Experiment No. 1

Date: / /

Aim: To determine the concentration in terms of molarity of $KMnO_4$ by titrating it aganist standard solution of oxalic acid.

Theory: The substances available in the state of high purity are used to prepare standard solutions by dissolving a fixed/definite mass in definite volume of water. Oxalic acid is a primary standard substance. Its molar mass is 126 g/mol

A. Preparation of standard solution of oxalic acid

Molar mass of oxalic acid ($H_2C_2O_4.2H_2O$) is 126 g/mol

For 1000 mL 1 M oxalic acid solution required mass is 126 g of oxalic acid

Hence for 100 mL of 0.1 M oxalic acid the required mass is

$$= \frac{126 \times 100 \times 0.1}{1000 \times 1}$$

= 1.26 g of oxalic acid

Apparatus: 100 mL standard flask, balance, watch glass, beaker, glass rod, etc.

Chemicals: Oxalic acid, distilled water.

Procedure:

1. Weigh accurately 1.26 g oxalic acid on watch glass.
2. Transfer the weighed oxalic acid to a beaker and wash the watch glass with distilled water and transfer washings to the beaker. Add little distilled water to dissolve it by stirring.
3. Transfer the solution of oxalic acid from beaker to 100 mL standard flask. Wash beaker twice with water and transfer washings to the 100 mL standard flask. Dilute the solution up to the mark on standard flask to make volume 100 mL.

B. Determination of molarity of $KMnO_4$ solution using standard solution of oxalic acid.

Apparatus: Burette, pipette, conical flask, burner, water bath, etc.

Chemicals: $KMnO_4$ solution, 0.1 M oxalic acid, dilute H_2SO_4.

Procedure:

1. Wash the burette, pipette and conical flask with water.
2. Rinse the burette with given $KMnO_4$ solution and then fill it. Remove air bubble from the nozzle and avoid leakage if any.
3. Adjust the level of $KMnO_4$ solution in burette up to zero mark with upper meniscus and fix it on a burette stand.
4. Rinse the pipette with standard 0.1 M oxalic acid solution.
5. Pipette out 10 mL of 0.1M oxalic acid solution and transfer into clean conical flask. Then add one test tube dilute sulphuric acid. (The solution remains colourless)
6. Heat the conical flask up to 60 to 70°C on wire gauze or water bath (as reaction at room temperature is very slow)
7. Place the conical flask with hot solution on a white porcelain tile below the burette.
8. Start adding $KMnO_4$ solution drop wise from burette in a conical flask with continuous stirring till light/faint pink colour is obtained in conical flask. Keep the flask constant shaking in a circular manner. This is called swirling of solution. See that the colour does not disappear even on vigorous shaking. This is end point of titration.
9. Note this reading as 'Pilot reading' (pilot reading is always in whole number.)
10. Now fill the burette again with $KMnO_4$ solution up to the zero mark with upper meniscus.
11. Repeat the above procedure and take minimum three more correct burette readings.
12. Note down the constant burette reading .....(x) mL (C.B.R.)
13. From C.B.R. calculate the molarity of given $KMnO_4$ solution.

Observations:

1. Solution in a burette : KMnO4
2. Solution by a pipette : oxalic acid
3. Solution in conical flask : oxalic acid + 1 tt dil. H_2SO_4
4. Indicator : self
5. End point : colourless to faint pink
6. Chemical Equation : $2KMnO_4 + 5H_2C_2O_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 10CO_2\uparrow$

Observation Table:

Burette level	Pilot reading	Burette reading in mL			C.B.R.
		I	II	III	
Final	.....	9.15	9.5	9.6	9.5 (x) mL
Initial	to	0.0	0.0	0.0	
Difference	mL	9.5	9.5	9.6	

Calculation: From above chemical equation

$2KMnO_4 + 5H_2C_2O_4 + 3H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 8H_2O + 10CO_2$

2 moles 5 moles

2×158 g (316 g) ≡ 1000 mL 5 M (molar mass of $KMnO_4$ = 158 g/mol)

∴ 1000 mL 5 M oxalic acid ≡ 316 g of $KMnO_4$

∴ 10 mL 0.1 M oxalic acid $= \frac{316 \times 10 \times 0.1}{1000 \times 5}$

$= 0.0632$ g of $KMnO_4$

∴ Hence .....(x) C.B.R. mL of $KMnO_4$ solution contains = 0.0632 g of $KMnO_4$

∴ 1000 mL of $KMnO_4$ contains $= \frac{0.0632 \times 1000}{9.5\text{...(x) CBR}} = 6.6526$

Hence molarity of $KMnO_4$ in the solution is $= \frac{0.0632 \times 1000}{9.5\text{...(x) CBR} \times 158}$

$= \frac{0.4}{9.5\text{(x) CBR}}$

= 0.0421 M

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Result: The molarity of $KMnO_4$ solution is 0.042 M

Remark and sign of teacher: .....

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MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. The molar mass of oxalic acid is
   a. 126 u ✓b. 126 g/mol
   c. 12.6 u d. 12.6 g/mol
2. To prepare 1 M solution of oxalic acid
   ✓a. 126 g of oxalic acid dissolve in distilled water and diluted to 1 L
   b. 12.6 g of oxalic acid dissolve in distilled water and diluted to 1 L
   c. 1.26 g of oxalic acid dissolve in distilled water and diluted to 1 L
   d. 0.126 g of oxalic acid dissolve in distilled water and diluted to 1 L
3. Water of crystallization present in oxalic acid is/are.....
   a. 1 ✓b. 2 c. 3 d. 5
4. Oxalic acid is used to prepare standard solution because it is a.....
   a. substance ✓b. primary standard substance
   c. secondary standard substance d. tertiary standard substance
5. The quantity of oxalic acid required to prepare 0.1 M 100 mL standard solution of oxalic acid is
   a. 126 g b. 12.6 g ✓c. 1.26 d. 0.126 g

Short answer questions

1. Calculate the molar mass of oxalic acid. (H = 1, C = 12, O = 16)

Ans molar mass of $H_2C_2O_4$ = (2×1) + (12×2) + (4×16)
= 2 + 24 + 64
= 90 g/mol

2. Why heating is required in oxalic acid and potassium permanganate titration?

Ans The solution is heated before titration because this reaction happens only at certain temp. so oxalic acid is heated to speed up the liberation of Mn^{2+}

3. Why one test tube of dilute sulphuric acid is required in permanganate titration?

Ans To prevent oxidation of manganese to form manganese dioxide

4. What is the oxidation state of carbon atom in oxalic acid after completion of redox titration?

Ans The oxidation state of carbon atom in oxalic acid changes from +3 to +4

5. Why primary standard substances are used to make standard solutions?

Ans primary standard substances are used in titration to determine unknown concentration

Remark and sign of teacher: .....

Observations:

1. Solution in a burette : KMnO4
2. Solution by a pipette : oxalic acid
3. Solution in conical flask : o.a + dil. H_2SO_4
4. Indicator : $KMnO_4$
5. End point : colourless to pink
6. Chemical Equation : $2KMnO_4 + 10FeSO_4(NH_4)_2SO_4 + 8H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 10(NH_4)_2SO_4 + 8H_2O$

Observation Table:

Burette level	Pilot reading	Burette reading in mL			C.B.R.
		I	II	III	
Final	7	7.5	7.5	7.6	7.5 (x) mL
Initial	to	0.0	0.0	0.0	
Difference	mL	7.5	7.5	7.6	

Calculation: From above chemical equation

$2KMnO_4 + 10FeSO_4(NH_4)_2SO_4 + 8H_2SO_4 \longrightarrow K_2SO_4 + 2MnSO_4 + 5Fe_2(SO_4)_3 + 10(NH_4)_2SO_4 + 8H_2O$

2 moles 10 moles

$2 \times 158 = 10$ moles of mohr's salt (molar mass of $KMnO_4 = 158$ g)

$\therefore$ 1000 mL 10M Mohr's salt $\equiv$ 316 g of $KMnO_4$

$\therefore$ 10 mL 0.1M Mohr's salt $= \dfrac{316 \times 10 \times 0.1}{1000 \times 10}$

$= 0.0316$ g of $KMnO_4$

$\therefore$ Hence .....(x) CBR mL of $KMnO_4$ solution contains = 0.0316 g of $KMnO_4$

$\therefore$ 1000 mL of $KMnO_4$ contains $= \dfrac{0.0316 \times 1000}{7.5\text{(x) CBR} \times 158}$

Hence molarity of $KMnO_4$ in the solution is $= \dfrac{0.0316 \times 1000}{\text{.....(x) CBR} \times 158}$

$= \dfrac{0.2}{7.5\text{(x) CBR}}$

$=$ 0.026 M

Result: The molarity of $KMnO_4$ solution is 0.026 M

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Remark and sign of teacher: .....

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MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. The indicator used in Redox titration is-----
   a. phenolphthalein b. methyl orange
   c. methylene blue ✓d. potassium permanganate
2. Select the titrant used in redox titration
   a. oxalic acid b. F.A.S ✓c. $KMnO_4$ d. H_2SO_4
3. The oxidation state of Mn in $KMnO_4$ in redox titration before titration is +7, the oxidation state of Mn after completion of titration is-----
   ✓a. +2 b. +3 c. +4 d. +7
4. The oxidation state of Iron in Mohr's salt is +2, the oxidation state of Iron after completion of titration is-----
   a. +1 b. +2 ✓c. +3 d. +4
5. The role of Mn^{2+} ion during oxidation-reduction titration of $KMnO_4$ by oxalic acid is-----
   ✓a. catalyst b. reductant c. oxidant d. reactant

Short answer questions

1. What specific name is given to the permanganate titrations?

Ans. Redox titration

2. Why heating is not required in F.A.S. and potassium parmanganate titration?

Ans. Because reaction rate is very high even at R.T. so heat is not required

3. Why is dilute sulphuric acid added while preparing a standard solution of Mohr's salt?

Ans. To prevent hydrolysis of ferrous sulphate

4. Calculate the molar mass of Mohr's salt (Fe = 56, S = 32, N = 14, H = 1, O = 16)

Ans. $(NH_4)_2 Fe(SO_4)_2 (H_2O)_6$ = = 392 g/mol

5. Calculate the amount of F.A.S. required to prepare M/20 standard solution of F.A.S.

Ans. M/20 standard solution of F.A.S means 0.05 M solution

1 M FAS = 392 g

0.1 M = 39.2 g

0.05 M = 19.6 g

Remark and sign of teacher: .....

Chemical Kinetics

Theory: Chemical kinetics is the study of the rates of the chemical reactions and the factors which affect these rates.

Rate of reaction: Rate of reaction can be measured in terms of either decrease in concentration of any one of the reactants or increase in concentration of any one of the products per unit time.

Factors which affect the rate of the reaction are concentration, temperature and catalyst.

Sodium thiosulphate reacts with hydrochloric acid and produces a colloidal solution of sulphur, which makes the solution translucent. The reaction occurs as follows :

$$Na_2S_2O_3(aq) + 2HCl(aq) \longrightarrow 2NaCl(aq) + H_2O(l) + SO_2(g) + S(s)\downarrow$$

Ionic form of the above reaction is written as :

$$S_2O_3^{2-}(aq) + 2H^+(aq) \longrightarrow H_2O(l) + SO_2(g) + S(s)\downarrow$$

The property of the colloidal solution of sulphur to make the solution translucent is used to study the rate of precipitation of sulphur. The rate of precipitation of sulphur increases with increase in the concentration of the reacting species or with increase in the temperature of the system. With increase in the concentration of reactants, the number of molecular collisions per unit time between the reacting species increases and consequently, the chances of product formation increase. This result increase in the rate of precipitation of sulphur. Similarly, on increasing the temperature, the kinetic energy of the reacting species increases. So the number of effective collisions that result in the formation of products increase leading to a faster rate of reaction.

Experiment No. 3

Date: / /

Aim: To study the effect of concentration on the rate of reaction between sodium thiosulphate and hydrochloric acid.

Theory: Law of mass action states that rate of a chemical reaction is directly proportional to the product of active masses (molar concentrations) of reactants. The rate of reaction between sodium thiosulphate and hydrochloric acid depends on the concentration of reactants. As the concentration of reactants increses, the rate of reaction also increases. The balanced chemical reaction is,

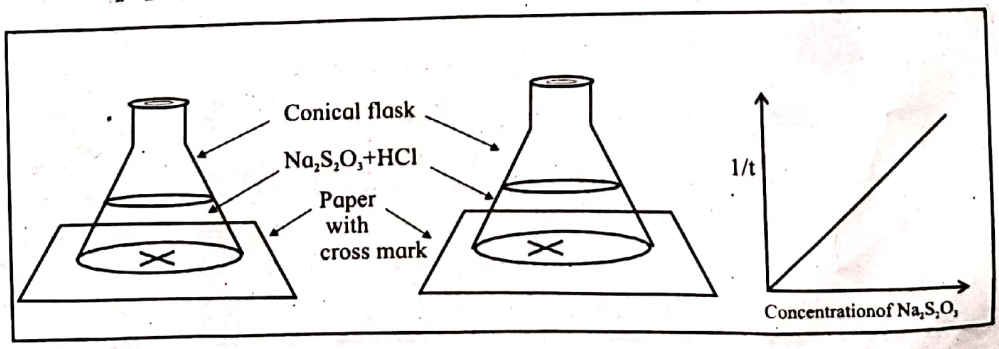
$$Na_2S_2O_3(aq) + 2HCl(aq) \longrightarrow S(s)\downarrow + NaCl(aq) + SO_2(g) + H_2O(l)$$

Sulphur formed during the reaction is insoluble and forms milky non transparent opaque colloidal solution. The time required to produce enough sulphur, so that cross mark on the paper kept below the conical flask can not be seen, when observed from top and hence rate of reaction be calculated.

Apparatus: Burette (50 mL), conical flask (250 mL), stop watch, plane paper with cross mark, measuring cylinder (10 mL), etc.

Chemicals: 0.1 M $Na_2S_2O_3$, 1 M HCl, distilled water.

Diagram:



Procedure:

1. Take four conical flasks (250 mL), wash with water and label them as A, B, C, D respectiv
2. Using 50 mL burette take exactly 20, 30, 40 and 50 mL 0.1 M $Na_2S_2O_3$ in the flasks A, B D respectively.
3. Using another 50 mL burette add 28, 18 and 8 distilled water to flasks A, B and C respectiv (There is no addition of distilled water in flask D)
4. With the help of 10 mL measuring cylinder, add 2 mL 1 M HCl to the flask A containing mL 0.1 M $Na_2S_2O_3$ and 28 mL distilled water. Start the stop watch immediately.
5. Shake and keep the conical flask on a paper having cross mark and view the cross ma through reaction mixture from top of the conical flask.
6. When the cross mark on the paper just become invisible stop the stop watch immediately a record the time required in seconds.
7. Repeat the experiment by adding 2 mL 1 M HCl to flasks B, C and D, simultaneously. B using stop watch record the time required, when cross mark on the paper just becom invisible. (Use same paper having cross mark for flasks B, C and D)

Observation Table:

Conical Flasks	0.1 M $Na_2S_2O_3$ in mL	H_2O mL	1M HCl mL	Time required to become cross mark invisible (t) sec	$1/t\ s^{-1}$	Concentration of $Na_2S_2O_3$
A	20	28	2	80	0.0125	0.04
B	30	18	2	50	0.0200	0.06
C	40	8	2	36	0.0277	0.08
D	50	-	2	33	0.03030	0.1

Graph: Plot a graph of 1/t against concentration of sodium thiosulphate.

Result:

Rate of reaction (1/t) is directly proportional to conc. of $Na_2S_2O_3$

Remark and sign of teacher: .....

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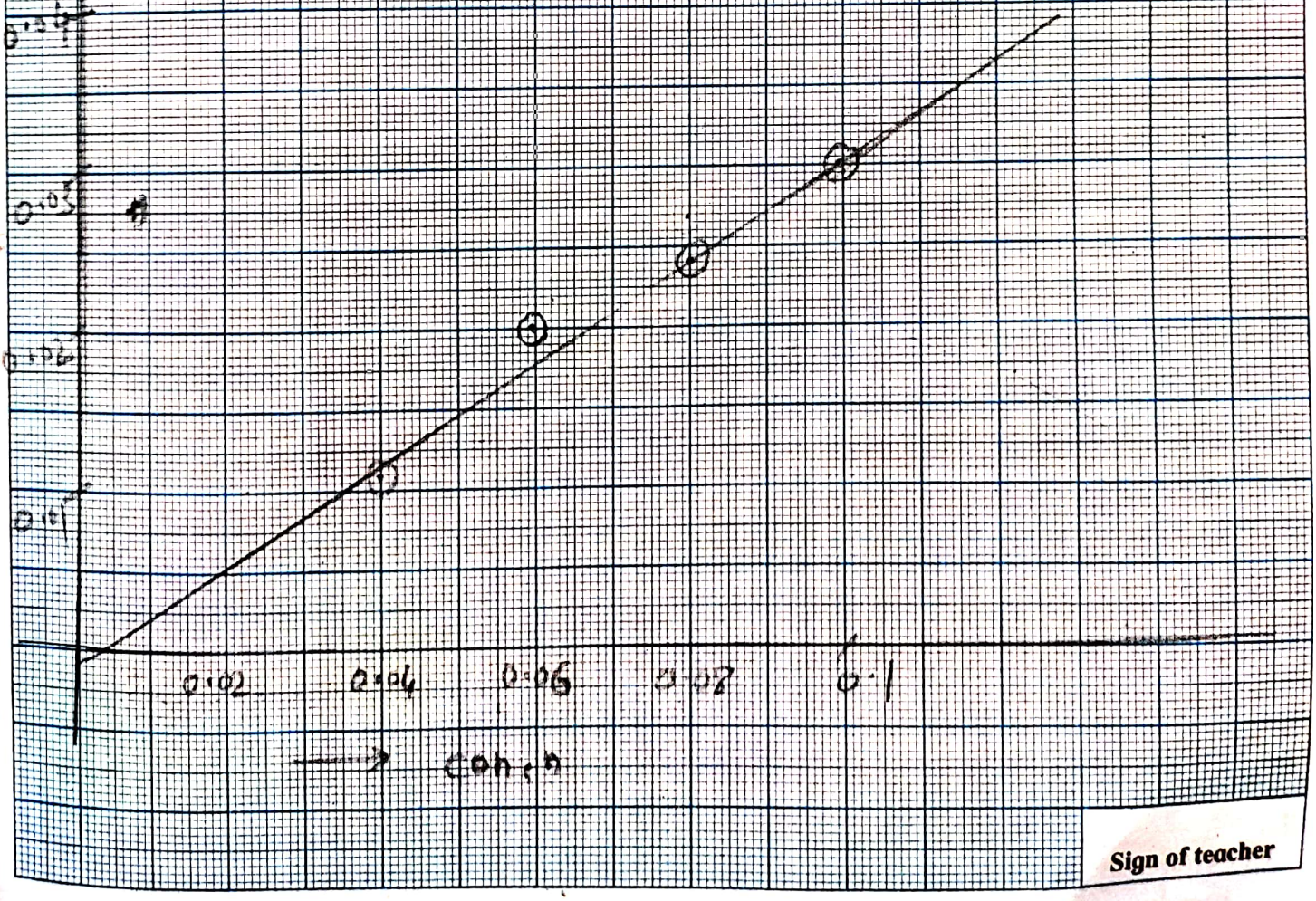
on x-axis - concentration

2 cm = 0·02

on Y-axis - $\frac{1}{\text{time}}$

2 cm = 0·01 s^{-1}



Sign of teacher

MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. The rate of reaction between 0.1 M $Na_2S_2O_3$ and 1 M HCl does NOT depends on
   ✓a. temperature b. concentration
   c. pressure d. catalyst

2. Sodium thiosulphate solution reacts with hydrochloric acid solution to produce .....
   ✓a. a colloidal solution of sulphur b. transparent solution of sulphur
   c. black solution of sulphur d. white precipitate of NaCl

3. The time required for completion of the reaction, when we add 2 mL of 1M HCl to the ..... A, B, C and D containing increasing order of concentration of 0.1 M $Na_2S_2O_3$ .....
   a. increases ✓b. decreases
   c. first decreases and then increases d. first increases and then decreases

4. The nature of graph for effect of concentration on rate of reaction between 0.1 M $Na_2S_2O_3$ and 1 M HCl is a straight line with .....
   a. decreasing slope ✓b. increasing slope
   c. increasing slope intersecting to y-axis d. decreasing slope intersecting to x-axis

Short answer questions

1. Define rate of reaction.

Ans. The rate of reaction is the speed at which chemical reaction takes place.

2. Mention the factors affecting the rate of reaction.

Ans. physical state of reactants, surface area, conc. of reactant, temp., catalyst

3. Write the name of law for the study of effect of concentration on the rate of reaction.

Ans. A differential rate law express the rea^n rate in term of change in conc^n of one or more reactants

4. Explain the nature of graph of 1/t against concentration of $Na_2S_2O_3$ solution.

Ans. The nature of graph of 1/t against concentration of $Na_2S_2O_3$ solution is a straight line with increasing slope.

5. Why rate of reaction is fastest, if distilled water is not added to 50 mL (i.e D flask) 0.1 M $Na_2S_2O_3$?

Ans. Because concentration of $Na_2S_2O_3$ is increases

Remark and sign of teacher: .....

Experiment No. 4

Date: / /

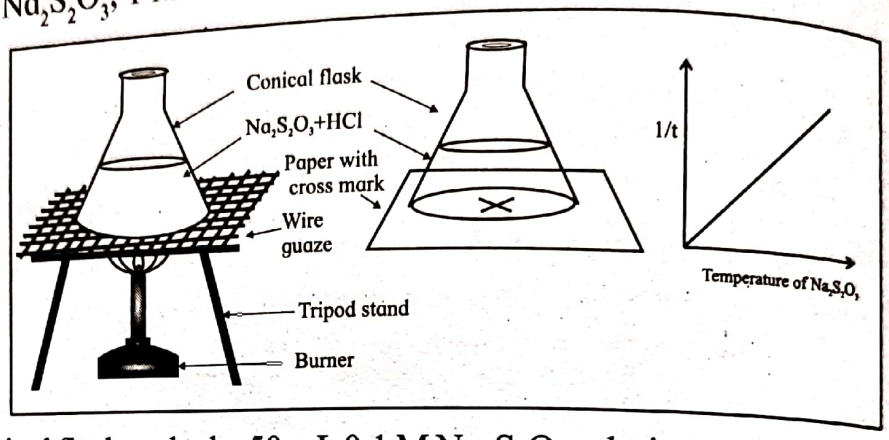
Aim: To study the effect of temperature on the rate of reaction between sodium thiosulphate and hydrochloric acid.

Theory: The rate of a chemical reaction depends upon temperature. As the temperature increases the rate of reaction increases due to increase in kinetic energy of the molecules. The increase in kinetic energy of molecules increases the number of effective collisions between reacting molecules.

Apparatus: Burettes (50 mL), conical flask(250 mL), stop watch, plane paper with cross mark, thermometer (360°C), wire gauze, tripod stand, measuring cylinder (10 mL), etc.

Chemicals: 0.1 M $Na_2S_2O_3$, 1 M HCl, distilled water

Diagram:



Procedure:

1. Clean the conical flask and take 50 mL 0.1 M $Na_2S_2O_3$ solution. Record its initial temperature using thermometer (t °C). Keep the conical flask on paper with cross mark.
2. Add 2 mL of 1M HCl to the concial flask, and start stop watch immediately shake well and record the time required for the colloidal sulphur formed during the reaction to hinder vision of cross mark.
3. In another conical flask take 50 mL 0.1 M $Na_2S_2O_3$ solution and heat it to increase temperature of solution by 10 °C[(t + 10) °C].
4. Remove the flask and keep it on paper with cross mark and add 2 mL of 1 M HCl solution shake well, start the stopwatch. Record the time required when cross mark on the paper become invisible.
5. Repeat the procedure at (t+20), (t+30) and (t+40) °C and record the time as before.

Observation Table:

Volume of 0.1 M $Na_2S_2O_3$ 50 mL

Volume of 1 M HCl added 2 mL

Temperature °C	Time required when cross mark just becomes invisible in seconds	1/t s^{-1}
t = 30	181	0.0055
30 (t)+10 = 40	153	0.0065
30 (t)+20 = 50	132	0.0075
30 (t)+30 = 60	147	0.0068
30 (t)+40 = 70	105	0.0095

Graph: Plot a graph of 1/t against the temperature.

Result: Rate of reaction between $Na_2S_2O_3$ and HCl Increases with increase in temp.

Remark and sign of teacher: .....

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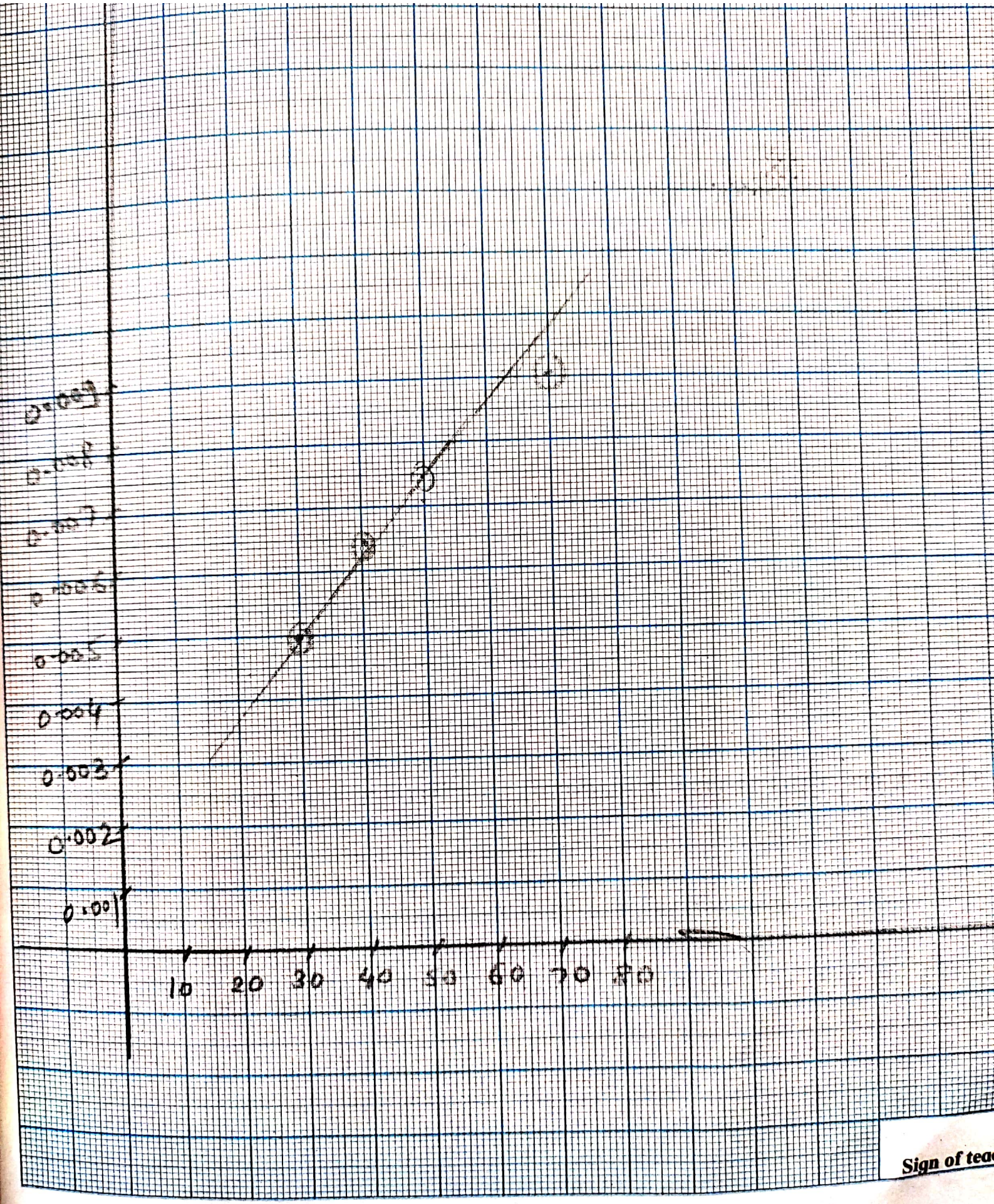


Sign of tea

Experiment No. 7

Date: / /

Aim: To determine enthalpy of dissolution of copper sulphate ($CuSO_4.5H_2O$) in water at room temperature.

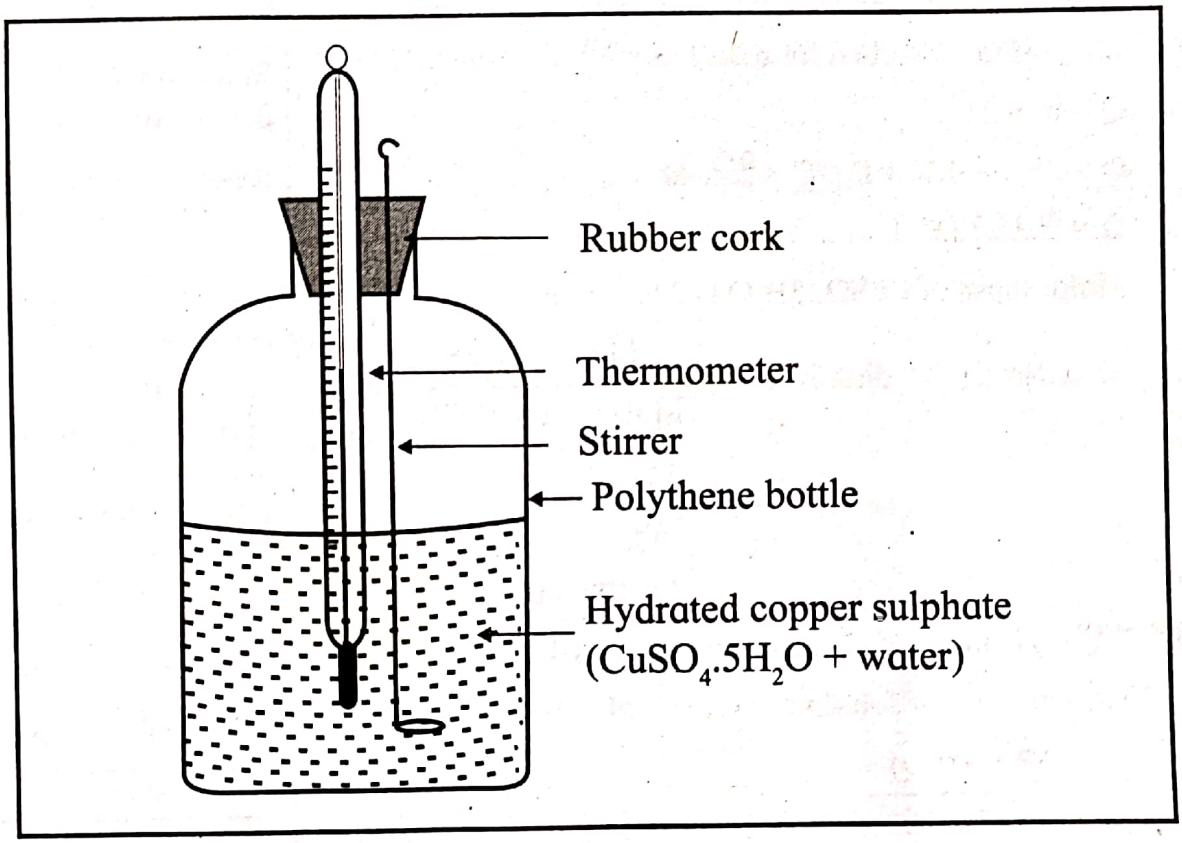
Theory: Heat of solution is the change in enthalpy when one mole of a substance is dissolved in a large amount of solvent so that further dilution does not change the enthalpy. Generally for 1 mole of solute 400 moles of solvent is recommended. Heat of solution is due to ionization or some hydrate formation. Dissolution may be exothermic or endothermic process.

Reaction: $CuSO_4.5H_2O(s) + H_2O(l) \longrightarrow CuSO_4(aq)$; $\Delta H = +11.7$ kJ/mol

Apparatus: Polythene bottle, cork having two holes,two 100 mL beakers, measuring cylinder.

Chemicals: Copper sulphate and distilled water.

Diagram:



Procedure:

1. Take 25mL water in a polythene bottle.
2. Fit cork on polythene bottle, insert stirrer and thermometer in two holes of the cork.
3. Record the initial temperature of water (t_1 °C).
4. Add 7 g of powdered copper sulphate ($CuSO_4.5H_2O$) to the polythene bottle.
5. Stir the solution to dissolve the copper sulphate completely.
6. Record the final temperature, when substance just dissolves (t_2 °C).

Note :

i. Specific heat capacity of commonly used PET type of polythene bottle can be approximated to 1 J/g °C = 1000 J/kg °C. ≅ 0.25 cal/g °C

ii. If the bottle is thin walled, its mass can be neglected if mass of water inside it is more than 100g.

iii. If a heavy bottle of different material is used, we need to know and use its water equivalent.

Observation Table:

1	Mass of $CuSO_4.5H_2O$ taken	-	0.5 g
2	Volume of water	-	25 mL
3	Mass of solution	m	25.5 g
4	Initial temperature water	t_1	26 °C
5	Final temperature of the solution	t_2	26.5 °C
6	Change in temperature	$\Delta t = 26.5\,^{0}C\ (t_2) - 26\,^{0}C\ (t_1)$	0.5 °C
7	Specific heat capacity of water	S	4.184 J/g °C

Calculation: Heat absorbed for dissolution of 0.5 g of $CuSO_4$

$Q = m\ S\ \Delta t$

$Q = 25.5 \times 4.184\ J/g\ ^{0}C \times 0.5\ \Delta t$

$Q = 53.346$ J.

Since dilute solution is used density of solution is 1 g/mL

Hence 25.5 mL = 25.5 g

Molar mass of $CuSO_4.5H_2O$ is 249 g/mol

$$\text{Moles of } CuSO_4 \text{ dissolved} = \frac{\text{Mass of } CuSO_4}{\text{Molar mass of } CuSO_4}$$

$$= \frac{0.5}{249}$$

$$= 2 \times 10^{-3} \text{ mol}$$

53.346 (Q) is the heat absorbed, when 2×10^{-3} mol of $CuSO_4$ is dissolved

The enthalpy of solution of $CuSO_4.5H_2O$ is therefore

$$\Delta H = \frac{53.346\ (Q)}{2 \times 10^{-3}}$$

$\Delta H = 26.346 \times 10^{3}$ J/mol

$\Delta H = +26.346$ kJ/mol

Space for log calculation

Number	log

Result:

The enthalpy of dissolution of given copper sulphate is 26.346 kJ/mol.

Remark and sign of teacher: .....

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Select [✓] the most appropriate answer from given alternatives of each sub question.

1. The removal of one electron from each atom in one mole is called.....
   a. enthalpy ✓b. first ionization enthalpy
   c. second ionization enthalpy d. electronegativity
2. Mathematically the enthalpy is represented by equation
   a. $\Delta H = H_2 - H_1$ ✓b. $H = U + PV$
   c. $\Delta H = \Delta U$ d. $\Delta H = \Delta U + P\,\Delta V$
3. The amount of copper sulphate used in dissolution is
   a. 2 g b. 3 g c. 5 g d. 7 g
4. The dissolution of copper sulphate is.....
   a. exothermic reaction ✓b. endothermic reaction
   c. reversible reaction d. irreversible reaction

Short answer questions

1. What is enthalpy?

Ans. Total heat content of any system is called enthalpy

2. What is enthalpy of the solution?

Ans. The enthalpy change in a process in which one mole of substance is dissolved in a specific amount of solvent is called enthalpy of solution

3. Write two reactions each showing exothermic and endothermic nature.

Ans. $NaOH + HCl \rightarrow NaCl + H_2O \quad \Delta H = -57.3\ kJ$

$CuSO_4 \cdot 5H_2O + H_2O \rightarrow CuSO_{4(aq)} \quad \Delta H = +11.7\ kJ$

4. Why is enthalpy of solution for some substances negative while for others it is positive?

Ans. For some reactions, heat releases so enthalpy is negative while for other reactions, heat absorbs so enthalpy change is positive.

5. Why is copper sulphate taken in powdered form?

Ans. Rate of reaction depends on size of particals. To increase rate copper sulphate taken in powdered form.

Remark and sign of teacher: .....

Experiment No. 8

Date: / /

Aim: To determine the enthalpy of neutralisation of strong acid 0.5M HCl and strong base 0.5M NaOH.

Theory: Enthalpy of neutralisation is an enthalpy change, when one mole of H^+ ions of an acid is completely neutralised by one mole of OH^- ions of a base to form one mole of water. Heat of neutralisation of any strong acid and strong base is almost constant, **$\Delta H = -57.3$ kJ**. It is due to complete dissociation of strong acid and strong base.

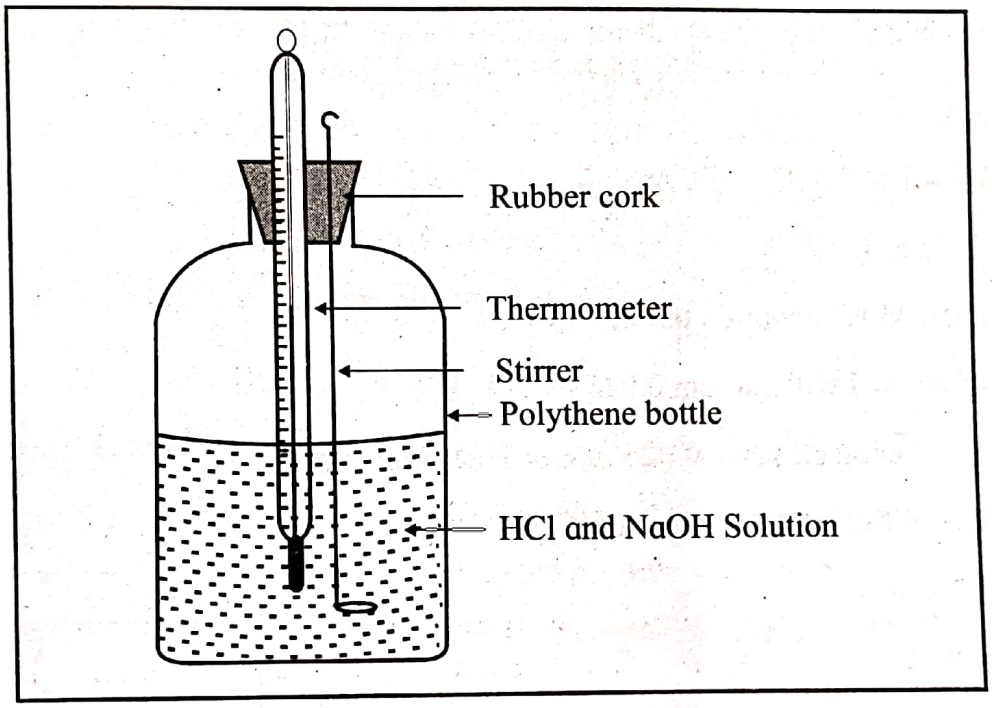
Reaction: $NaOH(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l)$; $\Delta H = -57.3$ kJ

In case of weak acid and strong base the enthalpy of neutralisation is less than that of strong acid and strong base as some heat is utilised for complete ionisation of weak acid.

Apparatus: Polythene bottle, cork with two holes, two beakers, thermometer ($1/10^0$), measuring cylinder, etc.

Chemicals: 0.5 M HCl and 0.5 M NaOH.

Diagram:



Procedure:

1. Take 50 mL 0.5 M HCl in a clean and dry polythene bottle.
2. Record its initial temperature ($t_1{}^0C$).
3. Wash the thermometer with water and gently wipe with filter paper.
4. Take 50 mL 0.5 M NaOH in a clean and dry beaker.
5. Record its initial temperature ($t_2{}^0C$).
6. Add NaOH solution to the polythene bottle, shake well.
7. Record the constant maximum temperature of the mixture ($t_4{}^0C$)

Note :

i. Specific heat capacity of commonly used PET type of polythene bottle can be approximated to 1 J/g ^{0}C = 1000 J/kg ^{0}C. $\cong$ 0.25 cal/g ^{0}C

ii. If the bottle is thin walled, its mass can be neglected if mass of water inside it is more than 100g.

iii. If a heavy bottle of different material is used, we need to known and use its water equivalent.

Observation Table:

1	Initial temperature of 0.5 M HCl	t_1	25 °C
2	Initial temperature of 0.5 M NaOH	t_2	23 °C
3	Mass of solution = Total volume of solution	m	100 g
4	Average temperature of both solutions (HCl + NaOH)	$t_3 = \frac{25(t_1) + 23(t_2)}{2}$	24 °C
5	Final temperature of mixture	t_4	27 °C
6	Rise in temperature	Δt = 27 °C (t_4) - 24 °C (t_3)	3 °C
7	Specific heat capacity of water	S	4.184 J/g °C

Calculation:

Enthalpy change during neutralisation of 50 mL 0.5 M HCl by 50 mL 0.5M NaOH.

$Q = m S \Delta t$

$Q = 100 \times 4.184$ J/g °C $\times$ 3 Δt

$Q =$ 1255.2 J.

1000 mL 0.5 M HCl contain 0.5 mol of HCl

50 mL 0.5 M HCl will contain 0.025 mol of HCl

1255.2 (Q) heat evolved when 0.025 mol of HCl neutralised

Enthalpy of nutralisation is therefore

$$\Delta H = \frac{1255.2\,(Q)}{0.025}$$

$\Delta H =$ 50208 J/mol

$\Delta H =$ 50.208 kJ/mol

Space for log calculation

Number	log

Result:-

The Enthalpy of neutralisation of strong acid HCl and strong base NaOH = - 50.208 kJ/mol

(Negative sign is because reaction is exothermic in nature)

Remark and sign of teacher: .....

.....

.....

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. Chemical reaction that absorbs heat from the surrounding is said to be ..... and has ..... ΔH at constant pressure

a. exothermic, positive
b. exothermic, negative
c. endothermic, negative
✓d. endothermic, positive

2. The following apparatus is used to determine the enthalpy of neutralisation of a given salt

✓a. viscometer
b. calorimeter
c. potentiometer
d. hygrometer

3. The pH of soil can be controlled through

✓a. neutralisation
b. acidic oxides
c. neutral oxides
d. basic oxides

4. When an acid is (H^+) added to alkali (OH^-) product is

a. hydroxide
✓b. water
c. salt
d. H_2 gas

Short answer questions

1. What is the enthalpy of neutralisation of a strong acid and a strong base ?

Ans. The enthalpy change when 1 mole of acid is completely neutralised by 1 mole of base to give 1 mole of H_2O is called enthalpy of neutralisation

2. Write the following statement as True/false

1. An exothermic reaction is characterized by the positive value of ΔH ...F.....
2. Heat is evolved when an exothermic reaction occurs .T.....
3. An endothermic reaction is characterized by the positive value of ΔH ....T....
4. The reaction vessel becomes hot when an endothermic reaction occurs ...F.....

3. Define enthalpy of neutralisation.

Ans. Enthalpy change when one mole of H^+ ions of an acid is completely neutralised by one mole of OH^- ions of base to form one mole of water is called enthalpy of neutralisation

4. Why the enthalpy of neutralisation of a strong acid with strong base is always the same?

Ans. The enthalpy of neutralisation is always constant for strong acid & strong base because all strong acids and strong bases are completely ionized in water

Remark and sign of teacher: .....

Experiment No. 9

Date: / /

Aim: To determine heat of displacement (enthalpy change) of 'Cu' from $CuSO_4$ solution by zinc dust.

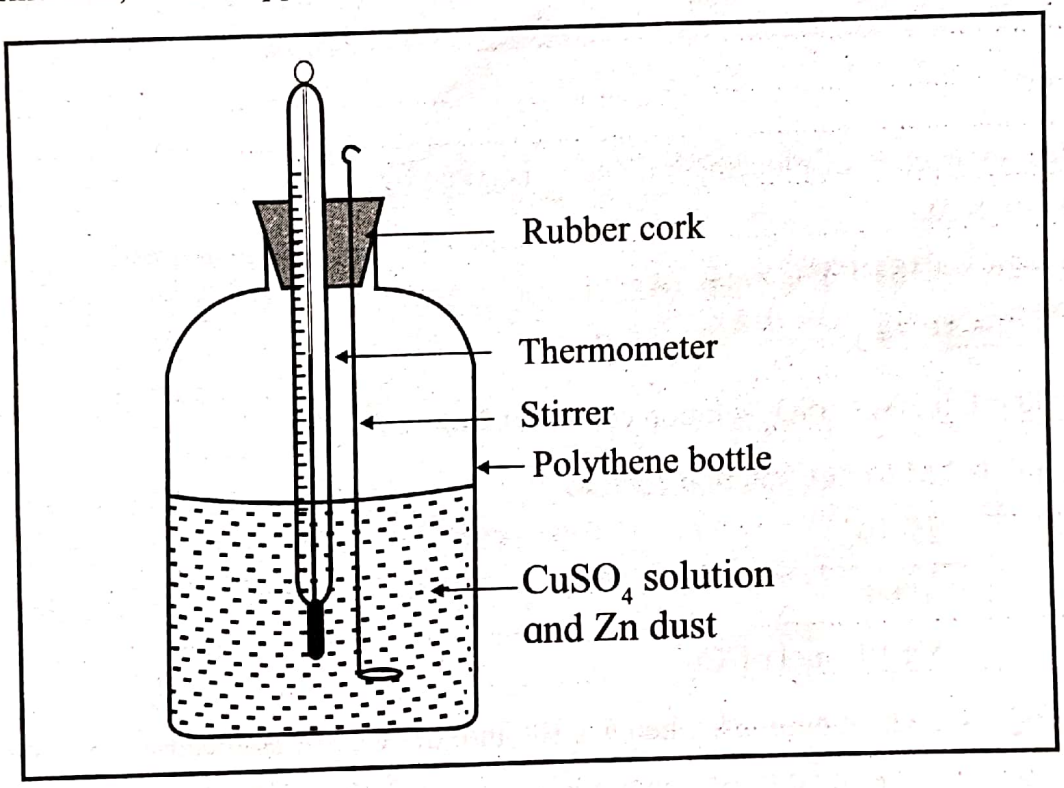
Theory: The elements having lower values of standard potential can displace another element from its solution having higher value of standard potential. The enthalpy change that occurs, when one mole of a substance is completely displaced from its aqueous solution is called enthalpy of displacement. Zinc dissolve in the copper sulphate solution by liberating heat and copper gets precipitated.

Reaction: $CuSO_4(aq) + Zn(s) \longrightarrow ZnSO_4(aq) + Cu(s)\downarrow; \Delta H = -217.5\ kJmol^{-1}$

Apparatus: Polythene bottle, cork with two holes, beakers, thermometer ($1/10^0$), measuring cylinder, etc.

Chemicals: Zinc dust, 0.2 M copper sulphate solution..

Diagram:



Procedure:

1. Take 25mL 0.2 M copper sulphate solution in a clean and dry polythene bottle.
2. Record its initial temperature ($t_1{}^0C$).
3. Take 1 g of zinc dust (powder), add it to the $CuSO_4$ solution in polythene bottle and shake well.
4. Record the maximum (final) temperature of the solution ($t_2{}^0C$).

Note :

i. The shaking of the solution till the blue colour of the $CuSO_4$ solution becomes colourless and copper metal gets deposited.

ii. Specific heat capacity of commonly used PET type of polythene bottle can be approximated to 1 J/g ^0C = 1000 J/kg ^0C. ≅ 0.25 cal/g ^0C

iii. If the bottle is thin walled, its mass can be neglected if mass of water inside it is more than 100g.

iv. If a heavy bottle of different material is used, we need to known and use its water equivalent

Observation Table:

1	Mass of 0.2 M $CuSO_4$ solution	-	25 g
2	Mass of zinc metal	-	1 g
3	Total mass of solution	m	26 g
4	Initial temperature of $CuSO_4$ solution	t_1	25 °C
5	Final temperature of mixture	t_2	38 °C
6	Rise in temperature	$\Delta t = 38\,^{\circ}C\ (t_2) - 25\,^{\circ}C\ (t_1)$	13 °C
7	Specific heat capacity of water	S	4.184 J/g °C

Calculation:

Heat evolved in displacement reaction is given by

$Q = m\ S\ \Delta t$

$Q = 26 \times 4.184\ J/g\ ^{\circ}C \times 13\ \Delta t$

$Q = 1414.19$ J.

1000 mL 0.2 M $CuSO_4$ solution contain 0.2 mol of 'Cu'

25 mL 0.2 M $CuSO_4$ solution contain

$$= \frac{25 \times 0.2}{1000}$$

$= 5 \times 10^{-3}$ mol of 'Cu'

1414.19 (Q) is the heat evolved, when 5×10^{-3} mol of 'Cu' is displaced it

Therefore enthalpy of displacement is

$$\Delta H = \frac{1414.19\ (Q)}{5 \times 10^{-3}}$$

$\Delta H = 282.98 \times 10^3$ J/mol

$\Delta H = -282.98$ kJ/mol

Space for log calculation

Number	log

Result:

The enthalpy of displacement of 'Cu' from copper sulphate by zinc dust $\Delta H = -282.98$ kJ/mol

(Negative sign is because reaction is exothermic in nature)

Remark and sign of teacher: .....

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. The number of water molecules present in hydrated $CuSO_4$ is/are

a. 1 b. 2

c. 3 ✓d. 5

2. The metal used for connection of railway tracks after a particular distance

a. Zn b. Al

c. K ✓d. Fe

3. A thermodynamic state function is a quantity

a. used to determine heat changes ✓b. whose value is independent of path

c. used to determine pressure volume work d. whose value depends on temperature only

4. The enthalpies of all elements in their standard state are

a. unity ✓b. zero

c. < O d. different for each element

Short answer questions

1. Why does Zinc displace copper from $CuSO_4$ solution?

Ans. zinc metal can displace copper from copper sulphate solution because zn is having large value of standard oxidation potential than copper.

2. What is enthalpy of displacement?

Ans. The heat change when one mole of metal is displaced from its aqueous solution by more electropositive metal.

3. What is specific heat of a substance?

Ans. The amount of energy required to raise the temp. of 1 g of a substance by 1°C is called specific heat of a substance

4. Write balanced chemical equation, when Iron filings are we kept in blue coloured solution of copper sulphate.

Ans. $3\,CuSO_{4(aq)} + 2\,Fe_{(s)} \longrightarrow Fe_2(SO_4)_3 + 3\,Cu_{(s)}$

Blue colourless red-brown ppt

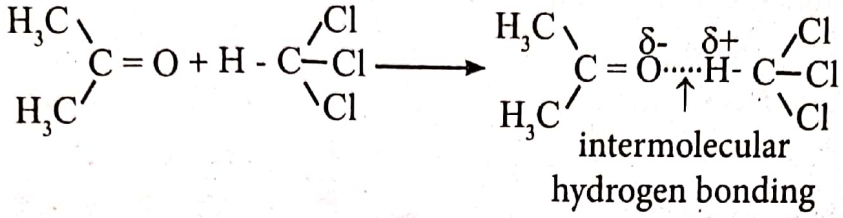
Remark and sign of teacher: .....

Experiment No. 10

Date: / /

Aim: To determine the enthalpy change during the interaction (hydrogen bond formation) between acetone and chloroform.

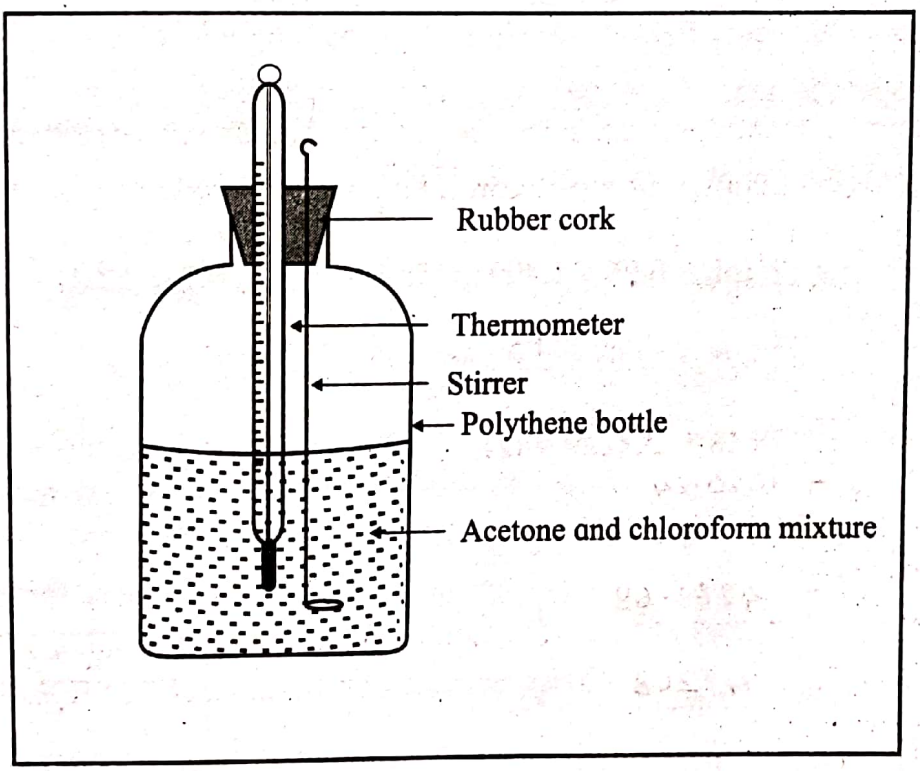
Theory: Intermolecular hydrogen bonding is formed, when acetone is mixed with chloroform. The process is exothermic and heat is evolved due to formation of intermolecular hydrogen bonding.



Apparatus: Polythene bottle, cork with two holes, stirrer, beakers, thermometer ($1/10^0$), measuring cylinder, etc.

Chemicals: Acetone, chloroform.

Diagram:



Procedure:

1. Take 25mL of acetone in dry polythene bottle.
2. Record its initial temperature ($t_1{}^0C$).
3. Take 25 mL of chloroform in a dry beaker.
4. Record its initial temperature ($t_2{}^0C$).
5. Add chloroform from beaker to the polythene bottle containing acetone, stir the mixture.
6. Record maximum (final) temperature of mixture ($t_3{}^0C$).

Note :

i. Specific heat capacity of commonly used PET type of polythene bottle can be approximated to 1 J/g ^0C = 1000 J/kg ^0C. ≅ 0.25 cal/g ^0C

ii. If the bottle is thin walled, its mass can be neglected if mass of water inside it is more than 100g.

iii. If a heavy bottle of different material is used, we need to known and use its water equivalent.

Observation Table:

1	Initial temperature of acetone	t_1	22 °C
2	Initial temperature of chloroform	t_2	26 °C
3	Mean temperature acetone and chloroform	$t_3 = \frac{22(t_1) + 26(t_2)}{2}$	24 °C
4	Maximum temperature of mixture	t_4	37 °C
5	Rise in temperature	$\Delta t = 37\ ^0C\ (t_4) - 24\ ^0C\ (t_3)$	13 °C

Calculation: Given data

1	Density of chloroform	d_1	$= 1.499\ g/cm^3$
2	Density of acetone	d_2	$= 0.787\ g/cm^3$
3	Specific heat of chloroform	S_1	$= 0.96\ J/g\ ^0C$
4	Specific heat of acetone	S_2	$= 2.18\ J/g\ ^0C$

Enthalpy change $(\Delta H) = (25mL \times S_1 \times d_1 + 25mL \times S_2 \times d_2).\Delta t$

$= (25mL \times 0.96 \times 1.499 + 25mL \times 2.18 \times 0.78)$ 13 Δt

$= (35.98 + 42.5) \times$ 13 Δt

$= 78.48 \times$ 13 $\Delta t = (z)$

= 1020·24

$= (z) \times 4.184$

= 4268·68 J

= 4·268 kJ

Space for log calculatio

Number	log

Result:

Enthalpy change due to formation of intermolecular hydrogen bonds when 25 mL of acetone is mixed with 25 mL of chloroform = 4·268 **kJ**

Remark and sign of teacher: .....

MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. The intermolecular hydrogen bonding present in between which atoms of chloroform and aceotone

   a. 'H' of acetone and 'Cl' of chloroform
   b. 'H' of acetone and 'H' of chloroform
   ✓c. 'O' of acetone and 'H' of chloroform
   d. 'O' of acetone and 'Cl' of chloroform

2. The enthalpy change due to formation of intermolecular hydrogen bonding between chloroform and acetone is

   ✓a. exothermic reaction
   b. endothermic reaction
   c. reversible reaction
   d. irreversible reaction

3. The heat of formation of substance are

   a. positive or negative
   ✓b. always negative
   c. always positive
   d. always zero

4. A reaction in which heat in given off to the surroundings is said to be

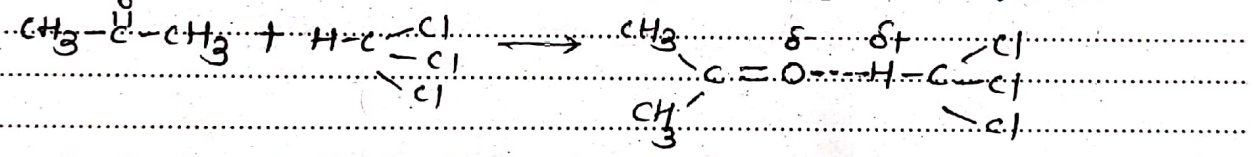
   a. exothermic reaction
   b. endothermic reaction
   ✓c. reversible reaction
   d. irreversible reaction

Short answer questions

1. What is intermolecular hydrogen bonding?

Ans. A hydrogen bond present between two like or unlike molecules is called intermolecular hydrogen bonding.

2. How does chloroform reacts with acetone in the presence of potassium hydroxide?

Ans. 

3. Write molecular formula of chloroform and acetone.

Ans. chloroform → $CHCl_3$

Acetone → $CH_3-\overset{O}{\overset{\|}{C}}-CH_3$

4. Write the name of functional group present in acetone.

Ans. carbonyl $>C=O$

5. The intermolecular hydrogen bonding between chloroform and acetone is exothermic or endothermic reaction.

Ans. Exothermic reaction.

Remark and sign of teacher: .....

Inorganic prepartions
Experiment No. 11

Date: / /

Aim: To prepare a pure sample of Ferrous Ammonium Sulphate (Mohr's salt).

Theory: Mohr's salt is one of the important laboratory reagent and used as a reducing agent. Chemically Mohr's salt is Ferrous Ammonium Sulphate (F.A.S.), an example of 'double salt'. It is prepared by dissolving an equimolar mixture of hydrated ferrous sulphate ($FeSO_4.7H_2O$) and ammonium sulphate [$(NH_4)_2SO_4$] in acidified water. Mohr's salt [$FeSO_4.(NH_4)_2SO_4.6H_2O$] crystallize as faint green coloured solid.

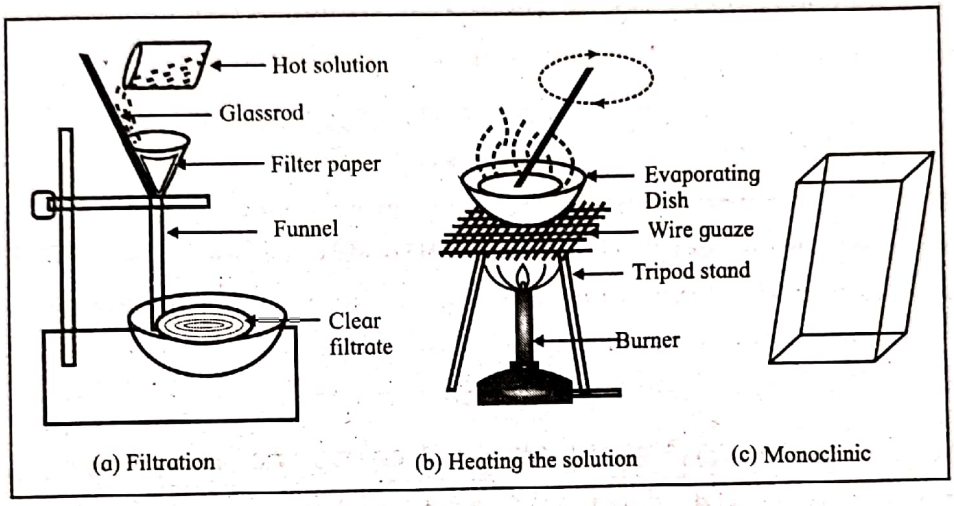
Chemical Equation:

$$\underset{(278)}{FeSO_4.7H_2O} + \underset{(132)}{(NH_4)_2SO_4} \longrightarrow \underset{(392)}{FeSO_4.(NH_4)_2SO_4.6H_2O} + H_2O$$

Apparatus: China dish, beakers, funnel, glass rod, tripod stand, wire gauze, pair of tongs etc.

Chemicals: Ammonium sulphate, ferrous sulphate, dilute sulphuric acid, etc.

Diagram:



Procedure:

1. Weigh accurately 3.5 g ferrous sulphate and 1.5 g ammonium sulphate and transfer into 100 mL beaker. Add about 2-3 mL of dilute sulphuric acid to prevent hydrolysis of ferrous sulphate.
2. In another 100 mL beaker boil about 20 mL of distilled water. Now add the boiling water to the contents of first beaker. Stir with a glass rod until the salts are completely dissolved.
3. Filter the hot solution to remove undissolved impurities and transfer the solution (filtrate) to a china dish. Heat the solution to concentrate up to the point of crystallization and cool it naturally to get good yield.
4. Filter the crystals to separate the mother liquor.
5. Wash the crystals with alcohol and dry it. The shape of Mohr's salt crystals is monoclinic.

Observations and Result:

1. Yield of ferrous ammonium sulphate crystals = 0.82 .....g
2. Colour of ferrous ammonium sulphate crystal is = light green
3. Shape of ferrous ammonium sulphate crystals = octahedral

Remark and sign of teacher: .....

MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. The mineral acid used in preparation of Mohr's salt is.....
   a. dil. HCl b. conc. HCl
   ✓c. dil. H_2SO_4 d. conc. H_2SO_4
2. Molar mass of Mohr's salt is ....
   ✓a. 392 g/mol b. 278 g/mol c. 132 g/mol d. 3.5 g
3. The shape of ferrous ammonium sulphate crystal is....
   a. monoclinic ✓b. octahedral c. hexagonal d. cubic
4. Concentration of filtrate leads to formation of pure crystals of Mohr's salt, the process involved is known as ....
   ✓a. crystallization b. fractional crystallization
   c. purification d. evaporation
5. The cooling of concentrated solution of F.A.S. is always done slowly....
   a. to get good colour b. to get shining crystals
   ✓c. to get good yield d. to get minimum crystals

Short answer questions

1. Why the concentrated solution should not be heated for a long time?

Ans. because small amount of remain will also get destroyed

2. What is crystalization point?

Ans. The temp. at which solid state begins to form, resulting in a mixture of solid particals and solutions.

3. Why dil. H_2SO_4 is added during preparation of Mohr's salt?

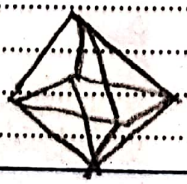
Ans. To prevent hydrolysis in aqueous solution, the dil. H_2SO_4 is added during preparation of mohr's salt.

4. In which type of volumetric titration Mohr's salt is used.

Ans. Redox titration

5. Draw the shape of Mohr's salt crystals?

Ans. Octahedral shape



Remark and sign of teacher: .....

Experiment No. 12

Date: / /

Aim: To prepare a pure sample of potash alum [$K_2SO_4.Al_2(SO_4)_3.24H_2O$].

Theory: An equimolar mixture of potassium sulphate and hydrated aluminum sulphate, w dissolved in acidified water, octahedral crystals of potash alum (a double salt) are obtained.

Chemical Reaction:

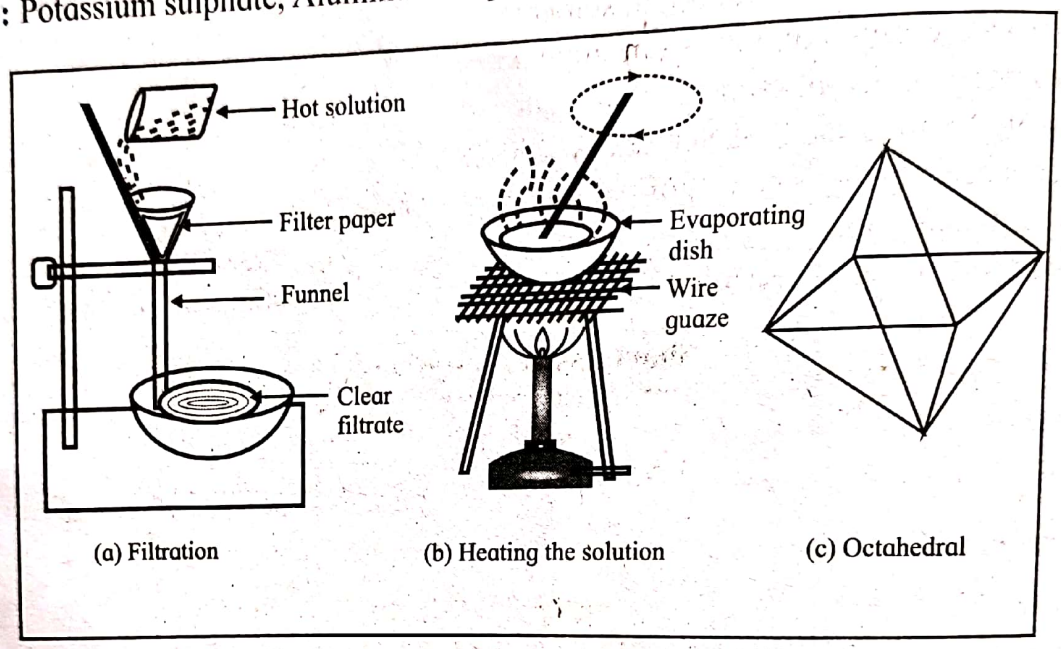
$$K_2SO_4 + Al_2(SO_4)_3.18H_2O + 6H_2O \longrightarrow K_2SO_4.Al_2(SO_4)_3.24H_2O$$

Potassium sulphate — Aluminium sulphate — Potash alum

Apparatus: Beakers, funnel, China dish, glass rod, tripod stand, wire gauze, etc.

Chemicals: Potassium sulphate, Aluminum sulphate, dilute sulphuric acid.

Diagram:



Procedure:

1. Weigh accurately 1.0 g of potassium sulphate and 4.0 g aluminum sulphate. Transfer it together into 100 mL beaker.
2. Take 20 mL distilled water in another beaker, boil it and add to first beaker containing both salts with constant stirring.
3. Add 2 mL of dilute sulphuric acid and heat the content for about five minutes.
4. If milkiness still persists filter the solution in a china dish.
5. Place the china dish on a wire gauze over the tripod stand and heat the solution with constant stirring till point of crystallisation is reached.
6. Cool the hot solution naturally. Soon crystals of potash alum will separates out.
7. Decant off mother liquor. Filter the crystals if required, wash with ice cold water, dry and weigh the crystals. Shape of potash alum crystal is octahedral.

Observation and Result:

1. Colour of potash alum crystals = colourless
2. Shape of potash alum crystals = octahedral
3. Yield of potash alum crystals = 0.03 g

Remark and sign of teacher: .....

MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. Water of crystallization present in aluminum sulphate are .....
   ✓a. 24 b. 18 c. 6 d. 1
2. Shape of potash alum crystal is .....
   a. moloclinic ✓b. octahedral
   c. cubic d. hexagonal
3. Potash alum is .....
   ✓a. double salt b. coordination complex
   c. 3D complex compound d. inorganic base
4. Dilute sulphuric acid is added during preparation of potash alum to
   ✓a. prevent hydrolysis of aluminum sulphate
   b. prevent hydrolysis of potassium sulphate
   c. prevent oxidation of potassium sulphate
   d. dissolve both the salts K_2SO_4 and $Al_2(SO_4)_3$.
5. The process occurs when crystals of potash alum is heated?
   a. burns the crystals b. the crystal melts
   ✓c. looses the water of crystallization d. no change occurs in crystal

Short answer questions

1. What is potash alum?

Ans. It is double salt of, potassium aluminium sulphate.

2. Write the uses of potash alum.

Ans. for water purification, leather tanning, dyeing

3. Why does an aqueous solution of potash alum turn blue litmus red?

Ans. Aqueous solution of potash alum is acidic due to hydrolysis of salt, hence aq. solution of potash alum turn blue litmus red.

4. Differentiate complex compound and a double salt.

Ans. Complex compound have two valency wheras double salt have normal one valency of metal.

Remark and sign of teacher: .....

Identification of functional group
Experiment No. 18

Date: / /

Aim: To determine the functional group of the given organic compound.

Theory: Organic chemistry is the study of hydrocarbons and its derivatives. Organic compounds are classified on the basis of their functional groups.

Functional Group: An atom or group of atoms bonded together in a unique manner so as to form a compound and represent its properties is called functional group.

The physical and chemical properties of compound containing different functional groups are different. So identification of functional group for an unknown organic compound is based on physical and chemical properties.

Apparatus: Test tube, test tube holder, test tube stand, etc.

Note : Only one compound should be given for identification of only one functional group in practical examination.

Test	Observation	Inference
1. Test for Carboxylic acid group Substance + 10% $NaHCO_3$ solution.	Substance soluble with brisk effervescence of CO_2 gas	Carboxylic group present $\left(-C(=O)OH\right)$
	No brisk effervescence of CO_2 gas	Carboxylic group absent
2. Test for Phenolic group Substance + little water + neutral $FeCl_3$ solution	Violet/green/blue/red (any one) colouration	Phenolic (Ar-OH) group present
	No Violet/green/blue/red (any one) colouration	Phenolic group absent
3. Test for Aldehyde group (liquid) Substance + 2-3 mL Schiff's reagent shake well	Pink colour appears	Aldehyde $\left(-C(=O)H\right)$ group present
	No pink colouration	Aldehyde group absent
OR		
Substance + Tollen's reagent heat/warm	Silver mirror is formed on inner side of the test tube	Aldehyde group present $\left(-C(=O)H\right)$
	Silver mirror is not formed	Aldehyde group absent
4. Test for Ketonic group (liquid) Substance + few drops of NaOH + few drops of sodium nitroprusside solution $Na_2[Fe(CN)_5NO]$	Red colour	Ketonic group $\left(>C=O\right)$ group present.
	No red colour	Ketonic group absent.

5. Test for Amino group Substance + conc. HCl in test tube -I and shake to dissolve. Cool under tap water, add excess of $NaNO_2$. In another test tube - II, take β-naphthol in NaOH Add cold solution from test tube -I into β-naphthol in NaOH from test tube -II.	Orange red dye stuff is formed	Amino $\left(-N\begin{matrix}H\\H\end{matrix}\right)$ group present.
	No orange red dye stuff	Amino group absent
6. Test for Unsaturation/ Hydrocarbons (solid) **If all the above tests (from 1 to 5) are negative and the substance is water immiscible or insoluble**	No specific test or functional group then	Unsaturated hydrocarbon is present [Unsaturation $\left(>C=C<\right)$ or (- C ≡ C -) present]
OR		
Alkaline $KMnO_4$ Test (Bayer's Test) Organic substance + little water + dil. alkaline $KMnO_4$ solution (1%)	Decolourisation (pink colour disappears)	Unsaturation present
	No decolourisation	Saturation present
[Alkaline $KMnO_4$ (1%): Dissolve 1 g of $KMnO_4$ (solid) in 100 ml of distilled water. Now add 10 g of anhydrous Na_2CO_3. Shake to dissolve and stopper the bottle]		
7. Test for alcoholic group (liquid) Substance + 2-3 crystals of $K_2Cr_2O_7$ + dil. H_2SO_4. Boil and hold $AgNO_3$ paper near mouth of test tube (Alcohols having sweet smell and they are miscible in water)	Black stains on $AgNO_3$ paper	Alcoholic (R-OH) group present
	No black stains on $AgNO_3$ paper	Alcoholic group absent
OR		
Substance + a very small piece of sodium metal	effervescence of H_2 gas	Alcoholic (R-OH) group present
	No effervescence of H_2 gas	Alcoholic group absent

Result: The given organic compound contains following functional group.

Name	Structure of functional group
.....	

Compound No.1

Test	Observation	Inference
1. Test for Carboxylic acid group Substance + 10% $NaHCO_3$ solution.	Substance soluble with CO_2 gas	-COOH group is present

Result: The given organic compound no.1 contains following functional group.

Name of the functional group	Structure of functional group
carboxylic acid group	$-\overset{O}{\overset{\|}{C}}-OH$

Compound No.2

Test	Observation	Inference
1. Test for Carboxylic acid group Substance + 10% $NaHCO_3$ solution.	NO brisk effervance of CO_2	carboxylic group absent
2. Test for Phenolic group Substance + little water + neutral $FeCl_3$ solution	Violet colouration	phenolic (Ar-OH) group present

Result: The given organic compound no.2 contains following functional group.

Name of the functional group	Structure of functional group
phenolic (Ar-OH)	Ar-OH

Compound No.3

Test	Observation	Inference
1. Test for Carboxylic acid group Substance + 10% $NaHCO_3$ solution.	No effervances of CO_2	carboxylic group absent
2. Test for Phenolic group Substance + little water + neutral $FeCl_3$ solution	No colouration	phenolic group absent
3. Test for Aldehyde group (liquid) Substance + 2-3 mL Schiff's reagent/ ~~Tollen's reagent~~ and heat	pink colour appears.	Aldehyde group present

Result: The given organic compound no.3 contains following functional group.

Name of the functional group	Structure of functional group
Aldehyde group	$-\overset{O}{\overset{\|}{C}}-H$

Compound No.4

Test	Observation	Inference
1. Test for Carboxylic acid group Substance + 10% $NaHCO_3$ solution.	No effervances of CO_2	carboxylic group absent

2. Test for Phenolic group Substance + little water + neutral $FeCl_3$ solution	No colouration	phenolic group absent
3. Test for Aldehyde group (liquid) Substance + 2-3 mL Schiff's reagent/ Tollen's reagent and heat	No colouration	Aldehyde group absent
4. Test for Ketonic group (liquid) Substance + few drops of NaOH + few drops of sodium nitroprusside soln	Red colouration	Ketonic group is present

Result: The given organic compound no.4 contains following functional group.

Name of the functional group	Structure of functional group
Ketonic	$-\overset{O}{\overset{\|}{C}}-$

Compound No.5

Test	Observation	Inference
1. Test for Carboxylic acid group Substance + 10% $NaHCO_3$ solution.	No effervances of CO_2	-COOH group is absent
2. Test for Phenolic group Substance + little water + neutral $FeCl_3$ soln	No colouration	Ph-OH absent
3. Test for Aldehyde group (liquid) Substance + 2-3 mL Schiff's reagent/ Tollen's reagent and heat	No colouration	$-\overset{O}{\overset{\|}{C}}-H$ absent
4. Test for Ketonic group (liquid) Substance + few drops of NaOH + few drops of sodium nitroprusside soln	No colouration	$-\overset{O}{\overset{\|}{C}}-$ absent
5. Test for Amino group Substance + conc. HCl and shake to dissolve. Cool under tap water, add excess of $NaNO_2$. + β-naphthol in NaOH	orange red dye stuff form	Amine ($-NH_2$) group present

Result: The given organic compound no.5 contains following functional group.

Name of the functional group	Structure of functional group
Amine	$-NH_2$

Remark and sign of teacher: .....

Reactions involved :

1. Test For Carboxylic group

$RCOOH + NaHCO_3 \longrightarrow RCOONa + H_2O + CO_2\uparrow$

2. Test for Phenolic group

$3C_6H_5OH + FeCl_3 \longrightarrow (C_6H_5O)_3Fe$ (Violet colour)

Imp note: 1. o-, m-, p- cresol and resorcinol gives violet or blue colouration.
2. β-naphthol gives green colouration. 3. ∝- naphthol gives pink colouration.

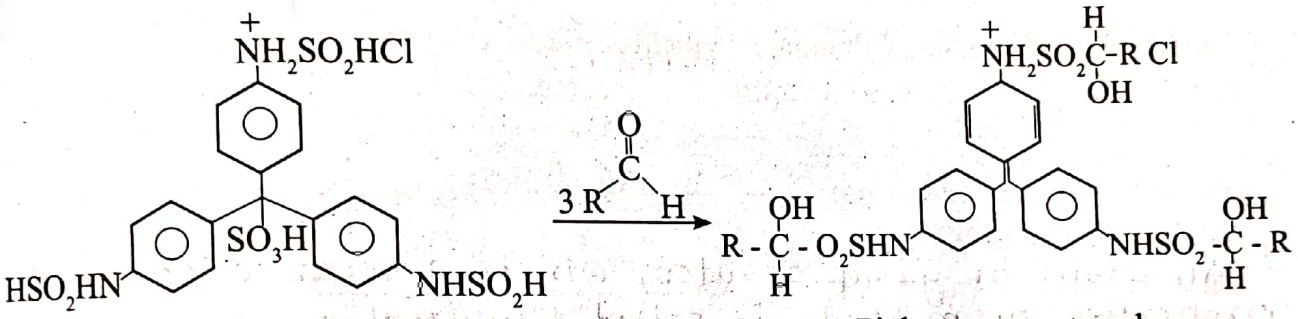
3. Test for aldehydic group

$CH_3CHO + 2Ag(NH_3)_2OH \xrightarrow{\Delta} CH_3COOH + 2Ag\downarrow + 4NH_3 + H_2O$

Tollen's reagent — Silver mirror

Tollen's reagent : Take 1 ml $AgNO_3$ + 2-3 ml NaOH ⟶ forms brown precipitate. Add NH_3 dropwise till brown precipitate just dissolves.

Chemical equation for Schiff's reagent



Schiff's reagent colourless — Pink or mangenta colour

4. Test for Ketonic group

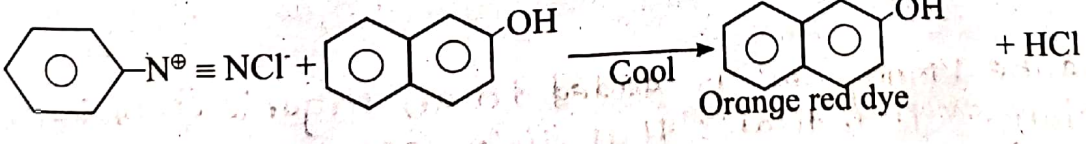
With sodium nitroprusside -

$CH_3COCH_3 + OH^- \longrightarrow CH_3COCH_2^- + H_2O$

$CH_3COCH_2^- + [Fe(CN)_5NO]^{2-} \longrightarrow [Fe(CN)_5NO.CH_3COCH_2]^{3-}$ Red colouration

5. Test for Amino group

i. $C_6H_5NH_2 + \text{conc. } HCl \xrightarrow{NaNO_2} C_6H_5N_2^+Cl^- + H_2O$

ii. 

6. Test for alcoholic group

$2ROH + 2Na \xrightarrow{\Delta} 2R\,ONa + H_2\uparrow$

Organic substance to be given for functional group detection

Carboxylic acids: Acetic acid, oxalic acid, benzoic acid.	**Phenols :** β-naphthol, resorcinol, phenol
Aldehyde : Benzaldehyde, formaldehyde	**Ketone :** Acetone, ethylmethyl ketone.
Primary amines : p-toluidine, p-nitroaniline, aniline	**Unsaturated hydrocarbons** : Naphthalene, butadiene, cinnamic acid
Alcohols : ethyl alcohol.	

MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. The functional group present in Methanal is .....

   a. $-C(=O)H$ ✓ b. $>C=O$ c. $-C(=O)OH$ d. $-NH_2$

2. Identify the functional group of primary amine

   a. $-NH_2$ ✓ b. $-N-$ c. $>N-H$ d. NH_3

3. The distinguishing test between alcohol and phenol is -

   a. bicarbonate test b. neutral $FeCl_3$ test ✓

   c. sodium nitroprusside test d. tollen's reagent

4. Primary amines on treatment with excess of $NaNO_2$, concentrated HCl and β-naphthol in alkaline medium gives.....

   a. green colour b. orange colour ✓

   c. violet colour d. red colour

5. Acetaldehyde when heated with ammonical silver nitrate solution gives .....

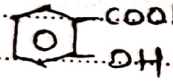
   a. red ppt b. silver mirror ✓ c. red colour d. grey mirror

Short answer questions

1. Define: Functional group.

Ans. An atom or group of atom which determine chemical properties of molecule is called Functional group.

2. Draw structure of an organic compound having two functional group in molecule.

Ans.  Salicylic acid

3. Give distinguishing test for carboxylic acid and phenol.

Ans. Sodium bicarbonate readily reacts with carboxylic acid but it does not react with phenol.

4. If alkaline $KMnO_4$ solution is added to an organic compound, it decolorises. Identify the functional group present in the compound?

Ans. If alkaline $KMnO_4$ sol^n is added to an organic compound it decolorises it indicates that such compound contain unsaturation $>C=C<$ or $-C\equiv C-$

5. Write a chemical reaction for Tollen's reagent test with ethanal.

Ans. $CH_3CHO + 2Ag(NH_3)_2OH \xrightarrow{\Delta} CH_3COOH + 2Ag\downarrow + 4NH_3 + H_2O$

Ethanal — Tollens Reagent — (silver mirror)

Remark and sign of teacher: .....

Experiment No. 19

Date: / /

Study of carbohydrates, fats, oils and proteins in pure form and detection of their presen in the given food stuffs.

Aim: To detect the presence of carbohydrates, proteins or fats and oils in the given food stuff.

Theory: Food is a necessary material which must be supplied to the body for its normal and prop functioning. The essential constituents of food are:

1. Carbohydrates 2. Proteins 3. Lipids (fats and oils) 4. Minerals 5. Vitamins 6. Water etc.

Apparatus: Test tube, test tube stand, test tube holder, glass rod, water bath, etc.

Chemicals: Fehling's solution (A and B), Benedict's solution, Iodine solution (I_2), conc. HNO 10% NaOH, 1% $CuSO_4$ solution, chloroform, benzene, 1% Ninhydrin solution etc.

1. Carbohydrates:

Carbohydrates are polyhydroxy aldehydes or polyhydroxy ketones, their derivatives and th substances which yield them on hydrolysis. The carbohydrates which can reduce Tollen's reager or Fehlings solution are called reducing sugars. For example glucose. Sucrose is a non reducin sugar. Some other examples of carbohydrates are starch, cellulose, maltose etc.

2. Proteins:

Proteins are complex, polymeric, nitrogenous organic compounds having high molecular mass on hydrolysis give α-amino acids having peptide/amide linkage $-(CO\text{-}NH)-$ in their molecules. **known as peptide linkage.** Proteins play vital role in living organism. For example heamoglobin present in blood, casein in milk, albumin in egg.

3. Fats and oils:

Lipids are defined as water insoluble organic biomolecules extracted from plants and animal cells by non-polar solvents. Chemically fats and oils are triesters of glycerol and higher fatty acids. At ordinary temperature oils are liquids while fats are solids. For example oil seeds, ground nuts, vanaspati ghee, butter, etc.

Foods Stuffs Required:

For Carbohydrates: Glucose powder, wheat-flour, rice, biscuits, fruits, potato, starch etc.

For Proteins : Milk, egg albumin (white) etc.

For Oil/Fat : Ground nut powder, butter, linseed oil, cotton seed oil, vansapati ghee etc.

Procedure:

First grind the given food stuff in mortar with a pestle and make its paste. Altenatively boil food stuff with minimum quantity of water. Use this extract or solution directly for the tests.

Perform the tests given below for carbohydrates, proteins, fats and oil by taking a small amount of extract each time. Record the results in a tabular form.

(Note: Only one food stuff is given in practical examination.)

Aim: To detect the presence of carbohydrates or proteins or fats and oils in the given food stuff.

Food stuff for carbohydrates (Perform any two tests)

Sr. No.	Test	Observation	Inference
1	**Solubility:** Substance + Water		
2	**Fehling Test:** Little substance + 1 mL Fehling solution 'A' and 'B'. Heat the test tube on a water bath	Brown ppt	carbohydrate is present
3	**Benedict's Test:** Little substance + add 2 mL Benedict's reagent. Heat gently.	—	—

Result : The given sugar powder **food stuff contains carbohydrates**

Food stuff for protein (Perform any two tests)

Sr. No.	Test	Observation	Inference
1	**Biuret Test:** Substance + 10% NaOH + few drops of 1% $CuSO_4$ solution, shake well	—	—
2	**Xanthoprotic Test:** Substance + few drops of conc. HNO_3. Shake a little and leave undisturbed for some time	—	—
3	**Ninhydrin Test:** Substance + NaOH solution + few drop of Ninhydrin reagent. Heat.	—	—

Result: The given.....food stuff contains protein.

Food stuff for fats and oils (Perform any two tests)

Sr. No.	Test	Observation	Inference
1	**Solubility:** a. Substance + Water	Immiscible in H_2O	oil is present
	b. Substance + chloroform	—	
2	**Spot Test:** Put a drop of substance on filter paper	miscible	oil is present
3	**Acrolein Test:** Substance + few crystals of potassium bisulphate. Heat	—	

Result: The given oil **food stuff contains fats or oils.**

Remark and sign of teacher: .....

MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. Fats and oils are -------
   ✓ a. triesters of glycerol and fatty acids b. diesters of glycerol and fatty acids
   c. glycerol and fatty acids d. glycol and fatty acids

2. ------- are insoluble in water but soluble in acidic or alkaline solutions
   a. fats ✓ b. oils c. proteins d. carbohydrates

3. Proteins contain ------- linkage.
   ✓ a. polypeptide b. polyester c. polypropylene d. polystyrene

4. Glucose powder when heated with Fehling solution gives-------
   a. blue ppt ✓ b. red ppt c. green ppt. d. black ppt

Short answer questions

1. What are Carbohydrates?

Ans. optically active polyhydroxy aldehyde or polyhydroxy ketones are called carbohydrates.

2. Write the name of chemical test, when protein in food stuff is treated with concentrated HNO_3.

Ans. xanthoprotein test

3. Write structure of peptide linkage present in proteins.

Ans. structure of peptide linkage present in protein is $-CO-NH-$

4. Mention Biuret test for proteins in short.

Ans. substance containing protein is treated with 10% NaOH and few drops of 1% $CuSO_4$ solution on shaking gives bluish Violet colour.

5. Write an important difference between oils and fats.

Ans. Fats are solid at room temp. but oils are liquid at room temp. oils are triesters of unsaturated fatty acids while fats are triesters of saturated fatty acids.

Remark and sign of teacher: .....

MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. The anion does NOT gives positive test with dil. H_2SO_4 and conc. H_2SO_4
   a. Cl^- b. CO_3^- c. CH_3COO^- ✓d. SO_4^-
2. When moisten oxalic acid is taken between the fingers, it smells like vinegar, indicates the presence of following anion
   a. sulphate b. nitrate ✓c. acetate d. nitrite
3. Canary yellow ppt. of ammonium phosphomolybdate indicates the presence of ..... radical
   a. Cl^- b. SO_4^{2-} ✓c. PO_4^{3-} d. NO_3^-
4. Smell of rotton eggs of a substance with dil. H_2SO_4 indicates the presence of ..... radical
   a. SO_3^{2-} b. SO_4^{2-} ✓c. S^{2-} d. $C_2O_4^-$

Short answer questions

1. **Write the formula of the compound formed in brown ring test.**

Ans. The compound formed in brown ring test is $[Fe(NO)(H_2O)_5]SO_4$

2. **Write the name of the complex formed, when sodium nitroprusside is added to O.S. of mixture in the confirmatory test of sulphide ion.**

Ans. sodium pentacyanonitrosylferrate (II) sulphide $Na_4[Fe(CN)_5NO]$

3. **Write the names of anion detected with the help of dil. H_2SO_4.**

Ans. CO_3^{2-} (carbonate ion), NO_2^- (Nitrite ion), S^{2-} (sulphide ion) SO_3^{2-} (sulphite ion)

4. **Write the names of anion detected with the help of conc. H_2SO_4.**

Ans. Cl^- (chloride), Br^- (bromide), I^- (iodide), NO_3^- (nitrate), CH_3COO^- (acetate ion)

5. **What is lime water and what happens on passing CO_2 gas through it?**

Ans. Lime water is solution of calcium hydroxide in water which is alkaline and turns milky on passing CO_2 gas through it.

6. **Describe the layer test for iodide ions?**

Ans. Take solution containing iodide ions and Cl_2 water and chloroform, shake well. chloroform layer acquire violet colour.

7. **How do you test the presence of sulphide ion in dry test.**

Ans. mixture of salts is treated with dil. H_2SO_4 which evolves colourless gas with smell of rotten eggs (H_2S) which turns lead acetate paper black.

Remark and sign of teacher: .....

Experiment No. 20 (Mixture No. 1)

Date: / /

Aim : Analyse two acidic (anion) radicals qualitatively from given inorganic mixture.

Apparatus : Test tubes, test tube holder, test tube stand, filter paper etc.

A. Preliminary tests:

Test	Observation	Inference
Color	white	Cl^-, SO_4^{2-}, nitrates, CO_3^{2-} may be present
Nature	Amorphous	CO_3^{2-}, S^{2-} may be present

B. Dry Tests for Acidic radicals (Test tube must be dry for following tests)

Test	Observations	Inference
1. Heating in a dry test tube:- Take a small quantity of the mixture in a clean and dry test tube and heat it strongly	colourless, odourless gas	CO_3^{2-}, $C_2O_4^{2-}$ may be present
2. Action of dil. H_2SO_4 : Take a small quantity of mixture + dilute H_2SO_4	colourless gas with brisk effervances of CO_2 gas	CO_3^{2-} may be present
3. Action of conc. H_2SO_4 : Take a small quantity of mixture + conc. H_2SO_4	colourless gas having pungent smell,	Cl^- may be present
4. Action of Cu foils and conc. H_2SO_4 Mixture + Cu filings and conc. H_2SO_4, heat it strongly	No coloured fumes	—
5. Action of MnO_2 and conc. H_2SO_4 Mixture + MnO_2 powder + conc. H_2SO_4	colourless gas turning moist blue litmus paper red	Cl^- may be present

Individual dry tests for SO_4^{2-} & PO_4^{3-} (if required)

1. Test for sulphate Mixture + dil. HCl, boil the solution + $BaCl_2$ solution	No white ppt	SO_4^{2-} is absent
2. Test for phosphate Mixture + conc. HNO_3 boil + excess of ammonium molybdate solution	No yellow ppt	PO_4^{3-} is absent

C. Preparation of original solution (O.S) : Mixture is dissolved in 20 mL quantity of distilled water in a beaker, stir with glass rod to dissolve the mixture. Clear solution is obtained. Use this O.S. for further tests of acidic radicals.

D. Wet Tests for Anion (Acidic Radicals)

1. O.S. + $AgNO_3$	White ppt soluble in dil. HNO_3 with CO_2 gas	CO_3^{2-} may be present.
If white ppt obtained in above test, perform following distinction test		
Distinction between Cl^-, Br^- and I^- : O.S. + dil. H_2SO_4 (till acidic) + chloroform + Cl_2 water (fresh) in excess, shake vigorously and observe the colour of chloroform layer carefully.	Chloroform layer colourless	Cl^- present
2. O.S. + $Ba(NO_3)_2$ solution	No ppt	—
3. O.S. + dil. acetic acid + (Freshly prepared) $FeSO_4$ solution	No ppt	—
4. O.S. + diphenyl amine + conc. H_2SO_4	No ppt	—
5. O.S. + $FeCl_3$ solution	No ppt	—
6. O.S. + dil. acetic acid + $CaCl_2$	No ppt	—
7. O.S. + dil. H_2SO_4 + 2-3 drops of $KMnO_4$	No ppt	—

E. Confirmatory tests for Acidic Radicals

1. C.T. for first detected acidic radical ..... CO_3^{2-} ..

Test	Observation	Inference
1. O.S. + 2-3 drops of phenolphthalein indicator	pink colour	CO_3^{2-} confirm
2. O.S. + dil. HCl	Effervances of CO_2	CO_3^{2-} confirm

2. C.T. for second detected acidic radical .....

Test	Observation	Inference
1. O.S. + Lead acetate	White ppt	Cl^- confirm
2. O.S. + MnO_2 + conc. H_2SO_4 and heat	Yellowish green gas	Cl^- confirm

Result :

The given inorganic mixture no. 1 contains following two anions (Acidic radicals)

i) ..... CO_3^{2-} ... (Name of anion) carbonate

ii) ..... Cl^- ..... (Name of anion) chloride

Remark and sign of teacher: .....

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.....

Experiment No. 21 (Mixture No. 2)

Date: / /

Aim : Analyse two acidic (anion) radicals qualitatively from given inorganic mixture.

Apparatus : Test tubes, test tube holder, test tube stand, filter paper etc.

A. Preliminary tests:

Test	Observation	Inference
Color	White	Cl^-, SO_4^{2-}, CO_3^{2-}, may be present
Nature	Amorphous	CO_3^{2-}, S^{2-} may be present

B. Dry Tests for Acidic radicals (Test tube must be dry for following tests)

Test	Observations	Inference
1. Heating in a dry test tube:- Take a small quantity of the mixture in a clean and dry test tube and heat it strongly	colourless, odourless gas	CO_3^{2-}, $C_2O_4^{2-}$ may be present
2. Action of dil. H_2SO_4 : Take a small quantity of mixture + dilute H_2SO_4	colourless gas with brisk effervance of CO_2	CO_3^{2-} may be present
3. Action of conc. H_2SO_4 : Take a small quantity of mixture + conc. H_2SO_4	—	—
4. Action of Cu foils and conc. H_2SO_4 Mixture + Cu filings and conc. H_2SO_4, heat it strongly	—	—
5. Action of MnO_2 and conc. H_2SO_4 Mixture + MnO_2 powder + conc. H_2SO_4	—	—

Individual dry tests for SO_4^{2-} & PO_4^{3-} (if required)

1. Test for sulphate Mixture + dil. HCl, boil the solution + $BaCl_2$ solution	White ppt insoluble in conc. HCl	SO_4^{2-} may be present
2. Test for phosphate Mixture + conc. HNO_3 boil + excess of ammonium molybdate solution	—	—

C. Preparation of original solution (O.S) : Mixture is dissolved in 20 mL quantity of distilled water in a beaker, stir with glass rod to dissolve the mixture. Clear solution is obtained. Use this O.S. for further tests of acidic radicals.

D. Wet Tests for Anion (Acidic Radicals)

1. O.S. + $AgNO_3$	White ppt soluble in dil. HNO_3 with CO_2 gas	CO_3^{2-} may be present
If white ppt obtained in above test, perform following distinction test		
Distinction between Cl^-, Br^- and I^- : O.S. + dil. H_2SO_4 (till acidic) + chloroform + Cl_2 water (fresh) in excess, shake vigorously and observe the colour of chloroform layer carefully.	—	—
2. O.S. + $Ba(NO_3)_2$ solution	—	—
3. O.S. + dil. acetic acid + (Freshly prepared) $FeSO_4$ solution	—	—
4. O.S. + diphenyl amine + conc. H_2SO_4	—	—
5. O.S. + $FeCl_3$ solution	—	—
6. O.S. + dil. acetic acid + $CaCl_2$	—	—
7. O.S. + dil. H_2SO_4 + 2-3 drops of $KMnO_4$	—	—

E. Confirmatory tests for Acidic Radicals

1. C.T. for first detected acidic radical .....

Test	Observation	Inference
1. O.S. + 2-3 drops of phenolphthalein indicator	pink colour	CO_3^{2-} confirmed
2. O.S. + dil. HCl	Effervances of CO_2 gas turn lime water milky	CO_3^{2-} confirmed

2. C.T. for second detected acidic radical .....

Test	Observation	Inference
1. O.S. + Lead acetate solution	white ppt soluble in ammonium acetate	SO_4^{2-} confirmed
2. O.S. + $BaCl_2$	white ppt of $BaSO_4$	SO_4^{2-} confirmed

Result :

The given inorganic mixture no.2 contains following two anions (Acidic radicals)

i) CO_3^{2-} (Name of anion)

ii) SO_4^{2-} (Name of anion)

Remark and sign of teacher: .....

.....

Experiment No. 22 (Mixture No. 3)

Date: / /

Aim : Analyse two acidic (anion) radicals qualitatively from given inorganic mixture.

Apparatus : Test tubes, test tube holder, test tube stand, filter paper etc.

A. Preliminary tests:

Test	Observation	Inference
Color	white	chlorides, nitrates, sulphat may be present
Nature	Amorphous	CO_3^{2-}, S^{2-} may be present

B. Dry Tests for Acidic radicals (Test tube must be dry for following tests)

Test	Observations	Inference
1. Heating in a dry test tube:- Take a small quantity of the mixture in a clean and dry test tube and heat it strongly	Reddish brown gas turns moist starch paper orange yellow	Br^- may be present
2. Action of dil. H_2SO_4 : Take a small quantity of mixture + dilute H_2SO_4	colourless gas with smell of rotten eggs	S^{2-} may be present
3. Action of conc. H_2SO_4 : Take a small quantity of mixture + conc. H_2SO_4	Yellowish brown gas having pungent smell	Br^- may be present
4. Action of Cu foils and conc. H_2SO_4 Mixture + Cu filings and conc. H_2SO_4, heat it strongly	No. Fumes	–
5. Action of MnO_2 and conc. H_2SO_4 Mixture + MnO_2 powder + conc. H_2SO_4	Reddish brown gas	Br^- may be present.

Individual dry tests for SO_4^{2-} & PO_4^{3-} (if required)

1. Test for sulphate Mixture + dil. HCl, boil the solution + $BaCl_2$ solution	No ppt	–
2. Test for phosphate Mixture + conc. HNO_3 boil + excess of ammonium molybdate solution	No ppt	–

C. Preparation of original solution (O.S) : Mixture is dissolved in 20 mL quantity of distilled water in a beaker, stir with glass rod to dissolve the mixture. Clear solution is obtained. Use this O.S. for further tests of acidic radicals.

D. Wet Tests for Anion (Acidic Radicals)

1. O.S. + $AgNO_3$	—	—
If white ppt obtained in above test, perform following distinction test		
Distinction between Cl^-, Br^- and I^- : O.S. + dil. H_2SO_4 (till acidic) + chloroform + Cl_2 water (fresh) in excess, shake vigorously and observe the colour of chloroform layer carefully.		
2. O.S. + $Ba(NO_3)_2$ solution	—	—
3.O.S. + dil. acetic acid + (Freshly prepared) $FeSO_4$ solution	—	—
4. O.S. + diphenyl amine + conc. H_2SO_4	—	—
5. O.S. + $FeCl_3$ solution	—	—
6. O.S. + dil. acetic acid + $CaCl_2$	—	—
7. O.S. + dil. H_2SO_4 + 2-3 drops of $KMnO_4$	—	—

E. Confirmatory tests for Acidic Radicals

1. C.T. For first detected acidic radical S^{2-}

Test	Observation	Inference
1. O.S. + acetic acid + Lead acetate	Black ppt	S^{2-} confirmed
2. O.S. + cadmium nitrate	Yellow ppt	S^{2-} confirmed

2. C.T. For second detected acidic radical Br^-

Test	Observation	Inference
1. O.S. + MnO_2 + conc. H_2SO_4 + heat	Reddish brown gas	Br^- confirmed
2. O.S. + Cl_2 water + $CHCl_3$	chloroform layer acquires yellow colour	Br^- confirmed

Result :

The given inorganic mixture no. 3 contains following two anions (Acidic radicals)

i) S^{2-} (Name of anion)

ii) Br^- (Name of anion)

Remark and sign of teacher: .....

.....

.....

MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

A colourless solid 'A' produces black spots on the skin. It's aqueous solution gives brown ring test and also gives yellow ppt. with KI solution 'A' could be
a. copper nitrate
✓c. silver nitrate
b. zinc nitrate
d. lead nitrate

Which of the following sulphide is completely precipitated in acidic medium
a. HgS
b. PbS
✓c. CdS
d. CuS

The colour of precipitate observed, when potassium iodide is added to water soluble lead salts is
a. black
b. white
✓c. yellow
d. red

Which of the following is NOT a preliminary test
a. charcoal cavity test
b. flame test
c. NaOH test
✓d. brown ring test

The colour of carbonate cation precipitate of group V is.....
a. black
b. green
✓c. white
d. yellow

Short answer questions

1. The removal of H_2S gas from filtrate is must before doing analysis of group III and V. Why?

Ans. If H_2S gas isn't boiled off then group IV cations also get precipited. It would react with HNO_3 and would be oxidised to colloidal sulphur which would interfere with further analysis.

2. Write the name of brown ppt. obtained, when Nessler's reagent is added in O.S. for confirmatory test of ammonium ion.

Ans. Brown ppt - Basic mercury (II) amido-iodine.

3. During the detection of groups, if Group-I is detected then for next Group test what care should be taken?

Ans. If group-I is detected then reagent must be added in bulk o.s. for complete ppt formation of group-I cation then filter it and filtrate is taken for further tests.

4. Why cracking noise/decrepitation is observed during dry test in qualitative analysis of cations?

Ans. Lead nitrate, barium nitrate, potassium bromide, etc. make cracking noise due to decomposition on heating in a dry test tube. Also due to heating bigger crystals breaks up into smaller ones.

5. Name a cation, which is not obtained from metal.

Ans. Ammonium ion, NH_4^+ is not obtain from metal.

Remark and sign of teacher: .....

Experiment No. 23 (Mixture No. 1)

Date: / /

Aim: Analyse two basic (cation) radicals qualitatively from given inorganic mixture.

Apparatus: Test tubes, test tube holder, test tube stand, filter paper etc.

A. Preliminary tests:

Test	Observation	Inference
Color	Light green	NH_4^+, Pb^{2+}, Al^{3+} may be present
Nature	crystalline	Nitrates, sulphates of NH_4^+, Al^{3+} may be present

B. Dry Tests for Basic radicals (Test tube must be dry for this test)

Test	Observation	Inference
1. Heating in a dry test tube:- Take a small quantity of the mixture a clean and in dry test tube and heat it strongly.	Formation of white sublimate	NH_4^+ may be present
2. Charcoal Cavity Test: Mixture + Na_2CO_3 solid in 1:2 proportion placed in fresh charcoal cavity, moisten with a drop of water. Heat it with blow pipe in a reducing (yellow) flame	Substance fuses and sinks in the cavity	NH_4^+ or Ca^{2+} salts may be present
3. NaOH Test: Mixture + NaOH solution & heat. Hold moist turmeric paper near the mouth of the test tube	moist turmeric paper turns brown	NH_4^+ may be present
4. Flame Test: Prepare a paste of the given mixture with conc. HCl on a watch glass. Make a small loop at the end of the platinum wire & dip it in the mixture or use glass rod. Heat it on oxidising flame (Blue) observe the colour change of the flame.	crimson red	Pb^{2+} may be present.

C. Preparation of original solution (O.S)

Take a small quantity of mixture in a beaker add 20 mL of distilled water, stir with glass rod to dissolve the mixture. If mixture does not dissolve completely then warm it to dissolve. Clear solution is obtained, which is used as a O.S for further tests.

1. Analysis of Group zero (NH_4^+)

Test	Observation	Inference
1. O.S. + NaOH solution + Heat, test with moist turmeric paper.	Evolution of NH_3 gas	Group zero present (NH_4^+)

2. O.S. + NaOH solution + Heat, Bring a glass rod dipped in conc. HCl. near the mouth of the test tube.	Dense white fumes of NH_4Cl	NH_4^+ present
C.T. for NH_4^+ : i. O.S. + Nessler's reagent in excess	Brown ppt	NH_4^+ confirmed
ii. O.S + Picric Acid (2, 4, 6 trinitro phenol)	Yellow ppt	NH_4^+ confirmed

Detection of group (if group zero is absent, two groups must be detected following test)

Test	Observation	Inference
1. O.S. + dil. HCl	White ppt	Group I (Pb^{2+}) present
2. O.S./Filtrate + dil HCl (heat) + H_2S gas or water	No ppt	Group II absent
3. O.S./Filtrate (Remove H_2S) + NH_4Cl (equal) + NH_4OH (till alkaline to litmus)	No ppt	Group III absent
4. O.S./Filtrate + NH_4Cl (equal) + NH_4OH (till alkaline to litmus) + H_2S gas or water	No ppt	Group IV absent
5. O.S./Filtrate (Remove H_2S) + NH_4Cl (equal) + NH_4OH (till alkaline to litmus) +$(NH_4)_2CO_3$	No ppt	Group V absent
6. O.S./Filtrate + NH_4Cl (equal) + NH_4OH (till alkaline to litmus) + Na_2HPO_4	No ppt	Group VI absent

2.Analysis of first detected group

Test	Observations	Inference
O.S. + NaOH + heat + moist turmeric paper	evolution of NH_3 gas	Group zero is present
O.S. + NaOH + Heat Bring glass rod in conc.HCl	Dense fumes of NH_4Cl	NH_4^+ is present.

2. C.T. for first detected radical

	Test	Observations	Inference
1.			
2.			

2. Analysis of second detected group

	Test	Observations	Inference
1.	Group I ppt + H_2O (excess) and boil	ppt dissolves	Pb^{2+} is present
2.			
3.			

3. C.T. for second detected radical

	Test	Observations	Inference
1.	Above solution + KI	yellow ppt	Pb^{2+} confirmed
2.	Above solution + $K_2Cr_2O_7$	yellow ppt	Pb^{2+} confirmed

Result:-

The given inorganic mixture no. 1 contains following two cations (Basic Radicals)

i) NH_4^+ (Ammonium ion)

ii) Pb^{2+} (Name of cation)

Remark and sign of teacher: .....

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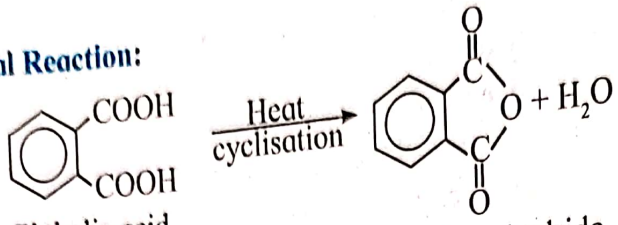
Activity No.1

Date: / /

Aim: To prepare phthalic anhydride.

Theory: Phthalic acid is a dicarboxylic acid which on heating loses a water molecule and undergo cyclisation reaction to form phthalic anhydride.

Chemical Reaction:

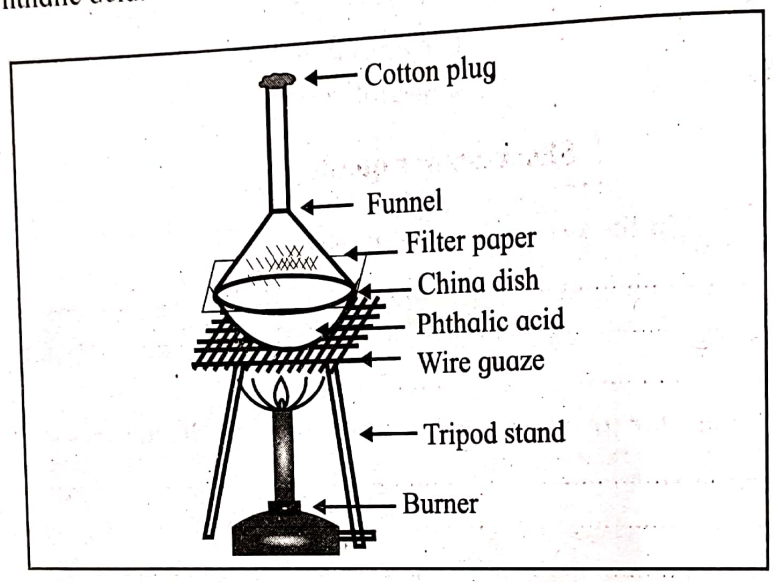


Phthalic acid — Phthalic anhydride

Apparatus: Evaporating dish, funnel, cotton, tripod stand, wire gauze, pair of tongs, filter paper, etc.

Chemicals: Phthalic acid.

Diagram:



Procedure:

1. Take 2 g of phthalic acid in a dry evaporating dish.
2. Cover the dish with filter paper having number of small holes in the centre.
3. Keep an inverted funnel on the filter paper and close nozzle of the funnel with cotton plug. Place evaporating dish on the tripod stand with wire gauze as shown in above Fig.
4. Now heat the china dish slowly and carefully on low flame.
5. After sometime the acid sublimes and anhydride collects on the inner side of the funnel.
6. Stop heating and remove the funnel carefully with pair of tongs and cool.
7. Collect the crystals of phthalic anhydride on the paper and weigh it.

Result:

1. Colour of the crystals = ...White....
2. Shape of the crystals = ...Needle....
3. Yield of phthalic anhydride = ...0·5....g

Remark and sign of teacher: .....

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MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. Phthalic acid is -----
   a. monocarboxylic acid ✓b. dicarboxylic acid
   c. tricarboxylic acid d. polycarboxylic acid
2. Phthalic anhydride is obtained by the process known as -----
   a. decomposition b. dehydration
   ✓c. sublimation d. distillation
3. Phthalic acid undergo ----- during preparation of phthalic anhydride
   ✓a. dehydration b. decarboxylation
   c. dehalogenation d. dehydrohalogenation
4. Shape of crystals of phthalic anhydride is -----
   ✓a. needle b. hexagonal
   c. triclinic d. monoclinic
5. Formation of phthalic anhydride takes place by ----- process/reaction.
   a. isolation ✓b. cyclisation
   c. decomposition d. diazotization

Short answer questions

1. Why cotton plug is used in the process of sublimation?

Ans. The cotton plug slows down the rise of the warm gases and prevent their escape during sublimation so that they get more time to condensed.

2. Write chemical equation for preparation of acetic anhydride from acetic acid.

Ans. $2\,CH_3-\overset{O}{\overset{\|}{C}}-OH \xrightarrow{800^\circ C} CH_3-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-CH_3 + H_2O$

3. What is the colour and shape of phthalic anhydride crystals?

Ans. colourless (white) having needle like shape.

4. Why slow heating is required to the contents during process of sublimation?

Ans. In process of sublimation at low temp. and low pressure, solid matter by pass liquid phase and converted directly from solid to gas easily.

5. Why filter paper is used with small holes in the centre during preparation of phthalic anhydride?

Ans. Because after slow heating of phthalic acid sublimes and phthalic anhydride formed rises through the holes in the filter paper and condensed on the inner side of funnel and filter paper.

Remark and sign of teacher: .....

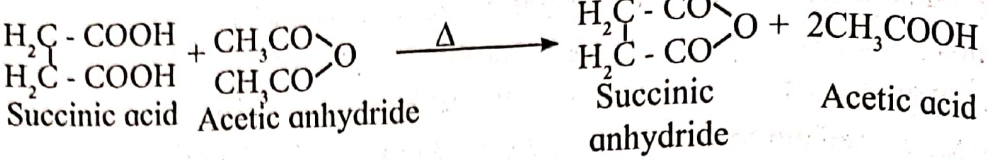
Activity No.2

Date: / /

Aim: To prepare succinic anhydride.

Theory: Succinic acid is a dicarboxylic acid which on heating loses a water molecule and undergo cyclisation reaction to form succinic anhydride.

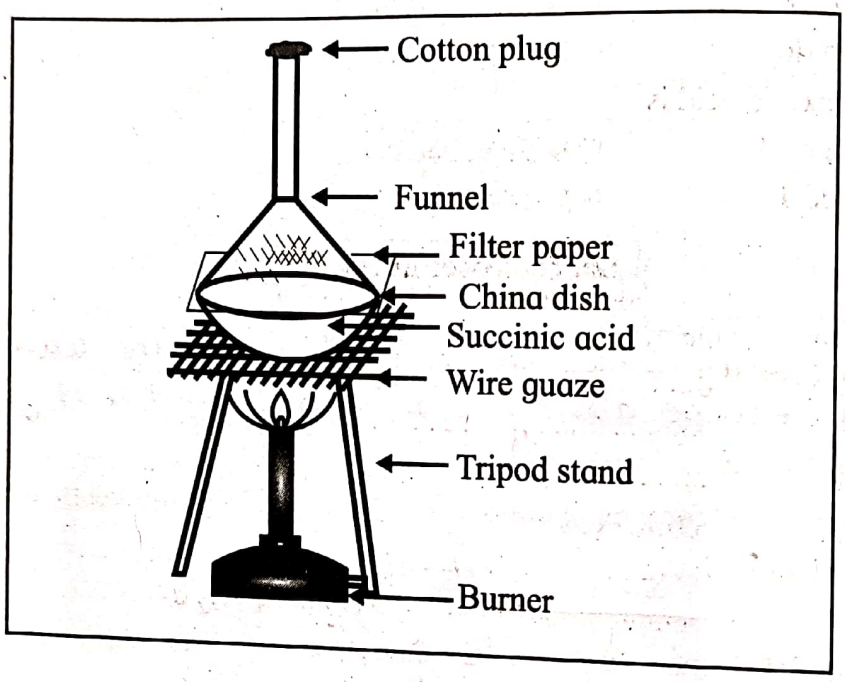
Chemicals Reaction:



Apparatus: Evaporating dish, funnel, cotton plug, tripod stand, wire gauze, pair of tongs, filter paper, etc.

Chemicals: Succinic acid.

Diagram:



Procedure:

1. Take 2 g of succinic acid in a dry evaporating dish, add 1 ml of acetic anhydride.
2. Cover the dish with filter paper having number of small holes in the centre.
3. Keep an inverted funnel on the filter paper close nozzle of the funnel with cotton plug. Place evaporating dish on the tripod stand with wire gauze as shown in above Fig.
4. Now heat the china dish slowly and carefully on low flame.
5. After sometime the acid sublimes and anhydride collects on the inner side of funnel.
6. Stop heating and remove the funnel carefully with pair of tongs and cool
7. Collect the niddle shape crystals of succinic anhydride on paper and weigh it.

Result:

1. Colour of the crystals = colourless
2. Shape of the crystals = Needle
3. Yield of succinic anhydride = 0.32 g

Remark and sign of teacher: .....

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MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. The molecular formula of succinic acid is -----
   - ✓a. $C_4H_6O_4$
   - b. $C_6H_4O_2$
   - c. $C_4H_4O_2$
   - d. $C_6H_6O_2$

2. The by product is formed in the formation of succinic anhydride is -----
   - a. water
   - ✓b. acetic acid
   - c. acetic anhydride
   - d. succinic acid

3. The process carried out to convert succinic acid to succinic anhydride is
   - a. oxidation
   - b. reduction
   - c. hydration
   - ✓d. dehydration

4. The role of acetic anhydride is chemical reaction is as
   - a. reducing agent
   - b. oxidising agent
   - ✓c. dehydrating agent
   - d. hydrating agent

5. IUPAC name of oxalic acid is
   - ✓a. ethanedioic acid
   - b. butanedioic acid
   - c. propanoic acid
   - d. propanedioic acid

Short answer questions

1. What happen when succinic acid undergoes dehydration?

Ans. When succinic acid undergoes dehydration it gives succinic anhydride.

2. Write IUPAC name of succinic acid.

Ans. Butanedioic acid

3. Write names and formulae of any two dicarboxylic acid other than phthalic acid and succinic acid.

Ans. ① malonic acid ($HOOC-CH_2-COOH$)

② Adipic acid ($HOOC-(CH_2)_4-COOH$)

4. Define the term fatty acid.

Ans. The acid which is found in fats and oils are called fatty acid.

OR Fatty acids are monocarboxylic acids having long hydrocarbon chain occuring as ester in fats and oils.

5. Write chemical equation for the preparation of propionic anhydride from propionic acid.

Ans. $CH_3-CH_2-\overset{O}{\overset{\|}{C}}-OH + CH_3-CO-O-CO-CH_3 \longrightarrow CH_3-CH_2-\overset{O}{\overset{\|}{C}}-O-\overset{O}{\overset{\|}{C}}-CH_2-CH_3 + 2CH_3COOH$

Remark and sign of teacher:

Activity No. 3

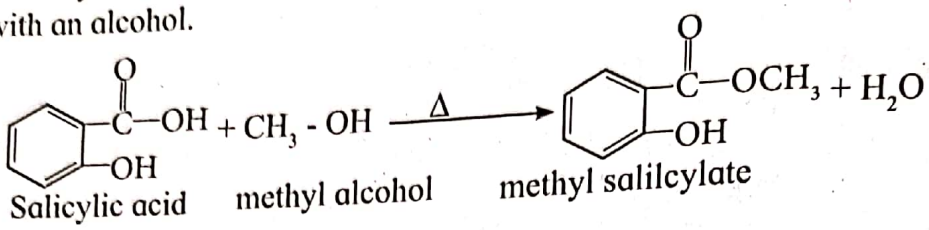
Date: / /

Aim: To prepare methyl Salicylate (oil of winter green) qualitatively.

Theory:

Carboxylic acids are converted to ester by the Fischer esterification, an acid catalysed reaction with an alcohol.

Reaction:



Salicylic acid methyl alcohol methyl salilcylate

Procedure:

1. Take a small amount of salicylic acid in a hard glass test tube.
2. Add 2-3 mL of methyl alcohol.
3. Add 1 mL cocentrated H_2SO_4
4. Heat the test tube for 10 to 15 minutes at low flame.
5. Observe the colour and take odour of the formed compound.

Observation and Result :

1. Colour of the compound = colourless
2. Odour of the compound = sweet fruity odour

Remark and sign of teacher: .....

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MCQ

Select [✓] the most appropriate answer from given alternatives of each sub question.

1. The molecular formula of methyl salicylate is.....
   a. $C_8H_7O_3$ ✓b. $C_8H_8O_3$ c. $C_7H_7O_3$ d. $C_8H_{10}O_3$
2. The hybridisation of carbon atoms of methyl salicylate is.....
   a. $SP\text{-}SP^2$ b. $SP^2\text{-}SP$ ✓c. $SP^3\text{-}SP^2$ d. $SP^3\text{-}SP$
3. Another name of methyl salicylate is.....
   a. oil of coconut b. oil of almonds ✓c. oil of winter green d. oil of vitriol
4. The role of H_2SO_4 in esterification reaction is.....
   a. oxidising agent b.reducing agent ✓c. dehydrating agent d. hydrating agent
5. The functional groups present in salicylic acid are .....
   ✓a. carboxylic acid and alcoholic b.alcoholic and ester c. ester and amide d. carboxylic acid and amide
6. Formation of water molecule in esterification reaction is by elimination of
   ✓a. -OH group from alcohol and 'H' from carboxylic acid
   b. -OH group from carboxylic acid and 'H' from alcohol
   c. -OH group from carboxylic acid and '-OH' from alcohol
   d. 'H' from alcohol and '-OH' from carboxylic acid

Short answer questions

1. **What is Fischer esterification?**

Ans. When carboxylic acid react with alcohol in presence of conc.H_2SO_4 to form ester such reaction is called Fischer esterification.

2. **Write a general chemical equation showing formation of ester.**

Ans. $R\text{-}\overset{O}{\overset{\|}{C}}\text{-}OH + R\text{-}OH \xrightarrow{conc.H_2SO_4} R\text{-}\overset{O}{\overset{\|}{C}}\text{-}O\text{-}R + H_2O$

3. **Write the role of conc. H_2SO_4 in esterification process?**

Ans. Dehydrating agent

Remark and sign of teacher: .....