J99T.1—Weirdons

Problem

Suppose a new kind of particle is discovered. This particle is known as the weirdon since it obeys weird statistics in which a given state may contain 0, 1, or 2 particles. Furthermore, weirdons are one dimensional and we will be considering a gas of non-interacting weirdons confined to a straight line of length L. The weirdons are weakly coupled to a thermal reservoir at temperature τ and the weirdon mass is m.

a) Suppose the chemical potential of the weirdons is μ. What is the occupancy of a state with energy ϵ? In addition, give numerical values of the occupancy for $(\mu-\epsilon)/\tau = -\infty$, $(\mu-\epsilon)/\tau = 0$, and $(\mu - \epsilon)/\tau = +\infty$

b) What is the density of states? (That is, the number of states per unit energy as a function of energy?) Remember, the weirdons are one dimensional and are confined to a "box" of length L.

c) Suppose the weirdon gas is cold ($\tau \to 0$) and contains N weirdons. What is the chemical potential?

d) Under the same conditions as part c), what is the total energy of the weirdon gas? Be sure to eliminate μ from your expression.

e) The low temperature heat capacity of the weirdon gas is proportional to the temperature to some power, $C \propto \tau^{\alpha}$. What is α?