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 $\beta = \dfrac{1}{k_B T}$, 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 $\lambda = 1.54\text{Å}$ 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 $7.2\,gcm^{-3}$. 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 $(M = 15 \cdot 5\,kgmol^{-1})$, 35% myoglobin $(M = 17 \cdot 2\,kgmol^{-1})$ and 30% ribonuclease $(M = 13 \cdot 7\,kgmol^{-1})$. 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 6.51×10^{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 $298\,K$. 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

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