Physics 324, Fall 2001 **Problem set #6** Due: Mon. 12/10/01

Assigned problems. *All five are to be turned in – start on the first two early; read chapter 11 before trying the final three. Two of the problems will be graded and will be worth 50 points each.*

1. a) Consider a particle in one dimension, with the potential

$$V(x) = -g(\delta(x+a) + \delta(x-a)) \ ,$$

where $\delta(x)$ is the Dirac delta function and $g > 0$. Find the ground state energy in terms of m, g, a and $\hbar$.

Correction: I didn't realize when I assigned this, that solving for the ground state energy involved solving a transcendental equation (which cannot be solved analytically). So just set up the equation you need to solve for the energy, and show how you can solve it graphically, similar to our treatment of the finite square well.

b) How does the ground state energy change as you increase a? Consider the analogous problem where the delta functions are replaced by finite square wells. Without solving any equations argue from the uncertainty principle why the ground-state energy will go up with the separation of the two square wells by comparing the cases when the square wells are touching each other, to when the are infinitely separated. *This can be considered as a crude model for certain types of molecular binding; the delta functions or square wells can represent atoms at separation* $2a$ *to which an electron is attracted. The sharing of the electron between the two atoms gives rise to the binding force you have found.*

Correction: You should be able to show that for large separation a, the binding energy goes to a constant (why?). You should also be able to show that for small separation a, the binding energy decreases as a increases.

2. Consider a step potential in one dimension,

$$V(x) = \begin{cases} 0 & x < 0 \\ -V_0 & x > 0 \end{cases} \ .$$

Sketch this potential (assume $V_0 > 0$). Assume a beam of particles is incident heading in the $+x$ direction, originating from $x = -\infty$, with energy E. Compute the reflection and transmission probabilities as a function of $k \equiv \sqrt{2mE}/\hbar$ and $k' \equiv \sqrt{2m(E+V_0)}/\hbar$. What would the classical result be for the reflection probability?

3. *Gasiorowicz 11-2*

4. *Gasiorowicz 11-5*

5. *Gasiorowicz 11-8*