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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.

P.T.O.

(*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 $\lim\limits_{P \to 0} \dfrac{F}{P} = 1$? 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.

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 27ºC ? 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 2727ºC, given that the moment of inertia of hydrogen gas molecule at this temperature is 4.6033×10^{-48} 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. 7

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 10Aº long make a transition from ground to first excited state ?

3

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 Helmoholtz-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