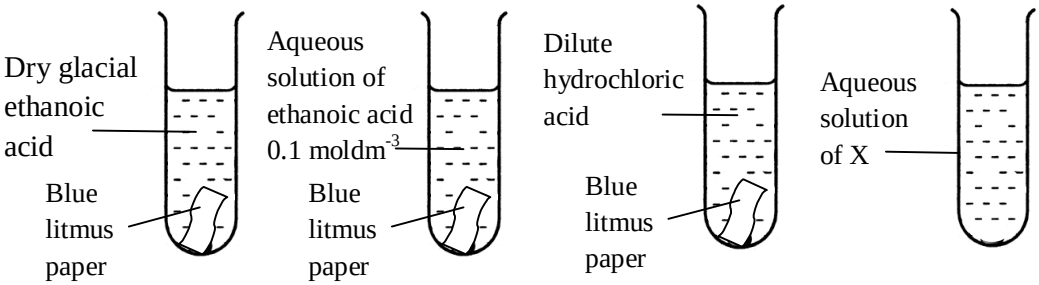


Diagram 5

a) (i) State the colour change of the litmus paper in test tubes Q and R.

.....

(ii) Write the formula of ion which caused the colour change of the litmus paper.

.....

[2 marks]

b) Is there any changes of colour of the litmus paper in test tube P? Explain why.

.....

.....

[2 marks]

c) Table 5 shows the pH value of aqueous solution of ethanoic acid and dilute hydrochloric acid of the same molarity.

Type of acid	**aqueous solution of ethanoic acid**	**dilute hydrochloric acid**
Molarity	0.1 moldm^{-3}	0.1 moldm^{-3}
pH value	3.0	1.0

Table 5

Explain why the pH value of aqueous solution of ethanoic acid is higher than the pH value of dilute hydrochloric acid.

.....

.....

.....

[2 marks]

d) Calcium carbonate powder is added into test tube R. Write the chemical equation for the reaction that takes place.

.....

[1 mark]

e) Aqueous solution of X is an acidic solution. As a chemistry student, describe briefly how you are able to prove that X is an acidic solution.

You are not allow to use litmus paper, pH meter or any indicators.

Procedure:

.....

.....

.....

.....

[3 marks]

Observation:

.....

.....

[1 mark]

6. (a) A student carried out an experiment to study the pH of a few aqueous solutions using pH paper. The results were tabulated below.

Aqueous solution	P	Q	R	S	T	U
pH	13	7	4	8	20	1

Table 6

Which of the solution in the table above could be

(i) Distilled water

……..……

(ii) Vinegar

……..……

(iii) Sodium hydroxide

……...……...

(iv) Hydrochloric acid

……..……...…….

[4 marks]

b) (i) An apple contains maleic acid $C_4H_8O_5$ which is a weak acid, What is meant by weak acid ?

……..……

(ii) The pH of 1.0 mol dm^{-3} maleic acid solution is higher than hydrochloric acid with the same concentration. Explain why.

……...……...

……

[2 marks]

c) Zinc powder is added to the test tube containing hydrochloric acid.

(i) Name the gas released.

……..……

(ii) Describe a chemical test to identify the gas.

……..……

……..……

(iii) Write a balanced equation for the reaction.

……..……

[3 marks]

PAPER 2: ESSAY

7. (a) (i) What is meant by 'standard solution' ?,

[1 mark]

(ii) Describe how 100cm^3 of 2.0 moldm^{-3} sodium hydroxide solution can be prepared in the school laboratory,
Your description should include the calculation
Use the information, Relative atomic mass of Na = 23, O =16 , H = 1

[7 marks]

(b) Using the 1.0 mol dm^{-3} sodium hydroxide solution from (a) above.
Describe how you would determine the unknown concentration of a sample of hydrochloric acid, HCl using the titration method.

You may use either methyl orange or phenolphthalein as indicator.

Include, in your answer, the chemical equation and calculation.

[12 marks]

8. (a) The following information is about sodium hydroxide solution and ammonia solution.

- pH of sodium hydroxide solution 1.0 mol dm^{-3} is 14
- pH of ammonia solution 1.0 mol dm^{-3} is 10

Explain why both solutions have different pH value.

[6 marks]

(b) The label of a reagent bottle was dirty caused by a chemical substance. The reagent is suspected to contain dilute hydrochloric acid.

Describe two chemical tests which can be used to identify the chemical solution if the chemical solution is dilute hydrochloric acid.

[8 marks]

(c) Glacial ethanoic acid does not release any gas when it is poured into pieces of calcium carbonate. However, effervescence occurs when several drops of water are added into the mixture of ethanoic acid and pieces of calcium carbonate.

Explain the statement.

[6 marks]

PAPER 3: STRUCTURE

9. Diagram 9 shows the results of titration between sulphuric acid and sodium hydroxide solution.

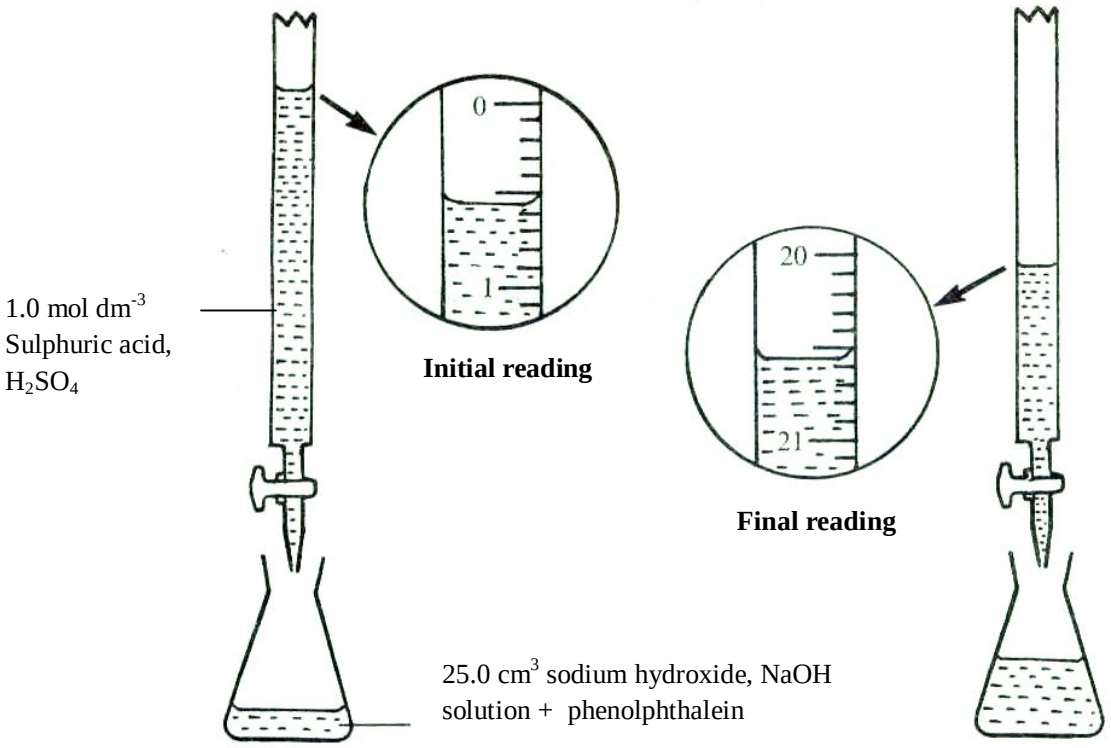


DIAGRAM 9

(a) Based on the diagram 2, record the final and initial burette readings of the burette.

Final reading = …….. cm^3

Initial reading = …….. cm^3

Volume of H_2SO_4 used = …… cm^3

[3 marks]

(b) Construct a table that can be used to record the result of the experiment.

[3 marks]

(c) (i) State the colour change in the solution.

……

[3 marks]

(ii) State the inference of the colour change.

……

[3 marks]

(d) Write the operational definition for the neutralisation.

……

……

[3 marks]

(e) You are given three examples of acids; sulphuric acid, ethanoic acid and hydrochloric acid. Classify them into monoprotic and diprotic acids.

[3 marks]

(f) Based on the titration results, calculate the molarity of sodium hydroxide solution used . Given the chemical equation for the neutralisation is as follow:

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

[3 marks]

10. A student carried out two experiments to determine the concentration of HX acid solution.

Experiment I

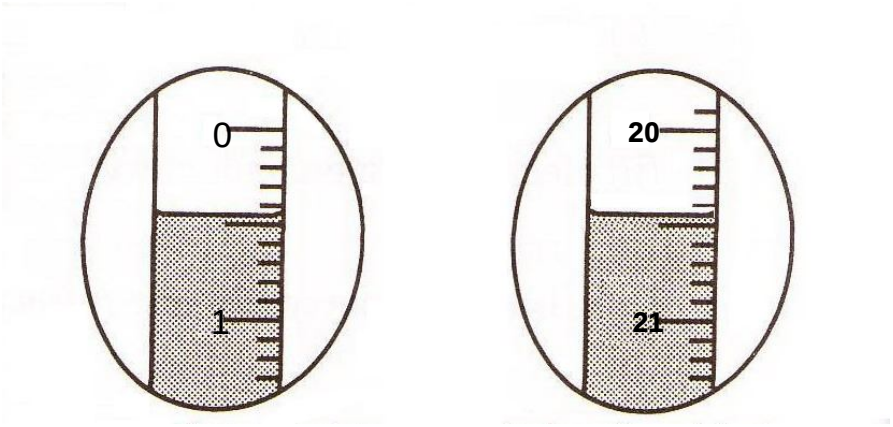
Titration of HX acid solution of unknown concentration with $20cm^3$ of sodium hydroxide solution 1.0 mol dm^{-3} using phenolftalein as indicator.

Experiment II

Titration of similar HX acid solution of difference concentration with $20cm^3$ of sodium hydroxide solution 1.0 mol dm^{-3} using phenolftalein as indicator.

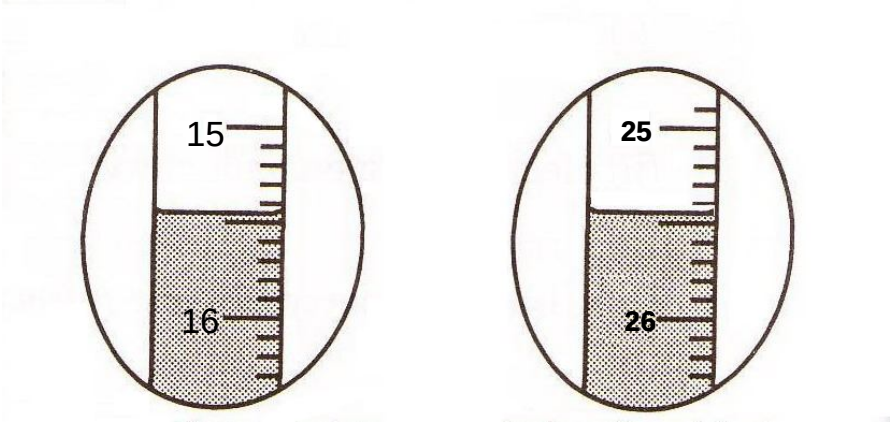
Diagram 10, shows the initial and final burette readings for both experiments.

Experiment 1



Initial burette reading Final burette reading

Experiment II



Initial burette reading Final burette reading

Diagram 10

(a) Construct a table to record the initial and final burette readings and the volumes of the acid used for both experiments.

[3 marks]

(b) State the colour change of phenolftalein in the titration.

……

[3 marks]

(c) The chemical equation for the reaction in the experiment is :

HX	+	NaOH	→	NaX	+	H_2O

Calculate the concentration of HX acid solutions used in both experiments.

(i) Experiment I

(ii) Experiment II

[3 marks]

(d) State the hypothesis in this experiment.

……..…….....……

.....…….……

[3 marks]

(e) If HX acid is replaced with sulphuric acid of the same concentration, it is found that the volume of the sulphuric acid used in the titration is half of the volume of HX acid. Explain why.

…….....…

…….....…

…….....……

[3 marks]

PAPER 3 : ESSAY

11.

Solid sodium hydroxide does not give any effect on dry red litmus paper. On the other hand, sodium hydroxide solution changes dry red litmus paper to blue.

With reference to the above statement, plan an experiment in the laboratory to study the role of water on the properties of alkali.

Your planning of experiment must include the following:

a) Problem statement
b) Hypothesis
c) List of materials and apparatus
d) Procedure
e) Tabulation of data

[17 marks]

SALTS

1. A salt is an ionic compound that is formed when the …… ion in an acid is replaced by a …… ion or ammonium ion (NH_4^+).

2. Solubility of salts.

Type of salt	Solubility in water
Sodium, potassium and ammonium salts	All are soluble.
Nitrate salts	
Sulphate salts	
Chloride salts	
Carbonate salts	

3. Preparation of soluble salts.

Preparation of soluble salts	**Example / Reactants**	**Chemical equation**
An acid reacts with reactive metal.	Magnesium and hydrochloric acid	$Mg + 2HCl \rightarrow MgCl_2 + H_2$

4. Insoluble salts can be prepared by …….…. in **double decomposition reaction.**
Example:

Silver nitrate solution reacts with sodium chloride solution, white precipitate formed.

Chemical equation: $\mathbf{Ag}NO_3 + Na\mathbf{Cl} \rightarrow \mathbf{AgCl}(s) + NaNO_3$

Ionic equation : $Ag^+ + Cl^- \rightarrow AgCl(s)$

5. Quantitive analysis of salts.
(a) Colour of salts

Colour	Solid	Solution
White or colourless	Sodium,potassium,magnesium, ammonium, Lead ,chlorides, sulphates,nitrates.	Na^+,K^+,Mg^{2+}, Pb^{2+}, Zn^{2+}, NH_4^+
Green		
Blue		
Brown		

(b) Action of heat on Carbonate and Nitrate salts.

Type of salt	Colour of salt before heating	Colour of residue	
		Hot	Cold
Copper (II) carbonate			
Lead (II) carbonate	White	Brown	
Lead (II) carbonate			
Zinc carbonate			
Magnesium nitrate			
Zinc nitrate			
Sodium nitrate			

(c) **Test for Anions.**

Summarise the tests used to identify anions in the table below.

Anion	Test	Observation and inference
Carbonate, CO_3^{2-}	Add 2 cm^3 hydrochloric acid, bubble the gas produced through lime water.	
Chloride, Cl^-		
Sulphate, SO_4^{2-}		White precipitate is formed, sulphate ion is present.
Nitrate, NO_3^-		

(d) **Specific tests for cations**

Cation	Reagent	Observation
Ammonium, NH_4^+		
Iron (II), Fe^{2+}		
Iron (III), Fe^{3+}		
Lead (II), Pb^{2+}		

PAPER 2: STRUCTURE

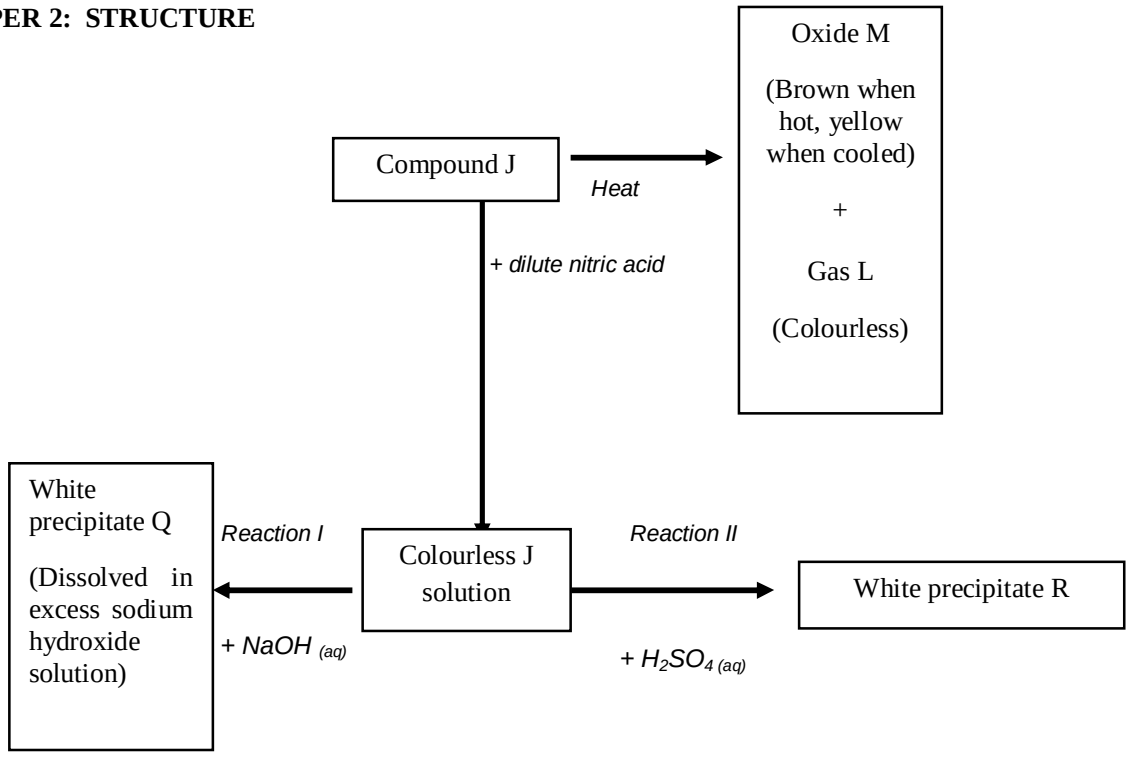


Diagram 1

1. Diagram 1 shows a series of chemical test done by a student to identify a compound J.

   a) With reference to reaction I, white precipitate Q is formed when reacts with sodium hydroxide solution and it is soluble in excess sodium hydroxide solution. Name all the ions which are probably present in solution J.

   .....

   [1 mark]

   b) Referring to reaction I and II,
   Name the cation that is present in solution J.

   .....

   [1 mark]

   c) Write the ionic equation for the reaction forming the white precipitate, R.

   …….

   [1 mark]

   d) Name two cations which produce white precipitates with sodium hydroxide solution that do not dissolve in excess sodium hydroxide solution.

   ……

   [1 mark]

(e) Describe a confirmatory test which you can use to differentiate the cations you named in (d).

.....

.....

.....

.....

[4 marks]

2. An experiment to investigate the effect of heat on solid lead (II) carbonate is shown on diagram 2.

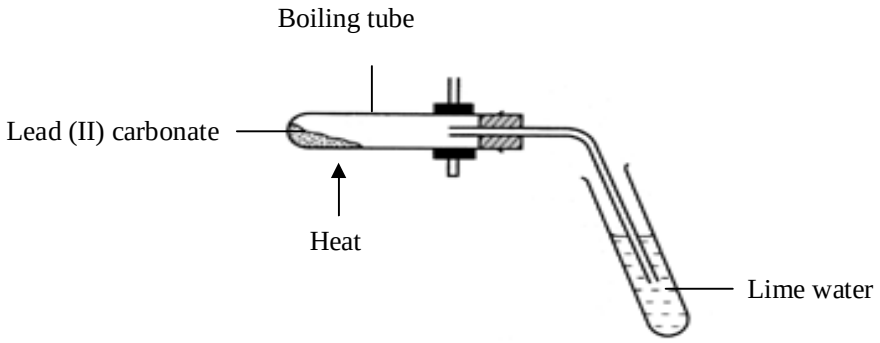


Diagram 2

(a) (i) State two observations of the above experiment.

……

……

…

[2 marks]

(ii) Write an equation for the reaction

……..

[1 mark]

(iii) Name the residue formed inside the boiling tube at the end of the experiment

……..…..…….

[1 mark]

(b) The result of the experiment is shown in Table 2.
[Relative atomic mass: Pb=207, C=12, O=16; 1 mol of gas occupies $24dm^3$ at room temperature and pressure]

Substance	Mass (g)
Mass of boiling tube	12.45
Mass of boiling tube and lead (II) carbonate before heating	23.13
Mass of boiling tube and residue after heating	22.56

Table 2

(i) Calculate the mass lead (II) carbonate used.

[2 marks]

(ii) Calculate the mass of residue formed.

[2 marks]

(iii) Calculate the volume of carbon dioxide evolved at room temperature and pressure.

[2 marks]

(c) All the residue is formed during the heating of lead (II) carbonate was dissolved in dilute nitric acid to form a colourless solution. When excess of sulphuric acid is added to the colourless solution, a white precipitate is formed.

(i) Name the white precipitate formed.

……...……

[1 mark]

(ii) Write an ionic equation for the reaction.

……...……

[1 mark]

3. Diagram 3 shows the formation of zinc nitrate and its conversion to other substances

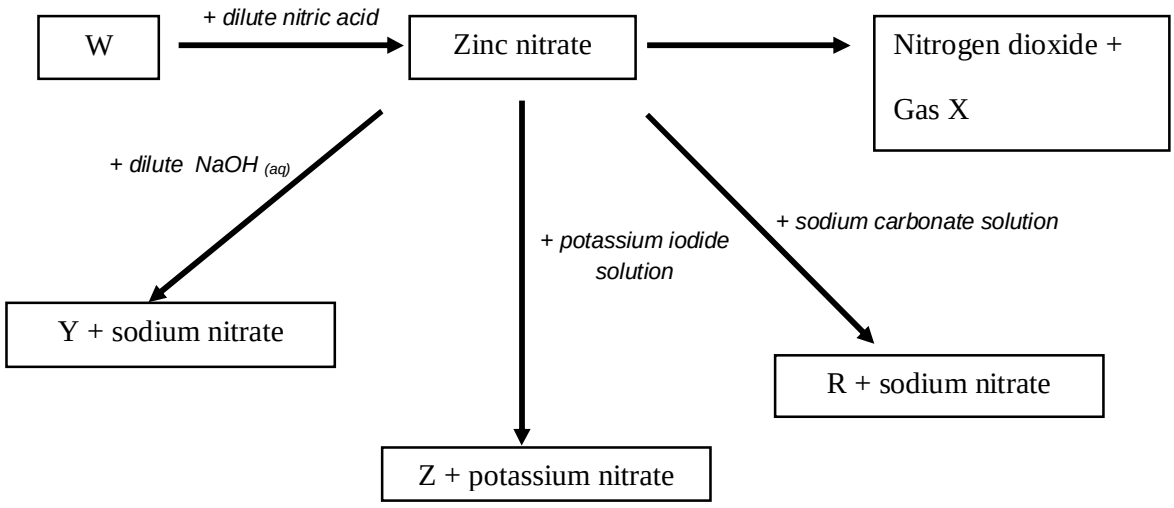


Diagram 3

(a) W is a white powder which reacts with dilute nitric acid. The powder is yellow in hot. Give the name of W.

……

[1 mark]

(b) A small amount of sodium hydroxide solution is added to zinc nitrate solution. Precipitate Y is produced.

(i) Write the chemical formula of Y.

……

[1 mark]

(ii) Describe what happens when sodium hydroxide is added to zinc nitrate.

……

[1 mark]

(c) (i) Zinc nitrate can be converted to nitrogen dioxide and gas X. How can this conversion be carried out?

……

[1 mark]

(ii) Name gas X

……

[1 mark]

(iii) Describe the observation during the experiment.

……

……

[1 mark]

(d) When potassium iodide is added to zinc nitrate solution a precipitation takes place.

(i) Name the substance Z

……

[1 mark]

(ii) Write an ionic equation to show how Z is produced.

……

[1 mark]

(e) Write the chemical formula of substance R

……..

[1 mark]

PAPER 2: ESSAY

4. (a) The following are three examples of sulphate salts that can be prepared in the laboratory.
   - Potassium sulphate
   - Lead (II) sulphate
   - Zinc sulphate

(i) From these examples, identify soluble and insoluble salts

[2 marks]

(ii) State the reactants for the preparation of the insoluble salts in 4 (a) (i).

[2 marks]

(b) With the aid of a labeled diagram, explain the crystallization method for preparing a soluble salt from its saturated solution.

[6 marks]

(c) You are given a solution that contains a mixture of iron (III) nitrate and iron (III) chloride. Describe the confirmatory test to determine the presence of cation and anion in the solution. Your description must include all the materials used, observation and conclusion.

[10 marks]

5. (a) Lead (II) sulphate is insoluble in water.
Describe the preparation of lead (II) sulphate in the laboratory.
In your description, include the reagents and chemical equation involved.

[10 marks]

(b) Table 5 shows the observations from some tests carried out on salt X.

Test	Observation
I: Heating on salt X solid	A metal oxide is formed and a brown gas is given off.
II: Salt X solution is mixed with excess aqueous ammonia	A white precipitate which is insoluble in excess ammonia is formed.

Table 5

Based on the information in Table 5.

(i) Identify anion that is present in Test I and describe a chemical test to verify the anion.

[4 marks]

(ii) Identify **two** cations that are present in Test II and describe a chemical test to verify the cations.

[6 marks]

PAPER 3: STRUCTURE

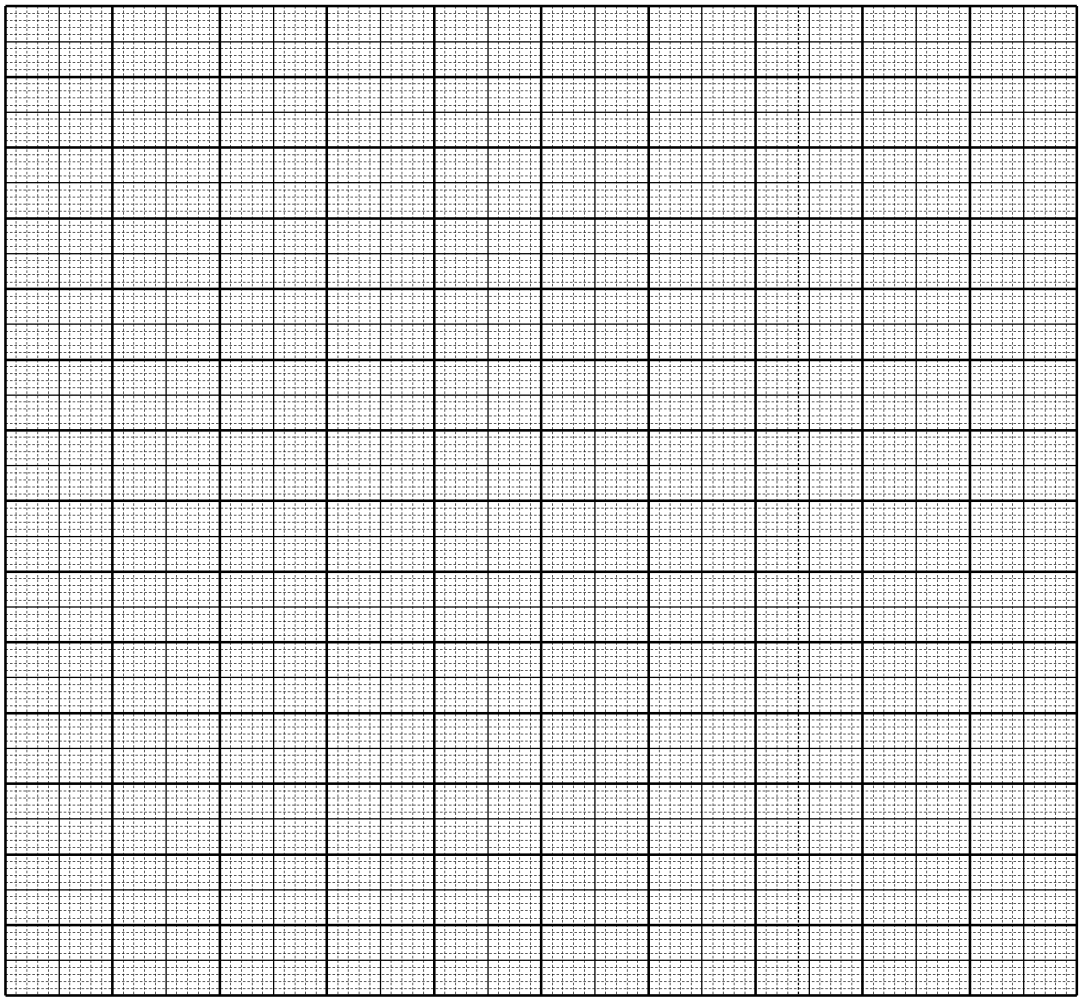
6. Seven test tubes of the same size are labelled 1 to 7. A fixed volume of 5.0 cm^3 of 1.0 $moldm^{-3}$ potassium chromate (VI) solution is placed in each of the seven test tubes. Varying amounts of 1.0 $moldm^{-3}$ of a nitrate salt of metal M is added to each test tube. For example, 1 cm^3 to test tube 1, 2 cm^3 of test tube 2, and so on until 7 cm^3 is added to test tube 7.

The height of the yellow precipitate formed in each test tube are recorded in the table 6.

Test tube	1	2	3	4	5	6	7
Height of precipitate (cm)	1.0	2.0	3.0	4.0	5.0	5.0	5.0

Table 6

(a) Based on results from table 6 , plot a graph of precipitate heights against volumes of M nitrate solution added.



(b) What is the volume of M nitrate solution that reacted completely with 5.0 cm^3 of potassium chromate (VI) solution? Explain your answer.

……

(c) Calculate the number of moles of potassium chromate (VI) found in the test tube and the number of moles of M ions that reacted completely with the 5.0 cm^3 of potassium chromate (VI) solution.

(d) Determine the formula of M chromate (VI).

……..……..

(e) Write the ionic equation for the formation of M chromate (VI).

……..……. [1 mark]

7. Diagram shows two containers, containing colourless solution labelled A and B.

A **B**

You are told that the two colourless solutions are calcium nitrate and magnesium nitrate. You are required to label correctly the name of each solution in the containers.

Design an experiment to identify which is calcium nitrate and which is magnesium nitrate solution by using aqueous of ammonia solution as a reagent.

Your answer should include the following:

(a) Problem statement
(b) Hypothesis
(c) All variables
(d) List of materials and apparatus
(e) Procedure
(f) Tabulation of data

[17 marks]