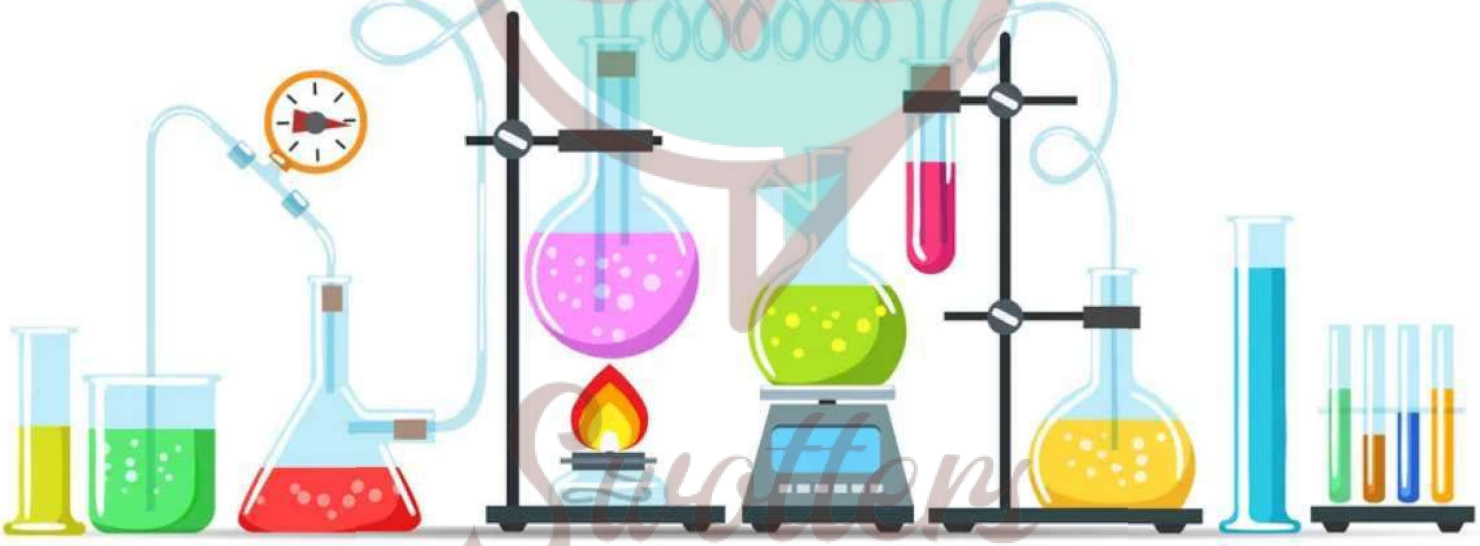
CHEMISTRY



Important Questions

Multiple Choice questions-

Question 1. $KMnO_4$ reacts with oxalic acid according to the equation $2MnO_4^- + 5C_2O_4^{2-} + 16H^+ \rightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$ Here 20 mL of 0.1 M $KMnO_4$ is equivalent to

(a) 50 mL of 0.5 M $C_2H_2O_4$

(b) 20 mL of 0.1 M $C_2H_2O_4$

(c) 20 mL of 0.5 M $C_2H_2O_4$

(d) 50 mL of 0.1 M $C_2H_2O_4$

Question 2. Which of the following is a redox reaction?

(a) $NaCl + KNO_3 \rightarrow NaNO_3 + KCl$

(b) $Mg(OH)_2 + 2NH_4Cl \rightarrow MgCl_2 + 2NH_4OH$

(c) $CaC_2O_4 + 2HCl \rightarrow CaCl_2 + H_2C_2O_4$

(d) $2Zn + 2AgCN \rightarrow 2Ag + Zn(CN)_2$

Question 3. The reduction potential values of M, N and O are +2.46 V, -1.13 V, -3.13 V respectively. Which of the following orders is correct regarding their reducing property?

(a) O > N > M

(b) M > O > N

(c) M > N > O

(d) O > M > N

Question 4. Which of the following processes does not involve either oxidation or reduction?

(a) Formation of slaked lime from quick lime

(b) Heating Mercuric Oxide

(c) Formation of Manganese Chloride from Manganese oxide

(d) Formation of Zinc from Zinc blende

Question 5. The number of moles of $KMnO_4$ reduced by one mole of KI in alkaline medium is

(a) One

(b) Two

(c) Five

(d) One fifth.

Question 6. What is known as Autooxidation?

(a) Formation of H_2O by the oxidation of H_2O_2.

(b) Formation of H_2O_2 by the oxidation of H_2O.

(c) Both (1) and (2) are true

(d) None of the above

Question 7. Which of the following statements regarding sulphur is incorrect?

(a) S_2 molecule is paramagnetic.

(b) The vapour at 200° C consists mostly of S_8 rings.

(c) At 600°C the gas mainly consists of S_2 molecules.

(d) The oxidation state of Sulphur is never less than +4 in its compounds.

Question 8. The oxidation number of Xe in $BaXeO_6$ is

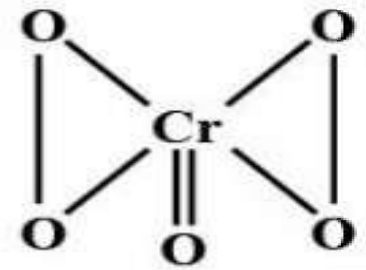
(a) 8

(b) 6

(c) 4

(d) 10

Question 9. CrO_5 has structure as shown, the oxidation number of chromium in the compound is?



(a) +10

(b) +6

(c) +4

(d) +5

Question 10. Pure water is bad conductor of electricity because

(a) It has high boiling point

(b) It is almost unionised

(c) Its molecules are associated with H- bonds

(d) Its pH is 7 at 25°C

Question 11. The oxidation process involves

(a) Increase in oxidation number

(b) Decrease in oxidation number

(c) No change in oxidation number

(d) None of the above

Question 12. The ionic mobility of alkali metal ions in aqueous solution is maximum for

(a) Li+

(b) Na+

(c) K+

(d) Rb+

Question 13. Pure water is bad conductor of electricity because

(a) It has high boiling point

(b) It is almost unionised

(c) Its molecules are associated with H- bonds

(d) Its pH is 7 at 25°C

Question 14. The oxidation number of Fe in K_4 [Fe $(CN)_6$] is

(a) 3

(b) 4

(c) 2

(d) Zero

Question 15. A standard hydrogen electrode has zero electrode potential because

(a) Hydrogen is easiest to oxidise

(b) This electrode potential is assumed to be zero

(c) Hydrogen atom has only one electron

(d) Hydrogen is the lightest element

Very Short:

1. What are redox reactions? Give an example.
2. Define oxidation and reduction in terms of electrons.
3. Define an oxidizing agent. Name the best oxidizing agent.
4. What is meant by reducing agent? Name the best reducing agent.
5. In the reaction $MnO_2 + 4HCl \rightarrow MnCl_2 + H_2O$ which species is oxidized?
6. What is the oxidation state of Ni in Ni $(CO)_4$?

7. What is a redox couple?
8. Define oxidation and reduction in the term of oxidation numbers.
9. What is the sum of oxidation numbers of all atoms in $HIO_4$4?
10. What is the oxidation number of N in $(NH_4)_2$ SO_2?

Short Questions:

1. HNO3 acts only as an oxidant whereas HNOz acts both as an oxidant and reductant. Why?
2. Balance the following equation by the ion-electron method.

   Zn(s) + NO3– → Zn2+(aq) + NH+ (aq) + H2O(l) (In acid solution)
3. Balance the following equation in acidic medium by oxidation number method.
4. Indicate the oxidising and reducing agent in the following reactions:
5. Which of the following redox reaction is oxidation & which is reduction?
6. What are the minimum and maximum oxidation numbers shown by sulfur?

Long Questions:

1. What are the minimum and maximum oxidation numbers shown by sulfur?
2. Starting with the correctly balanced half-reaction, write the overall net ionic equation for the following change:
3. Write the method used for balancing redox reaction by oxidation number method.
4. Determine the oxidation number of O in the following: OF2, Na2O2 & CH3COOH

   (i) OF_2

   (ii) Na_2O_2

   (ii) CH_3COOH
5. Determine the volume 6f M/8 $KMnO_4$ solution required to react completely with 25.0 cm3 of M/4 $FeSO_4$ solution in an acidic medium.

Assertion Reason Questions:

1. 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.

   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.

2. 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.

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.

Case Study Based Question:

1. Read the passage given below and answer the following questions:

The oxidation state of an individual atom is 0. The total oxidation state of all atoms in a neutral species is 0 and in an ion is equal to the ion charge. Group 1 metals have an oxidation state of + 1 and group 2 an oxidation state of + 2.

The oxidation state of fluorine is – 1 in compounds. Hydrogen generally has an oxidation state of + 1in compounds. Oxygen generally has an oxidation state of − 2 in compounds.

In binary metal compounds, group 17 elements have an oxidation state of − 1, group 16 elements of − 2, and group 15 elements of − 3. The sum of the oxidation states is equal to zero for neutral compounds and equal to the charge for polyatomic ion species. An atom is oxidised if its oxidation number increases and an atom is reduced if its oxidation number decreases.

The atom that is oxidised is the reducing agent and the atom that is reduced is the oxidising agent.

(1) One mole of acidified $K_2 Cr_2 O_7$ on reaction with excess KI will liberate n mole of I_2 then the value of n is:

(a) 6

(b) 1

(c) 3

(d) 7

(2) When electrons are transferred from Zn to Cu^{2+} in copper sulphate solution, the energy (heat) is:

(a) Absorbed

(b) Evolved

(c) Consumed

(d) Both (a) and (b)

(3) Negative $E^{\ominus}$ indicates that redox couple is

(a) Weaker reducing agent than H^+/ H_2 couple

(b) Stronger reducing agent than H^+/ H_2 couple

(c) Stronger oxidising agent than H^+/ H_2 couple

(d) Weaker oxidising agent than H^+/ H_2 couple

(4) Which of the following statements is/are incorrect?

(a) The reactants, which undergo oxidation and reduction are called reductant and oxidant respectively

(b) In redox reaction, the oxidation number of oxidant increases, while that of reductant decreases

(c) HNO_2 acts as an oxidising as well as reducing agent

(d) Oxidation is the process, in which electrons are lost

2. Read the passage given below and answer the following questions:

The concept of electron transfer is found unable to explain the redox changes or electron shift in case of covalent compounds.

To explain these changes a new concept, called oxidation number is introduced. Oxidation number is defined as the charge that an atom of the element has in its ion or appear to have when present in the combined state with other atoms. In other words, it is also defined as the charge that an atom appear to have in a compound when all other atoms are removed as ions from the compound.

The following steps are involved while calculating the oxidation number of an atom in a given compound/ ion.

Step I Write down the formula of given compound/ion leaving some space between the atoms.

Step II Write the oxidation state of each element above its atoms. Write down x above

the atom, oxidation state of which we have to find out.

Step III Multiply the oxidation numbers of each element with the number of atoms of that element present in the compound. Enclose the product in a bracket.

Step IV Equate the algebraic sum of the oxidation numbers of all the atoms present in compound to zero or to the charge in case of ionic species charge on the ion.

Step V Solve the equation obtained for the value of x.

(1) Highest oxidation state of Mn is present in:

(a)$KMnO_4$

(b)K_2MnO_4

(c)M_2nO_3

(d)MnO_2

(2) Identify the element which never has positive oxidation number in any of its compound?

(a) Oxygen

(b) Chlorine

(c) Fluorine

(d) Bromine

(3) When a manganous salt is fused with a mixture of KNO_3 and solid NaOH, the oxidation number of Mn changes, from + 2 to:

(a) + 4

(b) + 3

(c) + 6

(d) + 7

(4) The brown ring complex compound is formulated as $[Fe(H_2O)_5\ NO]SO_4$. What will be the oxidation state of iron in the given complex?

(a) + 2

(b) + 3

(c) + 4

(d) + 1

Answer Key:

MCQ

1. (d) 50 mL of 0.1 $MC_2H_2O_4$
2. (d) $2Zn + 2AgCN \rightarrow 2Ag + Zn(CN)_2$
3. (d) O > M > N
4. (a) Formation of slaked lime from quick lime
5. (b) Two
6. (b) Formation of H_2O_2 by the oxidation of H_2O.
7. (d) The oxidation state of sulphur is never less than +4 in its compounds.
8. (d) 10
9. (b) +6
10. (b) It is almost unionised
11. (a) Increase in oxidation number
12. (d) Rb^+
13. (b) It is almost unionised
14. (c) 2
15. (b) This electrode potential is assumed to be zero

Very Short Answer:

1. Redox reaction is a reaction in which oxidation and reduction take place simultaneously, e.g.
$Zn (s) + Cu^2+(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

2. Oxidation involves loss and reduction involves the gain of electrons.

3. The oxidizing agent is a substance that can gain electrons easily. F_2 is the best oxidizing agent.

4. The reducing agent is a substance that can lose electrons easily. Li is the best reducing agent

(ii)Dissociation increases, i.e., the equilibrium shifts forward.

5. HCl is oxidized to Cl_2

6. Zero

7. The redox couple consists of the oxidized and reduced form of the same substance taking part in an oxidation or reduction half-reaction, for example.

$Zn^{2+}(aq)$ / Zn, Cl_2 / $Cl^-(aq)$ etc.

8. Oxidation involves an increase in oxidation number while reduction involves a decrease in oxidation number.

$Sn^{2+} + 2Hg^{2+} \rightarrow Sn^{4+} + Hg^{2+}$

Here Sn^{2+} gets oxidised while Hg^{2+} gets reduced.

9. Zero

10.

$\overset{x+1}{(NH_4)_2}\ \overset{-2}{SO_4}$

$2x + 8(+1) - 2 = 0$

$2x + 8 - 2 = 0$

$x = -3$

The oxidation number of N is $(NH_4)_2\ SO_4$ is – 3.

Short Answer:

Ans: 1. Ox. No. of N in HNO_3 = +5

Ox No. of N in HNO_2 = +3

Maximum oxidation numbers which N can show is = + 5

(∴ It has only 5 valance electrons $2S^2 2P^3$)

The Ox. No. of N in HNO_3 is maximum and it can only decrease. Therefore, HNO_3 can act only as an oxidant. Minimum Ox. No. of N is -3.

Thus, HNO_2 in which Ox. No. of N is +3 Can decrease as well as increase. Thus, HNO_2 can act as an oxidant as well as a reductant.

Ans: 2. Oxidation half reaction

$$Zn(s) \longrightarrow Zn^{2+}(aq)$$

$$Zn(s) \longrightarrow Zn^{2+} + 2e^- \quad \ldots(1)$$

(To balance charge)

Reduction half reaction

$$NO_3^-(aq) \longrightarrow NH_4^+(aq)$$

$$NO_3^-(aq) \longrightarrow NH_4^+ + 3H_2O(l) \quad \text{(to balance O atom)}$$

$$NO_3^-(aq) + 10H^+(aq) \longrightarrow NH_4^+(aq) + 3H_2O(l)$$

(to balance H atom)

$$NO_3^-(aq) + 10H^+(aq) + 8e^- \longrightarrow NH_4^+ + 3H_2O(l)$$

Multiply (1) equation by 4 to equalize the no. of electron in both. Add both half reaction

$4\,Zn(s) \rightarrow Zn^{2}+(aq) + 8e–$

$Zn(s) + NO_3– (aq) + 10H+ (aq) \rightarrow 4Zn^{2+} (aq) + NH^{+}(aq) + 3H_2 2O(1)$

$– 1 + 10 = + 8 + 1$

$+ 9 = + 9$

Ans: 3.

increase in oxidation number

$$\overset{+7}{MnO_4^-}(aq) + \overset{+3}{COOH} \longrightarrow \overset{+2}{Mn}(aq) + \overset{+4}{CO_2}(g) + H_2O(l)$$

$$|$$

$$COOH$$

decrease in oxidation number

$$2\,MnO_4^-(aq) + 5\begin{vmatrix} COOH(aq) \\ | \\ COOH \end{vmatrix} \longrightarrow 2Mn^{2+} + 10CO_2 + 8H_2O$$

$$2\,MnO_4^-(aq) + 5\,COOH(aq) + 6H^+(aq) \longrightarrow$$

$$|$$

$$COOH$$

$$2Mn^{2+}(aq) + 10CO_2 + 8H_2O$$

Ans: 4. (i) $2Mg + SO_2 \rightarrow 2MgO + S$

Mg = Reducing agent

SO_2 = Oxidising agent

(ii)$2Cu^{2+} + 41 \rightarrow 2CuI + I_2$

Cu^{2+} = Oxidising agent

I- = Reducing agent

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

SO_2 = Oxidising ageiit

H_2S = Reducing agent

(iv)$Sn^{2+} + 2Hg^{2+} \rightarrow Hg2^{2+} + Sn^{4+}$

Sn^{2+} = Reducing agent

Hg^{2+} = Oxidising agent

Ans: 5. (i) $Zn \rightarrow Zn^{2+} + 2e^-$

Oxidation

(ii) $Cl2 + 2e^- \rightarrow 2Cl$-

Reduction

(iii) $Fe \rightarrow Fe^{2+} + 2e^-$

Oxidation

(tv) $Sn^{4+} + 2e^- \rightarrow Sn^{2+}$

Reduction

Ans: 6. The minimum oxidation number shown by S is – 2 since it can acquire 2 more electrons to achieve the nearest inert gas [Ar] configuration.

The maximum Ox. No. shown by S is +6 since it has 6 valance electrons. ($3S^2$ $3P^4$)

Long Answer:

Ans: 1. Various atoms are assigned oxidation number on the basis of the following rules:

1. An element in the free state has an oxidation number equal to zero, e.g. H2, He, K, Ag all have zero ox. no.

2. In a binary compound of a metal and a non-metal, the oxidation number of metal is positive while that of non-metal is negative. In NaCl the ox. no. of sodium +1 and ox. n. of chlorine is -1.

3. In a covalent compound, the atom with higher electronegativity has a negative oxidation number while another atom has a positive oxidation number.

4. The oxidation number of the radical or ions is equal to the electrical charge on it. for e.g. the ox. no. of Na+ is +1.

5. In neutral molecules, the algebraic sum of the oxidation number of all the atoms is zero.

Ans: 2. The skeletal equation is

$MnO_4^- + H^+ + Cl^-(aq) \rightarrow Mn^{2+} + Cl_2(g) + H_2O\ (l)$

Ox. no. of Mn change from +7 in MnO_4^- to +2

Whereas ox. no. of chlorine changes from -1 in Cl^- ions to 0 in Cl_2.

$$\text{Mn} \downarrow 5 \times 2$$

$$2\text{Cl} \longrightarrow \text{Cl}_2 \uparrow 2 \times 5$$

$$2\,\text{MnO}_4^-(aq) + 10\text{Cl}^-(aq) \longrightarrow 2\text{Mn}^{2+}(aq) + 5\text{Cl}_2(g)$$

(To balance 0 atoms)

$$2\,\text{MnO}_4^-(aq) + 10\text{Cl}^-(aq) \longrightarrow 2\text{Mn}^{2+}(aq) + 5\text{Cl}_2 + 8\text{H}_2\text{O}$$

$$2\,\text{MnO}_4^-(aq) + 10\text{Cl}^-(aq) + 16\text{H}^+ \longrightarrow 2\text{Mn}^{2+} + 5\text{Cl}_2 + \text{H}_2\text{O}$$

(to balance H atoms)

Ans: 3. The following steps are used for balancing the reactions by this methods:

1. Writing the skeletal equation for all the reactants and products of the reaction.
2. Assignment of the oxidation number of all atoms in each compound in the skeletal equation. Identify the atoms undergoing a change in their oxidation number.
3. Calculating the increase or decrease in oxidation number per atom and then for the whole molecule in which it occurs. If these are not equal, then multiplying by suitable coefficients such that these become equal.
4. Now balancing the chemical reaction with respect to all atoms except H & O.
5. Finally balancing with respect to H & O atom for balancing oxygen atoms add H20 molecules to the side deficient in it.

Ans: 4. (i) OF_2

Let the ox. no. of O = x

The ox. no. of each F = — 1

x – 2 = 0

x = +2

(ii) Na_2O_2

Let the o. no. of O = x

ox. no. of each Na = + 1

2 + 2x = 0

2x = – 2

x = – 1

(iii) CH_3COOH

Let the ox. no. of O = x

The ox. no. of each carbon atom = — 1

The ox. no. of hydrogen = +1

– 2 + 4 + 2x = 0

2x + 2 = 0

x = – 1

Ans: 5. The balanced ionic equation for the reaction is

$MnO_4^- + 5Fe^{2+} + 8H^+ \rightarrow Mn^{2+} + 5Fe^{3+} + 4H_2O$

from the balanced equation, it is evident that-

1 mole of $KMnO_4$ = 5 moles of $FeSO_4$

Applying the molarity equation to the balanced redox equation.

$$\frac{M_1V_1}{n_1}(KMnO_4) = \frac{M_2V_2}{n_2}(FeSO_4)$$

or $$\frac{1 \times V_1}{8 \times 1} = \frac{1}{4} \times \frac{25}{5}$$

or $$V_1 = \frac{1 \times 25 \times 8}{4 \times 5}$$

$$= 10.0 \text{ cm}^3$$

Thus, the volume of M/8 $KMnO_4$ solution required = 10.0 ml.

Assertion Reason Answer:

1. (ii) Both A and R are true but R is not the correct explanation of A.
2. (iii) A is true but R is false.

Case Study Answer:

1. Answer:

(1) (c) 3

(2) (b) Evolved

(3) (b) Stronger reducing agent than H^+/ H_2 couple

(4) (b) In redox reaction, the oxidation number of oxidant increases, while that of reductant decreases

2. Answer:

(1) (a)$KMnO_4$

(2) (c) Fluorine

(3) (c) + 6

(4) (b) + 3