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**AI—308—2017**

**FACULTY OF COMPUTER STUDIES**

**M.Sc. (Second Year) (Third Semester) EXAMINATION**

**MARCH/APRIL, 2017**

**PHYSICAL CHEMISTRY**

(Paper CH-534/3A)

(Statistical Thermodynamics)

**(Thursday, 27-4-2017)**

**Time : 2.00 p.m. to 5.00 p.m.**

*Time— Three Hours*

*Maximum Marks—75*

*N.B. :— (i) Attempt All questions.*

*(ii) Use of log table and calculator is allowed.*

*(ii) Attempt MCQ at once only.*

1. Solve any *three* : 15

(a) Explain in brief Lagrange method of undetermined multiplier.

(b) Define partition function. Explain its significance.

(c) Derive :

$$S = K_b N \ln \left[ \frac{a_e}{N} \right] + \frac{E}{T}.$$

(d) Calculate the nuclear partition function.

(e) Calculate the heat capacity of an element at a temperature equal to its characteristics temperature.

2. Solve any *three* : 15

(a) Derive the rel. for fluctuation in density and radioactive disintegration.

(b) Derive the relation for p.f. and thermodynamic function of internal energy, entropy, and Helmholtz work function.

P.T.O.

- (c) Calculate the relative number of distinguishable states in ice and in water at 273 K.
- (d) Explain in brief thermal characteristics of crystalline solid.
- (e) Write a note on mean symmetry and nuclear spin.
3. (a) Explain partition function. Derive translational partition function. 8

Or

Derive the derivation of a Maxwell-Boltzmann distribution.

- (b) Explain in brief Debye theory its limitations and modification. 7

Or

Using the principle of equipartition of energy, indicate the translational, vibrational and rotational contribution to the heat capacity of the H-molecule.

4. (a) Derive :

$$C_v = \left[ \frac{nR}{T^2} \right] \left[ \frac{\partial^2 \ln a}{\partial (T^2)} \right]. \quad 8$$

Or

Derive the relation for a rotational partition function.

Calculate the rotational partition of HCl at 25°C. The rotation constant of HCl is 10.59 cm<sup>-1</sup>.

The value of kT/hc (cm<sup>-1</sup>) at 298 K is 207.20.

- (b) Show that the entropy at absolute zero in a canonical ensemble can be expressed as  $S = K \log [g_0]$ . 7

Or

Find the ratio of Iodine molecules in the ground I<sub>st</sub> and I<sub>Ind</sub> excited vibration states at room temperature. The vibrational energy levels are separated by 214.6 cm<sup>-1</sup>.

5. (A) Select the *correct* alternative : 5

- (i) The entropy.....with increasing molar mass.
- (a) decreases (b) increases
- (c) no change (d) none of these
- (ii) Partition function is a.....quantity.
- (a) Dimensionless (b) Dimension
- (c) Both (a) and (b) (d) None of these
- (iii) The entropy of Co at absolute zero is :
- (a) Positive (b) Negative
- (c) Zero (d) None of these
- (iv) Vibration contribution to energy at low temperature is :
- (a) Negligible (b) Increases
- (c) Decreases (d) None of these
- (v) Partition function increases with.....of temperature.
- (a) increases (b) decreases
- (c) zero (d) none of these

(B) Write short notes on any *two* : 2×5=10

- (i) Combinationl problem
- (ii) Lattice model
- (iii) Mean distribution and mean square deviation.