8 Redox Reactions

I. Multiple Choice Questions (Type-I)

1. Which of the following is **not** an example of redox reaction?

(*i*) $CuO + H_2 \rightarrow Cu + H_2O$ (*ii*) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

(*iii*) $2K + F_2 \rightarrow 2KF$ (*iv*) $BaCl_2 + H_2SO_4 \rightarrow BaSO_4 + 2HCl$

Ans. (*iv*)

Explanation: Oxidation no. of all the elements remains unchanged.

2. The more positive the value of $E^{\ominus}$, the greater is the tendency of the species to get reduced. Using the standard electrode potential of redox couples given below find out which of the following is the strongest oxidising agent.

$E^{\ominus}$ values: $Fe^{3+}/Fe^{2+} = +0.77$; $I_2(s)/I^- = +0.54$;
$Cu^{2+}/Cu = +0.34$; $Ag^+/Ag = +0.80V$

(*i*) Fe^{3+} (*ii*) $I_2(s)$

(*iii*) Cu^{2+} (*iv*) Ag^+

Ans. (*iv*)

Explanation: Ag^+/Ag has highest value of reduction potential.

3. $E^{\ominus}$ values of some redox couples are given below. On the basis of these values choose the correct option.

$E^{\ominus}$ values: $Br_2/Br^- = +1.90$; $Ag^+/Ag(s) = +0.80$
$Cu^{2+}/Cu(s) = +0.34$; $I_2(s)/I^- = +0.54$

(*i*) Cu will reduce Br^- (*ii*) Cu will reduce Ag

(*iii*) Cu will reduce I^- (*iv*) Cu will reduce Br_2

Ans. (*iv*)

Explanation: Br_2 is better oxidizing agent than Cu^{2+}.

4. Using the standard electrode potential, find out the pair between which redox reaction is not feasible.

$E^{\ominus}$ values: $Fe^{3+}/Fe^{2+} = +0.77$; $I_2/I^- = +0.54$;
$Cu^{2+}/Cu = +0.34$; $Ag^+/Ag = +0.80$ V

(*i*) Fe^{3+} and I^- (*ii*) Ag^+ and Cu

(*iii*) Fe^{3+} and Cu (*iv*) Ag and Fe^{3+}

Ans. (*iv*)

Explanation: E^0_{cell} will be negative for the pair Ag and Fe^{3+}. Hence the reaction is not feasible.

5. Thiosulphate reacts differently with iodine and bromine in the reactions given below:

$2S_2O_3^{2-} + I_2 \longrightarrow S_4O_6^{2-} + 2I^-$

$S_2O_3^{2-} + 2Br_2 + 5H_2O \longrightarrow 2SO_4^{2-} + 2Br^- + 10H^+$

Which of the following statements justifies the above dual behaviour of thiosulphate?

(*i*) Bromine is a stronger oxidant than iodine.

(*ii*) Bromine is a weaker oxidant than iodine.

(*iii*) Thiosulphate undergoes oxidation by bromine and reduction by iodine in these reactions.

(*iv*) Bromine undergoes oxidation and iodine undergoes reduction in these reactions.

Ans. (*i*)

Explanation: Standard reduction potential of bromine is higher than Iodine.

6. The oxidation number of an element in a compound is evaluated on the basis of certain rules. Which of the following rules is **not** correct in this respect?

(*i*) The oxidation number of hydrogen is always +1.

(*ii*) The algebraic sum of all the oxidation numbers in a compound is zero.

(*iii*) An element in the free or the uncombined state bears oxidation number zero.

(*iv*) In all its compounds, the oxidation number of fluorine is – 1.

Ans. (*i*)

Explanation: In ionic hydrides hydrogen exist in –1 oxidation state.

7. In which of the following compounds, an element exhibits two different oxidation states.

(*i*) NH_2OH (*ii*) NH_4NO_3

(*iii*) N_2H_4 (*iv*) N_3H

Ans. (*ii*)

Explanation: Nitrogen exists in two different oxidation states *i.e.*, +5 and –3.

8. Which of the following arrangements represent increasing oxidation number of the central atom?

(*i*) $CrO_2^-, ClO_3^-, CrO_4^{2-}, MnO_4^-$ (*ii*) $ClO_3^-, CrO_4^{2-}, MnO_4^-, CrO_2^-$

(*iii*) $CrO_2^-, ClO_3^-, MnO_4^-, CrO_4^{2-}$ (*iv*) $CrO_4^{2-}, MnO_4^-, CrO_2^-, ClO_3^-$

Ans. (*i*)

Explanation: Oxidation no. of central element increases as +3, +5, +6, +7.

9. The largest oxidation number exhibited by an element depends on its outer electronic configuration. With which of the following outer electronic configurations the element will exhibit largest oxidation number?

(*i*) $3d^14s^2$ (*ii*) $3d^34s^2$

(*iii*) $3d^54s^1$ (*iv*) $3d^54s^2$

Ans. (*iv*)

Explanation: Total no. of electrons present in *d* and *s* subshell = 7.

10. Identify disproportionation reaction

(*i*) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

(*ii*) $CH_4 + 4Cl_2 \rightarrow CCl_4 + 4HCl$

(*iii*) $2F_2 + 2OH^- \rightarrow 2F^- + OF_2 + H_2O$

(*iv*) $2NO_2 + 2OH^- \rightarrow NO_2^- + NO_3^- + H_2O$

Ans. (*iv*)

Explanation: Oxidation no. of nitrogen decrease by 1 from NO_2 to NO_2^- and increase by +1 from NO_2 to NO_3^-.

11. Which of the following elements does not show disproportionation tendency?

(*i*) Cl (*ii*) Br

(*iii*) F (*iv*) I

Ans. (*iii*)

Explanation: Fluorine is the most electronegative element.

II. Multiple Choice Questions (Type-II)

In the following questions two or more options may be correct.

12. Which of the following statement(s) is/are not true about the following decomposition reaction.

$$2KClO_3 \rightarrow 2KCl + 3O_2$$

(*i*) Potassium is undergoing oxidation

(*ii*) Chlorine is undergoing oxidation

(*iii*) Oxygen is reduced

(*iv*) None of the species are undergoing oxidation or reduction

Ans. (*i*) and (*iv*)

Explanation: Potassium remains in same oxidation state and oxygen is being oxidized.

13. Identify the correct statement (s) in relation to the following reaction:

$$Zn + 2HCl \rightarrow ZnCl_2 + H_2$$

(*i*) Zinc is acting as an oxidant

(*ii*) Chlorine is acting as a reductant

(*iii*) Hydrogen ion is acting as an oxidant

(*iv*) Zinc is acting as a reductant

Ans. (*iii*) and (*iv*)

Explanation: Zinc is oxidized in the reaction and hydrogen is reduced.

14. The exhibition of various oxidation states by an element is also related to the outer orbital electronic configuration of its atom. Atom(*s*) having which of the following outermost electronic configurations will exhibit more than one oxidation state in its compounds?

(*i*) $3s^1$ (*ii*) $3d^14s^2$

(*iii*) $3d^24s^2$ (*iv*) $3s^23p^3$

Ans. (*iii*) and (*iv*)

Explanation: In option (*iii*) electron can be removed from 4*s* as well as 3*d*. Similarly, in option (*iv*) electron can be removed from 3*p* and 3*s* both.

15. Identify the correct statements with reference to the given reaction:

$$P_4 + 3OH^- + 3H_2O \rightarrow PH_3 + 3H_2PO_2^-$$

(*i*) Phosphorus is undergoing reduction only.
(*ii*) Phosphorus is undergoing oxidation only.
(*iii*) Phosphorus is undergoing oxidation as well as reduction.
(*iv*) Hydrogen is undergoing neither oxidation nor reduction.

Ans. (*iii*) and (*iv*)

Explanation: This is a kind of disproportionation reaction in which phosphorous is being reduced as well as oxidized whereas hydrogen remains same in +1 oxidation state.

16. Which of the following electrodes will act as anodes, when connected to Standard Hydrogen Electrode?

(*i*) Al/Al^{3+}	$E^\ominus = -1.66$
(*ii*) Fe/Fe^{2+}	$E^\ominus = -0.44$
(*iii*) Cu/Cu^{2+}	$E^\ominus = +0.34$
(*iv*) $F_2(g)/2F^-(aq)$	$E^\ominus = +2.87$

Ans. (*i*) and (*ii*)

Explanation: Both has negative value of standard reduction potential.

III. Short Answer Type

17. The reaction

$$Cl_2(g) + 2OH^-(aq) \rightarrow ClO^-(aq) + Cl^-(aq) + H_2O(l)$$

represents the process of bleaching. Identify and name the species that bleaches the substances due to its oxidising action.

Ans. The hypochlorite ion (ClO^-) formed in the reaction oxidises the colour-bearing stains of the substances to colourless compounds.

18. MnO_4^{2-} undergoes disproportionation reaction in acidic medium but MnO_4^- does not. Give reason.

Ans. In MnO_4^-, Mn is in highest oxidation state that is +7 thus here manganese cannot undergo oxidation that is why disproportionation is not possible whereas in MnO_4^{2-} manganese is in +6 oxidation state which can be oxidized as well as reduced.

19. PbO and PbO_2 react with HCl according to following chemical equations:

$$2PbO + 4HCl \rightarrow 2PbCl_2 + 2H_2O$$

$$PbO_2 + 4HCl \rightarrow PbCl_2 + Cl_2 + 2H_2O$$

Why do these compounds differ in their reactivity?

Ans. Lead is present in +4 oxidation state, whereas the stable oxidation state of lead in PbO is +2. PbO_2 thus can act as an oxidant (oxidising agent) and, therefore, can oxidise Cl^- ions of HCl into chlorine.

20. Nitric acid is an oxidising agent and reacts with PbO but it does not react with PbO_2. Explain why?

Ans. Since HNO_3 itself is an oxidising agent therefore, it is unlikely that the reaction may occur between PbO_2 and HNO_3. However, the acid-base reaction occurs between PbO and HNO_3 as PbO is a basic oxide:

$$2PbO + 4HNO_3 \rightarrow 2Pb(NO_3)_2 + 2H_2O$$

21. Write balanced chemical equation for the following reactions:

(*i*) Permanganate ion (MnO_4^-) reacts with sulphur dioxide gas in acidic medium to produce Mn^{2+} and hydrogensulphate ion. (Balance by ion electron method)

(*ii*) Reaction of liquid hydrazine (N_2H_4) with chlorate ion (ClO_3^-) in basic medium produces nitric oxide gas and chloride ion in gaseous state. (Balance by oxidation number method)

(*iii*) Dichlorine heptaoxide (Cl_2O_7) in gaseous state combines with an aqueous solution of hydrogen peroxide in acidic medium to give chlorite ion (ClO_2^-) and oxygen gas. (Balance by ion electron method)

Ans. (*i*) $MnO_4^- + SO_2 \rightarrow Mn^{2+} + \underset{\text{(acidic medium)}}{HSO_4^-}$

Balancing ion by electron method:

$$2 \times \{ MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$$

$$5 \times \{ SO_2 + 2H_2O \rightarrow HSO_4^- + 3H^+ + 2e^-$$

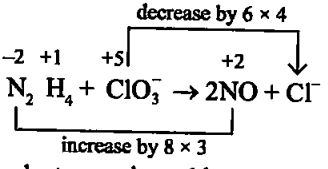
$$2MnO_4^- + 16H^+ + \cancel{10e^-} \rightarrow 2Mn^{2+} + 8H_2O$$

$$5SO_2 + 10H_2O \rightarrow 5HSO_4^- + 15H^+ + \cancel{10e^-}$$

$$2MnO_4^- + H^+ + 5SO_2 + 2H_2O \rightarrow 2Mn^{2+} + 5HSO_4^-$$

(*ii*) $N_2H_4 + ClO_3^- \rightarrow NO + \underset{\text{(Basic medium)}}{Cl^-}$

Balancing by oxidation number method:



To make the electron gain and loss equal.

$$3N_2H_4 + 4ClO_3^- \rightarrow 6NO + 4Cl^- + 6H_2O$$

(*iii*) $Cl_2O_7(g) + H_2O_2(aq) \rightarrow ClO_2^- + \underset{\text{(acidic medium)}}{O_2}$

Balancing by ion electron method:

$$2 \times \{ Cl_2O_7 + 6H^+ + 8e^- \rightarrow 2ClO_2^- + 3H_2O$$

$$8 \times \{ H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-$$

$$2Cl_2O_7 + 12H^+ + \cancel{16e^-} \rightarrow 4ClO_2^- + 6H_2O$$

$$8H_2O_2 \rightarrow 8O_2 + 16H^+ + \cancel{16e^-}$$

$$2Cl_2O_7 + 8H_2O_2 \rightarrow 4ClO_2^- + 6H_2O + 8O_2 + 4H^+$$

22. Calculate the oxidation number of phosphorus in the following species:

(*a*) HPO_3^{2-} and (*b*) PO_4^{3-}

Ans. (*a*) Let the oxidation number of phosphorus is x.

$\overset{x}{HPO_3^{2-}}$

$$+1 + x + (-2) \times 3 = -2$$
$$+1 + x - 6 = -2$$
$$x - 5 = -2 + 5$$
$$= +3$$

(*b*) $\overset{x}{PO_4^{3-}}$

$$x + (-2) \times 4 = -3$$
$$x - 8 = -3$$
$$x = -3 + 8$$
$$x = 5$$

23. Calculate the oxidation number of each sulphur atom in the following compounds:

(*a*) $Na_2S_2O_3$ (*b*) $Na_2S_4O_6$

(*c*) Na_2SO_3 (*d*) Na_2SO_4

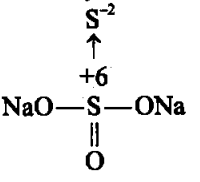
Ans. (*a*) Let the oxidation number of sulphur atom is x.

$\overset{x}{Na_2S_2O_3}$

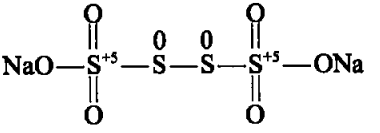
$$2 \times (+1) + 2x + (-2) \times 3 = 0$$
$$2 + 2x - 6 = 0$$
$$2x - 4 = 0$$
$$2x = 4$$
$$x = +2 \text{ (wrong)}$$

by conventional method.

It will be well explained by structure.



(*b*) $Na_2S_4O_6$



(*c*) $\overset{x}{Na_2SO_3}$

$$2 \times 1\ (+1) + x + (-2) \times 3 = 0$$
$$2 + x - 6 = 0$$
$$x = +4$$

(*d*) $\overset{x}{Na_2SO_4}$

$$2 \times (+1) + x + (-2) \times 4 = 0$$
$$2 + x - 8 = 0$$
$$x = +6$$

24. Balance the following equations by the oxidation number method.

(*i*) $Fe^{2+} + H^+ + Cr_2O_7^{2-} \rightarrow Cr^{3+} + Fe^{3+} + H_2O$

(*ii*) $I_2 + NO_3^- \rightarrow NO_2 + IO_3^-$

(*iii*) $I_2 + S_2O_3^{2-} \rightarrow I^- + S_4O_6^{2-}$

(*iv*) $MnO_2 + C_2O_4^{2-} \rightarrow Mn^{2+} + CO_2$

Ans. (*i*)

decrease by 6 (+6)

$$Fe^{2+} + H^+ + Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + Fe^{3+} + H_2O$$

increase by +1

To make increase and decrease equal

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

(*ii*)

$$\overset{0}{I_2} + \overset{+5}{NO_3^-} \rightarrow \overset{+4}{NO_2} + \overset{+5}{2IO_3^-}$$

decrease by 1; increase by 10

$$I_2 + 10\,NO_3^- + 4H_2O \rightarrow 10NO_2 + 2IO_3^- + 8OH^-$$

(*iii*) $I_2 + S_2O_3^{2-} \rightarrow I^- + S_4O_6^{2-}$

$$I_2 + 2\,S_2O_3^{2-} \rightarrow 2I^- + S_4O_6^{2-}$$

(*iv*) $MnO_2 + C_2O_4^{2-} \rightarrow Mn^{2+} + CO_2$

$$MnO_2 + C_2O_4^{2-} + 4H^+ \rightarrow Mn^{2+} + 2CO_2 + 2H_2O$$

25. Identify the redox reactions out of the following reactions and identify the oxidising and reducing agents in them.

(*i*) $3HCl(aq) + HNO_3(aq) \rightarrow Cl_2(g) + NOCl(g) + 2H_2O(l)$

(*ii*) $HgCl_2(aq) + 2KI(aq) \rightarrow HgI_2(s) + 2KCl(aq)$

(*iii*) $Fe_2O_3(s) + 3CO(g) \xrightarrow{\Delta} 2Fe(s) + 3CO_2(g)$

(*iv*) $PCl_3(l) + 3H_2O(l) \rightarrow 3HCl(aq) + H_3PO_3(aq)$

(*v*) $4NH_3 + 3O_2(g) \rightarrow 2N_2(g) + 6H_2O(g)$

Ans. (*i*)

O.N. increases

$$3HCl(aq) + HNO_3(aq) \rightarrow Cl_2(g) + NOCl(g) + 2H_2O(l)$$

O.N. decreases

Oxidizing agent — HNO_3

Reducing agent — HCl

(*iii*) This is not a redox reaction.

(*iii*) $\overset{+3}{Fe_2O_3}(s) + 3\overset{+2}{CO}(g) \xrightarrow{\Delta} 2\overset{0}{Fe}(s) + 3\overset{+4}{CO_2}(g)$

Fe — Oxidising agent

CO — Reducing agent

(*iv*) $\overset{+3}{P}\overset{-1}{Cl_3}(l) + 3H_2O(l) \longrightarrow 3\overset{-1}{HCl}(aq) + \overset{+3}{H_3PO_3}(aq)$

Above reaction is not a redox reaction.

(*v*) $\overset{-3}{4N}\overset{+1}{H_3} + 3\overset{0}{O_2}(g) \longrightarrow 2\overset{0}{N_2}(g) + 6\overset{-2}{H_2O}(g)$

Reducing agent — NH_3

Oxidising agent — O_2

26. Balance the following ionic equations:

(*i*) $Cr_2O_7^{2-} + H^+ + I^- \rightarrow Cr^{3+} + I_2 + H_2O$

(*ii*) $Cr_2O_7^{2-} + Fe^{2+} + H^+ \rightarrow Cr^{3+} + Fe^{3+} + H_2O$

(*iii*) $MnO_4^- + SO_3^{2-} + H^+ \rightarrow Mn^{2+} + SO_4^{2-} + H_2O$

(*iv*) $MnO_4^- + H^+ + Br^- \rightarrow Mn^{2+} + Br_2 + H_2O$

Ans. (*i*) $Cr_2O_7^{2-} + H^+ + I^- \rightarrow Cr^{3+} + I_2 + H_2O$

$$2 \times \{ Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O + 14H^+ + 6e^-$$

$$6 \times \{ 2I^- \rightarrow I_2 + 2e^-$$

$$2Cr_2O_7^{2-} + 28H^+ + \cancel{12e} \rightarrow 4Cr^{3+} + 14H_2O$$

$$12I^- \rightarrow 6I_2 + \cancel{12e}$$

$$2Cr_2O_7^{2-} + 28H^+ + 12I^- \rightarrow 4Cr^{3+} + 14H_2O + 6I_2$$

Dividing eq. by 2

$$Cr_2O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 7H_2O + 3I_2$$

(*ii*) $Cr_2O_7^{2-} + Fe^{2+} + H^+ \rightarrow Cr^{3+} + Fe^{3+} + H_2O$

$$Cr_2O_7^{2-} \rightarrow 2Cr^{3+} + 7H_2O + 14H^+ + 6e^- \quad ...(i)$$

$$6 \times \{ Fe^{2+} \rightarrow Fe^{3+} + e^- \quad ...(ii)$$

On adding (*i*) and (*ii*)

$$Cr_2O_7^{2-} + 14H^+ + \cancel{6e} \rightarrow 2Cr^{3+} + 7H_2O$$

$$6Fe^{2+} \rightarrow 6Fe^{3+} + \cancel{6e}$$

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

(*iii*) $MnO_4^- + SO_3^{2-} + H^+ \rightarrow Mn^{2+} + SO_4^{2-} + H_2O$

Reduction half:

$$2 \times \{ MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O$$

Oxidation half:

$$5 \times \{ SO_3^{2-} + H_2O \rightarrow SO_4^{2-} + 2H^+ + 2e^- \}$$

$$2\,MnO_4^- + 16H^+ + \cancel{10e^-} \rightarrow 2Mn^{2+} + 8H_2O$$

$$5\,SO_3^{2-} + 5H_2O \rightarrow 5\,SO_4^{2-} + 10H^+ + \cancel{10e^-}$$

$$2\,MnO_4^- + 6H^+ + 5\,SO_3^{2-} \rightarrow 2Mn^{2+} + 3H_2O + 5\,SO_4^{2-}$$

(*iv*) $MnO_4^- + H^+ + Br^- \rightarrow Mn^{2+} + Br_2 + H_2O$

Reduction half:

$$2 \times \{ MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O \}$$

$$5 \times \{ 2Br^- \rightarrow Br_2 + 2e^- \}$$

$$2\,MnO_4^- + 16H^+ + \cancel{10e^-} \rightarrow 2Mn^{2+} + 8H_2O$$

$$10\,Br^- \rightarrow 5\,Br_2 + \cancel{10e^-}$$

$$2\,MnO_4^- + 16H^+ + 10\,Br^- \rightarrow 2Mn^{2+} + 8H_2O + 5\,Br_2$$

IV. Matching Type

27. Match Column I with Column II for the oxidation states of the central atoms.

Column I	Column II
(*i*) $Cr_2O_7^{2-}$	(*a*) +3
(*ii*) MnO_4^-	(*b*) +4
(*iii*) VO_3^-	(*c*) +5
(*iv*) FeF_6^{3-}	(*d*) +6
	(*e*) +7

Ans. (*i*) → (*d*); (*ii*) → (*e*); (*iii*) → (*c*); (*iv*) → (*a*)

28. Match the items in Column I with relevant items in Column II.

Column I	Column II
(*i*) Ions having positive charge	(*a*) +7
(*ii*) The sum of oxidation number of all atoms in a neutral molecule	(*b*) –1
(*iii*) Oxidation number of hydrogen ion (H^+)	(*c*) +1
(*iv*) Oxidation number of fluorine in NaF	(*d*) 0
(*v*) Ions having negative charge	(*e*) Cation
	(*f*) Anion

Ans. (*i*) → (*e*); (*ii*) → (*d*); (*iii*) → (*c*); (*iv*) → (*b*); (*v*) → (*f*)

V. Assertion and Reason Type

In the following questions a statement of Assertion (A) followed by a statement of Reason (R) is given. Choose the correct option out of the choices given below each question.

29. Assertion (A) : Among halogens fluorine is the best oxidant.
Reason (R) : Fluorine is the most electronegative atom.
(*i*) Both A and R are true and R is the correct explanation of A.
(*ii*) Both A and R are true but R is not the correct explanation of A.
(*iii*) A is true but R is false.
(*iv*) Both A and R are false.

Ans. (*i*)
Explanation: Fluorine is most electronegative element that is why it is best oxidant among halogens.

30. Assertion (A) : In the reaction between potassium permanganate and potassium iodide, permanganate ions act as oxidising agent.
Reason (R) : Oxidation state of manganese changes from +2 to +7 during the reaction.
(*i*) Both A and R are true and R is the correct explanation of A.
(*ii*) Both A and R are true but R is not the correct explanation of A.
(*iii*) A is true but R is false.
(*iv*) Both A and R are false.

Ans. (*iii*)
Explanation: As permanganate ion changes to MnO_2.

31. Assertion (A) : The decomposition of hydrogen peroxide to form water and oxygen is an example of disproportionation reaction.
Reason (R) : The oxygen of peroxide is in –1 oxidation state and it is converted to zero oxidation state in O_2 and –2 oxidation state in H_2O.
(*i*) Both A and R are true and R is the correct explanation of A.
(*ii*) Both A and R are true but R is not the correct explanation of A.
(*iii*) A is true but R is false.
(*iv*) Both A and R are false.

Ans. (*i*)
Explanation: $2H_2O_2(aq) \rightarrow 2H_2O(l) + O_2(g)$
Here the oxygen of peroxide, which is present in –1 state, is converted to zero oxidation state in O_2 and decreases to –2 oxidation state in H_2O.

32. Assertion (A) : Redox couple is the combination of oxidised and reduced form of a substance involved in an oxidation or reduction half cell.
Reason (R) : In the representation $E^{\ominus}_{Fe^{3+}/Fe^{2+}}$ and $E^{\ominus}_{Cu^{2+}/Cu}$, Fe^{3+}/Fe^{2+} and Cu^{2+}/Cu are redox couples.

(*i*) Both A and R are true and R is the correct explanation of A.
(*ii*) Both A and R are true but R is not the correct explanation of A.
(*iii*) A is true but R is false.
(*iv*) Both A and R are false.

Ans. (*ii*)

Explanation: A redox couple is defined as having together the oxidised and reduced forms of a substance taking part in an oxidation or reduction half reaction.

VI. Long Answer Type

33. Explain redox reactions on the basis of electron transfer. Give suitable examples.

Ans. $2Na(s) + H_2(g) \rightarrow 2NaH(s)$ is a redox change.
$2Na(s) \rightarrow 2Na^+(g) + 2e^-$ and the other half reaction is:
$H_2(g) + 2e^- \rightarrow 2H^-(g)$
This splitting of the reaction under examination into two half reactions automatically reveals that here sodium is oxidised and hydrogen is reduced. Therefore, the complete reaction is a redox change.

34. On the basis of standard electrode potential values, suggest which of the following reactions would take place? (Consult the book for $E^\ominus$ value).
(*i*) $Cu + Zn^{2+} \rightarrow Cu^{2+} + Zn$
(*ii*) $Mg + Fe^{2+} \rightarrow Mg^{2+} + Fe$
(*iii*) $Br_2 + 2Cl^- \rightarrow Cl_2 + 2Br^-$
(*iv*) $Fe + Cd^{2+} \rightarrow Cd + Fe^{2+}$

Ans. On the basis of standard reduction potential (*ii*) reaction can take place as Mg has more negative value of E^0 cell. Thus, Mg will be oxidized and iron will be reduced.

35. Why does fluorine not show disproportionation reaction?

Ans. Because fluorine is most electronegative element and it shows only –1 oxidation state.

36. Write redox couples involved in the reactions (*i*) to (*iv*) given in question 34.

Ans. Cu^{2+}/Cu, Zn^{2+}/Zn, Fe^{2+}/Fe, Cd^{2+}/Cd.

37. Find out the oxidation number of chlorine in the following compounds and arrange them in increasing order of oxidation number of chlorine.
$NaClO_4$, $NaClO_3$, NaClO, $KClO_2$, Cl_2O_7, ClO_3, Cl_2O, NaCl, Cl_2, ClO_2.
Which oxidation state is not present in any of the above compounds?

Ans. $\overset{+1}{Na}\overset{+7}{Cl}O_4^{-2}$ Oxidation no. of chlorine = +7

$\overset{+1}{Na}\overset{+1}{Cl}O_3^{-2}$ Oxidation no. of chlorine = +5

$\overset{+1}{Na}\overset{+1}{Cl}O^{-2}$ Oxidation no. of chlorine = +1

$\overset{+1}{K}\overset{+3}{Cl}O_2^{-2}$ Oxidation no. of chlorine = +3

$\overset{+7}{Cl_2}O_7^{-2}$ Oxidation no. of chlorine = +7

$\overset{+6}{Cl}O_3^{-2}$ Oxidation no. of chlorine = +6

$\overset{+1}{Cl_2}O^{-2}$ Oxidation no. of chlorine = +1

NaCl Oxidation no. of chlorine = –1

Cl_2 Oxidation no. of chlorine = 0

$\overset{+4}{Cl}O_2^{-2}$ Oxidation no. of chlorine = +4

NaCl, Cl_2, Cl_2O, NaClO, $KClO_2$, ClO_2, $NaClO_3$, ClO_3, Cl_2O_7, $NaClO_4$.

38. Which method can be used to find out strength of reductant/oxidant in a solution? Explain with an example.

Ans. In redox systems, the titration method can be adopted to determine the strength of a reductant/oxidant using a redox sensitive indicator. The usage of indicators in redox titration is illustrated below: (*i*) In one situation, the reagent itself is intensely coloured, *e.g.*, permanganate ion, MnO_4^-. Here, MnO_4^- acts as the self indicator. The visible end point in this case is achieved after the last of the reductant (Fe^{2+} or $C_2O_4^{2-}$) is oxidised and the first lasting tinge of pink colour appears at MnO_4^- concentration as low as 10^{-6} mol dm^{-3} (10^{-6} mol L^{-1}). This ensures a minimal 'overshoot' in colour beyond the equivalence point, the point where the reductant and the oxidant are equal in terms of their mole stoichiometry.

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