Quantum Physics PHY4215- Exercise Sheet 10

1. An electron is bound in a one-dimensional region of space by a spring-like force with an effective spring constant of $k = 90.4$ eV nm^{-2}. (a) What is the ground state energy ? (b) How much energy must be absorbed for the electron to jump from the ground state to the second excited state ?

2. (a) At the classical turning points $\pm A$ the simple harmonic oscillator has kinetic energy $K = 0$ and potential energy $U = E$ where E is the total energy. USe this to show that $A = \sqrt{\frac{\hbar\omega_0}{k}}$ for an oscillator in the ground state.
(b) Find the turning points in the first and second excited states.

3. For the electron in example 1, in the ground state, what is the probability of finding it in a narrow interval of width 0.004nm located halfway between the equilibrium position and the classical turning point ?

4. Explain how the parity properties of energy eigenfunctions is used to show that the expectation value of x in all the energy eigenstates $\psi_n(x)$ of the harmonic oscillator is zero.