PHY304 - Statistical Mechanics

Spring 2021, IISER Mohali

Instructor: Dr. Anosh Joseph

PHY304: Homework 4

Due: Monday, February 22, 2021 at 11:00pm.

(Upload your solutions to Moodle as a single `.pdf` file.)

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1. Consider N massless particles of relativistic ideal gas in a volume V. Calculate the following:

   (a.) Canonical partition function Z.

   (b.) Internal energy $U \equiv U(T, V, N)$.

   (c.) Pressure p.

   (d.) Free energy $F \equiv F(T, V, N)$.

   (e.) Entropy $S \equiv S(T, V, N)$.

2. Consider N number of classical non-interacting particles moving inside a volume V. They have the potential energy

$$V(q_\nu) = g \sum_{k=1}^{N} \left(q_{ix}^4 + q_{iy}^4 + q_{iz}^4 \right), \tag{1}$$

   with g denoting a positive constant.

   Compute the internal energy $U \equiv U(T, V, N)$ of this system.

   Hint: You may use

$$\int_0^\infty e^{-x^n} dx = \Gamma(1 + \frac{1}{n}). \tag{2}$$