Total pages: 3

PG (NEW) CBCS
M.Sc. Semester-II Examination, 2019
CHEMISTRY
PAPER: CEM-201
(PHYSICAL CHEMISTRY –II)

Full Marks: 40 **Time: 2 Hours**

Group - A

Answer any four questions of the following: **2×2=4**

1. Calculate the average distance of the electron from the nucleus of H atom in the 2s state.
2. For an enzyme – substrate system obeying the simple Michaelis – Menten mechanism, the rate of product formation when the substrate concentration is very large, has the limiting value of 0.02 mol dm^{-3}. At a substrate concentration of 250 mg dm^{-3}, the rate is half of this value. Calculate k_1/k_{-1} assuming that $k_2 >> k_{-1}$.
3. How can you differentiate fluorescence from Raman signals?
4. How do the intensities of stokes and anti-stokes lines compare with each other in the vibrational Raman spectrum?
5. Comment on the rate of the reaction $S_2O_8^{2-} + 21^{-2} = SO_4^{2-} + I_2$ with the addition of KCI solution.
6. Write down the principle of relaxation method.
7. Calculate the average potential and kinetic energies of a harmonic oscillator in the ground state.
8. Show the different modes of vibrations of an AB_2 type non- linear molecule and assign the modes of vibrations which are IR active and which are Raman active?

(Turn over)

Group - B

Answer any four questions of the following: **4×2=8**

9. How does classical mechanics account for the existence of Raman spectrum?
10. What is radial distribution function? Construct the radial distribution function for 1s orbital of H- atom and hence show that the radial probability density is maximum at $r = a_o$, where a_o is the Bohr radius. Given :

$$\psi_{1s} = \frac{1}{\sqrt{\pi} a_o^3} e^{-r/a_o^3}$$

11. Define the raising and lowering operator in the context of linear SHO. Show that

$$[\hat{a}_-, \hat{a}_+] = 1$$

12. Derive the expression of relaxation time of the kinetic reaction

$$A \underset{K_{-1}}{\overset{k_1}{\rightleftharpoons}} B + C$$

(Where k_1 and k_{-1} are the forward and backward rate constants)

13. The solution to the poisson's equation give an expression for the electrical potential,

$$\psi_j(r) = \frac{A_1}{r} e^{kr} + \frac{A_2}{r} e^{-kr}$$

Using suitable boundary conditions, evaluate A_1 and A_2.

14. Describe in brief the different processes involved in the dissipation of energy from the excited electronic state.
15. State the rule of mutual exclusion principle in vibrational spectroscopy with a suitable example.
16. Show that the ion atmosphere has a charge equal to but opposite in sign as that of central ion.

(Turn over)

Group - C

Answer any two question of the following: 8×1=8

17. Use operator technique to obtain zero point energy and corresponding wave function of a simple harmonic oscillator.

18. a) Describe in detail the double sphere activated complex model for studying the influence of solvent dielectric constant on the rate of reactions between ions.

    b) Give an interpretation of entropy of active action in terms of the electro- striction of solvent molecules.

19. a) Use a trial function, $q= Nre^{-\alpha r}$ to calculate the ground state energy of the H- atom compare the result with the true value.

    b) If $|n>$ is the eigen function of Hamiltonian operator H of a simple harmonic oscillator with eigen value E_n then show that $a|n>$ is an eigen function of H^ with eigen value $(E_n - h\upsilon)$.

20. What is projection operator (^Pij)? What are the possible Eigen rules of projection operator? Show that for a system of quantum identical particles. Which are indistinguishable the wave functions must be either symmetric or antisymmetric with respect to the interchange of any two particles.

****