

Physics 2610H: Assignment III

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Problem 1. A 50 eV electron is trapped between electrostatic walls 200 eV high. How far does its wave function extend beyond the walls?

Solution 1.

Problem 2. To a good approximation, the hydrogen chloride molecule, HCl, behaves vibrationally as a quantum harmonic oscillator of spring constant 480 N m^{-1} and with effective oscillating mass just that of the lighter atom, hydrogen. If it were in its ground vibrational state, what wavelength photon would be just right to bump this molecule up to its next-higher vibrational energy state?

Solution 2.

Problem 3. A particle moving in a region of zero force encounters a precipice—a sudden drop in the potential energy to an arbitrarily large negative value. What is the probability that it will “go over the edge”?

Solution 3.

Problem 4. A beam of particles of energy E and incident upon a potential step of $U_0 = 54E$ is described by the wave function

$$\psi_{inc}(x) = e^{ikx}$$

- (a) Determine completely the reflected wave and the wave inside the step by enforcing the required continuity conditions to obtain their (possibly complex) amplitudes.
- (b) Verify by explicit calculation that the ratio of reflected probability density to the incident probability density is 1.

Solution 4.

Problem 5. What fraction of a beam of 50 eV electrons would get through a 50 volt, 1 nm wide electrostatic barrier?

Solution 5.