Physics 220
Homework #4
Spring 2017
Due Wednesday, 5/3/17

1. Griffith's 2.12
2. Griffith's 2.15
3. Prove that $\hat{H}\left(\hat{a}_-\left|\psi_n\right\rangle\right)=\left(E_n-\hbar\omega\right)\left|\psi_{n-1}\right\rangle$.
4. Starting from $\left|\psi_0\right\rangle$, use the raising operator to determine $\left|\psi_2\right\rangle$. Don't forget to normalize your solution. Then, using the analytic solution to the harmonic oscillator $\left|\psi_m\right\rangle=\left(\frac{m\omega}{\pi\hbar}\right)^{\frac{1}{4}}\frac{1}{\sqrt{2^m m!}}e^{-\frac{m\omega}{2\hbar}x^2}H_m\left(\sqrt{\frac{m\omega}{\hbar}}x\right)$ show that your solution using the raising operator for $\left|\psi_2\right\rangle$ agrees with the analytic solution.
5. Consider a charged particle of mass m and charge q in a one-dimensional harmonic oscillator potential. Suppose that an electric field E is turned on so that the potential energy is given by $V=\frac{m\omega^2}{2}x^2-q\mathrm{E}x$. What are the energies of the states? Hint: The problem is easier with a change of variables and thus let $y=x-\frac{q\mathrm{E}}{m\omega^2}$.
6. Griffith's 3.10
7. Griffith's 3.13