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**

a. Write down the differences between a clissical Harmonic oscillator and quantum Harmonic oscillator.

b. What are micelles and reverse micelles? Explain.

c. What is radial distribution function? Plot the Radial function, and Radial distribution function, for 2s orbital of hydrogen atom. Given: $R_{2s} = \left(\frac{1}{2a_0}\right)^{3/2}\left(2 - \frac{r}{a_0}\right)e^{-r/2a_0}$

d. What is the selection rule of vibrational Raman spectroscopy?

e. What are the effects of high electric field and frequency on ion conductance?

f. Two enzymes, A and B have turnover number of 200/s and 40000/s. Which one will be considered more efficient and why?

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 $\psi_0 = \left(\frac{\alpha}{\pi}\right)^{1/4} e^{-\alpha x^2/2}$,

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

b) Calculate the most probable distance of the electron from the nucleus in the ground state of hydrogen atom. Given $\psi_{1s} = \frac{1}{\sqrt{\pi} a_0^{\frac{3}{2}}} e^{-r/a_0}$

c) Calculate the $\langle 1/r \rangle$ for the H-atom for ls orbital and calculate the average potential energy of electron for H-atom in ls 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 CO_2 is Raman inactive whereas all the vibrational modes of H_2O are Raman active- Explain. 4+4=8

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

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.

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

$$E + S \underset{k_2}{\overset{k_1}{\rightarrow}} ES$$

$$ES \xrightarrow{k_3} P + E$$

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