Roll No. Total No. of Pages : 02

Total No. of Questions : 09

M.Sc.(Physics) (2015 to 2017) (Sem.–1)

THERMODYNAMICS & STATISTICAL PHYSICS

Subject Code : MPH-103

Paper ID : [A2712]

Time : 3 Hrs. Max. Marks : 100

INSTRUCTION TO CANDIDATES :

1. **Attempt FIVE questions in all including the compulsory question no. 9.**

Q1 a) Interpret each term of the equation dQ = dU+ dW and enunciate the law connected to it. (10)

b) Explain the concept of internal energy of a system. Formulate the first law of thermodynamics and explain its physical significance. (10)

Q2 a) Show that the probability that a system in equilibrium with a heat reservoir at temperature T may exist in a microstate of energy U_r is proportional to exp.($-U_r$/kT), where k is Boltzmann's constant. (10)

b) Using Maxwell-Boltzmann's law, show that the fraction of molecules within rhe momentum range p and p+dp is given by :

$$f(p)\,dp = 4\pi\,(1/\,2\,\pi\,mkT)^{3/2}\,e^{-p2/2mkT}\,p^2\,dp \text{ and,}$$

the fraction of molecules within the energy range ε and ε + dε is

$$f(\varepsilon)\,d\varepsilon = 2\pi\,(1/\pi kT)^{3/2}\,e^{-\varepsilon/kt}\,\varepsilon^{1/2}\,d\varepsilon \quad (10)$$

Q3 a) Differentiate between macrostate and microstate. How does probability depend upon the number of microstates? (12)

b) Define ensemble. Differentiate between canonical, micro canonical and grand canonical ensembles. (8)

Q4 a) What do you understand by the term phase space? Classify different types of phase space. Derive an expression for the number of states in the energy range E and E+dE. (12)

b) Mention the drawbacks with the definition of thermodynamic entropy. How are these overcomed in the concept of statistical entropy? (8)

Q5 a) Explain the concept of an ensemble. Distinguish clearly between canonical, micro-canonical and grand canonical ensembles. Apply it to the case of one dimensional oscillator. (12)

b) State the law of equipartition of energy. Explain the law of negative temperature. (8)

Q6 a) Give a detailed introduction of BE and FD statistics in comparison to MB statistics. Deduce Bose-Einstein distribution formula and explain the phenomenon of Bose-Einstein condensation. (12)

b) What is a degenerate gas? How do the Bose and Fermi distributions tend to explain Classical distribution? (8)

Q7 a) Deduce Fermi-Dirac distribution law. Hence obtain an expression for the energy of a Fermi gas at absolute zero and point out its physical significance. (10)

b) Define Fermi energy and derive an expression for Fermi energy at temperature T. Establish relation between mean energy of electron and Fermi energy. (10)

Q8 a) Prove with the help of necessary mathematical theory that the specific heat of a solid at low temperature varies as the cube of the temperature. Discuss critically how far you agree with the theoretical foundations of this derivation. Also discuss the modern improvements in the theory. (12)

b) Write short notes on (i) symmetric and antisymmetric wave functions and (ii) Dwarfs. (8)

Q9 a) When does quantum approach reduces to classical statistics?

b) Define internal energy. Express change in internal energy in terms of independent variables and V.

c) Give the physical significance of entropy and state second law of thermodynamics in terms of entropy.

d) Explain the term entropy. What is its S.I. unit? Show that the change in entropy in reversible adiabatic process is zero.

e) Write expressions for probability density for microcanonical, canonical and grand canonical ensembles.

f) What do you mean by Fermi temperature?

g) State law of equipartition of energy.

h) State the assumptions of Debye's theory of specific heat of solids. (8×2.5=20)