HW 6_2.

1. When we heat a specimen from absolute zero not every electron gains an energy proportional to k_BT. Note that electrons are fermions that obey Pauli's exclusion principle so an electron can only absorb energy if it can jump to an empty state. There are simply no empty states available in the lower energy range. Check Fig. 3 in chapter 6. At 500 K the Fermi Dirac distribution is still very steep so a couple of k_BT below the Fermi-level the $f(\varepsilon)$ is very close to 1. Only at very high temperatures i.e. 10,000 K or higher, I can expect empty states to exist at low energy levels. For normal temperatures at which we use electronic materials in devices, only empty and occupied states co-exists a couple of k_BT from the Fermi-level.
   a. Rework the derivation of page 141 and 142 to find the change in total internal energy in the free electron gas. Do not use the Planck distribution as we used for phonons in chapter 4, but use the Fermi-Dirac distribution for f(e), i.e. derive expression (27).
   b. In (a) you derived the ΔU, i.e. the change of internal energy caused by a temperature change. Can you modify this equation to get the total U?
   c. Once you get at equation (27) explain the meaning of each term in the integral in words.
   d. Rework the derivation on page 142 and 144 for the heat capacity of a free electron gas.

2. Compare the density of states of electrons in 3D with the density of states of phonons in 3D. How do they differ, and why are they different? Explain!

3. Work problem 6 at the end of chapter 6.

4. Work problem 10 at the end of chapter 6.

5. Work problem 9 at the end of chapter 6.