5. (a) Starting with the Clapeyron equation, derive the expression for Clausius– Clapeyron equation that explains the effect of temperature on pressure of a liquid. 5

(b) The vapour pressure of water at 90°C is 70.13 kPa and the molar enthalpy of vaporization between 90°C and 100°C is 2.268 kJ/g. Calculalate the vapour pressure of water at 100°C. 5

(c) Calculate the surface tension of liquid toluene and the radius of the capillary tube, if the level of water and toluene rose in the capillary is 9.8 cm and 5.2 cm, respectively. Given surface tension of water at 20°C = 72.75 dyne cm^{-1}, density of water = 998.2kg m^{-3} and density of toluene = 890.5 kg m^{-3}. 5

6. (a) Define coefficient of viscosity. Write SI unit of viscosity. Derive the expression for determination of viscosity of a liquid by using Ostwald's viscometer method. 5

(b) The viscosity of a liquid is 5×10^{-4} Nsm^{-2} at 27°C and 2.5×10^{-4} Ns m^{-2} at 327°C. Calculate the energy of activation of viscous flow assuming it to be constant in this temperature range. 5

(c) (i) The heat of vaporization of water is 1.5 times that of CCl_4. Which liquid will have the higher surface tension and why ? 2

(ii) Comment on the effect of addition of sucrose on the viscosity of water ? 2

(iii) Is it possible to liquify an ideal gas ? Explain. 1

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15.01.2025(M)

[This question paper contains 4 printed pages]

Your Roll No. : .....

Sl. No. of Q. Paper : **1393** **I**

Unique Paper Code : 2172011103

Name of the Paper : DSC 3 : Gaseous and Liquid State (Physical Chemistry - I

Name of the Course : **B.Sc.(Hons.) Chemistry**

Semester : I

Time : 2 Hours ***Maximum Marks : 60***

Instructions for Candidates :

(a) Write your Roll No. on the top immediately on receipt of this question paper.

(b) Attempt **four** questions in **all**. Question **NO.1** is compulsory.

(c) The questions should be numbered in accordance to the number in the question paper.

(d) Use of Scientific Calculator is permitted.

($R = 8.314$ J K^{-1} mol^{-1} $k = 1.38\times10^{-23}JK^{-1}$ $N_A = 6.023\times10^{23}$)

1. Answer **any 5** of the following :

(a) Why are viscosity of gases increases with increase in temperature whereas viscosity of liquids decreases with increase in temperature ? 3

P.T.O.

(b) Explain the effect of temperature and pressure on collision frequency of a gas. 3

(c) At same temperature the distribution of molecular speeds of hydrogen and helium is same. Explain. 3

(d) Why the composition of gases in the earth's atmosphere varies with height ? 3

(e) Discuss the effect of detergent concentration on the surface tension of water giving graphical representation. Why surface tension becomes nearly constant at higher concentrations of detergent ? 3

(f) Explain the dependence of surface tension on temperature and why the surface tension of a liquid becomes zero at its critical temperature. 3

2. (a) Starting from the postulates of the kinetic theory of gas derive the following equation 5

$$PV = \frac{1}{3}mN\langle c^2 \rangle$$

(b) Calculate the root mean square speed, average speed and most probable speed of H_2 molecules at 298K. 5

(c) Draw labelled diagram of P-V isotherms of CO_2. Explain these isotherms and continuity of states. 5

3. (a) Using the van der Waals equation of state, derive the following relation :

$$P_r = \frac{8T_r}{3V_r - 1} - \frac{3}{V_r}$$

State law of corresponding states based on this relation and significance of this relation. 5

(b) Calculate the fraction of oxygen gas molecules at 27°C and I atm possessing velocities between $400 \pm 10 m/s$. 5

(c) Derive an expression for the coefficient of viscosity of a gas, η in terms of the mean free path, λ and show that η of a gas is dependent on temperature, but is independent of pressure. 5

4. (a) Derive the expression of Barometric law :

$$p = p_0 \exp\left(-\frac{Mgh}{RT}\right)$$

Explain the effects of temperature and molar mass of the gas on the variation of pressure with height. 5

(b) Determine the molar mass of a gas if its pressure falls to one – fourth of its value in a vertical distance of 8 km at 27°C 5

(c) The Critical constants for water are T_c =647K, P_c = 218 atm and V_c = 0.05 $dm^3\ mol^{-1}$. Calculate the van der Waals constants and critical compressibility factor. 5

P.T.O.