

[This question paper contains 4 printed pages.]

Sr. No. of Question Paper : 796 E Your Roll No.....

Unique Paper Code : 217201

Name of the Course : B.Sc. (Hons.) Chemistry

Name of the Paper : Physical Chemistry – 1 (CHHT-203)

Semester : II

Duration : 3 Hours

Maximum Marks : 75

**Instructions for Candidates**

1. Write your Roll No. on the top immediately on receipt of this question paper.
2. Attempt six questions in all.
3. Question No. 1 is compulsory.
4. Use of scientific calculator and log table is allowed.

$$R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}; \quad N_A = 6.023 \times 10^{23} \text{ mol}^{-1}$$

1. Explain why (any five)
  - (a)  $10^{-8}$  M aqueous solution of HCl has pH 6.93 and not 8 at 298K.
  - (b) Discuss the conditions when the initial slope of the compressibility factor Z (PV/RT) vs pressure curve is (i) Positive, (ii) negative, or (iii) Zero
  - (c) The viscosity of gases increases and of liquid decreases with rise in temperature.
  - (d) In an acidified aqueous solution containing  $\text{NiCl}_2$  and  $\text{CuCl}_2$ , when  $\text{H}_2\text{S}$  is passed only CuS is precipitated not NiS.
  - (e) It is not possible to distinguish between  $\text{K}^+$  and  $\text{Cl}^-$  by x-ray diffraction method.
  - (f) Glycerol has high coefficient of viscosity than water and ether. (3×5)

P.T.O.

2. (a) Derive the expression for  $a$ ,  $b$  and  $R$  in terms of  $P_c$ ,  $V_c$  and  $T_c$  for van der Waals gases.
- (b) What is the average speed of Ar gas, given that their average energy is  $12.7 \text{ kJ mol}^{-1}$  (Molar mass (Ar) =  $40 \text{ g mol}^{-1}$ )
- (c) Derive equation of state for an ideal gas ( $PV=nRT$ ) using kinetic theory of gases. (4,4,4)
3. (a) State Maxwell distribution law of molecular speeds and calculate the root mean square speed, average speed and the most probable speed of hydrogen molecules at  $298 \text{ K}$ .
- (b) Define surface tension. Give its S. I. units. Describe the two methods for its determination.
- (c) A steel ball having diameter  $4 \text{ mm}$  and density  $7.9 \text{ g cm}^{-3}$  takes  $55$  seconds to fall through a distance of one meter through a liquid of density  $1.10 \text{ g cm}^{-3}$ . Calculate the absolute viscosity of the liquid. (4,4,4)
4. (a) Derive Bragg's equation for reflection of X-rays from the faces of a crystal and explain the physical significance of ' $n$ ' in the equation.
- (b) An X-ray ( $\lambda = 139.2 \text{ pm}$ ) powder photograph of cubic crystalline solid was taken. First order reflection maxima are ( $\sin \theta$ )  $0.4084$ ,  $0.4715$ ,  $0.6671$ ,  $0.7822$  and  $0.8172$ . What is the unit cell dimension? What is the lattice type?
- (c) X-ray diffraction pattern for solids show relatively sharper peaks as compared to those for liquids. Explain radial distribution function curve for liquid water. (4,4,4)
5. (a) Define Solubility Product. Write expressions of solubility product of (i)  $\text{CaF}_2$  and (ii)  $\text{Fe}_3(\text{PO}_4)_2$ .

- (b) If 50 ml of 0.1 M HCl is being titrated with 0.1 M NaOH. What is the pH of solution when (i) 10.0 ml (ii) 25.0 (iii) 49.0 and (iv) 51.0 of NaOH has been added ?
- (c) Phenolphthalein can be used as acid – base indicator. Justify the statement using (i) Ostwald theory and (ii) Quinonoid theory. (4,4,4)
6. (a) What are buffers ? Derive an expression for Henderson-Hasselbalch equation.
- (b) Calculate the pH of 0.1 M ammonium acetate solution  $K_a = 1.85 \times 10^{-5}$  and  $K_b = 1.85 \times 10^{-5}$  at 298 K. Show that pH of salt of weak acid and weak bases are independent of salt concentration.
- (c) Discuss the method to determine viscosity of liquids by Ostwald viscometer. (4,4,4)
7. (a) Define degree of ionization. Derive exact expression to compute  $[H_3O^+]$  for weak mono-protic acids.
- (b) Write various existing equilibria, mass balance and charge balance equation for aqueous solution of dibasic acid.
- (c) Calculate the pH of following solutions :
- (i) 0.1 M aqueous acetic acid solution:  $K_a = 1.8 \times 10^{-5}$
- (ii) 0.1 M Aqueous HCl solution.
- (iii) Water at 333 K,  $K_w(333 K) = 9.61 \times 10^{-14}$
- (iv) 0.05 M aqueous ammonia;  $K_b = 1.8 \times 10^{-5}$  (4,4,4)

8. (a) What is the law of rational indices ? The Weiss indices of some crystal planes are

(i)  $a \ b \ \infty$

(ii)  $a \ b \ c$

(iii)  $a \ \infty \ c$

What are the corresponding Miller indices ?

(b) Barium metal has body centered cubic lattice structure. Density of metal is  $3.5 \text{ g cm}^{-3}$ . Calculate the radius of barium atom. (At Mass of Barium =  $137 \text{ g mol}^{-1}$ ).

(c) Explain the rotating crystal method for determining the crystal structure. (4,4,4)