NORTHERN ILLINOIS UNIVERSITY

PHYSICS DEPARTMENT

Physics 283 – Modern Physics Spring 2023

Problem Set #11

Problem Set Due: Thurs., April 27, 2023
Read Krane: Chapter 10

1. Consider the case in which 6 non-interacting particles share 8 units of energy (where each particle is restricted to hold only integer units of energy). Using methods similar to what was done in class:

(a) Treat the particles as identical but distinguishable. Calculate the normalized probabilities of finding a particle with 8,7,6,5,4,3,2,1, and 0 units of energy. That is, calculate $f(E=8), f(E=7), f(E=6), \ldots, f(E=0)$. Plot $f(E)$ verses E. This distribution is the Maxwell-Boltzmann distribution.

(b) Treat the particles as identical but indistinguishable. Calculate the normalized probabilities of finding a particle with 8,7,6,5,4,3,2,1, and 0 units of energy. That is, calculate $f(E=8), f(E=7), f(E=6), \ldots, f(E=0)$. Plot $f(E)$ verses E. This distribution is the Bose-Einstein distribution.

(c) Treat the particles as identical but indistinguishable and obeying the Pauli Exclusion Principle. Calculate the normalized probabilities of finding a particle with 8,7,6,5,4,3,2,1, and 0 units of energy. That is, calculate $f(E=8), f(E=7), f(E=6), \ldots, f(E=0)$. Plot $f(E)$ verses E. This distribution is the Fermi-Dirac distribution.

2. Krane: **Problem 10** page 337 (show figure)

3. Krane: **Problem 12** page 337 (just show calculation)

4. Derive Equation 10.52 (the average energy of a free electron gas at absolute zero, $T = 0$)

5. Krane: **Problem 24** page 338 (sketch energy level diagram)