IN WORKING THESE PROBLEMS YOU WILL NEED TO LOOK UP SEVERAL PROPERTIES OF THE GASES AND LIQUIDS INVOLVED (E.G., DENSITIES AND HEAT CAPACITIES, ETC.), AS WELL AS VALUES OF FUNDAMENTAL CONSTANTS AND CONVERSION FACTORS BETWEEN DIFFERENT UNITS. AND YOU WILL NEED TO MAKE SIMPLIFYING ASSUMPTIONS AND APPROXIMATIONS.

1. Use the ideal gas law to generate Fig. 1.3 in the text (Fig. 1.2 in the 1st edition).

2. Consider Example Problem 2.2 in the text (it’s also Example Problem 2.2 in the 1st edition), in which 10g of water boils at 373K under a pressure of 1 atm. How much heat is absorbed by these 10g during this process?

3. Show that $C_p - C_v = R$ for a mole of ideal gas.

4. Consider a mole of ideal gas whose initial state is $T = 350K$ and $P = 2$ atm, which is heated at constant volume to a pressure of 10 atm. Afterwards, it expands reversibly and isothermally until its pressure drops back down to 2 atm. Finally, it is brought back to its initial state by extracting heat at constant pressure.
   (a) Draw this closed-cycle set of processes as a P-V diagram.
   (b) Calculate $w$ for each step, and for the overall process.

5. Suppose a mole of water is heated by 20K, at constant pressure (1 atm), from room temperature. Using the fact that the volume of water increases by about .02% upon its temperature being raised by 1K, calculate $w$, $q$, $\Delta U$ and $\Delta H$ for this heating process. What assumptions and approximations have you made in order to solve this problem?

6. The typical pressure in a car tire on a warm day (say, 80F) is about 40 psi. Suppose the valve is opened and the compressed air expands adiabatically against the constant external pressure of 1 atm. At the time the air pressure reaches 1 atm (and therefore the air stops expanding), what will be the temperature of the air? Keep tract of the assumptions and approximations you’ve made to solve this problem.

7. Conversely, consider the pumping up of a flat (14.7 psi) bicycle tire as an adiabatic compression of the air inside it. If the initial temperature of the air in the tire is 80F, how hot will it be when the pressure has been pumped up to 75 psi?

8. Suppose our bodies didn’t radiate any energy in the form of heat, i.e., imagine that our skin were perfectly thermally insulating. If our normal metabolism generated 10 kJ per hour per kg of body mass, what would be the increase in our body temperature after 2 hours? (Estimate our body’s heat capacity by that of water.)