LABORATORY MANUAL

ON ENGINEERING CHEMISTRY

OF

$1^{ST}/2^{ND}$ SEMESTER

(COMMON TO ALL BRANCHES)

According to the New Syllabus of SCTE & VT

NEW SYLLABUS (Effective from 2018-19 session)

Pr.2b. Engineering Chemistry Lab

(1st / 2nd semester Common)

Practical: 4 periods/week **Sessional : 50**
Marks Total Periods: 60 Periods **End Sem Exams :**
50 Marks Examination: 3 Hours **Total Marks :100**

Sl No.	**NAME OF THE EXPERIMENTS**
01	Preparation and study of physical and chemical properties CO_2 gas.
02	Preparation and study of physical and chemical properties NH_3 gas
03	Crystallization of Copper sulphate from copper carbonate
04	Simple acid-base titrations (i) Acidimetry (ii) Alkalimetry
05	Tests for acid radicals (Known): (i) Carbonate, (ii) Sulphide, (iii) Chloride, (iv) Nitrate and (v) Sulphate.
06	Test for Basic radicals (Known): (i) Ammonium, (ii) Zinc, (iii) Magnesium, (iv) Aluminium, (v) Calcium, (vi) Sodium and (vii) potassium
07	Test for unknown Acid radicals
08	Test for unknown basic radicals
09	Test for unknown salt (composed of one basic radical and one acid radical)

INDEX TABLE

Sl No.	NAME OF THE EXPERIMENTS	PAGE NO.	DATE OF EXPERIMENT PERFORMED	GRADE /MARK	SIGN. OF SUBJECT FACULTY	REMARK
01	Preparation and study of physical and chemical properties CO_2 gas.					
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06	Test for Basic radicals (Known): (i) Ammonium, (ii) Zinc, (iii) Magnesium, (iv) Aluminium, (v) Calcium, (vi) Sodium and (vii) Potassium					
07	Test for unknown Acid radicals					
08	Test for unknown Basic radicals					
09	Test for unknown salt (composed of one basic radical and one acid radical)					

EXPERIMENT NO.- O1

AIM OF THE EXPERIMENT:

Preparation and study of physical and chemical properties Carbon dioxide (CO_2) gas.

OBJECTIVES OF THE EXPERIMENT:

At the end of this experiment, students will be able to:

a. Name and specify the chemicals, which are used to prepare CO_2 gas in the laboratory.

b. Describe the physical and chemical properties of the gas

c. Test carbonate radical in the given salt sample.

d. Describe the procedure for preparation of gas in the laboratory.

e. Know the precautions and safety measures.

SET UP OF EXPERIMENT:
A. Apparatus Required :

a. Woulf's Bottle. b. Thistle Funnel 'c. Derive Tube. d. Rubber Cork, e. Gas Jar with Lid. f. Few Test Tubes.

B. Chemicals Required :

a. Marble chips (CaCO3), b. Dilute Hydrochloric Acid (HCI)

c. Litmus Paper, d. Magnesium Ribbon

e. Lime Water, f. Phenolphthalein Solution, g. NaOH Solution.

Theory:

In the Laboratory, carbon dioxide (CO_2) gas is prepared by the action of dilute hydrochloric acid (HCI) upon marble chips ($CaCO_3$) in a Woulf's bottle.

Chemical Equations :

$CaCO_3 + 2HCl \longrightarrow CaCl_2 + H_2O + CO_2$

Diagram :

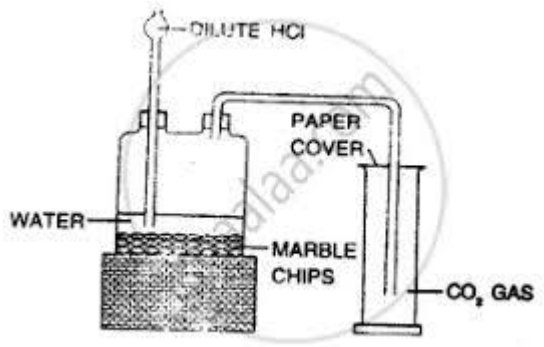

Fig. Preparation of CO_2 gas in laboratory

PROCEDURE:

Take a Woulf's bottle fitted with rubber cork, thistle funnel and delivery tube, Examine that it is perfect airtight. In case of air leakage, use melted paraffinwax or grease.

Introduce few small size marble chips into the Woulfs botttle by Opening one of its mouths

Now pour some water into the Woulf's bottle through the thistle funnel so as to cover the marble chips.

Insert the thistle funnel more into the Woulf's bottle such that its extreme end remains inside the water.

Now add little quantity of the dilute hydrochloric acid through the thistle funnel. Do not add excess amount of acid at a time to exhaust the marble chips before the experiment is completed.

Then collect The carbon dioxide gas in the gas jar by upward displacement of air. Test the

collected gas in the jar by showing a burning splinter at the mouth of the gas jar.

Study the properties of CO_2 gas by collecting the gas in different test tubes.

OBSERVATION:STUDY OF PROPERTIES

Physical Properties

SL.NO	EXPERIMENT	OBSERVATION	INFERENCE
01	**Appearance** :Observe the colour of the gas		
02	**Odour:** Smell the odour of the gas.		
03	**Burning Candle**: Enter a burning candle into a test tube full of CO_2 gas		
04	Inverttest tube full of CO_2 gas over another empty test tube containing air. Then add little lime to the test tube containing air initially.		
05	Collect the gas in a test tube half-filled with water. Sake the test tube vigorously by putting the thumb at its mouth and remove the thumb and observe the level/volume of water in the test tube.		

Chemical Properties

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SL NO.	EXPERIMENT	OBSERVATION	INFERENCE
01	A piece of moist litmus paper is shown to the gas.		
02	Pass the CO_2 gas through the 2-3 ml of very dilute solution f sodium hydroxide containing one drop of phenolphthalein solution.		
03	a. Pass the gas through limewater b. Pass the gas in excess c. Boil the solution		
04	Introduce a burning magnesium ribbon into a test tube/gas jar containing carbon dioxide gas.		

SAFETY AND PRECAUTIONS:

a. The fittings should be air tight The end of the thistle funnel must be remain deep inside the solution.
b. The shorter end of the delivery tube should remain above the surface of the solution in the Wolf's bottle.
c. The longer end of the delivery tube must reach the bottom of the gas jar.
d. Addition of excess acid should be avoided.
e. The gas should be collected after removing air from the apparatus.

EXPERIMENT NO.- O2

AIM OF THE EXPERIMENT:

Preparation and study of physical and chemical properties of Ammonia gas(NH_3).

OBJECTIVES OF THE EXPERIMENT:

At the end of this experiment, the students will be able to :

a. Detect the chemicals and apparatus required for preparation of ammonia gas in the laboratory.

b. Identify the formula of Nessler's reagent.

c. Know the precautions and safety measures.

SET UP OF EXPERIMENT:

A. Apparatus Required:

a. Hard Glass Test Tube b. Delivery tube

c. Gas 'jar with lid. D.ClampStand.

e. Bunsen Burner f.Cork

.g. Cork Borer h.Triangular flle

i. Test Tube

B. Chemicals Required:

a. Solid Ammonium Chloride (NH_4Cl).

b. Quick lime (CaO) or dry slakedlime $Ca(OH)_2$

Theory:

Ammonia gas is prepared in the laboratory by heating an intimate mixture of solid ammonium chloride andquick lime or dryslaked lime in 1:3 ratio.The gas is collected by the downward displacement of air as it is lighter than ajr.

PREPARATION OF AMMONIA GAS

DIAGRAM

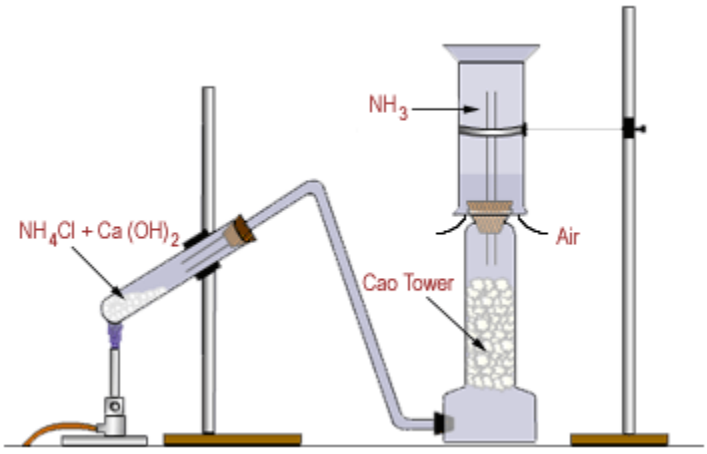

Fig. Preparation of Ammonia (NH_3) gas in laboratory

Chemical Equation

$2NH_4Cl + CaO \xrightarrow{\Delta} CaCl_2 + 2NH_3 + H_2O$

$2NH_4Cl + Ca(OH)_2 \xrightarrow{\Delta} CaCl_2 + 2NH_3 + H_2O$

PROCEDURE

a. Take a mixture of ammonium chloride and quick lime in 1:3 ratio.
in a mortar and mix them thoroughly and take this mixture in a hard glass test tube.
b. The hard glass test tube should be half filled with the mixture.
c. Fit the cork along with the delivery tube into the mouth of the hard glass test tube.
d. Clamp the hard glass test tube in the clamp stand.
f. Heat the hard glass test tube continuously.
g. Collect the gas by downward displacement of air.

SL NO.	EXPERIMENT	OBSERVATION	INFERENCE
01	Observe the colour of the gas		
02	Introduce a burning match stick into the gas jar containing gas		
03	.Invert test gas jar containing ammonia gas into the water		
04	Show a moist red litmus paper to the gas.		
05	Show a glass rod dipped in concentrated HCI to the gas		
06	pass the gas through about 2 CC of Nessler's reagent in a clean dry test tube		
07	Pass 2 CC of ferric chloride solution in a Clean dry test tube.		
08	First Slowly pass the gas through 2 CC of aqueous copper sulphate solution in a clean dry test tube and then in excess.		

Safety and Precautions

i. The mixture should be prepared with proper ratio.
ii. The hard glass tube should be fitted slightly inclined with the mouth downward so that water droplets, which will be produced during the reaction, are collected at the mouth of the test tube.
iii. The fittings should be air tight.
iv. The collected gas should be perfectly dried.
v. The students should not inhale the gas.

EXPERIMENT NO.- O3

AIM OF THE EXPERIMENT:

Crystallization of copper sulphate from copper carbonate.

OBJECTIVES OF THE EXPERIMENT:

At the end of this experiment, students will be able to know

a. The preparation of a crystal from its saturated solution.

b. Purification of a substance through the process of crystallization.

c. General basic properties of a crystal.

SET UP OF EXPERIMENT:
A. Apparatus Required :

a. Beaker, b. Funnel ,c. Glass rod d. China dish e. Bunsen Burner, f. Tripod stand g. Wire gauge h. Filter stand, i.Filter paper

B. Chemicals Required:

a. Copper Carbonate ($CuCO_3$), b. Dilute Sulphuric acid (H_2SO_4)

PROCEDURE

At first, about 40 ml of dil.sulphuric acid is taken in a beaker. The copper carbonate powder is added to the beaker pinch by pinch till a small quantity of copper carbonate solid left undissolved. Then the resulting solution in the beaker is heated for 2-3 minute to drive out carbon dioxide gas. The beaker is cooled and filtered into china dish. A few drop of dil.sulphuric acid is added to the filtrate in order to prevent hydrolysis of salt. The filtrate in the china dish is heated with constant stirring till crystallization point. When the crystallizationw point is reached , the china dish is removed from the flame and placed over a beaker full of water for cooling.After cooling ,crystals are separated from mother liquor by decantation and dried by spreading over a layer of filter paper to retain their shape.The crystals are then kept in a desiccator for some time.

Result

1. Colour of crystal_____.
2. Shape of crystal _____.

PRECAUTIONS

a. The solutionof copper sulphate prepared should be the saturated solution.
b. The solution should be slightly acidic otherwise the salt may get hydrolysed.
c. The filtrate should not be heated beyond the crystallization point.
d. The crystals should never be dried by heating.

EXPERIMENT NO.- O4(A)

AIM OF THE EXPERIMENT:

To determine the strength of supplied acid solution using a standard alkali solution.

OBJECTIVES OF THE EXPERIMENT:

At the end of this experiment, the students will able to

a) Perform the different types of titration by using different types of indicators.
b) Calculate the strength of the solution.
c) Acquire knowledge about concentration terms like Normality, Molarity etc.

THEORY:

A known volume of standard alkali is titrated against the supplied acid solution of unknown strength in presence of methyl orange indicator till the colour changes from yellow to light pink. Then volume of acid solution is determined. By knowing the volume of both the solutions and strength of acid solution can be determined by using the principle of equivalence. $N_1 X V_1 = N_2 XV_2$.

APPARATUS REQUIRED:

The required apparatus are:

a) Burette b) Burette stand c) Pipette(10 ml)-1 no. , d) Conical flask(250 ml)-1no., e) Wash bottle f. Beaker (500ml)-2nos. g. Glazed tile

CHEMICAL REQUIRED:

a) Acid solution (unknown strength) b) Alkali solution (1.02 N/10)

PROCEDURE

At first the burette, pipette, conical flask are washed thrice with tap water. The burette is rinsed with supplied acid solution and the washings are rejected. Then the burette is filled with the acid solution to a convenient level without air bubbles and is clamped in the burette stand. The pipette is rinsed with supplied alkali solution and the washings are rejected.10 ml of the alkali solution is pipetted out into the conical flask. 1-2 drops of methyl orange indicator is added to the flask. Initial Burette reading (I.B.R) is noted down. Then titration is carried out till the yellow colour just changed to pink. The process is repeated to get at least three concordant readings.

OBSERVATION TABLE

No. of Observation	Volume of Alkali taken(ml)	Initial Burette Reading (I.B.R) (ml)	Final Burette Reading (F.B.R) (ml)	Difference (ml)	Remark
1	10	X_1	X_2	X_R	Rough Value
2	10	X_2	X_3	X_C	Concordant value
3	10	X_3	X_4	X_C	
4	10	X_4	X_5	X_C	

Calculation

The volume of acid solution consumed = $V_1 = X_C$ ml

Strength of the acid solution = N_1 = ?

Volume of the alkali solution = V_2 =10 ml

Strength of the alkali solution = N_2 =1.02 $\frac{N}{10}$

Applying the principle of equivalence

$N_1 \times V_1 = N_2 \times V_2$

$$N_1 = \frac{N_2 \, X \, V_2}{V_1} = \frac{1.02 \frac{N}{10} \, X \, 10}{X_c} = Y \frac{N}{10}$$

Conclusion

The strength of acid solution is found to be Y $\frac{N}{10}$.

EXPERIMENT NO.-4(B)

AIM OF THE EXPERIMENT:

To determine the strength of supplied alkali solution using a standard acid solution.

OBJECTIVES OF THE EXPERIMENT:

At the end of this experiment, the students will able to

d) Perform the different types of titration by using different types of indicators.
e) Calculate the strength of the solution.
f) Acquire knowledge about concentration terms like Normality, Molarity etc.

THEORY:

A known volume of standard alkali is titrated against the supplied acid solution of unknown strength in presence of methyl orange indicator till the colour changes from yellow to light pink. Then volume of acid solution is determined. By knowing the volume of both the solutions and strength of acid solution can be determined by using the principle of equivalence i.e.,

$N_1 X V_1 = N_2 X V_2$

APPARATUS REQUIRED:

Required apparatus are:

b) Burette , b) Burette stand, c) Pipette(10 ml)-1 no. , d) Conical flask(250 ml)-1no., e) Wash bottle, f. Beaker (500ml)- 2nos., g. Glazed tile

CHEMICALS REQUIRED:

Required chemicals are:

b) Acid solution (unknown strength) b) Alkali solution (1.02 N/10)

PROCEDURE

At first the burette, pipette, conical flask are washed thrice with tap water. The burette is rinsed with supplied acid solution and the washings are rejected. Then the burette is filled with the acid solution to a convenient level without air bubbles and is clamped in the burette stand. The pipette is rinsed with supplied alkali solution and the washings are rejected.10 ml of the alkali solution is pipetted out into the conical flask. 1-2 drops of methyl orange indicator is added to

the flask. Initial Burette reading (I.B.R) is noted down. Then titration is carried out till the yellow colour just changed to pink. The process is repeated to get at least three concordant readings.

OBSERVATION TABLE

No. of Observation	Volume of Alkali taken(ml)	Initial Burette Reading (I.B.R) (ml)	Final Burette Reading (F.B.R) (ml)	Difference (ml)	Remark
1	10	X_1	X_2	X_R	Rough Value
2	10	X_2	X_3	X_C	Concordant value
3	10	X_3	X_4	X_C	
4	10	X_4	X_5	X_C	

Calculation:

The volume of acid solution consumed = $V_1 = X_C$ ml

Strength of the acid solution = $N_1 = 1.01\frac{N}{10}$

Volume of the alkali solution = V_2 =10 ml

Strength of the alkali solution = N_2 = ?

Applying the principle of equivalence

$N_1 \times V_1 = N_2 \times V_2$

$$N_1 = \frac{N_1 \, X \, V_1}{V_2} = \frac{1.01 \frac{N}{10} \, X \, 10}{X_c} = Y \frac{N}{10}$$

Conclusion:

The strength of acid solution is found to be $Y \frac{N}{10}$.

EXPERIMENT NO.- 5 to 9

TEST FOR ACID RADICALS

EXPERIMENT		OBSERVATION		INFERENCE	
(1)Test for Carbonate (CO_3^{2-})					
(i)	Take 2 ml of dil. HCl or dil. H_2SO_4 in a clean test tube. Warm it and add a little of the salt into it.	(i)	Effervescence takes place with the evolution of a colourless, odourless gas.	(i)	It may be CO_2 from CO_3^{2-}.
(ii)	Warm the above reaction mixture to get more gas and pass the gas slowly through lime water.	(ii)	First lime water turns milky and with excess of the gas milkiness disappears but this gas fails to change orange colour of $K_2Cr_20_7$ solution green.	(ii)	CO_3^{2-} is confirmed.

EXPERIMENT		OBSERVATION		INFERENCE	
(2) Test for Sulphlde(S^{2-})					
(i)	Take 2 ml of dil. HCl or dil. H_2SO_4 in a clean test tube. Warm it and add a little of the salt into it.	(i)	Effervescence takes place With the evolution of colourless gas with rotten egg smell	(i)	It may be H_2S gas from S^{2-}.
(ii)	Warm the above reaction mixture and show a filter black paper soaked with lead acetate solution to the evolved gas.	(ii)	The filter paper turns black	(ii)	S^{2-} is confirmed.

EXPERIMENT	OBSERVATION	INFERENCE

(3) Test for Chloride(Cl^-)					
(i)	Take a pinch of the salt in a clean and dry test tube and add 2-3 drops of conc. H_2SO_4 to it.	(i)	Effervescence takes place with the evolution of colourless gas which fumes in moist air.	(i)	It may be HCl from Cl^-.
(ii)	Warm the above reaction 2mixture and show a glass rod dipped in come. NH_4OH to the mouth of the test tube.	(ii)	Dense white fumes are 2. produced and white solid deposited on the tip of the glass rod.	(ii)	It is due to the formation of NH4Cl. Cl^- may present.
(iii)	Take a pinch of the salt in 3. a clean and dry test tube. Add a little MnO2 and 2-3 drops of cone. H_2SO_4. Heat the reaction mixture.	(iii)	Greeni sh yellow gas is 3. evolved which turns filter paper soaked in starch iodide solution blue.	(iii)	Chlorine gas comes out from chloride which liberates iodine from iodide. Cl^- may present.
(iv)	Take 1-2 ml supplied salt solution. Acidify it with 1-2 ml. of dil. HNO_3. Add few drops of $AgNO_3$ solution to it.	(iv)	A curdy white precipitate is formed.	(iv)	It is due to the formation of AgCl. Cl^- may present.

EXPERIMENT		**OBSERVATION**		**INFERENCE**	
(4)Test for Nitrate(NO_3^-)					
(i)	Take a pinch of the salt in a clean and dry test tube Add few pieces of copper turnings and 4-5 drops of conc. H_2SO4 and heat it.	(i)	Copious brown fumes are evolved and the solution turns green or bluish green.	(i)	Brown fume is due to NO_2 from nitrate (NO_3^-) salt.
(ii)	*Brown-ring Test* Take 1-2ml of the salt solution. Add equal volume of conc. H_2SO_4 slowly into the test tube. Cool the test tube perfectly under tap water. Then slowly add 2-3 ml of freshly prepared ferrous sulphate solution through the sides of the test tube.	(ii)	A brown ring is formed at the junction of two liquids layers.	(ii)	NO_3^- is confirmed.

EXPERIMENT	**OBSERVATION**	**INFERENCE**

(5)Test for Sulphate(SO_4^{2-})					
(i)	Take about 1-2 ml of salt solution. Acidify with 1-2 ml of dil. HCl. Add about 1 ml. of $BaCl_2$ solution.		A white precipitate is obtained.		SO_4^{2-} is confirmed.
(ii)	Add about 1 ml of conc. HCl to the above solution.		The precipitate is not soluble.		SO_4^{2-} is confirmed.

TEST FOR BASIC RADICALS

EXPERIMENT		OBSERVATION		INFERENCE	
Dry test tube heating					
	In a clean and dry test tube a pinch of the salt is heated.	(i) (ii) (iii) (iv) (v) (vi) The colour of the salt is changed. a. Yellow when hot & white when cold. b. Yellow when hot and cold. c. Yellowish brown in hot and yellow when cold d. Black residue.	Water varpours condensed at the cooler part of the test tube. Decrepitation took place. Salt is volatilised and white sublilmate is formed. Salt is first melted but finally infusible white mass left. Salt is fused on heating and solidified on cooling.	(i) (ii) (iii) (iv) (v) (vi) The salt is non-volatile. a. May be Zn^{2+} salt. b. May be Pb^{2+}salt. c. May be Sn^{2+} and Bi^{3+} salt d. May be Cu^{2+}, ,Ni^{2+} ,Mn^{2+} and Fe^{2+}.	Salt with water of crystallisation. May be crystalline salt. May be Volatile salt of NH_4^+, As^{3+} and Hg^{2+} . May be Mg^{2+} , Al^{3+} , Zn^{2+} , Ca^{2+} , Sr^{2+} , Ba^{2+} etc. May be alkali or alkaline earth metal salt (Na^+, K^+ etc.) May be salt of Pb2+, Bi^{2+},Sn^{2+} etc.

EXPERIMENT		OBSERVATION		INFERENCE	
Heating in a charcoal cavity					
(i)	A pinch of the salt is taken in a charcoal cavity and is heated in oxidising flame with a blow pipe.	(i) (ii) (iii) (iv) (v)	The salt is completely volatilised. An infusible incandescent white mass is obtained. The salt fused and sank into the charcoal cavity and reappeared on cooling. Original salt is white and formed a coloured mass. Original salt is coloured and is formed a coloured mass.	(i) (ii) (iii) (iv) (v)	May be NH_4^+ As^{3+}, Hg^{2+} (Sodalime test is to be performed) May be Mg^{2+},Al^{3+} , Zn^{2+},Ca^{2+},Ba^{2+},Sr^{2+} , Sn^{2+} . (Cobalt nitrate test is to be performed). May be alkali or alkaline earth metal salt like Na^+ K^+. (Flame test is to be performed.) May be Pb^{2+},Bi^{3+},Sn^{2+},Ag^+ etc. (Reduction test is to be performed) May be Cr^{3+},Mn^{2+}, Ag+ etc. Co^{2+},Ni^{2+}, Cu^{2+} . (Borax bead test is to be performed)
EXPERIMENT		**OBSERVATION**		**INFERENCE**	
Sodalime test (Volatile Salt)					
(i)	A pinch of salt is taken in a watch glass .A little sodalime is added with a drop of water. Then it is rubbed.	(i) (ii) (iii)	Ammonia gas is evolved and the colour of the mixture is not changed. Only colour of the residue is Changed to brown and there is no evolution of gas. No gas is evolved and no change in colour of residue.	(i) (ii) (iii)	May be NH_4^+, May be NH_4^+, May be As^{3+}

EXPERIMENT		OBSERVATION		INFERENCE	
Bulb tube test (For volatile salt)					
	A mixture of salt, anhydrous Na_2CO_3 and charcoal powder in the proportion of 1:3:1 was prepared. A little of the mixture is taken in a bulb tube and heated.	(i) (ii)	A white shinning mirror is formed A black shinning mirror is formed with the evolution of a gas having garlic odour.	(i) (ii)	May be Hg^{2+}. May be As^{3+}.

EXPERIMENT		OBSERVATION		INFERENCE	
Cobalt Nitrate Test (For infusible salt)					
	A pinch of salt is taken in a charcoal cavity. It is heated an oxidising flame till an infusible mass is obtained. A drop of cobalt nitrate solution is added and again heated strongly.	(i) (ii) (iii) (iv) (v)	Blue mass. Green muss. Pink mass.. Dirty green mass. Grey mass.	(i) (ii) (iii) (iv) (v)	May be Al^{3+}. May be Zn^{2+}. May be Mg^{2+}. May be Sn^{2+}. May be Ca^{2+},Sr^{2+}, Ba^{2+} (Flame test to be performed)

EXPERIMENT		OBSERVATION				INFERENCE	
Flame Test (For fusible salt)							
	A clean nichrome wire is moisten with conc. HCl. A pinch of a salt is taken by touching this wire to the salt .Then it is shown to the oxidizing flame. The colour of the flame is observed through naked eye and through double blue glass.		**<u>Colur through naked eye</u>**		**<u>Colour through double blue glass</u>**		
		(i)	Persistent golden	(i)	Colourless	(i)	May be Na^{+}.
		(ii)	yellow	(ii)	Red	(ii)	May be K^{+}.
		(iii)	Violet	(iii)	Light yellow	(iii)	May be Ca^{2+}.
		(iv)	Brick red	(iv)	Red	(iv)	May be Sr^{2+}.
		(v)	Crimson red	(v)	Green	(v)	May be Ba^{2+}.
		(vi)	Pea green Green flame with blue centre.	(vi)	__	(vi	May be Cu^{2+}.

EXPERIMENT		OBSERVATION		INFERENCE	
Charcoal Reduction Test (For white salt changing colour)					
	A mixture of salt and fusion mixture in the proportion of 1:1 is prepared. A little of this mixture is taken in a charcoal cavity and is heated in a reducing flame.	(i) (ii) (iii) (iv) (v)	White shinning malleable bead without incrustation which did not mark on paper. White shinning malleable bead with lemon yellow incrustation which marked on paper. Brittle bead with lemon yellow incrustation. Malleable white bread. Red scales without incrustation.	(i) (ii) (iii) (iv) (v)	May be Ag^{+}. May be Pb^{2+}. May be Bi^{3+}. May be Sn^{2+}. May be Cu^{2+}.

EXPERIMENT		OBSERVATION		INFERENCE	
Group Separation					
(i) (ii) (iii) (iv) (v)	About 2 ml of salt solution is taken in a test tube and little dil. HCl is added. The above solution is warmed and H_2S gas is passed through it About 2 ml. of the salt solution is taken in a test tube. Solid NH_4Cl is added till saturation and dil. NH_4OH till faintly ammoniacal. H_2S gas is passed through above solution. About 2ml. of salt solution is taken with solid NH_4Cl and dil. NH_4OH till ammoniacal. Then a saturated solution of ammonium carbonate is added.	(i) (ii) (iii) (iv) (v)	(a) White ppt. is formed (b)No white ppt. is formed. (a) A coloured precipitate is formed. (b) No precipitation formed . (a) A precipitate is formed. (b) No precipitation formed . (a) A coloured ppt. is formed. (b) No ppt. is formed. (a) A white ppt. is formed. (b) No white ppt.	(i) (ii) (iii) (iv) (v)	(a) Gr.I radical may be present. (b) Gr. I radicals are absent. (a) Gr. II radicals may be present. (b) Gr. II radicals are absent. (a) Gr. IIIA radicals may be present. (b) Gr. IIIA radicals are absent. Gr. IIIA radicals may be present. Gr. IIIB radicals are absent. (a)Gr.IV radicals may be present. (b)Gr.IV radicals are absent.

EXPERIMENT		OBSERVATION		INFERENCE	
TEST FOR GR-I RADICALS (Pb^{2+}, Ag^{+} Hg_2^{2+}) , Group reagent –dil. HCl					
	About 2 ml. of salt solution is taken in a test tube and treated with a little dil. HCI. The white ppt. is washed with distilled water and divided into two parts. Further distilled water is added wish washing.	 (i) (ii)	A white ppt. is formed. (a)The ppt. is dissolved on heating and reappeared on cooling. (b)The ppt. is not soluble in hot condition. (a)The ppt. is soluble and reappeared on acidified with dil.HNO_3. (b)The precipitate is turned black.	 (i) (ii)	Group-I radical Pb^{2+}, Ag^{+} or Hg_2^{2+}. (a)May be Pb^{2+} . (b)Pb^{2+} is absent. (a)May be Ag^{+}. (b)May be Hg_2^{2+}.

EXPERIMENT		OBSERVATION		INFERENCE	
TEST FOR GR-IIA RADICALS (Pb^{2+}, Hg^{2+} ,Cu^{2+} ,Bi^{3+}) & GR-IIB(As^{3+} ,Sb^{3+} ,Sn^{2+}), Group reagent- dil.HCl and H_2S					
	About 2 ml. of salt solution is taken and a little of HCl is added obtained.Then it is warmed and finally H_2S gas is passed through it.	(i) (ii) (iii) (iv) (iv)	Black precipitate is obtained Dark brown precipitate is obtained. Yellow ppt. is obtained. Orange ppt. is obtained. Dirty yellow or light brown ppt. is obtained.	(i) (ii) (iii) (iv)	May be Pb^{2+} or Hg^{2+} or Cu^{2+} . May be Bi^{3+} . May be As^{3+} . May Sb^{3+} . May be Sn^{3+} .

EXPERIMENT		OBSERVATION		INFERENCE	
TEST FOR GR-IIIA RADICALS (Fe^{3+}, Al^{3+} ,Cr^{3+}) , Group reagent- Solid NH_4Cl and NH_4OH					
	To about 2 ml. of salt solution NH_4Cl is added till saturation and then dii. NH_4OH is added to alkanline. till alkaline.	(i) (ii) (iii)	Reddish brown ppt is obtained. Gelatinous white ppt. is obtained. Greenish white ppt. is obtained.	(i) (ii) (iii)	Maybe Fe^{3+}. Maybe Al^{3+}. May be Cr^{3+}.

EXPERIMENT		OBSERVATION		INFERENCE	
Confirmatory Test for Aluminium(Al^{3+})					
	To about 2 ml. of salt solution NaOH solution is added drop by drop and then in excess.		Gelatinous white ppt. is formed.(white ppt. is soluble in excess NaOH).		Al^{3+} is confirmed.

EXPERIMENT		OBSERVATION		INFERENCE	
TEST FOR GR-IIIB RADICALS (Zn^{2+}, Mn^{2+} ,Co^{2+} ,Ni^{2+}) , Group reagent- Solid NH_4Cl, NH_4OH and H_2S					
	To about 2 ml. salt solution, solid NH_4Cl is added till saturation and then dil.NH_4OH is added till alkaline. Then H_2S gas is passed through it.	(i) (ii) (iii)	White ppt. is obtained. Buff coloured ppt. Black ppt. is obtained.	(i) (ii) (iii)	May be Zn^{2+}. May be Mn^{2+}. May be Co^{2+} or Ni^{2+}.

EXPERIMENT		OBSERVATION		INFERENCE	
Confirmatory Test for Zinc(Zn^{2+})					
	To about 2 ml. of salt solution, dil. NaOH is added drop by drop and then in excess.		White ppt. is formed. (white ppt. is soluble in excess NaOH).		Zn^{2+} is confirmed.

EXPERIMENT		OBSERVATION		INFERENCE	
TEST FOR GR-IV RADICALS (Sr^{2+}, Ba^{2+} ,Ca^{2+}), Group reagent- Solid NH_4Cl, NH_4OH and $(NH_4)_2CO_3$					
	To about 2 ml. salt solution, solid NH_4Cl is added till saturation and then dil.NH_4OH is added till alkaline. Then saturated solution of of $(NH_4)_2CO_3$ is added.		White ppt. is obtained.		Gr.IV radicals **(**Sr^{2+}, Ba^{2+}, Ca^{2+}) may be present.

EXPERIMENT		OBSERVATION		INFERENCE	
Confirmatory Test for Calcium(Ca^{2+})					
	To about 2 ml. salt solution, solid NH_4Cl is added till saturation and then dil.NH_4OH is added till alkaline. Then saturated solution of of $(NH_4)_2CO_3$ is added. The white ppt. obtained is dissolved in acetic acid and divided into three parts. Take one part of solution in a test tube and add ammonium oxalate solution followed by dil.NH_4OH.		White ppt. is formed.		Ca^{2+} is confirmed.

EXPERIMENT		OBSERVATION		INFERENCE	
TEST FOR GR-V RADICALS (Na^+, K^+, Mg^{2+},NH_4^+)					
Confirmatory Test for (Na^+)					
	To about 2 ml. of salt solution potassium pyroantimonate solution solution ($K_2H_2Sb_2O_7$) is added. colour in flame test. .		White ppt. is obtained, which gave persistent golden yellow colour in flame test.		Na+ is confirmed.

EXPERIMENT	OBSERVATION	INFERENCE
Confirmatory Test for Potassium (K^+)		
To about 2ml. of salt solution a few drops of cobalt nitrate solution is added followed by addition of solid $NaNO_2$, and dil. CH_3COOH. Then it is allowed to stand for five minutes.	Yellow ppt. of potassium cobaltinitrite is obtained,which gave violet purple colour in flame test.	K^+ is confirmed.

EXPERIMENT	OBSERVATION	INFERENCE
Confirmatory Test for Sodium (Mg^{2+})		
To about 2 ml. of salt solution solid NH_4Cl is added till saturation and dil. NH_4OH is added till ammoniacal. Then disodium-hydrogen phosphate is added.	White ppt. is obtained.	Mg^{2+} is confirmed.

EXPERIMENT	OBSERVATION	INFERENCE
Confirmatory Test for Ammonium (NH_4^+)		
To about 2 ml. of salt solution few drops of NaOH was added followed by a little Nessler's reagent. A brown ppt. is obtained. Then	Brown ppt. is obtained.	NH_4^+ is confirmed.

Conclusion:
Acid radical of the salt detected to be _____.
Basic radical of the salt detected to be _____.
Hence, the unknown supplied salt is detected to be _____.