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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 $a = b \neq c$; $\alpha = \beta = 90^\circ$, $\gamma = 120^\circ$.
- (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.

- (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 5.63×10^{-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

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

<i>Energy level</i>	:	0	1	2	3	4
<i>Number of particles</i>	:	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 :

<i>Experiment</i>	<i>Amount of Fe</i>
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) : 5

(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. 3

(b) Calculate the internal energy of 1 mol He at 25 °C. 2

(c) Calculate the characteristic vibrational temperature of O₂ 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)] : 5

(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 polydispersity 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)] : 10

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

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

(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 ferromagnetism 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

- (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. 2+2=4
- (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) $\text{Fe}(\text{OH})_3$ sol contains positively charged colloidal particles. In case of coagulation of this sol, the flocculation value of $\text{K}_3[\text{Fe}(\text{CN})_6]$ is $0.096 \text{ millimol L}^{-1}$ while that of K_2SO_4 is $0.210 \text{ millimol L}^{-1}$. Explain the reason behind this difference in flocculation value. 2

- (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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