



B.Sc./6th Sem/CEM/26(NEP)

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, CO<sub>2</sub> and O<sub>2</sub> at 100°C.

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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  $\infty c$ . Calculate the Miller indices of the plane.
7. State and explain Nernst heat theorem.
8. Addition of  $\text{HgI}_2$  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  $0.8560 \text{ g cm}^{-3}$ , 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.

- (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?

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

### Group - C

Answer any *one* question : 10×1=10

15. (a) Two liquids A and B form ideal solutions. At  $60^\circ\text{C}$ , 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  $60^\circ\text{C}$ , the vapour pressure rises to 300 mm Hg. Calculate the vapour pressure of pure A and pure B at  $60^\circ\text{C}$ .
- (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?

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- (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  $\text{SF}_6$  is a spherical top molecule.

3+2+3+2

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