PHYS 114 Contemporary Physics II - Rec 3

January 30, 2008

Specific heat capacity: The most exciting thing in chapter 11!

We are going to calculate and plot some of the basic formulas and ideas from last weeks lecture. Remember when plotting you need to import the proper libraries with the command:

```
from pylab import *
```

To access all of the plotting functions. Also you may find the commands:

```
figure(2)
subplot(211)
```

The first command makes a new plot (change the number 2 to another value for multiple plots) and the second command makes a subplot within the current plot that you are using. For an explanation of the 211 see the pylab webpage, or just play with the numbers yourself!

- First we are going to plot Ω_{total} for a system of two blocks A and B. Block A contains 450 harmonic oscillators (HO) and B contains 550 HO. There are $q = 2000$ quanta in the system. Plot Ω_{total} as a function of q_A, i.e. the number of quanta in block A. Have your program identify the most likely value of q_A and output it to the graph.

- Now plot the entropy $S = k \ln \Omega$ for the range of q_A. Plot S_A, S_B and $S_{total} = S_A + S_B$. Again have your program identify the most likely q_A.

- Now consider the composite block $C = A + B$. This block has 1000 HO which, for the purpose of this assignment, we will consider them lead atoms. Adding one quanta to the system changes then energy by $\Delta E = \hbar\omega$. You can calculate ω if you are given the mass and effective spring constant ($k_s = 5N/m$) of a lead atom. Given that the temperature is found by:

  $$\frac{1}{T} \approx \frac{\Delta S}{\Delta E} \tag{1}$$

  Plot the temperature (not the inverse!) as a function q for the range $q = [1000, 2000]$.

- We can now calculate the specific heat capacity C, for each atom. Plot the values of:

  $$C_{per\ atom}(T) \approx \frac{1}{n}\frac{\Delta E}{\Delta T} \tag{2}$$

  Compare this value to the experimental value of $C_{per\ atom}(T) = 3.8 \times 10^{-23} J/K$.