

2022

CHEMISTRY

M.Sc. Second Semester End Examination - 2022

PAPER - CEM-201

Full Marks : 50

Time : 6 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.
Illustrate the answers wherever necessary.*

1. Answer any four from the following : $2\frac{1}{2} \times 4 = 10$
- (a) Write down the Hamiltonian for H-atom problem in spherical polar form considering the origin being fixed at the nucleus.
 - (b) Normalize the following $\phi(\theta) = e^{-im\theta}$. State the significance of m, symbols have their usual meaning.
 - (c) What is phosphorescence? Explain it with proper diagram.

(Turn Over)

(2)

- (d) Calculate the charge density of ion-atmosphere.
- (e) The value of mean activity co-efficient (γ_{\pm}) of 0.005(M) KCl at 25°C is 0.927. What is the % of error in the value of γ_{\pm} predicted by the Debye-Huckel limiting law.
- (f) Explain Flash photolysis.
- (g) What do you mean by creation and annihilation operator? Explain with example.

2. Answer any four from the following : $5 \times 4 = 20$

- (a) Find out $(x^2)_n$ and $(p_x^2)_n$ for SHO following number operator formalism.
- (b) Derive quantitatively Debye-Huckel limiting law.
- (c) Advantages of thermodynamic formulation over absolute theory of reaction rates.
- (d) State and explain variation principle. You may use diagram if you find it suitable.
- (e) Thickness of ion atmosphere depends on which factors-discuss.

(3)

- (f) Starting from the expression of rotational energy levels of linear molecules deduce the expression for the wave number of Stokes line in Raman spectra.

3. Answer any one from the following : $1 \times 10 = 10$

- (a) (i) What is enzyme activity and how is it different from rate of an enzyme reaction. Michaelis constant (K_m) is the characteristic property of enzyme. – Explain. State its unit.
- (ii) How do you determine the rate constant of a first order reaction in different temperature condition using spectroscopy.
- (iii) For spherical bubble, inside pressure directing outward is greater than outside pressure directing inward–Explain. $4+3+3$
- (b) (i) Find the ground state wave function of a simple Harmonic Oscillator (SHO) following number operator formalism.
- (ii) Draw the vibrations of linear AB_2 molecule. Which of these are Raman active.

(4)

- (iii) Consider the following imaginary orbitals. $P_{1\pm 1} = N \sin^2 \theta e^{\pm i\phi}$
where N is the normalisation constant starting from these orbitals find out the expressions of corresponding real orbitals.

$$3+4+3=10$$