

6/CHE-352 Syllabus-2023

2026

(May-June)

FYUP : 6th Semester Examination

CHEMISTRY

(Physical Chemistry—II)

(CHE-352)

Marks : 75

Time : 3 hours

The figures in the margin indicate full marks for the questions.

1. (a) Define the following : 2+2=4
- (i) Thermodynamic scale of temperature
- (ii) Residual entropy
- (b) For a system of ideal gases, prove the relation $\mu_i = \mu_i^\circ + RT \ln P_i$. 4
- (c) Derive the phase rule from the concept of chemical potential. 5
- (d) State the third law of thermodynamics and explain its application in determining entropy. 2+3=5

(2)

OR

2. (a) What are partial molar quantities? Write the general expression for partial molar quantity of a component i in a mixture. $1\frac{1}{2} + \frac{1}{2} = 2$
- (b) Describe Nernst heat theorem. 2
- (c) Derive the following Maxwell relations starting from related thermodynamic equations : $2\frac{1}{2} + 2\frac{1}{2} = 5$
- (i) $\left[\frac{\partial T}{\partial P} \right]_S = \left[\frac{\partial V}{\partial S} \right]_P$
- (ii) $\left[\frac{\partial S}{\partial V} \right]_T = \left[\frac{\partial P}{\partial T} \right]_V$
- (d) Derive an expression showing the variation of chemical potential with temperature and pressure. $2\frac{1}{2} + 2\frac{1}{2} = 5$
- (e) Derive Gibbs-Duhem equation for a mixture consisting of i number of components. 4
3. (a) What is black-body radiation? Describe the spectral distribution of black-body radiation. $1 + 4 = 5$
- (b) Write down any three postulates of quantum mechanics. 3

(3)

- (c) What is Compton effect? X-rays with wavelength $1 \text{ \AA}$ are scattered from a carbon black. The scattered radiations are viewed at 90° to the incident beam. Calculate—

(i) Compton shift ($\Delta\lambda$);

(ii) wavelength of the scattered X-ray.

[Given : $m_e = 9.1 \times 10^{-31} \text{ kg}$,

$c = 3 \times 10^8 \text{ ms}^{-1}$, $h = 6.626 \times 10^{-34} \text{ Js}$]

$1 + 1\frac{1}{2} + 1\frac{1}{2} = 4$

- (d) Solve the Schrödinger equation for a particle in one-dimensional box of length a and obtain the energy expression. 5

- (e) What do you understand by quantization of energy? What will happen if the walls of a one-dimensional box are removed? $2 + 1 = 3$

OR

4. (a) What is photoelectric effect? Deduce Einstein's photoelectric effect equation. $1 + 3 = 4$

- (b) What do you understand by eigenfunctions and eigenvalues? Write down the eigenvalue equation. $1\frac{1}{2} + 1\frac{1}{2} + 1 = 4$

- (c) Show that if there are two eigenfunctions ψ_m and ψ_n corresponding to different values of m and n , then ψ_m and ψ_n will be orthogonal to each other. 3
- (d) Write notes on the following : $2 \times 2 = 4$
- Zero point energy of a particle in one-dimensional box
 - Heisenberg's uncertainty principle
- (e) Derive Schrödinger wave equation using de-Broglie equation. 5
5. (a) What is an ensemble? Briefly explain the different types of ensembles. $2 + 3 = 5$
- (b) Define molecular partition function. Mention its significance. $2 + 2 = 4$
- (c) Derive the relation between molecular and molar partition function. 3
- (d) Write the expression for the following thermodynamic functions in terms of partition function : $2 \times 4 = 8$
- Enthalpy
 - Entropy
 - Gibbs' free energy
 - Heat capacity (C_V)

OR

6. (a) Define the following : $2 \times 2 = 4$
- Thermodynamic probability
 - Mathematical probability
- (b) Derive the relationship between entropy and thermodynamic probability. 3
- (c) Derive the Boltzmann distribution law assuming each energy level is degenerate. 4
- (d) Prove that molecular partition function (Q) for a system is the product of translational, rotational, vibrational and electronic partition functions. 4
- (e) Calculate the translational partition function of NO molecule at 300 K in a volume of 1000 m^3 , assuming the gas to behave ideally.
- Given : $k = 1.38 \times 10^{-16} \text{ g cm}^2 \text{ s}^{-2}$
 $h = 6.626 \times 10^{-27} \text{ g cm}^2 \text{ s}^{-1}$ 5
7. (a) What do you understand by flux and driving force in an irreversible process? $1 + 1 = 2$
- (b) Derive Onsager reciprocity relation. 5
- (c) Derive Clausius inequality equation. 5
- (d) Write a brief note on electrokinetic phenomena. 5