



Department of Physics

Indian Institute of Technology Kharagpur

Kharagpur-721302, West Bengal, India

Subject No. PH41023(Statistical Physics-I)

Tuesday 31st January, 2023

date : 1st February 2023

Total Marks: 10

Class Test

§1. Let $P(x) = C e^{\frac{-x^2}{2a^2}}$ where C and a are constants.
Calculate $\langle x \rangle$ and $\langle x^2 \rangle$ given this probability distribution.

§2. Gas molecules of mass m are confined in a cylinder of radius R and height L (with $R \gg L$) kept vertically in the Earth's gravitational field. The average energy of the gas at low temperatures (such that $mgL \gg k_B T$) is given by

§3. The free energy of the gas of N particles in a volume V and at a temperature T is

$$F = Nk_B T \ln[a_0 V (k_B T)^{5/2} / N],$$

where a_0 is a constant and k_B denotes the Boltzmann constant. The internal energy of the gas is

§4. Consider an ideal gas whose entropy is given by

$$S = \frac{n}{2} [\sigma + 5R \ln \frac{U}{n} + 2R \ln \frac{V}{n}],$$

where n is the number of moles, σ is a constant, R is the universal gas constant, U is the internal energy and V is the volume of the gas. The specific heat at constant pressure is then given by