

402/Chem(N)

UG/4th Sem/CHEM-MJ-T-5/25

U.G. 4th Semester Examination - 2025

CHEMISTRY

[MAJOR]

Course Code : CHEM-MJ-T-5

(Physical-2)

[NEP-2020]

Full Marks : 40

Time : $2\frac{1}{2}$ Hours

*The figures in the right-hand margin indicate marks.
Candidates are required to give their answers in their
own words as far as practicable.*

1. Answer any **five** questions : $2 \times 5 = 10$
- i) What will be the change in time of flow of a liquid if radius of the capillary of a Ostwald's viscometer is increased by 2%?
 - ii) What is Compton wavelength? State the significance of the Compton effect.
 - iii) State and explain Ostwald's dilution law.
 - iv) What will be the nature of graph for conductometric titration of sulfuric acid ($\sim N/100$) vs. sodium hydroxide solution ($\sim N/10$) in aqueous medium. Give your explanation on it.
 - v) Define fugacity. For an ideal gas, what is the value of its fugacity coefficient?
 - vi) State Nernst's Distribution Law and give one of its applications.

[Turn over]

vii) Calculate the longest wavelength of light just able to eject a least bound photo electron from Copper (work function = 4.3 eV).

viii) Briefly explain what $|\Psi|^2$ represents in quantum mechanics.

2. Answer any **two** questions : 5 × 2 = 10

i) a) State Stokes's law and how it can be used to derive the coefficient of viscosity which can be determined by falling sphere method. 1 + 2

b) A liquid is flowing through a capillary of length l and radius r under a pressure P at the rate of 1 c.c./min. Calculate the rate of flow of the liquid under a pressure $1/2P$ through a capillary of length $4l$ and radius $2r$ at the same temperature. 2

ii) a) Transport number of the ions $\text{Li}^+ + \text{Na}^+$ and K^+ in aqueous solution increases Li^+ ion to K^+ ion—justify. $2 \frac{1}{2}$

b) The equivalent conductance of an infinitely dilute solution of ammonium chloride is 150 mho sq.cm and the ion conductances of hydroxide and chloride ions are 198 mho sq.cm and 76 mho sq.cm respectively. If the equivalent conductance of 0.01(N) ammonium chloride solution be 9.6 mho sq. cm, calculate its degree of dissociation at this concentration. $2 \frac{1}{2}$

- iii) Derive an expression for change in free energy due to mixing of two ideal gases. Also show that the free energy decreases due to mixing and decrease will be largest when equimolar quantities of the two components are mixed.

5

- iv) a) What are meant by 'Compton effect' and 'photoelectric effect'?

1+1

- b) Calculate the kinetic energy of the photo-electron emitted from the surface of potassium (work function = 2.26 eV) when illuminated by radiation of wavelength $4000 \text{ \AA}$.

3

3. Answer any two questions :

$10 \times 2 = 20$

- i) a) What is meant by partial molal quantities?

2

- b) Derive Gibbs-Duhem relations from the concept of chemical potential.

5

- c) The specific conductance of a saturated solution of AgCl is $1.55 \times 10^{-6} \text{ mho/cm}$ and that of pure water is $4.3 \times 10^{-7} \text{ mho/cm}$. The ionic mobilities of chloride and silver ions are $5.6 \times 10^{-4} \text{ cm/s}$ and $6.8 \times 10^{-4} \text{ cm/s}$ respectively. Calculate the solubility product of AgCl. The temperature is always the same.

3

- ii) a) Define specific conductance and equivalent conductance of electrolytic solutions. Derive a relation between them.
1+1+2
- b) How specific and equivalent conductance of a strong electrolyte vary with dilution? Give proper justification.
 $1\frac{1}{2}+1\frac{1}{2}$
- c) State Kohlrausch's law of independent migration of ions. How it is utilised to determine the equivalent conductance at infinite dilution of ammonium hydroxide solution?
1+2
- iii) a) Derive the expressions of eigenfunction and eigenvalue for a particle in 1-D box under normalised condition. Extend these expressions of eigenfunction and eigenvalue to 3-D box.
6+3
- b) What is meant by zero-point energy of a particle in a box?
1
- iv) a) Find inter-relationship among K_p , K_c and K_x , where the symbols have their usual meanings.
2
- b) Deduce Van't Hoff's reaction isotherm from chemical potential and hence attain Van't Hoff's isochore from this reaction isotherm.
4+2
- c) What is meant by commutation of operators? Give example.
2