PHYSICAL CHEMISTRY

REDOX REACTION

Question Stem for Question Nos. 1 and 2

Question Stem

A sample (5.6 g) containing iron is completely dissolved in cold dilute HCl to prepare a 250 mL of solution. Titration of 25.0 mL of this solution requires 12.5 mL of 0.03 M $KMnO_4$ solution to reach the end point. Number of moles of Fe^{2+} present in 250 mL solution is $\mathbf{x} \times 10^{-2}$ (consider complete dissolution of $FeCl_2$). The amount of iron present in the sample of **y%** by weight.

(Assume : $KMnO_4$ reacts only with Fe^{2+} in the solution

Use : Molar mass of iron as 56 g mol^{-1}) **[JEE(Advanced) 2021]**

1. The value of **x** is _____.

2. The value of **y** is _____.

3. In the chemical reaction between stoichiometric quantities of $KMnO_4$ and KI in weakly basic solution, what is the number of moles of I_2 released for 4 moles of $KMnO_4$ consumed? **[JEE(Advanced) 2020]**

4. An acidified solution of potassium chromate was layered with an equal volume of amyl alcohol. When it was shaken after the addition of 1 mL of 3% H_2O_2, a blue alcohol layer was obtained. The blue color is due to the formation of a chromium (VI) compound **'X'** . What is the number of oxygen atoms bonded to chromium through only single bonds in a molecule of **X**? **[JEE(Advanced) 2020]**

5. The amount of water produced (in g) in the oxidation of 1 mole of rhombic sulphur by conc.HNO_3 to a compound with the highest oxidation state of sulphur is _____.

(Given data : Molar mass of water = 18 g mol^{-1}) **[JEE(Advanced) 2019]**

6. To measure the quantity of $MnCl_2$ dissolved in an aqueous solution, it was completely converted to $KMnO_4$ using the reaction,

$MnCl_2 + K_2S_2O_8 + H_2O \rightarrow KMnO_4 + H_2SO_4 + HCl$ (equation not balanced).

Few drops of concentrated HCl were added to this solution and gently warmed. Further, oxalic acid (225 g) was added in portions till the colour of the permanganate ion disappeard. The quantity of $MnCl_2$ (in mg) present in the initial solution is _____.

(Atomic weights in g mol^{-1} : Mn = 55, Cl = 35.5) **[JEE(Advanced) 2018]**

7. In neutral or faintly alkaline solution, 8 moles permanganate anion quantitatively oxidize thiosulphate anions to produce X moles of a sulphur containing product. the magnitude of X is

[JEE(Advanced) 2016]

8. For the reaction

$I^- + ClO^-_3 + H_2SO_4 \rightarrow Cl^- + HSO^-_4 + I_2$

The correct statement(s) in the balanced equation is / are : **[JEE(Advanced) 2014]**

(A) Stoichiometric coefficient of HSO^-_4 is 6 (B) Iodide is oxidized

(C) Sulphur is reduced (D) H_2O is one of the products

9. Hydrogen peroxide in its reaction with KlO_4 and NH_2OH respectively, is acting as a

[JEE(Advanced) 2014]

(A) reducing agent, oxidising agent (B) reducing agent, reducing agent

(C) oxidising agent, oxidising agent (D) oxidising agent, reducing agent

SOLUTIONS

1. Ans. (1.87 or 1.88)

2. Ans. (18.75)

Solution for Q.1 & Q.2

$Fe + 2HCl \longrightarrow FeCl_2 + H_2$

x mole — x mole

Fe^{+2} + $MnO4^{-}$

$\frac{x}{10}$ mole — 12.5 ml

0.03 M

$n_f = 1$ — $n_f = 5$

$\frac{x}{10} = \frac{12.5 \times 0.03 \times 5}{1000}$

x = 0.01875 (x = 1.88 or 1.87)

wt of Fe = 1.05g

% Fe = $\frac{1.05}{5.6} \times 100$ = 18.75

3. Ans. (6)

Sol. $KMnO_4 + KI \longrightarrow MnO_2 + I_2$

Eq of $KMnO_4$ = Eq of I_2

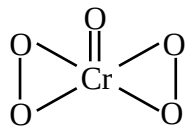
4 × 3 = n × 2

n = 6

4. Ans. (4)

Sol. $K_2CrO_4 + H_2O_2 \xrightarrow[\text{(In acidic medium)}]{\text{Amyl alcohol}} \underset{\substack{(X)\\(\text{Blue liquid})}}{CrO_5}$

Here the structure of CrO_5 is :-



Here, single bonded O-atoms with Cr is = 04

5. Ans. (288.00 to 288.30)

Sol. $S_8 + 48\ HNO_3 \longrightarrow 8H_2SO_4 + 48NO_2 + 16H_2O$

1 mole of rhombic sulphur produce 16 mole of H_2O i.e. 288 gm of H_2O

6. Ans. (126)

Sol. $\underset{a\ mole}{MnCl_2} + K_2S_2O_8 + H_2O \rightarrow \underset{a\ mole}{KMnO_4} + H_2SO_4 + HCl$

$C_2O_4^{--} + MnO_4^{-} \xrightarrow{H^+} CO_2$

m_{eq} of $C_2O_4^{--}$ = m_{eq} of MnO_4^{-}

2 × 0.225/90 = a × 5

a = 1 × [55 + 71] = 126 mg

7. Ans. (6)

Sol. $\overset{+7}{MnO_4^-} + \overset{+2}{S_2O_3^{2-}} \longrightarrow \overset{+4}{MnO_2} + \underset{X}{\overset{+6}{SO_4^{2-}}}$

Equivalents of MnO_4^- = equivalents of SO_4^{2-}

Moles of MnO_4^- × n-factor = moles of SO_4^{2-} × n-factor

$8 \times 3 = X \times 4$

$X = 6$

8. Ans. (A, B, D)

Sol. Oxidation half reaction :

$2I^- \rightarrow I_2 + 2e^-$ ....(1)

Reduction half reaction

$6H^+ + ClO_3^- + 6e^- \rightarrow Cl^- + 3H_2O$ ....(2)

Multiplying equation (1) by 3 and add in (2)

$6I^- + ClO_3^- + 6H^+ \rightarrow Cl^- + 3I_2 + 3H_2O$

$6I^- + ClO_3^- + 6H_2SO_4 \rightarrow Cl^- + 3I_2 + 3H_2O + 6HSO_4^-$

9. Ans. (A)

Sol. $\overset{+7}{H_2O_2} + KIO_4 \longrightarrow O_2 + I$ (with oxidation state lower than 7)

Reducing agent

$\overset{-1}{40NH_2OH} + 10H_2O_2 \longrightarrow 7H_2O + 20\ \overset{+3}{N_2O_3}$

Oxidising agent