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3 (Sem-1/CBCS) CHE HC 2

2020

(Held in 2021)

**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 : 1×7=7

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

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

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

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

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

Contd.

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

(c) Define fluidity of a fluid.

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

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

(f) In an aqueous solution of  $H_2S$  at a given temperature,  $[H_3O^+] = 0.01M$ ,  $K_{a_1} = 1.0 \times 10^{-7}$  and  $K_{a_2} = 1.0 \times 10^{-14}$ . 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)

(g) Define common ion effect.

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

(a) Define the following :

Collision frequency, Collision diameter.

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

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

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

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

(a) 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.

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

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

(e) 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?

4. (a) 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

(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) 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  $\text{CH}_3\text{COONa}$ . 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  $\text{OH}^-$  ions in the solution. 3+1=4

(vi) Give the different equilibria stages of  $\text{H}_3\text{PO}_4$  and compare pKa values in these stages. 3