Physics 140B: Homework 1
Due Jan 21, 2010

1. Consider a system of 1,000 diatomic molecules at temperature $T = \frac{1}{2}\theta_{vib}$.

   a) Find the mean number of molecules in the three lowest vibrational states.

   b) Find the mean vibrational energy per molecule in terms of the quantity $k\theta_{vib}$.

2. For a diatomic gas at a temperature $T \gg \theta_{rot}$, what fraction of the molecules will have their rotational energy greater than kT ?

3. For diamond, the Einstein temperature is estimated at 1450 K and the Debye temperature at 1860 K. Using both Einstein and Debye models, calculate the specific heat c_v of diamond at a temperature of 150 K; express your result in $J\,\text{kilomole}^{-1}\,K^{-1}$.

4. Solve Carter's Problem 18-3.

5. As a follow up to the above problem, calculate the "solar radiative flux" per unit area per unit time, as observed on the surface of the Earth. The distance between the Sun and the Earth is $1.5 \times 10^{11} m$.

   Next, suppose that the Earth, in order to maintain a *steady state*, continues to radiate away into space as much energy as it receives from the Sun. If the Earth is treated as a black body, what would its steady state temperature be? (Note that the Earth's own size is not relevant to this calculation).

6. Solve Carter's Problem 18-4.