

## West Bengal State University

B.A./B.Sc./B.Com. (Honours, Major, General) Examinations, 2011

Part - III

## CHEMISTRY — HONOURS

## Paper - V

Duration : 4 Hours

[ Maximum Marks : 100

Candidates are required to give their answers in their own words as far as practicable.

The figures in the margin indicate full marks.

## GROUP - A

( 50 Marks )

Answer any *three* questions, taking *one* from each Unit.

## Unit - 1

1. a) Define molecular partition function ( $f$ ). What is its unit and value at 0 K and at infinite temperature ? 1 + 2
- b) Suppose a molecule has two energy levels  $\epsilon_1 = 0$  and  $\epsilon_2 = k_B T$ . Calculate (i) the molecular partition function ( $f$ ) and (ii) the ratio of the number of molecules in the two levels.  
[  $k_B$  = Boltzmann constant,  $T$  = Kelvin temperature ] 1 + 1
- c) Derive, with the help of chemical potential, the relation between osmotic pressure ( $\pi$ ) of an ideally dilute solution with its molar concentration ( $C_2$ ) at  $T$  K temperature. Mention, clearly, the assumption(s) & approximation(s), if any, made at appropriate place(s). 5 + 1
- d) In an open container, on heating, sulphur melts but iodine sublimes. Explain why. 2
- e) What is an azeotropic mixture ? How would you ascertain that an azeotrope is a mixture not a compound ? 3

2. a) Consider an isolated system containing  $N$  molecules distributed among the possible non-degenerate energy levels represented by  $\epsilon_1, \epsilon_2, \dots$  etc. Assuming the expression for thermodynamic probability, show that under equilibrium condition number of molecules  $N_i$  in the energy level  $\epsilon_i$  is given by  $N_i = A \cdot \exp^{-b\epsilon_i}$  where  $A, b$  are constants.  
Taking  $b = \frac{1}{k_B T}$ , find the probability that a molecule has an energy  $\epsilon_i$ . 6
- b) The normal boiling point of a binary solution of  $A$  and  $B$  with mole fraction of  $A, x_A = 0.6589$ , is  $88^\circ\text{C}$ . At this temperature, the vapour pressures of pure liquid  $A$  and  $B$  are  $957$  and  $379.5$  torr respectively. Is the binary solution ideal? Give reason(s) in favour of your answer. 4
- c) State and explain 'Nernst heat theorem'. 3
- d) Starting from the appropriate form of the Duhem-Margules equation, obtain Konowaloff's rule. 3

### UNIT - 2

3. a) What is Miller index? Find the Weiss index and Miller index of the plane that intersect the crystallographic axes at the distances  $a, 2b, \infty c$ . 1 + 1 + 1
- b) A face-centred cubic crystal reflects X-ray radiation of wavelength  $\lambda = 150$  pm at an angle  $\theta = 20^\circ$  from a set of (100) planes for first order diffraction. Calculate the spacing  $d_{100}$  between two planes. Calculate the edge length  $a$  of this unit crystal. 2 + 1
- c) State and explain 'Schultz-Hardy rule'. 3
- d) Define 'degree of polymerization'. 2
- e) What is dipole moment of a molecule? The dipole moment of HCl molecule is  $1.03$  D and its bond length is  $127$  pm. Calculate the charge on the constituent atoms and the percentage of ionic character. 2 + 3
4. a) Estimate the fraction of void spaces in the face centered and body centered cubic lattices. 2 + 2
- b) With the help of Gibbs' adsorption isotherm, explain the effect of addition of (i) KCl and (ii) SDS to water. 2 + 2
- c) What do you mean by micelle and critical micelle concentration (C.M.C.)? 2

