

Physics 308: Assignment 2

Due in class Thursday, January 24, 2008

1. The energy of a particle in a classical, ideal gas fluctuates about an average value $\frac{3}{2}kT$ because of collisions. (a) Verify this by calculating $\langle \epsilon \rangle$, the mean of $\epsilon = \frac{1}{2}mv^2$, with respect to the Maxwell-Boltzmann speed distribution. (b) Show that $\langle \epsilon^2 \rangle - \langle \epsilon \rangle^2 = \frac{3}{2}(kT)^2$.
2. Consider a diatomic molecule with a single vibrational mode. Its energy spectrum is $\epsilon_n = \hbar\omega(n + \frac{1}{2})$, where $n = 0, 1, 2, \dots$ and ω is the characteristic frequency. (a) Show that the contribution to the specific heat is

$$C_{\text{vib}} = k_B e^{-\beta\hbar\omega} \left(\frac{\beta\hbar\omega}{1 - e^{-\beta\hbar\omega}} \right)^2.$$

- (b) Make a sketch of C_{vib} as a function of temperature.
3. 8–20 from *Modern Physics*, pg. 386
4. 8–24
5. 8–25