HW #7 Problems
Quantum 521

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1. Solve the double delta-function potential and obtain the even and odd parity energy eigenstates.

$$V(x) = -V_0 \left[\delta(x-a) + \delta(x+a)\right]$$

For what value of V_0 does only the ground state exist?

In the limit $mV_0a \gg \hbar^2$ find the binding energies. Explain physically why the binding energies become close together as a goes to infinity.

2. Consider the one-dimentional scattering of a particle of mass m and energy $E > 0$ off of an arbitrarily shaped potential barrier $V(x)$ that is non-zero only in the interval $0 < x < a$. Prove that the transmission coefficient is the same whether the particle is incident on the barrier from the left or the right.

3. Find the uncertainty product $\Delta x \Delta p$ for the simple harmonic oscillator for all states $|n\rangle$.

4. Calculate the time evolution of $\langle x \rangle$ and $\langle p \rangle$ for for the simple harmonic oscillator.

5. Prove that the parity operator for the one dimensional simple harmonic oscillator is $\hat{P} = \exp\left(i\pi\hat{N}\right)$ where $\hat{N}$ is the number operator.

6. Consider a charged particle $-q$ in a one dimenstional harmonic oscillator $V(x)$ with a constant electric field $\mathcal{E}$ in the x-direction. Find the energy eigenvalues. Find the energy eigenvectors.

7. For the ammonia molecule take the state at $t = 0$ to be $|\psi(0)\rangle = |1\rangle$. Calculate the probability as a function of time for the molecule to be in state $|1\rangle$.