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Roll No. | | | | | | | | | | | |

S. No. of Question Paper : **1606**

Unique Paper Code : **217201** **C**

Name of the Paper : **Physical Chemistry-I**

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

Semester : **II**

Duration : **3 Hours** Maximum Marks : **75**

(Write your Roll No. on the top immediately on receipt of this question paper.)

General Instructions :

(1) Attempt *six* questions in all.

(2) Attempt at least *two* questions from each Section.

(3) Question No. **1** is compulsory.

(4) Use of scientific calculator and log tables is allowed :

$R = 8.314\ JK^{-1}$, $k = 1.3806 \times 10^{-23}\ JK^{-1}$, $N_A = 6.023 \times 10^{23}\ mol^{-1}$.

1. Answer any *five* of the following :

(*a*) $MgSO_4$ gives precipitate with ammonium hydroxide but does not give precipitate in the presence of ammonium chloride.

(*b*) Why the values of second and third dissociation constants of phosphoric acid are very less as compared to first dissociation constant ?

(*c*) Discuss the effect of temperature on mean free path.

(*d*) What is common ion effect ? Discuss its application in qualitative analysis.

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(*e*) Why glycerol has higher coefficient of viscosity than water ?

(*f*) Discuss the effect of adding non-volatile impurities on boiling point of the liquid.

(*g*) Why NaCl crystal turns yellow on heating ? 3×5

Section A

2. (*a*) Define the terms collision diameter (σ) and mean free path (λ) of molecules in a gas. Obtain the following expression :

$$\lambda = \frac{1}{\sqrt{2}\pi\sigma^2 N}.$$

(*b*) Derive expression for viscosity of gases. How is it related to collision diameter ?

(*c*) Calculate the values of second and third Virial coefficients for carbon dioxide at 323 K when values of a = 3.6 atm dm^6 mol^{-2} and b = 0.0428 dm^3 mol^{-1}. 4,4,4

3. (*a*) Derive expression for pressure of an ideal gas.

(*b*) The critical constants using van der Waals equation for one mole of a gas are given as :

$$P_c = \frac{a}{27b^2}; \quad V_c = 3b; \quad T_c = \frac{8a}{27bR}$$

Using these, derive the universal relation :

$$P_r = \frac{8T_r}{3V_r - 1} - \frac{3}{V_r}.$$

(*c*) Reduce van der Waals equation into Virial equation of state and derive expression for Boyle's temperature. 4,4,4

4. (*a*) Draw Andrew's isotherms for CO_2 and explain continuity of states.

(*b*) Discuss the effect of detergent on the surface tension of water. How detergent action makes washing of oil/grease from clothes ?

(*c*) Five-fold rotation axis is absent in crystal systems. Explain 4,4,4

5. (*a*) Define surface tension. What are its SI units ? Why do certain liquids fall and rise in the capillary tube ?

(*b*) At 20^0C time taken by equal volumes of water and toluene to flow through a capillary tube are 102 and 69 seconds respectively. Densities of water and toluene are 998 and 866 kg m^{-3} respectively. Viscosity of water at this temperature is 1×10^{-3} Nm^{-2} s. What is the value of absolute viscosity of toluene ?

(*c*) Arrange the following in increasing order of (*i*) vapour pressure and (*ii*) boiling point. Water, ethyl alcohol and ethoxy ethane. Justify the answer. 4,4,4

Section B

6. (*a*) Derive Bragg's equation.

(*b*) Define the following symmetry elements :

(*i*) Mirror plane

(*ii*) Axis of rotation.

(*c*) The density of Li metal is 0.53 g/cm^3 and distance between the (100) plane of the metal is 350 pm. Determine whether the lattice is fcc or bcc. Molar mass of Li = 6.941 g/mol. 4,4,4

7. (*a*) Define degree of ionization. Explain at least *two* factors on which it depends. Derive expression for degree of ionization for a weak acid.

(*b*) Discuss the effect of temperature on ionic product of water.

(*c*) Calculate the pH values of the following solutions :

(*i*) 0.1 M acetic acid; $K_a = 1.8 \times 10^{-5}$.

(*ii*) 0.001 M NaOH

(*iii*) Equal volumes of 0.1 M HCl and 0.01 M NaOH

(*iv*) 0.01 M ammonia; $K_b = 1.8 \times 10^{-5}$. 5,3,4

P.T.O.

8. (*a*) Derive expressions for hydrolysis constant and degree of hydrolysis for salt of strong acid and weak base. Also derive expression for calculation of pH of hydrolysed solution.

(*b*) Solubility product of $Al(OH)_3$, $K_{sp} = 8.5 \times 10^{-2}$. Calculate the solubility of $Al(OH)_3$ in g/L (Al = 27, O = 16, H = 1).

(*c*) Draw and explain pH *Vs.* volume of base curve for the weak acid - strong base titration. 5,4,3

9. (*a*) How a solution of weak acid and its salt behave as a buffer ? Derive Henderson equation to calculate pH of the solution.

(*b*) Derive the expression for buffer capacity of an acidic buffer solution in terms of amounts of acid and salt present in it.

(*c*) Phenolphthalein and methyl orange can be used for strong acid – storng base titration. Justify. 4,4,4