**1-D Potential Well Exercise**

We’re going to examine some bound state wave functions in 1-D potentials given our class discussions and an on-line simulation found at <http://phet.colorado.edu/simulations/sims.php?sim=Quantum_Bound_States>. Click on the Run Now! button. We’re mostly concerned with the stationary state solutions, so once it starts running simply click pause and rewind to t=0.

1. **Square well**  
   Start with the square well.
   1. You’ll notice that you can’t adjust the total energy in this exercise. Why not?
   2. Describe the stationary state wave function *φ* for different eigenstates and explain the variations in *φ* with total energy.
   3. Vary the potential depth. Describe the change in *φ* or the probability density, *φ\*φ*. Explain the variations.
   4. Vary the width of the potential and describe the changes in *φ* or *φ\*φ*. Explain the variations.
   5. Estimate and verify the energy eigenvalues for 3 states (calculate both sides of the transcendental equation). Be sure to indicate all the necessary simulation inputs; I suggest you set the potential as we did in class: V = 0 outside the well, V and E both < 0.
   6. Do the energies change with particle mass as you expect? Show it quantitatively.
   7. How many eigenstates do you predict the delta function potential well has? Explain.
2. **Skewed/asymmetric potential well**Nowcreatean asymmetric potential well.
   1. Vary the width and depth and describe in every detail the changes to *φ* or *φ\*φ*. Be sure to adjust the potential appropriately to look at highly excited states too.
   2. Compare these observations to the results from the scattering potentials to indicate the broad, qualitative similarities in the wave functions when E > V.
3. **Other potential wells**  
   Look at the 1-D Coulomb and harmonic oscillator potentials.
   1. Compare the energy level structures of the square well, harmonic oscillator, and Coulomb potentials.
   2. What appears to be the likely cause for the differences between the energy level structures of the different potentials?