Some Basic Concepts of Chemistry

Single Correct Choice Type

1. In the reaction, $Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + NaI$ (not balanced), which of the following is/are true?
   (I) $Na_2S_2O_3$ is a reducing agent.
   (II) Iodine is an oxidizing agent.
   (III) It is an example of intermolecular redox reaction.
   (IV) In $Na_2S_4O_6$ the average oxidation state of S is (+5/2)
   (A) I, II, IV (B) I, II
   (C) I, II, III (D) I, II, III, IV

2. The number of electrons involved in the reduction of nitrate ion (NO_3^-) to hydrazine (N_2H_4) is
   (A) 8 (B) 7
   (C) 5 (D) 3

3. SO_2 under atmospheric condition changes to SO_x^{2-}. If oxidation number of *S* in is + 6, what is the value of *x* in SO_x^{2-}?
   (A) 1 (B) 2
   (C) 3 (D) 4

4. $NaIO_3$ reacts with $NaHSO_3$ according to equation: $IO_3^- + 3HSO_3^- \rightarrow I^- + 3H^+ + 3SO_4^{2-}$. The weight of $NaHSO_3$ required to react with 100 mL of solution containing 0.66 g of $NaIO_3$ is
   (A) 5.2 g (B) 4.57 g
   (C) 2.3 g (D) 10.4 g.

5. In the reaction $4I^- + Hg^{2+} \rightarrow HgI_4^{2-}$, 1 mol each of Hg^{2+} and I^- will form
   (A) 1 mol (B) 0.5 mol
   (C) 0.25 mol (D) 2 mol

6. A 0.46 g sample of As_2O_3 required 25.0 ml of $KMnO_4$ solution for its titration. The molarity of $KMnO_4$ solution is
   (A) 0.016 (B) 0.064
   (C) 0.032 (D) 0.128

7. Number of moles of $K_2Cr_2O_7$ reduced by 1 mole of Sn^{2+} is
(A) 1/3 (B) 1/6
(C) 2/3 (D) 1

8. Equivalent weight of H_3PO_2 (mol. wt. = M) when it disproportionates into PH_3 and H_3PO_3 is
(A) M (B) M/2
(C) M/4 (D) 3M/4

9. 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

10. What is the equivalent weight of $C_{12}H_{22}O_{11}$ in the following reaction?

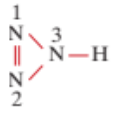
$$C_{12}H_{22}O_{11} + 36\ HNO_3 \rightarrow 6\ H_2C_2O_4 + 36\ NO_2 + 23\ H_2O$$

(A) 342/36 (B) 342/12
(C) 342/22 (D) 342/3

11. Which oxyacid of Cl cannot undergo disproportionation?
(A) HClO (B) $HClO_2$
(C) $HClO_3$ (D) $HClO_4$

12. Which of the following oxides is most basic?
(A) MnO (B) Mn_2O_3
(C) MnO_2 (D) Mn_2O_7

13. In this compound HN_3 (hydrazoic acid), oxidation state of N^1, N^2 and N^3 are



(A) 0, 0, 3 (B) 0, 0, –1
(C) 1, 1, –3 (D) –3, –3, –3

14. Which of the following agents is the most oxidizing?
(A) O_3 (B) $KMnO_4$
(C) H_2O_2 (D) $K_2Cr_2O_7$

15. When 1 mol of $KClO_3$ takes 4 mol of electrons, the expected product is
(A) ClO^{2-} (B) ClO^{4-}
(C) OCl (D) Cl^-

16. On the basis of structure, the oxidation states of two Cl atoms in $CaOCl_2$, respectively, are
(A) –1 and +1 (B) +2 and –2
(C) –2 and +2. (D) –1 and +3.

17. A blue color appears on addition of aqueous ammonia to aqueous $CuSO_4$ due to reaction

$$CuSO_4 + 4NH_3 \rightarrow [Cu(NH_3)_4]SO_4$$

In this reaction,
(A) copper is oxidized.
(B) copper is reduced.
(C) ammonia is reduced.
(D) None of these.

18. Among the following molecules, in which does bromine show the maximum oxidation number?
(A) $Hg_2(BrO_3)_2$ (B) Br–Cl
(C) $KBrO_4$ (D) Br_2

19. When copper is treated with a certain concentration of nitric acid, nitric oxide and nitrogen dioxide are liberated in equal volumes according to the equation,

$$xCu + yHNO_3 \rightarrow Cu(NO_3)_2 + NO + NO_2 + H_2O.$$

The coefficients of x and y are
(A) 2 and 3 (B) 2 and 6
(C) 1 and 3 (D) 3 and 8

20. What is the oxidation number of carbon in A?

$$CH_2(COOH)_2 \xrightarrow{P_4O_{10}} A$$

(A) +4 (B) +3/4
(C) +4/3 (D) +2/3

21. When iodine is passed through sodium thiosulphate, it is decolorized and sodium tetrathionate is formed. What is the change in the oxidation number of a sulphur atom in the reaction?
(A) 1/2 (B) 3/2
(C) 2 (D) 1

22. In the alkaline medium, the color of potassium dichromate solution changes from orange to yellow due to the formation of potassium chromate. What is the change in oxidation state of chromium?
(A) 1 (B) 2
(C) 3 (D) 0

23. The oxidation number of carbon in CH_2Cl_2 is
(A) –4 (B) +4
(C) 0 (D) –2

24. SO_2 is passed through an acidified solution of potassium dichromate, the oxidation state of S changes from
(A) +4 to 0 (B) +4 to +2
(C) +4 to +6 (D) +6 to +4

25. The oxidation states of sulphur in the anions SO_3^{2-}, $S_2O_4^{2-}$ and $S_2O_6^{2-}$ follow the order
(A) $S_2O_4^{2-} < SO_3^{2-} < S_2O_6^{2-}$
(B) $SO_3^{2-} < S_2O_4^{2-} < S_2O_6^{2-}$
(C) $S_2O_4^{2-} < S_2O_6^{2-} < SO_3^{2-}$
(D) $S_2O_6^{2-} < S_2O_4^{2-} < SO_3^{2-}$

26. Which of the following compounds contain the metal atom in its highest possible oxidation state?
(A) KSCN (B) MnO_2
(C) Cr_2O_3 (D) H_2SnCl_4

27. A compound of Xe and F is found to have 53.5% Xe. What is the oxidation number of Xe in this compound?
(A) –4 (B) 0
(C) +4 (D) +6

28. Which reaction involves neither oxidation nor reduction?
(A) $CrO_4^{2-} \rightarrow Cr_2O_7^{2-}$ (B) $Cr \rightarrow CrCl_3$
(C) $Na \rightarrow Na^+$ (D) $2S_2O_3^{2-} \rightarrow S_4O_6^{2-}$

29. Which one of the following is an example of disproportionation?
(A) $NH_3 + 3CuO \rightarrow 3Cu + 3H_2O + N_2$
(B) $5HI + HIO_3 \rightarrow 3H_2O + 3I_2$
(C) $I_2 + 2Na_2S_2O_3 \rightarrow 2NaI + Na_2S_4O_6$
(D) $P_4 + 3NaOH + 3H_2O \rightarrow 3NaH_2PO_2 + PH_3$

30. H_2O_2 acts as a reducing agent in
(A) $2 + HCl + H_2O_2 \rightarrow FeCl_3 + H_2O$
(B) $Cl_2 + H_2O_2 \rightarrow 2HCl + O_2$
(C) $2HI + H_2O_2 \rightarrow I_2 + H_2O$
(D) $H_2SO_3 + H_2O_2 \rightarrow H_2SO_4 + H_2O$

31. Which of the following has been arranged in order of increasing oxidation number of nitrogen?
(A) $NH_3 < N_2O_5 < NO < N_2$
(B) $NO_2^+ < NO_3^- < NO_2^- < N_3^-$
(C) $NH_4^+ < N_2H_4 < NH_2OH < N_2O$
(D) $NO_2 < NaN_3 < NH_4^+ < N_2O$

32. Which of the following agents is the most reducing?
(A) Mg (B) Na
(C) K (D) Br_2

33. No disproportionation is possible for
(A) AsH_3 (B) SF_4
(C) H_5IO_6 (D) PCl_3

34. In the reaction

$$3Br_2 + 6CO_3^{2-} + 3H_2O \rightarrow 5Br^- + BrO_3^- + 6HCO_3^-$$

(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.

35. When the ion $Cr_2O_7^{2-}$ acts as an oxidant in the acidic aqueous solution, the ion Cr^{3+} is formed. How many moles of Sn^{2+} would be oxidized to Sn^{4+} by one mol of $Cr_2O_7^{2-}$ ions?
(A) 1 (B) 2
(C) 4 (D) 3

36. A sample of 2.5 mol of hydrazine (N_2H_4) loses 25 mol of electrons on being converted to a new compound X. Assuming that there is no loss of nitrogen in the formation of the new compound, what is the oxidation number of nitrogen in compound X?
(A) –1 (B) –2
(C) +3 (D) +4

37. An element, which never has a positive oxidation state in any of its compounds, is
(A) boron. (B) oxygen.
(C) chlorine. (D) fluorine.

38. The average oxidation number of sulphur in $Na_2S_4O_6$ is
(A) 1.5 (B) 2.5
(C) 3 (D) 2

39. Oxidation number of fluorine in F_2O is
(A) +1 (B) +2
(C) –1 (D) –2

40. How many moles of $KMnO_4$ are required in the acidic medium for complete oxidation of 15 mol of $FeSO_4$?
(A) 2 (B) 3
(C) 4 (D) 5

41. Equivalent weight of MnO_4^- in acidic, basic, and neutral media is in the ratio of
(A) 3:5:15 (B) 5:3:1
(C) 5:1:3 (D) 3:15:5

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

43. In which of the following compounds, transition metal has zero oxidation state?
(A) CrO_5 (B) $NH_2 \cdot NH_2$
(C) $NOClO_4$ (D) $[Fe(CO)_5]$

44. Consider the following reactions:

(I) $C_2O_4^{2-} \rightarrow CO_2$ (II) $SO_4^{2-} \rightarrow SO_3^{2-}$

(III) $MnO_4^{2-} \rightarrow MnO_4^+$ (IV) $Fe^{3+} \rightarrow Fe^{2+}$

Choose the correct answer:
(A) (I) and (II) show oxidation.
(B) (III) and (IV) shows reduction.
(C) (I) and (III) show oxidation.
(D) (III) and (IV) shows oxidation.

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

46. How many moles of electron is needed for the reduction of each mole of Cr in the following reaction?

$$CrO_5 + H_7SO_4 \rightarrow Cr_2(SO_4)_3 + H_2O + O_2$$

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

47. Hydroxylamine reduces iron(III) according to following equation

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

Which statement is correct?
(A) *n*-factor for hydroxylamine is 1.
(B) Equivalent weight of $Fe_2(SO_4)_3$ is M/2.
(C) 6 Milliequiv. of $Fe_2(SO_4)_3$ is contained in 3 millimoles of ferric sulphate.
(D) All of these.

48. 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.

49. 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_4^{2-} and nitrate ?
(A) 0.7 L (B) 1 L
(C) 0.8 L (D) 1.1 L

50. 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

51. 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%

52. 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

53. 40% *w*/*V* NaCl solution (specific gravity = 1.12) is equivalent to
(A) 3.57×10^5 ppm (B) 3.57×10^6 ppm
(C) 1×10^6 ppm (D) 4×10^5 ppm

54. Oxalic acid ($H_2C_2O_4$) form two series of salt $HC_2O_4^-$ and $C_2O_4^-$. If 0.9 g of oxalic acid is in 100 mL solution, $HC_2O_4^-$ and $C_2O_4^-$ have normality, respectively,,
(A) 0.1 N, 0.1N (B) 0.1 N, 0.2 N
(C) 0.2 N, 0.2 N (D) 0.2 N, 0.1 N

Multiple Correct Choice type

1. $H_2C_2O_4$ and $NaHC_2O_4$ behave as acids as well as reducing agents. Which are correct statements?
(A) Equivalent weight of $H_2C_2O_4$ and $NaHC_2O_4$ are equal to their molecular weights when acting as reducing agents
(B) Equivalent weight of $H_2C_2O_4$ and $NaHC_2O_4$ are equal to half their molecular weights when acting as reducing agents
(C) 100 mL of 1 M solution of each is neutralized by equal volumes of 1 N $Ca(OH)_2$
(D) 100 mL of 1 M solution of each is oxidized by equal volumes of 1 M $KMnO_4$

2. For the following balanced redox reaction,

$$2MnO_4^+ + 4H^+ + Br_2 \rightleftharpoons 2Mn^{2+} + 2BrO_3^+ + 2H_2O$$

If the molecular wt. of MnO_4^-, Br_2 be M_x, M_y, respectively, then
(A) equivalent weight of MnO_4^+ is $M_x/5$.
(B) equivalent weight of Br_2 is $M_y/10$.
(C) the *n*-factor ratio of Mn^{2+} to BrO_3^- is 1 : 1.
(D) none of these.

3. Which of the following statements about the following reactions are wrong?

$$2Cu_2O(s) + Cu_2S(s) \rightarrow 6Cu(s) + SO_2g$$

(A) Both Cu_2O and Cu_2S are reduced.
(B) Only Cu_2S is reduced.
(C) Cu_2S is the oxidant.
(D) Only Cu_2O is reduced.

4. Which of the following substances undergo disproportionation reactions under basic medium?
(A) F_2 (B) P_4
(C) S_8 (D) Br_2

5. A reducing agent in a redox reaction undergoes
(A) a decrease in oxidation number.
(B) an increase in oxidation number.
(C) loss of electrons.
(D) gain of electrons.

6. Which of the following statements are correct?
(A) All reactions are oxidation and reduction reactions.
(B) Oxidizing agent is itself reduced.
(C) Oxidation and reduction always go side by side.
(D) Oxidation number during reduction decreases.

7. The metals undergoing disproportionation are
(A) Sn (B) Na
(C) Cu (D) Ca

8. Which of the following is correct about acidic nature?
(A) $H_3PO_4 > H_3PO_3$ (B) $H_3AsO_4 > H_3AsO_3$
(C) $HClO_4 > HClO_3$ (D) $HNO_3 > HNO_2$

9. In which of the following, oxidation number of oxygen is fractional?
(A) B_4O_{10} (B) B_2H_6
(C) CsO_2 (D) KO_3

10. The reaction $KI + I_2 \rightarrow KI_3$ is
(A) oxidation. (B) reduction.
(C) complex formation. (D) None of these.

11. The activity series of metals is
Au < Ag < Cu < Sn < Cd < Zn < Al < Mg < Na < Cs
Which reaction below **does not** occur spontaneously upon mixing the reagents shown?
(A) $Cd(s) + Al^{3+}(aq) \rightarrow Cd^{2+}(aq) + Al(s)$
(B) $Cd(s) + Cu^{2+}(aq) \rightarrow Cd^{2+}(aq) + Cu(s)$
(C) $Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$
(D) $Al(s) + Ag^+(aq) \rightarrow Al^{3+}(aq) + Ag(s)$

12. Which of the following represent redox reactions?
(A) $Cr_2O_7^{2-} + 2OH^- \rightarrow 2CrO_4^{2-} + H_2O$
(B) $2CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$
(C) $2MnO_4 + 3Mn^2 + 4OH^- \rightarrow 5MnO_2 + 2H_2O$
(D) $IO_4^- + I^- + H^+ \rightarrow I_2 + H_2O$

13. For the following balanced redox reaction,

$$2MnO_4^+ + 4H^+ + Br_2 \rightleftharpoons 2Mn^{2+} + 2BrO_3^+ + 2H_2O$$

If the molecular weight of MnO_4^-, Br_2 be M_{B1}, M_{B2}, respectively, then
(A) equivalent weight of MnO_4^- is $M_{B1}/5$.
(B) equivalent weight of Br_2 is $M_{B2}/10$.
(C) the *n*-factor ratio of Mn^{2+} to BrO_3^- is 1:1.
(D) none of these.

14. When non-stoichiometric compound $Fe_{0.95}O$ is heated in presence of oxygen, then it converts into Fe_2O_3. Which of the following statements are correct?
(A) Equivalent weight of $Fe_{0.95}$ O is $M_B/0.5$ where M_B is molecular weight of $Fe_{0.95}O$.

(B) The number of moles of Fe^{3+} and Fe^{2+} in 1 mol $Fe_{0.95}O$ are 0.1 and 0.85, respectively.
(C) The number of moles of Fe^{3+} and Fe^{2+} in 1 mol of $Fe_{0.95}O$ are 0.85 and 0.1, respectively
(D) The % composition of Fe^{2+} and Fe^{3+} in the non-stoichiometric compound is 89.47% and 10.53%, respectively.

15. A group of students attempted to estimate the concentration of Fe^{2+} by pipetting fixed volumes of the solution into a flask, adding an excess of dilute sulphuric acid, and then titrating with a standard solution of potassium manganate (VII) from a burette. The volume of $KMnO_4$ solution required by one student was 0.2 cm^3 higher than that of the other students. Which of the following are possible explanations for this discrepancy?
(A) The titration flask was rinsed with the solution of Fe^{2+} instead to water before titration.
(B) The last drop of Fe^{2+} solution was blown from the pipette into the flask.
(C) The burette was rinsed with water instead of the solution of $KMnO_4$ before titration.
(D) One student rinsed with the solution of Fe^{2+} and other rinsed with solution of $KMnO_4$ before titration.

16. 40 g NaOH, 106 g Na_2CO_3 and 84 g. $NaHCO_3$ is dissolved in water and the solution is made 1 L, 20 mL of this stock solution is titrated with 1 N HCl, hence which of the following statements are correct?
(A) The liter reading of HCl will be 40 mL, if phenolphthalein is used indicator from the very beginning.
(B) The liter reading of HCl will be 60 mL if phenolphthalein is used indicator from the very beginning.
(C) The liter reading of HCl will be 40 mL if methyl orange is used indicator after the first end point.
(D) The liter reading of HCl will be 80 mL, if methyl orange is used as indicator from the very beginning.

17. 150 mL of M/10 $Ba(MnO_4)_2$ in acidic can oxidize completely
(A) 150 mL of 1 M Fe^{2+} solution.
(B) 50 mL of 1 M FeC_2O_4 solution.
(C) 75 mL of 1 M $C_2O_4^{2-}$ solution.
(D) 25 mL of 1 M $K_2Cr_2O_7$ solution.

18. $\begin{matrix}COOH\\|\\COOH\end{matrix}$ and $\begin{matrix}COOK\\|\\COOK\end{matrix}$ behave as acids are well as reducing agents. Then which of the following are the correct statements?
(A) When they behave as reducing agents, then their equivalent weights are equal to half of their molecular weights, 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 neutralized by 200 mL 2 M of $KMnO_4$ in acidic medium.

19. 0.1 mol of MnO_4^- (in acidic medium) can
(A) oxidize 0.5 mol of Fe^{2+}
(B) oxidize 0.166 mol of FeC_2O_4
(C) oxidize 0.25 mol of $C_2O_4^{2-}$
(D) oxidize 0.6 mol of $Cr_2O_7^{2-}$

20. The reaction $3ClO^-(aq) \rightarrow ClO_3^-(aq) + 2Cl^-(aq)$ is an example of
(A) oxidation reaction.
(B) reduction reaction.
(C) disproportionation reaction.
(D) decomposition reaction.

Assertion–Reasoning Type

Choose the correct option from the following:
(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:** The equivalent weight of reducing agent, Fe^{2+} is 56 (atomic mass of Fe = 56).
Statement 2: Fe loses $2e^-$ to be converted into Fe^{2+}.

2. **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.

3. **Statement 1:** In CrO_5, there must be peroxide linkage.
Statement 2: The maximum oxidation number of an element cannot exceed its number of valence electron.

4. **Statement 1:** $CaCO_3 + 2HCl \rightarrow CaCl_2 + H_2O + CO_2$ is a redox reaction.
Statement 2: Equivalent weight of $CaCO_3$ in this reaction is 50.

5. **Statement 1:** Fe reacts with HCl to produce H_2 gas.
Statement 2: Fe is a better reducing agent than H_2.

6. **Statement 1:** Hydrogen peroxide acts only as oxidizing agent.
Statement 2: All peroxides can undergo disproportionation.

7. **Statement 1:** Oxidation number of carbon in HCN is +2.
Statement 2: Carbon always shows an oxidation state of +4.

8. **Statement 1:** When $SnCl_2$ solution is added to $HgCl_2$ solution, a milky white precipitate is obtained and on adding excess $SnCl_2$, a black precipitate is formed.
Statement 2: The disproportionation of Hg(II) is easier than its reduction only.

9. **Statement 1:** Iodine shows oxidation state of +1 and +3 in the compounds ICl and ICl_3, respectively.
Statement 2: Iodine coming below the halogens F, Cl, Br in the halogen group of elements in the periodic table shows a higher degree of electropositive nature.

10. **Statement 1:** In aqueous solution, SO_2 reacts with H_2S liberating sulphur.
Statement 2: SO_2 is an effective reducing agent.

11. **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.

12. **Statement 1:** The equivalent weight of reducing agent, Fe^{2+} is 56 (atomic mass of Fe = 56).

    Statement 2: Fe loses $2e^-$ to be converted into Fe^{2+}.

13. **Statement 1:** Equivalent weight of a species can be written as molecular weight of the species divided by valence factor.

    Statement 2: Valence factor represents valence in element, acidity in bases, basicity in acids and total charge on cation or anion in an ionic compound

14. **Statement 1:** In solution A(200 mL of 0.1 N HCl) and solution B(100 mL of 0.2 N HCl), the equivalents of H^+ are the same.

    Statement 2: Number of equivalents = Normality × Volume (in liter).

15. **Statement 1:** Addition of water to a solution containing solute and solvent changes its normality or molarity.

    Statement 2: The milliequivalents and millimoles of the solute are not changed on dilution.

Comprehension Type

Read the paragraphs and answer the questions that follow.

Paragraph I

Aqueous solution of sodium hypochlorite (NaOCl) is a household bleach and a strong oxidizing agent that reacts with chromite ion $[Cr(OH)_4]^-$ in basic solution to yield chromate (CrO_4^{2-}) and chloride ion.

1. Select the correct statement(s)
   (A) OCl^- has been oxidized and $[Cr(OH)_4]^-$ has been reduced.
   (B) OCl^- has been reduced and $[Cr(OH)_4]^-$ has been oxidized.
   (C) It is simply a neutralization reaction
   (D) It is simply a displacement reaction
2. Balanced equation (only redox species) is
   (A) $ClO^- + [Cr(OH)_4]^- \rightarrow CrO_4^{2-} + Cl^-$
   (B) $3ClO^- + [Cr(OH)_4]^- \rightarrow CrO_4^{2-} + 3Cl^-$
   (C) $3ClO^- + 2[Cr(OH)_4]^- \rightarrow 2CrO_4^{2-} + 3Cl^-$
   (D) $ClO^- + 2[Cr(OH)_4]^- \rightarrow 2CrO_4^{2-} + Cl^-$

Paragraph II

For the unbalanced reaction $AX + BY + H_2O \rightarrow HA + OY + X_2B$. Let the oxidation number of X be –2 and X, H_2O are not involved in redox reaction.

3. The element(s) undergoing oxidation is
   (A) A (B) B
   (C) Y (D) Both B and Y
4. The possible oxidation states of B and Y in BY are, respectively,
   (I) +1, –1 (II) +2, –2
   (III) +3, –3
   (A) I (B) II
   (C) III (D) I, II, III
5. If the above reaction is balanced in acid medium, the sum of smallest whole number stoichiometric coefficients of all the compounds will be
   (A) 9 (B) 8
   (C) 7 (D) 6

Paragraph III

Electron transfer or redox reactions involve simultaneous reduction and oxidation reactions. A substance is reduced when it gains electrons, and if it loses electrons it is said to be oxidized. A substance brings out reduction of other substances is called reducing agent, and the one which brings out oxidation of other substances is called oxidizing agent. In disproportionation, the same substance undergoes both oxidation and reduction. Two identical components of same molecule or different molecule undergo oxidation and reduction to result a common product in this reaction called comproportionation reaction.

6. $2MnO_4^{2-} + 2H_2O \rightarrow MnO_2 + 2MnO_4^- + 4OH^-$ is an example of
   (A) intermolecular redox reaction.
   (B) intramolecular redox reaction.
   (C) disproportionation reaction.
   (D) comproportionation reaction.
7. Which among the following is not a disproportionation reaction?
   (A) $P_4 + OH^- \rightarrow H_2PO_4^- + PH_3$
   (B) $S_2O_3^{2-} \rightarrow SO_4^{2-} + S$
   (C) $H_2O_2 \rightarrow H_2O + O_2$
   (D) $AgCl + NH_3 \rightarrow [Ag(NH_3)_2]Cl$
8. In the reaction $MnO_4^{2-} + 2H_2O + 2e^- \rightarrow MnO_2 + 4OH^-$, MnO_2, will act as
   (A) an oxidizing agent.
   (B) reducing agent.
   (C) both as an oxidizing and reducing agent.
   (D) precipitating agent.

Paragraph IV

A sample of iron(II) sulphate crystals, $FeSO_4 \cdot 7H_2O$ has been left open to the air and some of the iron(II) ions has been converted to iron(III). 4.2 g of the impure crystals were dissolved in a total of 250 cm^3 water and dilute sulphuric acid. 25 cm^3 portion of this solution was titrated with a solution of potassium bicarbonate(VI). The concentration of dichromate(VI) ions in this solution was 0.1 mol dm^{-3}. The average volume used was 23.5 cm^3.

9. How many moles of Fe^{2+} ions would there have been in the 250 cm^3 of stock solution?
   (A) 7.05×10^{-4} mol (B) 2.35×10^{-4} mol
   (C) 1.41×10^{-2} (D) 7.05×10^{-4} mol
10. What mass of Fe^{2+} ions should have been present in the 4.2 g of crystals?
    (A) 0.84 g (B) 0.90 g
    (C) 0.77 g (D) 0.62 g
11. The percentage purity of the crystal is
    (A) 69% (B) 72%
    (C) 88% (D) 94%

Paragraph V

1.00 g of a mixture having equal number of moles of carbonates of two alkali metals required 44.4 mL of 0.5 N HCl for complete reaction. Atomic weight of one of the metals is 7.00.

12. The number of moles of each metal carbonate is
(A) 0.1 (B) 0.0111
(C) 0.0055 (D) 0.00275

13. The number of equivalents of HCl used is
(A) 0.222 (B) 2.22
(C) 22.22 (D) 0.0222

Paragraph VI

Iodine titrations can be iodometric or iodimetric depending on using iodine directly or indirectly as an oxidizing agent in the redox titration.

(a) Iodimetric titrations in which a standard iodine solution is used as an oxidant and iodine is directly titrated against a reducing agent. For example,

$$2CuSO_4 + 4KI \rightarrow Cu_2I_2 + 2K_2SO_4 + I_2$$

(b) Iodimetric procedures are used for the determination of strength of reducing agent such as thiosulphates, sulphites, arsenites and stannous chloride, etc., by titrating them against standard solution of iodine taken in a burette

$$2Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + 2NaI$$

Starch is used as indicator near the end point which from blue color complex with I_3^-. The blue color disappears when there is not more of free I_2.

14. In the reaction $2CuSO_4 + 4KI \rightarrow Cu_2I_2 + 2K_2SO_4 + I_2$, the equivalent weight of $CuSO_4$ is (M_B: molecular weight)
(A) $M_B/8$ (B) $M_B/4$
(C) $M_B/2$ (D) M_B

15. The volume of KI solution used for $CuSO_4$ will be
(A) 100 mL (B) 40 mL
(C) 400 mL (D) 200 mL

16. When 319.0 g of $CuSO_4$ in a solution is reacted with excess of 0.5 M KI solution, then liberated iodine required 100 mL of 1.0 M $Na_2S_2O_3$ for complete reaction. The percentage purity of $CuSO_4$ in the sample is
(A) 10% (B) 20%
(C) 5% (D) none of these

Paragraph VII

Oleum is a mixture of H_2SO_4 and SO_3 (i.e., $H_2S_2O_7$). It is produced by passing SO_3 in H_2SO_4 solution. In order to dissolve free SO_3 in oleum, dilution of oleum is done, in which oleum converts into pure H_2SO_4. It is shown by the reaction as under:

$$H_2SO_4 + SO_3 + H_2O \rightarrow 2\,H_2SO_4\,(\text{pure})$$

$$SO_3 + H_2O \rightarrow H_2SO_4\,(\text{pure})$$

When 100 g sample of oleum is diluted with desired amount of H_2O (in g), then the total mass of pure H_2SO_4 obtained after dilution is known as percentage labeling in oleum. Through this process, the percentage composition of H_2SO_4, SO_3 (free) and SO_3 (combined) is calculated.

If oleum sample is labeled as "109% H_2SO_4", that is, 100 g of oleum on dilution with 9 g of H_2O provides 109 g pure H_2SO_4, in which all free SO_3 in 100 g of oleum is dissolved.

17. 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 $x^2 + y^2$?
(A) 0.15 (B) 0.42
(C) 0.62 (D) 0.80

18. The percentage of combined SO_3 in the given oleum sample is
(A) 20% (B) 30%
(C) 48.98% (D) 51 %

19. The percentage composition of free SO_3 and H_2SO_4 in the oleum sample, respectively, are
(A) 60%, 40% (B) 30%, 70%
(C) 85%, 15% (D) 40%, 60%

20. What volume of 1 M NaOH (in mL) will be required to react completely with H_2SO_4 and SO_3?
(A) 250 mL (B) 2224 mL
(C) 750 mL (D) 1800 mL

Integer Answer Type

The answer is a **non-negative integer**.

1. The number of electrons involved in the conversion of MnO_4^- to MnO_2 is _____.

2. In $Ba(H_2PO_2)_2$ the oxidation number of phosphorus is _____.

3. In bleaching powder ($CaOCl_2$), the oxidation states of chlorine are x and y. The value of $x + y$ is _____.

4. Given balanced chemical equation for oxidation of phosphorus (III) sulphide by nitric acid. The products include NO and SO_2. The reaction is

$$aP_4S_6 + bH^+ + cNO_3^- \rightarrow dNO + eH_3PO_4 + fSO_2 + gH_2O$$

What is the value of $(a + g)$?

5. In the redox reaction,

$$xNO_3^- + yAs_2S_3 + zH_2O \rightarrow AsO_4^{3-} + NO^+ + SO_4^{2-} + H^+$$

what is the value of (x/z)?

6. Oxidation state of Cr in CrO_5 is _____.

7. 0.01 mol 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+}. The value of n is _____.

8. 1575 g of oxalic acid $(COOH)_2{\cdot}xH_2O$ are dissolved in water and the volume made upto 250 mL. On titration, 16.68 mL of this solution requires 25 mL of N/15 NaOH solution for complete neutralization. The value of x is _____.

9. The equivalent weight of a metal carbonate 0.84 g of which reacts exactly with 40 mL of N/2 H_2SO_4 is _____.

10. 5 g of K_2SO_4 were dissolved in 250 mL of solution. The volume of this solution that should be used so that 1.2 g of $BaSO_4$ may be precipitated from $BaCl_2$ is _____. (Given that molar mass of $K_2SO_4 = 174\ g\ mol^{-1}$ and $BaSO_4 = 233\ g\ mol^{-1}$.)

Matrix–Match Type

1. Match the compound with the average oxidation state of Fe.

Column I	Column II
(A) $Fe_4[Fe(CN)_6]_3$	(p) 12/5
(B) $[Fe(NO)(H_2O)_5]SO_4$	(q) 2
(C) $Fe_3[Fe(CN)_6]_2$	(r) 18/7
(D) $Na_2[Fe(CN)_5NO]$	(s) 1

2. Match the reaction with its type.

Column I	Column II
(A) $V_2O_5 + 5Ca \rightarrow 2V + 5CaO$	(p) Non-metal displacement reaction
(B) $2NaH \rightarrow 2Na + H_2$	(q) Disproportionation reaction
(C) $P_4 + 3OH^- + 3H_2O \rightarrow PH_3 + 3H_2PO_2$	(r) Decomposition reaction
(D) $Ca + 2H_2O \rightarrow Ca(OH)_2 + H_2$	(s) Redox reaction

3. Match the characteristic properties with the elements.

Column I	Column II
(A) Metal which reacts with dilute acids to give H_2 gas.	(p) Zinc
(B) Metal whose container can be used to store conc. HNO_3.	(q) Silver
(C) Metal which is used as an electrode in Daniell cell.	(r) Aluminium
(D) Metal which does not react with dilute acids to give H_2 gas.	(s) Copper

4. Match the bold atoms in compounds with their oxidation numbers.

Column I	Column II
(A) $\mathbf{H_2O_2}$	(p) –1
(B) $Mn\mathbf{SO_4}$	(q) +3
(C) $\mathbf{AlCl_3}$	(r) +2
(D) $\mathbf{S_2Cl_2}$	(s) +6

5. Match the reactions with equivalent weights of their oxidizing/reducing agents.

Column I	Column II
(A) $NH_3 \rightarrow \overset{-}{N}O_3$	(p) M/3
(B) $FeC_2O_4 \rightarrow Fe^{3+} + 2CO_3^{2-}$	(q) M/6
(C) $H_2SO_5 \rightarrow S_8$	(r) M/8
(D) $K\overset{+7}{Mn}O_4 \rightarrow Mn^{2+}$	(s) M/5

ANSWERS

Single Correct Choice Type

1. (D)	2. (B)	3. (D)	4. (C)	5. (C)
6. (B)	7. (A)	8. (D)	9. (D)	10. (A)
11. (C)	12. (A)	13. (B)	14. (A)	15. (C)
16. (A)	17. (D)	18. (C)	19. (B)	20. (C)
21. (A)	22. (D)	23. (C)	24. (C)	25. (A)
26. (A)	27. (D)	28. (A)	29. (D)	30. (B)
31. (C)	32. (C)	33. (C)	34. (D)	35. (D)
36. (C)	37. (D)	38. (B)	39. (C)	40. (B)
41. (C)	42. (A)	43. (D)	44. (C)	45. (C)
46. (B)	47. (D)	48. (B)	49. (D)	50. (D)
51. (D)	52. (D)	53. (A)	54. (B)	

Multiple Correct Choice Type

1. (B, C, D)	2. (A, B, C)	3. (B, C, D)	4. (B, C, D)	5. (B, C)
6. (B, C, D)	7. (A, C)	8. (B, C, D)	9. (A, C, D)	10. (A, B, C)
11. (A, D)	12. (C, D)	13. (A, B, C)	14. (B, D)	15. (A, B, C)
16. (A, C, D)	17. (A, B, C, D)	18. (A, B, D)	19. (A, B, C)	20. (A, B, C)

Assertion–Reasoning Type

1. (D)	2. (A)	3. (A)	4. (D)	5. (A)
6. (D)	7. (C)	8. (A)	9. (A)	10. (C)
11. (B)	12. (C)	13. (B)	14. (A)	15. (B)

Comprehension Type

1. (B)	2. (C)	3. (D)	4. (D)	5. (B)
6. (C)	7. (D)	8. (B)	9. (C)	10. (A)
11. (D)	12. (B)	13. (D)	14. (D)	15. (D)
16. (C)	17. (C)	18. (C)	19. (D)	20. (B)

Integer Answer Type

1. (3)	2. (1)	3. (0)	4. (7)	5. (14)
6. (7)	7. (4)	8. (2)	9. (42)	10. (45)

Matrix–Match Type

1. A → (r); B → (s); C → (p); D → (q)
2. A → (s); B → (r, s); C → (q, s); D → (p, s)
3. A → (p, r); B → (r); C → (p, s); D → (q, s)
4. A → (r); B → (s); C → (q); D → (p, r)
5. A → (r, t); B → (p); C → (q); D → (s)