

## Physics 115A

Spring 2006

### Problem Set 4

Due by 4:00 pm Wednesday, 5/17 (in class, at my office, or in my mailbox)

#### 1. Finite barrier (25 points)

Consider the finite potential barrier

$$V(x) = \begin{cases} V_0 & \text{for } -a < x < a \\ 0 & \text{for } |x| > a \end{cases}$$

with  $V_0 > 0$ . Suppose a particle approaches the barrier from the left with energy  $E$ .

- Compute the transmission and reflection probabilities for  $E < V_0$ .
- Compute the transmission and reflection probabilities for  $E > V_0$ .
- For what values of  $E$  is the barrier “totally transparent”?

#### 2. Two delta functions (25 points)

Consider a potential consisting of two equally weighted delta functions at  $x = \pm a$ , that is,

$$V(x) = -\alpha\delta(x + a) - \alpha\delta(x - a)$$

with  $\alpha > 0$ .

- Find the bound state energies.  
(You will get a transcendental equation a bit similar to the one Griffiths describes for the finite square well. You don't need to solve it; but see parts b and c.)
- Show that if  $a$  is very large, the energy you obtain in part a is approximately that of a bound state in a *single* delta function potential.
- Find an approximate expression for the bound state energy when  $a$  is very small.  
(It may help to remember the Taylor expansion of  $e^z$ .)