

The University of Burdwan  
 B. Sc. (Honours) Sem-VI Examination, 2021  
 Subject: Chemistry  
 Paper: CC-14 (Physical Chemistry-IV)

Full Marks: 40

Attempt any eight questions

Time: 2 hours  
 $8 \times 5 = 40$

1. (i) Write down the basic difference between internal conversion (IC) and intersystem crossing (ISC). (ii) Why is phosphorescence a slower process than fluorescence?
2. (i) Briefly describe the Larmor precession in the context of NMR spectroscopy.  
 (ii) Calculate the frequency of electromagnetic radiation required for transition when a bare proton is placed under an external magnetic field of 1 T.  
 [Given:  $g = 5.585$ ,  $\beta_N = 5.052 \times 10^{-24} \text{ erg} \cdot \text{G}^{-1}$ ]
3. (i) Classify the following molecules into different rotational tops  
 (a)  $\text{CCl}_4$  (b)  $\text{CH}_3\text{Cl}$  (c)  $\text{CH}_2 = \text{CHCl}$  (d)  $\text{HD}$  (e)  $\text{CHCl}_3$  (f)  $\text{CH}_4$   
 (ii) Calculate the population ratio between the 5-th and 6-th rotational energy levels at 300 K.  
 [Given:  $B = 2.22775 \text{ cm}^{-1}$ ]
4. The fundamental and first overtone transitions of  $^{14}\text{N}^{16}\text{O}$  appeared at  $1876.06 \text{ cm}^{-1}$  and  $3724.20 \text{ cm}^{-1}$  respectively. Calculate the equilibrium vibration frequency, the anharmonicity, zero-point energy and the force constant of the molecule.
5. (i) Predict the  $^1\text{H}^1$ -NMR signal pattern for  $\text{CH}_3\text{CHDOH}$  under low and high resolution.  
 (ii) Write the mutual exclusion rule in the context of vibrational spectroscopy.
6. (i) What is quantum yield of fluorescence?  
 (ii) A uranyl-oxalate actinometer is irradiated for 15 minutes with light of wavelength 450 nm and oxalic acid equivalent to 12.0 cc of 0.001 M  $\text{KMnO}_4$  is found to have been decomposed. The quantum efficiency of the actinometer at this wavelength is 0.60. Calculate the average intensity of light used.
7. Show that the initial quantum yield is 2 for photochemical decomposition of HI and the quantum yield decreases from its initial value as the reaction proceeds.
8. (i) Mention with brief reasons, the effect of temperature on CMC.  
 (ii) The adsorption of acetic acid from aqueous solution of charcoal was governed by the relation  

$$\frac{x}{m} = 0.5C^{0.33}$$
 in which  $x/m$  and  $C$  are expressed in g per g and g/litre respectively. Find out the quantity of acetic acid that will be absorbed by a gram of charcoal from a litre of 0.2% (w/v) acetic acid solution.
9. Write a short note on Stern double layer and zeta potential.
10. What is surface excess? Show that the Gibbs adsorption isotherm is analogous to the two-dimensional ideal gas law.