2014

CHEMISTRY

(Major)

Paper : 6.2

Full Marks : 60

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Answer in brief : 1×7=7

(a) Write the Miller indices for the plane which intersects the *X*- and *Y*-crystallographic axes at 2*a* and 3*b* and which is parallel to *Z*-axis.

(b) State the numbers of octahedral and tetrahedral holes in an f.c.c. lattice.

(c) Find the highest order that can be observed in Bragg's reflection from a solid by X-ray.

(d) A positively charged AgI sol can be prepared by adding dilute solution of NaI to a slight excess of dilute solution of $AgNO_3$. State why the colloidal particles are positively charged.

(e) State why average molecular mass of a polymer is considered.

(f) Polyethylene is commercially available in two forms—low density polyethylene and high density polyethylene. State the difference in structure because of which the two differ in density.

(g) State what you mean by thermodynamic probability.

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

(a) For As_2S_3 sol, the flocculation values of NaCl solution and KCl solution are almost the same, though $CaCl_2$ solution has much less flocculation value. Explain this observation.

(b) Explain how the formation of micelle affects the electrical conductivity and the osmotic pressure of the solution.

(c) What do you mean by critical temperature in connection with superconductivity? Write in brief about high temperature superconductivity.

(d) Explain how coagulation of lyophilic sol can be affected.

3. *(a)* Answer *(i) or (ii)* and *(iii)* : 5×3=15

(i) Write what you mean by Schottky and Frenkel defects. Discuss the effects of these two defects. 2+3=5

Or

(ii) Explain why alkali metals are soft. 2

(iii) Distinguish between ferromagnetism and ferrimagnetism with respect to domain. 3

(b) Deduce an expression for the entropy of monatomic gas in terms of partition function. 5

Or

State what molecular partition function actually means. At what temperature does the molecular partition function become equal to the degeneracy of the ground state? The molecules of a gas belong to two energy levels, with energies zero and ε. The degeneracies of the two levels are g_1 and g_2 respectively. Find the expression for the molecular partition function. 1+1+3=5

(c) Distinguish between repeatable and reproducible results. Analysis of a

sample of iron gave the following percentage values for the Fe content :

7·08, 7·21, 7·12, 7·09, 7·16, 7·14, 7·07, 7·14, 7·18, 7·11

Calculate mean and standard deviation. 1+4=5

4. *(a)* Answer *(i), (ii), (iii) or (iv), (v)* and *(vi)* : 10×3=30

(i) Deduce Bragg's equation for X-ray diffraction by crystals. 4

(ii) The first-order reflections from (2 0 0), (2 2 0) and (1 1 1) planes of NaCl crystal appear at 5·9°, 8·4° and 5·2° respectively. Determine the unit cell type. 4

(iii) The radii of Ca^{2+} and O^{2-} are 94 pm and 146 pm respectively. Predict the crystal structure of CaO. 2

Or

(iv) In case of the ionic compounds of the type *BA*, explain how the radii of cation (B^{z+}) and anion (A^{z-}) decide the packing of ions in different holes. 4

(v) Lithium crystallizes as cubic lattice with density of 0·53 g cm^{-3}. The interplanar distance between (1 0 0) planes of the crystal is 350 pm. Find the unit cell type. 3

(vi) When NaCl crystal is exposed to Na vapours, the crystal acquires yellow colour. Explain this observation. 3

(b) Answer (i) and (ii) or (iii) and (iv) :

(i) Discuss about the osmotic pressure method for determination of the molar mass of polymer. State why this method gives number-average molar mass only. 4+1=5

(ii) A polymer sample is found to have the following distribution of molar masses :

Number of molecules	*Molar mass* (kg mol^{-1})
100	2·00
250	3·00
400	5·00
300	7·00
200	10·00
100	15·00

Calculate the number-average and the mass-average molar masses. 5

Or

(iii) Discuss the kinetics of addition polymerization. 5

(iv) Discuss how the co-ions and counter-ions are distributed around the charged colloidal particles. Define zeta potential. State how it is related to the dielectric constant of the dispersion medium. 3+1+1=5

(c) Answer *(i)* and *(ii) or (iii), (iv)* and *(v)* :

(i) For a diatomic molecule vibrating as a simple harmonic oscillator, obtain an expression for vibrational partition function. 5

(ii) Six distinguishable particles are distributed in three different energy levels (0, ε and 2ε) in the following manner. In one macrostate three particles are in the zero-energy level and the other three are in the energy level ε. In another macrostate, each energy level has 2 particles. Calculate the difference in entropy between the two macrostates. 5

Or

(iii) Deduce an expression for the translational partition function for a particle of mass m moving in a three-dimensional box of sides a, b and c, assuming that the potential is zero within the box. 4

(iv) Evaluate translational partition function for oxygen atom at 300 K contained in a volume of 1 dm^3. 3

(v) Find an expression for the internal energy of a system consisting of N independent particles in terms of molecular partition function. 3

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