



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

DEPARTMENT OF PURE AND APPLIED SCIENCE

OCT/NOV 2019 EXAMINATIONS

**COURSE CODE:** PHY 311  
**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**

1. a. Prove that  $K.E = 3/2KT$  Using equipartition theorem (6marks)
- b. Show the relationship  $\gamma$  for a polyatomic gas having  $f$  degrees of freedom (5marks)
- c. Briefly discuss the physical meaning of the following:
  - (i) Heat Capacity (2 marks)
  - (ii) Enthalpy (2 marks)
  - (iii) Helmholtz free energy (2 marks)
  - (iv) micro canonical Ensemble (2 marks)
  - (v) Canonical Ensemble (2 marks)
  - (vi) Grand Canonical Ensemble (2 marks)
  - vi) Partition function (2 marks)

**QUESTION 2**

Consider a system of  $N$  classical linear harmonic oscillators. Calculate

- a) The final entropy of the system (7 marks)
- b) The change in entropy of the system. (8 marks)

**QUESTION 3**

- a. What do partition function, Gibbs free energy, and chemical potential for gas particles absorbed on a one-dimensional “surface” look like? (6 marks)
- b. Which quantities are constant in the following?
  - (i) micro-canonical ensemble (3 marks)

- ii) canonical ensemble (3 marks)
- iii) grand-canonical ensemble (3 marks)

#### QUESTION 4

- a) What is Statistical mechanics? (5 Marks)
- b) Consider systems of 100 molecules in otherwise empty rooms. What is the average number of molecules in the front third of the rooms, the standard deviation about this value, and the relative fluctuation? (10 Marks)

#### QUESTION 5

- a. Which are the units of the micro-canonical and the grand-canonical partition function? Briefly explain. (5 marks)
- b. Calculate the isothermal compressibility of the fermion gas consisting of the free electrons in silver. Compare your answer with the experimental value for silver of  $0.99 \times 10^{-11} Pa^{-1}$ . (5 marks)
- c. Express the heat capacity at constant volume CV and the heat capacity at constant pressure CP as a second derivative of an appropriate thermodynamic potential (N = const) (5 marks)