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AI—150—2017

FACULTY OF SCIENCE

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

NOVEMBER/DECEMBER, 2017

(CBCS Pattern)

CHEMISTRY

Paper III (CH-413)

(Physical Chemistry—I)

(Wednesday, 15-11-2017) **Time : 10.00 a.m. to 1.00 p.m.**

Time—3 *Hours* *Maximum Marks*—75

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

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

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

Given :

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

(2) Mass of electron, $M_e = 9.109 \times 10^{-31}$ kg

(3) $c = 3 \times 10^8$ m/s

(4) R = 8.314 J/K/mole.

1. Solve any *three* : 15

(*a*) Explain the transformation of Schrödinger's wave equation from cartesian to polar co-ordinate system for motion of electron in hydrogen atom.

(*b*) What is tie line ? Explain its significance with an example.

(*c*) Calculate the ionic strength of :

(*i*) 0.15 m aluminium sulphate

(*ii*) a solution of 0.1 m KCl + 0.2 m K_2SO_4.

(*d*) State and explain Mitscherlich's law of isomorphism.

(*e*) State Onsager equation and explain how can this equation be revised for strong electrolytes ?

P.T.O.

2. Attempt any *three* of the following : 15

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

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

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

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

(*d*) Write an account of 'solid state defects'.

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

3. Solve the following :

(*a*) Set up and solve the Schrödinger's wave equation for H, He^{+1}, Li^{+2}, Be^{+3} systems and obtain *r*-equation, θ-equation and ϕ-equations. 7

Or

Write in detail on the variation method for approximate determination of ground state energy of the system of Hydrogen.

(*b*) What is normalisation of wave functions ? Show that the 1*s* wave function of H-atom given by :

$$\psi_{1s}, \psi_{100} = \frac{1}{\sqrt{\pi} a_0^{3/2}} (\exp)^{-r/a_0},$$

where a_0 is Bohr's radius is normalised.

[Given : $d\tau = r^2 dr \sin\theta \, d\theta d\phi$] 8

Or

Compare the normalised wave function for a particle in three-dimensional box with one-dimensional box and calculate degeneracies of a particle of mass '*m*' in 3D-box of width '*a*' having the energies :

(*i*) 3

(*ii*) 9

(*iii*) 12

(*iv*) 14 and

(*v*) 27; in units of $\frac{h^2}{8ma^2}$.

4. Solve the following :

(*a*) What is fugacity ? Explain clearly that the fugacity of a gas can be less or more than the pressure P. 8

Or

How Debye-Huckel limiting law is experimentally varified ? Calculate the mean activity coefficients, $\nu_{\pm}$ for :

(*i*) 0.01 molality solution of NaCl and

(*ii*) 0.001 molality solution of sodium sulphate at room temperature, 25°C in aqueous solution.

(*b*) Explain :

$$\lim_{P \to 0} \text{Real gas} \rightarrow \text{Ideal gas};$$

and how it is applied to solutions. Explain the e.m.f. method for determination of activity coefficients of electrolytic solutions. 7

Or

What is symmetry number, σ ? Calculate the rotational partition function of H_2 at 0°C and 27°C.

Given that :

$K = 1.38 \times 10^{-16}$ erg/deg/mole

$I = 0.459 \times 10^{-40}$ gm.cm^{-2}

and $\sigma = 2$.

5. (A) Select the *correct* alternatives : 5

(*i*) The zero-point energy of linear harmonic oscillator is :

(*a*) $E_0 = \frac{1}{2}h\nu$

(*b*) $E_0 = \frac{1}{4}h\nu$

(*c*) $E_0 = \frac{3}{2}h\nu$

(*d*) $E_0 = \frac{3}{4}h\nu$

where ν is frequency of vibrations.

P.T.O.

(*ii*) In a ternary system containing one-pair of partially miscible liquids, the systen along the binodal curve has degree of freedom, F = ...

(*a*) 0

(*b*) 1

(*c*) 2

(*d*) None of the above

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

(*a*) E, V, N

(*b*) T, V, N

(*c*) T, V, μ

(*d*) None of the above

(*iv*) With rise in temperature, conductance due to *n*- and *p*-type semiconductors ..... .

(*a*) increases

(*b*) decreases

(*c*) does not change

(*d*) both (*a*) and (*b*)

(*v*) The higher the frequency (A.C.), higher is the conductance is due to ..... .

(*a*) Debye-Huckel theory

(*b*) Debye-Folkenhagen effect

(*c*) Wien effect

(*d*) None of the above

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

(*i*) Ternary system containing three partially miscible pairs

(*ii*) Gouy-Chapman theory

(*iii*) Zeeman effect.