2016

CHEMISTRY

(Major)

Paper : 6·2

(Physical Chemistry)

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

(Symbols signify their usual meaning)

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

   (a) Name the crystal system with characteristics $a = b \neq c$; $\alpha = \beta = 90°$, $\gamma = 120°$.

   (b) Write the Miller indices of the plane which intersects the x-axis at $2a$ and which is parallel to y- and z-axes.

   (c) Write the definition of partition function.

　　　　　　　　　(Turn Over)

(2)

(d) Generally the mass average molar mass of a polymer is greater than its number average molar mass. State when they become equal.

(e) Name the type of polymerization which results in Nylon-66.

(f) State how doping enhances the electrical conductivity of a semiconductor.

(g) State where the octahedral voids of the fcc unit cell are located.

2. (a) The edge length in NaCl crystal is $5 \cdot 63 \times 10^{-10}$ m. Find the distance between (111) planes. 2

(b) Explain why alkali metals are soft. 2

Or

KCl acquires magenta colour when crystals of the compound is exposed to potassium vapours. Explain the observation. 2

(3)

(c) Consider a system of 6 distinguishable particles. One of the macrostates of the system has the following distribution of particles :

Energy level : 0 1 2 3 4
Number of particles : 0 0 2 2 2

Find thermodynamic probability. 2

(d) Explain how the formation of micelles affects the electrical conductivity of soap solution. 2

Or

Explain why protein-in-water sol undergoes coagulation on addition of alcohol. 2

3. Define systematic error and random error. State how these are related to precise and accurate measurements. An experiment was carried out to determine the amount of a metal in a sample and the result was found to be 35·68% while the true value is 35·98%. Find relative error. 2+1+2=5

Or

Define average deviation and standard deviation. Estimation of Fe present in a

sample showed the following results in a series of experiments :

Experiment	Amount of Fe
I	7·146%
II	7·098%
III	6·942%
IV	7·256%
V	6·593%

Find average deviation and standard deviation. 2+3=5

4. Answer either (a) and (b) or (c) and (d) :

(a) Find the ratio between the populations of the two states indicated by I and II, such that the energy difference between state II and state I, $(E_{II} - E_{I})$ is kT. The degeneracy in level I is 1 and that in level II is 3. 5

(b) Calculate the internal energy of 1 mol He at 25 °C. 3

(c) Calculate the characteristic vibrational temperature of O_2 if its fundamental vibrational wave number is 2337 cm^{-1}. 3

(d) Using Stirling approximation, find the value of ln(100!). 2

5. Answer either (a) or [(b) and (c)] :

(a) A mixture of two polymers contains w kg of each of the two. The molar mass of one polymer is 10 kg mol^{-1} and that of the other is 20 kg mol^{-1}. Calculate number average molar mass, mass average molar mass and poly-dispersity index. 2+2+1=5

(b) The osmotic pressure of 1 m^3 of a solution containing 2·5 kg of a polymer is found to be 250 Pa at 298 K. Assuming that the solution does not deviate from ideal behaviour, calculate the molar mass of the polymer. 3

(c) Write the different steps through which addition polymerization occurs. 2

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

(a) State Bragg's law and deduce the equation

$$2d \sin\theta = n\lambda$$
4

(b) Superconductivity in metal is observed only by cooling it to near absolute zero. Explain this observation. 3

(c) Show that the packing efficiency in ccp structure is nearly 74%.   3

(d) In case of the ionic compounds of the type BA, explain how the radii of the cation and the anion influence packing of the smaller ion in different holes.   4

(e) Write the difference between ferro-magnetism and antiferromagnetism with respect to domain.   3

(f) Using band theory, explain how electrical conductivity of conductor and semiconductor varies with temperature.   3

7. Answer [(a) and (b)] or [(c) and (d)] :   10

(a) Assuming a diatomic molecule to be rigid rotator, write the expression for rotational energy. Hence deduce an expression for the rotational partition function. What do you mean by characteristic rotational temperature?   1+3+1=5

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

(Continued)

(c) A particle of mass m is moving inside a box of length a, b and c along x-, y- and z-axes respectively. The potential inside the box is assumed to be zero. Find an expression for the translational partition function for a particle.   5

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

8. Answer either [(a), (b) and (c)] or [(d) and (e)] :   10

(a) What do you mean by protection of colloid? Explain the mechanism of protection of colloid.

(b) Write about the processes responsible for the charge of colloidal particles. Discuss in brief how the co-ions and counter-ions are distributed around the charged colloidal particles.   2+2=4

(c) $Fe(OH)_3$ sol contains positively charged colloidal particles. In case of coagulation of this sol, the flocculation value of $K_3[Fe(CN)_6]$ is 0·096 millimol L^{-1} while that of K_2SO_4 is 0·210 millimol L^{-1}. Explain the reason behind this difference in flocculation value.   2

(Turn Over)

(d) Discuss how the molecular mass of polymer can be determined by measuring osmotic pressure of its solution. 5

(e) What do you mean by condensation polymerization? Discuss about the kinetics of this type of polymerization.

1+4=5

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