

Sl. No. of Ques. Paper : 1329 F-7  
Unique Paper Code : 2171503  
Name of Paper : Paper-13, Physical Chemistry : Phase Equilibria & Binary Solutions  
Name of Course : B.Sc. (Hons.) Chemistry (FYUP)  
Semester : V  
Duration : 3 hours  
Maximum Marks : 75

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

Attempt five questions in all. Question No. 1 is compulsory.

Attempt at least one question from each Section.

Use of scientific calculator is allowed.

$$R=8.314 \text{ J mol}^{-1} \text{ K}^{-1}$$

1. Explain any five:

- (i) Skating is easy on ice.
- (ii) You are supplied with three identical metal rods: one of pure metal, another mixture of two metals with eutectic composition and third being a mixture with non-eutectic composition. How can you identify the rods?
- (iii) Diamond is hardest substance known. Account in terms of its structure.
- (iv) Iodine is distributed between water and benzene at 1 atm pressure with no solid iodine present. Calculate number of phases, components and degrees of freedom; suggest variables corresponding to degrees of freedom.
- (v) A mixture of  $\text{Na}_2\text{CO}_3$  and  $\text{K}_2\text{CO}_3$  is used as fusion mixture.
- (vi) For a binary solution at constant temperature the liquidus curve lies above the vaporous curve. Why? 3×5

#### SECTION A

2. (i) Determine the number of components present in  $\text{KCl-NaCl-H}_2\text{O}$  system and  $\text{KCl-NaBr-H}_2\text{O}$  system. What are the number of components if the salts are present in equal amounts for both the systems? 2,2,1
- (ii) (a) Compound A melts at  $6^\circ\text{C}$  and compound B melts at  $65^\circ\text{C}$ . There is a eutectic at  $1^\circ\text{C}$ , the eutectic solution being 20 mole % in B and an unstable compound  $\text{AB}_2$  which decomposes at  $30^\circ\text{C}$ . Sketch the simplest phase diagram consistent with above data and label the phase regions. 4

- (b) Draw the cooling curves for the solutions containing 10% and 67% of B for the above system. Indicate the phase appearing or disappearing at each break or halt. 2
- (iii) Explain why the various tie lines within the binodal curve are parallel neither to the side of triangle nor to each other. Under what conditions will the various tie lines be parallel to each other? 4
3. (i) An organic compound X melts at 80°C. If the vapor pressure of the liquid X is 10 mm at 84.8°C and 40 mm at 119.3°C, and that of solid X is 1 mm at 52.6°C, calculate the heat of vaporization of liquid, the boiling point and the entropy of vaporization at boiling point. 5
- (ii) On a triangular plot locate the point corresponding to the composition 15% of A, 25% of B and 60% of C. 3
- (iii) Draw and discuss the phase diagram of Sulphur system. "Sulphur obtained from nature is rhombic." Why? 5,2

## SECTION B

4. (i) Define critical solution temperature (CST). What is the effect of different types of impurities on CST? Explain with examples. 5
- (ii) Show that for a binary solution if one component exhibits negative deviation the other will also do. 3
- (iii) At 353 K, the vapor pressure of pure ethylene bromide and propylene bromide are 22.93 and 16.93 Nm<sup>-2</sup>, respectively, and these compounds form a nearly ideal solution. 3 mol of ethylene bromide and 2 mol of propylene bromide are equilibrated at 353 K and total pressure of 20.4 Nm<sup>-2</sup>.
- (a) What is the composition of the liquid phase?
- (b) What amount of each compound is present in the vapour phase? 7
5. (i) The partition co-efficient of iodine between CS<sub>2</sub> and H<sub>2</sub>O is 62.5. When iodine is distributed between CS<sub>2</sub> and KI solution (containing 6.40 g/L), the iodine concentration in CS<sub>2</sub> layer is 0.19 mol/L and the total I<sub>2</sub> in aqueous layer is 0.03 mol/L. Find out the equilibrium constant for the reaction.
- $$\text{KI} + \text{I}_2 \rightleftharpoons \text{KI}_3 \quad 5$$
- (ii) What is lever's rule? Deduce it from pressure *versus* composition diagram for the binary liquid mixture. 5
- (iii) Derive the Gibbs-Duhem-Margules equation from Gibbs-Duhem equation for binary liquid system. To which type of liquid mixtures (ideal or non-ideal) is the Gibbs-Duhem-Margules equation applicable? 5

## SECTION C

6. (i) State and derive Bragg's Law for X-ray diffraction. 5
- (ii) Give the various symmetry elements for a simple cubic lattice. Why is the five-fold symmetry not observed? 5
- (iii) Density of face centered Ag cubic crystal is  $10.5 \text{ g cm}^{-3}$ . Calculate:
- (a) Edge length
- (b) Interplanar distance for the planes (111), (200), (220)
- (c) The wavelength of X-rays if angle of diffraction is  $19.08^\circ$  for (111) plane. 1,3,1
7. Write short notes (any *three*):
- (a) Zone refining
- (b) Solvent extraction
- (c) Azeotropes
- (d) Rotating Crystal Method. 5,5,5