

Use separate answer
scripts for each group

B.Sc. (Honours) Examination, 2019
Semester-VI
Physics (Honours)
Course: BPC-62
(Statistical Mechanics & Solid State Physics)

Time: Three Hours

Full Marks: 40

Questions are of value as indicated in the margin.

Answer **any two** questions from **Group-A** and **two** questions from **Group-B**.

Group-A

1. a) What is an ensemble? Discuss micro-canonical and canonical ensemble.
b) Show that the number of quantum states for the particle of mass 'm' in a three dimensional potential box of edges l_x , l_y and l_z is obtained by dividing the phase space into cells each of volume h^3 , h being the Planck's constant. Also obtain the expression for the density of (quantum) states.
c) Define 'thermodynamic probability', how does it differ from mathematical Probability? Write down the expressions for 'thermodynamic probability' in M-D, B-E and F-D statistics. 3.5+4+2.5
2. a) Applying the M-B statistics obtain the expressions for the 'equation of state', 'molar internal energy', 'molar specific heat' and 'molar specific entropy' for an ideal gas.
b) Prove that the number of molecules of an ideal gas, in equilibrium at temperature T , and whose momenta lie in the range p and $p + dp$ is given by
$$N(p)dp = 4\pi N / (2\pi mkT)^{3/2} p^2 e^{-p^2 / 2mkT} dp.$$

c) How many photons are there in 1 c.c of radiation at 727°C ?
Given $\int_0^\infty \left[x^2 / (e^x - 1) \right] dx = 2.405$. 5.5+3+1.5
3. a) What do you mean by 'thermionic emission'? Write down the distribution law obeyed by electron gas and apply the same to derive Richardson-Dushman equation.
b) What is Fermi energy? Does it depend on temperature? Sketch the F-D distribution function at absolute zero and at any finite non-zero temperature.
c) The Fermi velocity of the electron in a metal is $0.7 \times 10^6 \text{ ms}^{-1}$. Calculate the Fermi temperature T_F . 5+4+1
4. a) Discuss Gibbs' Paradox. How is it resolved?
b) Discuss the difference between the Fermi-Dirac and the Bose-Einstein statistics. Under what conditions do Bose-Einstein and Fermi-Dirac statistics reduce to the classical statistics?
c) Name the statistics obeyed by each of the following particles: (i) deuterons, (ii) neutrons, (iii) He^3 , (iv) π -mesons. 3.5+4.5+2

Group-B

5. a) Calculate the packing fractions of simple face centred cubic crystal structures.
b) Derive primitive cell and write down the primitive vectors of a simple face centred lattice structure of lattice constant a .
c) Consider carbon structure and write the basis vectors required to produce the entire lattice.
d) Define reciprocal lattice vectors.
e) Show that reciprocal lattice structure of a simple fcc structure is a bcc structure. 2+2+1+3+2

P.T.O.

6. a) State the assumptions adopted in Drude's model.
b) Calculate the Electrical and thermal conductivity of metals by adopting Drude's model and hence derive the Weidmann-Franz law.
c) State the drawbacks of Drude's model.
d) What improvement was adopted in Sommerfeld's theory for metals? 2+6+1+1
7. a) Assuming the free electron model in solids obtain the density of states in one-, two- and three dimensions.
b) By adopting free electron theory, calculate the electronic specific heat of metals.
c) By adopting free electron theory obtain the variation of Chemical potential of metals with respect to temperature. 3+3+4
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