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NEPRT—42—2024

FACULTY OF SCIENCE

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

APRIL/MAY, 2024

CHEMISTRY

SCHEC-403

(Physical Chemistry)

(Wednesday, 24-04-2024) **Time : 10.00 a.m. to 1.00 p.m.**

Time—Three Hours *Maximum Marks*—80

N.B. :— (*i*) Question No. **1** is compulsory.

(*ii*) Solve any *three* questions from Q. Nos. **2** to **6**.

(*iii*) Use of log table and simple calculator is allowed.

Given :

(1) $h = 6.62 \times 10^{-34}$ Js

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

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

(4) Gas constant, $R = 8.314$ JK^{-1} mol^{-1}.

1. Solve the following : 20

(1) Explain the concept of orthogonality and normalization of wave functions with reference to 1s wave function of Hydrogen atom.

(2) Calculate the ionic strength of :

(*a*) 0.01 M sulphuric acid.

(*b*) A solution of 0.01 m HCl + 0.05 m $BaCl_2$.

P.T.O.

(3) Explain Wien effect in case of strong electrolytes.

(4) Describe in detail non-stiochiometric defects in solids.

2. Solve the following : 20

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

(*i*) 6

(*ii*) 9

(*iii*) 12

(*iv*) 14 in units of $(h^2/8\ ma^2)$.

(*b*) Derive Lippmann equation for surface excess phenomenon.

3. Attempt the following : 20

(*a*) What is activity and activity coefficient ? An aqueous solution at 25°C is 0.005 molal in NaCl and 0.008 molal in K_2SO_4. Calculate the activities of Na^+ and $SO_4^{\Theta\Theta}$ ions.

(*b*) What is tie-line ? Explain a three component system involving three pairs of partially miscible liquids with suitable phase diagram.

4. Answer the following : 20

(*a*) Evaluate the commutators :

(*i*) $[\hat{L}_2, \hat{L}_x] = 0$

(*ii*) $[\hat{L}_x, \hat{L}_y] = i\hbar\hat{L}_z$.

(*b*) What is fugacity ? Explain graphical method for its determination.

5. Solve the following : 20

(*a*) (*i*) What is electrical double layer ? Explain Stern's theory of electrical double layer in detail.

(*ii*) State phase rule and explain the terms involved in it.

(*b*) Explain representation of three component system in phase rule. Describe acetone-chloroform-water system with suitable phase diagram.

6. Write short notes on the following : 20

(*i*) Pauli's exclusion principle in quantum mechanical approach.

(*ii*) Ensemble and its types.

(*iii*) Onsager equation and its verification.

(*iv*) Born-Haber cycle for stability of ionic compounds.