Stoichiometry: Question

CONCEPTUAL QUESTIONS

MOLE:

1. How many moles of $K_2Cr_2O_7$ in acidic medium are required to react completely with one mole of KHC_2O_4
(A) 2 / 3 (B) 1 / 3 (C) 3 (D) 6

OXIDATION NUMBER

2. Sulphur has highest oxidation state in
(A) H_2SO_4 (B) SO_2 (C) $Na_2S_2O_3$ (D) $Na_2S_4O_6$

3. In which of the following compound transition metal has zero oxidation state
(A) CrO_5 (B) NH_2. NH_2 (C) $Ni(ClO_4)_2$ (D) $[Fe(CO)_5]$

TYPE OF REDOX REACTIONS

4. Consider the following reactions:
(i) $C_2O_4^{2-} \longrightarrow CO_2$ (ii) $SO_4^{2-} \longrightarrow SO_3^{2-}$
(iii) $MnO_4^{2-} \longrightarrow MnO_4^-$ (iv) $Fe^{3+} \longrightarrow Fe^{2+}$
Choose the correct answer:-
(A) (i) & (ii) shows oxidation (B) (iii) & (iv) shows reduction
(C) (i) & (iii) shows oxidation (D) (iii) & (iv) shows oxidation

5. In the reaction $Cl_2 + OH^- \longrightarrow Cl^- + ClO_3^- + H_2O$, Chlorine is
(A) oxidized (B) reduced
(C) oxidized as well as reduced (D) neither oxidized nor reduced

6. Which of the acid has oxidizing as well as reducing properties?
(A) HNO_3 (B) H_2SO_4 (C) HCl (D) HNO_2

7 Which of the following is disproportionation reaction:
(A) $2CrO_4^{2-} + 2H^+ \longrightarrow Cr_2O_7^{2-} + H_2O$ (B) $3Cl_2 + 6OH^- \longrightarrow 5Cl^- + ClO_3^- + 3H_2O$
(C) $CaCO_3 + 2H^+ \longrightarrow Ca^{2+} + H_2O + CO_2$ (D) none of these

8. In the following reaction
$3Br_2 + 6CO_3^{2-} + 3H_2O \longrightarrow 5Br^- + BrO_3^- + 6HCO_3^-$
(A) Bromine is oxidized and carbonate is reduced
(B) Bromine is reduced and water is oxidized
(C) Bromine is neither reduced nor oxidized
(D) Bromine is both reduced and oxidized

9. Which of the following are not examples of disproportionation reaction
(A) $Ag(NH_3)_2^+ + 2H^+ \longrightarrow Ag^+ + 2NH_4^+$
(B) $Cl_2 + OH^- \longrightarrow ClO^- + Cl^- + H_2O$
(C) $Cu_2O + 2H^+ \longrightarrow Cu + Cu^{2+} + H_2O$
(D) $2HCuCl_2 \xrightarrow{\text{dilute with } H_2O} Cu + Cu^{2+} + 4Cl^- + 2H^+$

Calculation of n-Factor

10. For the reaction: $2FeS_2 + \frac{11}{2}O_2 \longrightarrow Fe_2O_3 + 4SO_2$
What will be the equivalent weight of FeS_2, if the molecular weight of FeS_2 is M?
(A) $\frac{M}{8}$ (B) M (C) $\frac{M}{11}$ (D) Can't be calculated

SINGLE CORRECT CHOICE

LEVEL - I

MOLES

1. The number of moles of $CaCl_2$ needed to react with excess of $AgNO_3$ to produce 4.31 gram of AgCl.

   (A) 0.030 (B) 0.015 (C) 0.045 (D) 0.060

2. Calcium carbonate reacts with aqueous HCl to give $CaCl_2$ and CO_2 according to the reaction, $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$.

   The mass of $CaCO_3$ is required to react completely with 25 mL of 0.75 M HCl is
   (A) 0.1g (B) 0.5 g (C) 1.5 g (D) 0.94 g

3. Chlorine is prepared in the laboratory by treating manganese dioxide (MnO_2) with aqueous hydrochloric acid according to the reaction

   $4HCl\ (aq) + MnO_2(s) \rightarrow 2H_2O(l) + MnCl_2(aq) + Cl_2(g)$

   The grams of HCl react with 5.0 g of manganese dioxide will be [at.mass of Mn = 55]
   (A) 84 g (B) 0.84 g (C) 8.4g (D) 4.2 g

4. 25.4 g of iodine and 12.2 g of chlorine are made to react completely to yield a mixture of ICl and ICl_3. Calculate the ratio of moles of ICl and ICl_3.
   (A) 1 : 1 (B) 1 : 2 (C) 1 : 3 (D) 2 : 3

5. Calculate the weight of iron which will be converted into its oxide by the action of 18g of steam on it.
   (A) 37.3 gm (B) 3.73 gm (C) 56 gm (D) 5.6 gm

6. It takes 0.15 mole of ClO^- to oxidize 12.6 g of chromium oxide of a specific formula to $Cr_2O_7^{2-}$. ClO^- became Cl^-. The formula of the oxide is (atomic weight Cr = 52, O = 16)
   (A) CrO_3 (B) CrO_2 (C) CrO_4 (D) CrO

7. 8 g of sulphur is burnt to form SO_2 which is oxidized by Cl_2 water. The solution is treated with $BaCl_2$ solution. The amount of $BaSO_4$, precipitate is
   (A) 1 mole (B) 0.5 mole (C) 0.24 mole (D) 0.25 mole

8. 25.0 ml of HCl solution gave, on reaction with excess $AgNO_3$ solution 2.125 g of AgCl. The normality of HCl solution is
   (A) 0.25 (B) 0.6 (C) 1.0 (D) 0.75

GRAVIMETRIC ANALYSIS

9. If ten volumes of dihydrogen gas reacts with five volumes of dioxygen gas, how many volumes of water vapour would be:
   (A) 10 (B) 20 (C) 48 (D) 12

10. A 10.0 g samples of a mixture of calcium chloride and sodium chloride is treated with Na_2CO_3 to precipitate the calcium as calcium carbonate. This $CaCO_3$ is heated to convert all the calcium to CaO and the final mass of CaO is 1.62 gms. The % by mass of $CaCl_2$ in the original mixture is
    (A) 15.2% (B) 32.1% (C) 21.8% (D) 11.7%

CALCULATION OF n-Factor

11. 1.60g of a metal were dissolved in HNO_3 to prepare its nitrate. The nitrate on strong heating gives 2g oxide. The equivalent weight of metal is

(A) 16 (B) 32 (C) 48 (D) 12

12. Hydroxyl amine reduces iron (III) according to following equation

$$NH_2OH + Fe_2(SO_4)_3 \longrightarrow N_2(g) + H_2O + FeSO_4 + H_2SO_4$$

which statement is correct

(A) n-factor for Hydroxyl amines is 1

(B) equivalent weight of $Fe_2(SO_4)_3$ is M/2

(C) 6 meq of $Fe_2(SO_4)_3$ is contained in 3 millimoles of ferric sulphate

(D) all of these.

TYPES OF REDOX REACTIONS

13. How many moles of electron is needed for the reduction of each mole of Cr in the reaction,

$$CrO_5 + H_2SO_4 \longrightarrow Cr_2(SO_4)_3 + H_2O + O_2$$

(A) 4 (B) 3 (C) 5 (D) 7

TITRATIONS

14. Equal volumes of 1 M each of $KMnO_4$ and $K_2Cr_2O_7$ are used to oxidize Fe(II) solution in acidic medium. The amount of Fe oxidized will be

(A) more with $KMnO_4$ (B) more with $K_2Cr_2O_7$

(C) equal with both oxidizing agents (D) cannot be determined

15. The normality of a mixture obtained by mixing 100 ml of 0.2 M H_2SO_4 with 100 ml of 0.2 M NaOH will be

(A) 0.05 N (B) 0.1 N (C) 0.15 N (D) 0.2 N

16. A solution of $KMnO_4$ is reduced to MnO_2. The normality of solution is 1.8. The molarity will be

(A) 0.1 M (B) 0.6 M (C) 1.8 M (D) 0.3 M

17. Among the following which statement is not correct

(A) HNO_2 can act both as a reducing agent and as an oxidizing agent but HNO_3 acts only as an oxidizing agent.

(B) The oxidation number of phosphorus can vary from –3 to +5.

(C) The reaction between NaOH and H_2SO_4 is a redox reaction.

(D) Oxidation number can have positive, negative, zero or fractional values.

18. In redox reaction, H_2O_2 oxidizes $K_4[Fe(CN)_6]$ into K^+, Fe^{3+}, CO_3^{2-} and NO_3^- ions in acidic medium, than how many moles of H_2O_2 will react with 1 mole of K_4 $[Fe(CN)_6]$

(A) 5 moles (B) 9 moles

(C) 8 moles (D) 30.5 moles

19. Assuming full decomposition, the volume of CO_2 released at STP on heating 9.85 g of $BaCO_3$ (Atomic mass of Ba = 137) will be

(A) 0.84 L (B) 2.24 L

(C) 4.06 L (D) 1.12 L

20. A 20.00 mL sample of $Ba(OH)_2$ solution is titrated with 0.245 (M) HCl. If 27.15 mL of HCl is required, what is the molarity of the $Ba(OH)_2$ solution

(A) 0.166 M (B) 0.180 M

(C) 0.333 M (D) 0.666 M

21. Benzene diazonium chloride, $C_6H_5\overset{+}{N}_2\overset{-}{C}l$, was decomposed in the presence of hypophosphorous acid and the nitrogen evolved after drying was found to be 36.9 ml at one atmosphere and 27°C. The amount of salt taken must be nearly

(A) 481 mg (B) 240 mg

(C) 210 mg (D) 140 mg

22. Molarity of a 4% NaOH solution by weight having density 1.2 gm/ml will be

(a) 1.2 M (b) 1.4 M (c) 1.6 M (d) 1.8 M

23. Molarity of a 4% NaOH solution (weight/volume) will be

(a) 1.2 M (b) 1.0 M (c) 1.6 M (d) 0.5 M

24. Normality of a 0.1 M H_3PO_4 solution will be

(a) 0.2 (b) 0.4 (c) 0.3 (d) 0.05

25. 100 ml of 0.01 M H_2SO_4 is titrated against 0.2 M $Ca(OH)_2$, volume of $Ca(OH)_2$ required to reach end point will be

(a) 5 ml (b) 10 ml (c) 20 ml (d) 15 ml

LEVEL - II

MOLES

26. The molar ratio of Fe^{++} to Fe^{+++} in a mixture of $FeSO_4$ and $Fe_2(SO_4)_3$ having equal number of sulphate ion in both ferrous and ferric sulphate is

(A) 1 : 2 (B) 3 : 2 (C) 2 : 3 (D) can't be determined

27. Calculate the number of oxygen atoms required to combine with 7g of N_2 to form N_2O_3 when 80% of N_2 is converted to N_2O_3.

(A) 2.3×10^{23} (B) 3.6×10^{23} (C) 1.8×10^{21} (D) 5.4×10^{21}

28. A welding fuel gas contains carbon and hydrogen only. Burning a small sample of it in oxygen gives 3.38 g carbon dioxide, 0.690 g of water and no other products. A volume of 10.0 L (measured at STP) of this welding gas is found to weigh 11.6 g. The empirical formula, molar mass of the gas and molecular formula will be respectively

(A) CH_2, 30, C_2H_4 (B) CH, 30, C_2H_2 (C) CH, 26, C_2H_2 (D) CH_2, 26, C_2H_4

29. Which of the following has least mass

(A) 2 g atom of nitrogen (B) 3×10^{23} atoms of C (C) 1 mole of S (D) 7.0 g of Ag

VOLUMETRIC & GRAVIMETRIC ANALYSIS

30. Assuming fully decomposed, the volume of CO_2 released at STP on heating 9.85 g of $BaCO_3$ (Atomic mass of Ba = 137) will be

(A) 0.84 L (B) 2.24 L (C) 4.06 L (D) 1.12 L

31. Hydrochloric acid solutions A and B have concentration of 0.5 N and 0.1 N respectively. The volume of solutions A and B required to make 2 litres of 0.2 N hydrochloric are

(A) 0.5 l of A + 1.5 l of B (B) 1.5 l of A + 0.5 l of B
(C) 1.0 l of A + 1.0 l of B (D) 0.75 l of A + 1.25 l of B

32. Volume of a gas at STP is 1.12×10^{-7} cc. Calculate the number of molecules in it

(A) 3.01×10^{20} (B) 3.01×10^{12} (C) 3.01×10^{23} (D) 3.01×10^{24}

33. The mass of $BaCO_3$ produced when excess CO_2 is bubbled through a solution of 0.205 mol $Ba(OH)_2$ is

(A) 81 g (B) 40.5 g (C) 20.25 g (D) 162 g

REDOX REACTIONS

34. Which reaction does not involve either oxidation nor reduction?

(a) $VO^{2+} \rightarrow V_2O_3$ (b) $Na \rightarrow Na^+$
(c) $CrO_4^{2-} \rightarrow Cr_2O_7^{2-}$ (d) $Zn^{2+} \rightarrow Zn$

35. When $KMnO_4$ acts as an oxidizing agent and ultimately forms MnO_4^{2-}, MnO_2, Mn_2O_3, Mn^{2+} then the number of electrons transferred in each case respectively is:

(a) 4, 3, 1, 5 (b) 1, 5, 3, 7 (c) 1, 3, 4, 5 (d) 3, 5, 7, 1

36. The reaction $Cl_2 \rightarrow Cl^- + ClO_3^-$ is :

(a) Oxidation (b) Reduction

(c) Disproportionation (d) Neither oxidation nor reduction

37. One mole of N_2H_4 loses ten moles of electrons to from a new compound y. Assuming that all the nitrogen appears in the new compound. What is the oxidation state of nitrogen in y. There is not change in the oxidation state of hydrogen:

(a) –1 (b) –3 (c) +3 (d) +5

38. 1 mol of ferric oxalate is oxidized by x mol of MnO_4^- and also 1 mol of ferrous oxalate is oxidized by y mol of MnO_4^- in acidic medium. The ratio (x/y) is:

(a) 2 : 1 (b) 1: 2 (c) 3 : 1 (d) 1 : 3

39. 3×10^{-3} mole $K_2Cr_2O_7$ reacts completely with 4.5×10^{-3} mole X^{n+} to give XO_3^- and Cr^{3+}. The value of n is:

(a) 3 (b) 1 (c) 0 (d) 4

40. A certain ion X^{n+} is oxidized successively to XO_4^{2-} and then XO_4^- by a powerful oxidizing agent. If the number of moles of the oxidizing agent required in the successive steps of oxidation are in the ratio 4 : 1, n is:

(a) 3 (b) 1 (c) 2 (d) 4

CALCULATION OF n-FACTOR

41. In the following reaction (unbalanced) equivalent wt. of As_2S_3 is related to molecular wt. M by:

$As_2S_3 + H^+ + NO_3^- \rightarrow NO + H_2O + AsO_4^{3-} + SO_4^{2-}$

(a) M/2 (b) M/4 (c) M/28 (d) M/24

42. In the reaction, $2CuSO_4 + 4KI \rightarrow Cu_2I_2 + 2K_2SO_4 + I_2$ the ratio of equivalent weight of $CuSO_4$ to its molecular weight is:

(a) 1/8 (b) 1/4 (c) 1/2 (d) 1

TITRATIONS

43. A 100 ml solution of 0.1 N HCl was titrated with 0.2 N NaOH solution. The titration was discontinued after adding 30 ml of NaOH solution. The remaining titration was completed by adding 0.25 N KOH solution. The volume of KOH required for completing the titration is

(A) 70 ml (B) 32 ml (C) 35 ml (D) 16 ml

44. A solution of 10 ml 0.1 M $FeSO_4$ was titrated with $KMnO_4$ solution in acidic medium. The amount of $KMnO_4$ used will be:

(a) 5 ml of 0.1 M (b) 10 ml of 0.1 M

(c) 10 ml of 0.5 M (d) 10 ml of 0.02 M

45. If equal volumes of 1M $KMnO_4$ and 1M $K_2Cr_2O_7$ solutions are allowed to oxidized Fe^{2+} in acidic medium. The amount of iron oxidized will be:

(a) more by $KMnO_4$ solution (b) more by $K_2Cr_2O_7$ solution
(c) equal in both the cases (d) cannot be determined

46. What volume of 0.1 M $KMnO_4$ is needed to oxidize 100 mg of FeC_2O_4 in acidic solution?
(a) 4.1 mL (b) 8.2 mL (c) 10.2 mL (d) 4.6 mL

47. 60 ml 0.1 M $KMnO_4$ is treated with excess FeC_2O_4 in presence of H_2SO_4. The volume of CO_2 gas (measured at NTP) obtained is:
(a) 448 ml (b) 672 ml (c) 224 ml (d) 112 ml

48. 10.78 g of H_3PO_4 in 550 mL solution is 0.40 N. Thus this acid:
(a) has been neutralized to HPO_4^{2-} (b) has been neutralized to PO_4^{3-}
(c) has been reduced to HPO_3^{2-} (d) has been neutralized to $H_3PO_4^{-}$

VOLUME STRENGTH OF H_2O_2

49. The labeling on a bottle of H_2O_2 solution is 20 "vol", then the concentration of H_2O_2 in percentage strength will be:
(A) 3.03 % (B) 5% (C) 4.55% (D) 6.06 %

50. What volume of H_2O_2 solution of 22.4 "vol" strength is required to liberate 2240 mL of O_2 at NTP ?
(A) 300 mL (B) 200 mL (C) 100 mL (D) 500 mL

LEVEL-III

51. What volume of 1 M FeC_2O_4 (ferrous oxalate) solution is required for the complete oxidation of 100 ml of 1 M $Fe(SCN)_2$ solution into Fe^{3+}, SO_4^{2-}, CO_3^{2-} and nitrate ?
(A) 0.7 litre (B) 1 litre (C) 0.8 litre (D) 1.1 litre

52. A solution contains Cu^{2+} and $C_2O_4^{2-}$ ions which on titration with 1 M $KMnO_4$ consumes 10 ml of the oxidizing agent for complete oxidation in acidic medium. The resulting solution is neutralized with Na_2CO_3, acidified with dil. CH_3COOH and is treated with excess of KI. The liberated iodine requires 25 ml of 1 M of hypo solution, then that will be the molar ratio of Cu^{2+} to $C_2O_4^{2-}$ ions in solution ?
(A) 5 : 2 (B) 1 : 2 (C) 2 : 1 (D) 1 : 1

53. In redox reaction, $Ba(MnO_4)_2$ oxidises $K_4[Fe(CN)_6]$ into K^+, Fe^{3+}, CO_3^{2-} and NO_3^- ions in acidic medium, where $Ba(MnO_4)_2$ itself reduces into Mn^{2+}, than how many moles of $Ba(MnO_4)_2$ will react with 1 mole of $K_4[Fe(CN)_6]$
(A) 5 moles (B) 9 moles (C) 8 moles (D) 6.1 moles

54. For 109% labeled oleum if the number of moles of H_2SO_4 and free SO_3 be x and y respectively, then what will be the value of $\frac{x+y}{x-y}$?
(A) 1 (B) 18 (C) 1/3 (D) 9.9

55. A sample of tap water contains 366 ppm of HCO_3^- ions with Ca^{2+} ion. Now it is removed by Clark's method by addition of $Ca(OH)_2$. Then what minimum mass of $Ca(OH)_2$ will be required to remove

HCO_3^- ions completely from 500 g of same tap water sample

(A) 1 g (B) 0.4 g (C) 0.222 g (D) 0.111 g

56. 55 g $Ba(MnO_4)_2$ sample containing inert impurity is completely reacting with 100 mL of 56 'vol' strength of H_2O_2, then what will be the percentage purity of $Ba(MnO_4)_2$ in the sample ? (Ba – 137, Mn – 55)

(A) 40% (B) 25% (C) 10% (D) 68.18%

57. An aqueous solution of 0.57 g of KIO_3 (formula weight = 214) reacts with excess of KI in presence of HCl, where both converts into I_2. The liberated I_2 consumes certain volume of (0.1 M) $Na_2S_2O_3$, in basic medium where it converts into SO_4^{2-}, then find out the volume of $Na_2S_2O_3$ (in mL) needed to reach the equivalence point.

(A) 19.97 (B) 29.97 (C) 24 (D) 35

58. The simplest formula of a compound containing 50% of element X (atomic mass 10) and 50% of element Y (atomic mass 20) is

(A) XY (B) X_2Y (C) XY_3 (D) X_2Y_3

59. The number of water molecules present in a drop of water (volume 0.0018 ml) at room temperature is

(A) 6.023×10^{19} (B) 1.084×10^{18} (C) 4.84×10^{17} (D) 5.023×10^{23}

60. What will be the volume of CO_2 at NTP obtained on heating 10 grams of (90% pure) limestone

(A) 22.4 litre (B) 2.016 litre (C) 2.24 litre (D) 20.16 litre

MORE THAN ONE ANSWER QUESTIONS

Level-I

1. Which of the following solution (s) is / are 0.2 N?

(A) 3g acetic acid dissolve in 250 ml water

(B) 5.7 g $Al_2(SO_4)_3$ dissolve in 500 ml water

(C) 0.2 mole $Ca(OH)_2$ dissolve in one litter water

(D) 0.2 g equivalent of H_2SO_4 dissolve in 500 ml water

2. In which of the following compound(s) n-factor is more than 45 in redox reaction. Assuming all element in compound oxidized to it's maximum oxidation state

(A) $K_4[Fe(CN)_6]$ (B) Cu_2S

(C) $Fe(SCN)_3$ (D) $K_2[Cu(CN)_4]$

3. The oxidation number of Cr is +6 in :

(A) K_2CrO_4 (B) $K_2Cr_2O_7$ (C) $KCrO_3Cl$ (D) CrO_5

4. Dichromate ion in acidic medium oxidizes stannous ion as:

$$xSn^{2+} + yCr_2O_7^{2-} + zH^+ \longrightarrow aSn^{+4} + bCr^{3+} + cH_2O$$

(A) the value of x : y is 1 : 3 (B) the value of x + y + z is 18

(C) a : b is 3 : 2 (D) the value of z – c is 7

5. Mixture of 2 mol H_2SO_4 can be neutralized by

(A) 1 mol KOH (B) 2 mol $Ca(OH)_2$

(C) 4 mol NaOH (D) 2 mol KOH

6. 150 mL $\frac{M}{10}$ $Ba(MnO_4)_2$ in acidic solution can oxidize completely

(A) 150 mL 1 M Fe^{2+} (B) 50 mL 1 M $FeCrO_4$

(C) 75 mL 1 M $C_2O_4^{2-}$ ions (D) 25 mL 1 M $K_2Cr_2O_7$ solution

7. COOH | COOH and COOK | COOH behave as acid as well as reducing agent. Then which of the following are the correct statements regarding

COOH | COOH and COOK | COOH

(A) When both behaves as reducing agent, then their equivalent weights are equal to half of their molecular weight respectively

(B) 1000 mL of 1 N solution of each is neutralized by 1000 mL 1 N $Ca(OH)_2$

(C) 1000 mL of 1 M solution of each is neutralized by 1000 mL of 1 M $Ca(OH)_2$

(D) 1000 mL of 1 M solution of each is oxidised by 200 mL 2 M of $KMnO_4$ in acidic medium

8. x mmol of KIO_3 reacts completely with y mmol of KI to give I_2 quantitatively. If z mmol of hypo are required for complete titration against this I_2 then which relation is not correct ?

(A) z = 6x (B) 6y = 5z

(C) x = 5y (D) x + y = 2z

9. x ml of 0.01 N HCl are required for titration against a mixture of NaOH and Na_2CO_3 using phenolphthalein as indicator, when the colour changes from pink to colourless, few drops of methyl orange were then added and the titration was continued. Additional y ml of 0.01 N HCl were required. Which of the following values of x and y are possible?

(A) x = 10, y = 130 (B) x = 148, y = 54

(C) x = 36, y = 63 (D) x = 420, y = 140

10. Dichromate ion in acidic medium oxidizes stannous ion as

$$xSn^{2+} + yCr_2O_7^{2-} + zH^+ \rightarrow aSn^{4+} + bCr^{3+} + cH_2O$$

(A) The value of x : y is 1 : 3 (B) The value of x + y + z is 18

(C) The value of a : b is 3 : 2 (D) The value of x – c is 7

11. For the following balanced redox reaction,
$2MnO_4^- + 4H^+ + Br_2$ ® $2Mn^{2+} + 2BrO_3^- + 2H_2O$
If the molecular wt. of MnO_4^-, Br_2 be Mx, My respectively, then
(A) equivalent wt. of MnO_4^- is Mx/5

(B) equivalent wt. of Br_2 is My/10
(C) the n-factor ratio of Mn^{2+} to BrO_3^- is 1 : 1
(D) none of these

12. When non-stoichiometric compound $Fe_{0.95}O$ is heated in presence of oxygen, then it converts into Fe_2O_3, then which of the following statements are correct ?
(A) equivalent weight of $Fe_{0.95}O$ is M/0.5 where M is molecular weight of $Fe_{0.95}O$.
(B) The number of moles of Fe^{3+} and Fe^{2+} 1 moles $Fe_{0.95}O$ and 0.1 and 0.85 respectively.

(C) The number of moles of Fe^{3+} and Fe^{2+} in 1 mole of $Fe_{0.95}O$ are 0.85 and 0.10 respectively

(D) The % composition of Fe^{2+} and Fe^{3+} in the non stoichiometric compound is 89.47% and 10.53% respectively.

13. When FeS_2 is oxidized with sufficient O_2, then its oxidation product is found to be Fe_2O_3 and SO_2, if the molecular weight of FeS_2, Fe_2O_3 and SO_2 are M, M_x and M_Y, then which of the following statements are correct ?
(A) equivalent wt. of FeS_2 is M/11 (B) the molar ratio of FeS_2 to O_2 is 4 :11
(C) the molar ratio of FeS_2 to O_2 is 11 : 4 (D) The molar ratio of Fe_2O_3 and SO_2 is 1 : 4

14. 40 g NaOH, 106 g Na_2CO_3 and 84 g $NaHCO_3$ is dissolved in water and the solution is made 1 litre. 20 mL of this stock solution is titrated with 1N HCl, hence which of the following statements are correct.

(A) the titre reading of HCl will be 40 mL, if phenolphthalein is used indicator from the very beginning

(B) the titre reading of HCl will be 60 mL if phenolphthalein is used indicator from the very beginning.

(C) the titre reading of HCl will be 40 mL if the methyl orange is used indicator after the 1st end point

(D) the tire reading of HCl will be 80 mL, if methyl orange is used as indicator from the very beginning.

15. 150 mL $\frac{M}{10}$ $Ba(MnO_4)_2$ in acidic can oxidize completely
(A) 150 mL 1M Fe^{2+} (B) 50 mL 1M FeC_2O_4
(C) 75 mL 1M $C_2O_4^{2-}$ (D) 25 mL 1M $K_2Cr_2O_7$ solution

16. Which of the following quantities are dependent on temperature?
(A) Molarity (B) Normality (C) Molality (D) Mole fraction.

17. For the reaction :

$H_3PO_4 + Ca(OH)_2 \longrightarrow CaHPO_4 + 2H_2O$

1 mole   1 mole

then which of the following statements are correct ?

(A) the equivalent weight of H_3PO_4 is 49.
(B) the resulting solution is neutralized by 1 mole of KOH
(C) 1 mole of H_3PO_4 is completely neutralized by 1.5 mole of $Ca(OH)_2$
(D) none

18. 1 mol of H_2SO_4 will exactly neutralize

(A) 2 mol of ammonia
(B) 1 mol of $Ca(OH)_2$
(C) 0.5 mol of $Ba(OH)_2$
(D) 2 mol of NaOH

19. During the titration of a mixture of NaOH, Na_2CO_3 and inert substances against HCl.

(A) Phenolphthalein is used to detect the end point when half equivalent of Na_2CO_3 and full equivalent NaOH is consumed
(B) Phenolphthalein is used to detect the second end point
(C) Methyl orange is used to detect the final end point
(D) Methyl orange is used to detect the first end point

20. The reaction, $3ClO^-(aq) \longrightarrow ClO_3^-(aq) + 2Cl^-(aq)$ is an example of

(A) Oxidation reaction
(B) Reduction reaction
(C) disproportionation reaction
(D) Decomposition reaction

Level-II

21. 1 mole of a mixture of CO and CO_2 requires exactly 1 litre solution of 1 M NaOH for complete neutralization. If CO present in mixture is now converted to CO_2 and again the mixture is treated with NaOH, then after this conversion

(A) moles of CO_2 present initially in mixture = 1

(B) 2 litre NaOH solution of 1 M is more required for neutralization

(C) 2 litre solution of $\frac{1}{2}$ M NaOH is required more for neutralization

(D) 56 g KOH in aqueous solution is required more for neutralization

22. 2 g of oleum is diluted with water. The solution was then neutralized by 432.5 mL of 0.1 N NaOH. Select the correct statements :

(A) % of oleum is 108.11
(B) % of free SO_3 is 26.5 in oleum
(C) Equivalent of H_2SO_4 are 0.03
(D) Equivalent of $SO_3 = 6.625 \times 10^{-3}$

23. Which one is not correct about $VO + Fe_2O_3 \rightarrow FeO + V_2O_5$?

(A) 2 mole of VO reacts completely with 5 mole of Fe_2O_3

(B) 1 mole of VO reacts completely with 1.5 mole of Fe_2O_3

(C) Eq. weight of V_2O_5 = M/6 and of Fe_2O_3 is M/2

(D) Eq. weight of VO = M/3 and of FeO is 2M/3

24. 1 mole of H_3PO_3 reacts with NaOH in solution. Select the correct statements.

(A) 1 mole of NaOH will replace NH^+ ion from H_3PO_3

(B) 2 moles of NaOH will replace 2 NH^+ ion from H_3PO_3

(C) 3 moles of NaOH will replace 3 NH^+ ion from H_3PO_3

(D) On complete neutralization of H_3PO_3, the equivalent weight of H_3PO_3 = 41

25. 100 mL of 0.8 M NaOH are used to neutralized 100 mL solution obtained by passing 2.70 g SO_2Cl_2 in water. Select the correct statement

(A) The solution of SO_2Cl_2 has 0.2 M H_2SO_4 and 0.4 M HCl

(B) The volume ratio of NaOH used for H_2SO_4 and HCl is 1 : 2

(C) The volume ratio of NaOH used for H_2SO_4 and HCl is 1 : 1

(D) Molarity of SO_2Cl_2 solution is 0.1 M

26. Which one are correct about the solution that contains 3.42 ppm $Al_2(SO_4)_3$ and 1.42 ppm Na_2SO_4?

(A) $[Al^{3+}] = [Na^+]$ (B) $[SO_4^{2-}] = [Na^+] = [Al^{3+}]$

(C) $[SO_4^{2-}] = [Na^+] + [Al^{3+}]$ (D) $[SO_4^{2-}] = [Na^+]$

27. 100 mL of 0.1 M $NaHC_2O_4$ is neutralized by V_1 mL of 0.1 M NaOH and V_2 mL of a M $KMnO_4$ separately, then for complete neutralization

(A) volume of NaOH required = 200 mL (B) if M of $KMnO_4$ is 0.1 M then $\frac{V_1}{V_2} = 5:1$

(C) if M of $KMnO_4$ is 0.1 M then V_2 = 20 mL (D) if M of $KMnO_4$ is 0.2 M then V_2 = 2 mL

28. An mixture of $Na_2C_2O_4$ and $H_2C_2O_4$ requires 100 mL of 0.1 M $KMnO_4$ for complete neutralization. The same mixture on neutralization by a base requires 50 mL of 0.2 M NaOH solution. Which one are correct

(A) Mole ratio of $Na_2C_2O_4$ and $H_2C_2O_4$ = 4 : 1

(B) Equivalent ratio of $Na_2C_2O_4$ and $H_2C_2O_4$ = 4 : 1

(C) Moles of $C_2O_4^{2-}$ in mixture = 25×10^{-3}

(D) Mole ratio of $Na_2C_2O_4$ and $H_2C_2O_4$ = 1 : 4

29. Quantitative estimation of Fe^{2+} can be made by $KMnO_4$ in acidified medium. In which medium it can be estimated by $KMnO_4$.

(A) In H_2SO_4 (B) In HNO_3

(C) In HCl (D) all of these

30. Which one is not correct about the reaction : $FeS_2 \rightarrow Fe_2O_3 + SO_2$

(A) Eq. weight of FeS_2 is M/11 (B) Eq. wt. of SO_2 = M/5

(C) 1 mole of FeS_2 requires 7/4 mole of O_2 (D) S has –2 oxidation sate in FeS_2

Level-III

31. 0.220 g of a gas occupies a volume of 112 ml at a pressure of 1 atm and temperature of 273 K. The gas can be

(A) Nitrogen (B) nitrous oxide

(C) carbon dioxide (D) propane

32. Which of the following contains the same number of molecules?

(A) 1 g of O_2, 2 g of SO_2 (B) 1 g of CO_2, 1 g of N_2O

(C) 112 ml of O_2 at STP, 224 ml of He at 0.5 atm and 273 K

(D) 1 g of oxygen, 1 g of ozone

33. 0.2 mol of Na_3PO_4 and 0.5 mole of $Ba(NO_3)_2$ are mixed in 1L of solution. Which of the following is/are correct about this system.

(A) 0.2 mol of barium phosphate precipitate is obtained

(B) 0.1 mol of barium phosphate precipitate is obtained

(C) Molarity of Ba^{2+} ions in the resulting solution is 0.2

(D) Molarities of Na^+ and NO_3^- ions are 0.6 and 1.0 respectively.

34. 0.5 mole of sodium nitrite and 1 mole of ammonium chloride are mixed in aqueous solution. The solution is heated and the evolved gas is collected. Then which is/are correct about the gas/

(A) 22.4 L gas at STP (B) 11.2 L of gas at STP

(C) 0.5 mole of gas (D) 14 g of gas

35. 100 ml of mixture of CO and CO_2 is mixed with 30 ml of oxygen and sparked in a eudiometer tube. The residual gas after treatment with aqueous KOH has a volume of 10 ml which remains unchanged when treated with alkaline pyrogallol. If all the volumes are under the same conditions, point out the correct options.

(A) The volume of CO that reacts, is 60 ml

(B) The volume of CO that remains unreacted, is 10 ml

(C) The volume of O_2 that remains unreacted, is 10 ml

(D) The volume of CO_2 that gets absorbed by aqueous KOH, is 90 ml.

Passage-I

All such titration which involves the direct titration of Iodine with a reducing agent are grouped under Iodimetry. Iodimetry is employed to determine the strength of reducing agent such as sodium thio sulphate

$$I_2 + Na_2S_2O_3 \longrightarrow I^- + S_4O_6^{--}$$

If iodine is liberated as a result of chemical reaction involving oxidation of an iodide ion by a strong oxidizing agent in neutral or acidic medium the liberated iodine is then titrated with reducing agent. Iodometry is used to estimate the strength of oxidizing agent.

For example the estimation of Cu^{++} with thiosulphate.

$$Cu^{++} + I^- \longrightarrow Cu_2I_2 + I_2$$

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

Starch used as indicator near the end point which form blue colour complex with I_3^-. The blue colour disappears when there is no more of free I_2.

1. In Iodine titration Iodine remains in solution in the form of

(A) I_3^- (B) I_2 (C) I_3^+ (D) I^-

2. In the reaction, $2CuSO_4 + 4KI \longrightarrow Cu_2I_2 + 2K_2SO_4 + I_2$ the ratio of equivalent weight of $CuSO_4$ to its molecular weight is:

(A) 1/8 (B) 1/4 (C) ½ (D) 1

3. When 159.50g of $CuSO_4$ in a solution is reacted with KI, then the liberated iodine required 100 ml 1 M $Na_2S_2O_3$ for complete reaction, then what is the percentage purity of sample used in making the solution.

(A) 10% (B) 20% (C) 5% (D) None of these

4. 100 ml of 0.1 N hypo decolourised iodine by the addition of x g of crystalline blue vitriol to excess of KI. The value of x is

(A) 5g (B) 2.5g (C) 10g (D) 1.25g

Passage-II

Like acid base titration, in redox titration also, the equivalence point is reached when the reducing agent is completely oxidized by the oxidizing agent. But contrary to the acid-base titrations, oxidizing agents can themselves be used as internal indicator in redox titration e.g. $Cr_2O_7^{2-}$ (orange yellow), Cr^{3+} (green), MnO_4^- (purple), Mn^{2+} (light pink), where strength of the solution may be expressed as molarity i.e. number of moles of solute per litre of solution.

5. In a titration experiment, a student finds that 23.48 ml of a NaOH solution are needed to neutralize 0.5468g of KHP (molecular formula $KHC_8H_4O_4$). What is the concentration in molarity of NaOH solution?

(A) 0.114 M (B) 0.228M (C) 0.057M (D) 0.028 M

6. A 16.42 ml volume of 0.1327M $KMnO_4$ solution is needed to oxidize 25.00 ml of a $FeSO_4$ solution in an acidic medium. What is the number of moles of $FeSO_4$ being oxidized for the reaction

(A) 2.18×10^{-2} (B) 1.09×10^{-2} (C) 0.545×10^{-2} (D) 0.272×10^{-2}

7. A purple coloured solution is added from a burette to $FeSO_4$ solution kept in the flask. After sometime, the purple colour changes to light pink. The ion formed from that solution is

(A) MnO_4^- (B) Fe^{2+} (C) Fe^{3+} (D) Mn^{2+}

8. Concentrated aqueous sulphuric acid is 98% H_2SO_4 by mass and has a density of 1.84 g/ml. What volume of the concentrated acid is required to make 5 litre of 0.50M H_2SO_4 solution.

(A) 271.7 ml (B) 13.5 ml (C) 135.85 ml (D) 27.1 ml

Passage-III

Iodine titrations: Compounds containing iodine are widely used in titrations, commonly known as iodine titration. It is of two kinds:

(i) Iodometric titrations

(ii) Iodimetric titrations.

(i) **Iodometric titrations** : It is nothing but an indirect method of estimating the iodine. In this type of titration, an oxidizing agent is made to react with excess of KI, in acidic medium or, basic medium in which I^- oxidizes into I_2. Now the liberated I_2 can be titrated with $Na_2S_2O_3$ solution.

$$KI \xrightarrow{\text{Oxidising Agent}} I_2 \xrightarrow{Na_2S_2O_3/H^+} I^- + Na_2S_4O_6$$

Although solid I_2 is black and insoluble in water, but it converts into soluble I_3 ions

$$\underset{\text{Black}}{I_2(s)} + I^- \rightleftharpoons \underset{\text{dark brown}}{I_3^-}$$

Starch is used as indicator near the end point or equivalence point. Even small amount of I_2 molecules, gives blue colour with starch. The completion of the reaction can be detected when blue colour disappears at the and point. In iodimetric titration, the strength of reducing agent is determined by reacting it with I_2.

9. When 79.75 g of $CuSO_4$ sample containing inert impurity is reacted with KI, the liberated I_2 is reacted with 50 mL (1M) $Na_2S_2O_3$ in basic medium, where it oxidizes into SO_4^{2-} ions, and I_2 reduces into I^-, then what will be the % purity of $CuSO_4$ in sample ?
(A) 60% (B) 75% (C) 50% (D) 95%

10. When 214 g of KIO_3 reacts with excess of KI in presence of H^+, then it produces I_2. Now I_2 is completely reacted with 1 M $Na_2S_2O_3$ solution in basic medium, where it converts into SO_4^{2-} ions. Then what volume of $Na_2S_2O_3$ is needed to react the end point of the reaction?
(A) 500 mL (B) 800 mL (C) 1500 mL (D) 750mL.

11. A solution containing Cu^{2+} and $C_2O_4^{2-}$ ions M which on titration with M/10 $KMnO_4$ requires 50 mL. The resulting solution is neutralized with K_2CO_3, then treated with excess of KI. M The liberated I_2 required 25 mL M/10 $Na_2S_2O_3$ in acidic solution, then what is the difference of the number of m mole of Cu^{2+} and $C_2O_4^{2-}$ ions in the solution ?
(A) 40 (B) 10 (C) 30 (D) 50

12. When 1.66 g of KI is reacted with excess of KIO_3 in presence of dil. HCl, then I_2 is produced. The amount of KIO_3 reacted and the I_2 formed are respectively.
(A) 4×10^{-2} mole, 3×10^{-3} mole (B) 1.5×10^{-2} mole, 5×10^{-3} mole
(C) 5×10^{-2}mole, 1.5×10^{-3} mole (D) 2×10^{-3}mole, 6×10^{-3} mole.

Match the Column

1. Match the column

Column – I (Reaction)	**Column – II (Equivalent weight)**
(a) $NH_3 \longrightarrow NO_3^-$	(p) M/3
(b) $FeC_2O_4 \longrightarrow Fe^{3+} + 2CO_3^{2-}$	(q) M/6
(c) $H_2SO_5 \longrightarrow S_8$	(r) M/8
(d) $KMnO_4 \longrightarrow Mn^{2+}$	(s) M/5
	(t) reducing agent

2. Match the column

Column – I (Acid)	**Column – II (Nature)**
(a) H_3PO_4	(p) Monobasic
(b) H_3PO_3	(q) pentabasic
(c) H_3BO_3	(r) Tri basic
(d) EDTA	(s) Tetra basic
	(t) Dibasic

3. Match the following

Column – I	**Column – II**
(a) $KMnO_4 \xrightarrow{H^+} Mn^{+2}$	(p) M/2
(b) $MgC_2O_4 \longrightarrow Mg^{2+} + CO_2$	(q) M/5
(c) $K_2Cr_2O_7 \longrightarrow Cr^{+3}$	(r) M/6
(d) $CrO_5 \longrightarrow Cr_2O_3$	(s) M/3
	(t) Oxidising agent

ASSERTION/ REASON

(A) Statement – 1 is True, Statement – 2 is True; Statement – 2 is a correct explanation for Statement – 1.

(B) Statement – 1 is True, Statement – 2 is True; Statement – 2 is NOT a correct explanation for Statement – 1.

(C) Statement – 1 is True, Statement – 2 is False.

(D) Statement – 1 is False, Statement – 2 is True.

1. **STATEMENT – 1:** In the titrations of Na_2CO_3 with HCl using methyl orange indicator, the volume required at the equivalence point is twice that of acid required using phenolphthalein indicator.

   STATEMENT – 2: Two moles of HCl are required for complete neutralization of one mole of Na_2CO_3.

2. **STATEMENT – 1:** The molality of the solution does not change with temperature

   STATEMENT – 2: The molality is expressed in units of moles per 1000 gm of solvent.

3. **STATEMENT – 1 :**In the roasting of FeS_2, ore is converted into ferric oxide and SO_2 gas. The equivalent mass of FeS_2 is equal to molecular weight /11.

   STATEMENT – 2: The n-factor for reducing agent is total net change in oxidation number per formula unit.

4. **STATEMENT-1:** Molarity and molality of solution change with temperature

   STATEMENT-2 : On changing temperature the density of the solution is changed

5. **STATEMENT-1:** Atomic wt. of P atom in the molecule P_xO_y is $\frac{2yE_p}{x}$ where E_p is the equivalent mass of P atom

   STATEMENT-2 : The n factor of P is = $\frac{x}{y}$

6. **STATEMENT-1:** 109% H_2SO_4 represent a way to express concentration of industrial H_2SO_4

   because

   STATEMENT-2 : It represents that 9g H_2O reacts with 40g SO_3 to produce 49g H_2SO_4 in addition to 100g H_2SO_4

7. **STATEMENT-1:** The percentage of nitrogen in urea is 46.6%

   STATEMENT-2: Urea is a covalent compound.

8. **STATEMENT-1:** Molarity and molality of a solution both change with density.

   STATEMENT-2: Density of a solution changes when percentage by mass of a solution changes.

9. **STATEMENT-1** : H_3PO_3 is a dibasic acid and it's salt Na_3PO_3 does not exists

   STATEMENT-2 : Being dibasic nature, only two H are replaceable.

10. **STATEMENT-1 :** Addition of water to a solution containing solute and solvent changes it's normality or molarity.

    STATEMENT-2 : The milliequivalent and millimoles of the solute are not changed on dilution.

INTEGER ANSWER TYPE QUESTIONS

1. 0.01 mole of FeS_n (iron (II) sulphide) required 0.06 mole of AO_4^{3-} for complete oxidation. The species formed are FeO, SO_2 and A^{2+}. Calculate the value of n.

2. A solution containing 2.68×10^{-3} mol of A^{n+} ions requires 1.61×10^{-3} mol of MnO_4^- for the complete oxidation of A^{n+} to AO_3^- in acidic medium. What is the value of n ?

3. Haemoglobin contains 0.25% iron by weight. The molecular weight of Haemoglobin is 89600. Calculate the no. of iron atom per molecule of Haemoglobin.

4. Copper forms two oxides. For the same amount of copper, twice as much oxygen was used to form first oxide than to form second one. If valence of Cu in I oxide is 2, then find the valence of Cu in second oxide ?

5. 1.575 g of oxalic acid $(COOH)_2 . xH_2O$ are dissolved in water and the volume made upto 250 mL. On titration 16.68 mL of this solution requires 25mL of N/15 NaOH solution for complete neutralization. Calculate x.

6. What is the oxidation number of Cr in $K_2Cr_2O_7$? (Need to answer the integer part only).

7. One mole of N_2H_4 loses 10 moles of electrons to form a new compound Y. Assuming that all nitrogen appears in the new compound, what is the oxidation number of nitrogen in Y (there is not change in the oxidation state of hydrogen). (Need to answer the integer part only).

8. 0.63 g of dibasic acid was dissolved in water. The volume of the solution was made 100 mL. 2 mL of this acid solution required 10 mL $\frac{N}{5}$ NaOH solution. What is the normality of acid.

9. A solution of H_2O_2 is titrated against a solution of $KMnO_4$. The reaction is

$$2MnO_4^- + 5H_2O_2 + 6H^+ \rightarrow 2Mn^{2+} + 5O_2 + 8H_2O$$

If it requires 46.9 mL of 1.45 M $KMnO_4$ to oxidize 20 g of H_2O_2, find the approximate mass percentage of H_2O_2 in this solution.

10. Find the amount of caustic soda (in gram) required for complete neutralization of 100 mL 1 N HCl.

SUBJECTIVE QUESTIONS

1. Calculate the weight of MnO_2 and the volume of HCl of specific gravity 1.2 gml^{-1} and 4% nature by weight needed to produce 1.78 litre of Cl_2 at STP by the reaction. $MnO_2 + 4\,HCl \longrightarrow MnCl_2 + 2H_2O + Cl_2$

2. A solution of H_2O_2, labeled as '20 volumes' was left open. Due to this some H_2O_2 decomposed and the volume strength of the solution decreased. To determine the new volume strength of the H_2O_2 solution, 10 mL of the solution was taken and it was diluted to 100 mL. 10mL of this diluted solution was titrated against 25 mL of 0.0245 M $KMnO_4$ solution under acidic condition. Calculate the volume strength of the H_2O_2 solution.

3. A 2.0 g sample of a mixture containing sodium carbonate, sodium bicarbonate and sodium sulphate is heated till the evolution of CO_2 ceases. The volume of CO_2 at 750 mm Hg pressure and at 298 K is measured to be 123.9 mL. A 1.5 g of the sample requires 150 mL of M/10 HCl for complete neutralization. Calculate the percentage composition of the components of the mixture.

4. One litre of a mixture of O_2 and O_3 at STP was allowed to react with an excess of acidified solution of KI. The iodine liberated required 40 mL of M/10 sodium thiosulphate solution for titration. What is the mass per cent of ozone in the mixture? Ultraviolet radiation of wavelength 300 nm can decompose ozone. Assuming that one photon can decompose one ozone molecule, how many photons would have been required for the complete decomposition of ozone in the original mixture.

5. Potassium selenate is isomorphous with potassium sulphate and contains 45.52% selenium by weight. Calculate the atomic weight of selenium. Also report the equivalent weight of potassium selenate.

6. Borax in water gives:

$$B_4O_7^{2-} + 7H_2O \longrightarrow 4H_3BO_3 + 2OH^-$$

How many gram of borax ($Na_2B_4O_7.10H_2O$) are required to?

a) Prepare 50 mL of 0.2 M solution

b) neutralize 25 mL of 0.1934 M of HCl and H_2SO_4 separately

7. For estimating ozone in the air, a certain volume of air is passed through an acidified or neutral KI solution when oxygen is evolved and iodide is oxidized to give iodine. When such a solution is acidified, free iodine is evolved which can be titrated with standard $Na_2S_2O_3$ solution. In an experiment, 10 litre of air at 1 atm and 27°C were passed through an alkaline KI solution, at the end, the iodine entrapped in a solution on titration as above required 1.5 mL of 0.01 N $Na_2S_2O_3$ solution. Calculate volume % of O_3 in sample.

8. 1.249 g of a sample of pure $BaCO_3$ and impure $CaCO_3$ containing some CaO was treated with dil.HCl and it evolved 168 ml of CO_2 at NTP. From this solution, $BaCrO_4$ was precipitated, filtered and washed. The precipitate was dissolved in dilute sulphuric acid and diluted to 100 ml. 10 ml of this solution, when treated with KI solution, liberated iodine which required exactly 20 ml of 0.05 N $Na_2S_2O_3$. Calculate the percentage of CaO in the sample.

9. In a quality control analysis for sulphur impurity 5.6g steel sample was burnt in a stream of oxygen and sulphur was converted into SO_2 gas. The SO_2 was then oxidized to sulphate by using H_2O_2 solution to which had been added 30 mL of 0.04M NaOH. The equation for reaction is:

$$SO_{2(g)} + H_2O_{2(aq)} + 2OH^-_{(aq)} \longrightarrow SO_4^{2-}{}_{(aq)} + 2H_2O_{(l)}$$

22.48 mL of 0.024M HCl was required to neutralize the base remaining after oxidation reaction. Calculate % of sulphur in given sample.

10. A granulated sample of aircraft alloy (Al, Mg, Cu) weighing 8.72g was first treated with alkali and then with very dilute HCl, leaving a residue. The residue after alkali boiling weighed 2.10g and the acid insoluble residue weighed 0.69g. What is the composition of the alloy?

11. 2.480g of $KClO_3$ are dissolved in conc. HCl and the solution was boiled. Chlorine gas evolved in the reaction was then passed through a solution of KI and liberated iodine was titrated with 100 mL of hypo. 12.3 mL of same hypo solution required 24.6 mL of 0.5 N iodine for complete neutralization. Calculate % purity of $KClO_3$ sample.

12. P and Q are two elements which forms P_2Q_3 and PQ_2. If 0.15 mole of P_2Q_3 weights 15.9g and 0.15 mole of PQ_2 weights 9.3g, what are atomic weights of P and Q?

13. 25 mL of a solution containing Fe^{2+} and Fe^{3+} sulphate acidified with H_2SO_4 is reduced by 3g of metallic zinc. The solution required 34.25 mL of N/10 solution of $K_2Cr_2O_7$ for oxidation. Before reduction with zinc, 25 mL of the same solution required 22.45 mL of same $K_2Cr_2O_7$ solution. Calculate the strength of $FeSO_4$ and $Fe_2(SO_4)_3$ in g/litre of solution.

14. 50 mL solution of H_2O_2 was treated with excess KI (s) and the solution was acidified with acetic acid. The liberated iodine required 40 mL 0.5 M $Na_2S_2O_3$ solution for the end point using starch as indicator. Find the "molarity" and "volume strength" of the H_2O_2 solution.

15. 2.0g sample of $KMnO_4$ (MW = 158) containing some inert materials was dissolved in water acidified with H_2SO_4 resulting solution was treated with 62 mL 0.5 M oxalic acid solution. The excess of oxalic acid was back titrated with 20 mL 0.1 M $K_2Cr_2O_7$. Calculate percent purity of $KMnO_4$ sample.

PREVIOUS YEAR IIT-JEE QUESTIONS

1. The oxidation number of phosphorus in $Ba(H_2PO_2)_2$ is

(A) +3 (B) +2

(C) +1 (D) –1 **[IIT 1991]**

2. The oxidation states of the most electronegative element in the products of the reaction, BaO_2 will dil.H_2SO_4 is

(A) 0 and –1 (B) –1 and –2

(C) –2 and 0 (D) –2 and –1 **[IIT 1991]**

3. Read the following statement and explanation and answer as per the options given below :

Statement-1 : In the titration of Na_2CO_3 with HCl using methyl orange indicator, the volume required at the equivalence point is twice that of the acid required using phenolphthalein indicator.

Statement-2: Two moles of HCl are required for the complete neutralization of one mole of Na_2CO_3.

[IIT 1991

4. For the redox reaction : $2MnO_4^- + C_2O_4^{2-} + H^+ \rightarrow Mn^{2+} + CO_2 + H_2O$, the correct coefficients of the reactants for the balanced reaction are

	MnO_4^-	$C_2O_4^{2-}$	H^+
(A)	2	5	16
(B)	16	5	2
(C)	5	16	2
(D)	2	16	5

[IIT 1992]

5. The number of moles of $KMnO_4$ that will be needed to react completely with one mole of ferrous oxalate in acidic solution is

(A) $\frac{3}{5}$ (B) $\frac{2}{5}$

(C) $\frac{4}{5}$ (D) 1 **[IIT 1997]**

6. The normality of 0.3 M phosphorous acid (H_3PO_3) is

(A) 0.1 (B) 0.9

(C) 0.3 (D) 0.6 **[IIT 1999]**

7. The oxidation number of sulphur in S_8, S_2F_2, H_2S respectively, are

(A) 4,2,3 (B) 0,3,2

(C) 0,1,–2 (D) 0,–2,–2 **[IIT 1999]**

8. Amongst the following identify the species with an atom in +6 oxidation state

(A) MnO_4^- (B) $Cr(CN)_6^{3-}$

(C) NiF_6^{2-} (D) CrO_2Cl_2 **[IIT 2000]**

9. The reaction, $3ClO^-(aq) \rightarrow ClO_3^-(aq) + 2Cl^-(aq)$, is a example of

(A) oxidation reaction (B) reduction reaction

(C) disproportionation reaction (D) decomposition reaction

10. An aqueous solution of 6.3 g oxalic acid dihydrate is made up to 250 ml. The volume of 0.1 N NaOH required to completely neutralize 10 ml of this solution is

(A) 40 ml (B) 20 ml

(C) 10 ml (D) 4 ml **[IIT 2001]**

11. In the standardization of $Na_2S_2O_3$ using $K_2Cr_2O_7$ by iodometry, the equivalent weight of $K_2Cr_2O_7$ is

(A) (molecular weight)/2 (B) (molecular weight)/6

(C) (molecular weight)/6 (D) same as molecular weight **[IIT 2001]**

12. How many moles of electron weight one kilogram?

(A) 6.023×10^{23} (B) $\frac{1}{9.108} \times 10^{31}$

(C) $\frac{6.023}{9.108} \times 10^{54}$ (D) $\frac{1}{9.108 \times 6.023} \times 10^{8}$ **[IIT 2008]**

13. Which has maximum number of atoms?

(A) 24 g of C(12) (B) 56 g of Fe(56)

(C) 27 g of Al(27) (D) 108 g of Ag (108) **[IIT 2003]**

14. Mixture X = 0.02 mol of $[Co(NH_3)_5SO_4]$ Br and 0.02 mol of $[Co(NH_3)_5BNr]SO_4$ was prepared in 2 litre of solution.

1 litre of mixture X + excess $AgNO_3 \rightarrow$ Y.

1 litre of mixture X + excess $BaCl_2 \rightarrow$ Z.

(A) 0.01, 0.01 (B) 0.02, 0.01

(C) 0.01, 0.02 (D) 0.02, 0.02 **[IIT 2003]**

15. The pair of the compounds in which both the metals are in the highest possible oxidation state is

(A) $[Fe(CN)_6]^{3-}$, $[Co(CN)_6]^{3-}$ (B) CrO_2Cl_2, MnO_4^-

(C) TiO_3, MnO_2 (D) $[Co(CN)_6]^{3-}$, MnO_3 **[IIT 2004]**

16. 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

(A) 3 (B) 4

(C) 5 (D) 6 **[IIT 2007]**

Subjective Type Questions

1. A solid mixture (5.0 g) consisting of lead nitrate and sodium nitrate was heated below 600ºC until the weight of the residue was constant. If the loss in weight is 28.0 per cent, find the amount of lead nitrate and sodium nitrate in the mixture. **[IIT 1990]**

2. Calculate the molality of 1 litre solution of 93% H_2SO_4 (weight/volume). The density of the solution is 1.84 g/ml. **[IIT 1990]**

3. A solution of 0.2 g of a compound containing Cu^{2+} and $C_2O_4^{2-}$ ions on titration with 0.02 M $KMnO_4$ in presence of H_2SO_4 consumes 22.6 ml. of the oxidant. The resultant solution is neutralized with Na_2CO_3, acidified with dil. acetic acid and treated with excess KI. The liberated iodine requires 11.3 ml of 0.05 M $Na_2S_2O_3$ solution for complete reduction. Find out the molar ratio of Cu^{2+} to $C_2O_4^{2-}$ in the compound. Write down the balanced redox reactions involved in the above titrations. **[IIT 1991]**

4. A 1.0 g sample of Fe_2O_3 solid of 55.2% purity is dissolved in acid and reduced by heating the solution with zinc dust. The resultant solution is cooled and made upto 100.0 ml. An aliquot of 25.0 ml of this solution requires 17.0 ml of 0.0167 M of solution of an oxidant for titration. Calculate the number of electrons taken up by the oxidant in the reaction of the above titration. **[IIT 1991]**

5. A 2.0 g sample of a mixture containing sodium carbonate, sodium bicarbonate and sodium sulphate is gently heated till the evolution of CO_2 ceases. The volume of CO_2 at 750 mm Hg pressure and at 298 K is measured to be 123.9 ml. A 1.5 g of the same sample requires 150 ml of (M/10) HCl for complete neutralization. Calculate the % composition of the components of the mixture. **[IIT 1992]**

6. One gram of commercial $AgNO_3$ is dissolved in 50 ml. of water. It is treated with 50 ml. of a KI solution. The silver iodide thus precipitated in filtered off. Excess of KI in the filtrate is titrated with (M/10) KIO_3 solution in pressure of 6 M HCl till all I^- ions are converted into ICl. It requires 50 ml. of (M/10) KIO_3 solution. 20 ml of the same stock solution of KI requires 30 ml. of (M/10) KIO_3 under similar conditions. Calculate the percentage of $AgNO_3$ in the sample.

(Reaction : $KIO_3 + 2KI + 6HCl \rightarrow 3ICl + 3KCl + 3H_2O$) **[IIT 1992]**

7. Upon mixing 45.0 ml. of 0.25 M lead nitrate solution with 25.0 ml of 0.10 M chromic sulphate solution, precipitation of lead sulphate takes place. How many moles of lead sulphate are formed? Also, calculate the molar concentrations of the species left behind in the final solution. Assume that lead sulphate is completely insoluble. **[IIT 1993]**

8. The composition of a sample of Wustite is $Fe_{0.93}O_{1.00}$. What percentage of the iron is present in the form of Fe(III)? **[IIT 1994]**

9. 8.0575×10^{-2} kg of Glauber's salt is dissolved in water to obtain 1 dm^3 of a solution of density 1077.2 kg m^{-3}. Calculate the molarity, molality and mole fraction of $Na_2.SO_4$ in the solution.

[IIT 1994]

10. A 3.00 g sample containing Fe_3O_4, Fe_2O_3 and an inert impure substance, is treated with excess of KI solution in presence of dilute H_2SO_4. The entire iron is converted into Fe^{2+} along with the liberation of iodine. The resulting solution is diluted to 100 ml. A 20 ml of the diluted solution requires 11.0 ml of 0.5 M $Na_2S_2O_3$ solution to reduce the iodine present. A 50 ml of the diluted solution, after complete extraction of the iodine requires 12.80 ml of 0.25 M $KMnO_4$ solution in dilute H_2SO_4 medium of the oxidation of Fe^{2+}. Calculate the percentage of Fe_2O_3 and Fe_3O_4 in the original sample.

[IIT 1996]