Problem Set #1

Phys 614

Due: 12 Noon, Thursday, April 13, 2023

Problem 1

For a quantum-mechanical system of non-interacting particles in the Grand Canonical Ensemble, calculate the probability $P(N)$ that the system has exactly N particles. Express your answer entirely in terms of N and the mean number of particles $\bar{N}$.

Problem 2

Do the same as (1) for a system of classical, but indistinguishable, non-interacting particles all moving in a common potential $V(\vec{r})$.

Problem 3

What is the statistical significance of your answers to problems (1) and (2)?

Problem 4

Consider a system of non-interacting "N-yons", particles which are between Fermions and Bosons in the following sense: For "N-yons", the largest number of particles allowed in one quantum-mechanical state is $N_{\max}$ ($1 \leq N_{\max} \leq \infty$), independent of the state.

(a) Find the mean occupation number $\langle n_i \rangle$ of a state with single-particle energy ϵ_i.

(b) Show that you recover the Fermi result for $\langle n_i \rangle$ if $N_{\max} = 1$.

(c) Show that you recover the Bose result for $N_{\max} \to \infty$.