1. **Particle in 3D box**
   Consider a single free electron inside a cubic box of side L. Solving the time-independent Schroedinger Equation in cartesian co-ordinates using separation of variables, show that the allowed energy levels assuming periodic boundary conditions are

$$E = \frac{\hbar^2}{2m}\frac{4\pi^2}{L^2}(n_x^2 + n_y^2 + n_z^2)$$

   where $n_i \in I$.

2. **Connections between classical and quantum simple harmonic oscillators**

   (a) Consider a quantum simple harmonic oscillator of energy in quantum state n. Show that the classical amplitude A corresponding to this state is $A = \sqrt{(2n+1)\frac{\hbar}{m\omega}}$. As expected, the classical amplitude increases with the quantum number n.

   (b) By comparing the diagram given in class to result of (a) show for several n values that the quantum oscillator can be found in classically forbidden regions.

   (c) The probability of finding a quantum simple harmonic oscillator between x and x+dx is $\rho(x)dx = |\psi(x)|^2 dx$. Show that the probability of finding a classical oscillator between x and x+dx is

$$\rho(x) = \frac{dx}{\pi\sqrt{A^2 - x^2}}$$

   (d) $\rho(x)$ is called the probability density. Qualitatively compare the shape of the classical and quantum probability densities, using the diagrams of the quantum simple harmonic oscillator wave functions given in class.