Title

1. Tutorial 6 -

1. Consider an electron in a one dimensional well with depth, $V_{\mathrm{d}} = 15\epsilon_1$, where $\epsilon_1 = \hbar^2 \pi^2 / 2ma^2$ is the ground state energy of the electron - also known as its zero point energy.

    (a) Sketch the potential energy function. Indicate the particle in a box energy levels, and the corresponding particle in a well energy levels, in your sketch. How do the energy levels of the particle in a box change when the well depth is finite? Which levels change the most?

    (b) Sketch the energy eigenfunctions of the electron in the well. For which eigenfunction is the probability of finding the electron with $x > a$ the greatest?

2. Suppose there are four independent electrons in the well of question 1.

    (a) Using particle in a box energy levels, estimate the ground state energy of the four electron system? Is your estimate higher or lower than the actual ground state energy for a finite depth well?

    (b) Using particle in a box energy levels, estimate the ionization energy of the four electron system? Is your estimate higher or lower than the actual ionization energy for a finite depth well?

    (c) Using particle in a box energy levels, estimate the electron affinity of the four electron system? Is your estimate higher or lower than the actual electron affinity for a finite depth well?

    (d) Sketch the absorption spectrum of the four electron system. Use particle in a box energy levels to estimate the transition frequencies (expressed as multiples of ϵ_1 / h). Note that in the dipole approximation (i.e., weak applied electromagnetic field), only transitions of one electron are allowed. Also, the particle in a box selection rule (odd-odd and even-even transitions are forbidden) is only approximately satisfied. Thus, particle-in-a-box forbidden transitions occur, but with very weak peak intensity.

3. Repeat question 2 for a system with five independent electrons.