M.Sc. DEGREE (PGCSS) EXAMINATION

Faculty of Science

First Semester

Applied Physics

APH1C02 – Thermal and Statistical Physics

[For 2012 admission Students]

Time: Three Hours Maximum Weight: 30

Part A

(Answer any **SIX** questions. Each question carries a weightage of **ONE**)

1. Write a note on Canonical and grand canonical ensembles.

2. Give the physical significance of entropy.

3. Show that with the increase in pressure, boiling point of liquid increases.

4. Obtain partition function for a photon gas.

5. Write a note on density matrix.

6. Narrate Lambda transition.

7. Explain free electron model of gas.

8. Explain briefly the two fluid model for liquid Helium II.

9. State Wiener – Khinchin theorem.

10. Distinguish between first and second order phase transitions.

(6 x 1 = 6 weights)

Part B

(Answer any **FOUR** questions. Each question carries a weightage of **TWO**)

11. Prove the thermodynamic relation

$(\partial S/\partial V)_T = (\partial P/\partial T)_V$ and hence prove that

$dP/dT = L/T(V_2-V_1)$

12. Show that if the partition function is given by Z, the mean energy $\bar{E}$ is given by

$\bar{E} = - \partial \log z / \partial \beta$ where $\beta = 1/kT$

13. Calculate the value of Fermi energy at absolute zero temperature.

14. The density of sodium is 0. 97 x 10^3 kg/m^3 and its molar mass is 0.023. Find the Fermi energy of the electron gas in metallic sodium and the specific heat of sodium at a temperature T.

15. Show that the electron gas in copper is degenerate at room temperature.

16. Show that for a one dimensional, field free Ising model

$$\overline{\sigma_k \sigma_l \sigma_m \sigma_n} = [\tanh \beta J]^{n-m+l-k} \quad \text{where } k \leq l \leq m \leq n$$

(4 x 2 = 8 weights)

Part C

(Answer any **ALL** questions. Each question carries a weightage of **FOUR**)

17. What are thermodynamic potentials? Deduce from them the Maxwell's thermodynamic relations. What is the importance of these functions?

OR

Obtain Maxwell's thermodynamic relations from the I and II laws of thermodynamics.

18. Obtain the translational, rotational and vibrational partition functions for a diatomic molecule.

OR

Give a detailed introduction of BE and FD statistics in comparison to MB statistics.

19. Discuss with theory BE condensation. Explain super fluidity.

OR

Derive the equation of state of an ideal Fermi gas at very low temperature.

20. Explain Ising model. How can the results of Ising model be applied to Lattice gas?

OR

Obtain an expression for the probability density of a canonical ensemble. Show that log is additive for two systems in thermal contact with heat reservoir.

(4 x 4 = 16 weights)