

Chemistry (P.G.)**[CBCS]****M.Sc. Second Semester End Examination-2024****(Regular & Supplementary Paper)****PAPER- CEM-201 [Physical Chemistry]****Full Marks: 40****Time: 02 Hrs***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.***Group-A****1. Answer any four questions.****4×2=8**

- Write down the differences between a classical Harmonic oscillator and quantum Harmonic oscillator.
- What are micelles and reverse micelles? Explain.
- What is radial distribution function? Plot the Radial function, and Radial distribution function, for 2s orbital of hydrogen atom. Given: $R_{2s} = \left(\frac{1}{2a_0}\right)^{3/2} \left(2 - \frac{r}{a_0}\right) e^{-r/2a_0}$
- What is the selection rule of vibrational Raman spectroscopy?
- What are the effects of high electric field and frequency on ion conductance?
- Two enzymes, A and B have turnover number of 200/s and 40000/s. Which one will be considered more efficient and why?

(2)

Group-B**Answer any four questions.****4×8=32**

2. a) Evaluate the expectation value of potential energy of the harmonic oscillator in the ground state. The ground-state normalized wave function for the harmonic oscillation is $\psi_0 =$

$$\left(\frac{\alpha}{\pi}\right)^{1/4} e^{-\alpha x^2/2},$$

$$\text{where } \alpha = \frac{2\mu\pi\nu}{h}$$

- b) Calculate the most probable distance of the electron from the nucleus in the ground state of hydrogen atom. Given $\psi_{1s} =$

$$\frac{1}{\sqrt{\pi}a_0^{3/2}} e^{-r/a_0}$$

- c) Calculate the $\langle 1/r \rangle$ for the H-atom for 1s orbital and calculate the average potential energy of electron for H-atom in 1s orbital from it. Given: $\psi_{1s} = \frac{1}{\sqrt{\pi}a_0^{3/2}} e^{-r/a_0}$ **2+3+3=8**

3. a) What is the essential condition of Raman spectroscopy? State the mutual exclusion principle.

- b) Asymmetric stretching and bending mode of CO₂ is Raman inactive whereas all the vibrational modes of H₂O are Raman active- Explain. **4+4=8**

4. a) What are the effect of temperature on CMC? Discuss.

(3)

- b) Discuss on the classification of surfactants.

- c) For pure rotational Raman spectroscopy of a linear diatomic molecule what will be the energy expressions for Stokes' and anti-Stokes' lines. Show the Raman transition of such molecules indicating the energy separations between the lines.

$$2+2+4=8$$

5. a) Derive Walden's rule.

- b) Larger ions satisfy Walden's rule more accurately than the smaller ions. Explain.

- c) The Debye-Huckel-Onsagar equation is $\lambda_m = \lambda_m^0 - (A + B\lambda_0)\sqrt{c}$. What are the significances of the term A and B? Explain. **3+2+3=8**

6. a) What are the difference between surface tension and interfacial tension?

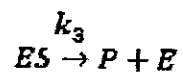
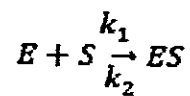
- b) Write the BET isotherm equation and state the significance of the parameters therein. Draw appropriate plots to show different types of BET isotherm for adsorption of a gas on a solid surface.

- c) Verify the validity of Langmuir adsorption isotherm by graphical method. **1+(2+2)+3=8**

7. a) Explain the influence of solvent on reaction rate for a simple ionic reaction using double sphere model.

(4)

b) The following mechanism has been proposed for the enzyme catalysis.



Show that the reaction rate is given by $r = \frac{k_3[E]_0[S]}{k_m + [S]}$; where the

symbols have their usual meanings. Discuss the rate when

$k_m \gg [S]$ and $k_m \ll [S]$.

3+(3+2) = 8