UG 5th Semester Examination 2021

Chemistry (Honours)

Paper: DSE-1

(Advanced Physical Chemistry)

Full Marks : 25   Time: Two Hours

The figures in the margin indicate full marks

1. Choose the correct alternative in each question (any five) $1 \times 5 = 5$

a) Which of the following is not a method for determination of molecular mass of a polymer?

(i) viscosity method

(ii) sedimentation method

(iii) boiling point method

(iv) osmotic pressure method

b) When $T \to \infty$, value of the single-particle partition function will be (given: degeneracy of level $j = g_j$

(i) 1   (ii) g_0 (iii) $\sum g_j$ (iv) $1/\sum g_j$

c) Minimum separation of (1 2 3) planes of an orthorhombic unit cell with a = 0.82 nm, b = 0.94 nm, c = 0.75 nm is

(i) 0.21 nm

(ii) 0.51 nm

(iii) 0.36 nm

(iv) not enough data

d) Which of the following elements has a body centered cubic lattice structure?

(i) Mg

(ii) Ca

iii) Ni

(iv) Na

e) For a face centred cubic lattice, the miller indices for which strong diffraction line is observed are:

(i) (1 0 0)   (ii) (1 1 1)   (iii) (1 1 0)   (iv) (2 1 0)

f) Which one of the following has lowest Debye Temperature?

(i) Al
(ii) Au
(iii) Fe
(iv) Si

g) The intercepts on the crystallographic axes of a plane with Miller indices (h k l) with unit cell dimensions a, b and c are:
i) h, k, l
 ii) a, b, c
iii) h/a, k/b, l/c
iv) a/h, b/k, c/l

h) Which of the following is known as Staudinger index?
i) Reduced viscosity, ii) Inherent viscosity, iii) Intrinsic viscosity, iv) None of these

2. Answer *any* **four** questions: $2×4 = 8$
a) The angle of a Bragg reflection from a set of crystal planes separated by 128.2 pm is 19.76^0 .

Calculate the wavelength of X-rays.

b) State the coordination number of a sphere in each of the following arrangements: (a) ccp; (b) hcp; (c) bcc; (d) fcc;

c) Show that internal energy of a system of independent particles is given by

$U= nRT^2 (\delta lnq/\delta T)_V$.

d) .Calculate Boltzmann population of two non-degenerate energy levels at 25^0C if the energy levels are separated by 1000 cm^{-1}

 e) What is Gibbs paradox in the entropy of mixing of ideal gases and how did Gibbs resolve it?

f) Show that the weight average molar mass of a polymer is generally greater than the number average molar mass.

g) Define canonical ensemble and microcanonical ensemble.

h) Show that entropy is a logarithmic function of thermodynamic probability.

3. Answer *any* **two** questions: 6×2 = 12

a) i) Derive the expression of entropy of a perfect gas using the classical microcanonical ensemble.

ii) Insulin forms crystals of orthorhombic type with a = 13 nm, b=7.48 nm and c= 3.09 nm. If the density of the crystal is 1.315 x 10^3 kg/m³, and there are 66 insulin molecules per unit cell, what is the molar mass of insulin?

iii) Draw the structure of a block copolymer.   2+3+1 = 6

b) i) Derive the relation between Gibbs free energy and partition function . Compare mathematical probability with thermodynamical probability.

ii) Show that five fold rotation axis cannot be found in crystals   (2+2)+2 = 6

c) i) Draw a temperature(T)-Entropy(S) curve for a paramagnetic solid, and show that absolute zero of temperature cannot be obtained by means of successive cooling.

ii) What is polaron and bi-polaron? Describe with help of a diagram.   3+3=6

(d)(i) A protein sample consists of an equimolar mixture of haemoglobin (M=15.5 kgmol⁻¹, ribonuclease (M=13.7 kg mol⁻¹) and myoglobin (M=17.2 kg mol⁻¹). Calculate the number-average and weight-average molecular weight. Which is greater?

(ii) Show that for a square lattice the separation of (h k) planes is $\frac{a}{\sqrt{h^2+k^2}}$, where "a" is the unit cell edge length.   3+ 3 = 6