Total No. of printed pages = 8

3 (Sem 6) CHM M2

2015

CHEMISTRY

(Major)

Theory Paper : M-6.2

Full Marks – 60

Time – Three hours

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

1. Answer in brief : 1×7=7

   (a) State why diffraction of X-rays by crystals can be observed, but not that of visible radiation.

   (b) State why lyophilic sols are more stable than lyophobic sols.

   (c) The intercepts of a crystal plane along the crystallographic axes are $\frac{3}{2}$a, 2b and c respectively. Find the Miller indices of the plane.

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(d) The first law of Thermodynamics is $dU = dq + dw$. State what dq refers to in terms of population of particles in energy levels.

(e) Name the type of semiconductor that may be obtained when Si is doped with phosphorus.

(f) Define polydispersity index of a polymer.

(g) Write the basic difference between electrophoresis and elecro-osmosis.

2. Answer the following questions : $2 \times 4 = 8$

(a) Find the ratio $d_{100} : d_{110} : d_{111}$ of a cubic lattice.

(b) Addition of NaCl solution to Au sol results in coagulation of the sol. But in presence of soluble starch addition of NaCl solution cannot affect precipitation of Au sol. Explain this observation.

(c) Write what you mean by partition function. What does the partition function refer to at absolute zero temperature ?

(d) Assume that the molecules of a gas are in two energy levels – zero and ε, the degeneracy being g_1 and g_2 respectively. Find the expression for the molecular partition function.

3. (a) What do you mean by thermodynamic probability ? Six distinguishable particles are distributed in three energy levels (0, ε and 2ε) in the following manner—

Energy level :	0	ε	2ε
Macrostate I :	3	3	0 (no. of particles)
Macrostate II :	2	2	2 (no. of particles)

Calculate the difference in entropy between the two macrostates I and II. 1+4=5

Or

Consider 9 distinguishable particles divided equally among 3 non-degenerate energy levels. Find thermodynamic probability for this distribution. Show how the value of thermodyamic probability changes if one particle is removed from one level and added to another level. 2+3=5

(b) Discuss about the viscosity method for determination of average molar mass of macromolecules. 5

Or

AgI sol can be prepared by adding dilute $AgNO_3$ solution to KI solution. Taking this example of AgI sol, discuss how Helmholtz double layer is formed. Explain what you mean by Zeta potential. 3+2=5

(c) (i) Distinguish between systematic error and random error. 2

(ii) The compound AB was analysed in a series of experiments when the percentage of the element A was found to be 7.146, 7.098, 6.942, 7.256 and 6.593. Find average deviation. Show whether any of the measurements can be eliminated or not. 2+1=3

4. (a) Answer either (i), (ii) and (iii) or (iv), (v) and (vi) :

(i) Explain the rock salt structure of crystal lattice. 4

(ii) Show that the packing efficiency in simple cubic lattice is 52.36%. 2

(iii) Using X-ray of wavelength 180 pm the first order reflection from a metal was found at $2\theta = 47.2^{\circ}$. If this reflection was from (110) plane of bcc unit cell, calculate edge length of the cubic unit cell. 4

Or

(iv) Show that the lowest value of redius ratio, γ_+/γ_- must be 0.414 so that the smaller cation can fit into the octahedral hole formed by the bigger anions. 3

(v) Explain what you mean by low temperature superconductivity. 2

(vi) A diffraction experiment on the element Po gave lines at the following values of 2θ when an X-ray of wavelength 71 pm was used–

12.1°, 17.1°, 21.0°, 24.3°, 27.2°, 29.9°, 34.7°, 36.9°, 38.9°, 40.9° and 42.8°. Identify the unit cell type and determine the edge length, given that Po forms cubic lattice. 5

(b) Answer either (i), (ii) and (iii) or (iv), (v), and (iv) :

(i) Explain why colloid solutions are thermodynamically unstable. 3

(ii) Explain the cleansing action of soaps and detergents. Which of these two is more effective in hard water and why ? 3+1=4

(iii) A protein sample consists of an equimolar mixture of haemoglobin, ribonuclease and myoglobin. If the molar masses of haemoglobin, ribonuclease and myoglobin are 15.5 kg mol^{-1}, 13.7 kg mol^{-1} and 17.2 kg mol^{-1} respectively, calculate number average molar mass of the protein. 3

Or

(iv) Explain why macromolecular solution shows high viscosity. 3

(v) Explain why deltas are formed at a place where rivers meet the sea. 3

(vi) Define flocculation value. Calculate the valume of 0.1 M $BaCl_2$ solution required to coagulate 1 dm^3 As_2S_3 sol, if the flocculation value of $BaCl_2$ is 4. 1+3=4

(c) Answer either (i) and (ii) or (iii) and (iv) :

(i) Deduce an expression for the most probable distribution of N numbers of distinguishable particles among the various energy levels. 6

(ii) The rotational constant of HCl is 10.59 cm^{-1}. Calculate the rotational partition function of HCl at 300 K, assuming the molecule to be a rigid rotator. 4

Or

(iii) Express internal energy in terms of partition function. Hence find the value of internal energy of 1 mol of a monatomic gas. Also deduce an expression for the heat capacity at constant volume of 1 mol monatomic gas. 2+3+2=7

(iv) Calculate translational partition function of He atom at 300K in a volume of $1m^3$. 3

(Symbols signify their usual meaning)