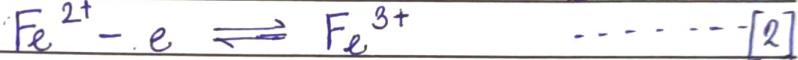
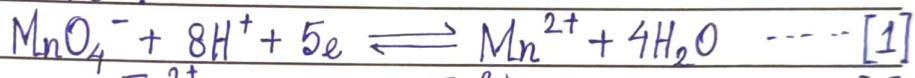


DETERMINATION OF STRENGTH OF $KMnO_4$ SOLUTION

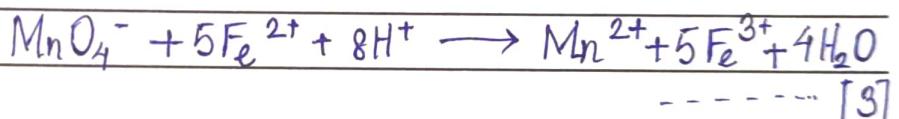
By TITRATING IT WITH STANDARD FERROUS AMMONIUM SULPHATE

SOLUTION

Potassium permanganate in H_2SO_4 medium oxidises Fe^{2+} to Fe^{3+} .

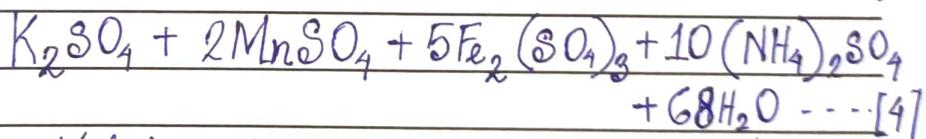
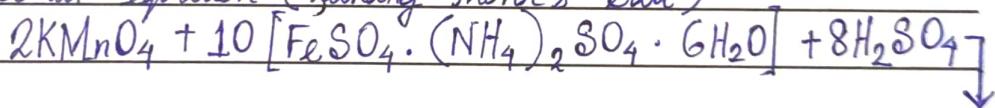


Equation (2) is multiplied by 5 and then added to equation (1),



PRINCIPLE

Molecular equation (taking Mohr's Salt)



$FeSO_4$ of Mohr's salt takes part as a reducing agent in this reaction.

So, with help of standard Mohr's salt solution in 2(N) H_2SO_4 medium in the presence of phosphoric acid, $KMnO_4$ solution can be titrated at ordinary temperature to determine the strength, g/L and molar strength of $KMnO_4$ solution.

If V_1 ml. Mohr's salt of strength S_1 (N) requires V_2 ml. KMnO_4 solution of strength S_2 (N) to reach the equivalence point, then $V_1 S_1 = V_2 S_2$.
 or $S_2 = \frac{V_1 S_1}{V_2}$.

Indicator: KMnO_4 solution is the self-indicator in this titration.

NECESSARY APPARATUS

Apparatus : 1) Burette (50 mL), 2) Pipette (25 mL),
 3) Stand and burette clamp, 4) Conical flask, 5) Wash bottle, 6) Measuring cylinder.

CHEMICALS

Chemicals : 1) Standard (N/10) Mohr's salt solution,
 2) (~N/10) KMnO_4 solution of unknown strength, 3) 2(N) H_2SO_4 solution, 4) Syrupy H_3PO_4 (or NH_4HF_2).

1) Burette, pipette and conical flask are washed first with first tap water and then with distilled water.

PROCEDURE

2) Burette is rinsed twice with 2-3 ml. supplied KMnO_4 solution each time. The burette is filled with this KMnO_4 solution upto the '0' mark.
 3) The pipette is rinsed with standard Mohr's salt solution. 25 mL Mohr's salt solution is transferred to 500 mL conical flask with a pipette, 15 mL of 2(N) H_2SO_4 solution and 3 mL syrupy H_3PO_4 .

are added to the solution and the mixture is shaken well.

4) The conical flask containing Mohr's salt solution is placed on a piece of white paper below the burette. KMnO_4 solution from the burette is added slowly with gentle shaking of the solution. The pink colour of KMnO_4 disappears as soon as it comes in contact with the solution. Titration is continued till one drop of KMnO_4 solution brings a faint pink colour that persists for 30 seconds. Addition of KMnO_4 is stopped.

Burette reading is noted. This process is repeated twice.

Strength of standard Mohr's salt solution = 0.972 (N/10)

EXPERIMENTAL RESULT	No. of titration	Volume of Mohr's salt (ml)	Burette reading for KMnO_4 solution		Volume of KMnO_4 solution required (ml)	Mean- KMnO_4 (ml)
			Initial (ml)	Final (ml)		
	1	25	0	25.2	25.2	
	2	25	0	25.1	25.1	25.1
	3	25	0	25.1	25.1	

$$V_1 S_1 = V_2 S_2 \quad [V_1 = \text{Vol. of mohr's salt} = 25 \text{ ml}, S_1 = 0.972, V_2 = \text{Vol. of } \text{KMnO}_4]$$

$$\therefore S_2 = \frac{V_1 S_1}{V_2} = \frac{25 \times 0.972}{25.1 \times 10} (\text{N}) = 0.0968 (\text{N})$$

$$= 25.1 \text{ ml}$$

CALCULATION

$$\text{Amount of } \text{KMnO}_4 \text{ in } \text{g.L}^{-1} = 0.0968 \times 31.6 = 3.0588$$

$$\text{Molar strength} = \frac{3.0588}{158} (\text{M}) = 0.0193 (\text{M})$$

TEST FOR FUNCTIONAL GROUPS PRESENT IN ORGANIC COMPOUNDS

● Test for ALDEHYDE ($-CHO$) and KETO ($>C=O$) Groups :

EXPERIMENT	OBSERVATION	INFERENCE
● Preliminary test :-		
① 2,4 -DNP test \Rightarrow 2-3 ml of 2,4 - DNP. (Brady's reagent) is added to 2ml of alcoholic solution of the sample and shaken.	1) Red (or yellow) precipitate	1) Aldehyde ($-CHO$) or keto ($>C=O$) group may be present
● Distinctive tests for aldehydes and Ketones : * If the test (1) is positive the given tests are performed.	a) In a test tube, about 0.1g (0.2ml) sample is added to a mixture of equal volumes of Fehling A and Fehling B solutions. The	a) Brick red precipitate (of Cu_2O). a) Presence of aldehyde group is confirmed.

EXPERIMENT	OBSERVATION	INFERENCE
reaction mixture is heated for 4-5 minutes in a boiling water bath.		
b) In a test tube, about 3 ml Tollen's reagent is shaken with a small amount of the sample. If the reaction mixture does not turn grey or black, the mixture is placed in a hot water bath for few minutes.	b) A shining mirror is formed on the inner surface of the test tube or a grey precipitate is formed.	b) Confirms the presence of aldehyde group (-CHO).

All compounds having aldehyde group (particularly aromatic aldehydes) do not respond to Fehling's test. Hence, Tollen's reagent is used in the detection of -CHO group.

● Test for Carboxylic Acid (-COOH) Group :

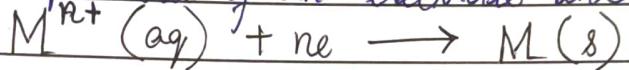
EXPERIMENT	OBSERVATION	INFERENCE
1) Test with NaHCO_3 : A small amount of the sample is added to 5 ml saturated solutions of NaHCO_3 , taken in a	1) Effervescence (due to liberation of CO_2).	1) Carboxylic acid group (-COOH) may be present.

EXPERIMENT	OBSERVATION	INFERENCE
test tube.		
2) Esterification Test: About 0.5 g (or 0.5 ml) of the sample is taken in a test tube to which 2ml ethanol and 1ml concentrated H_2SO_4 are added. The mixture is then heated in a boiling water bath. The mixture is poured into 10ml Na_2CO_3 solution, taken in a beaker.	2) sweet fruity smell.	2) Presence of carboxylic acid ($-COOH$) group is confirmed.

VARIATION OF CELL POTENTIAL IN $Zn|Zn^{2+}||Cu^{2+}|Cu$ WITH CHANGE IN CONCENTRATION OF ELECTROLYTES ($CuSO_4/ZnSO_4$)

Theory :

With increase in concentration of the electrolyte, the reduction potential of an electrode increases —



In case of a Zn-Cu electrochemical cell, zinc electrode acts as the anode and copper electrode acts as the cathode.

EMF of the cell is — $E_{cell} = E_{cathode} - E_{anode}$.

In this equation, it is found that E_{cell} increases with increase in $E_{cathode}$ and decrease in E_{anode} . So for the cell $Zn|Zn^{2+}||Cu^{2+}|Cu$, E_{cell} can be increased by using a higher concentration of Cu^{2+} and a lower concentration of Zn^{2+} .

The relation between the concentration of electrolytes and the standard electrode potential can be found from Nernst Equation :

$$E_{cell} = E_{cell}^{\circ} - \frac{0.059}{n} \log \frac{[M]}{[M^{n+}]} = E_{cell}^{\circ} + \frac{0.059}{n} \log [M^{n+}]$$

(Active mass of solid, $[M] = 1$; E° = standard electrode potential).

► Chemicals : i) 1(M) $ZnSO_4$ solution, ii) 1(M) $CuSO_4$ solution, iii) 0.1 (M) $ZnSO_4$ solution,

iv) 0.1 (M) CuSO_4 solution, v) Clean Zn and Cu-rods.

⇒ Preparation of 0.1 (M) solution : 25 ml of 1 (M) solution is pipetted out and taken in a 250 ml volumetric flask. Remaining volume is made upto the mark with distilled water. Volumetric flask is shaken well to get a homogeneous solution.

● Procedures :

- 1) A beaker (500 ml) is half-filled with 1 (M) CuSO_4 solution.
- 2) The Cu-rod is cleaned with a sand paper and suspended in the copper sulphate (CuSO_4) solution (partially dipped) from a wooden slab.
- 3) A porous pot is half-filled with 1 (M) ZnSO_4 solution. A Zn rod is cleaned with sand paper and partially dipped in the ZnSO_4 solution. The porous pot along with the Zn-rod is suspended from the wooden slab in the CuSO_4 solution in beaker.
- 4) The +ve end of the voltmeter with high internal resistance, is connected to the Cu-rod and the -ve end is connected to the Zn-rod by a conducting wire, with the help of a screw.
- 5) The readings of the voltmeter is taken when the fluctuation of its pointer becomes stable.
- 6) After this, the experiment is repeated taking 0.1 (M) ZnSO_4 and 1 (M) CuSO_4 solution ; 1 (M) ZnSO_4 and 0.1 (M) CuSO_4 ; 0.1 (M) ZnSO_4 and 0.1 (M) CuSO_4 solutions respectively.

● Observations :-

No. of Observations	Concentration of ZnSO_4 solution	Concentration of CuSO_4 solution	EMF of the cell
1	1(M)	1(M)	
2	0.1(M)	1(M)	
3	1(M)	0.1(M)	
4	0.1(M)	0.1(M)	

● Conclusion :-

On decreasing the concentration of ZnSO_4 solution around the Zn-electrode, EMF of the cell increases. On the other hand, on increasing the concentration of CuSO_4 solution around the Cu-electrode, EMF of the cell increases.

WET TEST OF BASIC RADICALS

EXPERIMENT	Observation	INFERENCE
In a test tube, a small amount of the solution is heated with potassium iodide solution.	Golden-yellow precipitate dissolves on heating. Golden sprangles (needle - shaped precipitate) appears on cooling.	$Pb(NO_3)_2 + 2KI \rightarrow PbI_2 \downarrow$ (yellow) + $2KNO_3$ PbI_2 is soluble in hot water but insoluble in cold water.

 Ca^{2+} ion

About 2ml of the solution is taken in a test tube and made alkaline with NH_4OH to which ammonium oxalate solution is added.	Heavy white precipitate soluble in HCl but insoluble in acetic acid.	Precipitate of insoluble calcium oxalate, soluble in HCl. $CaCl_2 + (NH_4)_2C_2O_4 \rightarrow CaC_2O_4 \downarrow + 2NH_4Cl$ $CaC_2O_4 + 2HCl \rightarrow CaCl_2 + H_2C_2O_4$

EXPERIMENT	OBSERVATION	INFERENCE
STRONTIUM (Sr^{2+}) radical		
About 0.2g SrCl_2 is dissolved in 10ml distilled water and the following tests are performed with the solution.	White precipitate.	White precipitate is of strontium sulphate, which is solution in dilute HCl.
2ml solution is taken in a test tube and make alkaline with NH_4OH solution. The solution is then heated with $(\text{NH}_4)_2\text{SO}_4$ solution.		$\text{SrCl}_2 + (\text{NH}_4)_2\text{SO}_4 \rightarrow \text{SrSO}_4 \downarrow + 2\text{NH}_4\text{Cl}$
BARIUM (Ba^{2+}) radical		
About 0.2g BaCl_2 is dissolved in 10ml distilled water. $(\text{NH}_4)_2\text{SO}_4$ solution is added to 2ml solution taken in a test tube.	White precipitate insoluble in HCl	White precipitate is of barium sulphate.
		$\text{BaCl}_2 + (\text{NH}_4)_2\text{SO}_4 \rightarrow \text{BaSO}_4 \downarrow + 2\text{NH}_4\text{Cl}$
MAGNESIUM (Mg^{2+}) radical		
In a 100 ml beaker, 0.2g of magnesium sulphate ($\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$)		

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EXPERIMENT	OBSERVATION	INFERENCE
is dissolved in 10 ml distilled water.		
a) 2 ml of the solution is taken and made alkaline with a solution of NaOH or NH ₃ OH.	a) White precipitate	a) White precipitate is of insoluble magnesium hydroxide. $\text{MgSO}_4 + 2\text{NaOH} \rightarrow \text{Mg(OH)}_2 + \text{Na}_2\text{SO}_4$
b) The ppt obtained shaken with NH ₄ Cl solution.	b) The precipitate dissolves in NH ₄ Cl solution.	b) The precipitate dissolves due to the formation of soluble MgCl ₂ . $\text{Mg(OH)}_2 + 2\text{NH}_4\text{Cl} \rightarrow \text{MgCl}_2 + 2\text{NH}_4\text{OH}$

WET TEST OF ACID RADICALS

EXPERIMENT	OBSERVATION	INFERENCE
CO_3^{2-} radical		
a) About 3ml of Na_2CO_3 solution is taken in a test tube and BaCl_2 solution is added.	a) White precipitate	a) The white precipitate formed is of insoluble BaCO_3 . $\text{Na}_2\text{CO}_3 + \text{BaCl}_2 \rightarrow \text{BaCO}_3 \downarrow + 2\text{NaCl}$
b) Dilute HCl is added to the precipitate.	b) The precipitate dissolves in dilute HCl.	b) BaCO_3 reacts with HCl to give soluble BaCl_2 . $\text{BaCO}_3 + 2\text{HCl} \rightarrow \text{BaCl}_2 + \text{CO}_2 \uparrow + \text{H}_2\text{O}$
S^{2-} radical		
a) AgNO_3 solution is added to 2ml aqueous ammonium sulphide solution.	a) Black precipitate	a) The black ppt. is of silver sulphide. $\text{Na}_2\text{S} + 2\text{AgNO}_3 \rightarrow \text{Ag}_2\text{S} \downarrow + 2\text{NaNO}_3$
b) The ppt. is heated with dilute HNO_3 .	b) The ppt. dissolves in HNO_3 .	b) The ppt. gives soluble silver nitrate. $\text{Ag}_2\text{S} + 2\text{HNO}_3 \rightarrow 2\text{AgNO}_3 + \text{H}_2\text{S} \uparrow$

EXPERIMENT	OBSERVATION	INFERENCE
Cl^- radical		
1) To about 2 ml sample solution, dilute HNO_3 and AgNO_3 solution are added. The sample is ag. NaCl .	Curdy white ppt. is obtained.	The curdy white ppt is of insoluble AgCl . $\text{NaCl} + \text{AgNO}_3 \rightarrow \text{AgCl} \downarrow + \text{NaNO}_3$
a) A part of the ppt. is shaken with HNO_3 .	a) Ppt. does not dissolve.	a) AgCl is insoluble in HNO_3 .
b) The other part of the ppt. is taken in a test tube and shaken with NH_4OH solution.	b) Precipitate dissolves.	b) Due to formation of soluble complex of argento-ammonium chloride. $\text{AgCl} + 2\text{NH}_4\text{OH} \rightarrow [\text{Ag}(\text{NH}_3)_2]\text{Cl} + 2\text{H}_2\text{O}$

 NO_3^- radicals

In a test tube, 2 ml of the zinc nitrate $[\text{Zn}(\text{NO}_3)_2]$ solution is mixed with equal volume of freshly prepared acidified ferrous sulphate solution. The test tube is held inclined to which, conc. H_2SO_4	Brown ring formed at the junction of two liquids.	HNO_3 is reduced by ferrous sulphate to nitric oxide (NO). NO combines with FeSO_4 to give a brown complex of nitrosoferrous sulphate - pentahydrate. $\text{Zn}(\text{NO}_3)_2 + \text{H}_2\text{SO}_4 \rightarrow 2\text{HNO}_3 + \text{ZnSO}_4$
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EXPERIMENT	OBSERVATION	INFERENCE
is poured carefully from the side of test tube. The mix. is cooled under tap water.		$6\text{FeSO}_4 + 2\text{HNO}_3 + 3\text{H}_2\text{SO}_4 \rightarrow 3\text{Fe}_2(\text{SO}_4)_3 + 2\text{NO} + 4\text{H}_2\text{O}$ $\text{FeSO}_4 + \text{NO} + 5\text{H}_2\text{O} \rightarrow [\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^{\text{SO}_4}$ (Brown coloured complex)
	SO_4^{2-} radical	
About 2ml aq. $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ solution in conc. HCl. is taken in a test tube to which barium chloride solution is added.	White ppt. insoluble	The white ppt. is of insoluble BaSO_4 .

EXPERIMENT	OBSERVATION	INFERENCE
is poured carefully from the side of test tube. The mix. is cooled under tap water.		$6\text{FeSO}_4 + 2\text{HNO}_3 + 3\text{H}_2\text{SO}_4 \rightarrow 3\text{Fe}_2(\text{SO}_4)_3 + 2\text{NO} + 4\text{H}_2\text{O}$ $\text{FeSO}_4 + \text{NO} + 5\text{H}_2\text{O} \rightarrow [\text{Fe}(\text{H}_2\text{O})_5\text{NO}]^{\text{SO}_4}$ (Brown coloured complex)
SO_4^{2-} radical	About 2ml ag. $\text{MgSO}_4 \cdot 7\text{H}_2\text{O}$ solution in conc. HCl. is taken in a test tube to which barium chloride solution is added.	White ppt. insoluble The white ppt. is of insoluble BaSO_4 . $\text{MgSO}_4 + \text{BaCl}_2 \rightarrow \text{BaSO}_4 \downarrow + \text{MgCl}_2$ (white)

Date

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DRY TEST FOR ACID RADICALS

EXPERIMENT	OBSERVATION	INFERENCE
	CO_3^{2-} radical	
a) 0.2g Na_2CO_3 sample is taken in a test tube and acidified with dilute HCl or H_2SO_4 .	a) Colourless, odourless gas.	a) Carbonate salts react with dilute acids to liberate CO_2 . $\text{Na}_2\text{CO}_3 + 2\text{HCl} \rightarrow 2\text{NaCl} + \text{CO}_2 \uparrow + \text{H}_2\text{O}$
b) The issuing gas is passed into clear lime water.	b) The lime water initially turns turbid and then transparent.	b) Clear lime water turns turbid due to the formation of insoluble CaCO_3 . $\text{Ca}(\text{OH})_2 + \text{CO}_2 \rightarrow \text{CaCO}_3 \downarrow + \text{H}_2\text{O}$ In presence of excess CO_2 , CaCO_3 forms soluble $\text{Ca}(\text{HCO}_3)_2$ and the solution becomes transparent. $\text{CaCO}_3 + \text{CO}_2 + \text{H}_2\text{O} \rightarrow \text{Ca}(\text{HCO}_3)_2$

EXPERIMENT	OBSERVATION	EXPLANATION
	S^{2-} radical	
About 0.2g Na_2S is taken in a test tube and dilute HCl or H_2SO_4 is added.	Gas with odour of rotten egg evolved.	Sulphite salts reacts with dilute acids to liberate H_2S gas with a rotten egg smell. $Na_2S + 2HCl \rightarrow 2NaCl + H_2S \uparrow$
• Filter paper soaked in lead acetate solution is held in the gas.	• Lead acetate paper turns black.	• Lead acetate reacts with H_2S to give black lead sulphide. $(CH_3COO)_2Pb + H_2S \rightarrow$ \downarrow $(black)PbS \downarrow + 2CH_3COOH$
	Cl^- radical	
In a dry test tube, 0.2g NaCl sample is heated with conc. H_2SO_4 .	Pungent smelling gas.	The pungent smelling gas is of HCl. $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl \uparrow$
a) Moist blue litmus paper held on issuing gas.	2) The blue litmus paper turns red.	a) HCl (acidic gas) turns blue litmus paper red.
b) A glass rod soaked in NH_4OH held on issuing gas.	b) Dense white fumes.	b) HCl and NH_4OH react to give solid NH_4Cl producing dense white fumes. $HCl + NH_4OH \rightarrow NH_4Cl \downarrow + H_2O$

EXPERIMENT	OBSERVATION	INFERENCE
0.2g of the sample is taken in a test tube and heated with concentrated H_2SO_4 .	Brown gas.	Nitrate salts react with concentrated H_2SO_4 to give nitric acid, which at high temperature is decomposed to brown coloured NO_2 gas. $Zn(NO_3)_2 + H_2SO_4 \rightarrow ZnSO_4 + 2HNO_3$ $4HNO_3 \rightarrow 2H_2O + 4NO_2 \uparrow$ (brown) $+ O_2 \uparrow$
	SO_4^{2-} radical	

1 part of the sample is mixed with 4 parts of Na_2CO_3 and heated in a reducing flame in a charcoal block.	Solid residue.	C reduces SO_4^{2-} salt to S^{2-} salt. $MgSO_4 + Na_2CO_3 = MgCO_3 + Na_2SO_4$ $Na_2SO_4 + 4C \rightarrow Na_2S + 4CO \uparrow$