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Reg. No. : .....

Name : .....

Second Semester M.Sc. Degree Examination, November 2021

Chemistry/Polymer Chemistry/Analytical Chemistry

CH/CL/PC 223 – PHYSICAL CHEMISTRY – II

(2020 Admission)

Time : 3 Hours Max. Marks : 75

SECTION – A

Answer **two** among (a), (b) and (c) from each. Each sub question carries **2** marks.

1. (a) What is the importance of radial distribution function?

   (b) What are spherical harmonics?

   (c) Mention Pauli's antisymmetry principle.

2. (a) HCl has a rotational constant, B value of 10.59 cm^{-1} and a centrifugal distortion constant, D of 5.3×10^{-4} cm^{-1}. Estimate the vibrational frequency and force constant of the molecule.

   (b) Give the origin of P, Q, R branches in the rotational fine structure of a molecule. Draw a typical spectrum of vibrating diatomic rotator.

   (c) Mention the complementarity of IR and Raman spectra.

3. (a) Derive the relation between partition function and entropy.

   (b) Calculate the rotational partition function of HCl at 25°C, if its rotational constant is 10.59 cm^{-1}.

   (c) Prove that the total partition function is the product of individual partition functions.

P.T.O.

4. (a) Give the assumptions involved in Einstein's theory of heat capacity of solids.

(b) What is Fermi energy? Give an expression. Calculate its value for metallic silver in joules at 0K if the number of free electrons per volume is 5.9×10^{28} per cm^{-3} and mass of one electron is 9.1×10^{-31} kg.

(c) State the law of equipartition of energies in gas molecules. Apply equipartition principle to find the heat capacity of methane in terms of universal gas constant.

5. (a) Calculate the mean activity coefficient of 0.02 M $BaCl_2$ in water at 25°C.

(b) Draw the graph and explain the theory of conductometric titration of a mixture of strong and weak acids against a strong base.

(c) Explain the significance of Butler - Volmer equation.

(10 × 2 = 20 Marks)

SECTION – B

Answer either (a) or (b) from each question. Each sub question carries **5** marks.

6. (a) Write the Schrodinger equation for hydrogen atom in polar coordinates and separate the variables.

(b) Show that any two associated Legendre functions satisfy orthogonality condition.

7. (a) The fundamental and first overtone transitions of $^{14}N^{16}O$ are centred at 1876 cm^{-1} and 3724cm^{-1}. Evaluate the equilibrium vibration frequency, the anharmonicity, the exact zero point energy and the force constant.

(b) Explain the origin of rotational and vibrational Raman spectra.

8. (a) Prove that $\beta = \frac{1}{kt}$

(b) Derive and explain the importance of Sackur - Tetrode equation.

9. (a) Derive Bose - Einstein law.

(b) Give the use of FD statistics in explaining the phenomena, thermionic emission.

10. (a) What are the advantages and limitations of Debye Huckel Onsagar equation?

(b) Describe a method to determine the liquid junction potential.

(5 × 5 = 25 Marks)

SECTION – C

Answer any **three** questions. Each question carries **10** marks.

11. Set up Schrodinger equation for a non-planar rigid rotor in spherical polar coordinate. Separate the variable and solve it. Interpret the solutions.

12. Explain the theory of electronic spectra of molecules by describing on vibrational coarse and rotational fine structures, Fortrat parabloae and predissociation.

13. Derive and discuss on Maxwell - Boltzmann distribution law. What are the characteristics of partition function?

14. What are the limitations of Einsteins theory of heat capacity? Derive and discuss Debye theory of specific heat capacity of solids.

15. (a) Describe the theory and application of cyclic voltametry.

(b) Describe the working of any two fuel cells.

(3 × 10 = 30 Marks)