U.G. 3rd Semester Examination - 2021

CHEMISTRY

Course Code: BCEMCCHC301

Course Title: Physical Chemistry II

Full Marks : 30 Time : 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 **ten** questions: 1×10=10

a) What is Reynold's number? What does it indicate?

b) "Entropy of an isolated system is constant"– Justify.

c) A liquid is allowed to fall from a burette. Can Poiseuille equation be applied in this case?

d) What is Wien effect?

e) Find the quantum numbers associated with the energy level of $\frac{6h^2}{8ml^2}$ of a particle having mass 'm' in a cubical box of side 'I'.

f) Normalise: $e^{\frac{-By^2}{2}}$ over the range $-\infty \leq y \leq \infty$, where β is some constant.

g) What will happen to the viscosity of a gas if pressure is doubled keeping temperature constant?

h) What is the significance of conductance ratio $\left(\frac{\wedge_{eq}^{c}}{\wedge_{eq}^{0}}\right)$ for a weak electrolyte?

i) Give the definition of chemical potential. Is it extensive or intensive property?

j) Write down the expression of ΔS_{mix} for an ideal binary gas mixture. Under what condition it will have maximum value at a particular temperature.

k) A gas obeys the quation of state $p(V–nb)=nRT$ (Where symbols have their usual meaning). Comment on the sign of the μ_{JT} in Joule Thomson experiment.

l) In concentrated CdI_2 solution transport no of iodide ion is negative–Why?

m) What will be the effect of throttling on Nitrogen and Helium at room temperature?

n) What is meant by Clausius inequality?

o) The life-time of an excited state is 10^{-9} sec. Calculate the uncertainty in the energy of the state.

2. Answer any **five** questions from the following: $2\times5=10$

a) Show that the function $f(\theta)=3\cos^2\theta-1$ is an eigenfunction of $-\hbar^2\left(\frac{\partial^2}{\partial\theta^2}+\cot\theta\frac{\partial}{\partial\theta}\right)$. What is the eigenvalue?

b) For a reaction: $\Delta G=56818.7+67.36T\log T-303.72T$ in Joule unit. Find ΔS and ΔH at $37^{o}C$.

c) Starting from van't Hoff reaction isotherm arrive at van't Hoff reaction isobar.

d) If the viscosity coeffcient of CO_2 is 14.80 micropoise at $20^{o}C$, what is the molecular diameter?

e) Show that for an isothermal and reversible change at constant pressure the decrease of Gibbs free energy is a measure of the network available.

f) With increase in dilution specific conductance of a weak electrolyte decreases while equivalent conductance increases. Explain why.

g) Write down Maxwell Relation and then arrive Clapeyron equation from this.

h) Prove that the eigen value of Hermitian operator is a real number.

3. Answer any **two** questions from the following: $5\times2=10$

a) i) Derive Van't Hoff equation from Van't Hoff reaction isotherm.

ii) A sphere of radius 5×10^{-2} and density 1.10 gm/c.c falls at constant velocity through a liquid of density 1 gm/cc and viscosity 1 poise.

What is the velocity of fall?

$2\frac{1}{2}+2\frac{1}{2}=5$

b) Establish the following Maxwell's thermodynamic relation : $\left(\frac{\partial S}{\partial p}\right)_T=-\left(\frac{\partial V}{\partial T}\right)_P$.

Starting from S=f(p, T) and using the above Maxwell's thermodynamic relation, show that

$C_p - C_v = T\left(\frac{\partial V}{\partial T}\right)_p \left(\frac{\partial p}{\partial T}\right)_v$. Hence establish that at 4°C, $C_p = C_v$ for water. 2+2+1= 5

c) i) For free particle moving in a one dimensional box of length L, $\langle x \rangle = \frac{L}{2}, \langle p_x \rangle = 0, \quad \langle x^2 \rangle = \frac{L^2}{3} - \frac{L^2}{2n^2\pi^2}$ and $\langle p_x^2 \rangle = \frac{n^2h^2}{4L^2}$ then show that the minimum value of the uncertainty product will be greater than $\frac{1}{2}\hbar$ for such system.

ii) Consider the ground state wave function of SHO; $\psi_o(x) = \left(\frac{\beta}{\pi}\right)^{\frac{1}{4}} e^{-\frac{\beta x^2}{2}}$ where β is some constant. Find out the value of average linear momentum for such system.

$2\frac{1}{2} + 2\frac{1}{2} = 5$

———————