Exercise-1

✍ **Marked questions are recommended for Revision.**

PART - I : SUBJECTIVE QUESTIONS

Section (A) : Classical Concept of Equivalent weight / Mass, Equivalent weight, n-factor and Normality for Acid, Base and Precipitate

A-1. Determine the equivalent weight of the following ions :
(a) Na^+ (b) Al^{3+} (c) NO^+ (d) Cl^-
(e) CO_3^{2-} (f) SO_4^{2-} (g) PO_4^{3-}

A-2. Determine the equivalent weights of the following salts :
(a) NaCl (b) K_2SO_4 (c) $Ca_3(PO_4)_2$

A-3.✍ 1.12 litre dry chlorine gas at STP was passed over a heated metal when 5.56 g of chloride of the metal was formed. What is the equivalent weight of the metal?

Section (B) : Equivalent weight, n-factor and Normality for Oxidant and Reductant

B-1.✍ A mixture of CuS (molecular weight = M_1) and Cu_2S (molecular weight = M_2) is oxidised by $KMnO_4$ (molecular weight = M_3) in acidic medium, where the product obtained are Cu^{2+}, Mn^{2+} and SO_2. Find the equivalent weight of CuS, Cu_2S and $KMnO_4$ respectively.

B-2. Determine the equivalent weight of the following oxidising and reducing agents :
(a) $KMnO_4$ (reacting in acidic medium $MnO_4^- \longrightarrow Mn^{2+}$)
(b) $KMnO_4$ (reacting in neutral medium $MnO_4^- \longrightarrow MnO_2$)

Section (C) : Equivalent Concept for Acid Base Titration and Precipitation Reactions

C-1. 0.98 g of the metal sulphate was dissolved in water and excess of barium chloride was added. The precipitated barium sulphate weighted 0.95 g. Calculate the equivalent weight of the metal.

C-2. A dilute solution of H_2SO_4 is made by adding 5 mL of 3N H_2SO_4 to 245 mL of water. Find the normality and molarity of the diluted solution.

C-3.✍ What volume at NTP of gaseous ammonia will be required to be passed into 30 cm^3 of 1 N H_2SO_4 solution to bring down the acid strength of the latter to 0.2 N ?

Section (D) : Equivalent Concept for Redox reactions, $KMnO_4$ / $K_2Cr_2O_7$ v/s Reducing Agents & their Redox Titration

D-1.✍ 1.60 g of a metal A and 0.96 g of a metal B when treated with excess of dilute acid, separately, produced the same amount of hydrogen. Calculate the equivalent weight of A if the equivalent weight of B is 12.

D-2. It requires 40 mL of 1 M Ce^{4+} to titrate 20 mL of 1M Sn^{2+} to Sn^{4+}. What is the oxidation state of the Cerium in the product ?

D-3. 25 mL of a solution of Fe^{2+} ions was titrated with a solution of the oxidizing agent $Cr_2O_7^{2-}$. 50 mL of 0.01 M $K_2Cr_2O_7$ solution was required. What is the molarity of the Fe^{2+} solution ?

D-4.✍ How many mL of 0.3M $K_2Cr_2O_7$ (acidic) is required for complete oxidation of 5 mL of 0.2 M SnC_2O_4 solution.

Section (E) : Iodometric/Iodimetric Titration, Calculation of Available Chlorine from a sample of Bleaching Powder

E-1. 10 g sample of bleaching powder was dissolved into water to make the solution one litre. To this solution 35 mL of 1.0 M Mohr salt solution was added containing enough H_2SO_4. After the reaction was complete, the excess Mohr salt required 30 mL of 0.1 M $KMnO_4$ for oxidation. The % of available Cl_2 approximately is (mol wt = 71)

E-2. A mixture containing As_2O_3 and As_2O_5 required 20 mL of 0.05 N iodine solution for titration. The resulting solution is then acidified and excess of KI was added. The liberated iodine required 1.116 g hypo ($Na_2S_2O_3.5H_2O$) for complete reaction. Calculate the mass of the mixture. The reactions are:

$As_2O_3 + 2I_2 + 2H_2O \longrightarrow As_2O_5 + 4H^+ + 4I^-$

$As_2O_5 + 4H^+ + 4I^- \longrightarrow As_2O_3 + 2I_2 + 2H_2O$ (Atomic weight : As = 75)

Section (F) : Volume strength of H_2O_2, Hardness of water

F-1. 20 ml of H_2O_2 after acidification with dil H_2SO_4 required 30 ml of $\frac{N}{12}$ $KMnO_4$ for complete oxidation. Detemine the strength of H_2O_2 solution.

F-2. A 100 mL sample of water was treated to convert any iron present to Fe^{2+}. Addition of 25 mL of 0.002 M $K_2Cr_2O_7$ resulted in the reaction :

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

The excess $K_2Cr_2O_7$ was back-titrated with 7.5 mL of 0.01 M Fe^{2+} solution. Calculate the parts per million (ppm) of iron in the water sample.

F-3. By which reason temporary and permanent hardness occur ?

F-4. Define two method by which we can soften the water sample.

PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A) : Classical Concept of Equivalent weight / Mass, Equivalent weight, n-factor and Normality for Acid, Base and Precipitate

A-1. x g of the metal gave y g of its oxide. Hence equivalent weight of the metal

(A) $\frac{y-x}{x} \times 8$ (B) $\frac{x}{(y-x)} \times 8$ (C) $\frac{x}{y} \times 8$ (D) $\frac{x+y}{x} \times 8$

A-2. Equivalent wt. of H_3PO_4 in each of the reaction will be respectively -

$H_3PO_4 + OH^- \rightarrow H_2PO_4^- + H_2O$

$H_3PO_4 + 2OH^- \rightarrow HPO_4^{2-} + 2H_2O$

$H_3PO_4 + 3OH^- \rightarrow PO_4^{3-} + 3H_2O$

(A) 98, 49, 32.67 (B) 49, 98, 32, 67 (C) 98, 32.67, 49 (D) 32.67, 49, 98

A-3. 3 g of an oxide of a metal is converted to chloride completely and it yielded 5 g of chloride. Equivalent weidht of the metal is :

(A) 33.25 (B) 3.325 (C) 12 (D) 20

Section (B) : Equivalent weight, n-factor and Normality for Oxidant and Reductant

B-1. An ion is reduced to the element when it absorbs 6×10^{20} electrons. The number of equivalents of the ion is:

(A) 0.1 (B) 0.01 (C) 0.001 (D) 0.0001

B-2. When N_2 is converted into NH_3, the equivalent weight of nitrogen will be :
(A) 1.67 (B) 2.67 (C) 3.67 (D) 4.67

B-3. In the ionic equation $2K^+BrO_3^- + 12H^+ + 10e^- \longrightarrow Br_2 + 6H_2O + 2K^+$, the equivalent weight of $KBrO_3$ will be:
(A) M/5 (B) M/2 (C) M/6 (D) M/4
(where M = molecular weight of $KBrO_3$)

Section (C) : Equivalent Concept for Acid Base Titration and Precipitation Reactions

C-1. If one mole of H_2SO_4 reacts with one mole of NaOH, equivalent weight of H_2SO_4 will be :
(A) 98 (B) 49 (C) 96 (D) 48

C-2. How many millilitres of 0.1N H_2SO_4 solution will be required for complete reaction with a solution containing 0.125 g of pure Na_2CO_3 :
(A) 23.6 mL (B) 25.6 mL (C) 26.3 mL (D) 32.6 mL

C-3. One litre of a solution contains 18.9 g of HNO_3 and one litre of another solution contains 3.2 g of NaOH. In what volume ratio must these solution be mixed to obtain a neutral solution?
(A) 3 : 8 (B) 8 : 3 (C) 15 : 4 (D) 4 : 15

Section (D) : Equivalent Concept for Redox reactions, $KMnO_4$ / $K_2Cr_2O_7$ v/s Reducing Agents & their Redox Titration

D-1. If equal volumes of 0.1 M $KMnO_4$ and 0.1 M $K_2Cr_2O_7$ solutions are allowed to oxidise Fe^{2+} to Fe^{3+} in acidic medium, then Fe^{2+} oxidised will be :
(A) more by $KMnO_4$ (B) more by $K_2Cr_2O_7$
(C) equal in both cases (D) cannot be determined.

D-2. Which of the following solutions will exactly oxidize 25 mL of an acid solution of 0.1 M iron (II) oxalate:
(A) 25 mL of 0.1 M $KMnO_4$ (B) 25 mL of 0.2 M $KMnO_4$
(C) 25 mL of 0.6 M $KMnO_4$ (D) 15 mL of 0.1 M $KMnO_4$

D-3. An element A in a compound ABD has oxidation number –n. It is oxidised by $Cr_2O_7^{2-}$ in acid medium. In the experiment, 1.68×10^{-3} moles of $K_2Cr_2O_7$ were used for 3.36×10^{-3} moles of ABD. The new oxidation number of A after oxidation is :
(A) 3 (B) 3 – n (C) n – 3 (D) +n

D-4. The number of moles of oxalate ions oxidized by one mole of MnO_4^- ion in acidic medium is :
(A) 5/2 (B) 2/5 (C) 3/5 (D) 5/3

Section (E) : Iodometric/Iodimetric Titration, Calculation of Available Chlorine from a sample of Bleaching Powder

E-1. What can be the maximum percentage of available chlorine possible in a given bleaching powder sample (Take formula of bleaching powder as $CaOCl_2$) ?
(A) 52.9% (B) 55.9 % (C) 58% (D) 60%

E-2. A 0.2 g sample containing copper (II) was analysed iodometrically, where copper(II) is reduced to copper (I) by iodide ions. $2Cu^{2+} + 4I^- \longrightarrow 2\,CuI + I_2$
If 20 mL of 0.1 M $Na_2S_2O_3$ solution is required for titration of the liberated iodine, then the percentage of copper in the sample will be :
(A) 31.75 % (B) 63.5 % (C) 53 % (D) 37 %

Section (F) : Volume strength of H_2O_2, Hardness of water

F-1. A substance which participates readily in both acid-base and oxidation-reduction reactions is :
(A) Na_2CO_3 (B) KOH (C) $KMnO_4$ (D) $H_2C_2O_4$

F-2._ A fresh H_2O_2 solution is labeled as 11.2 V. Calculate its concentration in wt/vol percent.
(A) 3.4 (B) 6.8 (C) 1.7 (D) 13.6

F-3.✍ The amount of lime, $Ca(OH)_2$ required to remove the hardness in 60 L of pond water containing 1.62 mg of calcium bicarbonate per 100 ml of water, will be :
(A) 4.44 g (B) 0.222 g (C) 2.22 g (D) 0.444 g

F-4. What will the concentration of $[Ca^{+2}]$ in a sample of 1 litre hard water if after treatment with washing soda 10 g insoluable $CaCO_3$ is precipitated.
(A) 0.2 M (B) 0.1 M (C) 0.3 M (D) 0.4 M

PART - III : MATCH THE COLUMN

1.

Column I	**Column II**
(A) 4.1 g H_2SO_3	(p) 200 mL of 0.5 N base is used for complete neutralization
(B) 4.9 g H_3PO_4	(q) 200 millimoles of oxygen atoms
(C) 4.5 g oxalic acid ($H_2C_2O_4$)	(r) Central atom is in its highest oxidation number
(D) 5.3 g Na_2CO_3	(s) May react with an oxidising agent

Exercise-2

✍ **Marked questions are recommended for Revision.**

PART - I : ONLY ONE OPTION CORRECT TYPE

1.✍ 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

2. Oxalic acid, $H_2C_2O_4$, reacts with paramagnet ion according to the balanced equation $5H_2C_2O_4$ (aq) + $2MnO_4^-$ (aq) $\rightleftharpoons$ 2 Mn^{2+} (aq) + 10 CO_2 (g) + 8 H_2O (l). The volume in mL of 0.0162 M $KMnO_4$ solution required to react with 25.0 mL of 0.022 M $H_2C_2O_4$ solution is :
(A) 13.6 (B) 18.5 (C) 33.8 (D) 84.4

3.✍ x mmol of $KMnO_4$ react completely with y mmol of $MnSO_4$ in presence of fluoride ions to give MnF_4 quantitatively. Then :
(A) x = y (B) 4x = y (C) x > y (D) x < y

4.✍ 1 mol each of H_3PO_2, H_3PO_3 and H_3PO_4 will neutralise respectively x mol of NaOH, y mol of $Ca(OH)_2$ and z mol of $Al(OH)_3$ (assuming all as strong electrolytes). x, y, z are in the ratio of :
(A) 3 : 1.5 : 1 (B) 1 : 2 : 3 (C) 3 : 2 : 1 (D) 1 : 1 : 1

5. The amount of wet NaOH containing 15% water required to prepare 70 litres of 0.5 N solution is :
(A) 1.65 kg (B) 1.4 kg (C) 16.5 kg (D) 140 kg

6.✍ $28\,NO_3^- + 3As_2S_3 + 4H_2O \longrightarrow 6AsO_4^{3-} + 28NO + 9SO_4^{2-} + 8H^+$.
What will be the equivalent mass of As_2S_3 in above reaction : (Molecular mass of As_2S_3 = M)
(A) $\frac{M}{2}$ (B) $\frac{M}{4}$ (C) $\frac{M}{24}$ (D) $\frac{M}{28}$

7. If 25 mL of a H_2SO_4 solution reacts completely with 1.06 g of pure Na_2CO_3, what is the normality of this acid solution :
(A) 1 N (B) 0.5 N (C) 1.8 N (D) 0.8 N

8. 125 mL of 63% (w/v) $H_2C_2O_4.2H_2O$ solution is made to react with 125 mL of a 40%(w/v) NaOH solution. The resulting solution is: (ignoring hydrolysis of ions)
(A) neutral (B) acidic (C) strongly acidic (D) alkaline

9. 25 mL of a 0.1 M solution of a stable cation of transition metal Z reacts exactly with 25 mL of 0.04 M acidified $KMnO_4$ solution. Which of the following is most likely to represent the change in oxidation state of Z correctly :
(A) $Z^+ \rightarrow Z^{2+}$ (B) $Z^{2+} \rightarrow Z^{3+}$ (C) $Z^{3+} \rightarrow Z^{4+}$ (D) $Z^{2+} \rightarrow Z^{4+}$

10. How many litres of Cl_2 at STP will be liberated by the oxidation of NaCl with 10 g $KMnO_4$ in acidic medium: (Atomic weight : Mn = 55 and K = 39)
(A) 3.54 (B) 7.08 (C) 1.77 (D) None of these

11. One gram of Na_3AsO_4 is boiled with excess of solid KI in presence of strong HCl. The iodine evolved is absorbed in KI solution and titrated against 0.2 N hypo solution. Assuming the reaction to be

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

calculate the volume of hypo consumed. [Atomic weight of As = 75]
(A) 48.1 mL (B) 38.4 mL (C) 24.7 mL (D) 30.3 mL

12. If 10 g of V_2O_5 is dissolved in acid and is reduced to V^{2+} by zinc metal, how many mole of I_2 could be reduced by the resulting solution, if it is further oxidised to VO^{2+} ions :
[Assume no change in state of Zn^{2+}ions] (Atomic masses : V = 51, O = 16, I = 127)
(A) 0.11 (B) 0.22 (C) 0.055 (D) 0.44

13. During the disproportionation of Iodine to iodide and iodate ions, the ratio of iodate and iodide ions formed in alkaline medium is :
(A) 1 : 5 (B) 5 : 1 (C) 3 : 1 (D) 1 : 3

14. If 1 mL of a $KMnO_4$ solution react with 0.140 g Fe^{2+} and if 1 mL of KHC_2O_4. $H_2C_2O_4$ solution react with 0.1mL of previous $KMnO_4$ solution, how many millilitres of 0.20 M NaOH will react with 1 mL of previous KHC_2O_4. $H_2C_2O_4$ solution in which all the protons (H^+) are ionisable ?
(A)15/16 mL (B) 13/16 (C) 11/14 (D) None of these

PART - II : NUMERICAL VALUE TYPE

1. How many equivalents of Mg would have to react in order to liberate 4 N_A electrons? ($Mg – 2e^- \rightarrow Mg^{2+}$)

2. A certain weight of pure $CaCO_3$ is made to react completely with 20 mL of a HCl solution to give 224 mL of CO_2 gas at STP. The normality of the HCl solution is:

3. The volume of 3 M $Ba(OH)_2$ solution required to neutralize complety 120 mL of 1.5M H_3PO_4 solution is:

4. In an experiment, 50 mL of 0.1 M solution of a salt reacted with 25 mL of 0.1 M solution of sodium sulphite. The half equation for the oxidation of sulphite ion is :

$$SO_3^{2-} (aq) + H_2O \longrightarrow SO_4^{2-} (aq) + 2H^+ + 2e^-$$

If the oxidation number of metal in the salt was 3, what would be the new oxidation number of metal :

5. When tetracarbonylnickel(0) is heated, it dissociates into its components. If 5 moles of this compound is heated and the resulting gaseous component is absorbed by sufficient amount of I_2O_5, liberating I_2. What volume of 4M Hypo solution will be required to react with this I_2 : $Ni(CO)_4 \xrightarrow{\Delta} Ni + 4CO$

6. 1 mole of OH^- ions is obtained from 85 g of hydroxide of a metal. What is the equivalent weight of the metal?

7. An oxide of a metal contains 40% oxygen, by weight. What is the equivalent weight of the metal?

8. In the following reaction, $3Fe + 4H_2O \longrightarrow Fe_3O_4 + 4H_2$, if the atomic weight of iron is 56, then its equivalent weight will be :

9. What volume of 0.05 M $Ca(OH)_2$ solution is needed for complete conversion of 10 mL of 0.1 M H_3PO_4 into $Ca(H_2PO_4)_2$?

10. Potassium acid oxalate $K_2C_2O_4.3H_2C_2O_4.4H_2O$ can be oxidized by MnO_4^- in acid medium. Calculate the volume of (in mL) 1 M $KMnO_4$ reacting in acid solution with 5.08 gram of the acid oxalate.

11. In the following reaction, SO_2 acts as a reducing agent :

$$SO_2 + Cl_2 + 2H_2O \longrightarrow H_2SO_4 + 2HCl$$

Find the equivalent weight of SO_2.

PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. In the titration of $K_2Cr_2O_7$ and ferrous sulphate, following data is obtained :
V_1 mL of $K_2Cr_2O_7$ solution of molarity M_1 requires V_2 mL of $FeSO_4$ solution of molarity M_2.
Which of the following relations is/are true for the above titration :
(A) $6 M_1V_1 = M_2V_2$ (B) $M_1V_1 = 6 M_2V_2$ (C) $N_1V_1 = N_2V_2$ (D) $M_1V_1 = M_2V_2$

2. Choose the correct statement(s) :
(A) 1 mole of MnO_4^- ion can oxidise 5 moles of Fe^{2+} ion in acidic medium.
(B) 1 mole of $Cr_2O_7^{2-}$ ion can oxidise 6 moles of Fe^{2+} ion in acidic medium.
(C) 1 mole of Cu_2S can be oxidised by 1.6 moles of MnO_4^- ion in acidic medium.
(D) 1 mole of Cu_2S can be oxidised by 1.33 moles of $Cr_2O_7^{2-}$ ion in acidic medium.

3. Which of the following samples of reducing agents is /are chemically equivalent to 25 mL of 0.2 N $KMnO_4$ to be reduced to Mn^{2+} and water :
(A) 25 mL of 0.2 M $FeSO_4$ to be oxidized to Fe^{3+}
(B) 50 mL of 0.1 M H_3AsO_3 to be oxidized to H_3AsO_4
(C) 25 mL of 0.1 M H_2O_2 to be oxidized to H^+ and O_2
(D) 25 mL of 0.1 M $SnCl_2$ to be oxidized to Sn^{4+}

4. To a 25 ml H_2O_2 solution excess acidified solution of KI was added. The iodine liberated 20 ml of 0.3 N sodium thiosulphate solution. Use these data to choose the correct statements from the following :
(A) The weight of H_2O_2 present in 25 ml solution is 0.102 g
(B) The molarity of H_2O_2 solution is 0.12 M
(C) The weight of H_2O_2 present in 1 L of the solution is 0.816 g
(D) The volume strength of H_2O_2 is 1.344 L

5. There are two sample of HCl having molarity 1N and 0.25 N. Find volume of these sample taken in order to prepare 0.75 N HCl solution. (Assume no water is used) :
(A) 20 mL, 10 mL (B) 100 mL, 50 mL (C) 40 mL, 20 mL (D) 50 mL, 25 mL

6. If mass of KHC_2O_4 (potassium acid oxalate) required to reduce 100 mL of 0.02 M $KMnO_4$ in acidic medium is x g and to neutralise 100 mL of 0.05 M $Ca(OH)_2$ is y g, then which of the following options may be correct :
(A) 2x = y (B) x = 2y
(C) x = y (D) absolute values of x & y cannot be determined.

PART - IV : COMPREHENSION

Read the following passage carefully and answer the questions.

Comprehension # 1

Equivalent Mass :

The equivalent mass of a substance is defined as the number of parts by mass of it which combine with or displace 1.0078 parts by mass of hydrogen, 8 parts by mass of oxygen and 35.5 parts by mass of chlorine.

The equivalent mass of a substance expressed in grams is called **gram equivalent mass.**

The equivalent mass of a substance is not constant. It depends upon the reaction in which the substance is participating. A compound may have different equivalent mass in different chemical reactions and under different experimental conditions.

(A) Equivalent mass of an acid : It is the mass of an acid in grams which contains 1.0078 g of replaceable H^+ ions or it is the mass of acid which contains one mole of replaceable H^+ ions. It may be calculated as :

$$\text{Equivalent mass of acid} = \frac{\text{Molecular mass of acid}}{\text{Basicity of acid}}$$

Basicity of acid = number of replaceable hydrogen atoms present in one molecule of acid

(B) Equivalent mass of a base : It is the mass of the base which contains one mole of replaceable OH^- ions in molecule.

$$\text{Equivalent mass of base} = \frac{\text{Molecular mass of base}}{\text{Aciditiy of base}}$$

Acidity of base = Number of replaceable OH^- ions present in one molecule of the base

Equivalent mass of an oxidising agent :

(a) Electron concept : Equivalent mass of oxidising agent = $\frac{\text{Molecular mass of oxidising agent}}{\text{Number of electrons gained by one molecule}}$

(b) Oxidation number concept : Equivalent mass of oxidising agent = $\frac{\text{Molecular mass of oxidising agent}}{\text{Total change in oxidation number per molecule of oxidising agent}}$

1. Equivalent mass of $Ba(MnO_4)_2$ in acidic medium is : (where M stands for molar mass)
(A) M/5 (B) M/6 (C) M/10 (D) M/2

2. Equivalent mass of $Fe_{0.9}O$ in reaction with acidic $K_2Cr_2O_7$ is : (M = Molar mass)
(A) 7 M/10 (B) 10 M/7 (C) 7 M/9 (D) 9 M/7

3. Equivalent weight of oxalic acid salt in following reaction is : (Atomic masses : O = 16, C = 12, K = 39)
$H_2C_2O_4 + Ca(OH)_2 \longrightarrow CaC_2O_4 + H_2O$
(A) 90 (B) 45 (C) 64 (D) 128

Comprehension # 2

Some amount of "20V" H_2O_2 is mixed with excess of acidified solution of KI. The iodine so liberated required 200 mL of 0.1 N $Na_2S_2O_3$ for titration.

4. The volume of H_2O_2 solution is :
(A) 11.2 mL (B) 37.2 mL (C) 5.6 mL (D) 22.4 mL

5. The mass of $K_2Cr_2O_7$ needed to oxidise the above volume of H_2O_2 solution is :
(A) 3.6 g (B) 0.8 g (C) 4.2 g (D) 0.98 g

6. The volume of O_2 at STP that would be liberated by above H_2O_2 solution on disproportionation is :
(A) 56 mL (B) 112 mL (C) 168 mL (D) 224 mL

Comprehension # 3

Answer Q.7, Q.8 and Q.9 by appropriately matching the information given in the three columns of the following table.

Equivalent weight = $\frac{\text{Molecular weight / Atomic weight}}{\text{n} - \text{factor}}$ n-factor is very important in redox as well as non-redox reactions.

In general n-factor of acid/base is number of moles of H^+/OH^- furnished per mole of acid/base. n-factor of reactions is number of moles of electrons lost or gained per mole of reactant columns 1, 2, 3 contain reactions, n-factor & equivalent weight respectively.

Column-1		Column-2		Column-3	
(I)	$MnO_4^- + 2H_2O \longrightarrow MnO_2 + 4OH^-$	(i)	1	(P)	158
(II)	$MnO_4^- \longrightarrow MnO_4^{-2}$	(ii)	$\frac{10}{6}$	(Q)	96
(III)	$Br_2 + OH^- \longrightarrow BrO_3^- + Br^-$	(iii)	3	(R)	34
(IV)	$H_2O_2 \longrightarrow O_2 + H_2O$	(iv)	2	(S)	52.6

7. For $KMnO_4$ in strong basic medium correct combination is -
(A) (I) (ii) (R) (B) (II) (i) (P) (C) (II) (iii) (S) (D) (I) (iv) (Q)

8. For $KMnO_4$ in neutral medium correct combination is -
(A) (I) (iii) (Q) (B) (II) (i) (R) (C) (I) (iii) (S) (D) (II) (iii) (R)

9. For a disproportionation reaction the only correct combination is -
(A) (I) (ii) (R) (B) (II) (ii) (Q) (C) (IV) (i) (S) (D) (III) (ii) (Q)

Exercise-3

*** Marked Questions may have more than one correct option.**

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

1. In basic medium, I^- is oxidised by MnO_4^-. In this process, I^- changes to : **[JEE 2004, 3/144]**
(A) IO_3^- (B) I_2 (C) IO_4^- (D) IO^-

2. Consider a titration of potassium dichromate solution with acidified Mohr's salt solution using diphenylamine as indicator. The number of moles of Mohr's salt required per mole of dichromate is : **[JEE 2007, 3/162]**
(A) 3 (B) 4 (C) 5 (D) 6

3. The reagent (s) used for softening the temporary hardness of water is (are) : **[JEE 2010, 3/163]**
(A) $Ca_3(PO_4)_2$ (B) $Ca(OH)_2$ (C) Na_2CO_3 (D) NaOCl

Paragraph for Questions Nos. 4 to 5

Bleaching powder and bleach solution are produced on a large scale and used in several house hold products. The effectiveness of bleach solution is often measured by iodometry.

4. 25 mL of household bleach solution was mixed with 30 mL of 0.50 M KI and 10 mL of 4N acetic acid. In the titration of the liberated iodine, 48 mL of 0.25 N $Na_2S_2O_3$ was used to reach the end point. The molarity of the household bleach solution is **[IIT-JEE 2012, 3/136]**
(A) 0.48 M (B) 0.96 M (C) 0.24 M (D) 0.024 M

5. Bleaching powder contains a salt of an oxoacid as one of its components. The anhydride of that oxoacid is **[IIT-JEE 2012, 3/136]**
(A) Cl_2O (B) Cl_2O_7 (C) ClO_2 (D) Cl_2O_6

6.* For the reaction : $I^- + ClO_3^- + H_2SO_4 \longrightarrow Cl^- + HSO_4^- + I_2$
The correct statement(s) in the balanced equation is/are : **[JEE (Advanced) 2014, 3/120]**
(A) Stoichiometric coefficient of HSO_4^- is 6. (B) Iodide is oxidized.
(C) Sulphur is reduced. (D) H_2O is one of the products.

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

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

Few drops of concentrated HCl were added to this solution and gently warmed. Further, oxalic acid (225 mg) was added in portions till the colour of the permanganate ion disappeared. 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, 3/120]**

PART - II : JEE (MAIN) ONLINE PROBLEMS (PREVIOUS YEARS)

1. Hydrogen peroxide acts both as an oxidising and as a reducing agent depending upon the nature of the reacting species. In which of the following cases H_2O_2 acts as a reducing agent in acid medium ?
[JEE(Main) 2014 Online (12-04-14), 4/120]
(1) MnO_4^- (2) $Cr_2O_7^{2-}$ (3) SO_3^{2-} (4) KI

2. Permanent hardness in water cannot be cured by : **[JEE(Main) 2015 Online (10-04-15), 4/120]**
(1) Treatment with washing soda (2) Boiling
(3) Ion exchange method (4) Calgon's method

3. 1.4 g of an organic compound was digested according to Kjeldahl's method and the ammonia evolved was absorbed in 60 mL of M/10 H_2SO_4 solution. The excess sulphuric acid required 20 mL of M/10 NaOH solution for neutralization. The percentage of nitrogen in the compound is :
[JEE(Main) 2015 Online (10-04-15), 4/120]
(1) 24 (2) 5 (3) 10 (4) 3

4. The volume of 0.1 N dibasic acid sufficient to neutralize 1 g of a base that furnishes 0.04 mole of OH^- in aqueous solution is : **[JEE(Main) 2016 Online (10-04-16), 4/120]**
(1) 400 mL (2) 600 mL (3) 200 mL (4) 80 mL

5. For standardizing NaOH solution, which of the following is used as a primary standard ?
[JEE(Main) 2018 Online (16-04-18), 4/120]
(1) Sodium tetraborate (2) Ferrous Ammonium Sulfate
(3) Oxalic acid (4) dil. HCl

6. The temporary hardness of water is due to : **[JEE(Main) 2019 Online (09-01-19), 4/120]**
(1) $CaCl_2$ (2) $Ca(HCO_3)_2$ (3) NaCl (4) Na_2SO_4

7. In the reaction of oxalate with permanganate in acidic medium, the number of electrons involved in producing one molecule of CO_2 is : **[JEE(Main) 2019 Online (10-01-19), 4/120]**
(1) 5 (2) 1 (3) 2 (4) 10

8. 25 ml of the given HCl solution requires 30 mL of 0.1 M sodium carbonate solution. What is the volume of this HCl solution required to titrate 30 mL of 0.2 M aqqueous NaOH solution?
[JEE(Main) 2019 Online (11-01-19), 4/120]
(1) 12.5 mL (2) 75 mL (3) 50 mL (4) 25 mL

9. The hardness of water sample (in terms of equivalents of $CaCO_3$) containing 10^{-3} M $CaSO_4$ is :
(molar mass of $CaSO_4$ = 136 g mol^{-1}) **[JEE(Main) 2019 Online (12-01-19), 4/120]**
(1) 10 ppm (2) 50 ppm (3) 90 ppm (4) 100 ppm

10. The volume strength of 1M H_2O_2 is: (Molar mass of H_2O_2 = 34 g mol^{-1})
[JEE(Main) 2019 Online (12-01-19), 4/120]
(1) 11.35 (2) 22.4 (3) 16. 8 (4) 5.6

Answers

EXERCISE - 1

PART - I

A-1. (a) 23 ; (b) E = 9 ; (c) E = 30 ; (d) E = $\frac{35.5}{1}$; (e) E = 30 ; (f) E = 48 ; (g) E = 31.67

A-2. (a) E = 58.5 or E = 58.5 ; (b) E = 87 or E = 87 ; (c) E = 51.67 or E = 51.67

A-3.	20.1	**B-1.**	$\frac{M_1}{6}, \frac{M_2}{8}, \frac{M_3}{5}$	**B-2.**	(a) 31.6 ; (b) 52.67	**C-1.**	72.61
C-2.	0.06 N, 0.03 M	**C-3.**	537.6 mL	**D-1.**	20	**D-2.**	+3
D-3.	0.12 M.	**D-4.**	2.22 mL.	**E-1.**	7.1%	**E-2.**	0.25075 g
F-1.	2.12 g/L	**F-2.**	126 ppm				

F-3. Temporary hardness - due to bicarbonates of Ca & Mg
Permanent hardness - due to chlorides & sulphates of Ca & Mg.

F-4. There are some method by which we can soften the water sample.

(a) By boiling : $2HCO_3^- \longrightarrow H_2O + CO_2 + CO_3^{2-}$

or By Slaked lime : $Ca(HCO_3)_2 + Ca(OH)_2 \longrightarrow CaCO_3 + 2H_2O$
$Ca^{2+} + CO_3^{2-} \longrightarrow CaCO_3$

(b) By Washing Soda : $CaCl_2 + Na_2CO_3 \longrightarrow CaCO_3 + 2NaCl$

(c) By ion exchange resins : $Na_2R + Ca^{2+} \longrightarrow CaR + 2Na^+$

(d) By adding chelating agents like $(PO_3^-)_3$ etc.

PART - II

A-1.	(B)	**A-2.**	(A)	**A-3.**	(A)	**B-1.**	(C)	**B-2.**	(D)
B-3.	(A)	**C-1.**	(A)	**C-2.**	(A)	**C-3.**	(D)	**D-1.**	(B)
D-2.	(D)	**D-3.**	(B)	**D-4.**	(A)	**E-1.**	(B)	**E-2.**	(B)
F-1.	(D)	**F-2.**	(A)	**F-3.**	(D)	**F-4.**	(B)		

PART - III

1. (A – p,s) ; (B – q,r) ; (C – p,q,s) ; (D – r)

EXERCISE - 2

PART - I

1.	(A)	**2.**	(A)	**3.**	(D)	**4.**	(D)	**5.**	(A)
6.	(D)	**7.**	(D)	**8.**	(A)	**9.**	(D)	**10.**	(A)
11.	(A)	**12.**	(A)	**13.**	(A)	**14.**	(A)		

PART - II

1.	4	**2.**	1	**3.**	90	**4.**	2	**5.**	2
6.	68	**7.**	12	**8.**	21	**9.**	10 mL	**10.**	16
11.	32								

PART - III

1.	(AC)	**2.**	(ABCD)	**3.**	(ACD)	**4.**	(ABD)	**5.**	(ABCD)
6.	(BCD)								

PART - IV

1.	(C)	**2.**	(B)	**3.**	(C)	**4.**	(C)	**5.**	(D)
6.	(B)	**7.**	(B)	**8.**	(C)	**9.**	(D)		

EXERCISE - 3

PART - I

1.	(A)	**2.**	(D)	**3.**	(B)	**4.**	(C)	**5.**	(A)
6.*	(ABD)	**7.**	126 mg						

PART - II

1.	(1)	**2.**	(2)	**3.**	(3)	**4.**	(1)	**5.**	(3)
6.	(2)	**7.**	(2)	**8.**	(4)	**9.**	(4)	**10.**	(1)