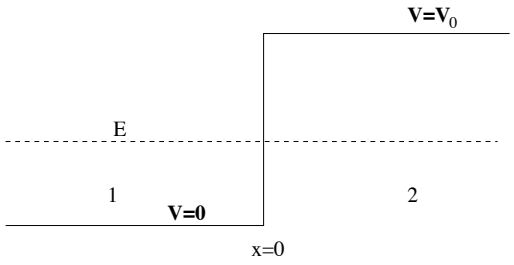
Quantum Physics (PHY 201)
IISER Bhopal
Assignment 5 (07-10-2010)

1. As we have seen in the class, the continuity equation for a quantum mechanical system with purely real potential, $V(x)$, is given by, $\frac{\partial P(x,t)}{\partial t} + \frac{\partial J_x}{\partial x} = 0$. Now, assume that $V(x)$ is complex. Follow the same analysis which we used to derive the above continuity equation in the class and show that, the continuity equation in case of complex $V(x)$ is given by, $\frac{\partial P(x,t)}{\partial t} + \frac{\partial J_x}{\partial x} = 2P(x,t)\Im(V(x))$, where $\Im(V(x)$ is the imaginary part of the potential, $V(x)$ and $P(x,t) = \Psi^*(x,t)\Psi^*(x,t)$ denotes the probability density.

   (**Note:** As a special case of the result that we have derived above, let's assume, $J(x) = 0$. In this case, a positive value of $\Im(V(x)$ implies $\frac{\partial P(x,t)}{\partial t} > 0$. So, $\Im(V(x)$ works like a source of particles. On the other hand, a negative value of $\Im(V(x)$ implies there exists a sink of particles in the system.)

2. A beam of electrons is incident on the left hand side of the step potential barrier which is drawn in the figure below, Assume that the electrons have energy $E < V_0$ and that $V = 0$ for $x \leq 0$ and $V = V_0$ for



   $x > 0$.
   a) Write down Schrodinger equations in regions 1 and 2.
   b) By solving Scrodinger equation find the incident wave, reflected wave and transmitted wave.
   c) Find the coefficients of reflection and transmittance.

3. A particle of mass m moves in a potential that has the form as shown in the figure below. The potential function satisfies $V(x) = \infty$ for $x < 0$, $V(x) = 0$ for $0 \leq x \leq L/2$, $V(x) = V_0$ for $L/2 < x \leq L$ and $V(x) = \infty$ for $x > L$. Assume that $E > V_0$. Find the equation satisfied by the energy E.