Assignment Two
Statistical Physics
Kigali Institute of Science and Technology
December 2011

This assignment is due at the beginning of class on Wednesday, 28 December. Please let me know if you have questions on any of these problems. I am happy to meet and provide help. I probably will not be available over the weekend, however.

These exercises are based on problems 1.26, 1.33, and 1.36 from Schroeder's book *An Introduction to Thermal Physics*. My shipment of these books has still not arrived from the U.S., but I continue to hope it will arrive soon. I will let you know as soon as they arrive. In the mean time, there is one copy of this book that you can consult in the department library.

1. A battery is connected in series to a resistor, which is immersed in water (to prepare a nice hot cup of tea). Would you classify the flow of energy from the battery to the resistor as "heat" or "work"? What about the flow of energy from the resistor to the water?

2. An ideal diatomic gas, in a cylinder with a movable piston, undergoes the rectangular cyclic process shown in Fig. 1.34 on page 23 of the textbook. Assume that the temperature is always such that rotational degrees of freedom are active, but vibrational modes are "frozen out." Also, assume that the only type of work done on the gas is quasi-static compression-expansion work.

   (a) For each of the four steps A through D, compute the work done on the gas, the heat added to the gas, and the change in the energy content of the gas. Express all answers in terms of P_1, P_2, V_1, and V_2. (Hint: Compute ΔU before Q, using the ideal gas law and the equipartition theorem.)
   (b) Describe in words what is physically being done during each of the four steps; for example, during step A, heat is added to the gas (from an external flame or something) while the piston is held fixed.
   (c) Compute the net work done on the gas, the net heat added to the gas, and the net change in energy of the gas during the entire cycle. Are the results as you expected? Explain briefly.

3. In the course of pumping up a bicycle tire, 1 litre of air at 1 atmosphere is compressed adiabatically to a pressure of 7 atmospheres. (Air is mostly diatomic.)

   (a) What is the final volume of the air after compression?
   (b) How much work is done compressing the air? (Be careful with units.)
   (c) If the air temperature is initially 300 kelvin, what is the the temperature of the air after compression?