1. The energy difference between the ground state (lowest energy level) and first excited state (next level up) in a hydrogen atom is about 10 eV (eV = electron volt). The diameter of a hydrogen atom is ≈ 1 $\AA = 10^{-10}$ m. If we model a hydrogen atom as a 1-D box with hard walls, then what is the length of the box to get the same energy level spacing as hydrogen?

2. Consider a particle of mass = m sitting in the ground state of a box of length=l. Suppose that one wall of the box is *suddenly* moved out so that the length of the box becomes length = 3l.

   a) If the energy of the particle is measured right after moving the wall, then what is the probability that the particle with be found in the n=10 state of the new box?

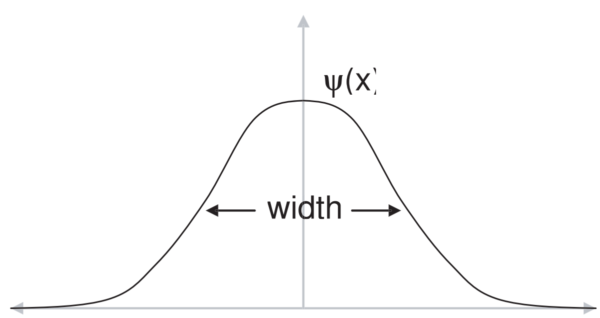
   b) How does this probability change with time?

3. Suppose I create 10^6 systems, each identical, with a particle of mass=m sitting in the ground state of a box of length=l. I then perform the following experiment on each box: I stick a tiny detector into the box and measure the momentum of the particle inside.

   a) What will the histogram of my measurements look like?

   b) How does the width of the histogram depend on the box length l? Is this consistent with the Heisenberg Uncertainty Principle?

4. Suppose a free particle at t=0 is prepared in the state $\psi(x) = Ae^{-ax^2}$, where "A" and "a" are constants. How does the width of $|\psi(x)|^2$ change with time? How do you physically interpret this result?



Note: There's a hard integral in this problem. You might need to look in a book or use Mathematica or some equivalent. The following integral may also be of use $\int_{-\infty}^{\infty} e^{-\alpha(x-b)^2}dx = \sqrt{\frac{\pi}{\alpha}}$.