Chemistry (Theory)

[Time allowed: 3 hours] *[Maximum marks:70]*

General Instructions:

(i) All questions are compulsory.
(ii) Marks for each question are indicated against it.
(iii) Question numbers **1** to **8** are very short-answer questions and carry **1** mark each.
(iv) Question numbers **9** to **18** are short-answer questions and carry **2** marks each.
(v) Question numbers **19** to **27** are also short-answer questions and carry **3** marks each.
(vi) Question numbers **28** to **30** are long-answer questions and carry **5** marks each.
(vii) Use Log Tables, if necessary. Use of calculators is not allowed.

Q9. A 1.00 molal aqueous solution of trichloroacetic acid (CCl_3COOH) is heated to its boiling point. The solution has the boiling point of 100.18°C. Determine the van't Hoff factor for trichloroacetic acid. (K_b for water = 0.512 kg mol^{-1}) **2**

OR

Define the following terms:
(i) Mole fraction
(ii) Isotonic solutions
(iii) van't Hoff factor
(iv) Ideal solution

Ans. Molality of solution = m = 1.00 m
Boiling points of solution = T_b = 100.18° C = 373.18 K
Boiling point of water (solvent) = $T°_b$ = 100.00° C = 373 K
Elevation in boiling point = $T_b - T°_b$
Observed boiling point = 373.18 K - 373 K = 0.18 K
K_b for water = 0.512 K kg mol^{-1}
Since, $\Delta T_b = K_b\, m$
$= 0.512 \times 1 = 0.512$ K
$\therefore$ Calculated boiling point = 0.512 K

$$\text{van't Hoff Factor (i)} = \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$

$$= \frac{0.18\,\text{K}}{0.512\ \text{K}}$$

$$i = 0.35$$

OR

(i) **Mole fraction:**
The mole fraction of a component in a mixture is defined as the ratio of the number of moles of the component to the total number of moles of all the components in the

mixture. Mathematically, it is represented as:

$$\text{Mole fraction of a component} = \frac{\text{Number of moles of the component}}{\text{Total number of moles of all components}}$$

Mole fraction is denoted by 'x'.

(ii) **Isotonic solution:**
It is a type of solution that has the same salt concentration as its surrounding environment and thus the substances around it neither lose nor gain water by osmosis.

(iii) **van't Hoff factor :**
It is defined as the ratio of the experimental value of colligative property to the calculated value of the colligative property and is used to find out the extent of dissociation or association. Mathematically, it is represented as:

$$i = \frac{\text{Normal molar mass}}{\text{Abnormal molar mass}}$$
$$= \frac{\text{Observed colligative property}}{\text{Calculated colligative property}}$$
$$= \frac{\text{Total number of moles of particles after association/dissociation}}{\text{Number of moles of particles before association/dissociation}}$$

Value of i :

For association, $i < 1$

For dissociation, $i > 1$

No association or dissociation, $i = 1$

(iv) **Ideal Solutions**:
The solutions which obey Raoult's law over the entire range of concentration are known as **ideal solutions.**

Q10. What do you understand by the 'order of a reaction'? Identify the reaction order from each of the following units of reaction rate constant: **2**
(i) L^{-1} mol s^{-1}
(ii) L mol^{-1} s^{-1}

Ans.
The sum of the powers of the concentrations of the reactants of a chemical reaction in the rate law expression is called the order of that chemical reaction.
Rate = $k[A]^x[B]^y$
Order of reaction = $x + y$
The orders of reaction for the following units are:
(i) L^{-1} mol s^{-1}: Zero order

(ii) L mol^{-1} s^{-1}: Second order

Q11. Describe a conspicuous change observed when
(i) a solution of NaC*l* is added to a sol of hydrated ferric oxide.
(ii) a beam of light is passed through a solution of NaC*l* and then through a sol. **2**

Ans. (i) When NaCl is added to ferric oxide sol, it dissociates to give Na^+ and Cl^- ions. Particles of ferric oxide sol are positively charged. Thus, they get coagulated in the presence of negatively charged Cl^- ions.
(ii) When a beam of light is passed through a solution of NaC*l*, then scattering of light is observed. This is known as the Tyndall effect. This scattering of light illuminates the path of the beam in the colloidal solution.

Q12. What is meant by coagulation of a colloidal solution? Describe briefly any three methods by which coagulation of lyophobic sols can be carried out. **2**

Ans. The process of setting of colloidal particles is called coagulation of the sol. It is also known as precipitation. Following are the three methods by which coagulation of lyophobic sols can be carried out.

(i) Electrophoresis: In this process, the colloidal particles move towards oppositely charged electrodes and get discharged resulting in coagulation.

(ii) Mixing of two oppositely charged sols: When equal proportions of oppositively charged sols are when mixed, they neutralise each other resulting in coagulation.

(iii) Dialysis: By this method, electrolytes present in sol are removed completely and colloid becomes unstable resulting in coagulation.

Q13. Describe the following:
(i) The role of cryolite in electro metallurgy of aluminium.
(ii) The role of carbon monoxide in the refining of crude nickel.

Ans. (i) Cryolite is used in the electrolytic reduction of alumina so as to reduce its melting point and make it a good conductor of electricity.
(ii) Carbon monoxide is used in the purification of nickel because it reacts with nickel to give a volatile complex called nickel tetracarbonyl, which on heating, decomposes to gives pure nickel metal.

Q14. What is meant by (i) peptide linkage (ii) biocatalysts? **2**

Ans. (i) **Peptide linkage:** Peptide linkage is an amide formed between –COOH group and $–NH_2$ group of two amino acids. Peptide linkage is responsible for the primary structure of proteins.
(ii) **Biocatalyst:** A biocatalyst is a substance, especially an enzyme that initiates or modifies the rate of a chemical reaction in a living body. Example, amylase

Q15. Explain the following giving an appropriate reason in each case.
(i) O_2 and F_2 both stabilize higher oxidation states of metals but O_2 exceeds F_2 in doing so.
(ii) Structures of Xenon fluorides cannot be explained by Valence Bond approach. **2**

Ans. (i) O_2 and F_2 both stabilize higher oxidation states of metals but O_2 exceeds F_2 in doing so due to ability of oxygen to form multiple bonds to metals.

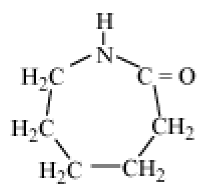
(ii) According to the valence bond approach, covalent bonds are formed by the overlapping of half filled atomic orbital. But xenon has fully filled electronic configuration. Hence the structure of xenon fluorides cannot be explained by VBT.

Q16. Complete the following chemical equations: **2**
(i) $Cr_2O_7^{2-} + H^+ + I^- \rightarrow$
(ii) $MnO_4^- + NO_2^- + H^+ \rightarrow$

Ans. (i) $Cr_2O_7^{2-} + 14H^+ + 6I^- \rightarrow 2Cr^{3+} + 3I_2 + 7H_2O$
(ii) $2MnO_4^- + 5NO_2^- + 6H^+ \rightarrow 2Mn^{2+} + 5NO_3^- + 3H_2O$

Q17. Draw the structure of the monomer for each of the following polymers: **2**
(i) Nylon 6
(ii) Polypropene

Ans. (i) Caprolactum is monomer unit of Nylon 6



Caprolactam

(ii) Propene is monomer unit of polypropene

$CH_3 – CH = CH_2$

Q18. Write the main structural difference between DNA and RNA. Of the two bases, thymine and uracil, which one is present in DNA? **2**

Ans. The structural differences between DNA and RNA are –
(i) The sugar in DNA is deoxyribose lacking oxygen atom at 2’C , while that in RNA is ribose having oxygen atom at 2’C.
(ii) DNA has a double-stranded helical structure, while RNA has a single-stranded helical

structure.

(iii) DNA contains the base thymine, while RNA contains uracil.