# Physics 140B: Homework 2
# Due Jan 28, 2010

1. A problem from the previous chapters:

   Consider a gas consisting of 1 kilomole of Helium-4 atoms at 0° C and at atmospheric pressure.

   a) Using Maxwell's law of distribution of speeds (11.28), determine the number of atoms in this gas whose energy $\varepsilon$ lies within an interval of width $10^{-22}$ J around the mean value of $\varepsilon$. *viz.* $\frac{3}{2}kT$.

      *Hint: For this, it may be better that you first express Maxwell's distribution law in terms of the variable $\varepsilon$, rather than $v$.*

   b) Next, using expression (12.25), determine the number of "single-particle energy states" that lie within the energy interval specified above.

   c) Finally, determine the *mean* number of particles *per* energy state in this range of $\varepsilon$.

2. Solve Carter's problem 18.6.

3. Solve Carter's Problem 18.9.

   *Hint: For this, write $U = u(T) \cdot V$ and $P = \frac{1}{3}u(T)$, to finally show that $u \propto T^4$.*

4. Solve Carter's problem 18.16.

5. Consider a Bose-Einstein gas, in three dimensions, consisting of particles with energy-momentum relationship $\varepsilon = Ap^s$, where $A$ is a constant and $s$ a number; the values $s = 1$ and $s = 2$ are quite familiar, but here $s$ is unspecified.

   Examine the phenomenon of Bose-Einstein condensation in this gas and determine

   a) the manner in which the condensation temperature $T_B$, depends on the particle density $N/V$,

   b) the manner in which the condensate fraction $N_0/N$ varies with $T$, and

c) the manner in which the specific heat $C_v$, and the entropy $S$ of the gas vary with $T$ when $T < T_B$.

*Hint: in lieu of the number of "single-particle energy states", $g(\varepsilon)d\varepsilon$, make use of the phase space expression* $4\pi V \frac{p^2 dp}{h^3}$.