XIIth 2023-24
Date : 16/10/2023

Chemistry Theory Round -01

Max.Marks :- 35
Time 90 Minutes.

General Instructions : The question paper is divided into four sections.
(1) Section A : Q.No.1 contains Five Multiple choice type of question carrying **One** mark each.
Q.No.2 contains Five very short answer type of questions carrying **One** mark each.
(2) Section B : Q.No.3 to Q.9 are short answer type of question carrying **Two** marks each.
(3) Section C : Q.No.10 to Q. No.14 are short answer type of questions carrying **Three** marks each
(4) Section D: Q.No.15 to Q.No.18 are long answer type of questions carrying **Four** marks each.
(5) Figures to the right indicate full marks

MODEL ANSWER KEY

Section -A [05]

Q.1 Select and write the correct answers for the following multiple choice type of questions.

(i) The pH of weak monoacidic base is 11.2, its OH^- ion concentration is _____

(a) 1.585×10^{-3} mol dm^{-3} (b) 3.010×10^{-11} mol dm^{-3}

(c) 1.585×10^{-3} mol dm^{-3} (d) 1.585×10^{-11} mol dm^{-3}

(ii) The spin only magnetic moment of Mn^{2+} ion is _____

(a) 4.901 BM **(b) 5.916 BM**

(c) 3.873 BM (d) 2.846 BM

(iii) The glycosidic linkage present in maltose is _____

(a) α, β -1, 2-glycosidic linkage **(b) α -1, 4-glyc**osidic linkage

(c) β -1, 4-glycosidic linkage (d) α -1, 6-glycosidic linkage

(iv) In calculating osmotic pressure, the concentration of solute is expressed in _____

(a) Molarity (b) Molality

(c) Mole fraction (d) Percentage

(v) The correct formula for complex compound, sodium hexacyanoferrate(III) is _____

(a) $Na[Fe(CN)_6]$ (b) $Na_2[Fe(CN)_6]$

(c) $Na_3[Fe(CN)_6]$ (d) $Na_4[Fe(CN)_6]$

Q.2. Answer the following questions. **[05]**

(i) Write the name of the technique used to know the geometry of nano-particles.

Ans : The technique used to know geometry of nanoparticles is X-ray diffraction or XRD.

(ii) Write the name of platinum complex used in the treatment of cancer.

Ans : The name of platinum complex used in the treatment of cancer is cisplatin

(iii) Write the SI unit of cryoscopic constant.

Ans : The SI unit of cryoscopic constant is K kg mol^{-1} or ^oC kg mol^{-1}

(iv) What is chiral carbon atom ?

Ans : Carbon atom in a molecule which carries four different atoms/groups attached to it is called chiral carbon

(v) Calculate ΔS of the surrounding if the standard enthalpy of formation of methanol is –238 g kJ mol^{-1}

Ans : Given,

$S = 6.85 \times 10^{-4}$ mol L^{-1}, P = 1 bar.

$K_H = ?$

$$K_H = \frac{S}{P}$$

$\therefore S = K_H \times P$

$= 6.85 \times 10^{-4}$ mol $L^{-1} \times 1$ bar

$\therefore S = 6.85 \times 10^{-4}$ mol L^{-1} bar

Section -B : Attempt any -4 (Q. 3 to 9) [08]

Answer the following questions :

Q.3 Distinguish between lanthanides and actinides.

Ans :

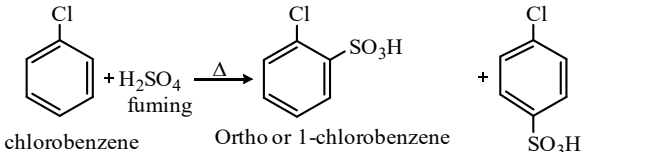
Lanthanides	**Actinides.**
(i) Essentially + 3 oxidation state	(i) Variable oxidation state.
(ii) Shows similar properties	(ii) Changes in properties
(iii) Co-ordination number is greater than 6	(iii) Co-ordination number is 6
(iv) Mostly non-radioactive except promethium	(iv) Actinoids are highly reactive radioactive elements.
(v) Lanthanides have low tendency to form complexes	(v) Actinides show greater tendency to form complexes.

Q.4 Write the chemical reactions for the following.

a) Chlorobenzene is heated with fuming H_2SO_4.

Ans : Chemical reaction:-

chlorobenzene is heated with fuming H_2SO_4 :

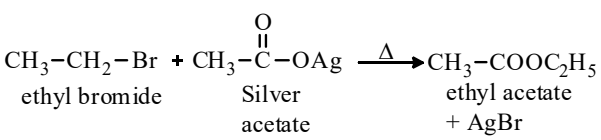


chlorobenzene — Ortho or 1-chlorobenzene Sulphonic acid — (Para or 4-Chlorobenzene sulphonic acid)

(Para or 4-Chlorobenzene sulphonic acid)

b) Ethyl bromide is heated with silver acetate.

Ans : Ethyl bromide is heated with silver acetate :



ethyl bromide — Silver acetate — ethyl acetate + AgBr silver bromide

Q.5 Define extensive property. Calculate the work done during the expansion of two moles of an ideal gas from to dm^3 to 20 dm^3 at 298 K in vacuum.

Ans : Extensive property :-

A property which depends on the amount of matter present in a system is called on extensive property. eg. mass, volume

Numerical :-

In vaccume, $P = 0$

Work done, $W = -P\Delta v$

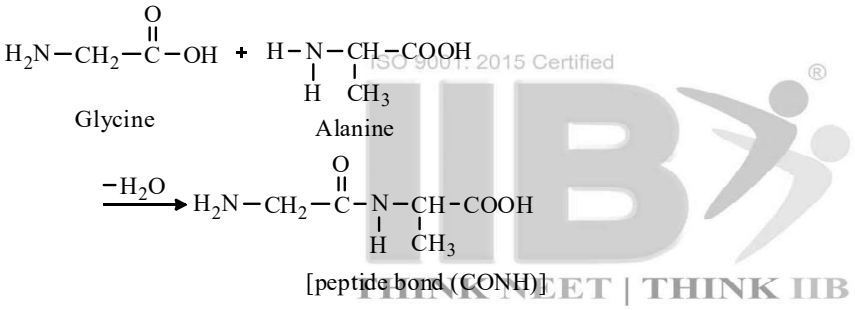
$$W = 0 \times \Delta v$$

$$\therefore \quad W = 0$$

It is called as free expansion.

Q.6 Explain formation of peptide linkage in protein with an example.

Ans : Peptide linkage is formed by condensation of acidic (–COOH) group of one molecule of α-amino acid and basic ($-NH_2$) group of other molecule of α-amino acid.



Q.7 Derive an expression to calculate molar mass of non-volatile solute by osmotic pressure measurement.

Ans : According to Van't Hoff equation, for very dilute solution,

$\pi = CRT$

where, π = Osmotic pressure,

C = Concentration = $\frac{n_2}{V}$

Now, $n_2 = \frac{W_2}{M_2}$

n_2 = number of moles of solute

W_2 = Mass (weight) of solute

M_2 = Molar mass of solute

$$\therefore \quad \pi = \frac{n_2 RT}{V} \text{ or } \quad \pi = \frac{W_2 RT}{M_2 \times V}$$

Rearranging, we get.

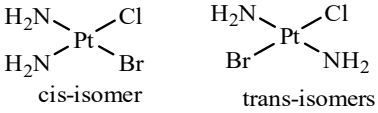
$$M_2 = \frac{W_2 RT}{\pi V}$$

where, W_2 = weight of non-volatile solute

M_2 = Molar mass of solute

Q.8 Write the structures of geometrical isomers of diammine bromochloroplatinum(II).

Ans : Geometrical isomers of [Pt (NH_2) BrCl]



Q.9 What is polysaccharides ? Write two examples of polysaccharides.

Ans : Polysaccharides are the complex biomolecules which are formed by linking of large number of monosacchrides unit by glycosidic linkage (or bonds) eg. Starch, Cellulose, Glycogen, etc.

Section -C : Attempt any -3 (Q.10 to 14) [09]

Q.10 Define osmosis. How will you determine molar mass of non-volatile solute by elevation of boiling point.

Ans : Osmosis $\Rightarrow$ The net spontaneous flow of solvent molecules into the solution from more dilute solution to more concentrated solution through a semipermeable membrane is called osmosis.

Determination of molar mass of non-volatile solute by ΔTb.

We have,

$\Delta Tb \propto m$

$\therefore \quad \Delta T_b = K_b \times m \qquad (1)$

where K_b = Ebullioscopic constant.

But, $$m = \frac{\text{moles of solute}}{\text{mass of solvent in kg}}$$

$$\therefore \quad m = \frac{1000 \times W_2}{M_2 \times W_1}$$

$$\therefore \quad m = \frac{1000 \times W_2}{M_2 \times W_1}$$

Putting in equation (i), we get

$$\therefore \quad \Delta T_b = \frac{K_b \times 1000 \times W_2}{M_2 \times W_1}$$

$$\therefore \quad M_2 = \frac{1000 \times K_b \times W_2}{\Delta Tb \times W_1}$$

Q.11 A weak monobasic acid is 10% dissociate in 0.05 M solution. What is percent dissociation in 0.15 M.

Ans : Given :

Mono basic acid

$C_1 = 0.05\ M = 5 \times 10^{-2}\ M$

$C_2 = 0.15\ M = 15 \times 10^{-2}\ M$

% dissociation of $C_1 = 10\%$

To find : % dissociation of C_2 = ?

Solution :-

$$\alpha_1\% = 10\% = \frac{10}{100} = 10^{-1}$$

$$\alpha_1 = \sqrt{\frac{K_a}{C}} \Rightarrow \alpha^2.C = K_a$$

$$\therefore \quad \alpha_1^2.C_1 = \alpha_2^2.C_2$$

$$\therefore \quad \alpha_2^2 = \alpha_2^2.C_2$$

$$\therefore \quad \alpha_1^2 = \alpha_1^2.C_1 = \frac{(10^{-1})^2 \times 5 \times 10^{-2}}{15 \times 10^{-2}}$$

$$\therefore \quad \alpha_2^2 = 0.33 \times 10^{-2}$$

$$\therefore \quad \alpha_2^2 = 0.33$$

$$\therefore \quad \alpha_2 = \sqrt{0.0033}$$

$$\therefore \quad \alpha_2 = 0.0574$$

$$\therefore \quad \alpha_2 = 5.74 \times 10^{-2}$$

$$\therefore \quad \%\alpha_2 = 5.74 \times 10^{-2} \times 10^2$$

$$\therefore \quad \%\ \alpha_2 = 5.74\%$$

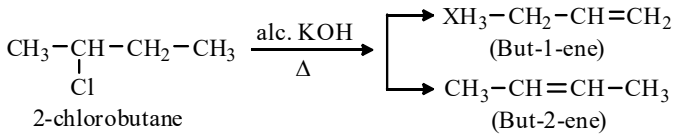
Q.12 Explain dehydrohalogenation reaction of 2-chlorobutane. Write use and environmental effect of CFC.

Ans : Dehydrohalogenation reaction :

When an alkyl halide having at least one β -hydrogen is boiled with alcoholic solution of potassium hydroxide, it undergoes elimination of hydrogen atom from β -carbon and halogen atom from α -carbon resulting in the formation of an alkene. This reaction is called β -elimination reaction as it involves elimination of halogen and β -hydrogen atom it is also called as dehydrohalogenation reaction as hydrogen and halogen are removed in this reaction.

Dehydrohalogenation reaction of 2-Chlorobutane :

2-chlorobutane on heating with alcoholic KOH gives mixture of But-1-ene and But-2-ene.



Use of CFC :

CFC are used as refrigerants in refrigerators and air conditioners.

Environmental effect of CFC.

Chlorofluorocarbons (CFC) are responsible for ozone depletion.

Q.13 What are interstitial compounds ? Give the classification of alloys with examples.

Ans : Interstitial compounds :

When small atoms like hydrogen, carbon or nitrogen are trapped in the interstitial spaces within the central lattice, the compounds formed are called interstitial compounds. eg. Steel and cast iron

Classification of alloys:-

(i) Ferrous allys:-

They have atoms of other elements distributed randomly in atoms of iron in the mixture.

eg. Nikkel stee, chromium steel, stainless steel etc.

(ii) Non-ferrous alloys :

These alloys are formed by mixing atoms of transition metal other than iron with a non-transition elements.

eg. Brass which is an alloy of copper and zinc, bronze which is an alloy of copper and tin etc.

Q.14 Explain formation of $[CoF_6]^{3\ominus}$ complex with respect to

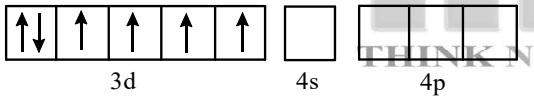
i) Hybridisation ii) Magnetic properties

iii) Inner/outer complex iv) Geometry

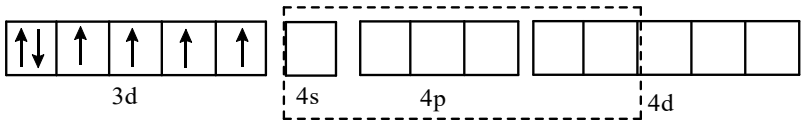
Ans : Formation of $[COF_6]^{3-}$ complex :

(i) Hybridisation :-

The oxidation state of cobalt is +3 valence shell electronic configuration of CO^{3+} is



Six orbitals available for hybridisation



Six metal orbitals after bonding with six F^- ligands lead to the sp^3d^2 hybridisation.

(ii) Magnetic properties:- The complex is paramagnetic, since it has 4 unpaired electrons.

(iii) Inner/outer complex: It has sp^3d^2 outer complex.

(iv) Geometry: It is octahedral complex.

Section -D : Attempt any 2 (Q.15 to 18) [08]

Q.15 Derive relationship between ΔH and ΔU for gaseous reaction.

Ans : Relationship between ΔH and ΔU

At constant, ΔH and ΔU are related as.

$$\Delta H = \Delta U + P\Delta V$$

For gaseous reaction, ΔV cannot be neglected, thus,

$$\Delta H = \Delta U + P(V_2 - V_1)$$

$$\Delta H = \Delta U + PV_2 - PV_1 \quad \text{---- (1)}$$

Where V_1 and V_2 are the volumes of gaseous reactants and products respectively.

We assume reactant and product behave ideally. Thus applying ideal gas equation.

$PV = nRT$

When n_1 moles of gaseous reactants produce n_2 moles of gaseous products.

$\therefore\ PV_1 = n_1RT$ and $PV_2 = n_2RT$

Substituting in equation (1)

$$\Delta H = \Delta U + n_2RT - n_1RT$$

$$\therefore \quad \Delta H = \Delta U + (n_2 - n_1)\,RT$$

$$\therefore \quad \boxed{\Delta H = \Delta U + \Delta nRT}$$

Q.16 Write chemical reactions for the following conversions.

i) Ethyl bromide to ethyl methyl ether

ii) Ethyl bromide to ethene

iii) Bromobenzene to toluene

iv) Chlorobenzene to biophenyl

Ans : Organic conversions :

(i) Ethyl bromide to ethyl methyl ether.

$$C_2H_5Br + CH_3{-}O{-}Na \xrightarrow{\Delta} C_2H_5{-}O{-}CH_3 + NaBr$$

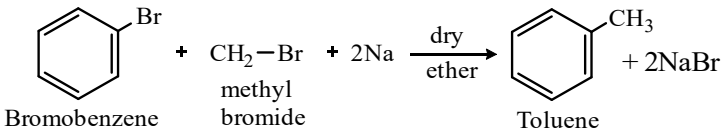
Ethyl bromide Sodium methoxide Ethyl-methyl ether

(ii) Ethyl bromide to ethene.

$$C_2H_5Br + KOH \xrightarrow{\Delta} H_2C = CH_2 + KBr + H_2O$$

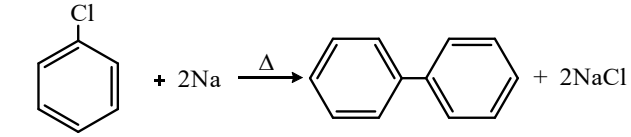
Ethyl bromide (Alcoholic) Ethylene

(iii) Bromobenzene to toluene



Bromobenzene Toluene

(iv) Chlorobenzene to biphenyl



Chlorobenzene Biphenyl

Q.17 The $[OH^-]$ concentration is 2.87×10^{-4} in the solution of NaOH. Calculate the pH of the solution.

Write a note on refining of iron.

Ans : Numerical

Given : $[OH^-] = 2.87 \times 10^{-4}$

Now $pOH = -\log_{10} [OH^-]$

$= -\log_{10} [2.87 \times 10^{-4}]$

$= -\log_{10} 10^{-4} - \log_{10} 2.87$

$= 4.0 - 0.3195$

$\therefore$ pOH = 3.6805

Now pH + pOH = 14

$\therefore$ pH = 14 – pOH = 14 – 3.6805

$\therefore$ pH = 10.3195

Refining of Iron :-

Purification of iron is called as refining of iron.

Pure iron is obtained by electrolytic refining of impure iron. Refining of iron can be carried out by various methods such as liquification, distillation and oxidation to obtain cast, wrought and steel iron.

Q.18 Define isothermal and isochoric process. Show that pH + pOH = 14.

Ans : (i) Isothermal process :-

It is the process in which the temperature of the system remains constant through out the transformation ($\Delta T = 0$)

(ii) Isochoric process :-

It is a process in which the volume of system remains constant during the transformation.

Proof :-

The ionic product of water.

$K_w = [H^+] [OH^-]$

$= 1 \times 10^{-14}$ at 25°C

$\therefore \quad 1 \times 10^{-14} = [H^+] [OH^-]$

Taking $\log_{10}$ and giving negative sign on both sides we get.

$-\log_{10} 10^{-14} = -\log_{10} [H^+] + (-\log_{10} [OH^-])$

But.

$-\log_{10} [H^+] = pH$ and

$-\log_{10} [OH^-] = pOH$

$\therefore$ pH + pOH = 14