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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, $\left[H_3O^+\right] = 0.01M$, $K_{a_1} = 1.0\times10^{-7}$ and $K_{a_2} = 1.0\times10^{-14}$. Molar concentration of S^{2-} in the solution will be —

(i) $1.0\times10^{-7}M$

(ii) $1.0\times10^{-9}M$

(iii) $1.0\times10^{-19}M$

(iv) $1.0\times10^{-23}M$

(Choose the correct option)

(g) Define common ion effect.

2. Answer the following questions : 2×4=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 : 5×3=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 $1.0\times10^{-7}m$. 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 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 pKa values in these stages. 3
