PHAS2228: Statistical Thermodynamics Problem Sheet 1
Solutions to be handed in to Dr Campanelli by 27th October 2008

1. A system in a heat bath consists of a mole of a perfect gas with a pressure of 1.7 $\times 10^4$ N m^{-2} and a volume of 1.9 m^3 . It is compressed reversibly until it reaches a pressure of 6.0 $\times 10^4$ N m^{-2}.

(i) Calculate the heat transferred (in J) between the system and the heat bath during the compression, showing all your working.

(ii) Is heat gained or lost by the system?

(iii) What is the temperature of the system (in K)? [the gas constant R = 8.31 J mol^{-1} K^{-1} .]

2. Write down the equation of state for a mole of a perfect monoatomic gas, using only its energy E , pressure P , and volume V as variables. If P = 2 $\times 10^5$ N m^{-2} and the gas is in a cylindrical volume of radius 0.15m and length 1.2m, calculate the total thermal energy of the gas and its temperature.

(a) A frictionless piston is used to quasistatically compress the gas to one third of its original volume. If this compression is carried out isothermally, calculate how much work is done on the gas, and the change in total thermal energy.

(b) repeat the calculation as for (a) but now assume that the compression is isobaric (i.e. at constant pressure).

(c) after the isobaric compression in case (b), the pressure is now increased at constant volume until it reaches the final situation of case (a). Again calculate the work done on the gas and the energy change.

[Hint: you will find it useful in (a) to (c) above to draw a P V diagram of each change.]

3. Show that for a quasistatic adiabatic pro cess in a perfect gas, with constant sp ecific heats (Cp and Cv), the following relation holds: P V^γ = constant where γ=Cp /Cv .