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LB—156—2023

FACULTY OF SCIENCE

M.Sc. (First Year) (First Semester) EXAMINATION

APRIL/MAY, 2023

(CBCS/New Pattern)

CHEMISTRY

Paper III (CH-413)

(Physical Chemistry–I)

(Tuesday, 9-5-2023) **Time : 10.00 a.m. to 1.00 p.m.**

Time—Three Hours *Maximum Marks*—75

N.B. :— (*i*) Attempt *all* questions.

(*ii*) Use of calculator and log table is allowed.

Given :

(*i*) Symmetry number HCl = 1

(*ii*) $h = 6.626 \times 10^{-34}$ Js

(*iii*) $m_e = 9.109 \times 10^{-31}$ kg

(*iv*) $c = 3 \times 10^{8}$ m/s

(*v*) R = 8.314 J/K/mole

(*vi*) N = 6.022×10^{23} molecules

(*vii*) Boltzmann constant, K = 1.38×10^{-29} J/K

1. Solve any *three* : 15

(*a*) Describe any *four* postulates of quantum mechanics.

P.T.O.

(*b*) What are line, edge and screw dislocations ?

(*c*) Explain a three component system involving two pairs of partially miscible liquids with a suitable phase diagram.

(*d*) Prove that :

(*i*) $[L_+, L\_] = 2\hbar L_Z$

(*ii*) Operator $\hat{S}_x$ commutes with $\hat{S}^2$.

(*e*) Explain Eutectic systems containing two solid and a liquid components.

(*f*) Explain Spin-Orbit coupling with reference to multiplet structure of sodium-D-line.

2. Attempt any *three* : 15

(*a*) What is meant by an activity coefficient of an electrolytc ? Distinguish between mean molar activity coefficient, X± and mean molar activity coefficient Y±.

(*b*) What is meant by packing of uniform spheres ? Explain it with reference to simple cubic lattice unit cells.

(*c*) How Debye-Huckel theory is extended by Onsager ? Explain the verification of Onsager's equation with its limitations.

(*d*) Derive :

$$Q_t = \frac{(2\pi mkT)^{3/2}}{h}.V$$

where $V = L_x + L_y + L_z$, volume of a molecule in three directions.

(*e*) Draw a phase diagram for the Eutectic systems containing three components. Explain it.

(*f*) Explain orthogonality and Normalisation of wave functions with examples.

3. Attempt the following :

(*a*) Differentiate between f & v. Calculate the activity coefficient and Cu^{+2} and PO_4^{3-} ions as well as V± of 0.02 m solution of $Cu_3(PO_4)_2$. 8

Or

What are extensive properties ? Explain chemical potential and partial molar heat content with their significance.

(*b*) The rotational partition constant B of CHl(g) detesmined by microwave spectsoscopy is 10.59 cm^{-1}. Calculate rotational partition function of HCl at 100 K temperature. 7

Or

For the sound state of 1-D harmonic oscillator, show that the average value of its kinetic and potential energies are equal. Draw a rough sketches of Ψ and Ψ^2 when v = 0, 1, 2 and 3.

4. Attempt the following :

(*a*) State the Schrodinger wave equation in spherical co-ordinate system and use it to obtain phi-equation, theta-equation and radial equation for hydrogen and hydrogen-like systems. 8

Or

(*i*) Explain a system, an assembly and the ensembles in detail.

(*ii*) Describe applications of partition functions.

P.T.O.

(*b*) When an electron in a certain excited energy level in 1-D box of length 2.00 Å and makes a transition to a ground state, a photon of wavelength 8.79×10^{-9} m is emitted. Find the quantum number in the initial state. 7

Or

Write an account on first order and non-degenerate perturbation theory for a system of H-atom.

5. Write short notes on any *three* of the following : 15

(*i*) Gouy-Chapman theory of electrical double layer.

(*ii*) Octahedral and tetrahedral voids in closed packed structure of solids.

(*iii*) Lippmann equation for surface excess phenomenon

(*iv*) Thermodynamic probability

(*v*) Isomorphism in crystallography.