PRAYAS

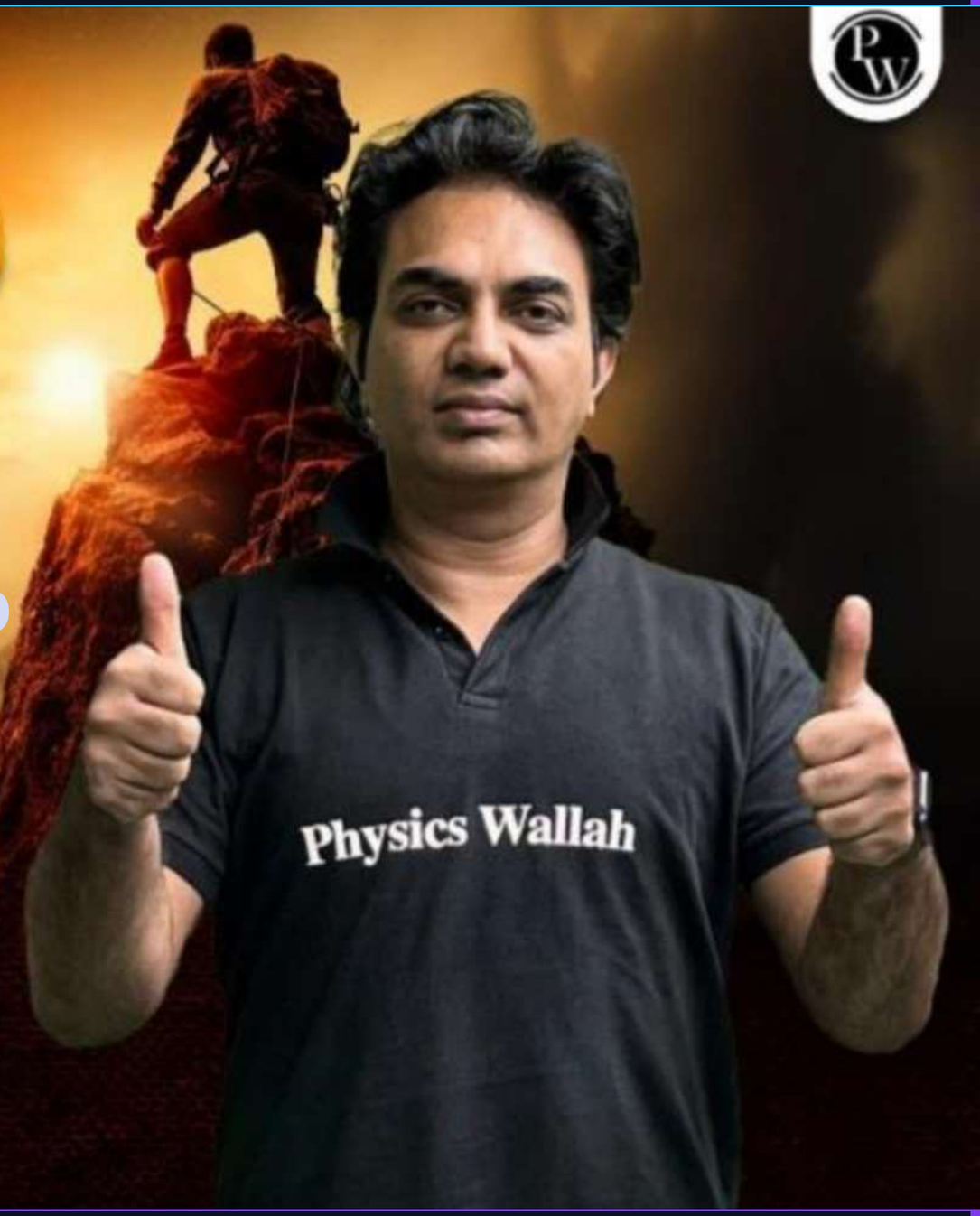
JEE 2026

PHYSICAL CHEMISTRY

Redox Reaction

Lecture – 07

FAISAL RAZAQ



Topics to be covered

A Volume Strength and % Labelling

ATDB.uno

TELEGRAM GROUP BY FAISAL SIR

@FAISALSIRPW

Question

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

eq = n-factor × molarity × vol

N

Acid + Base ⟶

LOE

m·eq of acid = m·eq of base

$N_1V_1 = N_2V_2$

$N \times 30 = 0.2 \times 15$

$N = 0.1\ N$

IIT JEE Adv.

$(10-x)$ g → x g

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)

$$\overset{+2\ -2}{CuS} + \overset{+1\ -2}{Cu_2S} + \overset{+7}{KMnO_4} \xrightarrow{H^+} \overset{+2}{Mn} + \overset{+2}{Cu} + \overset{+4}{SO_2}$$

(n = 6) (n = 8) (n = 5)

$\frac{10-x}{M_{Cu_2S}} \times 8$ $\frac{x}{M_{CuS}} \times 6$

Eq. of $KMnO_4$ = Eq. of Cu_2S + Eq. of CuS

$$\frac{(400 \times 0.4 \times 5) - (200 \times 1 \times 1)}{1000} = \frac{(10-x)}{M_{Cu_2S}} \times 8 + \frac{x}{M_{CuS}} \times 6 \quad \text{— (1)}$$

JEE Main 27 July 2022 Shift-1

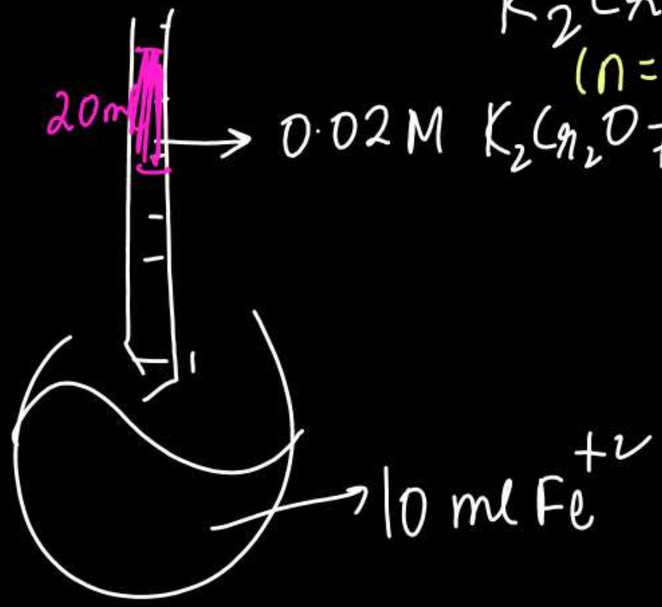
Mohr Salt
Fe^{+2}

$3 \times 2 = 6$

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 ___24___ $\times 10^{-2}$ M. (Nearest Integer)

$$\overset{+6}{K_2Cr_2O_7} + Fe^{+2} \xrightarrow{H^+} Fe^{+3} + \overset{+3}{Cr}$$

$(n=6)$ $(n=1)$



LOE

m.eq of $K_2Cr_2O_7$ = m.eq of Fe^{+2}

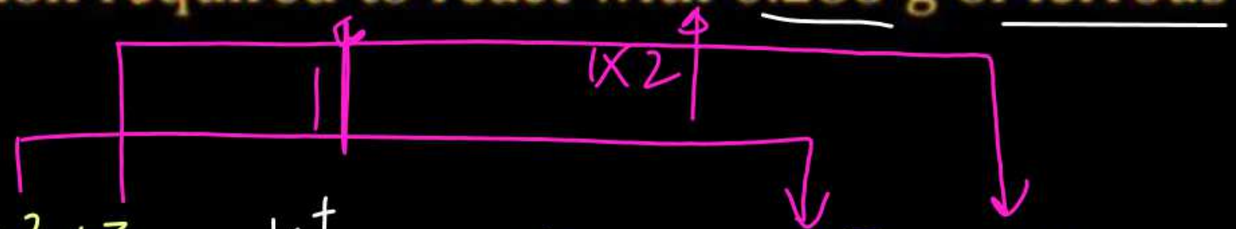
$6 \times 0.02 \times 20 = 1 \times M \times 10$

$M = 0.24$ M

JEE Main 5 Sep 2020 Shift-2

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)



$$\overset{+6}{K_2Cr_2O_7} + \overset{+2\,+3}{FeC_2O_4} \xrightarrow{H^+} \overset{+3}{Cr} + \overset{+3}{Fe} + \overset{+4}{CO_2}$$

$(n = 6)$

LOE

$$\text{Eq of } K_2Cr_2O_7 = \text{Eq. of } FeC_2O_4$$

$$6 \times 0.02 \times V = \frac{0.288}{144/3}$$

$$V = 50 \text{ ml}$$

Balancing Redox Reaction

1. Balance all the atoms other than O and H.
2. Find change in oxidation number in reduction and oxidation and equate them.
3. Balance charge on both the sides.
4. Balance O and H with water.

$Fe^{+2} + Cr_2O_7^{2-} \longrightarrow Fe^{+3} + Cr^{+3}$

Balance in acidic Medium.

Oxidation half : $Fe^{+2} \longrightarrow Fe^{+3} + e^- \times 6$

Reduction half : $6e^- + \overset{+6}{Cr_2}O_7^{2-} \longrightarrow 2Cr^{+3}$

after two steps

$6Fe^{+2} \longrightarrow 6Fe^{+3} + 6e^-$

$14H^+ + 6e^- + Cr_2O_7^{2-} \longrightarrow 2Cr^{+3} + 7H_2O$

$6Fe^{2+} + 14H^+ + Cr_2O_7^{2-} \longrightarrow 6Fe^{+3} + 2Cr^{+3} + 7H_2O$

$MnO_4^- + I^- \longrightarrow MnO_2 + IO_3^-$

Balance in basic medium.

Oxidation half : $I^- \longrightarrow \overset{+5}{I}O_3^- + 6e^-$

Reduction half : $3e^- + \overset{+7}{Mn}O_4^- \longrightarrow \overset{+4}{Mn}O_2 \times 2$

after two steps

$6OH^- + I^- \longrightarrow IO_3^- + 6e^- + 3H_2O$

$4H_2O + 6e^- + 2MnO_4^- \longrightarrow 2MnO_2 + 8OH^-$

$2MnO_4^- + I^- + H_2O \longrightarrow 2MnO_2 + IO_3^- + 2OH^-$

$Br_2 \longrightarrow Br^- + BrO_3^-$

Balance in basic medium.

3. $Br_2 \longrightarrow Br^- + BrO_3^-$

Balance in Basic medium.

$$2e^- + \overset{0}{Br_2} \longrightarrow 2\overset{-1}{Br^-} \quad \times 5$$

$$\overset{0}{Br_2} \longrightarrow 2\overset{+5}{BrO_3^-} + 10\,e^-$$

$$10e^- + 5Br_2 \longrightarrow 10Br^-$$

$$12OH^- + Br_2 \longrightarrow 2BrO_3^- + 10e^- + 6H_2O$$

$$12OH^- + 6Br_2 \longrightarrow 2BrO_3^- + 10Br^- + 6H_2O$$

For the redox reaction

$$MnO_4^- + C_2O_4^{2-} + H^+ \longrightarrow Mn^{2+} + CO_2 + H_2O$$

the correct coefficient of the reactants for the balanced equation are

$$5e^- + \overset{+7}{Mn}O_4^- \longrightarrow \overset{+2}{Mn} \quad \times 2$$

$$\overset{+3}{C_2}O_4^{2-} \longrightarrow 2CO_2 + 2e^- \quad \times 5$$

$$16H^+ + 10e^- + 2MnO_4^- \longrightarrow 2Mn^{2+} + 8H_2O$$

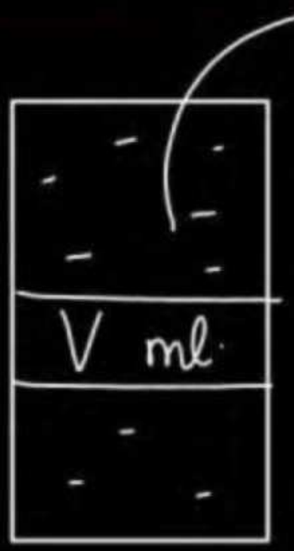
$$5C_2O_4^{2-} \longrightarrow 10CO_2 + 10e^-$$

$$2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \longrightarrow 10CO_2 + 2Mn^{2+} + 8H_2O$$

Volume Strength of H_2O_2

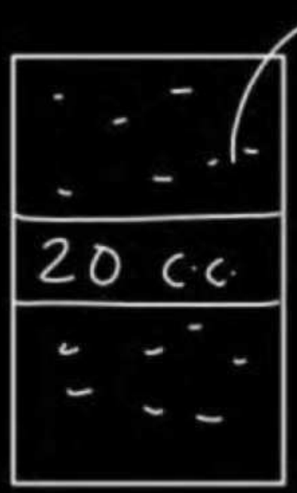
$H_2O_2 \longrightarrow H_2O + O_2$

1 c.c = 1 cm^3 = 1 ml



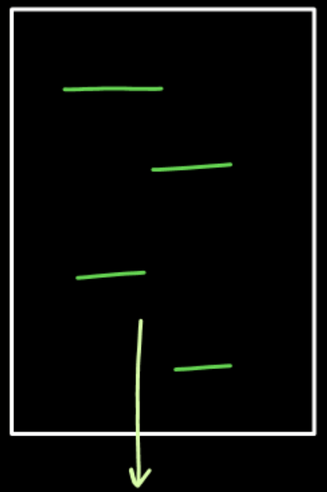
1 ml H_2O_2 solution $\longrightarrow$ O_2

V ml O_2 at STP दबाव |



1 ml H_2O_2 soln $\longrightarrow$ 20 ml O_2 gas at STP.

Volume of O_2 gas produced at STP by the decomposition of 1 ml H_2O_2 solution is known as volume strength of that H_2O_2 solution.



Volume strength = $5.6 \times N$

$V \cdot S = 11.2 \times M$

IIT-JEE 1992

The volume strength of 1.5 N H_2O_2 solution is

(A) 4.8

(B) 8.4

(C) 3.0

(D) 8.0

$V \cdot 5 = 5.6 \times 1.5$

$= 8.40$

IIT-JEE 1995

$V \cdot S = 5 \cdot 6 \times N$

A 5.0 cm^3 solution of H_2O_2 liberates 0.508 g of iodine from an acidified KI solution. Calculate the strength of H_2O_2 solution in terms of volume strength at STP.

$$\overset{-1}{H_2O_2} + \overset{-1}{KI} \longrightarrow \overset{0}{I_2} + \overset{-2}{H_2O}$$

$(n=2)$ $(n=1)$ $(n=2)$

$$\text{Eq wt} = \frac{\text{Mol wt}}{n} = \frac{254}{2} = 127$$

LOE

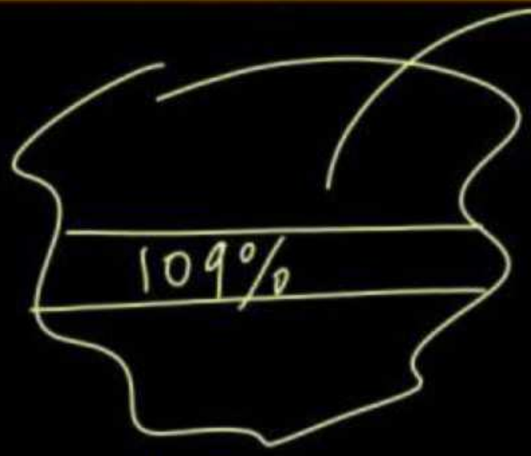
m·eq of H_2O_2 = m·eq of I^- = meq of I_2

$$5 \times N = \frac{0.508}{127} \times 1000 \qquad 4$$

$$N = \frac{4}{5} = 0.8\ N$$

$$V \cdot 5 = 5 \cdot 6 \times N = 5 \cdot 6 \times 0 \cdot 8 = 4 \cdot 48$$

Percentage Labelling of Oleum



dilute

100 gm → 109 gm total H_2SO_4 मिलेगा

Oleum sample ← $H_2S_2O_7$ →

Fuming H_2SO_4 = (H_2SO_4 + SO_3)

$SO_3 + H_2O \longrightarrow (H_2SO_4)$ बना है

(H_2SO_4) पहले से पड़ा है + (H_2SO_4) बना है = % labelling

Question Find out the percentage of free SO_3 in 109% oleum.

Let the sample of oleum = 100g → x g SO_3

→ $(100-x)$ g H_2SO_4 (मुक्त से है)

$1\,SO_3 + H_2O \longrightarrow 1\,H_2SO_4$

x g

$\downarrow$

$\frac{x}{80}$ ⟶ $\left(\frac{x}{80} \times 98\ g\right)$ बना है

$(100-x) + \left(\frac{x \times 98}{80}\right) = 109$

$x = 40$

$\therefore \%\,SO_3 = 40\%$

$9\ gm. = \frac{1}{2}\ mol\ H_2O$

$100\ g \longrightarrow 109\ g.$

$1\ SO_3 + 1\ H_2O \longrightarrow H_2SO_4$

$\frac{1}{2}$ mol water reacts with $\frac{1}{2}$ mol $SO_3 = (40\ g)$

$\% SO_3 = 40\%$

Question find out the labelling of oleum sample having 40% free SO_3.

Minimum labelling of oleum = greater than 100%

assuming 0 g SO_3 + 100 g H_2SO_4 $\xrightarrow{H_2O\ (0\ g)}$ 100 g H_2SO_4

For Maximum labelling ज्यादा से ज्यादा H_2O add करना चाहिये।

assuming 100 g SO_3 + 0 g H_2SO_4 $\xrightarrow{H_2O}$ H_2SO_4 (total)

$\frac{100}{80} \times 98 = 122.5$ g

ATDB.uno

In the following redox equation,

$$xUO^{2+} + Cr_2O_7^{2-} + yH^+ \longrightarrow aUO_2^{2+} + zCr^{+3} + bH_2O$$

the values of coefficients x, y and z respectively,

(1) 3, 8, 2

(2) 3, 8, 7

(3) 3,2,4

(4) 3,1,8

Question

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%

Question

The equivalent weight of Br_2 is 96 in the following disproportionation reaction.

$Br_2 + OH^- \rightarrow Br^- + H_2O + ?$ (Oxidized product)

The oxidation state of Br in the oxidized product is(Br = 80)

IIT JEE Adv.

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.

JEE Adv. 1998

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.

Module - H.W.

Prarambh : 28 to 40

Prabal : 1 to 36.