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6 SEM TDC PHY M 1

2017

(May)

PHYSICS

(Major)

Course : 601

(Statistical Mechanics)

Full Marks : 60

Pass Marks : 24/18

Time : 3 hours

The figures in the margin indicate full marks for the questions

1. Choose the correct option (any *five*) : 1×5=5

(a) The statistical condition of equilibrium of two systems in thermal contact is

(i) $T_1 = T_2$

(ii) $S_1 = S_2$

(iii) $\Omega_1 = \Omega_2$

(iv) $\frac{\partial}{\partial E_1} \log \Omega_1(E_1) = \frac{\partial}{\partial E_2} \log \Omega_2(E_2)$

(b) The relative probability between two different energy states having difference $1 \cdot 1 \times 10^{-20}$ joules at 40 K temperature is

(i) e^{-1} (ii) e^{-2}

(iii) e (iv) e^{2}

(c) If Z_1, Z_2, Z_3 are independent partition functions of a system, the total partition function of the combined system is

(i) $Z = Z_1 + Z_2 + Z_3$

(ii) $Z = Z_1 \cdot Z_2 \cdot Z_3$

(iii) $\frac{1}{Z} = \frac{1}{Z_1} + \frac{1}{Z_2} + \frac{1}{Z_3}$

(iv) None of the above

(d) In Bose-Einstein statistics, the number of particles condensing into ground state is

(i) zero

(ii) all

(iii) $\eta \left[1 - \left(\frac{T}{T_0}\right)^{3/2}\right]$

(iv) $\eta \left[1 - \left(\frac{T}{T_0}\right)^{1/2}\right]$

(e) The Fermi function $f(\varepsilon) = \frac{n(\varepsilon)}{g(\varepsilon)}$ has value ½, when

(i) $\varepsilon < \varepsilon_f$

(ii) $\varepsilon > \varepsilon_f$

(iii) $\varepsilon = \varepsilon_f$ at absolute zero

(iv) $\varepsilon = \varepsilon_f$ at any temperature

(f) Which gas at absolute zero temperature possesses energy and exerts pressure?

(i) Oxygen gas

(ii) Photon gas

(iii) Electron gas

(iv) No gas

2. (a) Derive Liouville theorem. 6

(b) Give thermodynamic interpretation of the Lagrange's undetermined multipliers appearing in the distribution laws. 6

3. Derive Boltzmann relation between entropy and probability. 5

4 Express internal energy in terms of partition function. 5

Or

Establish the relation $S = kN \log Z + \frac{3}{2} kT$. 5

5. Distinguish among classical statistics, Fermi-Dirac statistics and Bose-Einstein statistics. 3

6. What are the basic postulates used in Bose-Einstein statistics? Derive an expression for Bose-Einstein distribution law. 3+6=9

Or

What are fermions? Derive a distribution law for them. 3+6=9

7. Discuss the condition at which Bose-Einstein and Fermi-Dirac statistics reduces to Maxwell- Boltzmann statistics. 4

8. Apply Bose-Einstein statistics to the photon gas and derive Planck's law of blackbody radiation. 7

9. Bosons may condense at very low temperature. Discuss on the basis of statistical mechanics. 5

10. What is the cause of degeneracy pressure inside a white dwarf star? Explain the limit depending on which some stars become white dwarf and other become neutron star or black hole. 1+4=5

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