8 Redox Reactions

Trend Analysis with Important Topics & Sub-Topics

		2020		2019		2018		2017		2016	
Topic Name	**Sub-Topic**	**QNS.**	**LOD**	**QNS.**	**LOD**	**QNS.**	**LOD**	**QNS.**	**LOD**	**QNS.**	**LOD**
Oxidation number	oxidation number	1	E								
Disproportionation and balancing of redox reaction	disproportionation reaction			1	A	1	D				
	balancing of redox reaction					1	A				
LOD - Level of Difficulty	**E - Easy**	**A - Average**				**D - Difficult**		**Qns - No. of Questions**			

Topic 1: Oxidation and Reduction Reactions

1. Zn gives H_2 gas with H_2SO_4 and HCl but not with HNO_3 because ***[2002]***
   (a) Zn acts as an oxidising agent when it reacts with HNO_3
   (b) HNO_3 is weaker acid than H_2SO_4 and HCl
   (c) In electrochemical series, Zn is above hydrogen
   (d) NO_3^- is reduced in preference to hydronium ion
2. Which of the following involves a redox reaction?
   (a) Reaction of H_2SO_4 with NaOH ***[1997]***
   (b) Production of ozone from oxygen in the atmosphere by lightning
   (c) Production of nitrogen oxides from nitrogen and oxygen in the atmosphere by lightning
   (d) Evaporation of water ***[1995]***
3. The loss of electron is termed as
   (a) oxidation (b) reduction
   (c) combustion (d) neutralization

Topic 2: Oxidation Number

4. What is the change in oxidation number of carbon in the following reaction? ***[2020]***
   $CH_4(g) + 4Cl_2(g) \longrightarrow CCl_4(l) + 4HCl(g)$
   (a) 0 to + 4 (b) – 4 to + 4
   (c) 0 to – 4 (d) + 4 to + 4
5. The oxidation state of Cr in CrO_6 is ***[NEET Odisha 2019]***
   (a) +4 (b) –6
   (c) +12 (d) +6
6. Oxidation numbers of P in PO_4^{3-}, of S in SO_4^{2-} and that of Cr in $Cr_2O_7^{2-}$ are respectively ***[2009]***
   (a) + 3, + 6 and + 5 (b) + 5, + 3 and + 6
   (c) – 3, + 6 and + 6 (d) + 5, + 6 and + 6
7. The oxidation states of sulphur in the anions SO_3^{2-}, $S_2O_4^{2-}$ and $S_2O_6^{2-}$ follow the order ***[2003]***
   (a) $S_2O_6^{2-} < S_2O_4^{2-} < SO_3^{2-}$
   (b) $S_2O_4^{2-} < SO_3^{2-} < S_2O_6^{2-}$
   (c) $SO_3^{2-} < S_2O_4^{2-} < S_2O_6^{2-}$
   (d) $S_2O_4^{2-} < S_2O_6^{2-} < SO_3^{2-}$
8. A compound contains atoms of three elements *A*, *B* and *C*. If the oxidation number of *A* is +2, *B* is +5, and that of *C* is –2, the possible formula of the compound is : ***[2000]***
   (a) $A_2(BC_3)_2$ (b) $A_3(BC_4)_2$
   (c) $A_3(B_4C)_2$ (d) ABC_2

9. The oxidation number of phosphorus in pyrophosphoric acid is *[1999]*
(a) +3 (b) +1
(c) +4 (d) +5

10. The oxidation number of chromium in potassium dichromate is *[1988, 1995]*
(a) +6 (b) – 5
(c) – 2 (d) +2 11. Phosphorus has the oxidation state of + 3 in
(a) Phosphorous acid *[1994]*
(b) Orthophosphoric acid
(c) Hypophosphorous acid
(d) Metaphosphoric acid.

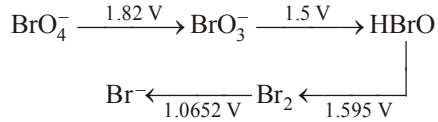
Topic 3: Disproportionation and Balancing of Redox Reactions

12. Which of the following reactions are disproportionation reaction? *[2019]*
(a) $2Cu^{+} \rightarrow Cu^{2+} + Cu$
(b) $3MnO_4^{2-} + 4H^{+} \rightarrow 2MnO_4^{-} + MnO_2 + 2H_2O$
(c) $2KMnO_4 \xrightarrow{\Delta} K_2MnO_4 + MnO_2 + O_2$
(d) $2MnO_4^{-} + 3Mn^{2+} + 2H_2O \xrightarrow{\Delta} 5MnO_2 + 4H^{+}$
Select the **correct** option from the following:
(a) (a) and (b) only (b) (a), (b) and (c)
(c) (a), (c) and (d) (d) (a) and (d) only

13. For the redox reaction *[2018]*
$MnO_4^{-} + C_2O_4^{2-} + H^{+} \rightarrow Mn^{2+} + CO_2 + H_2O$
The correct coefficients of the reactants for the balanced equation are

	MnO_4^{-}	$C_2O_4^{2-}$	H^{+}
(a)	16	5	2
(b)	2	5	16
(c)	5	16	2
(d)	2	16	5

14. Consider the change in oxidation state of bromine corresponding to different emf values as shown in the diagram below : *[2018]*



Then the species undergoing disproportionation is
(a) BrO_3^{-} (b) BrO_4^{-}
(c) HBrO (d) Br_2

15. A mixture of potassium chlorate, oxalic acid and sulphuric acid is heated. During the reaction which element undergoes maximum change in the oxidation number ? *[2012]*
(a) S (b) H
(c) Cl (d) C

16. When Cl_2 gas reacts with hot and concentrated sodium hydroxide solution, the oxidation number of chlorine changes from : *[2012]*
(a) zero to +1 and zero to –5
(b) zero to –1 and zero to +5
(c) zero to –1 and zero to +3
(d) zero to +1 and zero to –3

17. The following redox reaction is balanced by which set of coefficients ? *[1999]*
$aZn + bNO_3^{-} + cH^{+} \rightarrow dNH_4^{+} + eH_2O + fZn^{2+}$

	a	b	c	d	e	f
(a)	1	1	10	1	3	1
(b)	2	2	10	2	3	2
(c)	4	2	10	1	3	4
(d)	4	1	10	1	3	4

18. In which of the following reactions, there is no change in valency ? *[1994]*
(a) $4\,KClO_3 \longrightarrow 3KClO_4 + KCl$
(b) $SO_2 + 2H_2S \longrightarrow 2H_2O + 3S$
(c) $BaO_2 + H_2SO_4 \longrightarrow BaSO_4 + H_2O_2$
(d) $3\,BaO + O_2 \longrightarrow 2\,BaO_2$.

19. Which substance serves as a reducing agent in the following reaction ? *[1994]*
$14H^{+} + Cr_2O_7^{2-} + 3Ni \rightarrow 2Cr^{3+} + 7H_2O + 3Ni^{2+}$
(a) H_2O (b) Ni
(c) H^{+} (d) $Cr_2O_7^{2-}$

Topic 4: Electrode Potential and Oxidising, Reducing Agents

20. The standard electrode potential (E°) values of Al^{3+}/Al, Ag^{+}/Ag, K^{+}/K and Cr^{3+}/Cr are –1.66 V, 0.80 V, –2.93V and –0.74 V, respectively. The correct decreasing order of reducing power of the metal is *[NEET Odisha 2019]*
(a) Al > K > Ag > Cr
(b) Ag > Cr > Al > K
(c) K > Al > Cr > Ag
(d) K > Al > Ag > Cr

21. Standard reduction potentials of the half reactions are given below :

$F_2(g) + 2e^- \rightarrow 2F^-(aq)$; $E^\circ = +2.85$ V

$Cl_2(g) + 2e^- \rightarrow 2Cl^-(aq)$; $E^\circ = +1.36$ V

$Br_2(l) + 2e^- \rightarrow 2Br^-(aq)$; $E^\circ = +1.06$ V

$I_2(s) + 2e^- \rightarrow 2I^-(aq)$; $E^\circ = +0.53$ V

The strongest oxidising and reducing agents respectively are : ***[2012 M]***

(a) F_2 and I^- (b) Br_2 and Cl^-

(c) Cl_2 and Br^- (d) Cl_2 and I_2

22. The oxide, which cannot act as a reducing agent, is ***[1995]***

(a) NO_2 (b) SO_2

(c) CO_2 (d) ClO_2

ANSWER KEY															
1	(d)	4	(b)	7	(b)	10	(a)	13	(b)	16	(b)	19	(b)	22	(c)
2	(c)	5	(d)	8	(b)	11	(a)	14	(c)	17	(d)	20	(c)		
3	(a)	6	(d)	9	(d)	12	(a)	15	(c)	18	(c)	21	(a)		

Hints & Solutions

1. (d) Zinc gives H_2 gas with dil H_2SO_4/HCl but not with HNO_3 because in HNO_3, NO_3^- ion is reduced and give NH_4NO_3, N_2O, NO and NO_2

NOTES

$[Zn + 2HNO_3 \longrightarrow Zn(NO_3)_3 + 2H] \times 4$ (nearly 6%)

$HNO_3 + 8H \longrightarrow NH_3 + 3H_2O$

$NH_3 + HNO_3 \longrightarrow NH_4NO_3$

$4Zn + 10HNO_3 \longrightarrow 4Zn(NO_3)_2 + NH_4NO_3 + 3H_2O$

Zn is above of hydrogen in electrochemical series. So, Zn displaces H_2 from dilute H_2SO_4 and HCl with liberation of H_2.

$Zn + H_2SO_4 \rightarrow ZnSO_4 + H_2$

2. (c) (a) $2NaOH + H_2SO_4 \longrightarrow \underset{\text{(neutralization)}}{Na_2SO_4} + 2H_2O$

(b) $3\overset{0}{O_2} \xrightarrow{\text{Light}} 2\overset{0}{O_3}$ (not redox reaction)

(c) $\underset{0}{N_2} + \underset{0}{O_2} \xrightarrow{\text{Light}} \underset{+2\ -2}{2NO}$ (redox reaction)

here oxidation of N_2 & reduction of O_2 is taking place

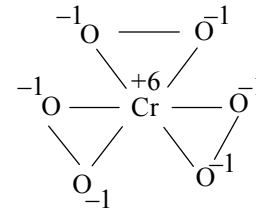
(d) $H_2O(l) \xrightarrow{\Delta} H_2O(g)$ (not redox reaction)

3. (a) Losing of electron is called oxidation.

4. (b) $\overset{-4}{CH_4}(g) + 4Cl_2(g) \rightarrow \overset{+4}{C}Cl_4(l) + 4HCl(g)$

Change in oxidation state of carbon is –4 to +4.

5. (d) +6 is the most appropriate oxidation state of Cr in CrO_6.



6. (d) $PO_4^{3-} = x + 4(-2) = -3; x - 8 = -3; x = +5$

$SO_4^{2-} = x + 4(-2) = -2; x - 8 = -2; x = +6$

$Cr_2O_7^{2-} = 2x + 7(-2) = -2; 2x - 14 = -2;$

$2x = 12; x = +6$

7. (b) $SO_3^{2-} \rightarrow$ S is in +4 oxidation state

$S_2O_4^{2-} \rightarrow$ S is in +3 oxidation state

$S_2O_6^{2-} \rightarrow$ S is in +5 oxidation state

NOTES

The structure of $S_2O_4^{2-}$ and $S_2O_6^{2-}$ are symmetrical. Thus, both sulphur atoms are in same oxidation state. This is not the case with $S_2O_3^{2-}$ or $S_4O_6^{2-}$ ions.

8. (b) Oxidation number of a compound must be 0. Using the values for A, B and C in the four options we find that $A_3(BC_4)_2$ is the answer.

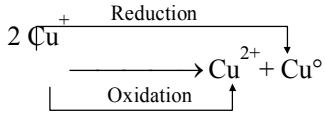
Check : $(+2)3 + [(+5) + 4(-2)]2 = 6 + (5 - 8)2 = 0$

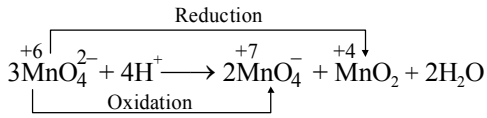
9. (d) Pyrophosphoric acid $H_4P_2O_7$
Let oxidation state of phosphorus is x
$(4 \times 1 + (-2) \times 7 + 2x) = 0$
$\therefore 2x = 10$ or $x = +5$

10. (a) Let x = oxidation no. of Cr in $K_2Cr_2O_7$.
$\therefore (2 \times 1) + (2 \times x) + 7(-2) = 0$ or $2 + 2x - 14 = 0$ or $x = +6$.

11. (a) O.N. of P in H_3PO_3 (phosphorous acid)
$3 \times 1 + x + 3 \times (-2) = 0$ or $x = +3$
In orthophosphoric acid (H_3PO_4) O.N. of P is + 5, in hypophosphorous acid (H_3PO_2) it is + 1 while in metaphosphoric acid (HPO_3), it is + 5.

12. (a) In a disproportionation reaction, one species undergoes both oxidation and reduction.





13. (b) $\overset{+7}{Mn}O_4^- \longrightarrow \overset{+2}{Mn^{2+}}$; $5e^-$ gain ...(i)

$\overset{+3}{C_2}O_4^{2-} \longrightarrow \overset{+4}{C}O_2$; $2e^-$ loss ...(ii)

Multiplying (i) by 2 and (ii) by 5 to balance e^-

$$2\,MnO_4^- + 5\,C_2O_4^{2-} \longrightarrow 2\,Mn^{2+} + 10\,CO_2$$

On balancing charge;

$$2\,MnO_4^- + 5\,C_2O_4^{2-} + 16\,H^+ \longrightarrow 2\,Mn^{2+} + 10\,CO_2 + 8\,H_2O$$

14. (c) Calculate E°_{cell} corresponding to each compound undergoing disproportionation reaction. The reaction for which E°_{cell} comes out + ve is spontaneous.

$HBrO \longrightarrow Br_2$ $E^\circ = 1.595$ V, SRP (cathode)

$HBrO \longrightarrow BrO_3^-$ $E^\circ = -1.5$ V, SOP (anode)

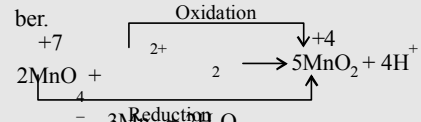
$2HBrO \longrightarrow Br_2 + BrO_3^-$

E°_{cell} = SRP (cathode) – SRP (anode)
= 1.595 – 1.5
= 0.095 V

$E^\circ_{cell} > 0 \Rightarrow \Delta G^\circ < 0$ [spontaneous]

NOTES

Reaction in (d) involves comproportionation or synproportionation. When two reactants, each containing the same element but with a different oxidation number, form a product in which the element involved reach the same oxidation number.



It is opposite to disproportionation.

15. (c) $\overset{+5}{KClO_3} + H_2C_2O_4 + \overset{+6}{H_2SO_4} \rightarrow \overset{+6}{K_2SO_4} + \overset{-1}{KCl} + CO_2 + H_2O$

i.e. maximum change in oxidation number is observed in Cl (+5 to –1).

16. (b) On reaction with hot and concentrated alkali a mixture of chloride and chlorate is formed

$$3Cl_2 + 3\,NaOH(\text{excess}) \xrightarrow{\text{Hot}} \overset{-1}{5NaCl} + \overset{+5}{NaClO_3} + 3H_2O$$

17. (d) $Zn \rightarrow Zn^{+2} + 2e^-$ ....(1)

$8e^- + 10H^+ + NO_3^- \rightarrow NH_4^+ + 3H_2O$ ....(2)

operate eq. (1) × 4 + eq. (2) × 1

$$4Zn + 10H^+ + NO_3^- \rightarrow 4Zn^{2+} + NH_4^+ + 3H_2O$$

18. (c) $\overset{+2\ -1}{Ba\,O_2} + \overset{+1}{H_2}\,\overset{+6\ -2}{S\,O_4} \longrightarrow \overset{+2\ +6\ -2}{Ba\,S\,O_4} + \overset{+1\ -1}{H_2\,O_2}$

In this reaction, none of the elements undergoes a change in oxidation number or valency.

19. (b) The element undergo oxidation itself and reduces others is known as reducing agent. In this reaction O. N. of Ni Changes from 0 to + 2 and hence Ni acts as a reducing agent.

20. (c) Lesser is the reduction potential greater is the reducing power.
Reducing power : K > Al > Cr > Ag

21. (a) F_2 is the strongest oxidising agent as it has highest reduction potential while I^- is the strongest reducing agent since it has lowest reduction potential.

NOTES

Higher the value of reduction potential, higher will be the oxidising power whereas the lower the value of reduction potential higher will be the reducing power.

22. (c) Carbon has the maximum oxidation state of + 4, therefore carbon dioxide (CO_2) cannot act as a reducing agent.