Assignment 10

1. This question is based on Prob. 6.18 in the text.
(a) Do the first part of Prob. 6.18, showing how Z (the partition function) can be used as a generating function to obtain the mean value of E^2 (i.e. derive the first equation in the problem).
(b) Write the quantity, $(\sigma_E)^2$ (for which you have an expression in your notes) in terms of Z and its derivatives with respect to β.
(c) Now write the specific heat at constant volume, $C_V = \partial U/\partial T|_V$, with a change of variables so that it is expressed in terms of a partial of U with respect to β, rather than T.
(d) Since you know how U can be generated from Z (see notes), it is now possible to carry out the differentiation to find an expression for C_V in terms of Z, β, and constants. Write the final result for C_V in terms of $(\sigma_E)^2$ and temperature (rather than β) and verify that it agrees with the second equation in Prob. 6.18.
(e) It should now be clear that a wider distribution function corresponds to a higher value of C_V. Look up typical specific heats for steam (water vapour), liquid water, and ice. Do a rough hand sketch of the distribution functions of each on the same graph. (I am interested in the widths of the distribution function, rather than their amplitudes). Comment on the results.

2. Do Prob. 6.39 in the text. You may omit the repetition for the He atom in part (b). [FYI at a temperature as high as 1000 K the height is greater than 100 km.]

3. Starting with the Helmholtz Function for a monatomic ideal gas, derive Eqn. 2.49.