Homework Assignment #12
Due date: Wednesday, December 13, 2017

1. Reed, Chapter 9, 9-4
2. Reed, Chapter 9, 9-5
3. Reed, Chapter 9, 9-6
   It may help you to sketch the potential V(x).
4. Consider a particle of mass $m$ in the usual infinite square well potential that extends from $x = 0$ to $x = L$. What is the first-order correction to the unperturbed energy eigenvalues if the potential is subjected to a perturbation $\Delta V = \frac{1}{2}kx^2$?
5. A harmonic oscillator in the ground state is subjected to a perturbing potential $\Delta V = \beta x^4$. What is the first-order correction to the ground state energy? Recall that the ground state eigenfunction is
   \[ \psi_0 = \frac{\sqrt{\alpha}}{\pi^{1/4}}e^{-\alpha^2x^2/2} \text{ where } \alpha = \left(\frac{mk}{\hbar^2}\right)^{1/4} \]
   Give your answer in terms of $\alpha$ and $\beta$. You will need ONE of the following integrals:
   \[ \int_0^{\infty} x^n e^{-cx} dx = \frac{n!}{c^{n+1}} \]
   \[ \int_0^{\infty} e^{-cx} dx = \frac{1}{2} \sqrt{\frac{\pi}{c}} \]
   \[ \int_0^{\infty} x^2 e^{-cx} dx = \frac{1}{4c} \sqrt{\frac{\pi}{c}} \]
   \[ \int_0^{\infty} x^3 e^{-cx} dx = \frac{3}{8c^2} \sqrt{\frac{\pi}{c}} \]
6. Reed, Chapter 9, 9-21