1) For an electron confined to a 2-dimensional box of length 0.1 nm, what is the kinetic energy of the ground state? How does this compare to the energy of an electron confined to a 1-dimensional box?

2) An electron is trapped in an infinite square-well potential of width 0.5 nm. If the electron is initially in the n=4 state, what are the various photon energies that can be emitted as the electron jumps to the ground state?

3) How many different energy levels can a particle in a 2-dimensional box have that are less than 60E₀ where E₀ = \( \frac{\pi^2 \hbar^2}{2mL^2} \)? Show your work.

4) The harmonic oscillator potential is \( U(x) = \frac{1}{2} m \omega_0^2 x^2 \); a particle of mass \( m \) in this potential oscillates with frequency \( \omega_0 \). The ground-state wavefunction for a particle in the harmonic oscillator potential has the form \( \psi(x) = A \exp(-ax^2) \) By substituting \( U(x) \) and \( \psi(x) \) into the one-dimensional time-independent Schrödinger Equation, find expressions for the ground-state energy \( E \) and the constant \( a \) in terms of \( m \), \( \hbar \), and \( \omega_0 \).

5) The \( \text{H}_2 \) molecule can be approximated by a simple harmonic oscillator having spring constant \( k = 1.1 \times 10^3 \) N/m. Find (a) the energy levels and (b) the possible wavelengths of photons emitted with the \( \text{H}_2 \) molecule decays from the third excited state eventually to the ground state. (Hint, you will need to use the reduced mass.)

6) Calculate the probability that an electron in the ground state of the hydrogen atom can be found between 0.95a₀ and 1.05a₀.

7) Extra credit. The first degenerate energy eigen value for a particle a 2-D infinite square well potential is \( E = 50E₀ \) with \( n_x = n_y = 5 \) and \( n_x = 1, n_y = 7 \). What are the next three degenerate energy eigen values? You may want to write a short computer program to find it.