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NY—164—2023

FACULTY OF SCIENCE

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

NOVEMBER/DECEMBER, 2023

(CBCS/New Pattern)

CHEMISTRY

(CH-413)

(Physical Chemistry-I)

(Saturday, 09-12-2023)

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 calculator and logarithmic table is allowed.

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

(ii) Boltzmann Constant, $k = 1.38 \times 10^{-23}$ J/K

(iii) σ for H_2 gas = 2

(iv) Velocity of light, $c = 3 \times 10^8$ ms⁻¹.

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

(vi) Avogadro's number, $N = 6.02 \times 10^{23}$ molecules.

(vii) $R = 8.314$ J/K/Mole.

1. Solve any *three* :

15

(a) Describe 'Zeeman splitting by quantum mechanical approach.

(b) What are (i) metal excess and (ii) metal deficiency defects ? Explain their consequences.

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- (c) Explain three component systems involving one-pair of partially miscible liquids with a suitable phase diagram.
- (d) Evaluate the commutators :

$$(i) \left[\hat{L}_z, \hat{L}_z \right] = \pm \hbar L \pm$$

$$(ii) \left[\hat{S}^2, \hat{S}_x \right] = 0.$$

- (e) Draw a phase diagram of a system, water-acetone-chloroform and explain the significance of Tie-line.
- (f) Explain 3-D box problem with degeneracy of energy states.

2. Attempt any *three* :

15

- (a) Why $\lim_{P \rightarrow 0} \frac{F}{P} = 1$? Explain the graphical method for determination of fugacity of real gases.
- (b) State and explain Mitscherlich's law of Isomorphism.
- (c) What are (i) Debye-Falken-Hagen and (ii) Wein effect ? Explain.
- (d) Explain the term 'partition function and derive the expression for vibrational partition function at low and high temperatures.
- (e) Write an account on two-solid and one-liquid Eutectic systems.
- (f) What is rigid rotator ? Solve the Schrodinger wave equation in polar co-ordinate system to explain it.

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3. Attempt the following :

15

- (a) Using Debye-Huckel limiting law calculate the activity coefficient of Na^+ and SO_4^{2-} ions and the mean-ionic activity coefficients of a 0.01 molal solution of Na_2SO_4 in water at 27°C ?

8

Or

What is activity and activity coefficient ? Explain how E.M.F. method is used to calculate them ?

- (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 $4.6033 \times 10^{-48} \text{ kgm}^2$.

Or

- (i) Explain the concept of thermodynamic probability. How is it related to entropy ?
- (ii) Write an essay on 'Thermodynamic properties and partition functions.'

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4. Answer the following :

15

- (a) (i) Explain Pauli's exclusion principle using quantum mechanical approach.
- (ii) Explain Spin-orbit coupling and R-S coupling in detail.

8

Or

What is meant by normalised and un-normalised wave functions ? Explain with reference to 1S-wave function of hydrogen atom.

- (b) What is the wavelength of light absorbed when an electron in a linear molecule 10Å long make a transition from ground to first excited state ?

Or

What are approximate methods ? Explain variation theorem, linear variation principle in case of a system of hydrogen. 7

5. Write short notes on any *three* : 15

- (i) Zeta-potential and Helmholtz-Perrin theory of electrical double layer.
- (ii) Packing of uniform spheres, face-centered cubic lattice.
- (iii) Lippmann equation
- (iv) A system, assembly and ensemble
- (v) Edge dislocation and screw dislocations