

ECE G201, Homework #2, Due January 30, 2009

1. Problem 1.7, text.
2. Problem 1.9, text.
3. Problem 1.14, text.
4. Problem S1A.3, text.
5. Problem S1A.8, text.

6. a. Determine an approximate ground state energy for a ball in a one-dimensional racquetball court. (Use the infinite potential well approximation) Use approximate masses and sizes.
b. To what energy level does motion across the court at 60 miles/hour correspond? (What is the approximate quantum number, "n"?)
c. Does the quantum formulation reduce to the expected, non-quantized classical result? Explain.

7. Determine the product of the uncertainty in momentum and position, $\Delta p \Delta x$, for the $n=2$ state in the infinite potential well. How does the result compare with that expected from the uncertainty principle? How does the result compare with the result for $n=1$?

8. Derive the transmission and reflection coefficients for the case of tunneling through a square potential barrier with $0 < E < U_0$. In this case the wavefunction inside the barrier is given by $\psi_0 = Fx^{\beta x} + Ge^{-\beta x}$, $\beta = [2m(U_0 - E)/\hbar^2]^{1/2}$. Note: the \hbar in the equation should be "h-bar," and $U_0 = E_p$. Do the coefficients sum to one?

9. Plot the transmission coefficient as a function of particle energy (for $E < U_0$, and for $E > U_0$ (from class)) for electrons incident on a barrier with the following characteristics. Note that the transmission coefficient should be continuous as a function of E for all energies. ($E > 0$)
 $U_0 = 0.5 \text{ eV}$
 $a = 10 \text{ \AA}$

10. Derive an expression for the transmission through the barrier when $\beta a \gg 1$, and show that the transmission decreases exponentially with barrier thickness. In addition to this, give an intuitive rationale for this result based on the magnitude of the wavefunction in the classically forbidden region. Note that much real world tunneling of interest takes place in this limit.

11. Problem S1A.12 (Please cite references if used to solve this problem – this is a commonly solved quantum mechanics problem. It is covered in Pierret, for example). Note that there may be an extra x in the exponent for $\psi_c(x)$, depending on your text printing date. I have it in mine. The exponent should just be $-a(x-L)$.

12. Problem S1A.11