Physics 410 -- Spring 2018

Homework #8, due Wednesday March 28

1. [1] Kittel & Kroemer, Chapter 6, problem 1.

2. [1] Kittel & Kroemer, Chapter 6, problem 2.

3. [3] Kittel & Kroemer, Chapter 7, problem 1.
For part (a), it is easy to get an answer a factor of 2 too small. When you calculate the number of orbitals between k and k+dk, realize that k can be positive or negative.

4. [3] Kittel & Kroemer, Chapter 7, problem 11.
Start from the Grand Canonical probability distribution. In class we showed how to derive $\langle N \rangle$ from $\mathcal{Z}$. You must also derive $\langle N^2 \rangle$ from $\mathcal{Z}$. Remember, there are only two terms in the grand canonical sum for fermions, so don't waste time and paper using the derivative trick. The whole problem can be done in 2 lines once you figure it out.

5. [3] Kittel & Kroemer, Chapter 7, problem 12.
You can do this one using Eq. (5.83), as suggested. The reason I am not asking you to do this one from scratch, as in the previous problem, is because $\mathcal{Z}$ has an infinite number of terms in the sum for bosons.

6. [4] Kittel & Kroemer, Chapter 7, problem 3, part (a) only.
There are two ways to do this problem.
Method 1: Start from the definition of pressure, Eq. (3.26). Don't worry about how to take a derivative at constant entropy – if you keep the system in its ground state the entropy doesn't change. Use the formula for the ground state energy U_0 of the Fermi gas, Eq. (7.10), but expressed in terms of the volume V.
Method 2: Start from Eq. (7.12), where X is the pressure p. To calculate the pressure due to a single orbital, all you need to know is how the energy of the orbital depends on the system volume, which is given in the problem.