2021

Chemistry

[Fifth Semester]

Paper - DSE-1T

Full Marks : 40

Time : 2 hours

The figures in the right-hand margin indicate marks.

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

Illustrate the answers wherever necessary.

Group - A

1. **Answer any <u>five</u> of the following :**   **5×2=10**

    (a) What is equal a priori probability?

    (b) Write down Bravais lattices in two dimensions with drawing.

    (c) What is the difference between the heat capacity models proposed by Einstein and Debye.

    (d) What is Canonical and Grand Calonical ensembles?

(2)

(e) What is the difference between weiss and Miller indices.

(f) Write the total number of axis of symmetry and plane of symmetry in a cubic unit cell.

(g) Why Debye$-T^3$ law is not valid at very low temperature?

(h) The molecules of a gas have two energy states, zero and '$\in$' and degeracies g_1 and g_2, respectively. Write down the expression for molecular partition function.

Group - B

Answer any four of the following :   **4×5=20**

2. (a) Prove that in a cubic lattice, planes with inter planer separation $a/\sqrt{7}$ are absent.

(b) An orthorhombic unit cell has the following parameters : a $=0.5\overset{\circ}{A}$, b=1$\overset{\circ}{A}$, C=1.5$\overset{\circ}{A}$. What is the spacing of the (123) planes?   2+3=5

3. (a) The number of molecules in three succesive non-degenerate level of equal gap are 1000, 100 and 10 respectively. Show that the arrangement corresponds to Boltzmann-like distribution.

(3)

    (b) Write the limitation of Maxwell-Boltzmann distribution law.   3+2

4. (a) In a FCC lattice with all the positions occupied by A atoms, th body-centred octahedral hole is occupied by an atom B of an appropriate size. For such a crystal, calculate the void space per unit volume of unit cell. Also predict the formula of the compound.

    (b) What are the success and draw back of Debye's equation?   3+2=5

5. (a) The first order reflection from crystal plane in a cubic crystal occurs at 13°41′. Find the Miller indices of the plane. Given a = 5.63Å, λ=1.54Å [$\sin^2 13°41′$=0.056]

    (b) The Dybye's law has been found to be quite satisfactory in the case of many metallic systems, specially for cubical monoatomic ones–Why? 3+2=5

6. (a) What is meant by partition function?

    (b) Derive expression for the following thermodynamic functions in terms of partition function.
      (i) Gibbs free energy
      (ii) Heat capacity   1+2+2

(4)

7. (a) The single particle partition function (q) for a certain system has the form $q = AVe^{BT}$. Find out average energy per particle.

(b) Calculate the total number of microstates for 6 identical particle with their occupation number {1,2,3} in three state. 3+2

Group - C

Answer any one question : 1×10=10

8 (a) Consider a system of n-molecules, distributed among non-deganerate energy levels represented by $\in_0, \in_1, \in_2$ .... etc. Write down the expression for partition function for the system. Show that internal energy (U) of a system can be expressed as

$$U = nkT^2 \left(\frac{\partial \ln q}{\partial T} \right)_V$$

(b) Show that the entropy is a logarithmic function of thermodynamic probablity.

(c) What is Debye characteristics temperature?

(5)

(d) Ag is known to crystallise in f.c.c. form and the distance between the nearest neighbour atoms is 2.87Å. Calculate the density of Ag.

[At. wf. of Ag =108]   3+3+2+2=10

9. (a) Write down the assumptions of the Einstein's treatment of specific heat capacity of solid and derive the equation and also show that Dulong-Petit's law is special case of Einstein Equation.

(b) Derive Manwell-Boltzmann distribution for degenerate energy level.   5+5=10