

B.Sc. 3rd Semester (Honours) Examination, 2021-2022

CHEMISTRY

Course ID: 31411

Course Code: SHCHE/301/C-5

Course Title: Physical Chemistry-II

Time: 1 Hour 15 Minutes

Full Marks: 25

Figures in the right hand side margin indicate marks.

Candidates are required to give their answers in their own words as far as practicable.

1. Answer *any five* of the following questions: 1×5 = 5
- a) Why does the variation of viscosity coefficient of a liquid with temperature follow a different trend from that of gas?
 - b) What is the unit of equivalent conductance?
 - c) Why is chemical equilibrium called a dynamic equilibrium?
 - d) Under what condition the K_p and K_c values of a chemical reaction occurring in gaseous phases be equal?
 - e) Write the expression of chemical potential of the i -th component in a mixture of non-ideal gases.
 - f) Are the functions $\psi = \sin^{-1} x$ ($-1, +1$) and $\psi = e^{i\theta}$ ($0, 2\pi$) acceptable?
 - g) Mention the experiments which demonstrate the particle and wave nature of electromagnetic radiation.
 - h) Explain how momentum uncertainty increases when we try to decrease the position uncertainty in microscope.
2. Answer *any two* of the following questions: 5×2 = 10
- a) i) Write down the Poiseuille's expression for determination of the coefficient of viscosity of a liquid. Mention the important assumption in obtaining the formula?
ii) Discuss the variation of equivalent and specific conductance on dilution.
- (1+1)+3 = 5

b) i) "If the standard free energy change of a reaction is zero, the reaction is thermodynamically impossible." - State whether the statement is true or false. Justify.

ii) The equilibrium constant K_p for the reaction $\text{H}_2(\text{g}) + \text{S}(\text{s}) \rightleftharpoons \text{H}_2\text{S}(\text{g})$ is 20.2 at 945°C and 9.21 at 1065°C . Calculate ΔH^0 assuming it to be temperature independent. 2+3 = 5

c) i) Find the entropy of mixing at 300 K and 1 atm when 10 moles of Ne are mixed with 20 moles of an equimolar mixture of He and Ne.

ii) Prove that if a substance is in equilibrium between two phases, its chemical potential must have same value in both the phases. 2+3 = 5

d) Write the general expression of the acceptable normalized wave function of the harmonic oscillator. Evaluate the expectation values of x and x^2 (using Gamma function) and root mean square uncertainty in position for the ground state of the harmonic oscillator. 5

[Given $\psi_0 = \left(\frac{\alpha}{\pi}\right)^{\frac{1}{4}} e^{(-\alpha x^2/2)}$]

3. Answer *any one* of the following questions: 10×1 = 10

a) i) State Kohlrausch's law of independent migration of ions and explain it with an example.

ii) Find $\langle X \rangle$ for the ground stationary state of a particle in a three-dimensional box.

iii) Find $[z^3, d/dz]$.

iv) The value of Debye-Huckel constant $A = 0.51$ at 25°C . Calculate its value at 30°C .

v) Why should a titrant be taken ten times stronger than the titre in conductometric titration? 3+2+2+2+1 = 10

b) i) Mention the observations of photoelectric effect that are not explained by the classical theory of light.

ii) Show that the eigenvalues of the Hermitian operator are real.

iii) Explain why the conductance of H^+ ions in water is very high.

iv) At 25°C , the ionic mobilities of ammonium and chlorate ions are estimated to be 6.6×10^{-4} and $5.7 \times 10^{-4} \text{ cm}^2\text{V}^{-1}\text{s}^{-1}$, respectively. Calculate equivalent conductance of ammonium chlorate and transport numbers of two ions. 2+2+2+4 = 10