

B.Sc. 1st Semester (Honours) Examination, 2022 (CBCS)

Subject : Chemistry

Course : CC-II

Time: 2 Hours

Full Marks: 40

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

1. Answer any five questions:

2×5=10

- (a) For the reaction $\alpha A \rightarrow \text{Products}$, the plot of $\frac{1}{[A]}$ vs t gives a straight line. What is the order of the reaction?
- (b) A spontaneous polymerization reaction is exothermic — Explain.
- (c) Calculate the number of binary collisions per cc of N_2 gas at 1 atm. and $25^\circ C$.
[The diameter of N_2 - molecule = 3.74 \AA]
- (d) Find out the value of $\int \frac{2}{2} / \int \frac{5}{2}$.
- (e) What is the compressibility factor of the gas? Draw a curve of compressibility factor vs pressure of an ideal gas.
- (f) Find the dimension of van der Waals' constant 'a'.
- (g) The efficiency of a Carnot engine can not be 100% — Comment.
- (h) Derive Gibbs' - Helmholtz equation.

2. Answer any two questions:

5×2=10

- (a) (i) How does the Arrhenius equation $K = Ae^{-E_a/RT}$ look at $T \rightarrow \infty$. Mention its significance.
- (ii) Find an expression for the half-life period of simple n th order reaction.
- (iii) What is meant by 'steady-state' of a reaction?
- (b) (i) Explain the effect of temperature rise on the mean free path of an ideal gas held at constant pressure.
- (ii) Show that the fraction of molecules of an ideal gas moving with speeds between C_{mp} and $1.0001 C_{mp}$ is constant for any gas at any temperature.

(c) (i) Show that the work involved in a reversible, adiabatic pressure change of one mole ideal gas is given by $W = C_V T_1 \left[\left(\frac{P_1}{P_2} \right)^{R/C_P} - 1 \right]$, where T_1 is the initial temperature and P_1 and P_2 are the initial and final pressures, respectively.

(ii) Derive the following relationship: 3+2

$$\left(\frac{\partial S}{\partial P} \right)_T = - \left(\frac{\partial V}{\partial T} \right)_P$$

(d) (i) Derive an expression for Joule - Thomson co-efficient (μ_{JT}) of a gas obeying the equation $P(V - b) = RT$. Comment on the result you obtain.

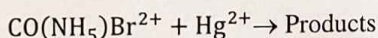
(ii) What is meant by 'Clausius Inequality'? (3+1)+1

3. Answer any two questions: 10×2=20

(a) (i) What is homogeneous catalysis? Give one example.

(ii) Prove that for an enzyme catalysis reaction the Michaelis constant is the substrate concentration at which the rate is one-half of the limiting rate.

(iii) Demonstrate graphically the primary salt effect of the following reaction:



Mention the slope value.

(iv) What do you mean by negative order reaction? Give an example. 2+4+2+2

(b) (i) For every process in an isolated system, $\Delta U = 0$. — Justify or criticise the statement.

(ii) Classify each of the following processes as reversible or irreversible:

(I) Freezing of water at 0°C and 1 atm. pressure.

(II) Freezing of super-cooled water at -10°C and 1 atm.

(iii) Draw and explain the T-S diagram for an ideal gas which undergoes Carnot Cycle. What does the enclosed area signify?

(iv) The heats of formation of CO_2 from diamond and graphite are -94500 cal and -94050 cal respectively. What is the enthalpy-change in the transformation of diamond to graphite? 2+(1+1)+(3+1)+2

(c) (i) From one-dimensional velocity distribution, find out the average kinetic energy of a molecule moving along one dimension.

(ii) For a van der Waals' gas $P_C = 112.2$ atm. and $b = 0.03707$ lit mol^{-1} . Find the reduced temperature of a gas at 27°C .

(iii) Higher the critical temperature of a gas easier it is to liquify. — Comment.

(iv) Using equipartition principle, calculate the total energy of methane at room temperature. 4+2+2+2

(d) (i) Obtain an expression for rate constant for a reaction in which a first order is opposed by a first order in terms of equilibrium concentration.

(ii) Prove that $C_p - C_v = T \left(\frac{\partial p}{\partial T} \right)_v \left(\frac{\partial v}{\partial T} \right)_p$.

(iii) The Helmholtz energy of one mole of a certain gas is given by

$$A = - \left(\frac{a}{v} \right) - RT \ln(V - b) + f(T).$$

set up the expression for pressure of the gas.

(iv) Find the time required for the decomposition of $\frac{n-1}{n}$ th fraction of the initial amount of A undergoing a first order reaction $2A \rightarrow \text{Products}$.

(v) What is inversion temperature?

3+2+2+2+1
