8	Redox Reaction	Book:

1 Mark Questions

Q. 1. Choose the correct alternative :

(i) Oxygen has oxidation state of +2 in :

(a) H_2O_2 (b) H_2O

(c) OF_2 (d) SO_2

Ans. (c) OF_2

(ii) White P reacts with caustic soda. The products are PH_3 and NaH_2PO_2. This reaction is an example of :

(a) oxidation (b) reduction

(c) disproportionation (d) neutralisation

Ans. (c) disproportionation

(iii) What products are expected from the disproportionation reaction of hypochlorous acid?

(a) $HClO_3$ and ClO_2 (b) $HClO_2$ and $HClO_4$

(c) HCl and Cl_2O (d) HCl and $HClO_3$

Ans. (d) HCl and $HClO_3$

(iv) Which of the following is the strongest oxidizing agent?

(a) F_2 (b) Cl_2

(c) Br_2 (d) I_2

Ans. (a) F_2

Q. 2. Fill in the blanks :

(a) The reaction in which electrons are transferred from one reactant to another is called _____ reaction.

(b) The lowest possible oxidation state of nitrogen is _____.

(c) Among SO_2, H_2SO_4 and sodium thiosulpate, the sulphur has the highest oxidation state in _____.

(d) Among the halide ions, _____ is the most powerful reducing agent.

Ans. (a) redox

(b) –3

(c) H_2SO_4

(d) iodide

Q. 3. Classify the following as oxidation and reduction reaction on the basis of addition or removal of oxygen/hydrogen :

(a) $ZnO + C \rightarrow Zn + CO$

(b) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

(c) $Cl_2 + H_2 \rightarrow 2HCl$

(d) $H_2S + Cl_2 \rightarrow 2HCl + S$

(e) $4HCl + MnO_2 \rightarrow MnCl_2 + Cl_2 + 2H_2O$

(f) Vegetable oil + $H_2 \rightarrow$ Vegetable ghee

Ans. (a) Reduction

(b) Oxidation

(c) Reduction

(d) Reduction

(e) Oxidation

(f) Reduction

Q. 4. What happens when hydrogen sulphide gas is passed through solution containing zinc ions?

Ans. White ppt of ZnS is formed.

Q. 5. Show by an equation an example where decomposition reaction is not a redox reaction

Ans. $\overset{+2\,+4\,-2}{CaCO_3}_{(s)} \xrightarrow{\Delta} \overset{+2\,-2}{CaO}_{(s)} + \overset{+4\,-2}{CO_2}_{(g)}$

Q. 6. Which reaction occurs at cathode in a galvanic cell?

Ans. Reduction

Q. 7. What is the significance of a salt bridge in a galvanic cell?

Ans. It converts the two half cells and completes the circuit. It keeps the solution electrically neutral in the two half cells.

Q. 8. What is the role of diphenylamine in the potassium dichromate titration?

Ans. Diphenylamine is used as an indicator. As $Cr_2O_7^{-}$ does not act as self-indicator, it oxidises the diphenylamine after the end point to produce intense blue colour which signifies the completion of titration.

2 Marks Questions

Q. 1. With the help of reactions, show what happens when aluminium is placed in an aqueous solution containing silver ions.

Ans. $Al(s) \rightarrow Al^{+3}(aq) + 3e^-$ (oxidation)

$Ag^+(aq) + e^- \rightarrow Ag(s)$ (reduction)

Total reaction :

$Al(s) \rightarrow Al^{+3}(aq) + 3e^-$

$[Ag^+(aq) + e^- \rightarrow Ag(s)] \times 3$

$Al(s) + 3Ag^+(aq) \rightarrow Al^{+3}(aq) + 3Ag(s)$

Q. 2. Write the reaction when zinc rod is immersed in an aqueous solution of copper nitrate.

$Zn(s) + Cu^{+2} + 2NO_3^- \rightarrow Zn^{+2}(aq) + 2NO_3^-(aq) + Cu(s)$

Ans. Zinc atom loses two electrons, get oxidised and pass into the solution in the form of Zn^{+2} ions.
The blue colour of the solution is discharged, due to conversion of blue coloured Cu^{+2} ions into copper atoms. The electrons lost by zinc are accepted by Cu^{+2} ions and thus Cu^{+2} ions are reduced.

Commonly Made Error
- Students often do not write correct equations.

Answering Tips
- Students must practice to write correct equations.
- Charges should be properly written.

Q. 3. Determine the change in oxidation number of S in H_2S and SO_2 in the following :

$$2H_2S(g) + SO_2(g) \rightarrow 3S(s) + 2H_2O(g)$$

Ans. $\overset{-2}{2H_2S}(g) + \overset{+4}{SO_2}(g) \rightarrow \overset{0}{3S}(s) + 2H_2O(g)$

O.N. of S changes from –2 in H_2S and +4 in SO_2 to O in elemental sulphur.

Commonly Made Error
- Students often get confused with correct oxidation number.

Answering Tips
- Students must write the oxidation numbers and then specify the changes involved.

Q. 4. Give reason : The oxidation number of fluorine in all its compounds is always –1.

Ans. The oxidation number of fluorine in all its compounds is always –1 because it has seven electrons in its valence shell and needs only one electron to have octet configuration and fluorine is very reactive.

Q. 5. Give reason : Chlorine liberates iodine from KI solution.

Ans. The oxidising power of halogens on going down the group (17) decreases. Fluorine having highest oxidising power and iodine having the least.
Thus, chlorine placed above iodine can replace I^- ions in solution.
Chlorine undergoes metal displacement reaction and displaces iodine from KI solution.

$$\overset{0}{Cl_2}(g) + \overset{+1-1}{2KI}(aq) \longrightarrow \overset{+4\ -1}{2KCl}(aq) + \overset{0}{I_2}(s)$$

Q. 6. What sort of information can you draw from the following reaction?

$(CN)_2(g) + 2OH^-(aq) \rightarrow CN^-(aq) + CNO^-(aq) + H_2O(l)$

Ans. It is a disproportionation reaction in which $(CN)_2$ is simultaneously reduced to CN^- ions and oxidised to CNO^- ions. The reaction takes place in basic medium.

3 Marks Questions

Q. 1. Show how formation of magnesium oxide is a redox reaction.

Ans. In the formation of MgO :

$$2Mg + O_2 \rightarrow 2MgO$$

Here, Mg loses two electrons to form Mg^{2+}. Therfore, magnesium has undergone oxidation.

$$Mg \rightarrow Mg^{2+} + 2e^-$$
$$2Mg \rightarrow 2Mg^{2+} + 4e^-$$

Oxygen atom has accepted two electrons given by magnesium and has undergone reduction.

$$O + 2e^- \rightarrow O^{2-}$$
$$O_2 + 4e^- \rightarrow 2O^{2-}$$

Thus, in this reaction, electrons are transferred from one reactant to another is called as redox reaction.
Here magnesium is a reducing agent while oxygen is an oxidising agent.

Commonly Made Error
- Some students often get confused with the correct equations involved.

Answering Tips
- Students must understand clearly the meaning of redox reaction.
- Based on it, frame their equations.
- Write correct equations and justify why it is redox reaction.

Q. 2. Identify the substance oxidised and reduced, oxidising agent and reducing agent for each of the following reactions :

(1) $2AgBr(s) + C_6H_6O_2(aq) \rightarrow 2Ag(s) + 2HBr(aq) + C_6H_4O_2(aq)$
(2) $HCHO(l) + 2[Ag(NH_3)_2]^+(aq) + 3OH^-(aq) \rightarrow 2Ag(s) + HCOO^-(aq) + 4NH_3(aq) + 2H_2O(l)$
(3) $HCHO(l) + 2Cu^{2+}(aq) + 5OH^-(aq) \rightarrow Cu_2O(s) + HCOO^- + 3H_2O(l)$
(4) $N_2H_4(l) + 2H_2O_2(l) \rightarrow N_2(g) + 4H_2O(l)$

Ans.

S.No	Substance oxidised	Substance reduced	Oxidising agent	Reducing agent
(1)	$C_6H_6O_2(aq)$	$AgBr(s)$	$AgBr$	$C_6H_6O_2(aq)$
(2)	$HCHO(l)$	$[Ag(NH_3)_2]^+(aq)$	$[Ag(NH_3)_2]^+(aq)$	$HCHO(l)$
(3)	$HCHO(l)$	$Cu^{2+}(aq)$	$Cu^{2+}(aq)$	$H_2O_2(l)$
(4)	$N_2H_4(l)$	$H_2O_2(l)$	$H_2O_2(l)$	$N_2H_4(l)$

5 Marks Questions

Q. 1. State the rules for the determination of oxidation number of an atom.

Ans. (1) Oxidation Number of all elements in the uncombined state/elementary state is zero.

(2) Oxidation Number in a monoatomic ion is equal to charge present on an ion.

(3) Fluorine has Oxidation Number –1 in all compounds.

(4) Oxidation Number in all compounds of alkali metals is +1 in and that of alkaline earth metal is +2.

(5) Oxidation Number of hydrogen in all compounds except hydrides is +1.

(6) In KH, CaH_2, the Oxidation Number of hydrogen is +1.

(7) Oxidation Number of oxygen (except in peroxides, suboxides or super oxides) is –2.

(8) Algebraic sum of oxidation number of all atoms in a neutral molecule is zero.

Q. 2. Find the oxidation number of :

(1) S in $Na_2S_4O_6$

(2) Cr in $K_2Cr_2O_7$

(3) Mn in K_2MnO_4

(4) Fe in Fe_3O_4

Ans. The oxidation number of

(1) S in $Na_2S_4O_6$

Oxidation number of Na = +1, O = –2, $S = x$, then substituting oxidation number values in neutral molecule $Na_2S_4O_6$

We get, $(+1) \times 2 + (x) \times 4 + (-2) \times 6 = 0$

$2 + 4x - 12 = 0$

$4x = +12 - 2 = +10$

$x = +\frac{10}{4} = +\frac{5}{2}$

∴ The oxidation number of S in $Na_2S_4O_6$ is +5.

(2) Cr in $K_2Cr_2O_7$

Oxidation number of K = +1, O = –2, Cr = x, then substituting oxidation no. values in neutral molecule $K_2Cr_2O_7$

We get, $(+1) \times 2 + (x) \times 2 + (-2) \times 7 = 0$

$2x = +14 - 2 = +12$

$x = +\frac{12}{2} = +6$

∴ The oxidation number of Cr in $K_2Cr_2O_7$ is +6.

(3) Mn in K_2MnO_4

Oxidation number of K = +1, O = –2, Mn = x, then substituting oxidation no. values in neutral molecule K_2MnO_4

We get, $(+1) \times 2 + (x) + (-2) \times 4 = 0$

$x = 8 - 2 = +6$

$x = +6$

∴ The oxidation number of Mn in K_2MnO_4 is +6

(4) Fe in Fe_3O_4

Oxidation number of O = –2, Fe = x, then substituting oxidation no. values in neutral molecule Fe_3O_4

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

$3x = 8$

$x = +\frac{8}{3}$

∴ The oxidation number of Fe in Fe_3O_4 is + 8.

Commonly Made Error

- Students often get confused with correct oxidation number.

Answering Tips

- Students must practice to write correctly the oxidation numbers and find the correct oxidation number of asked element.
- Students must avoid creating errors in calculations.

Q. 3. Calculate the oxidation number of the underlined elements in the following ions?

(1) $\underline{I}O_3^-$ **(2) $\underline{Mn}O_4^{2-}$**

(3) $\underline{P}O_4^{3-}$ **(4) $\underline{S}O_4^{2-}$**

Ans. (1) IO_3^-

Let oxidation number of I be x, O = –2 as IO_3^- has charge equal to –1, then sum of oxidation no. of all atoms is equal to –1.

Therefore, $(x) + (-2) \times 3 = -1$

$x = -1 + 6$

$x = 5$

Hence oxidation number of I in IO_3^- ion is +5.

(2) MnO_4^{2-}

Let oxidation number of Mn be x, O = –2 as MnO_4^{2-} has charge equal to –2, then sum of oxidation no. of all atoms is equal to –2.

Therefore, $(x) + (-2) \times 4 = -2$

$x = -2 + 8$

$x = 6$

Hence oxidation number of Mn in MnO_4^{2-} ion is +6.

(3) PO_4^{3-}

Let oxidation number of P be x, O = –2 as PO_4^{3-} has charge equal to –3, then sum of oxidation no. of all atoms is equal to –3.

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

$x = -3 + 8$

$x = 5$

Hence oxidation number of P in PO_4^{3-} ion is +5.

(4) SO_4^{2-}

Let oxidation number of S be x, O = –2 as SO_4^{2-} has charge equal to –2, then sum of oxidation no. of all atoms is equal to –2.

Therefore, $(x) + (-2) \times 4 = -2$

$x = -2 + 8$

$x = 6$

Hence oxidation number of S in SO_4^{2-} ion is +6.

Commonly Made Error

- Some students make mistakes in positive and negative charges.

Answering Tips

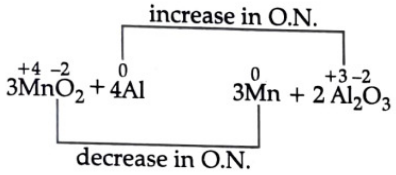
- Students must learn the concept of oxidation number properly.
- They must practice how to calculate oxidation number.

Q. 4. Identify the substance undergoing oxidation, the substance undergoing reduction, the oxidising agent and the reducing agent in each of the following reactions :

$$3MnO_2 + 4Al \rightarrow 3Mn + 2Al_2O_3$$

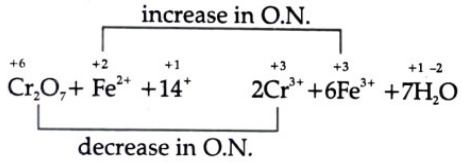
$$Cr_2O_7 + 6Fe^{2+} + 14H^+ \rightarrow 2Cr^{3+} + 6Fe^{3+} + 7H_2O$$

Ans. Writing the oxidation numbers of all atoms involved in the given reaction, we have



From the above it is clear that the oxidation number of Al increases from 0 to +3. Hence, Al undergoes oxidation and acts as a reducing agent. In MnO_2, the oxidation number of Mn decreases from +4 to 0. Therefore, MnO_2 undergoes reduction and acts as an oxidizing agent.

For the given reaction, we have



From the above, it is clear that the oxidation number of Fe^{2+} ion increases from +2 to +3. Therefore, Fe^{2+} ion gets oxidised and acts as a reducing agent. In $Cr_2O_7^{2-}$ ion, the oxidation number of Cr decreases from +6 to +3. Hence, $Cr_2O_7^{2-}$ ion gets reduced and acts as an oxidizing agent.

Q. 5. Calculate the oxidation number of sulphur, chromium and nitrogen in H_2SO_5, CrO_5 and NO^{3-}. Suggest structure of these compounds. Count for the fallacy.

Ans. (1) H_2SO_5

Oxidation number of sulphur in H_2SO_5

$2 \times (+1) + x + 5 \times (-2) = 0$

$x = 10 - 2 = +8$

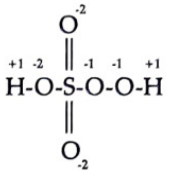
But the oxidation number + 8 for sulphur is not possible as it has only 6 electrons in its valence shell.

It can exhibit maximum oxidation state = + 6.

Hence, in H_2SO_5, two oxygen atoms must be linked together.

Considering this fallacy can be removed.

Therefore, the structure of H_2SO_5 should be :



Based on the above structure, we have,

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

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

$x = +6$

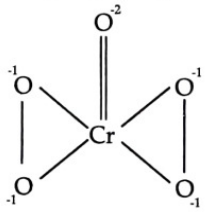
(2) CrO_5

Oxidation number of Cr in CrO_5

$x + 5 \times (-2) = 0$

$x = +10$

But the oxidation number +10 for chromium is not possible as it has only 6 electrons in its valence shell. It can exhibit maximum oxidation state = + 6. Fallacy can be removed by considering the structure of CrO_5 as given below :



Based on the above structure, we have,

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

$-4 + x - 2 = 0$

$x = +6$

(3) NO_3^-

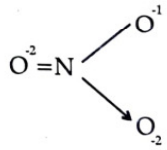
The oxidation number of N in NO_3^-,

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

(as NO_3^- bears charge -1)

$x = +5$

The structure of NO_3^- is :



Based on the above structure,

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

$x = +5$

Therefore, this structure gives the same oxidation number for N in NO_3^-.

Hence there is no fallacy.

Commonly Made Error

- Students get confuse and write incomplete answers.

Answering Tips

- Students must read the question carefully.
- They must not forget to draw the proper structure.

Q. 6. Balance the following equation by oxidation number method :

$$K_2Cr_2O_7 + HCl \rightarrow KCl + CrCl_3 + H_2O + Cl_2$$

Q. 7. Balance the following equation by ion-electron method :

$$Cr(OH)_3 + IO_3^- + OH^- \rightarrow CrO_4^- + I^- + H_2O$$

Ans. The given equation is :

$$Cr(OH)_3 + IO_3^- + OH^- \rightarrow CrO_4^- + I^-$$

Write the oxidation number of atoms :

$$\overset{+3}{Cr}(\overset{-2}{O}\overset{+1}{H})_3 + \overset{+5}{I}\overset{-2}{O_3^-} \rightarrow \overset{+6}{Cr}\overset{-2}{O_4^{2-}} + \overset{-1}{I^-}$$

$Cr(OH)_3$ undergoes oxidation while IO_3^- undergoes reduction.

The given reaction can be split up in the following two half reactions :

$Cr(OH)_3 \rightarrow CrO_4^{2-}$ (oxidation half reaction)

$IO_3^- \rightarrow I^-$ (reduction half reaction)

Balancing oxidation half reaction :

The atoms other than H and O i.e. Cr are already balanced.

The given reaction proceeds in basic medium. Therefore, O atoms should be balanced by adding OH^-.

They can be balanced as :

$$Cr(OH)_3 + OH^- + 4OH^- \rightarrow CrO_4^{2-} + 4H_2O$$

or, $$Cr(OH)_3 + 5OH^- \rightarrow CrO_4^{2-} + 4H_2O$$

The right hand side is deficient in three negative charges. Therefore, charge can be balanced by adding three electrons on the right.

$$Cr(OH)_3 + 5OH^- \rightarrow CrO_4^{2-} + 4H_2O + 3e^-$$

This is the balanced oxidation half reaction.