Physics 162a, Fall 2008 – Problem Set 6
Due Monday, October 27

1. Consider a nonrelativistic particle in one dimension. Let $f(\hat{x})$ be expandable in a power series. Show that $[\hat{p}, f(\hat{x})] = -i\hbar \frac{\partial f}{\partial x}(\hat{x})$.

2. Consider a spin-$\frac{1}{2}$ system with Hamiltonian $H = -\mu B \hat{S}_z$. Compute the entropy of the system in the canonical ensemble as a function of temperature. Compute the limit of the density matrix and of the entropy as the temperature goes to zero, and as the temperature goes to infinity. Given a qualitative explanation of the behavior of these quantities in each of these limits.

3. Compute the density matrix, the entropy, and the average energy of a simple harmonic oscillator in the canonical ensemble.


5. Consider a 1d particle in a potential $V = \frac{1}{4!}x^4$. Using scaling, find the characteristic length and energy scales of the system.