QUANTUM MECHANICS III

PHYS 518

Problem Set # 3

Distributed: Oct.14, 2011

Due: Oct. 21, 2011

1. Resonant Transmission Redux: Barrier A has $V = 6$eV and $\delta = 1.5$Ang. B has $V = 0$eV and $\delta = 8$Ang.

a. Compute and plot the transmission probability for E in the range $0 < E < 12.0$ for the double barrier potential ABA.

b. Do a back-of-the-envelop calculation to estimate the width of the lowest transmission resonance.

c. Compare your estimate from **b.** to the computation done in **a.**, after you make a blowup around the lowest resonance.

2. Bound States: A well has depth 6 eV ($V = -6$eV) and width $\delta = 8$Ang. The potential on the asymptotic left and right is $V_L = V_R = 0$.

a. Compute the bound state energies ($E < 0$).

b. Compute the transmission probability for the range $0 < E < 6$eV.

c. Compare your results for **a.** and **b.** with the results of Problem #1**a.**

d. Discuss the similarities and differences between these results.

3. Multiple Wells: Two wells with the properties described in problem #2 are separated by an intermediate region of width $\delta = 1.5$Ang and potential 0 eV. The asymptotic potentials are as usual $V_L = V_R = 0$.

a. Compute the bound state energies.

b. Describe how the bound state energy spectrum is related to the bound state spectrum obtained in Problem #2.

c. Describe the symmetry properties of the eigenfunctions. To do this you do not need to construct the eigenfunctions, though you are welcome to do so if you wish.

d. Do you expect the resonance transmission peaks to split in the range $0 < E \cdots$? Explain.

4. A Comparison: Figure 14.5 (p. 65) shows the energies of the transmission resonances in a double barrier potential ($V_{barrier} = 20, \delta_{barrier} = 2$) as a function of the separation of the two barriers. Fig. 24.2 (p. 103) shows the energies of the eigenstates in a binding potential of depth 20 eV as a function of the width of the well. Compare these two figures and describe how they speak to you.