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AG—150—2018

FACULTY OF SCIENCE

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

NOVEMBER/DECEMBER, 2018

(CBCS Pattern)

CHEMISTRY

Paper III (CH-413)

(Physical Chemistry—I)

(Friday, 30-11-2018)   **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 e^- = M_e = 9.109×10^{-31} kg

                 (3) $C = 3 \times 10^{10}$ cm/s

                 (4) $N = 6.023 \times 10^{23}$ molecules

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

                 (6) $R = 82.06$ c.c. atm./deg./mole.

1.   Solve any *three* :   15

   (a)   What are operators in quantum mechanics ? State Laplacian and Hamiltonian operators in one-dimensional and three-dimensional problems.

   (b)   Explain tricomponent system, water-acetone-chloroform.

                                                       P.T.O.

(c) Calculate the ionic strength of a solution prepared by mixing :

(i) 0.1 M KNO_3, 0.2 M K_2SO_4 and 0.05 M $Cu(NO_3)_2$ and

(ii) 0.01 M NaCl and 0.001 M Na_2SO_4.

(d) Explain N&P-type semiconductors. What is the effect of temperature on them ?

(e) What is Zeta-potential ? Explain Helmholtz-Perrin theory of electrical double layer.

2. Solve any *three* (out of five) : 15

(a) Prove that : $\left[\hat{L}^2, L_{\hat{y}}\right] = 0$.

(b) Describe the Eutectic systems containing two solid and a liquid components with phase diagram.

(c) Define partition function and derive an expression for rotational partition function.

(d) Write a short note on Isomorphism in crystals.

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

3. Solve the following :

(a) Explain : 8

(i) Spin-orbit coupling

(ii) Zeeman effect.

Or

Write an account on perturbation theory, first order and non-degenerate.

(b) What is normalisation of wave functions ? Show that 1s-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, $d\tau = r^2 dr \sin\theta \, d\theta \, d\phi$) 7

Or

Explain in case of H-atom, the radius of maximum probability to locate e^- is 0.529 Å. What is the wavelength of light absorbed when an e^- in a linear molecule 10 Å long make a transition from ground to first excited state.

4.   Solve the following :

(*a*)   Explain clearly the term fugacity. How is it determined for Real gases ?   7

Or

Explain Debye-Hückel limiting law. An aqueous solution at 25°C is 0.005 m in NaCl and 0.008 m in K_2SO_4. Calculate the activities of Na^+ and SO_4^{--}-ions.

(*b*)   What are activity and activity coefficient ? Describe a solubility method for determination of activity coefficients of electrolytic solutions.   8

Or

Calculate the translational partition function for one mole of nitrogen at 2 atmospheres and 27°C, assuming the gas behaves ideal.

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

(*a*)   The phi-equation for hydrogen and hydrogen like systems is :

(*i*) $\dfrac{\partial^2 \phi}{d\phi^2} + m^2 \phi = 0$

(*ii*) $\dfrac{\partial^2 \phi}{d\phi^2} - m^2 \phi = 0$

(*iii*) $\psi = R \, \Theta \, \phi$

(*iv*)   Both (*i*) and (*ii*)

P.T.O.

(*b*) In a ternary system containing one-pair of partially miscible liquids, the system along the binodal curve is :

(*i*) Invariant

(*ii*) Monovariant

(*iii*) Bivariant

(*iv*) None of the above

(*c*) In canonical ensemble, the constants are :

(*i*) E, V, N

(*ii*) T, V, N

(*iii*) T, V, μ

(*iv*) None of the above

(*d*) In Cubical Close Packing (CCP), the structure has .... fold axis of symmetry which is passing through diagonals of the cube :

(*i*) 6

(*ii*) 2

(*iii*) 3

(*iv*) Both 6 and 3

(*e*) According to Debye-Hückel theory of strong electrolytes :

(*i*) $\wedge_V > \wedge_\infty$

(*ii*) $\wedge_V < \wedge_\infty$

(*iii*) $\wedge_V = \wedge_\infty$

(*iv*) $\wedge_V \neq \wedge_\infty$

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

(*a*) Ternary systems with three partially miscible pairs

(*b*) Wien effect

(*c*) Degeneracy of energy states.