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AI—188—2017

FACULTY OF SCIENCE

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

MARCH/APRIL, 2017

(CBCS PATTERN)

CHEMISTRY

Paper-III, CH-413

(Physical Chemistry-I)

(Tuesday, 25-4-2017) **Time : 10.00 a.m. to 1.00 p.m.**

Time— Three Hours *Maximum Marks*—75

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

(*ii*) *All* questions carry equal marks.

(*iii*) Solve Q. No. 5 (A) MCQ in one attempt only.

Given : (1) $h = 6.626\times10^{-34}$ Js.

(2) Mass of electron, $M_e = 9.1091\times10^{-31}$kg.

(3) Velocity of light, $c = 3\times10^{8}$ ms^{-1}

(4) Gas constant, R = 8.314 JK^{-1} mole^{-1}

(5) Boltzmann constant, $k = 1.38\times10^{-23}$J/K.

(6) Avogadro's number, N = 6.022×10^{23} moles.

1. Solve any *three* (out of five) : 15

(*a*) Explain Orthogonality and normalisation of wave functions.

(*b*) State the Gibb's phase rule equation, reduce it for three component systems and explain the terms involved in it with examples.

(*c*) Calculate the ionic strength of a solution prepared by mixing 50 ml of 0.2M KNO_3, 20 ml 0.15M K_2SO_4 and 30 ml of 0.05M $Cu(NO_3)_2$.

P.T.O.

(*d*) Write an account on :

(*i*) Schottky defect

(*ii*) Frenkel defect.

(*e*) Define Zeta-Potential and explain Gouy-Chapman theory of electrical double layer.

2. Attempt any *three* (out of five) : 15

(*a*) Define Lader operators and prove that :

$$[L_+ \; L_- \;] = 2\hbar L_z .$$

(*b*) Explain three component system involving two pairs of partially miscible liquids using phase diagram.

(*c*) What are partition function ? Derive an expression for electronic partition function.

(*d*) Define (*i*) Electron affinity and (*ii*) Latice energy and explain Lattice energy using Born-Haber cycle for the formation of ionic solid, MX.

(*e*) Derive the Lipmann equation of surface excess phenomenon.

3. Solve the following :

(*a*) State the Schrodinger's wave equation in Hamiltonian form and solve it for a linear harmonic oscillator. Show that zero-point energy for linear harmonic oscillator is, $E_0 = \frac{1}{2}hv$.

Or

Write an account on first order and non-degenerate perturbation theory. 8

(*b*) For particle in one-dimensional box problem, show that :

$$\Psi n = A\sin\left(\frac{n_x \pi x}{l}\right)_{n_x = 1, 2, 3, 4.....}$$

An electron is confined in a one-dimensional box as length 1Å. Calculate its ground state energy in eV. is quantisation of energy levels observables.

Or

What is degeneracy of energy states ? Calculate degeneracies of a particle of mass '*m*' in three-dimensional cubical box of width '*a*' having the energies : 7

(*i*) 6

(*ii*) 9

(*iii*) 11

(*iv*) 14

in units of $\frac{h^2}{8ma^2}$

Explain zero-point energy for that particle.

4. Solve the following :

(*a*) What is fugacity ? Explain the graphical method of its determination.

Or

Explain Debye-Hückel limiting law.

Calculate the activity coefficients of sodium and sulphate ions and the mean activity coefficient of 0.01 molal solution of sodium sulphate in water at room temperature. 8

(*b*) Define (*i*) Activity and (*ii*) Activity coefficient.

Describe solubility method for determination of activity coefficients of electrolytic solutions.

Or

The rotational partition constant B of HCl (*g*) determined by microwave spactroscopy is 10.6 cm^{-1}. Calculate rotational partition function of HCl at (*i*) 1000K & (*ii*) 2273K. (Symmetry number of HCl = 1.) 7

P.T.O.

5. (*a*) Select the *correct* alternatives. 5

(*i*) For spin-angular momentum, which of the following commutation is wrong ?

(*a*) $[\hat{S}_x, \hat{S}_y] = i\hbar\hat{S}_z$ (*b*) $[\hat{S}^2, \hat{S}_x] = 0$

(*c*) $[\hat{S}_z, \hat{S}_x] = -i\hbar\hat{S}_y$ (*d*) $[\hat{S}_y, \hat{S}_z] = -i\hbar\hat{S}_x$.

(*ii*) In three component systems, Tie-lines are not used in the region of.....

(*a*) One phase (*b*) Two phases

(*c*) Three phases (*d*) Both (*a*) & (*c*).

(*iii*) In micro-canonical ensemble, the constants are.....

(*a*) E, V, N (*b*) T, V, N

(*c*) T, V, u (*d*) None of the above (*a*), (*b*) & (*c*).

(*iv*) Generally, Transition metal compounds exhibit.....

(*a*) Metal excess defects (*b*) Metal defficiency defects

(*c*) Stoichiometric defects (*d*) Both (*a*) and (*b*).

(*v*) According to Debye-Hückel theory, which of the following relation is *true* ?

(*a*) $\Lambda_v > \Lambda_\infty$ (*b*) $\Lambda_v < \Lambda_\infty$

(*c*) $\Lambda_v = \Lambda_\infty$ (*d*) Λ_v is never equal to Λ_∞

where, Λ_v & Λ_∞ are equivalent conductances at dilution V and at infinite dilution for strong electrolytes.

(B) Write short notes on any *two* : 10

(*a*) Ternary systems containg two solid and one liquid components.

(*b*) Wien effect

(*c*) Spin-orbit coupling.