CHAPTER 8

Redox Reactions

Redox Reactions (Oxidation and Reduction), Oxidation Number

1. What is the change in oxidation number of carbon in the following reaction? *(2020)*

$CH_4(g) + 4Cl_2(g) \rightarrow CCl_4(l) + 4HCl(g)$

a. 0 to + 4 b. –4 to + 4

c. 0 to –4 d. +4 to + 4

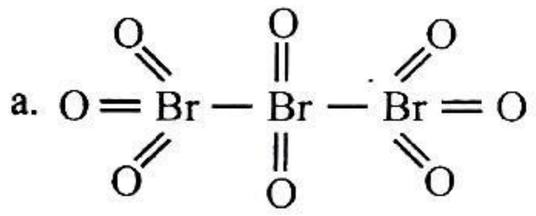
2. The oxidation number of the underlined atom in the following species *(2020-Covid)*

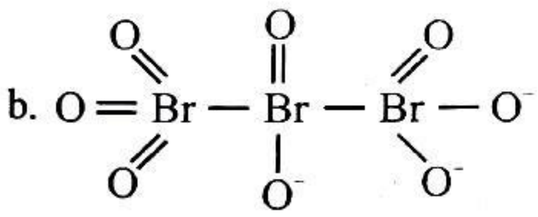
a. $\underline{Cl}O_3^-$ is +5 b. $K_2\underline{Cr_2}O_7$ is +6

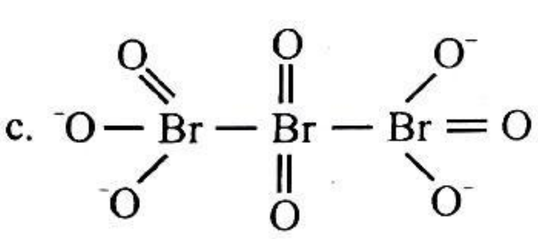
c. $H\underline{Au}Cl_4$ is +3 d. $Cu_2\underline{O}$ is –1

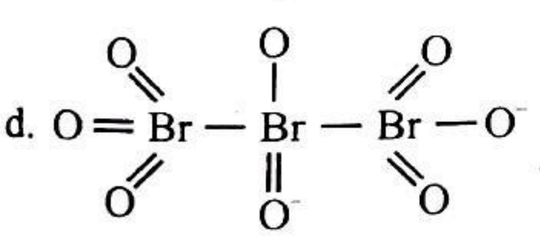
Identify the incorrect option

3. The correct structure of tribromooctaoxide is *(2019)*

a. 

b. 

c. 

d. 

4. Hot concentrated sulphuric acid is a moderately strong oxidising agent. Which of the following reactions does not show oxidising behaviour? *(2016 - I)*

a. $C + 2H_2SO_4 \rightarrow CO_2 + 2SO_2 + 2H_2O$

b. $CaF_2 + H_2SO_4 \rightarrow CaSO_4 + 2HF$

c. $Cu + 2H_2SO_4 \rightarrow CuSO_4 + SO_2 + 2H_2O$

d. $3S + 2H_2SO_4 \rightarrow 3SO_2 + 2H_2O$

5. In acidic medium, H_2O_2 changes $Cr_2O_7^{-2}$ to CrO_5 which has two (—O—O—) bonds. Oxidation state of Cr in CrO_5 is: *(2014)*

a. +3 b. +6

c. –10 d. +5

6. The pair of compounds that can exist together is *(2014)*

a. $FeCl_3$, $SnCl_2$ b. $HgCl_2$, $SnCl_2$

c. $FeCl_2$, $SnCl_2$ d. $FeCl_3$, KI

7. The oxidation state of Cr in CrO_5 is *(2014)*

a. –6 b. +12

c. +6 d. +4

8. 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 Pre)*

a. C b. S

c. H d. Cl

9. In which of the following compounds, nitrogen exhibits highest oxidation state? *(2012 Pre)*

a. NH_2OH b. N_2H_4

c. NH_3 d. N_3H

10. The oxide, which cannot act as a reducing agent is: *(2010 Pre, 1995)*

a. CO_2 b. ClO_2

c. NO_2 d. SO_2

11. 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

12. Which is the best description of the behaviour of bromine in the reaction given below: *(2004)*

$H_2O + Br_2 \rightarrow HOBr + HBr$

a. Both oxidised and reduced

b. Oxidised only

c. Reduced only

d. Proton acceptor only

13. Oxidation state of Fe in Fe_3O_4 is: *(1999)*

a. $\frac{3}{2}$ b. $\frac{4}{5}$

c. $\frac{5}{4}$ d. $\frac{8}{3}$

14. In which of the following compounds, transition metal has zero oxidation state? *(1999)*

a. $[Fe(CO)_5]$ b. $NH_2\text{-}NH_2$

c. $NOClO_4$ d. CrO_5

15. Which of the following is redox reaction? *(1997)*

a. Evaporation of H_2O

b. Both oxidation and reduction

c. H_2SO_4 with NaOH

d. In atmosphere O_3 from O_2 by lighting

16. Which substance is serving as a reducing agent in the following reaction? *(1994)*

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

a. H^+ b. $Cr_2O_7^{2-}$

c. H_2O d. Ni

17. The oxidation state of I in $H_4IO_6^-$ is: *(1994)*

a. +1 b. –1

c. +7 d. +5

Types of Redox Reactions and Balancing of Redox Reactions

18. Which of the following reactions is the metal displacement reaction? Choose the right option. *(2021)*

a. $Cr_2O_3 + 2Al \xrightarrow{\Delta} Al_2O_3 + 2Cr$

b. $Fe + 2HCl \longrightarrow FeCl_2 + H_2\uparrow$

c. $2Pb(NO_3)_2 \longrightarrow 2PbO + 4NO_2 + O_2\uparrow$

d. $2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$

19. Which of the following reactions are disproportionation reaction? *(2019)*

A. $2Cu^+ \longrightarrow Cu^{2+} + Cu^0$

B. $3MnO_4^{2-} + 4H^+ \longrightarrow 2MnO^-_4 + MnO_2 + 2H_2O$

C. $2KMnO_4 \xrightarrow{\Delta} K_2MnO_4 + MnO_2 + O_2$

D. $2MnO_4^- + 3Mn^{2+} + 2H_2O \longrightarrow 5MnO_2 + 4H^{\oplus}$

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

20. For the redox reaction

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

The correct coefficients of the reactants for the balanced equation are: *(2018)*

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

21. Number of moles of MnO_4^- required to oxidize one mole of ferrous oxalate completely in acidic medium will be: *(2008)*

a. 0.2 moles b. 0.6 moles

c. 0.4 moles d. 7.5 moles

Redox Reactions and Electrode Processes

22. Standard electrode potential of three metals X, Y and Z are –1.2 V, +0.5 V and –3.0 V respectively. The reducing power of these metals will be: *(2011 Pre)*

a. X > Y > Z b. Y > Z > X

c. Y > X > Z d. Z > X > Y

23. On electrolysis of dilute sulphuric acid using platinum electrodes, the product obtained at the anode will be: *(1992)*

a. Hydrogen b. Oxygen

c. Hydrogen sulphide d. Sulphur dioxide

Answer Key

1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
b	d	a	b	b	c	c	d	d	a	d	a	d	a	b	d

17	18	19	20	21	22	23
c	a	a	b	c	d	b

Explanations

1. (b) $CH_4(g) + 4Cl_2(g) \rightarrow CCl_4(l) + 4HCl(g)$

In the given reaction:

Let oxidation number of Carbon be x.

H has + 1 oxidation number.

In CH_4:

$x + 4 \times 1 = 0$

$x = -4$

In CCl_4:

Cl oxidation state is –1.

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

$x = +4$

Thus, change in oxidation state of carbon is from –4 to +4.

2. (d) (a) $\underline{Cl}O_3^-$

Let oxidation state of Cl be x.

$x + 3(-2) = -1$

$x = +5$

(b) $K_2\underline{Cr}_2O_7$

Let oxidation state of Cr be x.

$2(+1) + 2x + 7(-2) = 0$

$x = +6$

(c) $H\underline{Au}Cl_4$

Let oxidation state of Au be x.

$(+1) + x + 4(-1) = 0$

$x = +3$

(d) $Cu_2\underline{O}$

Let oxidation state of O be x.

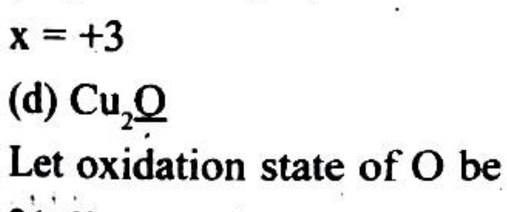
$2(+1) + x = 0$

$x = -2$

3. (a) Tribromooctaoxide is a neutral molecule and does not contain any charge. This structure contains all oxygen atoms bonded with double bonds with bromine atoms. It contains three Bromine atoms and eight O atoms. Two terminal Br atoms will make bond with three O atoms and a Br-Br bond.

The oxidation no of bromine is $\frac{16}{3}$ in this structure.

The correct structure of Br_3O_8 is:

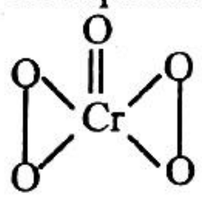


Tribromooctaoxide

4. (b) $\overset{+2\ -1}{CaF_2} + \overset{+1\ +6\ -2}{H_2SO_4} \rightarrow \overset{+2\ +6\ -2}{CaSO_4} + \overset{+1\ -1}{2HF}$

This reaction is not a oxidation reaction as none of the atom in the reaction is showing any change in the oxidation number. H_2SO_4, here in the reaction is not acting as a reducing nor an oxidising agent.

5. (b) CrO_5 has a very famous butterfly structure containing two peroxo bonds. Oxygen in peroxide has -1 oxidation state. It can be represented as:



Let oxidation state of Cr be x.

$x + 4(-1) + 1(-2) = 0$

$x = +6$

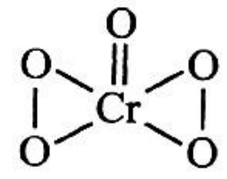
6. (c) Compounds having lower oxidation number and those which cannot be reduced by one another can exist together.

Both $FeCl_2$ and $SnCl_2$ are reducing agents with low oxidation numbers.

$Fe^{2+} + Sn^{2+} \rightarrow$ No reaction

7. (c) CrO_5 has butterfly structure having two peroxo bonds.

Peroxo oxygen has –1 oxidation state.



Let oxidation state of Cr be 'x'.

$CrO_5 : x + 4(-1) + 1(-2) = 0 \Rightarrow x = +6$

8. (d) The reaction between given species can be written as:

$KClO_3 + H_2C_2O_4 + H_2SO_4 \xrightarrow{\Delta} K_2SO_4 + KCl + CO_2$

Oxidation No. of different Elements	Reactant side	Product side
S	+ 6	+ 6
C	+ 3	+ 1
Cl	+ 4	– 1

Change in O.N. of 'S' = 0 (6 – 6)

Change in O.N. of 'C' = 1 (4 – 3)

Change in O.N. of 'Cl' = 5 (4 – (–1))

So, 'Cl' is going maximum change in oxidation number.

9. (d) Let oxidation state of N be x.

So, oxidation state of N in $N_3H = -1/3$

$NH_2OH = x + 2 - 1 = -1$

$N_2H_4 = 2x + 4 = -2$

$NH_3 = -3$

$\therefore$ In N_3H, N is present in its highest oxidation state.

10. (a) When an element is present in its maximum oxidation state, it cannot be oxidized further which means it cannot act as a reducing agent. Since carbon is in maximum state of + 4, therefore carbon dioxide (CO_2) cannot act as a reducing agent.

11. (d) Let x be the oxidation state of P, S and Cr respectively in the following cases:

PO_4^{3-} $\quad x + [4 \times (-2)] + (-3) = 0$

$x = 5$

SO_4^{2-} $\quad 2x + 14 - 2 = 0$

$x = 6$

$Cr_2O_7^{2-}$ $x + (8 - 2) = 0$

$x = 6$

Oxidation state of PO_4^{3-} is 5, SO_4^{2-} is 6 and $Cr_2O_7^{2-}$ is 6.

12. (a) $H_2O + \overset{0}{Br_2} \rightarrow H\overset{+1}{O}Br + \overset{-1}{H}Br$

In Br_2, Br has 0 oxidation state, in HOBr, it has +1 oxidation state and in HBr, it has –1 oxidation state. Thus, Br_2 is oxidised as well as reduced hence, it is a redox reaction.

13. (d) Let oxidation state of Fe be x.

$x = -2$

In Fe_3O_4:

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

$3x = +8$

$x = +8/3$

14. (a) CO is a neutral ligand due to which complex as a whole has 0 charge. Oxidation state of Fe in $Fe(CO)_5$ is zero.

15. (b) Redox reactions are those chemical reactions which involve transfer of electrons from one chemical species to another. In this reaction, both reduction and oxidation takes place simultaneously.

16. (d) $14H^+ + \overset{+6}{Cr_2O_7^{2-}} + 3\overset{0}{Ni} \rightarrow 7\overset{-2}{H_2O} + 3\overset{+2}{Ni^{2+}} + 2\overset{+3}{Cr^{3+}}$

On reactant side, Ni has 0 oxidation state and on product side, it has +2 oxidation state. Ni is getting oxidized from 0 to +2 Oxidation state.

Since the oxidation number of Ni increases from 0 to 2, therefore, it acts as a reducing agent.

17. (c) Let x = Oxidation state of I. Since oxidation state of H = +1 and oxidation state of O = –2. Therefore, for $H_4IO_6^-$,

$(4 \times 1) + x + (6 \times -2) = -1$ or $x = +7$

18. (a) (a) $Cr_2O_3 + 2Al \xrightarrow{\Delta} Al_2O_3 + 2Cr$

(b) $Fe + 2HCl \rightarrow FeCl_2 + H_2 \uparrow$

Both are examples of displacement reactions. But, reaction in option (a) is an example of metal displacement reaction (Al displaces Cr from Cr_2O_3).

(c) $2Pb(NO_3)_2 \rightarrow 2PbO + 4NO_2 + O_2 \uparrow$

This reaction is an example of decomposition reaction.

(d) $2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$

This reaction is also an example of thermal decomposition reaction.

19. (a) Disproportionation Reaction: In this reaction, same element undergoes oxidation and reduction simultaneously.

A. $\overset{+1}{2Cu^+} \longrightarrow \overset{+2}{Cu^{2(+)}} + \overset{0}{Cu}$ Disproportionation (red: +1 → 0; oxd: +1 → +2)

B. $\overset{+6}{3MnO_4^{2(-)}} + 4H^{(+)} \longrightarrow \overset{+7}{2MnO_4^-} + \overset{+4}{MnO_2}$ Disproportionation (red: +6 → +4; oxd: +6 → +7)
$+2H_2O$

C. $\overset{+7}{2KMnO_4^{-2}} \longrightarrow \overset{+6}{K_2MnO_4} + \overset{+4}{MnO_2} + \overset{0}{O_2}$ ∴ not a disproportionation

D. $\overset{+7}{MnO_4} + 3\overset{+2}{Mn^{2+}} + 2H_2O \longrightarrow 5\overset{+4}{MnO_2} + 4H^{\oplus}$ not a disproportionation

20. (b) First balance C atoms:

$\overset{+7}{MnO_4^-} + \overset{+3}{C_2O_4^{2-}} + H^+ \rightarrow \overset{+2}{Mn^{2+}} + 2\overset{+4}{CO_2} + H_2O$

Balance Mn atoms as:

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

Balance O atoms by adding $8H_2O$ to the products side:

$2MnO_4^- + 5C_2O_4^{2-} \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$

Balance H atoms by adding $16H^+$ to the reactants side:

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

21. (c) According to chemical equation:

$FeC_2O_4 \rightarrow Fe^{+2} + 2CO_2 + 2e^-\} \times 5$

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

Comparing equation (1) and (2):

$5FeC_2O_4 + 2MnO_4^- + 16H^+ \rightarrow 2Mn^{2+} + 5Fe^{2+} + 10CO_2 + 12H_2O$

Accordingly, 5 moles of FeC_2O_4 requires 2 moles of MnO_4^-.

So, 1 mole of MnO_4^- will need $\frac{2}{5}$ moles of FeC_2O_4

= 0.4 moles of MnO_4^-

22. (d) More negative the reduction potential, more will be its reducing power, so among these, Z being the most powerful reducing agent, Z > X > Y.

23. (b) Dissociation of sulfuric acid can be represented as:

$H_2SO_4 \rightarrow 2H^+ + SO_4^{2-}$

Dissociation of water is:

$H_2O \rightarrow H^+ + OH^-$

At anode: $4OH^- \rightarrow 2H_2O + O_2 + 4e^-$

At Cathode: $2H^+ + 2e^- \rightarrow H_2$