NATIONAL OPEN UNIVERSITY OF NIGERIA
PLOT 91, CADASTRAL ZONE, NNAMDI AZIKIWE EXPRESSWAY, JABI - ABUJA
FACULTY OF SCIENCES

DEPARTMENT OF PURE AND APPLIED SCIENCE

2021_1 EXAMINATIONS

COURSE CODE: **PHY311**
COURSE TITLE: **KINETIC THEORY AND STATISTICAL MECHANICS**
CREDIT UNIT: **2**
TIME ALLOWED: **(2 HRS)**

INSTRUCTION: ***Answer question 1 and any other three questions***

QUESTION 1

(a) Define the following terms;
i- ensemble ii- microstate iii-macrostates [9 marks]

(b) In how many independent ways can 200 molecules be divided evenly between the two halves of a box [5marks]

(c) How many macrostates are there that correspond to 150 molecules in one half of the box and 50 in the other. [5marks]

(d) What is the entropies for the two cases above? [6 marks]

QUESTION 2

(a) With aid of well label diagram distinguish between Energy level, Energy state and degeneracy

[10marks]

(b) Show that the Boltzmann equation describing the Microstate W of a system of entropy is

$$S = k_\beta In\, W$$ [5marks]

QUESTION 3

(a) Two states with energy difference $4.83 \times 10^{-21} joule$ occur with relative probability e^2. Calculate the temperature.(Take $k = 1.38 \times 10^{-23} j/K$) [7marks]

(b) A system can take only three different energy states
$\varepsilon_1 = 0, \varepsilon_2 = 1.38 \times 10^{-21} joule\ and\ \varepsilon_3 = 2.76 \times 10^{-21} joule$. These three state can occur in 2,

5 and 4 different ways respectively. Find the probability that at temperature 100K the system may be in

i- one of the microstate of the energy ε_3

ii- the ground state energy ε_1 [8marks]

QUESTION 4

(a) Show that the work done on the body in a reversible process at constant temperature is the change of Helmholtz free energy. [5marks]

(b) show that the entropy of a system in a canonical ensemble can be expressed as

$$\sigma = \sum_i \rho_i \, log \rho_i$$ [10marks]

QUESTION 5

(a) Eight similar cons are tossed for a large number of times. Calculate

(i) The Probability of getting the heads of 5 coins uppermost

(ii) The probability of most probable combination

(iii) The probability of least probable combination. [9marks]

(b) Calculate the probability that in tossing a coin 10 times we get

(i) all heads

(ii) 5 heads 5 tails

(iii) 3 heads 7 tails [6marks]