

U.G. 5th Semester Examination - 2025

CHEMISTRY

[MAJOR-VII]

Course Code : CHEM-MAT-7

(Physical-3)

[NEP-2020]

Full Marks : 60

Time : $2\frac{1}{2}$ Hours*The figures in the right-hand margin indicate marks.**Candidates are required to give their answers in their own words as far as practicable.*

1. Answer any ten questions: $2 \times 10 = 20$

a) $E_{S_n^{2+}/S_n}^0 = -0.140V$ and $E_{S_n^{4+}/S_n^{2+}}^0 = +0.15V$

Calculate $E_{S_n^{4+}/S_n}^0$.

- b) Why saturated calomel electrode is generally used in the potentiometric titration in the teaching laboratories?
- c) Define Ebullioscopic constant. Calculate its value for pure water.
- d) Human blood is isotonic with 0.9% NaCl solution at 27°C. What is the Osmotic Pressure of blood?
- e) Define Miller indices.
- f) Molal concentration or molar concentration, which is practically and theoretically more important and why?
- g) Explain why *p*-dichlorobenzene has zero dipole moment while *p*-dihydroxybenzene has definite value?

[Turn Over]

- h) Write the Phase rule in its general form, explaining all the terms.
- i) State Konowaloff's rule with suitable example.
- j) Define an azeotropic mixture. Give one example.
- k) K_b or K_f , are those properties of pure solvent or the solute or the solution? Explain your answer.
- l) Write down the Debye expression for orientation polarizability, explaining the terms.
- m) What are the main characteristics of an ideal solution?
- n) State Bragg's Law of Diffraction, explaining the terms.
- o) The dipole moment of HCl molecule is 1.04 Debye and the bond length HCl is $1.3 \text{ \AA}$. Estimate the percentage of ionic character.

2. Answer any four questions: $5 \times 4 = 20$

- a) i) Show that the relative lowering in vapour pressure is a colligative property.
- ii) What is the physical significance of K_f ? Calculate K_f of a substance with a molar mass of 154 g/mol , $T_f = 250 \text{ K}$ and

$$s\mu_{f,M} = \frac{3K_f}{M_f} \quad 2+3$$
- b) i) Explain the terms Deliquescence and Efflorescence with suitable example.
- ii) What is a Eutectic mixture? Give examples. $2+3$

- c) i) What is a quinhydrone electrode?
- ii) Show how pH of a buffer (acidic) solution can be measured using quinhydrone electrode by EMF measurement. $1+4$
- d) i) Write down the Debye-Hückel's Limiting equation, explaining the meaning of the symbols used in the equation.
- ii) Using this theory, show graphically how the mean activity co-efficient varies with ionic strength for 1:1, 1:2, 1:3, 2:2 etc. electrolytes. $2+3$
- e) Distinguish between a compound with congruent melting point and incongruent melting point.
- f) Calculate the packing fractions for fcc and bcc crystals. $2\frac{1}{2} + 2\frac{1}{2}$

3. Answer any two questions: $10 \times 2 = 20$

- a) i) Consider the following cell.
 $(\text{Pt}) | \text{H}_2(1 \text{ atm}) | \text{HCl}(m) | \text{AgCl}(s) - \text{Ag}$
 where m = molality of the solution.
 How will you obtain the standard reduction potential of $\text{AgCl}(s) | \text{Ag}$ electrode and mean activity co-efficient of HCl solution? 5
- ii) Define ionic strength of an electrolyte solution. Calculate ionic strength for 0.005 M KCl and 0.005 M BaCl_2 . $2+1\frac{1}{2}+1\frac{1}{2}$
- b) i) Draw sketches showing the planes with Miller indices (111), (010), (200). 6

- ii) Find the interplaner spacing (d_{hpl}) in a cubic system. 4
 - c) i) Derive Duhem-Margules equation for binary liquid mixtures from the chemical potential consideration. 3
 - ii) Acetic acid associates in benzene forming dimers. 1.65gm acetic acid dissolved in 100gm benzene raised the boiling point by 0.36°C . Calculate the degree of association of acetic acid. ($K_b=2.57^{\circ}\text{C}$). 3
 - iii) Define C.S.T for two-component systems. Give examples of systems that show upper C.S.T and lower C.S.T and both. 4
 - d) i) What are induced polarization (P_i) and orientation polarization (P_o)? Show graphically how the total molar polarization (P_t) varies with $1/T$ for polar and non-polar molecules. 4
 - ii) What is Liquid junction potential? How can the effect of Liquid junction potential be overcome? 2+2
 - iii) Give two examples of industrial applications of electrolysis. 2
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