Physics 410 -- Spring 2018

Homework #9, due Wednesday April 4

1. [3] Kittel & Kroemer, Chapter 8, problem 1.
   Part (a) is a rehash of what we already did in class. Do it anyway for practice. For part (c), you may find it easier to draw separate diagrams for energy and entropy.

2. [1] Kittel & Kroemer, Chapter 8, problem 2, part (b) ONLY.
   This is nearly identical to the previous problem, except now you are using the combined system as an air conditioner instead of as a heat pump. When you are done, plug in the same temperatures as in problem 1 to get a numerical value for the ratio Q_l/Q_{hh}.

3. [2] Kittel & Kroemer, Chapter 8, problem 7.
   A simple "yes" or "no" is not enough here! You must explain your answer. Calculate the net cooling power (heat removed from the interior per unit time) of the refrigerator if the interior is at -13 C and the exterior is at 27 C. Don't forget about the 100 W of power going into the interior from the light bulb. If you answered "no" to the question, then the net cooling power for this example will certainly be negative.

4. [2] Kittel & Kroemer, Chapter 8, problem 5.

5. [3] Kittel & Kroemer, Chapter 8, problem 6.
   It is not clear what the authors mean by "cooling power" in this problem. For this problem only, assume they are referring to the power P supplied to the cooling unit. (Normally, the term "cooling power" means the net heat taken out of the cold reservoir per unit time, i.e. $\dot{Q}_l$.)

6. [4] Kittel & Kroemer, Chapter 8, problem 3.
   This is the hardest problem on this set. You will find equations 4.20, 4.23, and 4.52 helpful. To answer part (a), you don't have to go through all 4 steps of the cycle. You can just look at the two isentropic steps, $2 \rightarrow 3$ and $4 \rightarrow 1$.

   I suggest you define the following constant to save writing: $\alpha \equiv \dfrac{\pi^2}{15\hbar^3 c^3}$