

2026

6th Semester Examination (CCFUP : NEP)

CHEMISTRY

Paper : MJ 12-T

(Single Core Major)

(Physical Chemistry-IV)



Full Marks : 40

Time : Two Hours

*The figures in the margin indicate full marks.
Candidates are required to give their answers
in their own words as far as practicable.*

Group - A

Answer any *five* questions : $2 \times 5 = 10$

1. Osmosis is not a colligative property, osmotic pressure is colligative property — Explain.
2. Establish Nernst distribution law from Henry's law.
3. Write down the number of phases, number of components and evaluate the degrees of freedom for the following equilibrium :

Solid carbon is in equilibrium with gaseous CO, CO₂ and O₂ at 100°C.

P.T.O.

(2)

4. Show that Dulong-Petit's law is only a special case of Einstein's equation.
5. Does HD show rotational spectra? If yes, then explain the reason.
6. The Planes in a ~~crystalline~~ solid intersect the crystals axes at $3a$, $-2b$ and ∞ . Calculate the Miller indices of the plane.
7. State and explain Nernst heat theorem.
8. Addition of HgI_2 to an aqueous solution of KI results in an increase in vapour pressure of solution. Why?

Group - B

Answer any *four* questions :

$$5 \times 4 = 20$$

9. (a) Write Debye assumption made in the treatment of heat capacity of solid.
- (b) Potassium crystallizes as a bcc lattice and the length of a unit cell is 533.3 pm . Given that the density of potassium is 0.8560 g cm^{-3} , calculate the Avogadro number.
- (c) What is unit cell? 2+2+1
10. (a) Derive thermodynamically an expression for the osmotic pressure of a solution in terms of the molar concentration of the solute.

(3)

- (b) The freezing point of 0.1 molal KCl solution is 272.63 K . Calculate the degree of dissociation of KCl in the solution. [Given : $K_f = 1.86 \text{ K kg mol}^{-1}$]. 3+2
11. (a) Draw and explain briefly the phase diagram of water.
- (b) Show that the greatest number of phases that can coexist in equilibrium in a one-component system is three. 3+2
12. (a) What is UCST?
- (b) Calculate the boiling point of water at a place where atmospheric pressure is 0.85 atm .
[Given the normal boiling point of water is 373.15 K and $\Delta_{\text{vap}}H = 40.7 \text{ kJ/mol}$].
- (c) Write the Trouton's rule. 2+2+1
13. (a) State the third law of thermodynamics. Show that the statement is consistent with the statistical definition of entropy.
- (b) Derive the relation connecting the entropy of a system with the partition function. 2+3
14. (a) Show that vibrational levels are equally spaced.
- (b) What is first overtone?



(4)

- (c) The first line in the rotational spectrum of $\text{C}^{12}\text{O}^{16}\text{O}$ molecule is found to be 3.8424 cm^{-1} . Calculate the bond length.
- 2+1+2

Group - C

Answer any *one* question : $10 \times 1 = 10$

15. (a) Two liquids A and B form ideal solutions. At 60°C , the vapour pressure of a solution consisting of 2 mol of A and 3 mol of B is 280 mm of Hg. On addition of further one mole of A to this solution at 60°C , the vapour pressure rises to 300 mm Hg. Calculate the vapour pressure of pure A and pure B at 60°C .

(b) Derive an expression for the dissociation energy of a diatomic molecule.

(c) When can there be boiling point depression?

(d) Assuming the Debye heat capacity equation to be applicable, show that the entropy of a perfect solid

at very low temperature should be equal to $\frac{1}{3}C_P$,

where C_P is the heat capacity at the given temperature.

3+3+2+2

16. (a) Using X-ray of wavelength $\lambda = 1.790 \times 10^{-8} \text{ cm}$, a metal produces a reflection at $2\theta = 47.2^\circ$. If this be first order reflection from the (110) plane of bcc unit cell, what is the edge length of the cube?

(5)

(b) Molal depression of freezing point is the property of solvent and not the solute. — Explain.

(c) Derive Clausius-Clapeyron equation assuming Clapeyron equation.

(d) Show that SF_6 is a spherical top molecule.

3+2+3+2