OBSERVATIONS:

1. Solution in Burette : $KMnO_4$ solution
2. Solution in Pipette : 10ml M/20 F.A.S solution
3. Solution in Conical Flask : 10ml M/20 F.A.S + one test tube of dil H_2SO_4
4. Indicator : $KMnO_4$ solution
5. End point : Colourless to faint pink

OBSERVATION TABLE:

	Burette Readings		Volume of	Volume of	C.B.R.
	Initial Burette Reading (ml)	Final Burette Reading (ml)	F.A.S. (ml)	$KMnO_4$ (ml)	
1.	0	10.2	10	10.2	
2.	0	10.3	10	10.3	10.2 ml
3.	0	10.2	10	10.2	

CALCULATIONS :

M_1 = Molarity of $KMnO_4$ M_2 = Molarity of F.A.S.

V_1 = Volume of $KMnO_4$ V_2 = Volume of F.A.S.

A] Molarity of $KMnO_4$

$5M_1V_1 = M_2V_2$

$5M_1 \times 10.2 = \frac{1}{20} \times 10$

$M_1 = \frac{1 \times \cancel{10} \times 1}{\cancel{20}_2 \cdot 10.2 \cdot 5}$

$= \underline{\underline{0.01M}}$

B] Strength of $KMnO_4$ solution:

Strength = $M_1 \times$ Molar mass of $KMnO_4$

$= 0.01 \times 158$

$= \underline{\underline{1.58 g/L}}$

OBSERVATION:

1. Solution in burette : $KMnO_4$ solution
2. Solution in pipette : 10ml M/40 oxalic acid solution
3. Solution in conical flask : 10ml M/40 oxalic acid + one test tube of H_2SO_4
4. Indicator : $KMnO_4$ solution
5. End point : Colourless to faint pink

OBSERVATION TABLE:

	Burette Readings		Volume of oxalic acid(ml)	Volume of $KMnO_4$(ml)	C.B.R.
	Initial Burette reading(ml)	Final Burette reading(ml)			
1.	0	9.7	10	9.7	9.7
2.	0	9.5	10	9.5	
3.	0	9.7	10	9.7	

CALCULATIONS:

M_1 = Molarity of oxalic acid M_2 = Molarity of $KMnO_4$

V_1 = Volume of oxalic acid V_2 = Volume of $KMnO_4$

A] Molarity of $KMnO_4$

$\therefore 5M_1V_1 = 2M_2V_2$

$5 \times M_1 \times 9.7 = \cancel{2} \times \frac{1}{\cancel{140}_{2}} \times 1\cancel{0}$

$\therefore M_1 = \frac{1/14}{9.7} = 0.0103\,M \approx \underline{\underline{0.01M}}$

$\boxed{\therefore M_1 = 0.01M}$

B] Strength of $KMnO_4$

$\therefore$ Strength of $KMnO_4$ solution $= M_1 \times$ Molar mass of $KMnO_4$

$= 0.01 \times 158$

$= \underline{\underline{1.58}}\ g/L$

OBSERVATION:

1) Initial temperature of acid and base = $t_1°C$ = 33°C
2) Final temperature after neutralisation = $t_2°C$ = 39°C
3) Change in temperature $\Delta t = (t_2 - t_1)°C = (39-33)°C$ = 6°C
4) Mass of the mixture solution after neutralisation = 200g
5) Calorimeter constant of calorimeter = W J/°C

CALCULATIONS:

Determination of calorimeter constant:

t_1 (temp of cold water) = 25°C

t_2 (temp of hot water) = 55°C, t_3 (temp of mixture) = 40°C

$$W = 4.184 \times \left(100 \times \frac{(t_2 - t_1)}{(t_3 - t_1)} - 100\right)$$

$$= 4.184 \times \left(100 \times \frac{(55-40)}{(40-25)} - 100\right) = \underline{0\ J/°C}$$

Enthalpy of neutralisation:

Enthalpy change during neutralisation of 100ml of 1M HCl:

$$\Delta H = (200 + W) \times (t_{mix} - t_{mean}) \times 4.184\ J$$

Enthalpy change during neutralisation of 1000 ml of 1M HCl:

$$\Delta H = (200 + W) \times (t_{mix} - t_{mean}) \times 4.184 \times \frac{1000}{100}$$

$$= 200 \times (39°C - 33°C) \times 4.184 \times 10 = 50200\ J$$

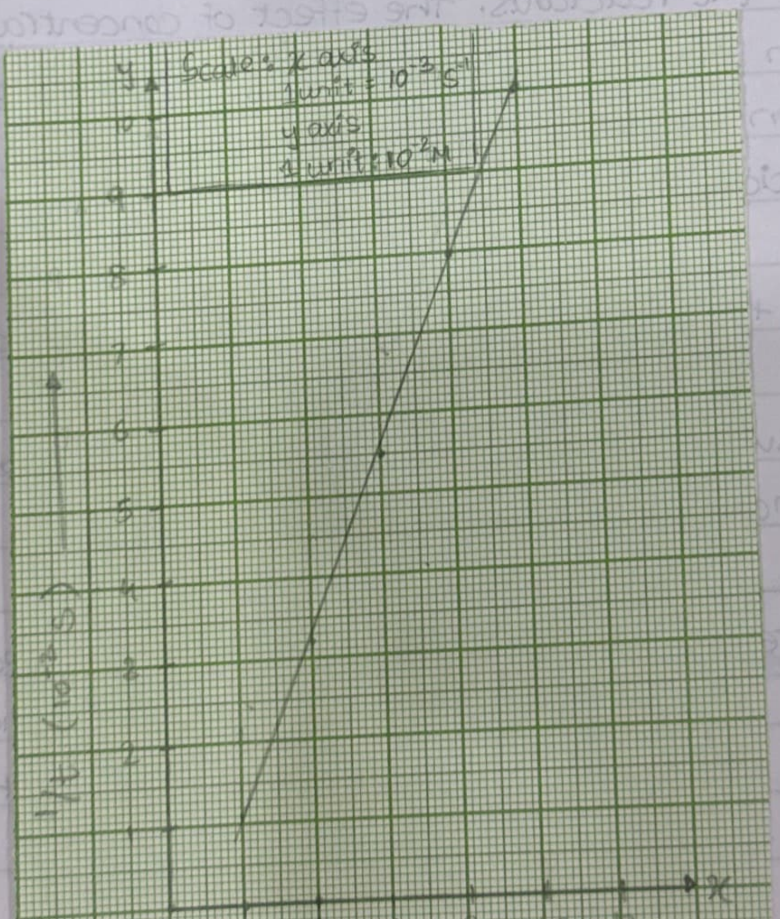
$$= 50.2\ kJ$$

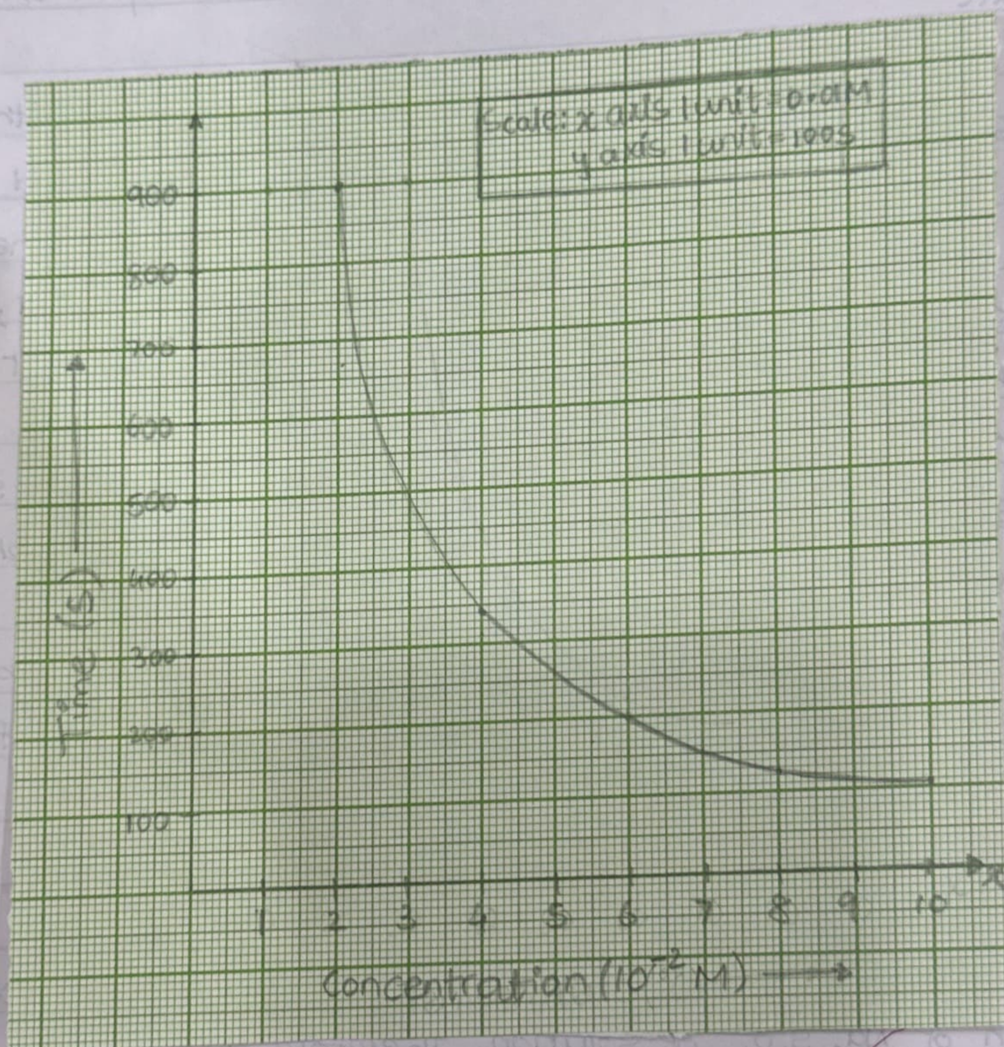
∵ Heat is produced during neutralisation reaction, the enthalpy of neutralisation is negative.

∴ Enthalpy of neutralisation = $\underline{-50.2\ kJ}$

OBSERVATIONS:

Flask No.	Vol. of $Na_2S_2O_3$ sol. (ml)	Vol. of water (ml)	Total vol. of sol. (ml)	Concentration of $Na_2S_2O_3$ sol.	Vol. of 1M HCl (ml)	Time taken for cross to become invisible (s)	$\frac{1}{t}$ (s^{-1})
1.	10	40	50	0.02M	10	900	0.0011
2.	20	30	50	0.04M	10	312.5	0.0032
3.	30	20	50	0.06M	10	222	0.0055
4.	40	10	50	0.08M	10	125	0.0080
5.	50	0	50	0.1M	10	100	0.0095





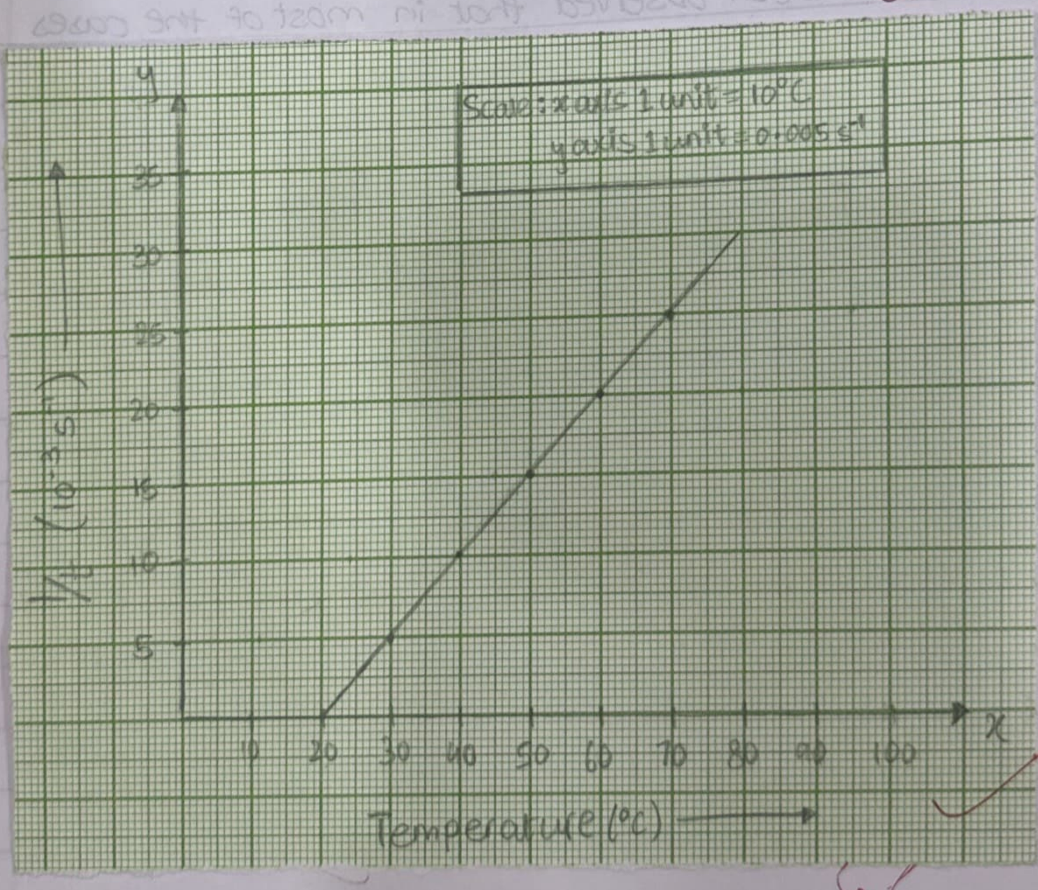
Scale: x axis 1 unit = 0.01M
y axis 1 unit = 100s
900
800
700
600
500
400
300
200
100
1
2
3
4
5
6
7
8
9
10
Concentration (10^{-2} M)

OBSERVATIONS:

Volume of 0.05M $Na_2S_2O_3$ solution taken each time = 25ml

Volume of 0.05M HCl added each time = 10ml

Sr. No.	Temperature (°C)	Time taken for cross to become invisible (s)	$\frac{1}{t}$ (s^{-1})
1.	30	180	0.005
2.	40	90	0.011
3.	50	60	0.016
4.	60	45	0.022
5.	70	38	0.026

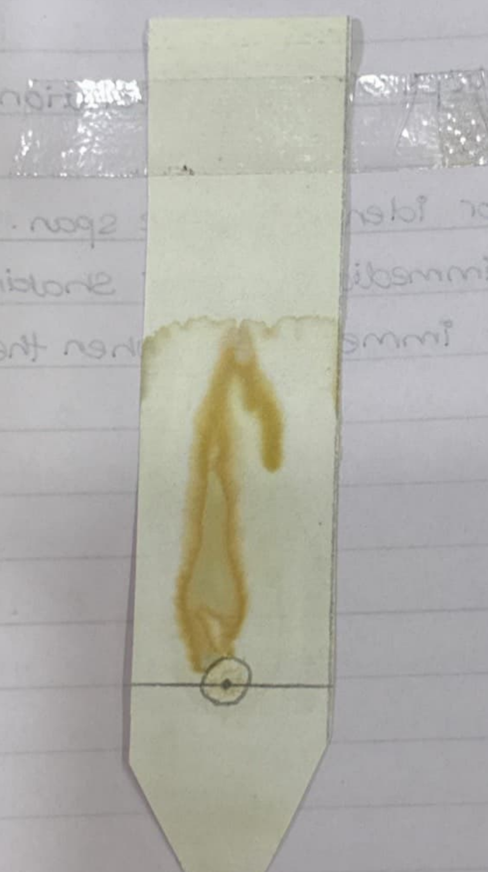


OBSERVATION TABLE:

Flask	Volume of 0.1M KIO_3 (ml)	Volume of dil. H_2SO_4 (ml)	Volume of water (ml)	Starch solution (ml)	Volume of 0.01M Na_2SO_3 added (ml)	Time of appearance of blue colour (s)
1.	10	10	80	5	20	36
2.	20	20	70	5	20	4
3.	30	30	60	5	20	26
4.	40	40	50	5	20	19

OBSERVATION TABLE:

Test tube	Oil used for emulsification	Time taken for separation of layers	
		Without soap	With soap
A	Coconut oil	87	158
B	Groundnut oil	90	157
C	Mustard oil	90	180
D	Castor oil	60	240

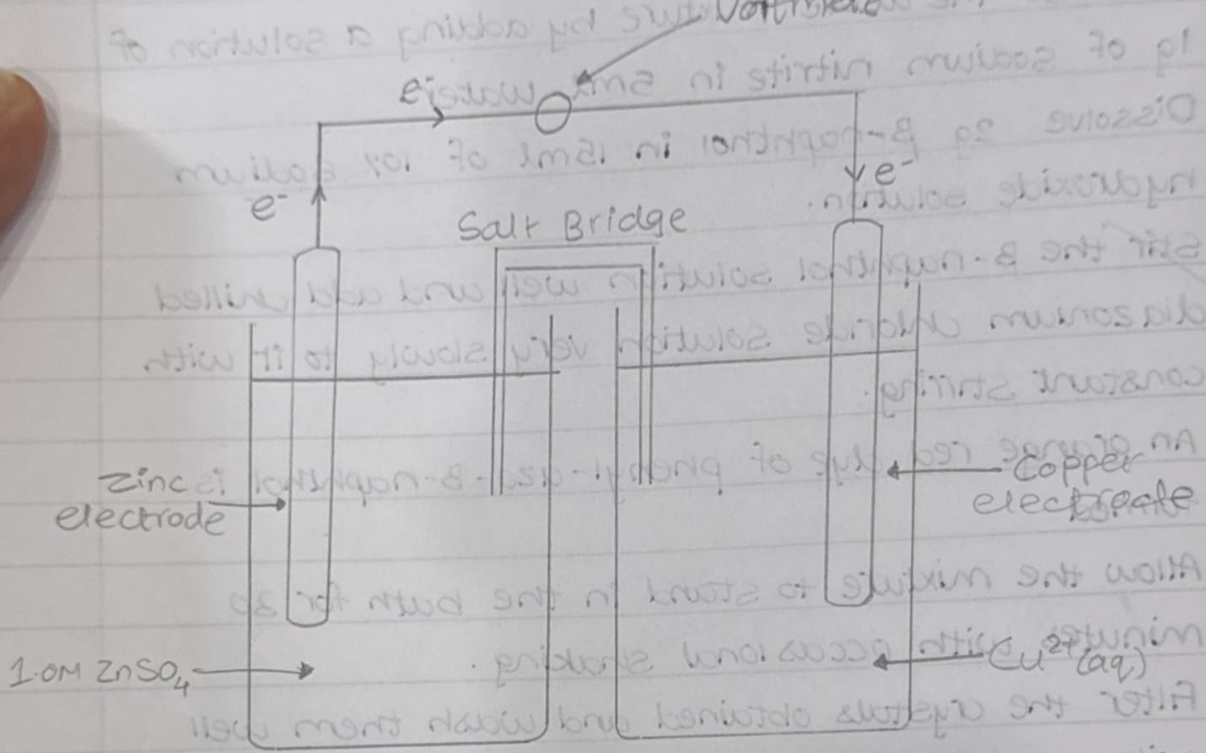


Sl. No.	Colour of the spot	Distance travelled by components from reference line (cm)	Distance travelled by solvent from reference line (cm)	R_f Value
1.	Faint Green	2cm	4.3cm	0.46
2.	Orange brown	3.6cm	4.3cm	0.83cm.

CALCULATION:

R_f values can be calculated by using the following expression

$$R_f = \frac{\text{Distance travelled by substance from the reference line (cm)}}{\text{Distance travelled by solvent from the reference line (cm)}}$$



Set up of $Zn(s)/Zn^{2+}(aq)$ (1.0M) $||$ $Cu^{2+}(aq.)$ (x M) $/Cu(s)$ cell

OBSERVATION TABLE

Concentration of $ZnSO_4$ solution	Concentration of $CuSO_4$ Solution	EMF of the cell
1M	1M	1.1V
1M	0.5M	1.091V
1M	0.025M	1.052 V
1M	0.0125M	1.043V
0.5M	1M	1.108 V
0.025M	1M	1.147V
0.0125M	1M	1.157V

CHEMICAL REACTIONS FOR CARBOXYLIC ACID GROUP:

1) $NaHCO_3 + CH_3COOH \longrightarrow CH_3COONa + CO_2 + H_2O$

(Sodium hydrogen carbonate) (Acetic acid) (Sodium acetate)

2) $CH_3COOH + CH_3CH_2OH \xrightleftharpoons{HA} CH_3COCH_2CH_3 + H_2O$ (with C=O)

(Acetic acid) (Ethanol) (Ethyl acetate) (Fruity smell)

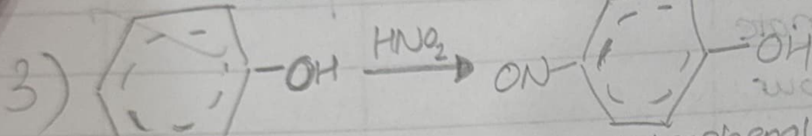
CHEMICAL REACTIONS FOR PHENOLIC GROUP:

1) $FeCl_3 + 6C_6H_5OH \xrightarrow{KOH} [Fe(OC_6H_5)_6]^{3-} + 3HCl$

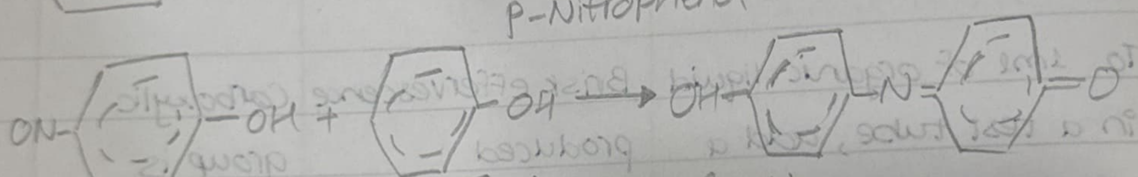
Ferric Chloride — Phenol — Violet Complex

2) $2NaNO_2 + H_2SO_4 \longrightarrow 2HNO_2 + Na_2SO_4$

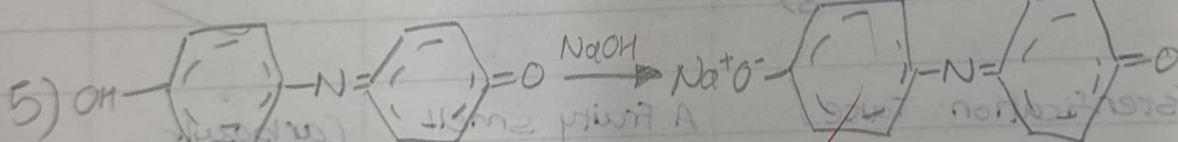
Sodium Nitrite — Nitrous acid

3) 

p-Nitrophenol

4) 

Indophenol (red)

5) 

(red) — Indophenol anion (blue)

CHEMICAL REACTIONS FOR ALCOHOLIC GROUP:

1) $C_2H_5OH + 2Na \longrightarrow 2C_2H_5ONa + H_2\uparrow$

2) $2C_2H_5OH + (NH_4)_2Ce(NO_3)_6 \longrightarrow [(C_2H_5OH)_2Ce(NO_3)_4] + 2NH_4NO_3$

(Red colour)

3) $CH_3\overset{O}{\overset{\|}{C}}OH + CH_3CH_2OH \xrightleftharpoons{H^+} CH_3\overset{O}{\overset{\|}{C}}OCH_2CH_3 + H_2O$

4) $C_2H_5OH + KOH \longrightarrow C_2H_5OH + H_2O$

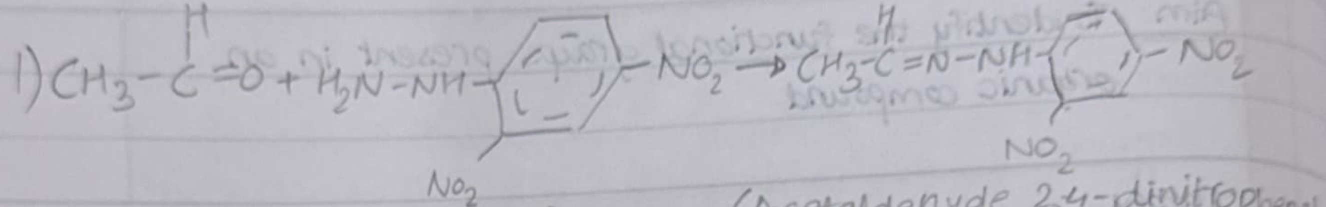
5) $S{=}C{=}S + C_2H_5OK \xrightarrow{KOH} \left(S{=}\overset{SK}{\overset{|}{C}}{-}OC_2H_5\right)$

Potassium ethyl xanthate

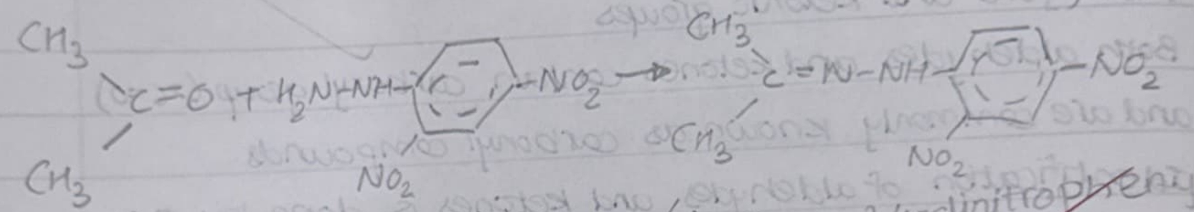
(Yellow ppt.)

CHEMICAL REACTIONS FOR ALDEHYDE GROUP:

1)



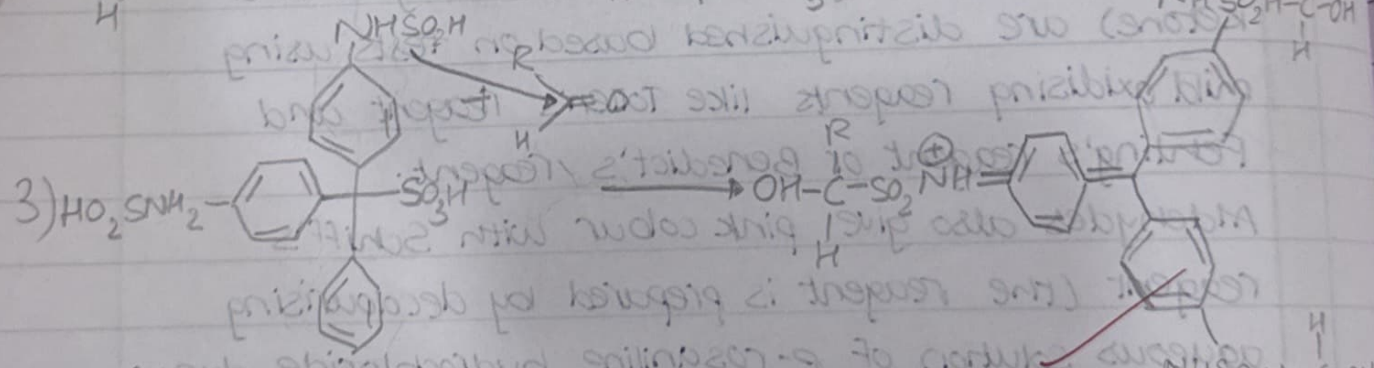
(2,4-DNP) (Acetaldehyde 2,4-dinitrophenyl hydrazone)



(2,4-DNP) (Acetone-2,4-dinitrophenyl hydrazone)

2) $$R(H)C=O + NaHSO_3 \longrightarrow R-C(H)(OH)SO_3Na$$

3)

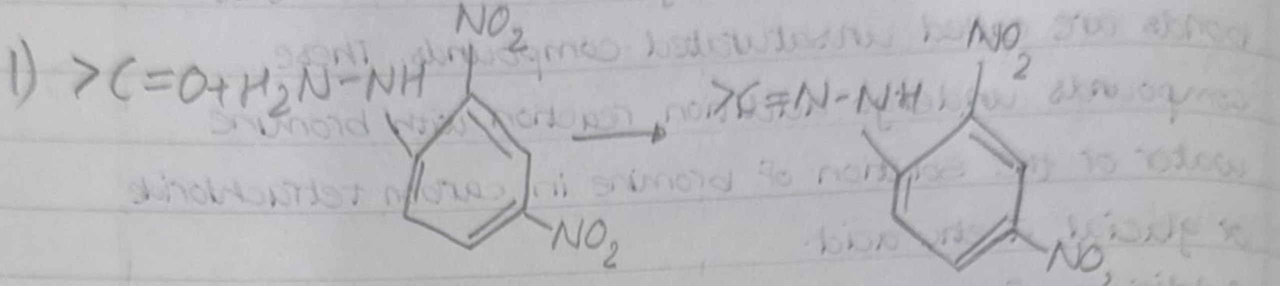


(Schiff reagent) Colourless (Schiff adduct) (Magenta)

4) $$RCHO + \underbrace{2Cu^{2+} + 5OH^-}_{\text{Fehling's Solution}} \longrightarrow \underset{\text{(Red)}}{Cu_2O\downarrow} + RCOO^- + 3H_2O$$

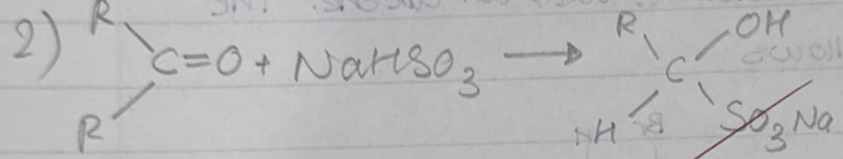
5) $$2Ag(NH_3)_2^+ + RCHO + 3OH^- \longrightarrow RCOO^- + 2Ag\downarrow + 4NH_3 + 2H_2O$$

CHEMICAL REACTIONS FOR KETONE GROUP:



(2,4-DNP)

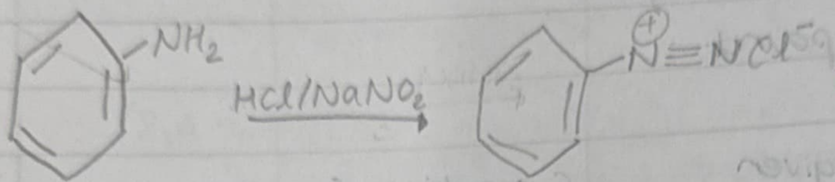
(2,4-dinitrophenylhydrazone of carbonyl compound)

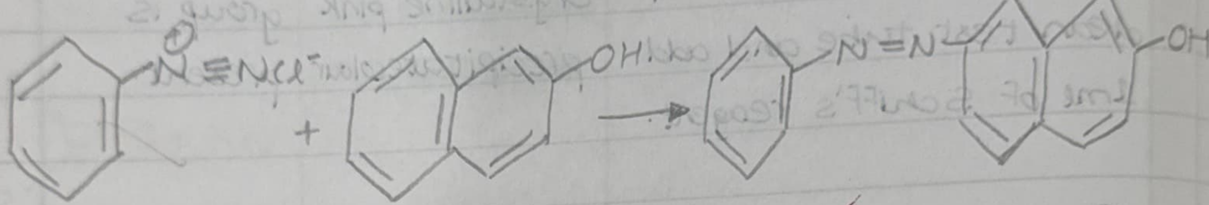


CHEMICAL REACTIONS FOR AMINO GROUP:

1) $C_6H_5NH_2 + HCl \longrightarrow C_6H_5NH_3^+Cl^-$

2)





CHEMICAL REACTIONS FOR UNSATURATION:

1) $$-\underset{|}{C}=\underset{|}{C}- + \underset{\text{(orange red)}}{Br_2} \xrightarrow{CCl_4} \underset{\text{(colourless)}}{-\underset{|}{\overset{Br}{\overset{|}{C}}}-\underset{|}{\overset{Br}{\overset{|}{C}}}-}$$

2) $$-C\equiv C- + 2Br_2 \xrightarrow{CCl_4} \underset{\text{(colourless)}}{-\underset{\underset{Br}{|}}{\overset{Br}{\overset{|}{C}}}-\underset{\underset{Br}{|}}{\overset{Br}{\overset{|}{C}}}-}$$

3) $$2KMnO_4 + H_2O \longrightarrow 2KOH + 2MnO_2 + 3[O]$$

$$>C=C< + H_2O + [O] \xrightarrow{OH^-} \underset{\text{(colourless)}}{-\underset{|}{\overset{OH}{\overset{|}{C}}}-\underset{|}{\overset{OH}{\overset{|}{C}}}-} + KOH$$

CHEMICAL REACTIONS FOR CARBOHYDRATES:

1) Fehling's solution test:

$$R\text{-}CHO + 2CuSO_4 + 4NaOH \rightarrow RCOOH + 2Na_2SO_4 + \underset{\text{(Brick red ppt)}}{Cu_2O} + 2H_2O$$

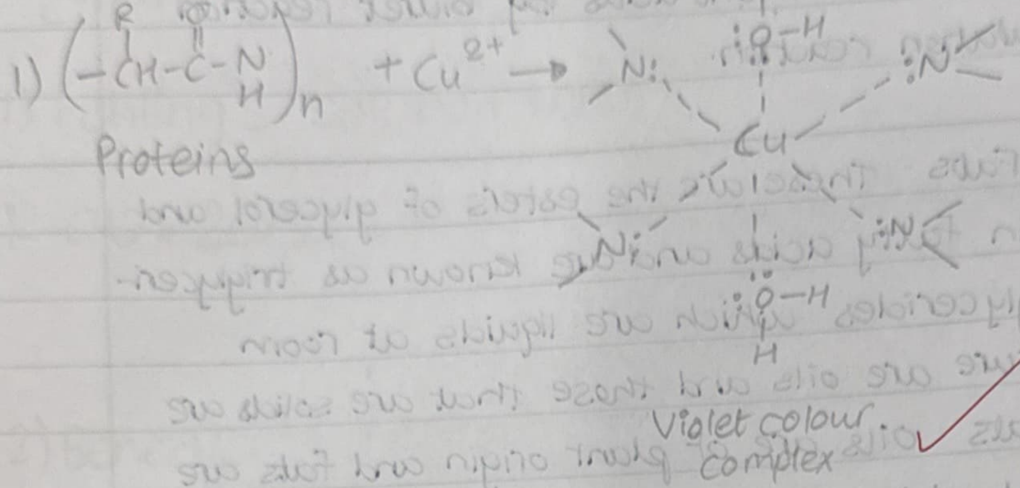
2) Benedict's test:

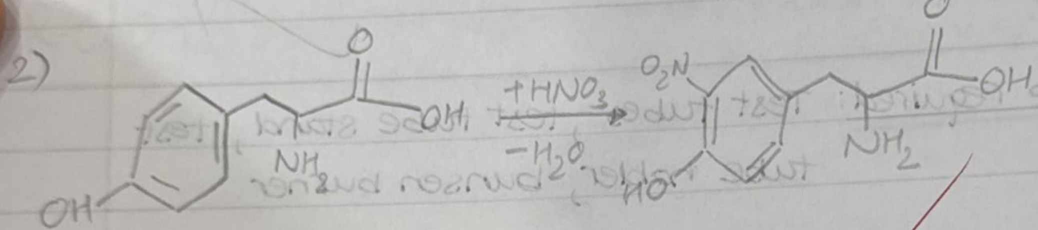
$$R\text{-}CHO + 2CuSO_4 + 4Na_2CO_3 \rightarrow RCOOH + 2Na_2SO_4 + \underset{\text{(Brick Red ppt)}}{Cu_2O} + 2C$$

3) Tollen's test:

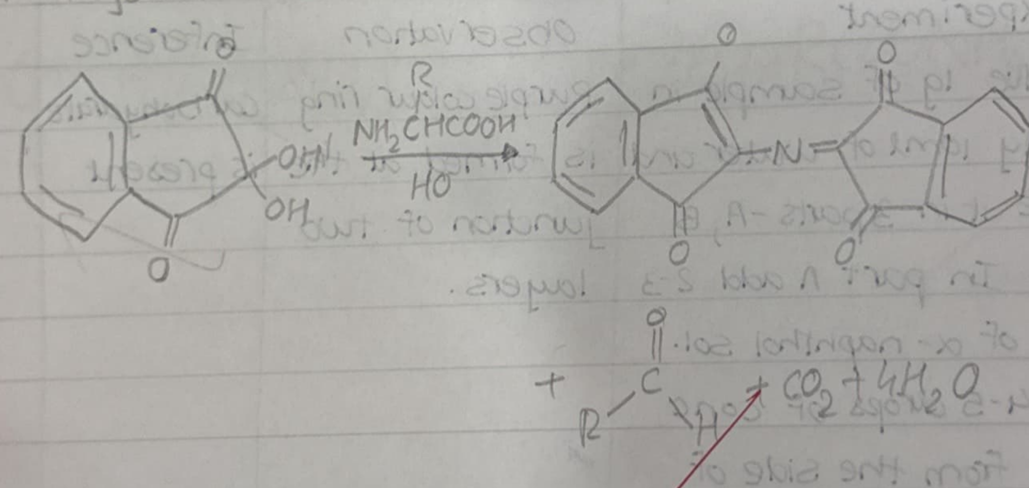
$$R\text{-}CHO + 2[Ag(NH_3)_2]^{2+} + 2OH^- \rightarrow 2Ag + RCOONH_4 + H_2O + 3N$$

CHEMICAL REACTIONS FOR PROTEINS

1) 

2) 

3) Ninhydrin Test:



CHEMICAL REACTIONS FOR FAT

1) Oil or Fat $\xrightarrow{\Delta}$ Glycerol + fatty acids

2) $$\begin{array}{c} CH_2OH \\ | \\ CHOH \\ | \\ CH_2OH \end{array} \xrightarrow[\Delta]{KHSO_4} \begin{array}{c} CH_2 \\ \| \\ CH \\ | \\ CHO \end{array} + 2H_2O$$

(Glycerol) (Acrolein)

CHEMICAL REACTIONS FOR STARCH

$$I_3^- + \text{Starch} \xrightarrow{\text{Multi Step process}} \longrightarrow I_2 + I^-$$

TEST FOR CHLORIDE ION (Cl^-).

1) $MnO_2 + 2NaCl + 2H_2SO_4 \rightarrow Na_2SO_4 + MnSO_4 + 2H_2O + Cl_2$
(Greenish yellow pungent gas)

2) $NaCl + AgNO_3 \rightarrow NaNO_3 + AgCl$
(White precipitate)

$AgCl + 2NH_4OH \rightarrow [Ag(NH_3)_2]Cl + 2H_2O$
Diammine silver (I) chloride

3) $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$
$HCl + NH_3 \rightarrow NH_4Cl$
(White fumes)

TEST FOR AMMONIUM ION (NH_4^+)

1) $(NH_4)_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2NH_3 + 2H_2O$

$NH_3 + HCl \rightarrow NH_4Cl$

(Dense white fumes)

2) $2K_2HgI_4 + NH_3 + 3KOH \rightarrow HgO.Hg(NH_2)I + 7KI + 2H_2O$

(Basic mercury II amido-iodine)

(Brown precipitate)

TEST FOR NITRATE ION (NO_3^-)

1) $NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$

$6FeSO_4 + 3H_2SO_4 + 2HNO_3 \rightarrow 3Fe_2(SO_4)_3 + 4H_2O + 2NO$

$FeSO_4 + NO \rightarrow [Fe(NO)]SO_4$

(Nitroso Ferrous Sulphate)

Brown.

2) $NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$

$4HNO_3 \rightarrow 4NO_2 + O_2 + 2H_2O$

$2NaNO_3 + 4H_2SO_4 + 3Cu \rightarrow 3CuSO_4 + Na_2SO_4 + 4H_2O + 2NO$

$2NO + O_2 \rightarrow 2NO_2$

(Brown Fumes)

TEST FOR LEAD ION (Pb^{2+})

1) $PbCl_2 + 2KI \longrightarrow PbI_2 + 2KCl$
(Hot solution) (Yellow precipitate)

2) $PbCl_2 + K_2CrO_4 \longrightarrow PbCrO_4 + 2KCl$
(Hot solution) (Lead Chromate)
(Yellow precipitate)

3) $PbCrO_4 + 4NaOH \rightleftharpoons Na_2[Pb(OH)_4] + Na_2CrO_4$
(Sodium tera hydroxoplumbate (II))

TEST FOR SULPHATE ION (SO_4^{2-})

1) $Na_2SO_4 + BaCl_2 \longrightarrow BaSO_4 + 2NaCl$
(white precipitate)

2) $Na_2SO_4 + (CH_3COO)_2Pb \longrightarrow PbSO_4 + 2CH_3COONa$
(white precipitate)

TEST FOR CUPRIC ION (Cu^{2+})

1) $3CuS + 8HNO_3 \longrightarrow 3Cu(NO_3)_2 + 2NO + 3S + 4H_2O$

2) $S + 2HNO_3 \longrightarrow H_2SO_4 + 2NO$

$2Cu^{2+} + SO_4^{2-} + 2NH_3 + 2H_2O \longrightarrow Cu(OH)_2 \cdot CuSO_4 + 2NH_4^+$

$Cu(OH)_2 \cdot CuSO_4 + 8NH_3 \longrightarrow 2[Cu(NH_3)_4]SO_4 + 2OH^- + SO_4^{2-}$

(Tetraammine copper(II) Sulphate (deep blue))

3) $[Cu(NH_3)_4]SO_4 + 4CH_3COOH \longrightarrow CuSO_4 + 4CH_3COONH_4$

$2CuSO_4 + K_4[Fe(CN)_6] \longrightarrow Cu_2[Fe(CN)_6] + 2K_2SO_4$

(Potassium hexacyanoferrate(II)) (Copper hexacyanoferrate(II)) (Chocolate brown precipitate)

TEST FOR SULPHATE ION (SO_4^{2-})

1) $Na_2SO_4 + BaCl_2 \longrightarrow \underset{\text{(white ppt.)}}{BaSO_4} + 2NaCl$

2) $Na_2SO_4 + (CH_3COO)_2Pb \longrightarrow \underset{\text{(white ppt.)}}{PbSO_4} + 2CH_3COONa$

TEST FOR ALUMINIUM ION (Al^{3+})

1) $AlCl_3 + 3NaOH \longrightarrow Al(OH)_3 + 3NaCl$

$Al(OH)_3 + NaOH \longrightarrow NaAlO_2 + 2H_2O$

(write gelatinous ppt.) (sodium meta aluminate)

TEST FOR CHLORIDE ION (Cl^-)

1) $MnO_2 + 2NaCl + 2H_2SO_4 \rightarrow Na_2SO_4 + MnSO_4 + 2H_2O + Cl_2$

2) $NaCl + AgNO_3 \rightarrow NaNO_3 + AgCl$ (white ppt)

$AgCl + 2NH_4OH \rightarrow [Ag(NH_3)_2]Cl + 2H_2O$

3) $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

$HCl + NH_3 \rightarrow NH_4Cl$

TEST FOR COBALT ION (Co^{2+})

1) $CoS + HNO_3 + 3HCl \rightarrow CoCl_2 + NOCl + S + 2H_2O$

$CoCl_2 + 7KNO_2 + 2CH_3COOH \rightarrow K_3[Co(NO_2)_6] + 2KCl + 2CH_3COOK + NO + H_2O$

(Potassium hexanitritocobaltate(III))

(Yellow ppt.)

2) $Co^{2+}(aq) + 4NH_4CNS \rightarrow (NH_4)_2[Co(CNS)_4] + 2NH_4^+$

(Blue colour)

TEST FOR NITRATE ION (NO_3^-)

1) $NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$

$6FeSO_4 + 3H_2SO_4 + 2HNO_3 \rightarrow 3Fe_2(SO_4)_3 + 4H_2O + 2NO$

$FeSO_4 + NO \rightarrow [Fe(NO)]SO_4$

(Brown ring)

2) $NaNO_3 + H_2SO_4 \rightarrow NaHSO_4 + HNO_3$

$4HNO_3 \rightarrow 4NO_2 + O_2 + 2H_2O$

$2NaNO_3 + 4H_2SO_4 + 3Cu \rightarrow 3CuSO_4 + Na_2SO_4 + 4H_2O + 2NO$

$2NO + O_2 \rightarrow 2NO_2$

(Brown fumes)

TEST FOR BARIUM ION (Ba^{2+})

1) $BaCO_3 + 2CH_3COOH \rightarrow (CH_3COO)_2Ba + H_2O + CO_2$

$(CH_3COO)_2Ba + K_2CrO_4 \rightarrow BaCrO_4 + 2CH_3COOK$

(Barium Chromate)

(Yellow ppt.)

TEST FOR CARBONATE ION (CO_3^{2-})

1) $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + H_2O + CO_2$

$Ca(OH)_2 + CO_2 \longrightarrow CaCO_3 + H_2O$

2) $MgSO_4 + n\,CO_3^{2-}(aq) \longrightarrow MgCO_3 + SO_4^{2-}$
(white ppt.)

TEST FOR MAGNESIUM ION (Mg^{2+})

1) $Mg^{2+} + Na_2HPO_4 \longrightarrow Mg(NH_4)PO_4 + NH_4OH + 2Na^+ + H_2O$

(Magnesium Ammonium Phosphate (white ppt.))

TEST FOR PHOSPHATE ION (PO_4^{3-})

1) $Na_2HPO_4 + 12(NH_4)_2MoO_4 + 23HNO_3 \rightarrow (NH_4)_3[P(Mo_3O_{10})_4] + 2NaNO_3 + 21NH_4NO_3 + 12H_2O$

(canary yellow ppt.)

2) $3Co(NO_3)_2 + 2PO_4^{3-} \rightarrow Co_3(PO_4)_2 + 6NO_3^-$

(violet colour)

3) $Co_3(PO_4)_2 + CH_3COOH \rightarrow 3Co(COOCH_3)_2 + H_3PO_4$

(soluble)

TEST FOR AMMONIUM ION (NH_4^+)

1) $(NH_4)_2SO_4 + 2NaOH \longrightarrow Na_2SO_4 + 2NH_3 + 2H_2O$

$NH_3 + HCl \longrightarrow NH_4Cl$ (dense white fumes)

2) $2K_2HgI_4 + NH_3 + 3KOH \longrightarrow HgO.Hg(NH_2)I + 7KI + 2H_2O$ (Brown ppt.)