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3 (Sem-1/CBCS) CHE HC 2

2025

CHEMISTRY

(Honours)

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) Define common ion effect.

(b) In an aqueous solution of H_2S at a given temperature, $[H_3O^+] = 0.01M$, $K_{a1} = 1.0 \times 10^{-7}$ and $K_{a2} = 1.0 \times 10^{-14}$. Molar concentration of S^{2-} in the solution will be —

(i) $1.0 \times 10^{-7} M$

(ii) $1.0 \times 10^{-9} M$



(iii) $1.0 \times 10^{-19} M$

(iv) $1.0 \times 10^{-23} M$

(Choose the correct option)

(c) In a tetrahedral void, there are _____ number of spheres around each void and _____ number of voids around each sphere. (Fill in the blanks)

(d) In a bcc lattice, the anion *B* occupies the corner and cation *A* occupies the centre. Find the formula of the compound.

(e) Define fluidity of a fluid.

(f) Arrange the following liquids in the increasing order of their surface tensions at the same temperature :
water, acetic acid, ethanol, diethyl ether.

(g) Correct representation of the kinetic gas equation is —

(i) $PV = \frac{1}{2} m N \overline{c^2}$

(ii) $PV = \frac{1}{3} m N \overline{c^2}$

(iii) $PV = \frac{1}{2} m N (\overline{c})^2$

(iv) $PV = \frac{1}{3} m N (\overline{c})^2$

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

(a) What is meant by ionic product of water? How does it vary with temperature?

(b) Define vapour pressure of a liquid. How vapour pressure of a liquid is related to its boiling point?

(c) Both *NaCl* and *KCl* have fcc structures. But *KCl* behaves towards X-rays like a simple cubic array. Explain.

(d) Define the following :
Collision frequency, Collision diameter.

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

(a) Derive the Henderson-Hasselbalch equation for a buffer solution of a weak acid and its salt.
How the dissociation constant of a weak acid can be determined by measuring the pH of a buffer solution containing equimolar amounts of the acid and its salt?

(b) Derive the Ostwald's dilution law for a weak acid. Give the limitation of the Ostwald's dilution law.

- (c) State the law of constancy of interfacial angles and law of rational indices.

Draw the (100), (110) and (111) planes in a simple cubic crystal system.

- (d) Define surface tension of a liquid. Give its SI unit. Describe drop number method to measure surface tension of a liquid.

- (e) On the basis of Maxwell distribution of molecular speeds, derive an expression for most probable speed of gas molecules. At a given temperature, compare average speed, most probable speed and root mean square speed of a gas.

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

- (i) Explain how temperature and concentration affects the degree of ionisation of weak electrolyte. 3

- (ii) What is buffer action? With the help of a suitable example, explain the mechanism of buffer action. Define buffer capacity. 1+3+1=5

- (iii) The pH intercellular fluid and blood of human body is naturally maintained. Name the buffers that helps to maintain the pH of human blood 7.4. 2

- (iv) Obtain an expression for hydrolysis constant of CH_3COONa . 3

- (v) The degree of hydrolysis of sodium acetate in its 0.01M solution is 0.023%. Calculate the hydrolysis constant, K_h and concentration of OH^- ions in the solution. 3+1=4

- (vi) Give the different equilibria stages of H_3PO_4 and compare pK_a values in these stages. 3

- (b) Answer **either** [(i) and (ii)] **or** [(iii), (iv) and (v)] :

- (i) Explain a method of determination of vapour pressure of a liquid. 4

- (ii) What is radial distribution function? Explain how the radial distribution function is used for elucidation of structure of liquid. 2+4=6

(iii) Explain the cleansing action of detergents. 3

(iv) Explain how surface tension of water is influenced by the addition of sugar and common salt separately. 3

(v) Compare the viscosity of liquid with gas in terms of change of temperature and pressure. 4

(c) Answer **either** [(i), (ii) and (iii)]
or [(iv), (v) and (vi)] :

(i) Obtain a relation between mean free path and co-efficient of viscosity of a gas. 5

(ii) How does co-efficient of viscosity of a gas vary with temperature and pressure ? 2

(iii) The mean free path of N_2 gas at 273K and 1 bar pressure is $1.0 \times 10^{-7} m$. Calculate the mean free path of the gas at 273K and 0.01 bar pressure. 3

(iv) From kinetic gas equation, show that average translational kinetic energy of an ideal gas is proportional to its absolute temperature. 3

(v) Calculate the average translational kinetic energy of one molecule and one mole of oxygen gas at 27°C. 4

(vi) Give the causes of deviation from ideal behaviour by a real gas. 3



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