



‘সমানো মন্ত্র: সমিতি: সমানী’

UNIVERSITY OF NORTH BENGAL
B.Sc. Honours 5th Semester Examination, 2023

CC12-CHEMISTRY
PHYSICAL CHEMISTRY

Time Allotted: 2 Hours

Full Marks: 40

The figures in the margin indicate full marks.

1. Answer any **five** questions from the following: 1×5 = 5
- Why $\psi^* \psi$ is used in place of ψ^2 ?
 - What is a photosensitizer?
 - What are selection rules for anharmonic vibrator?
 - N_2 does not show microwave spectra — Explain why.
 - Write down the significance of molar absorption co-efficient.
 - Define gold number.
 - What is a rigid rotator?
2. Answer any **three** questions from the following: 5×3 = 15
- (i) Show that Ae^{-ax} is an eigen function of the operator. What is the eigen value? 2+1
 - (ii) What do you mean by degenerate and non-degenerate eigen functions? 2
 - (b) (i) With the help of Jablonski diagram briefly explain the phenomenon of fluorescence and phosphorescence. 4
 - (ii) What is meant by Quenching of Fluorescence? 1
 - (c) (i) Derive the relation between thermodynamic probability and entropy. 2
 - (ii) Using partition function show that for a monoatomic gas, 3
- $$U = \frac{3}{2} NRT \quad \text{and} \quad p = \frac{NRT}{V}$$
- (d) (i) What do you mean by polarizability of a molecule? Explain Raman effect in terms of polarizability. 1+2
 - (ii) Explain the mechanism of Micelle formation. 2
 - (e) (i) Define Lambert-Beer's Law. If absorbance (A) of a solution is 1 (one) at λ_{\max} then find out the percentage of absorbed photons with wavelength λ_{\max} . 1+2
 - (ii) How can Einstein's Photoelectric equation be verified? 2

3. Answer any *two* questions from the following: 10×2 = 20
- (a) (i) What is Quantum Efficiency? 2
- (ii) Explain why the Quantum Efficiency for the reaction between H₂ and Cl₂ is high but for H₂ and Br₂ is low although both are chain reactions? 4
- (iii) Monochromatic light is passed through a 1 mm path length cell containing 0.005 mole/dm³ solution. The light intensity is reduced to 16% of its value. Calculate the Molar extinction coefficient of the sample. 4
- (b) (i) Explain with diagram the P, Q, R branches of Vibrational-Rotational spectrum for a diatomic molecule. 5
- (ii) What are Hot Bands? 2
- (iii) The equilibrium intermolecular distance of CO is 113.53 pm. Calculate the energy of the molecule for $J = 1$. [Given C = 12, O = 16] 3
- (c) (i) What is Compton Effect? 2
- (ii) Although CO₂ has no permanent dipole moment, yet it shows both Infrared and Raman spectra. — Comment. 3
- (iii) Give three differences between Harmonic and Anharmonic oscillators. 2
- (iv) Write a short note on Franck-Condon principle. 3
- (d) (i) Find the frequency of absorption for the first electronic transition of 1,3 butadiene treating its π electrons on the basis of particle in a box model. The bond length is 154 pm for C – C and 135 pm for C = C. 3
- (ii) Find the degeneracy of the first four energy levels of a particle in a 3D box of dimensions $a = b = 2c$. 4
- (iii) Derive the quantum mechanical operators for the three components of angular momentum. 3

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