NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES
DEPARTMENT OF PHYSICS
2025_1 EXAMINATION

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. (a) Define partition function (5marks)
   (b) A certain statistical microcanonical system has only one accessible state with Energy $E = NkT\ln\frac{v}{v_0}$ Where v_0 is a constant
   (i) Write the partition function of the system (10marks)
   (ii) Find the average pressure for the system as a function of volume, and temperature.

   Note that the relationship between average pressure and partition function is given as $p = \frac{1}{\beta}\frac{\partial}{\partial v}\ln Z$ (15marks)
2. (a)(i)Two coins were tossed together in a particular statistical experiment.
   Write down the set of all possible outcomes which constitute the sample space. (5marks)
   (ii) Mention the relationship existing between entropy and probability(5marks)
   (b)(i) Explain the concept of Combination in arranging large number of statistical particles.(5marks)
   (ii) Seven physicists assembled for a meeting shake hands with one another. How many handshake took place?(5marks)

3. (a)State and explain equipartition theorem (7marks)

   (b) (i)Briefly explain Maxwell's Velocity distribution(10marks)

   (b)(ii) Draw a schematic diagram showing the Maxwellian velocity distribution.(3marks)

4. If the partition function for a phonon is given as
   $Z_{ph} = \frac{1}{1-e^{-\beta E_v}}$
   Show that the expression for Helmholtz free energy is given as
   $F = -\left(\frac{8\pi^5 k_B^4}{45\hbar^{-}}\right)v$. Take $(\int_0^\infty x^2 In\left(1-e^{-x}\right)dx = -\frac{\pi^4}{45})$ (20marks)
5. Suppose that the energy of a particle can be represented by the expression $E(z) = az^2$ where z is a coordinate or momentum and can take the values from $-\infty$ to $+\infty$.
   (a)Show that the average energy per particle for a system of such particles subjected to Boltzmann statistics is given as $\vec{E} = \frac{}{2}k\vec{l}'$. (10marks)
   (b)State the principle of equipartition of energy and discuss briefly the relation to the above calculation(10marks)