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L—150—2019

FACULTY OF SCIENCE

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

MARCH/APRIL, 2019

(CBCS Pattern)

CHEMISTRY

Paper III, CH-413

(Physical Chemistry—I)

(Friday, 26-4-2019) **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), MCQ in one-attempt only.

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

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

(3) $c = 3 \times 10^8$ ms^{-1}.

(4) R = 8.314 JK^{-1} mole^{-1}.

(5) N = 6.022×10^{23} molecules.

(6) Boltzmann constant, $k = 1.38 \times 10^{-23}$ J/K.

(7) σ for H_2 gas = 2.

1. Solve any *three* : 15

(*a*) (*i*) Describe any *three* postulates of quantum mechanics.

(*ii*) Explain why $\psi^2 = \psi.\psi^*$; why not $\psi.\psi$?

(*b*) Write an account of Zeeman splitting and desire the expression of wave equation for Hydrogen atom.

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

(*d*) Calculate the ionic strength of :

(*i*) 0.01 m aluminium chloride

(*ii*) A solution of 0.01 m HCl + 0.02 m $CaCl_2$.

(*e*) Explain the concept of Lattice energy with reference to the formation of sodium chloride cyrstal.

2. Solve any *three* : 15

(*a*) Evaluate the commutators :

(*i*) $[L_z, L_\pm] = \pm\hbar L_\pm$

(*ii*) $[\hat{S}^z, S_{\hat{x}}] = 0$.

(*b*) Write a note on 'Recapitulation of phase rule and terms involved in it'.

(*c*) Derive : $Q_t = \frac{(2\pi_{mk}T)^{3/2}}{h} \cdot V$.

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

(*d*) Explain :

(*i*) N and P type semiconductors and

(*ii*) Effect of temperature on N and P-type semiconductor.

(*e*) Describe Stern's theory of Electrical double layers.

3. Solve the following :

(*a*) State the Schrödinger's wave equation in polar co-ordinate system and use it to obtain phi-equation, theta equation and radial equation for hydrogen and hydrogen like systems.

Or

Describe a First-order and non-degenerate perturbation theory for the system of H-atom. 8

(*b*) When a particle of mass 9.1×10^{-18} gm in a certain one-dimensional box goes from $n = 5$ level to $n = 2$ level, it emits a photon for frequency 6.0×10^{14} s^{-1}. Find the length of the box.

Or

Show that 1s-wave function of H-atom given by $\psi_{1s} = \psi_{1,0,0} = 1/\sqrt{\pi}\, a_0^{3/2}.e^{(-r/a_0)}$.

where a_0 is te Bohr's radius, is normalised. 7

4. Solve the following :

(*a*) Describe Debye-Hückel theory for activity coefficient of electrolytic solutions.

Calculate the mean ionic coefficient, $\sqrt{\pm}$ of (*i*) 0.001 M NaCl and (*ii*) 0.01 M $BaCl_2$; in aqueous solutions at 25°C.

Or

Why $\lim\limits_{p \to 0} \frac{F}{P} = 1$?

Explain the graphical method for determination of fugacity of real gases. 7

(*b*) Calculate the characteristic rotational temperature and rotational partition function for H_2 gas at 2727°C given that the moment of inertia of hydrogen gas molecule at this temperature is 4.6033×10^{-48} kgm^2.

Or

Explain chemical potential, partial molar volume and partial molar heat content with their significances. 8

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

(*i*) K.E. of a particle in terms of angular momentum and moment of inertia is ....

(*a*) K.E. = $\frac{I^2}{2L}$

(*b*) $\frac{L^2}{2I}$

(*c*) L^2I

(*d*) $2L^2I$

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

(*a*) 3-phase

(*b*) 2-phase

(*c*) 1-phase

(*d*) Both (*a*) and (*c*)

(*iv*) At low temperature which of the following expression is correct ?

(*a*) $q_{\text{vib.}} = \frac{T}{Q_{vib}} e^{-Q_{\text{vib}}/2T}$

(*b*) $q_{\text{vib.}} = e^{-Q_{\text{vib.}}/2T}$

(*c*) $q_{\text{vib.}} = e^{-Q_{\text{vib.}}/T}$

(*d*) None of the above

(*iv*) Transition metal compounds generally exhibit ....

(*a*) Metal excess defects

(*b*) Metal deficiency defects

(*c*) Stoichiometric defects

(*d*) Both (*a*) and (*b*)

(*v*) Intercept of the plot between $\wedge_C$ and $\sqrt{C}$ extrapolated to zero concentration is :

(*a*) $\wedge_v$

(*b*) $\wedge_0$

(*c*) $\wedge_\infty$

(*d*) Both (*b*) and (*c*)

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

(*i*) Lippmann equations

(*ii*) Wine effect

(*iii*) Two-solid and one-liquid component Eutectic systems

(*iv*) Spin-orbit coupling