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PHYSICAL CHEMISTRY

REDOX REACTION

Lecture –06

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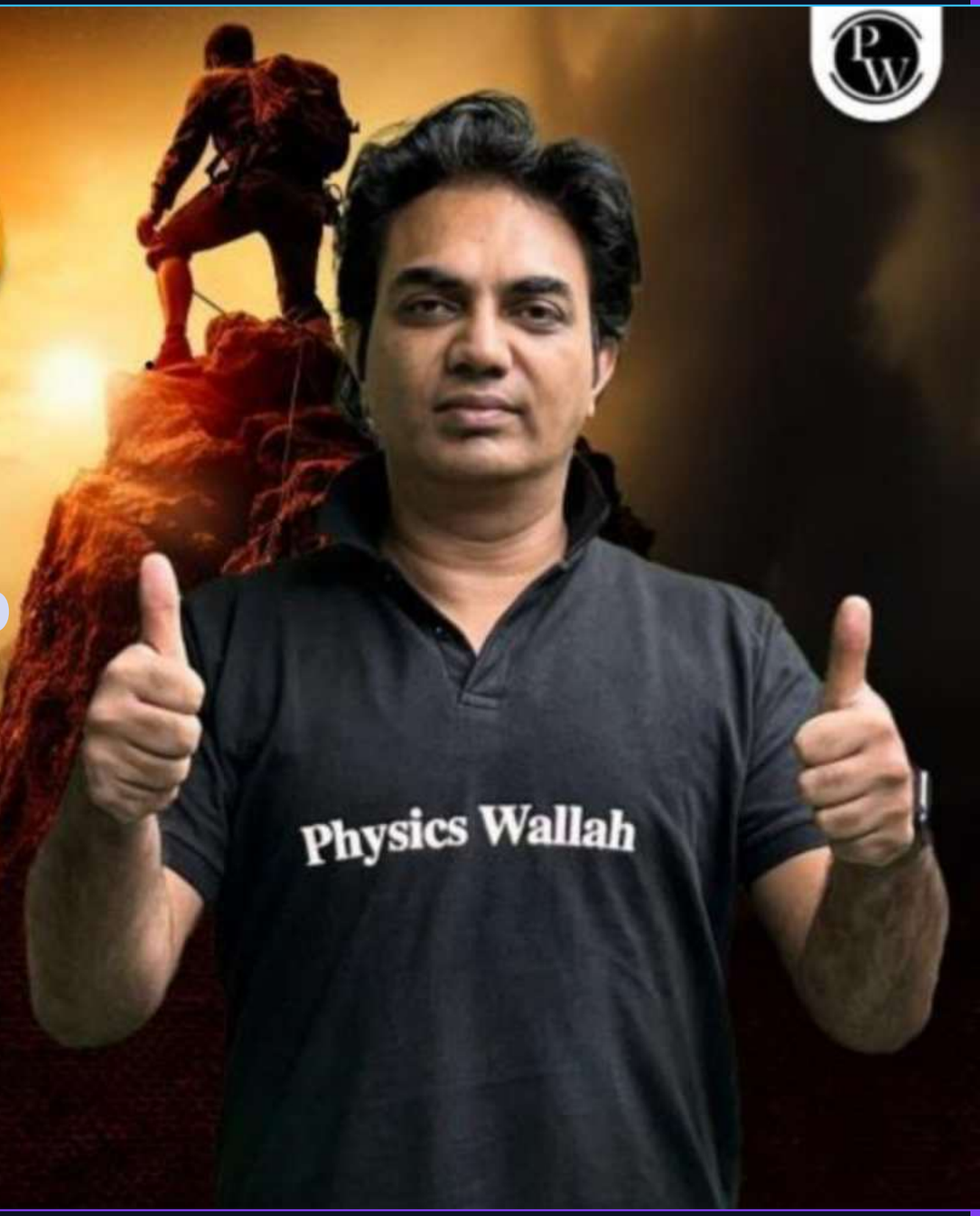

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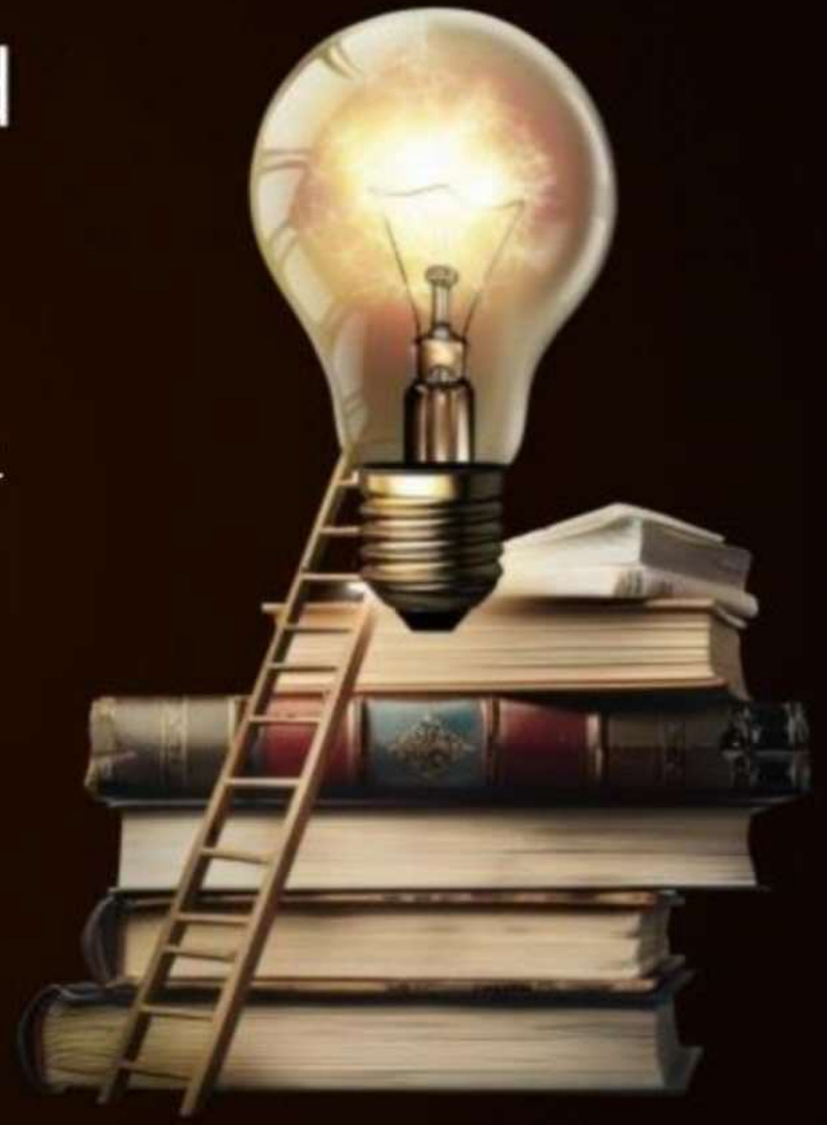
Topics to be covered

A Law of equivalence

B Volume Strength and labelling of oleum



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TELEGRAM GROUP BY FAISAL SIR

@FAISALSIRPW

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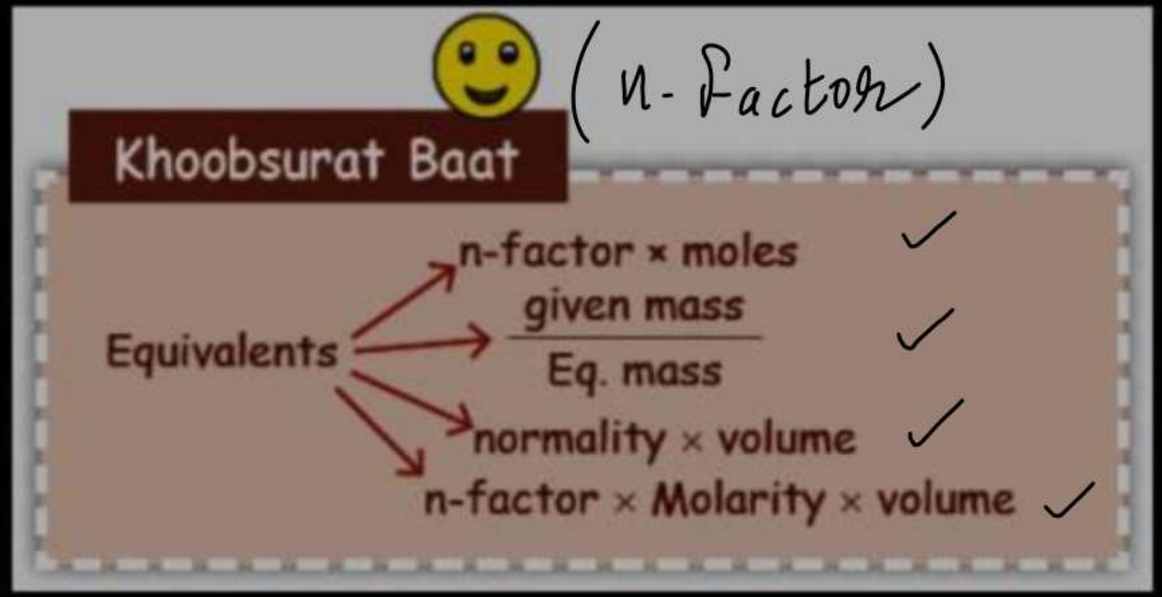

$$\text{Eq. mass} = \frac{\text{Molar mass}}{\text{n-Factor}}$$

$$\text{Normality} = \text{Molarity} \times \text{n-Factor}$$

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Question When metal is burnt with oxygen and weight of oxygen used or wt of oxide formed is given—

$2 \times 2 = 4$

$0 \rightarrow -2$

$$\text{Metal} + O_2 \longrightarrow \text{metal oxide}$$

$x_g \qquad y_g$

$$\text{Eq wt} = \frac{\text{M.wt}}{n} = \frac{32}{4} = 8$$

LOE

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Eq of metal = Eq of Oxygen.

$$\frac{x}{E} = \frac{y}{8}$$

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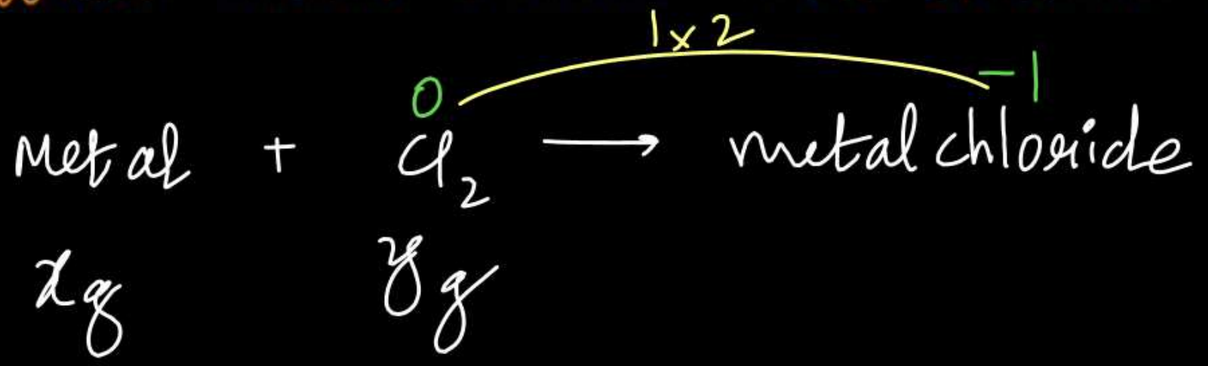
Question When metal reacts with chlorine to give chloride–



LOE

Eq. of metal = Eq. of Chlorine

$$\frac{x}{E} = \frac{g}{35.5}$$

$$\text{Eq wt} = \frac{\text{Mol. wt.}}{n}$$

$$= \frac{71}{2}$$

$$= 35.5$$

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Question

2·2 gm metal reacts with chlorine to form 3·08 g metal chloride. Find out the eq. wt of metal.

3·08
2·20
0·88

metal + Cl_2 ⟶ metal chloride.

2·2 g 0·86 g

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$$\frac{2.2}{E} = \frac{0.88}{35.5}$$

$$E = \frac{35.5 \times 2.2}{0.88}$$

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Question When metal reacts with nitrogen to give its nitride—

Nitride = N^{-3}

$$\text{metal} + \overset{0}{N_2} \xrightarrow{3\times 2} \overset{-3}{\text{metal nitride}}$$

x g y g

Eq wt = $\frac{\text{Mol wt}}{n}$

$= \frac{28}{6}$

LOE

Eq of metal = Eq of nitrogen

$$\frac{x}{E} = \frac{y}{28/6}$$

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Simple Titrations

The aim of simple titration is to find the concentration of an unknown solution with the help of the known concentration of another solution.

(a) Acid-base titrations
(b) Redox titrations

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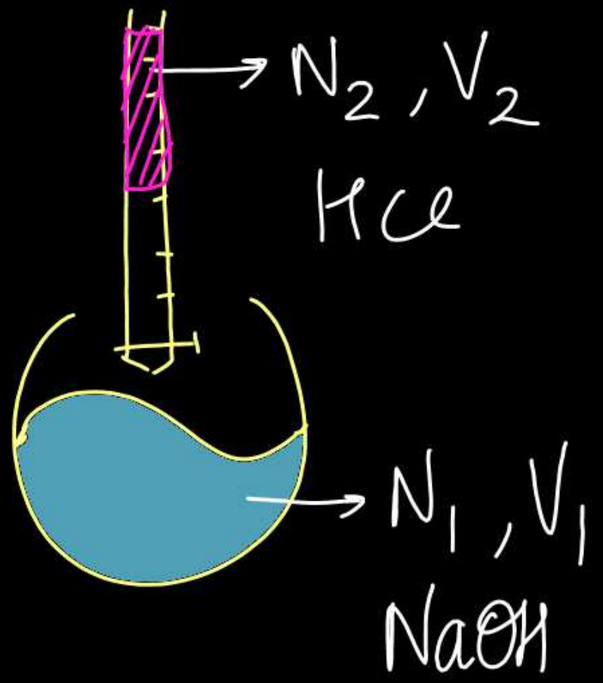
Acid-Base Titration

$N_2 = M_2 \times n_2$

$N_1 = M_1 \times n_1$

$HCl + NaOH \longrightarrow$



LOE

Eq of HCl = Eq of NaOH

$$N_2 V_2 = N_1 V_1$$

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$$n_1 \times M_1 \times V_1 = n_2 \times M_2 \times V_2$$

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Redox Titration

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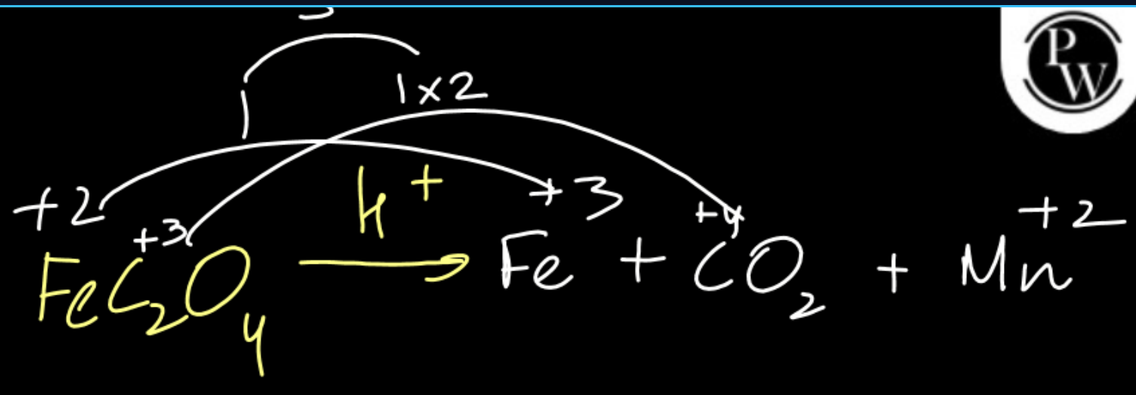

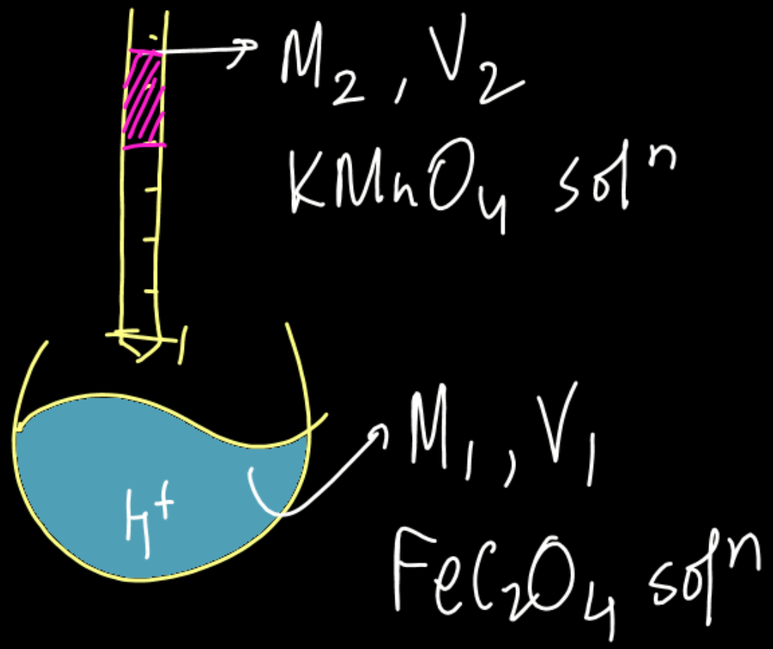

Eq of $KMnO_4$ = Eq of FeC_2O_4

$$n_2 \times M_2 \times V_2 = n_1 \times M_1 \times V_1$$

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Question

Find out the volume of 0·2 M $KMnO_4$ which is used to completely oxidise 1·44 g FeC_2O_4 in acidic medium.

$$KMnO_4 + FeC_2O_4 \xrightarrow{H^+} Fe^{+3} + CO_2 + Mn^{+2}$$

$(n=5)$ $(n=3)$

LOE

$$5 \times 0.2 \times V = \left(\frac{1.44 \times 3}{144}\right)$$

$\Downarrow$ eq $\Downarrow$ eq

$$V = 0.03\ lt = 30\ ml.$$

$$\text{Eq wt} = \frac{\text{Mol wt}}{n} = \frac{144}{3}$$

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74. Only 2 mL of $KMnO_4$ solution of unknown molarity is required to reach the end point of a titration of 20 mL of oxalic acid (2 M) in acidic medium. The molarity of $KMnO_4$ solution should be _____ M.

[04 April, 2024 (Shift-I)]

$$\overset{+7}{KMnO_4} + \overset{+3}{H_2C_2O_4} \longrightarrow \overset{+2}{Mn} + \overset{+4}{CO_2}$$

$(n=5)$ $(n=2)$

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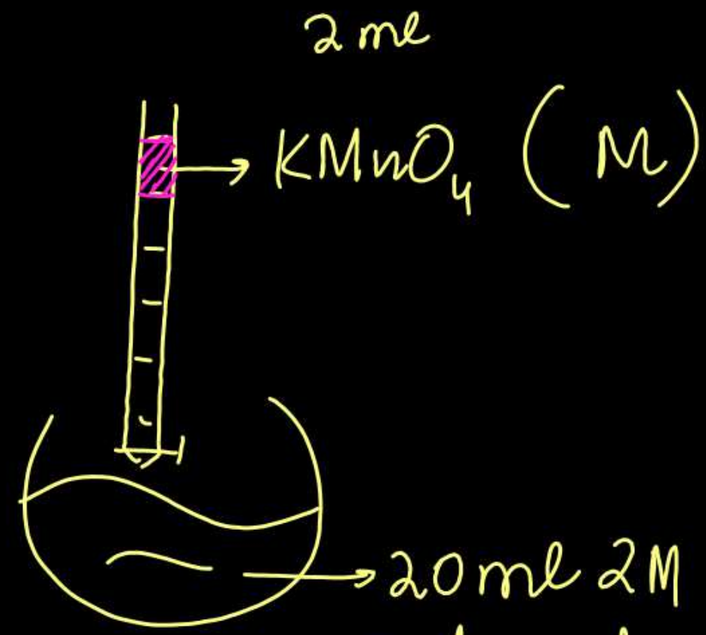
LOE m.eq of $H_2C_2O_4$ = m.eq of $KMnO_4$

$2 \times 2 \times 2 = 5 \times M \times 2$

$M = 8\ M$



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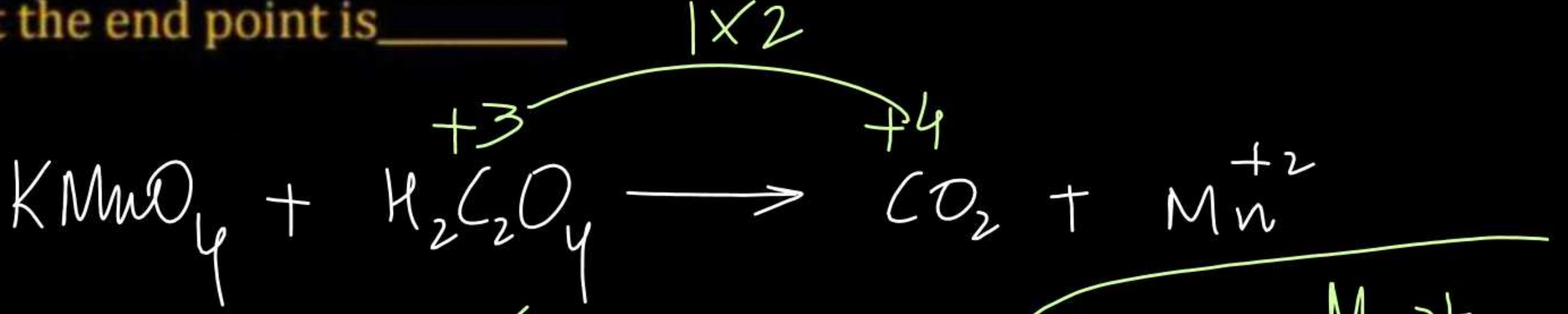
JEE Main 27 July 2022 Shift-1

In the titration of $KMnO_4$ and oxalic acid in acidic medium, the change in oxidation number of carbon at the end point is_____



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change = 1

$$\text{Eq wt} = \frac{\text{M. wt}}{2}$$

$$= \frac{90}{2} = 45$$

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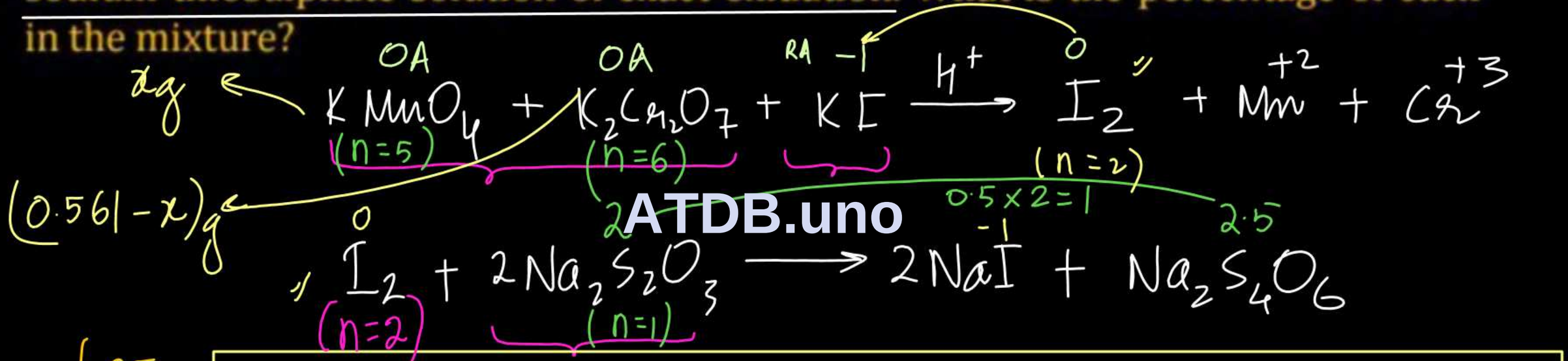
A mixture of pure $K_2Cr_2O_7$ and pure $KMnO_4$ weighing 0.561g was treated with excess of KI in acidic medium. Iodine liberated required 100 ml of 0.15 M of sodium thiosulphate solution of exact oxidation. What is the percentage of each in the mixture?



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LOE

Eq of hypo = Eq of I_2 = Eq of KI = Eq of $KMnO_4$ + Eq of $K_2Cr_2O_7$

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$$\frac{100 \times 0.15 \times 1}{1000} = \frac{x}{\left(\frac{M_{KMnO_4}}{5}\right)} + \frac{(0.561 - x)}{\left(\frac{M_{K_2Cr_2O_7}}{6}\right)}$$

$x = ?$

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K.B.O

$$\underset{x\ \text{eq.}}{A} + \underset{x\ \text{eq}}{B} \longrightarrow C$$

x eq $\longrightarrow \frac{x}{n_1}$ mol. (n_1 = n-factor of C in first Rxn)

$$C + D \longrightarrow E$$

$\frac{x}{n_1}$ mol $\longrightarrow \left(\frac{x}{n_1}\cdot n_2\right)$ eq $\qquad \left(\frac{x}{n_1}\cdot n_2\right)$ eq. (n_2 = n-factor of C in second Rxn)

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Note: if $n_1 = n_2$ then equivalents of A = Eq. of = D = Eq. of E

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Question

If 83 mL of 0.45 M NaOH solution neutralizes a 235 mL HCl solution. Calculate the molarity of the HCl solution.

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Question 2

When 30 ml of acid is neutralized by 15 ml of 0.2 N alkali, the acid concentration is _____

A 0.1 N

B 0.2 N

C 0.3 N

D 0.4 N

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JEE Main 5 Sep 2020 Shift-2

(3)

The volume, in ml, of 0.02 M $K_2Cr_2O_7$ solution required to react with 0.288 g of ferrous oxalate in acidic medium is _____.

(Molar Mass of FeC_2O_4 = 144 g/mol)

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JEE Main 27 July 2022 Shift-1

4

20 mL of 0.02 M $K_2Cr_2O_7$ solution is used for the titration of 10 mL of Fe^{2+} solution in the acidic medium. The molarity of Fe^{2+} solution is _____ $\times 10^{-2}$ M. (Nearest Integer)

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(5)

A 10 g mixture of Cu_2S and CuS was treated with 400 ml of 0.4 M - MnO_4^- in acid solution producing SO_2, Cu^{2+} and Mn^{2+}. The SO_2 was boiled off and the excess of MnO_4^- was titrated with 200 ml of 1 M - Fe^{2+} solution. The percentage of CuS in original mixture is (Cu = 64)

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6

An aqueous solution containing 0.10 g KIO_3 (formula weight = 214.0) was treated with an excess of KI solution. The solution was acidified with HCl. The liberated I_2 consumed 45.0 mL of thiosulphate solution to decolourise the blue strach-iodine complex. Calculate the molarity of the sodium thiosulphate solution.

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JEE Main 26 June 2022 Shift-2

7

20 mL of 0.02 M hypo solution is used for the titration of 10 mL of copper sulphate solution, in the presence of excess of KI using starch as an indicator. The molarity of Cu^{2+} is found to be_____ $\times 10^{-2}$ M [nearest integer]

Given : $2Cu^{2+} + 4I^- \longrightarrow Cu_2I_2 + I_2$

$I_2 + 2S_2O_3^{2-} \longrightarrow 2I^- + S_4O_6^{2-}$

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Question (8)

0.3 g of an oxalate salt was dissolved in 100 mL solution. The solution required 90 mL of N/20 $KMnO_4$ for complete oxidation. The % of oxalate ion in salt is

A 33%

B 66%

C 70%

D 40%

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Question

Molecular masses of NH_3 and N_2 are x_1 and x_2, respectively. In the reaction.

$N_2 + 3H_2 \rightarrow 2NH_3$,

Their equivalent weights are y_1 and y_2. The $(y_1 - y_2)$ is

A $\left(\frac{2x_1 - x_2}{6}\right)$

B $(x_1 - x_2)$

C $(3x_1 - x_2)$

D $(x_1 - 3x_2)$

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10

H_2S (5 moles) reacts completely with acidified aqueous potassium permanganate solution. In this reaction, the number of moles of water produced is x, and the number of moles of electrons involved is y. The value of (x + y) is _____.

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Question

0.7 gm of $Na_2CO_3.xH_2O$ is dissolved in 100 ml, 20 ml of which required 19.8 ml of 0.1 N HCl. The value of x is

A 4

B 3

C 2

D 1

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12

A solution of 0.2 g of a compound containing Cu^{2+} and $C_2O_4^{2-}$ ions on titration with 0.02M $KMnO_4$ in presence of H_2SO_4 consumes 22.6 ml. of the oxidant. The resultant solution in neutralized with Na_2CO_3, acidified with dil. acetic acid and treated with excess KI. The liberated iodine requires 11.3 ml of 0.05M $Na_2S_2O_3$ solution for complete reduction. Find out the molar ratio of Cu^{2+} to $C_2O_4^{2-}$ in the compound.

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13

35. Which of the following options are correct for the reaction

$$2[Au(CN)_2]^-_{(aq)} + Zn(s) \rightarrow 2Au(s) + [Zn(CN_4)]^{-2}_{(aq)}?$$

[6 April, 2023 (Shift-I)]

A. Redox reaction

B. Displacement reaction

C. Decomposition reaction

D. Combination reaction

Choose the correct answer from the options given below:

(A) A and B only (B) A only

(C) C and D only (D) A and D only

Sol. (A) $2[\overset{+1}{Au}(CN)_2]^- + \overset{0}{Zn}(s) \rightarrow 2\overset{0}{Au} + [\overset{+2}{Zn}(CN)_4]^{-2}$

It is a redox reaction in which Zn displaced Au^+

Reduction and Oxidation both are taking place simultaneously.

assan hai yar kyu ghabra jate ho

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58. The equivalent weight of a metal is double that of oxygen. How many times is the weight of its oxide greater than weight of the metal?

(A) 1.5 (B) 2 (C) 0.5 (D) 3

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(a) **Iodimetry:** In these titrations, standard I_2 solution is used to titrate easily oxidisable substances. It includes the estimations of thiosulphates, sulphite arsenite etc.

$$2S_2O_3^{2-} + I_2 \rightarrow S_4O_6^{2-} + 2I^-$$

$$SO_3^{2-} + I_2 + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2I^-$$

$$AsO_3^{3-} + I_2 + H_2O \rightarrow AsO_4^{2-} + 2H^+ + 2I^-$$

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$$H_2S + I_2 \rightarrow S + 2I^- + 2H^+$$

$$Sn^{2+} + I_2 \rightarrow Sn^{4+} + 2I^-$$

$$N_2H_4 + 2I_2 \rightarrow N_2 + 4H^+ + 4I^-$$

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(b) **Iodometry**: In iodiometric titrations, an oxidising agent is allowed to react with excess of KI (or I^-) solution.

It includes the estimations of following species

$$2MnO_4^- + 10I^- + 16H^+ \rightleftharpoons Mn^{+2} + 5I_2 + 8H_2O$$

$$IO_3^- + 5I^- + 6H^+ \rightleftharpoons 3I_2 + 3H_2O$$

The I_2 liberated is titrated with hypo solution ($Na_2S_2O_3$).

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$$I_2 + 2S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$$

I_2, though insoluble in water, remains in solution containing KI as KI_3.

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68. If 83 mL of 0.45 M NaOH solution neutralizes a 235 mL HCl solution, then calculate the molarity of the HCl Solution.

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