3 (Sem–6) CHM M 2

2020

CHEMISTRY

(Major)

Paper : 6·2

(Physical Chemistry)

Full Marks : 60

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Answer the following in brief : 1×7=7

(a) A substance A_xB_y crystallizes in an *fcc* lattice in which atoms *A* occupy each corner of the cube and atoms *B* occupy the centres of each face of the cube. What will be the correct formula of the substance ?

(b) A group 13 element is added in small amounts to *Ge* crystal. The doped crystal acts as _____ semiconductor.
(Fill up the gap)

(c) What is the unit of flocculation value of a coagulating electrolyte ?

(d) What happens when a freshly precipitated $Fe(OH)_3$ is shaken with little amount of dilute solution of $FeCl_3$? Give reaction.

(e) The weight average molecular weight of a polymer is 29,000. If the polydispersity index of the polymer is 0·7, what will be its number average molecular weight ?

(f) If Z is the partition function and $\beta = \frac{1}{k_B T}$, what will be the average energy of the system ?

(g) The formation of micelles takes place above a particular temperature called ——. *(Fill up the gap)*

2. Answer the following questions : 2×4=8

(a) Match crystal system/unit cells mentioned in Column I with their characteristics features mentioned in Column II :

Column I	Column II
(A) Simple cubic and face centred cubic	(p) have the cell parameters $a=b=c$ and $\alpha=\beta=\gamma$.
(B) Cubic and rhombohedral	(q) are two crystal systems.
(C) Cubic and tetragonal	(r) have only two crystallographic angles of 90°.
(D) Hexagonal and monoclinic	(s) belong to same crystal system.

(b) On passing H_2S through an aqueous solution of SO_2, a yellow turbidity is formed. Why ?

(c) Distinguish between error and uncertainty with examples.

(d) Give the physical significance of molecular partition function.

3. *(a)* What are Schottky defects ? Derive an expression for the number of Schottky defects in a crystal. 2+3=5

Or

State Bragg's law and deduce the equation

$$2d \sin\theta = n\lambda$$

The diffraction of barium with X-radiation of wavelength 2·29Å gives a first order reflection at 30°. What will be the distance between the diffracted planes ? 3+2=5

(b) Using partition function, deduce an expression for the entropy of monatomic gas. 5

Or

Using the concept of partition function, deduce an expression for the internal energy of monoatomic ideal gas. Hence find an expression for the heat capacity at constant volume. 3+2=5

(c) Write briefly about the various types of errors in measurement. An experiment was conducted to determine the amount of calcium present in dolomite. The result was found to be 21·85% while the true value is 21·73%. Find the relative error. 3+2=5

4. Answer ***either*** *(a), (b)* and *(c)* ***or*** *(d), (e)* and *(f)*:

(a) Explain the origin of low temperature super conduction in terms of Cooper pair. 3

(b) The first order reflection of a beam of X-rays from 100 planes of *NaCl* occurs at an angle of $6°30'$. Calculate the wavelength of the X-ray. What would be the angle of reflection if X-rays of $\lambda = 1{\cdot}54\text{Å}$ were used. 4

(c) What is radius ratio ? How does radius ratio help in determining the structure of ionic solids and co-ordination number of ions ? Explain. 3

(d) An element crystallizes in a body centered cubic structure with a cell edge of 288 *pm*. The density of the element is $7{\cdot}2\,gcm^{-3}$. How many atoms are present in 208 *g* of the element ? 4

(e) How does electrical conductivity of metals and semi-conductors vary with temperature ? 3

(f) Why does *LiCl* acquire pink colour when heated in *Li* vapour? 3

5. Answer **either** *(a), (b)* and *(c)* **or** *(d), (e)* and *(f)*:

(a) Discuss the light scattering method for determination of the molar mass of polymer. 4

(b) A protein sample has 35% haemoglobin $\left(M = 15{\cdot}5\, kg\, mol^{-1}\right)$, 35% myoglobin $\left(M = 17{\cdot}2\, kg\, mol^{-1}\right)$ and 30% ribonuclease $\left(M = 13{\cdot}7\, kg\, mol^{-1}\right)$. Calculate the number-average and mass-average mass of the protein. 3

(c) Discuss the origin of charge on colloidal particles in detail. 3

(d) What are super conductors? Define low and high temperature super conductors with suitable examples. 1+3=4

(e) Discuss the kinetics of condensation polymerization. 3

(f) In a polymer sample 25% molecules have molar mass 15,000, 40% have molar mass 20,000 and the rest have molar mass 25,000. Calculate weight average and number average molar mass of the polymer. 3

6. Answer ***either*** *(a), (b)* and *(c)* ***or*** *(d), (e)* and *(f)*:

(a) For a diatomic molecule vibrating as a simple harmonic oscillator, obtain an expression for vibrational partition function. 4

(b) The frequency of absorption band for *CO* associated with its vibrational transition is $6{\cdot}51\times10^{13}$ per second.

(i) At what temperature does kT become equal to the energy of the vibrational transition ?

(ii) Calculate the fraction of CO molecules in the vibrational level $v=1$ at $27°C$. 2+2=4

(c) Write the expression for Boltzmann distribution. Mention the meaning of the terms involved. Gives its physical significance. 2

(d) Calculate the residual entropy of one mole of CO at $298K$. Discuss accuracy and precision with examples. 2+2=4

(e) Calculate the translational partition function of H_2 molecule confined to a 1000 cm^3 vessel at $25°C$. 3

(f) Calculate the internal energy of 1 mole of He at $25°C$. 3
