SELECT THE CORRECT ALTERNATIVE (ONLY ONE CORRECT ANSWER)

1. 50 mL of 0.1 M solution of a salt reacted with 25 mL of 0.1 M solution of sodium sulphite. The half reaction for the oxidation of sulphite ion is :-

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

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

(A) zero (B) 1 (C) 2 (D) 4

2. An element A in a compound ABD has oxidation number A^{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 3.26 10^{-3} moles of ABD. The new oxidation number of A after oxidation is :-

(A) 3 (B) 3 – n (C) n – 3 (D) +n

3. The incorrect order of decreasing oxidation number of S in compounds is :-

(A) $H_2S_2O_7 > Na_2S_4O_6 > Na_2S_2O_3 > S_8$ (B) $H_2SO_5 > H_2SO_3 > SCl_2 > H_2S$

(C) $SO_3 > SO_2 > H_2S > S_8$ (D) $H_2SO_4 > SO_2 > H_2S > H_2S_2O_8$

4. Which reaction does not represent autoredox or disproportionation :-

(A) $Cl_2 + OH^- \longrightarrow Cl^- + ClO_3^- + H_2O$ (B) $2H_2O_2 \longrightarrow H_2O + O_2$

(C) $2Cu^+ \longrightarrow Cu^{+2} + Cu$ (D) $(NH_4)_2Cr_2O_7 \longrightarrow N_2 + Cr_2O_3 + 4H_2O$

5. Match List-I (Compounds) with List-II (Oxidation states of nitrogen) and select answer using the codes given below the lists :-

	List-I		**List-II**
(a)	NaN_3	1.	+5
(b)	N_2H_2	2.	+2
(c)	NO	3.	–1/3
(d)	N_2O_5	4.	–1

Code :	(a)	(b)	(c)	(d)
(A)	3	4	2	1
(B)	4	3	2	1
(C)	3	4	1	2
(D)	4	3	1	2

6. Which of the following is a redox reaction :-

(A) $2\ CrO_4^{2-} + 2H^+ \rightarrow Cr_2O_7^{2-} + H_2O$ (B) $CuSO_4 + 4\ NH_3 \rightarrow [Cu(NH_3)_4]\ SO_4$

(C) $Na_2S_2O_3 + I_2 \rightarrow Na_2S_4O_6 + NaI$ (D) $Cr_2O_7^{2-} + 2OH^- \rightarrow 2\ CrO_4^{2-} + H_2O$

7. In which of the following reaction is there a change in the oxidation number of nitrogen atoms :-

(A) $2\ NO_2 \rightarrow N_2O_4$ (B) $NH_3 + H_2O \rightarrow NH_4^+ + OH^-$

(C) $N_2O_5 + H_2O \rightarrow 2HNO_3$ (D) none

8. In the reaction

$xHI + yHNO_3 \longrightarrow NO + I_2 + H_2O$

(A) x = 3, y = 2 (B) x = 2, y = 3 (C) x = 6, y = 2 (D) x = 6, y = 1

9. For the redox reaction :

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

the correct stoichiometric coefficients of MnO_4^-, $C_2O_4^{2-}$ and H^+ are respectively

(A) 2,5,16 (B) 16,5,2 (C) 5,16,2 (D) 2,16,5

10. Which of the following relations is incorrect :-

(A) 3 N $Al_2(SO_4)_3$ = 0.5 M $Al_2(SO_4)_3$ (B) 3 M H_2SO_4 = 6 N H_2SO_4

(C) 1 M H_3PO_4 = 1/3 N H_3PO_4 (D) 1 M $Al_2(SO_4)_3$ = 6 N $Al_2(SO_4)_3$

11. The mass of oxalic acid crystals ($H_2C_2O_4 . 2H_2O$) required to prepare 50 mL of a 0.2 N solution is :-

(A) 4.5 g (B) 6.3 g (C) 0.63 g (D) 0.45 g

12. 125 mL of 63% (w/v) $H_2C_2O_4 . 2H_2O$ is made to react with 125 mL of a 40% (w/v) NaOH solution. The resulting solution is :-

(A) neutral (B) acidic (C) strongly acidic (D) alkaline

13. A certain weight of pure $CaCO_3$ is made to react completely with 200 mL of an HCl solution to give 224 mL of CO_2 gas at STP. The normality of the HCl is :-

(A) 0.05 N (B) 0.1 N (C) 1.0 N (D) 0.2 N

14. The volume of 1.5 M H_3PO_4 solution required to neutralize exactly 90 mL of a 0.5 M $Ba(OH)_2$ solution is :-

(A) 10 mL (B) 30 mL (C) 20 mL (D) 60 mL

15. Volume V_1 mL of 0.1 M $K_2Cr_2O_7$ is needed for complete oxidation of 0.678 g N_2H_4 in acidic medium. The volume of 0.3 M $KMnO_4$ needed for same oxidation in acidic medium will be :-

(A) $\frac{2}{5}V_1$ (B) $\frac{5}{2}V_1$ (C) 113 V_1 (D) can't say

16. 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_2CrO_7

(C) equal in both cases (D) can't be determined

17. If 10 g of V_2O_5 is dissolved in acid and is reduced to V^{2+} by zinc metal, how many mole 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] (V = 51, O = 16, I = 127) :

(A) 0.11 mole of I_2 (B) 0.22 mole of I_2 (C) 0.055 mole of I_2 (D) 0.44 mole of I_2

18. Given that 50.0 mL of 0.01 M $Na_2S_2O_3$ solution and 5 10^{-4} mole of Cl_2 react according to equation,

$Cl_2(g) + S_2O_3^{2-} \longrightarrow SO_4^{2-} + Cl^- + S$

Answer the following :

(i) The balanced molecular equation is :

(A) $Cl_2 + H_2O + Na_2S_2O_3 \longrightarrow Na_2SO_4 + S + 2HCl$ (B) $Cl_2 + Na_2S_2O_3 \longrightarrow 2NaCl + Na_2SO_4$

(C) $Cl_2 + S_2O_3^{2-} \longrightarrow SO_4^{2-} + S + Cl^-$ (D) none of these

(ii) How many moles of $S_2O_3^{2-}$ are in the above sample :-

(A) 0.00050 (B) 0.0025 (C) 0.01 (D) 0.02

(iii) How many equivalents of oxidising agents are in this sample for the above reaction :-

(A) 0.001 (B) 0.080 (C) 0.020 (D) 0.010

(iv) What is the molarity of Na_2SO_4 in this solution :-

(A) 0.080 M (B) 0.040 M (C) 0.020 M (D) 0.010 M

19. 0.3 g of an oxalate salt was dissolved in 100 mL solution. The solution required 90 mL of N/20 $KMnO_4$ for complete oxidation. The % of oxalate ion in salt is :-

(A) 33% (B) 66% (C) 70% (D) 40%

20. A 0.518 g sample of limestone is dissolved in HCl and then the calcium is precipitated as CaC_2O_4. After filtering and washing the precipitate, it requires 40.0 mL of 0.250 N $KMnO_4$ solution acidified with H_2SO_4 to titrate it as. The percentage of CaO in the sample is :-

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

(A) 54.0 % (B) 27.1 % (C) 42 % (D) 84 %

21. In the reaction $CrO_5 + H_2SO_4 \rightarrow Cr_2(SO_4)_3 + H_2O + O_2$ one mole of CrO_5 will liberate how many moles of O_2 :-

(A) 5/2 (B) 5/4 (C) 9/2 (D) 7/2

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

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

calculate the volume of thiosulphate hypo consumed. [Atomic weight of As = 75]

(A) 48.1 mL (B) 38.4 mL (C) 24.7 mL (D) 30.3 mL

23. 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+}

24. Find the volume of strength of H_2O_2 solution prepared by mixing of 250 mL of 3N H_2O_2 & 750 mL of 1N H_2O_2 solution :-

(A) 1.5 V (B) 8.4 V (C) 5.6 V (D) 11.2 V

25. 25 mL of 0.50 M H_2O_2 solution is added to 50 mL of 0.20 M $KMnO_4$ in acid solution. Which of the following statement are true :-

(A) 0.010 mole of oxygen is liberated (B) 0.005 mole of $KMnO_4$ are left

(C) 0.030 g atom of oxygen gas is evolved (D) 0.0025 mole H_2O_2 does not react with $KMnO_4$

26. Hydrogen peroxide in aqueous solution decomposes on warming to give oxygen according to the equation

$2H_2O_2\,(aq) \longrightarrow 2H_2O\,(\ell) + O_2\,(g)$

Under conditions where 1 mole of gas occupies 24 dm^3. 100 cm^3 of XM solution of H_2O_2 produces 3 dm^3 of O_2. Thus X is :-

(A) 2.5 (B) 1 (C) 0.5 (D) 0.25

27. Temporary hardness is due to HCO_3^- of Mg^{2+} and Ca^{2+}. It is removed by addition of CaO.

$Ca(HCO_3)_2 + CaO \rightarrow 2CaCO_3 + H_2O$

Mass of CaO required to precipitate 2 g $CaCO_3$ is :-

(A) 2.00 (B) 0.56 g (C) 0.28 g (D) 1.12 g

28. Bottle (A) contain 320 mL of H_2O_2 solution & labeled with 10 V H_2O_2 & Bottle (B) contain 80 mL H_2O_2 having normality 5N. If bottle (A) & bottle (B) mixed & solution filled in bottle (C). Select the correct lable for bottle (C) in term of volume strength & in term of g / litre. :-

(A) 13.6 "V" & 41.285 g/L (B) 11.2 "V" & 0.68 g/L

(C) 5.6 "V" & 0.68 g/L (D) 5.6 "V" & 41.285 g/L

CHECK YOUR GRASP				ANSWER KEY								EXERCISE -1			
Que.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**
Ans.	C	B	D	D	A	C	D	C	A	C	C	A	B	C	A
Que.	**16**	**17**	**18(i)**	**(ii)**	**(iii)**	**(iv)**	**19**	**20**	**21**	**22**	**23**	**24**	**25**	**26**	**27**
Ans.	B	A	A	A	A	D	B	A	D	A	A,C,D	B	B	A	B
Que.	**28**														
Ans.	A														

SELECT THE CORRECT ALTERNATIVES (ONE OR MORE THEN ONE CORRECT ANSWERS)

1. 1 mol of iron (Fe) reacts completely with 0.65 mol O_2 to give a mixture of only FeO and Fe_2O_3. Mole ratio of ferrous oxide to ferric oxide is :-

(A) 3 : 2 (B) 4 : 3 (C) 20 : 13 (D) none of these

2. 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

3. If a piece of iron gains 10% of its weight due to partial rusting into Fe_2O_3. The percentage of total iron that has rusted is :-

(A) 23 (B) 13 (C) 23.3 (D) 25.67

4. An ore of iron, Wustite has the formula $F_{0.93}O_{1.00}$. The mole fraction of total iron present in the form of Fe(II) is :-

(A) 0.82 (B) 0.85 (C) 0.15 (D) 0.37

5. HNO_3 oxidises NH_4^+ ions to nitrogen and itself gets reduced to NO_2. The moles of HNO_3 required by 1 mol of $(NH_4)_2SO_4$ is :-

(A) 4 (B) 5 (C) 6 (D) 2

6. 25 mL of a 0.1 M solution of a stable cation of transition metal Z reacts exactly with 25 ml of 0.04 mL 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) $Z^{2+} \rightarrow Z^{4+}$

7. How many litres of Cl_2 at S.T.P. will be liberated by oxidation of NaCl with 10 g $KMnO_4$:-

(A) 3.54 litres (B) 7.08 litres (C) 1.77 litres (D) none of these

8. 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

9. $28\ NO_3^- + 3As_2S_3 + 4H_2O \rightarrow 6AsO_4^{3-} + 28\ NO + 9SO_4^{2-} + H^+$

What will be the equivalent mass of As_2S_3 in above reaction

(A) $\frac{M.wt.}{2}$ (B) $\frac{M.wt.}{4}$ (C) $\frac{M.wt.}{24}$ (D) $\frac{M.wt.}{28}$

10. When ZnS is boiled with strong nitric acid, the products are zinc nitrate, sulphuric acid and nitrogen dioxide. What are the changes in the oxidation numbers of Zn, S and N.

(A) +2, +4, –1 (B) +2, +6, –2 (C) 0, +4, –2 (D) 0, +8, –1

11. When arsenic sulphide is boiled with NaOH, sodium arsenite and sodium thioarsenite are formed

$x\ As_2S_3 + y\ NaOH \longrightarrow Na_3AsO_3 + x\ Na_3AsS_3 + \frac{y}{2}\ H_2O$. What are the values of x and y ?

(A) 1, 6 (B) 2, 8 (C) 2, 6 (D) 1, 4

12. An element forms two different sulphates in which its weight % is 28 and 37. What is the ratio of oxidation numbers of the element in these sulphates ?

(A) 1 : 2 (B) 1 : 3 (C) 2 : 1 (D) 3 : 2

13. CN^- is oxidised by NO_3^- in presence of acid :

$a\ CN^- + b\ NO_3^- + c\ H^+ \longrightarrow (a + b)\ NO + a\ CO_2 + \frac{c}{2}\ H_2O$

What are the values of a, b, c in that order :

(A) 3,7,7 (B) 3,10,7 (C) 3,10,10 (D) 3,7,10

14. Which of the following solutions will exactly oxidize 25 mL of an acid solution of 0.1 M Fe (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 $KMnO_4$

15. 4.9 gm of $K_2Cr_2O_7$ is taken to prepare 0.1 L of the solution. 10 mL of this solution is further taken to oxidise Sn^{2+} ion into Sn^{4+} ion Sn^{4+} so produced is used in 2nd reaction to prepare Fe^{3+} ion then the millimoles of Fe^{3+} ion formed will be (assume all other components are in sufficient amount) [Molar mass of $K_2Cr_2O_7$ = 294 g].

(A) 5 (B) 20 (C) 10 (D) none of these

16. The following equations are balanced atomwise and chargewise.

(i) $Cr_2O_7^{2-} + 8H^+ + 3H_2O_2 \longrightarrow 2Cr^{3+} + 7H_2O + 3O_2$

(ii) $Cr_2O_7^{2-} + 8H^+ + 5H_2O_2 \longrightarrow 2Cr^{3+} + 9H_2O + 4O_2$

(iii) $Cr_2O_7^{2-} + 8H^+ + 7H_2O_2 \longrightarrow 2Cr^{3+} + 11H_2O + 5O_2$

The precise equation/equations representing the oxidation of H_2O_2 is /are :

(A) (i) only (B) (ii) only (C) (iii) only (D) all the three

17. 35 mL sample of hydrogen peroxide gives of 500 mL of O_2 at 27 C and 1 atm pressure. Volume strength of H_2O_2 sample will be :-

(A) 10 volume (B) 13 volumes (C) 11 volume (D) 12 volume

18. 20 mL of 0.1 M solution of compound $Na_2CO_3.NaHCO_3.2H_2O$ is titrated against 0.05 M HCl, x mL of HCl is used when phenolphthalein is used as an indicator and y mL of HCl is used when methyl orange is the indicator in two separate titrations. Hence (y – x) is :-

(A) 40 mL (B) 80 mL (C) 120 mL (D) none of these

19. 0.10 g of a sample containing $CuCO_3$ and some inert impurity was dissolved in dilute sulphuric acid and volume made up to 50 mL. This solution was added into 50 mL of 0.04 M KI solution where copper precipitates as CuI and I^- is oxidized into I_3^-. A 10 mL portion of this solution is taken for analysis, filtered and made up free I_3^- and then treated with excess of acidic permanganate solution. Liberated iodine required 20 mL of 2.5 mM sodium thiosulphate solution to reach the end point.

Determine weight percentage of $CuCO_3$ in the original sample.

(A) 7.41 (B) 74.1 (C) 61.75 (D) none of these

20. A 150 mL of solution of I_2 is divided into two unequal parts. I part reacts with hypo solution in acidic medium. 15 mL of 0.4 M hypo was consumed. II part was added with 100 mL of 0.3 M NaOH solution. Residual base required 10 mL of 0.3 M H_2SO_4 solution for complete neutralization. What was the initial concentration of I_2 ?

(A) 0.08 M (B) 0.1 M (C) 0.2 M (D) none of these

21. A mixture of H_2SO_4 and $H_2C_2O_4$ (oxalic acid) and some inert impurity weighing 3.185 g was dissolved in water and the solution made up to 1 litre, 10 mL of this solution required 3 mL of 0.1 N NaOH for complete neutralization. In another experiment 100 mL of the same solution in hot condition required 4 mL of 0.02M $KMnO_4$ solution for complete reaction. The wt. % of H_2SO_4 in the mixture was :-

(A) 40 (B) 50 (C) 60 (D) 80

22. 0.80 g of sample of impure potassium dichromate was dissolved in water and made upto 500 mL solution. 25 mL of this solution treated with excess of KI in acidic medium and I_2 liberated required 24 mL of a sodium thiosulphate solution. 30 mL of this sodium thiosulphate solution required 15 mL of N/20 solution of pure potassium dichromate. What was the percentage of $K_2Cr_2O_7$ in given sample?

(A) 73.5 % (B) 75.3 % (C) 36.75 % (D) none of these

BRAIN TEASERS — ANSWER KEY — EXERCISE -2

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	B	B	C	B	C	D	A	A	D	D	A	D	D	D	C
Que.	16	17	18	19	20	21	22								
Ans.	A	B	B	B	B	A	A								

EXERCISE–03 MISCELLANEOUS TYPE QUESTIONS

TRUE / FALSE

1. In a compound, all the atoms of a particular element have the same oxidation number.
2. In H_2O_2, both oxygen atoms have same oxidation number but in $Na_2S_2O_3$, the two S-atoms do not have same oxidation number.
3. In the reaction :

   $3\ Cl_2 + 6\ NaOH \longrightarrow 5\ NaCl + NaClO_3 + 3H_2O$, Cl_2 acts purely as an oxidizing agent.
4. In a redox reaction, the oxidation number of an element can either increase or decrease but both cannot happen simultaneously.
5. In $CaOCl_2$ both the chlorine atom are in same oxidation state.

FILL IN THE BLANKS

1. Oxidizing agent (or oxidant) is a substance in which oxidation number of one of the atoms ..... .
2. Reducing agent (or reductant) is a substance which ..... electrons.
3. In the reaction $2\ H_2O_2 \longrightarrow 2\ H_2O + O_2$, hydrogen peroxide is ..... .
4. In the reaction $2\ KClO_3 \longrightarrow 2\ KCl + 3\ O_2$, the element which has been oxidised is ..... and the element which has been reduced is ..... .
5. The compound $YbBa_2Cu_3O_7$ which shows superconductivity, has copper in oxidation state ..... Assume that the rare earth element ytterbium is in the usual + 3 oxidation state.
6. In HCN oxidation number of carbon is ..... .
7. The reaction $NH_4NO_2 \rightarrow N_2 + 2H_2O$ ..... disproportionation reaction.

MATCH THE COLUMN

1.

	Column-I		Column-II
(A)	When Bi_2S_3 converted into Bi^{5+} and S	(p)	18
(B)	When $Al_2(Cr_2O_7)_3$ reduced into Cr^{3+} in acidic medium	(q)	11
(C)	When FeS_2 converted into Fe_2O_3 and SO_2	(r)	2
(D)	When $Mn(NO_3)_2$ converted into MnO_4^{2-} and NO	(s)	10

2.

	Column-I		Column-II
(A)	Eq. wt. $= \frac{\text{Molecular weight}}{33}$	(p)	When CrI_3 oxidises into $Cr_2O_7^{2-}$ and IO_4^-
(B)	Eq. wt. $= \frac{\text{Molecular weight}}{27}$	(q)	When $Fe(SCN)_2$ oxidises into Fe^{3+}, SO_4^{2-}, CO_3^{2-} and NO_3^-
(C)	Eq. wt. $= \frac{\text{Molecular weight}}{28}$	(r)	When NH_4SCN oxidizes into SO_4^{2-}, CO_3^{2-} and NO_3^-
(D)	Eq. wt. $= \frac{\text{Molecular weight}}{24}$	(s)	When As_2S_3 oxidises into AsO_3^- and SO_4^{2-}

3.

	Column-I		Column-II
(A)	$\underline{P_2H_4} \longrightarrow PH_3 + P_4H_2$	(p)	$E = \frac{3M}{4}$
(B)	$\underline{I_2} \longrightarrow I^- + IO_3^-$	(q)	$E = \frac{3M}{5}$
(C)	$MnO_4^- + Mn^{2+} + H_2O \longrightarrow \underline{Mn_3O_4} + H^+$	(r)	$E = \frac{15M}{26}$
(D)	$\underline{H_3PO_2} \longrightarrow PH_3 + H_3PO_3$	(s)	$E = \frac{5M}{6}$

ASSERTION & REASON

These questions contains, Statement I (assertion) and Statement II (reason).

(A) Statement-I is true, Statement-II is true ; Statement-II is correct explanation for Statement-I.

(B) Statement-I is true, Statement-II is true ; Statement-II is NOT a correct explanation for statement-I

(C) Statement-I is true, Statement-II is false

(D) Statement-I is false, Statement-II is true

1. **Statement-I :** Oxidation involves loss of electrons and reduction involves gain of electrons.
   Because
   Statement-II : The overall reaction in which oxidation and reduction occur simultaneously is called redox reaction.

2. **Statement-I :** H_2SO_4 cannot act as reducing agent.
   Because
   Statement-II : Sulphur cannot increase its oxidation number beyond +6.

3. **Statement-I :** The oxidation state of superoxide ion in KO_2, CsO_2 and RbO_2 is $-1/2$.
   Because
   Statement-II : Since the oxidation state of an alkali metal in any compound is always +1, the oxidation state of oxygen is $-1/2$ in the O_2^- ion.

4. **Statement-I :** In the redox reaction
   $8\ H^+(aq) + 4\ NO_3^- + 6\ Cl^- + Sn(s) \rightarrow SnCl_6^{2-} + 4\ NO_2 + 4\ H_2O$
   the reducing agent is Sn (s),
   Because
   Statement-II : In balancing half reaction, $S_2O_3^{2-} \rightarrow S(s)$, the number of electrons added on the left is 4.

5. **Statement-I :** Among Br^-, O_2^{2-}, H^- and NO_3^-, the ions that could not act as oxidising agents are Br^- and H^-.
   Because
   Statement-II : $Br^{\ominus}$ and H^- could not be reduced.

COMPREHENSION BASED QUESTIONS

Comprehension # 1

Oleum is considered as a solution of SO_3 in H_2SO_4, which is obtained by passing SO_3 in solution of H_2SO_4. When 100 g sample of oleum is diluted with desired weight of H_2O then the total mass of H_2SO_4 obtained after dilution is known as % labelling in oleum.

For example, a oleum bottle labelled as '109% H_2SO_4' means the 109 g total mass of pure H_2SO_4 will be formed when 100 g of oleum is diluted by 9 g of H_2O which combines with all the free SO_3 present in oleum to form H_2SO_4 as $SO_3 + H_2O \longrightarrow H_2SO_4$

1. What is the % of free SO_3 in an oleum that is labelled as '104.5 % H_2SO_4'?

(A) 10 (B) 20 (C) 40 (D) none of these

2. 9.0 g water is added into oleum sample labelled as '112% H_2SO_4' then the amount of free SO_3 remaining in the solution is :

(A) 14.93 L at STP (B) 7.46 L at STP (C) 3.73 L at STP (D) 11.2 L at STP

3. If excess water is added into a bottle sample labelled as '112 % H_2SO_4' and is reacted with 5.3 g Na_2CO_3, then find the volume of CO_2 evolved at 1 atm pressure and 300 K temperature after the completion of the reaction :

(A) 2.46 L (B) 24.6 L (C) 1.23 L (D) 12.3 L

4. 1 g of oleum sample is diluted with water. The solution required 54 mL of 0.4 N NaOH for complete neutralization. The % of free SO_3 in the sample is :

(A) 74 (B) 26 (C) 20 (D) none of these

Comprehension # 2

The strength of H_2O_2 is expressed in several ways like molarity, normality, % (w/V), volume strength, etc. The strength of "10 V" means 1 volume of H_2O_2 on decomposition gives 10 volumes of oxygen at STP or 1 litre of H_2O_2 gives 10 litre of O_2 at STP. The decomposition of H_2O_2 is shown as under :

$$H_2O_2\ (aq) \longrightarrow H_2O\ (\ell) + \frac{1}{2} O_2\ (g)$$

H_2O_2 can acts as oxidising as well as reducing agent, as oxidizing agent H_2O_2 converted into H_2O and as reducing agent H_2O_2 converted into O_2, both cases it's n-factor is 2.

$\therefore$ Normality of H_2O_2 solution = 2 Molarity of H_2O_2 solution

1. What is the molarity of "11.2 V" of H_2O_2 ?

(A) 1 M (B) 2 M (C) 5.6 M (D) 11.2 M

2. What is the percentage strength (% w/V) of "11.2 V" H_2O_2 ?

(A) 1.7 (B) 3.4 (C) 34 (D) none of these

3. 20 mL of H_2O_2 solution is reacted with 80 mL of 0.05 M $KMnO_4$ in acidic medium then what is the volume strength of H_2O_2 ?

(A) 2.8 (B) 5.6 (C) 11.2 (D) none of these

4. 40 g $Ba(MnO_4)_2$ (mol. wt. = 375) sample containing some inert impurities in acidic medium is completely reacted with 125 mL of "33.6 V" of H_2O_2. What is the percentage purity of the sample ?

(A) 28.12 % (B) 70.31 % (C) 85 % (D) none of these

Comprehension # 3

$$\text{Equivalent weight} = \frac{\text{Molecular weight / Atomic weight}}{\text{n – factor}}$$

n-factor is very important in redox as well as non-redox reactions. With the help of n-factor we can predicts the molar ratio of the reactant species taking part in reactions. The reaciprocal of n-factor's ratio of the reactants is the molar ratio of the reactants.

In general n-factor of acid/base is number of moles of H^+ /OH^- furnished per mole of acid/base. n-factor of a reactant is no. of moles of electrons lost or gained per mole of reactant.

Example 1 :

1. In acidic medium : $KMnO_4$ (n = 5) $\longrightarrow$ Mn^{2+}
2. In basic medium : $KMnO_4$ (n = 3) $\longrightarrow$ Mn^{2+}
3. In neutral medium : $KMnO_4$ (n = 1) $\longrightarrow$ Mn^{6+}

Example 2 : $FeC_2O_4 \longrightarrow Fe^{3+} + 2CO_2$

Total no. of moles of e^- lost by 1 mole of $FeC_2O_4 = 1 + 1 \quad 2 \Rightarrow 3$

$\therefore$ n-factor of $FeC_2O_4 = 3$

1. n-factor of $Ba(MnO_4)_2$ in acidic medium is :

(A) 2 (B) 6 (C) 10 (D) none of these

2. For the reaction,

$H_3PO_2 + NaOH \longrightarrow NaH_2PO_2 + H_2O$

What is the equivalent weight of H_3PO_2 ? (mol. wt. is M)

(A) M (B) M/2 (C) M/3 (D) none of these

3. For the reaction, $Fe_{0.95}O$ (molar mass : M) $\longrightarrow Fe_2O_3$. What is the eq. wt. of $Fe_{0.95}O$?

(A) $\frac{M}{0.85}$ (B) $\frac{M}{0.95}$ (C) $\frac{M}{0.8075}$ (D) none of these

4. In the reaction, $xVO + yFe_2O_3 \longrightarrow FeO + V_2O_5$. What is the value of x and y respectively ?

(A) 1, 1 (B) 2, 3 (C) 3, 2 (D) none of these

MISCELLANEOUS TYPE QUESTION **ANSWER KEY** EXERCISE -3

- ***True / False***

1. F **2.** T **3.** F **4.** F **5.** F

- ***Fill in the Blanks***

1. decrease **2.** loses **3.** oxidized as well as reduced

4. oxygen has been oxidised ($O^{2-} \longrightarrow O_2$) ; chlorine has been reduced ($Cl^{+5} \longrightarrow Cl^{-1}$)

5. x = +7/3 **6.** +2 **7.** is not

- ***Match the Column***

1. (A) $\rightarrow$ s ; (B) $\rightarrow$ p ; (C) $\rightarrow$ q ; (D) $\rightarrow$ r

2. (A) $\rightarrow$ q ; (B) $\rightarrow$ p ; (C) $\rightarrow$ s ; (D) $\rightarrow$ r

3. (A) $\rightarrow$ s ; (B) $\rightarrow$ q ; (C) $\rightarrow$ r ; (D) $\rightarrow$ p

- ***Assertion - Reason Questions***

1. B **2.** A **3.** A **4.** B **5.** A

- ***Comprehension Based Questions***

Comprehension #1 : 1. (B) **2.** (C) **3.** (C) **4.** (B)

Comprehension #2 : 1. (A) **2.** (B) **3.** (B) **4.** (B)

Comprehension #3 : 1. (C) **2.** (A) **3.** (C) **4.** (B)

1. Calculate the oxidation number of underlined elements in the following compounds :

(a) $K[\underline{Co}(C_2O_4)_2.(NH_3)_2]$ (b) $K_4\underline{P}_2O_7$ (c) $\underline{Cr}O_2Cl_2$

(d) $Na_2[\underline{Fe}(CN)_5NO^+]$ (e) $\underline{Mn}_3O_4$ (f) $Ca(\underline{Cl}O_2)_2$

(g) $[\underline{Fe}(NO)(H_2O)_5]SO_4$ (h) $\underline{Zn}O_2^{2-}$ (c) $\underline{Fe}_{0.93}O$

2. Write balanced net ionic equation for the following reactions in acidic solution.

(a) $S_4O_6^{2-}(aq) + Al(s) \longrightarrow H_2S(aq) + Al^{3+}(aq)$

(b) $S_2O_3^{2-}(aq) + Cr_2O_7^{2-}(aq) \longrightarrow S_4O_6^{2-}(aq) + Cr^{3+}(aq)$

(c) $ClO_3^-(aq) + As_2S_3(s) \longrightarrow Cl^-(aq) + H_2AsO_4^-(aq) + HSO_4^-(aq)$

(d) $IO_3^-(aq) + Re(s) \longrightarrow ReO_4^-(aq) + I^-(aq)$

(e) $HSO_4^-(aq) + As_4(s) + Pb_3O_4(s) \longrightarrow PbSO_4(s) + H_2AsO_4^-(aq)$

(f) $HNO_2(aq) \longrightarrow NO_3^- + NO(g)$

3. Write balanced net ionic equations for the following reactions in basic solution :

(a) $C_4H_4O_6^{2-}(aq) + ClO_3^-(aq) \longrightarrow CO_3^{2-}(aq) + Cl^-(aq)$

(b) $Al(s) + BiONO_3(s) \longrightarrow Bi(s) + NH_3(aq) + Al(OH)_4^-(aq)$

(c) $H_2O_2(aq) + Cl_2O_7(aq) \longrightarrow ClO_2^-(aq) + O_2(g)$

(d) $Tl_2O_3(s) + NH_2OH(aq) \longrightarrow TlOH(s) + N_2(g)$

(e) $Cu(NH_3)_4^{2+}(aq) + S_2O_4^{2-}(aq) \longrightarrow SO_3^{2-}(aq) + Cu(s) + NH_3(aq)$

(f) $Mn(OH)_2(s) + MnO_4^-(aq) \longrightarrow MnO_2(s)$

4. $KMnO_4$ oxidizes X^{n+} ion to XO_3^-, itself changing to Mn^{2+} in acid medium. $2.68 \quad 10^{-3}$ mole of X^{n+} requires $1.61 \quad 10^{-3}$ mole of MnO_4^-. What is the value of n? Also calculate the atomic mass of X, if the weight of 1g equivalent of XCl_n is 56.

5. In a quantitative determination of iron in an ore, an analyst converted 0.40 g, of the ore into its ferrous. This required 40.00 mL of 0.1 N solution of $KMnO_4$ for titration.

(i) How many milliequivalents of $KMnO_4$ does 40.00 mL of 0.1 N solution represent?

(ii) How many equivalents of iron were present in the sample of the ore taken for analysis?

(iii) How many grams of iron were present in the sample?

(iv) What is the percentage of iron in the ore?

(v) What is the molarity of $KMnO_4$ solution used?

(vi) How many moles of $KMnO_4$ were used for titration ? (Fe = 56)

6. The mixture of CuS (molar weight = M_1) and Cu_2S (molecular weight = M_2) oxidised by $KMnO_4$ (molecular weight = M_3) in acidic medium, the product obtained are Cu^{2+}, SO_2. Find the equivalent weight of CuS, Cu_2S and $KMnO_4$ respectively.

7. Consider the reaction $H^+ + IO^-_4 + I^- \rightarrow I_2 + H_2O$. Find the ratio of coefficients of IO_4^- , I^- and I_2.

8. 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 solution.

9. What volume at NTP of gaseous ammonia will be required to be passed into 30 cc of N – H_2SO_4 solution to bring down the acid strength of the latter to 0.2 N.

10. A solution containing 4.2 g of KOH and $Ca(OH_2)$ is neutralized by an acid. It consums 0.1 equivalent of acid, calculate the percentage composition of the sample.

11. How many mL of 0.1 N HCl are required to react completely with 1 g mixture of Na_2CO_3 and $NaHCO_3$ containing equimolar amounts of two?

12. 0.5 g of fuming H_2SO_4 (oleum) is diluted with water. The solution requires 26.7 mL of 0.4N NaOH for complete neutralization. Find the % of free SO_3 in the sample of oleum.

13. 10 g $CaCO_3$ were dissolved in 250 mL of M HCl and the solution was boiled. What volume of 2 M KOH would be required to equivalence point after boiling? Assume no change in volume during boiling.

14. H_3PO_4 is a tri basic acid and one of its salt is NaH_2PO_4. What volume of 1 M NaOH solution should be added to 12 g of NaH_2PO_4 to convert it into Na_3PO_4?

15. 1.64 g of mixture of $CaCO_3$ and $MgCO_3$ was dissolved in 50 mL of 0.8 M HCl. The excess of acid required 16 mL of 0.25 M NaOH for neutralization. Calculate the percentage of $CaCO_3$ and $MgCO_3$ in the sample.

16. 1.5 g of chalk were treated with 10 mL of 4N – HCl. The chalk was dissolved and the solution made to 100 mL, 25 mL of this solution required 18.75 mL of 0.2 N – NaOH solution for complete neutralisation. Calculate the percentage of pure $CaCO_3$ in the sample of chalk?

17. A solution contains Na_2CO_3 and $NaHCO_3$. 20 mL of this solution required 4 mL of 1N – HCl for titration with Ph indicator. The titration was repeated with the same volume of the solution but with MeOH. 10.5 mL of 1 – N HCl was required this time. Calculate the amount of Na_2CO_3 & $NaHCO_3$.

18. A solution contains a mix of Na_2CO_3 and NaOH. Using Ph as indicator 25 mL of mixture required 19.5 mL of 0.995 N HCl for the end point. With MeOH, 25 mL of the solution required 25 mL of the same HCl for the end point. Calculate g/L of each substance in the mixture.

19. 200 mL of a solution of mixture of NaOH and Na_2CO_3 was first titrated with Ph and $\frac{N}{10}$ HCl. 17.5 mL of HCl was required for end point. After this MeOH was added and 2.5 mL of same HCl was again required for next end point. Find out amounts of NaOH and Na_2CO_3 in the mix.

20. A solution contains Na_2CO_3 and $NaHCO_3$. 10 mL of this requires 2 mL of 0.1 M H_2SO_4 for neutralisation using Ph indicator. MeOH is then added when a further 2.5 mL of 0.2 M H_2SO_4 was needed. Calculate strength of Na_2CO_3 and $NaHCO_3$.

21. A sample containing Na_2CO_3 & NaOH is dissolved in 100 mL solution. 10 mL of this solution requires 25 mL of 0.1 N HCl when Ph is used as indicator. If MeOH is used as indicator 10 mL of same solution requires 30 mL of same HCl. Calculate % of Na_2CO_3 and NaOH in the sample.

22. It required 40.05 mL of 1 M Ce^{4+} to titrate 20 mL of 1 M Sn^{2+} to Sn^{4+}. What is the oxidation state of the cerium in the product.

23. A volume of 12.53 mL of 0.05093 M SeO_2 reacted with exactly 25.52 mL of 0.1 M $CrSO_4$. In the reaction, Cr^{2+} was oxidized to Cr^{3+}. To what oxidation state was selenium converted by the reaction.

24. Pottasium 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 0.1 M $KMnO_4$ reacting in acid solution with one gram of the acid oxalate.

25. A 1.0 g sample of H_2O_2 solution containing x% H_2O_2 by mass requires x cm^3 of a $KMnO_4$ solution for complete oxidation under acidic conditions. Calculate the normality of $KMnO_4$ solution.

26. Metallic tin in the presence of HCl is oxidized by $K_2Cr_2O_7$ to stannic chloride, $SnCl_4$. What volume of deci-normal dichromate solution would be reduce by 1 g of tin.

27. 5 g sample of brass was dissolved in one litre dil. H_2SO_4. 20 mL of this solution were mixed with KI, liberating I_2 and Cu^+ and the I_2 required 20 mL of 0.0327 N hypo solution for complete titration. Calculate the percentage of Cu in the alloy.

28. 0.84 g iron ore containing x percent of iron was taken in a solution containing all the iron in ferrous condition. The solution required x mL of a dichromatic solution for oxidizing the iron content to ferric state. Calculate the strength of dichromatic solution.

29. The neutralization of a solution of 1.2 g of a substance containing a mixture of $H_2C_2O_4.2H_2O$, $KHC_2O_4.H_2O$ and different impurities of a neutral salt consumed 18.9 mL of 0.5 N NaOH solution. On titration with $KMnO_4$ solution, 0.4 g, of the same substance needed 21.55 mL of 0.25 N $KMnO_4$. Calculate the % composition of the substance.

30. 50 g of a sample of $Ca(OH)_2$ is dissolved in 50 mL of 0.5 N HCl solution. The excess of HCl was titrated with 0.3 N – NaOH. The volume of NaOH used was 20cc. Calculate % purity of $Ca(OH)_2$.

31. One g of impure sodium carbonate is dissolved in water and the solution is made up to 250 mL. To 50 mL of this made up solution, 50 mL of 0.1 N – HCl is added and the mix after shaking well required 10 mL of 0.16 N – NaOH solution for complete titration. Calculate the % purity of the sample.

32. What amount of substance containing 60% NaCl, 37% KCl should be weighed out for analysis so that after the action of 25 mL of 0.1 N $AgNO_3$ solution, excess of Ag^+ is back titrates with 5 mL of NH_4SCN solution. Given that 1 mL of NH_4SCN = 1.1. mL of $AgNO_3$.

33. A bottle labelled with "12 V H_2O_2" contain 700 mL solution. If a student mix 300 mL water in it what is the g/litre strength & normality and volume strength of final solution.

34. 50 mL of an aqueous solution of H_2O_2 were treated with an excess of KI solution and dilute H_2SO_4, the liberated iodine required 20 mL of 0.1 N $Na_2S_2O_3$ solution for complete interaction. Calculate the concentration of H_2O_2 in g/ℓ.

35. 100 kg hard water contains 5 g $MgSO_4$. Find hardness.

36. One litre hard water contains 1 mg $CaCl_2$ and 1 mg $MgSO_4$. Find hardness.

37. Calculate the hardness of water sample which contains 0.001 mol $MgSO_4$ per litre of water.

38. A solution of a 0.4 g sample of H_2O_2 reacted with 0.632 g of $KMnO_4$ in the presence of sulphuric acid. Calculate the percentage purity of the sample of H_2O_2.

39. 5 litre of a solution of H_2O_2 with x N strength is diluted to 5.5 litre. This 5.5 litre H_2O_2 solution gives 28 litre O_2 at NTP. Find the value of x.

40. Calculate the amount of lime $Ca(OH)_2$ required to remove the hardness in 60 litre of pond water containing 1.62 mg of calcium bicarbonate per 100 mL of water.

41. 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. Find out the % of available Cl_2 approximately is (mol wt. 71).

42. Calculate the amount (in milligrams) of SeO_3^{-2} in solution on the basis of following data 20 mL of M/60 solution of $KBrO_3$ was added to a definite volume of SeO_3^{-2} solution. The bromine evolved was removed by boiling and excess of $KBrO_3$ was back titrated with 5 mL of M/25 solution of $NaAsO_2$. The reactions are given below. (Atomic mass of K = 39, Br = 80, As = 75, Na = 23, O = 16, Se = 79)

(a) $SeO_3^{-2} + BrO_3^- + H^+ \longrightarrow SeO_4^{-2} + Br_2 + H_2O$

(b) $BrO_3^- + AsO_2^- + H_2O \longrightarrow Br^- + AsO_4^{-3} + H^+$

43. 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 solution of an oxidant for titration. Calculate the number of moles of electrons taken up by the oxidant in the reaction of the above titration.

CONCEPTUAL SUBJECTIVE EXERCISE — ANSWER KEY — EXERCISE-4(A)

1. **(a)** +3 **(b)** +5 **(c)** +6 **(d)** +2 **(e)** 8/3 or (2 and 3)
(f) +3 **(g)** +2 **(h)** +2 **(i)** 200/93 = 2.15

2. **(a)** $S_4O_6^{2-}(aq) + 6Al\ (s) + 20\ H^+ \longrightarrow 4\ H_2S\ (aq) + 6Al^{3+}\ (aq) + 6H_2O$

(b) $6S_2O_3^{2-}(aq) + Cr_2O_7^{2-}\ (aq) + 14\ H^+ \longrightarrow 3\ S_4O_6^{2-}\ (aq) + 2\ Cr^{3+}\ (aq) + 7H_2O$

(c) $14ClO_3^-(aq) + 3As_2S_3\ (s) + 18\ H_2O \longrightarrow 14\ Cl^-\ (aq) + 6H_2AsO_4^-\ (aq) + 9HSO_4^-\ (aq) + 15H^+$

(d) $7IO_3^-(aq) + 6Re\ (s) + 3H_2O \longrightarrow 6\ ReO_4^-\ (aq) + 7I^-\ (aq) + 6H^+$

(e) $30HSO_4^-(aq) + As_4\ (s) + 10\ Pb_3O_4(s) + 26H^+ \longrightarrow 30\ PbSO_4\ (s) + 4H_2AsO_4^-\ (aq) + 24H_2O$

(f) $3HNO_2\ (aq) \longrightarrow HNO_3 + 2NO\ (g) + H_2O$

3. **(a)** $3C_4H_4O_6^{2-}(aq) + 5ClO_3^-\ (aq) + 18\ OH^- \longrightarrow 12\ CO_3^{2-}\ (aq) + 5\ Cl^-\ (aq) + 15H_2O$

(b) $11Al\ (s) + 3BiONO_3\ (s) + 21H_2O + 11OH^- \longrightarrow 3Bi\ (s) + 3NH_3\ (aq) + 11Al\ (OH)_4^-(aq)$

(c) $4H_2O_2\ (aq) + Cl_2O_7\ (aq) + 2OH^- \longrightarrow 2ClO_2^-\ (aq) + 4O_2\ (g) + 5H_2O$

(d) $Tl_2O_3\ (s) + 4NH_2OH\ (aq) \longrightarrow 2TlOH\ (s) + 2N_2\ (g) + 5H_2O$

(e) $Cu(NH_3)_4^{2+}\ (aq) + S_2O_4^{2-}\ (aq) + 4OH^- \longrightarrow 2SO_3^{2-}\ (aq) + Cu\ (s) + 4NH_3\ (aq) + 2H_2O$

(f) $3Mn(OH)_2\ (s) + 2MnO_4^-\ (aq) \longrightarrow 5MnO_2\ (s) + 2H_2O + 2OH^-$

4. 2, 41

5. **(i)** 4.0, **(ii)** 0.0040, **(iii)** 0.224, **(iv)** 56.00%, **(v)** 0.02M, **(vi)** 0.0008 mol

6. $\frac{M_1}{6}, \frac{M_2}{8}, \frac{M_3}{5}$ **7.** 1 : 7 : 4 **8.** 0.06 N and 0.03 M **9.** 537.6 mL

10. KOH = 35%, $Ca(OH)_2$ = 65% **11.** V = 157.89 mL **12.** 20.72 %

13. V = 25 mL **14.** 200 mL **15.** $MgCO_3$ = 51.22%, $CaCO_3$ = 48.78 %

16. 83.33 **17.** 0.424 g ; 0.21g **18.** 23.2 g, 22.28 g **19.** 0.06 g ; 0.0265 g

20. 4.24 g/L ; 5.04 g/L **21.** 39.85% ; 60.15% **22.** +3

23. zero **24.** V = 31.68 mL **25.** 0.588 N **26.** 337 mL

27. 41.53 % **28.** 0.15 N **29.** $H_2C_2O_4.2H_2O$ = 14.36%, $KH_2O_4.H_2O$=81.71%

30. 1.406 % **31.** 90.1% **32.** 0.1281 g

33. 25.5 g/L, 1.5 N, 8.4 V **34.** 0.68 g/L **35.** 41.66 ppm

36. 1.734 ppm **37.** 100 ppm **38.** 85% **39.** x = 1

40. 0.444 g **41.** 7.1% **42.** 84mg **43.** 6

1. 1.2475 g of crystalline copper sulphate was dissolved in water and excess of KI was added. The liberated iodine consumed 50 mL N/10 $Na_2S_2O_3$ solution to reach the end point of the titration. Calculate the number of water molecules of hydration in crystalline copper sulphate salt.

2. A 1g sample of $K_2Cr_2O_7$ containing some inert material was entirely reduced with conc. HCl. The chlorine liberated was passed through hot solution of NaOH at 80^0C, and it completely diproportionates to form ClO_3^- and Cl^-. This $NaClO_3$ was isolated and its reduction with KI (aq) liberated iodine, giving Cl^-.The iodine thus liberated required 100 mL of decinormal hypo solution for complete titration. What is the percentage purity of the dichromate sample?

3. 2.5g of mixture of crystalline oxalic acid ($H_2C_2O_4.\ 2H_2O$) and sodium oxalate ($Na_2C_2O_4$) was dissolved in 100 mL of water. 50 mL of this solution was titrated against N/10 NaOH solution when 119.05 mL of the base was found necessary to reach the end point with phenolphthalein as the indicator. 1g of the mixture was dissolved in water and the solution titrated against N/10 $KMnO_4$ in the presence of dil. H_2SO_4. What is the volume of $KMnO_4$ needed for getting the end point with 0.5g of the mixture?

4. 25 mL of a solution containing HCl was treated with excess of M/5 KIO_3 and KI solution of unknown concentration where I_2 liberated is titrated against a standard solution of 0.021 M $Na_2S_2O_3$ solution whose 24 mL were used up. Find the strength of HCl and volume of KIO_3 solution consumed :

5. 0.6213 g of sample contains an unknown amount of As_2O_3. The sample was treated with HCl resulting information of $AsCl_3$ (g) which was distilled into a beaker of water. The hydrolysis reaction is as follows :

$$AsCl_3 + 2H_2O \rightarrow HAsO_2 + 3H^+ + 3Cl^-$$

The amount of $HAsO_2$ was determined by titration with 0.04134 M I_2, requiring 23.04 mL to reach the equivalence point. The redox products in the titration were H_3AsO_4 and I^-. Find the amount of $KMnO_4$ needed to oxidize As in As_2O_3 to its maximum possible oxidation state in acidic medium.

6. A sample of steel weighing 0.6 g and containing S as an impurity was burnt in a stream of O_2, when S was converted to its oxide SO_2.SO_2 was then oxidized to SO_4^{--} by using H_2O_2 solution containing 30 mL of 0.04 M NaOH. 22.48 mL of 0.024 M HCl was required to neutralize the base remaining after oxidation. Calculate the % of S in the sample :

7. In the presence of fluoride ion, Mn^{2+} can be titrated with MnO_4^-, both reactants being converted to a complex of Mn(III). A 0.545 g sample containing Mn_3O_4 was dissolved and all manganese was converted to Mn^{2+}. Titration in the presence of fluoride ion consumed 31.1 mL of $KMnO_4$ that was 0.177 N against oxalate.
   (a) write a balanced chemical equation for the reaction, assuming that the complex is MnF_4^-.
   (b) what was the % of Mn_3O_4 in the sample ?

8. A mixture of two gases, H_2S and SO_2 is passed through three beakers successively. The first beaker contains Pb^{2+} ions, which absorbs S^{2-} forming PbS. The second beaker contains 25 mL of 0.0396 N I_2 to oxidize SO_2 to SO_4^{2-}. The third contains 10 mL of 0.0345 N thiosulphate solution to retain any I_2 carried over from the second absorber. A 25 L gas sample was passed through the apparatus followed by an additional amount of N_2 to sweep last traces of SO_2 from first and second absorber. The solution from the first absorber was made acidic and treated with 20 mL of 0.0066 M $K_2Cr_2O_7$ which converted S^{2-} to SO_2. The excess dichromate was reacted with solid KI and the liberated iodine required 7.45 mL of 0.0345 N $Na_2S_2O_3$ solution. The solutions in the second and third absorbers were combined and the resultant iodine was titrated with 2.44 mL of the same thiosulphate solution. Calculate the concentrations of SO_2 and H_2S in mg/L of the sample :

9. 1 g of a moist sample of a mixture of $KClO_3$ and KCl was dissolved in water and made upto 250 mL. 25 mL of this solution was treated with SO_2 to reduced chlorate into chloride and the excess SO_2 was boiled off. When the total chloride was precipitated, 0.1435 g of AgCl was obtained. In another experiment 25 mL of the original solution was treated with 30 mL of 0.2 N solution of $FeSO_4$ and unreacted $FeSO_4$ required 37.5 mL of 0.08 N solution of an oxidizing agent for complete oxidation. Calculate the molar ratio of chlorate and chloride in the given mixture. Fe^{2+} reacts with ClO_3^- according to equation :

$$ClO_3^- + 6Fe^{2+} + 6H^+ \rightarrow Cl^- + 6Fe^{3+} + 3H_2O$$

Also calculate the mass percent of moisture present in the moist sample.

10. A steel sample is to be analysed for Cr and Mn simultaneously. By suitable treatment the Cr is oxidized to $Cr_2O_7^{2-}$ and the Mn to MnO_4^-. A 10.00 g sample of steel is used to produce 250.0 mL of a solution containing $Cr_2O_7^{2-}$ and MnO_4^-. A 10.00 mL portion of this solution is added to a $BaCl_2$ solution and by proper adjustment of the acidity, the chromium is completely precipitated as $BaCrO_4$; 0.0549 g is obtained. A second 10.00 mL portion of this solution requires exactly 15.95 mL of 0.0750 M standard Fe^{2+} solution for its titration (in acid solution). Calculate the % of Mn and % of Cr in the steel sample.

11. 1.16 g $CH_3(CH_2)_nCOOH$ was burnt in excess air and the resultant gases (CO_2 and H_2O) were passed through excess NaOH solution. The resulting solution was divided in two equal parts. One part required 50 mL of 1 N HCl for neutralization using phenolphthalein as indicator. Another part required 80 mL of 1 N HCl for neutralization using methyl orange as indicator. Find the value of n and the amount of excess NaOH solution taken initially.

12. A 1.5 g sample containing oxalic acid and some inert impurity was dissolved in enough water and volume made up to 250 mL. A 20 mL portion of this solution was then mixed with 30 mL of an alkali solution. The resulting solution was then treated with stoichiometric amount of $CaCl_2$ just needed for precipitation of oxalate as CaC_2O_4. Solution was filtered off and filtrate was finally titrated against 0.1 M HCl solution. 8.0 mL of acid was required to reach the equivalence point. At last, the above neutral solution was treated with excess of $AgNO_3$ solution and AgCl obtained was washed, dried and weighed to be 0.4305 g. Determine mass percentage of oxalic acid in the original sample :

13. A 1 g sample containing NaOH as the only basic substance and some inert impurity was left exposed to atmosphere for a very long time so that part of NaOH got converted into Na_2CO_3 by absorbing CO_2 from atmosphere. The resulting sample was dissolved in water and volume made upto 100 mL. A 20 mL portion of this solution required 16 mL 0.25 M HCl solution to reach the equivalence point when methyl orange was used as indicator. In a separate analysis, 20 mL portion of the same solution was taken along with phenolphthalein indicator and mixed with 50 mL of 0.1 M HCl solution. An additional 9.00 mL 0.1 M $Ba(OH)_2$ solution was required to just restore the pink colour of solution. Determine mass percentage of NaOH in the original sample and mass percentage of Na_2CO_3 in the sample after exposure to atmosphere.

BRAIN STORMING SUBJECTIVE EXERCISE — ANSWER KEY — EXERCISE-4(B)

1. 5	**2.** 58.8%	**3.** 77.45 mL
4. $V_{KIO_3} = 0.42$ mL , [HCl] = 0.0168 N	**5.** 0.06 g	**6.** 1.76 %
7. 40.77%	**8.** 0.12 mg H_2S/L, 0.718 mg SO_2/L	
9. ClO_3^-/Cl^- = 1, 1.5% moisture by mass	**10.** Cr = 2.821% , Mn = 1.498%	
11. n = 4, NaOH = 6.4 g	**12.** 82.5	**13.** 80, 36.05 %

1. MnO_4^- is good oxidising agent in different medium changing to - **[AIEEE-02]**

$MnO_4^- \longrightarrow Mn^{2+}$

$\longrightarrow MnO_4^{2-}$

$\longrightarrow MnO_2$

$\longrightarrow Mn_2O_3$

Changes in oxidation number respectively are -

(1) 1, 3, 4, 5 (2) 5, 4, 3, 2 (3) 5, 1, 3, 4 (4) 2, 6, 4, 3

2. Oxidation number of Cl in $CaOCl_2$ (bleaching powder is) **[AIEEE-02]**

(1) Zero, since it contains Cl_2

(2) –1, since it contains Cl^-

(3) +1, since it contains ClO^-

(4) +1 and –1 since it contains ClO^- and Cl^-

3. Which of the following is a redox **[AIEEE-02]**

(1) $2NaAg(CN)_2 + Zn \longrightarrow Na_2Zn(CN)_4 + 2Ag$ (2) $BaO_2 + H_2SO_4 \longrightarrow BaSO_4 + H_2O_2$

(3) $N_2O_5 + H_2O \longrightarrow 2HNO_3$ (4) $AgNO_3 + KI \longrightarrow AgI + KNO_3$

4. In the coordination compound, $K_4[Ni(CN)_6]$, the oxidation state of nickel is **[AIEEE-03]**

(1) +1 (2) +2 (3) –1 (4) 0

5. The oxidation state of Cr in $[Cr(NH_3)_4Cl_2]^+$ is - **[AIEEE-05]**

(1) +2 (2) +3 (3) 0 (4) +1

6. The oxidation state of chromium in the final product formed by the reaction between Kl and acidified potassium dichromate solution is - **[AIEEE-05]**

(1) +6 (2) +4 (3) +3 (4) +2

7. Which of the following chemical reaction depicts the oxidizing behaviour of H_2SO_4 ? **[AIEEE-06]**

(1) $Ca(OH)_2 + H_2SO_4 \rightarrow CaSO_4 + 2H_2O$

(2) $NaCl + H_2SO_4 \rightarrow NaHSO_4 + HCl$

(3) $2PCl_5 + H_2SO_4 \rightarrow 2POCl_3 + 2HCl + SO_2Cl_2$

(4) $2HI + H_2SO_4 \rightarrow I_2 + SO_2 + 2H_2O$

Que.	1	2	3	4	5	6	7
Ans	3	4	1	2	2	3	4

EXERCISE–05 [B] PREVIOUS YEARS QUESTIONS

1. The oxidation number of phosphorus in $Ba(H_2PO_2)_2$ is : **[JEE 1990]**

(A) +3 (B) +2 (C) +1 (D) –1

2. The number of electrons to balance the following equation :- **[JEE 1991]**

$NO_3^- + 4H^+ + e^- \rightarrow 2H_2O + NO$ is

(A) 5 (B) 4 (C) 3 (D) 2

3. What is the volume strength of 1.5 N H_2O_2 : **[JEE 1991]**

(A) 4.8 (B) 8.4 (C) 3.0 (D) 8.0

4. The oxidation states of the most electronegative element in the products of the reaction of BaO_2 with dilute H_2SO_4. **[JEE 1991]**

(A) 0 and –1 (B) –1 and –2 (C) –2 and 0 (D) –2 and +2

5. For the redox reaction, **[JEE 1992]**

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

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

6. The number of mole of $KMnO_4$ that will need to react completely with one mole ferrous oxalate in acidic solution is : **[JEE 1997]**

(A) 2/5 (B) 3/5 (C) 4/5 (D) 1

7. The number of mole of $KMnO_4$ that will be needed to react with one mole of sulphite ion in acidic solution is : **[JEE 1997]**

(A) 2/5 (B) 3/5 (C) 4/5 (D) 1

8. The equivalent mass of $MnSO_4$ is half its molecular mass when it is converted to : **[JEE 1998]**

(A) Mn_2O_3 (B) MnO_2 (C) MnO_4^- (D) MnO_4^{2-}

9. The oxidation number of sulphur in S_8, S_2F_2 and H_2S respectively are : **[JEE 1999]**

(A) 0, +1 and –2 (B) +2, +1 and –2

(C) 0, +1 and +2 (D) –2, +1 and –2

10. The normality of 0.3 M phosphorus acid (H_3PO_3) is : **[JEE 1999]**

(A) 0.1 (B) 0.9 (C) 0.3 (D) 0.6

11. Among the following species in which oxidation state of the element is +6 : **[JEE 2000]**

(A) MnO_4^- (B) $Cr(CN)_6^{3-}$ (C) NiF_6^{2-} (D) CrO_2Cl_2

12. Oxidation number of iron in $Na_2[Fe(CN)_5NO^{\oplus}]$ is : **[JEE 2001]**

(A) +2 (B) +3 (C) +8/3 (D) none of these

13. An aqueous solution of 6.3 g of oxalic acid dihydrate is made upto 250 mL. The volume of 0.1 N NaOH required to completely neutralise 10 mL of this solution is : **[JEE 2001]**

(A) 40 mL (B) 20 mL (C) 10 mL (D) 4 mL

14. How many moles of electron weigh one kilogram : **[JEE 2002]**

(A) $6.023 \quad 10^{23}$ (B) $\frac{1}{9.108}\times10^{31}$ (C) $\frac{6.023}{9.108}\times10^{54}$ (D) $\frac{1}{9.108\times6.023}\times10^{8}$

15. Which has maximum number of atoms : **[JEE 2003]**

(A) 24 g of C (12) (B) 56 g of Fe (56) (C) 27 g of Al (27) (D) 108 g of Ag (108)

16. In basic medium I^- oxidises by MnO_4^-. In this process I^- replaces by : **[JEE 2004]**

(A) IO_3^- (B) I_2 (C) IO_4^- (D) IO^-

17. Amongst the following, the pair having both the metals in their highest oxidation state is : **[JEE 2004]**

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

(C) TiO_2 and MnO_2 (D) $[MnCl_4]^{2-}$ and $[NiF_6]^{-2}$

18. O_3 does not oxidise : **[JEE 2005]**

(A) KI (B) $FeSO_4$ (C) $KMnO_4$ (D) K_2MnO_4

19. A 5.0 cm^3 solution of H_2O_2 liberates 0.508 g of iodine from an acidified KI solution. Calculate the strength of H_2O_2 solution in terms of volume strength at STP. **[JEE' 1995]**

20. 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 require 11 mL of 0.5 M $Na_2S_2O_3$ solution to reduce the iodine present. A 50 mL of diluted solution after complete extraction of the iodine requires 12.80 mL of 0.25 $KMnO_4$ solution in dilute H_2SO_4 medium for the oxidation of Fe^{2+}. Calculate the percentages of Fe_2O_3 and Fe_3O_4 in the original sample. **[JEE 2000]**

21. One litre of a mixture of O_2 and O_3 at NTP 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 percent 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? **[JEE 97,5]**

22. A sample of hard water contains 96 ppm of SO_4^{2-} and 183 ppm of HCO_3^-, with Ca^{2+} as the only cation. How many moles of CaO will be required to remove HCO_3^- from 1000 kg of this water? If 1000 kg of this water is treated with the amount of CaO calculate above, what will be the concentration (in ppm) of residual Ca^{2+} ions (Assume $CaCO_3$ to be completely insoluble in water)? If the Ca^{2+} ions in one litre of the treated water are completely exchanged with hydrogen ions, what will be its pH (one ppm means one part of the substance in one million part of water, weight / weights)? **[JEE' 1997]**

23. An aqueous solution containing 0.10 g KIO_3 (formula wt. 214.0) was treated with an excess of KI solution. The solution was acidified with HCl. The liberated I_2 consumed 45.0 mL of thiosulphate solution to decolourise the blue starch – iodine complex. Calculate the molarity of the sodium thiosulphate solution. **[JEE 1998]**

24. How many millilitre of 0.5 M H_2SO_4 are needed to dissolve 0.5 g of copper II carbonate ? **[JEE 1999]**

25. Hydrogen peroxide solution (20 mL) reacts quantitatively with a solution of $KMnO_4$ (20 mL) acidified with dilute H_2SO_4. The same volume of $KMnO_4$ solution is just decolorized by 10 mL of $MnSO_4$ in neutral medium simultaneously forming a dark brown precipitate of hydrated MnO_2. The brown precipitate is dissolved in 10 mL of 0.2 M sodium oxalate under boiling condition in the presence of dilute H_2SO_4. Write the balanced equations involved in the reactions and calculate the molarity of H_2O_2. **[JEE 2001]**

PREVIOUS YEARS QUESTIONS — ANSWER KEY — EXERCISE -5[B]

Que.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
Ans.	C	C	B	B	A	B	A	B	A	D	D	A	A	D	A
Que.	16	17	18												
Ans.	A	B	C												

19. 4.48

20. Fe_2O_3 = 49.33 %, Fe_3O_4 = 34.8%

21. 6.57% O_3 (by weight), 1.2 10^{21} photons

22. 1.5, 40 ppm, pH = 2.6989

23. 0.0623 M

24. 8.097 mL

25. 0.1 M