



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

DEPARTMENT OF PHYSICS

2024 1 EXAMINATION

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 2 questions*

1. (a). Two coins are tossed, what is the probability that
 - (i.) Two heads appear
 - (ii.) At least, one tail appears
 - (iii.) At least one head appears
 - (iv.) Probability of getting at least one head and one tail.
- b (i) Differentiate between microcanonical, canonical and Grand canonical ensemble.
- (ii) Using the dumb-bell model of diatomic molecules, write down the formula for momentum Inertia of the diatomic molecule
2. Using the statistical equation of the partition function and equation of entropy explain and derive Gibb's paradox.
3. The total energy of a photon as describe using Planck's radiation law is given as

$$u = \int_0^{\infty} u_{\nu} d\nu = \frac{8\pi h}{c^3} \int_0^{\infty} \frac{\nu^3 d\nu}{e^{\frac{h\nu}{k_B T}} - 1}$$

- (a) Obtain Rayleigh law and Wein displacement law
- (b) Show that the relationship between the total energy u and Stefan's constant α is given as

$$u = \frac{8\pi^5}{15(ch)^3} (k_B T)^4 = \alpha T^4. \text{ Take } \int_0^\infty \frac{x^3}{e^x - 1} dx = \frac{\pi^3}{15}$$

4. (a) Using graphical illustrations, explain electronic heat capacity
(b) Give the definition of entropy in statistical physics
(c) Give a general argument to explain why and under what circumstances the entropy of an isolated system will remain constant or increase.
5. (a) A classical harmonic oscillator of mass m and spring constant k is known to have a total energy E but its starting time is completely unknown. Find the probability density function $p(x)$ where $p(x)dx$ is the probability that the mass would be found in the interval dx at x .
(b) What are the reduced density matrices in position and momentum spaces?

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