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3 (Sem - 1/CBCS) CHE HC 2

2023

CHEMISTRY

(Honours Core)

Paper : CHE-HC-1026

(Physical Chemistry-I)

Full Marks : 60

Time : Three hours

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

1. Answer the following as directed : $1 \times 7 = 7$

- (a) Write *one* postulate of kinetic molecular theory of gas.
- (b) Define most probable velocity of a gas.
- (c) Explain the term coefficient of viscosity.
- (d) What is compressibility factor?
- (e) Define critical temperature.
- (f) Write the significance of van der Waals constant 'a' and 'b'.
- (g) How surface tension of liquid varies with temperature?

Contd.



2. Answer the following questions : $2 \times 4 = 8$

(a) Why real gases deviate from ideal behaviour?

(b) Prove that $P_c V_c = \frac{3}{8} RT_c$.

(c) Define mean free path. Does it depend upon the velocity of the molecule?

(d) Explain qualitatively the structure of liquid water.

3. Answer **any three** of the following questions : $5 \times 3 = 15$

(a) Derive the expression for critical constants in terms of van der Waals constants.

(b) Using the expression for Maxwell distribution of speed. Show that the average kinetic energy of a gas molecule is given by $\frac{3}{2} KT$.

(c) The compressibility factor for hydrogen gas is always greater than 1. Explain. Calculate the root mean square velocity of sulphur dioxide molecule at 427°C . $2+3=5$

(d) Discuss the impurity defect in crystal with the help of a suitable example. Write *two* points to distinguish between Frenkel defect and Schottky defect. $2+3=5$

(e) Define co-efficient of viscosity.

Write the theory of determination of co-efficient of viscosity of a liquid by Ostwald viscometer method. $2+3=5$

4. Answer **any three** of the following questions : $10 \times 3 = 30$

(a) Define surface tension of a liquid.

What are its units?

How surface tension of a liquid is determined?

What is the effect of temperature on the surface tension of a liquid?

$2+1+5+2=10$

(b) (i) Derive Henderson equation for acid and basic buffer solution. 5

(ii) Calculate the change in pH when 0.05cm^3 of $1M$ NaOH solution is added to one litre of buffer solution containing $0.1M$ acetic acid and $0.1M$ sodium acetate at $300K$.

Given that K_a for acetic acid at $300K$ is 2.0×10^{-5} . 5

(c) Define Collision diameter.

Obtain an expression for bimolecular collision frequency of a pure gas.

Explain how collision diameter of a gas can be calculated from measurement of co-efficient of viscosity of the gas.

$1+5+4=10$

- (d) (i) What is meant by ionic product of water? Show that $\text{pH} = \frac{1}{2} \text{p}K_w$ for pure water. If $K_w = 4.0 \times 10^{-14}$ for pure water at 317K, calculate p^{OH} .

$$1+2+2=5$$

- (ii) Discuss the buffer action of an aqueous solution of ammonium acetate and a mixture of acetic acid and sodium acetate in water.

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- (e) Define Mean free path of a gas molecule. Does it depend upon the velocity of the molecule? Calculate the Mean free path of O_2 molecule at 25°C and a pressure of 10^{-3} mm Hg , given that the collision diameter is 361 pm . Express the effect of temperature and pressure on Mean free path.

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

- (f) Define Buffer capacity. Express in Mathematical form. If 0.001 mole of acid is added to 500 ml of buffer solution, its pH decreases by 0.01 unit. Calculate the buffer capacity of the buffer solution. How do you know that buffer index is always positive? Write two applications of Buffers in Chemistry and Biology.

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