



বিদ্যাসাগর বিশ্ববিদ্যালয়  
**VIDYASAGAR UNIVERSITY**

**Question Paper**

**B.Sc. Honours Examinations 2021**

(Under CBCS Pattern)

**Semester - VI**

**Subject: PHYSICS**

**Paper : C 14-T & P**

**Statistical Mechanics**

**Full Marks : 60 (Theory-40 + Practical-20)**

**Time : 3 Hours**

*Candidates are required to give their answers in their own words as far as practicable.*

*The figures in the margin indicate full marks.*

**[Theory]**

Answer *any two* of the following:

2×15=30

1. What is Gibbs paradox? Derive Sackur-Tetrode equation for the entropy of an ideal monoatomic gas. How does it resolve the Gibbs paradox? Starting from the expression for the thermodynamic probability of Bose-Einstein statistics, obtain Plank's distribution law.

2+5+2+6

2. Show that the chemical potential of an ideal gas of Bosons cannot be positive. Explain Bose-Einstein condensation. How does it differ from ordinary condensation?

5+7+3

3. Write down the expression for the occupation probability for the Fermi-Dirac statistics, explaining the meaning of each term in the expression.

Draw the F-D distribution function  $T=0$  and  $T = \text{finite}$ . What do you mean by Fermi level in each case? What do you mean by Fermi sphere?

Consider an electron gas at  $0\text{K}$ . Show that its total energy  $u_0$  and Fermi energy  $E_F$  are related by  $u_0 = \frac{3}{5} E_F$ . Assume total number of electron is  $N$ .

5+5+5

4. Derive Stefan's law from Planck's distribution formula. Show that the number density of photons varies with the absolute temperature  $T$  as  $T^3$ .

8+7

Answer *any one* of the following:

1×10=10

5. Find out the zero-point energy of a Fermi gas.

Consider a system of two identical particles. Assume three states are possible for each particle. What are the possible states of the system when the particles are (i) bosons and (ii) fermions?

What are the probabilities of two bosons and two fermions occupying the same state?

Write down the principle involved in these cases.

3+3+2+2

6. Write down the single particle partition function for a system having two non-degenerate energy levels with energies:  $\epsilon_1 = -\mu B$  and  $\epsilon_2 = \mu B$ . Evaluate internal energy, specific heat and entropy for this system.

4+2+2+2

### [Practical]

Answer *any one* of the following:

1×20=20

7. Write down the Python program to plot specific heat of solids as given in Einstein distribution function and in Debye distribution function with temperature. Assume that the Debye temperature  $T_D$  is 225 K and the Einstein temperature  $T_E (=h\nu/k)$  is 174 K.

8. Write down the Python program to plot Fermi-Dirac distribution function with energy at three different temperatures 10K, 100K and 400K. Assume that the chemical potential in this temperature range is fixed at the zero value.
9. Write down the Python program to plot Bose-Einstein distribution function with energy at three different temperatures 10K, 100K and 400K. Assume that the chemical potential in this temperature range is fixed at the zero value.

(You may use *matplotlib* library in Python for plotting your function. You need not to show any plot. Write the necessary Python code only.)

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