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3 (Sem-2) CHM M1

2022

CHEMISTRY

(Major)

Paper : 2.1

(Physical Chemistry)

Full Marks : 60

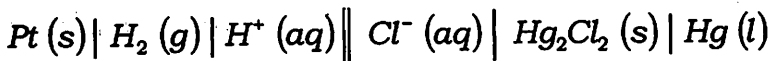
Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following questions in brief :
1×7=7
 - (a) How does the mean free path define the ideal behaviour of H_2 gas at room temperature ? 1

Contd.

- (b) Write down the cell reaction for the cell —



1

- (c) Define thermotropic and lyotropic liquids. 1

- (d) Explain whether an aqueous solution of K_2SO_4 can be regarded as ideal or not. 1

- (e) What are the advantages of reference electrodes? 1

- (f) Two van der Waals gases have the same value of 'b' but one of them has a greater value of 'a'. Which of the two gases would occupy greater volume under identical conditions? 1

- (g) Define refractive index. 1

2. Answer the following questions: 2×4=8

- (a) Find the collision flux of O_2 at a temperature of 300 K and a pressure of 1 bar. 2

(b) Explain the origin of colligative properties. 2

(c) Gas A obeys the equation

$$PV_m = \frac{RT}{\left(1 + \frac{b}{V_m}\right)}$$

and gas B obeys

$P(V_m - b) = RT$. Would it be possible to liquify either A or B? Justify your answer. 2

(d) Write a short note on fuel cells. 2

3. Answer the following questions: **(any three)** 5×3=15

(a) Show that for a very low concentration of a substance B

$\pi V = [B] RT$, where all symbols have their usual meaning. 5

(b) What is the importance of the principle of corresponding states? The equation of state of a certain gas is given by

$$P = \frac{RT}{V_m} + \frac{(a + bT)}{V_m^2}, \text{ where } a \text{ and } b$$

are constants. Find $\left(\frac{\partial V}{\partial T}\right)_P$. 2+3=5

- (c) Define a buffer solution. Deduce the Henderson-Hasselbalch equation for both acidic and basic buffers.

1+2+2=5

- (d) Discuss the Stalagmometric method for the determination of surface tension of a liquid. What is the SI unit of surface tension?

4+1=5

- (e) Find a relation between the cell potential and the reaction Gibbs free energy. Calculate the ionic strength and mean activity coefficient of a $1.00 \text{ m mol kg}^{-1} \text{ CaCl}_2(\text{aq})$ solution at 25°C .

3+2=5

4. (a) Answer **either** (i), (ii) and (iii) **or** (iv):

- (i) For a van der Waals gas the value of P_c is $1.01 \times 10^7 \text{ Pa}$ and that of the van der Waals constant 'b' is $5.0 \times 10^{-5} \text{ m}^3 \text{ mol}^{-1}$. Calculate its critical temperature.

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- (ii) Calculate the values of C_p and C_v for CO_2 and H_2O molecules.

$$1\frac{1}{2} + 1\frac{1}{2} = 3$$

- (iii) Discuss the construction of a calomel electrode. Explain the reaction taking place in the electrode. 5

- (iv) What is viscosity of a fluid? Discuss how exactly it arises in liquids and gases. Derive an expression for the coefficient of viscosity of a gas in terms of mean free path. Discuss the effect of temperature and pressure on viscosity of a gas and compare these with those of liquids.

$$1 + 2 + 4 + 3 = 10$$

(b) Answer **either** (i) and (ii) **or** (iii) and (iv):

- (i) Derive the Stokes-Einstein equation. The molar ionic conductance at infinite dilution of silver ions is $61.92 \times 10^{-4} \text{ Sm}^2 \text{ mol}^{-1}$ at 25°C . Calculate the ionic mobility of silver ions at 25°C at infinite dilution. 3+2=5

(ii) Using the concept of chemical potential show that the relative lowering of vapour pressure of a solution containing a non-volatile, non-electrolyte solute is equal to the mole fraction of the solute. 5

(iii) Discuss briefly about the structure of liquid crystals. 5

(iv) Using the postulates of kinetic theory of gases, deduce an expression for the pressure of the gas. 5

(c) Answer (i) **or** (ii) and (iii) **or** (iv):

(i) What do you mean by distribution of molecular speeds? Explain what information can be obtained from speed distribution curves. Using a graphical representation discuss the effect of temperature on the distribution of molecular speeds. 2+2+2=6

- (ii) What is a concentration cell? Taking the example of a hydrogen electrode, explain how concentration cells are classified. Explain the types of cells in which the liquid junction potential is maximum. 1+3+2=6
- (iii) Explain briefly, how the equilibrium constant of a reaction can be calculated from the measurement of standard electrode potential. 4
- (iv) Calculate the single electrode potential at 298 K for a Zn half cell electrode dipped in a 0.01M $ZnSO_4$ solution. Given that $E_{Zn^{2+}/Zn}^{\circ} = -0.763V$. 4
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