NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES
DEPARTMENT OF PHYSICS
2025_2 EXAMINATIONS

COURSE CODE: PHY311
COURSE TITLE: KINETIC THEORY AND STASTISTICAL MECHANICS
CREDIT UNIT: 2
TIME ALLOWED: (2 HRS)
INSTRUCTION: ***Answer question 1 and any other two questions***

1. Derive Maxwell's velocity distribution law From the Maxwell-Boltzmann function. Given that A = z/N where A is the degeneracy parameter, z is the partition function and N is the total number of particles. (30marks)
2. (a). Write down the rotational energy level formula for a diatomic molecule defining all the parameters (5marks)

   (b). If the rotational partition function for a certain diatomic molecule is given as:

   $Z_{rot} = \int_0^{\infty} (2j+1) e^{-\frac{j(j+1)\theta_{rot}}{T}} dj$. Where the rotational temperature $\theta_{rot} = \frac{h^2}{8\pi^2 I k_B}$. Then show that the rotational energy of the molecule is given as $U_{rot} = Nk_B T$. Take $U_{rot} = Nk_B T^2 \frac{\partial}{\partial T} \ln Z_{rot.}$ (15marks)

3. (a)Explain Fermi-Dirac distribution. (5marks)

   (b)If the number of ways of arranging a particle under Fermi statistics is given as

   $$w(N_i) = \prod \left({g_i}/{N_i} \right) = \prod \frac{g_i}{(g_i - N_i)! N!}$$

   Then show that Fermi-Dirac distribution function is given as

   $f(E) = \frac{1}{e^{\beta(E-\mu)} + 1}$. (15marks)

4. (a) (i)Define Statistical Mechanics (5marks)
   (ii)Briefly explain the concept of formulation of statistical mechanics. (5marks)
   b(i) Define Permutation as applicable to statistical physics. (5marks)
   (ii) Write the equation for both canonical and grand canonical partition function (5marks)

5. A system of two energy levels E_0 and E_1 is populated by N particles at temperature T. The particles populate the energy levels according to the classical distribution law.
   (a)Derive the expression for the average energy per particle (5marks)
   (b)Compute the average energy per particle vs the temperature as $T \to 0$ and $T \to \infty$. (5marks)
   (c) Derive an expression for the specific heat capacity of the system of N particles (5marks)
   (d) Compute the specific heat in the limit $T \to 0$ and $T \to \infty$. (5marks)