B.Sc. Semester-VI Examination, 2022-23

PHYSICS [Honours]

Course ID : 62412 Course Code : SH/PHS/602/C-14/T-14

Course Title : Statistical Mechanics

Time : 1 Hour 15 Minutes Full Marks : 25

The figures in the right-hand margin indicate marks.

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

SECTION–I

1. Answer any **five** questions: 1×5=5

   a) Which of the statistics (FD, BE, and MB) will you use for a system having oxygen molecules? Explain.

   b) State the most significant difference between the assumptions of Einstein and Debye theories of specific heat of solid.

   c) Define grand canonical ensemble.

   d) Define the 'degeneracy parameter'.

   e) If three identical particles are distributed over three single particle states, how many possibilities are allowed if the particles are electrons?

   f) What are the basic assumptions of Plank's theory of Black body radiation?

   g) State Rayleigh-Jean's law for black body radiation?

   h) What is ultraviolet catastrophe?

SECTION–II

2. Answer any **two** questions: 5×2=10

   a) Derive the Richardson-Dushman equation for current density of thermionic emission from metal. 5

   b) State how the enumeration of the number of microstates leads to Gibbs Paradox. How can it be resolved? 3+2

   c) Write down the postulates of the Fermi-Dirac statistics. Derive an expression for the probability distribution of particles governed by the Fermi-Dirac statistics. 1+4

   d) For a two dimensional free electron gas, show that the number density is given by $n = \frac{4\pi mkT}{h^2} ln\left(e^{\frac{E_F}{kT}} + 1\right)$. 5

SECTION–III

3. Answer any **one** question: 10×1=10

a) Define phase space and phase trajectory. Consider a system of N weakly coupled particles obeying Maxwell- Boltzmann statistics, kept at a temperature T . Each particle may exist in one of the three non-degenerate levels of energy $-\varepsilon, 0, +\varepsilon$.

i) What is the entropy of the system at T = 0K?

ii) What is the maximum possible entropy of the system?

iii) What is the minimum possible energy of the system?

iv) What is the partition function of the system?

v) What is the most probable energy of the system?

vi) If C(T) be the heat capacity of the system, find the value of $\int_0^T \frac{C(T)}{T} dT$.

(1+1)+(1+1+1+1+2+2)

b) State Kirchhoff's law of radiation. Using classical mechanics, deduce Rayleigh-Jeans law of radiation. Assuming Plank's law, derive Wien's displacement law. Two stars A and B radiate maximum energy at 360 nm and 480 nm, respectively. What is the ratio of their absolute temperatures? 1+5+2+2

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