Problem 1

(a) Write down the Hamiltonian for two identical noninteracting particles in the infinite square well. Verify that the fermion ground state given in the example is an eigenfunction of H, with the appropriate eigenvalue.

(b) Find the next two excited states (beyond the ones given in the example) − wave functions and energies − for each of the three cases (distinguishable, identical bosons, identical fermions)

Problem 2

Imagine two noninterating particles, each of mass m, in the infinite square well. If one is in the state ψ_n (Equation 2.24) and the other state ψ_m is orthogonal to ψ_n, calculate $\langle (x_1 - x_2)^2 \rangle$, assuming that they are identical bosons.

Problem 3

(a) Suppose you put both electrons in a helium atom into the $n = 2$ state; what would the energy of the emitted electron be?

(b) Describe (quantitatively) the spectrum of the helium ion, He^+