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NAME: _____

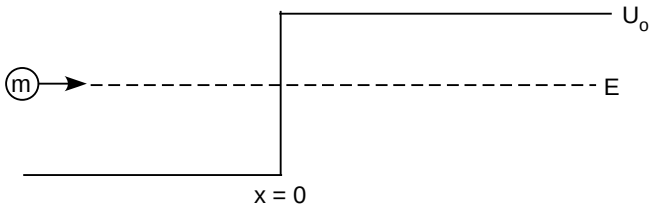
PHYSICS 4D
SPRING 2009
EXAM 3

MAKE SURE TO SHOW ALL WORK IN COMPLETE DETAIL. NO CREDIT WILL BE GIVEN IF NO WORK IS SHOWN. THE POINT VALUE OF EACH PROBLEM IS AN INDICATED.

1. A particle of mass *m* is confined to move in a 1-dimensional box of length *L* where $U(x) = 0$ for 0<x<L and $U(x) = \infty$ for x<0 and x>L . (20 pts)
    a) Starting with the Time-Independent Schrodinger Equation derive the wavefunction $\psi(x)$.
    b) Normalize $\psi(x)$.
    c) Determine the momentum of the particle.
    d) Determine the energy of the particle.
    e) Find the energy of the ground state and the first excited state.
    f) Write down the complete wavefunction(s) $\Psi(x,t)$ for the first excited state.

2. Energy principles for the quantum oscillator can be used to relate $<p_x^2>$ to $<x^2>$. Obtain an expression for the uncertainty in momentum Δp_x for the quantum oscillator in the ground state. (10 pts) Hint: $\langle x^2 \rangle = \frac{\hbar}{2m\omega}$

3. Consider a particle of energy E incident from the left on the infinite step potential shown below where $E < U_0$. (20 pts)



a) Starting with the Time-Independent Schrodinger Equation derive the wavefunction $\psi(x)$ to the left and right of the step potential.

b) Write down the complete wavefunction $\Psi(x,t)$ to the left and right of the step potential.

c) Derive and expression for the Transmission and Reflection coefficient.

d) If a current of 1A is incident on the step potential calculate how much current is transmitted and reflected.

e) Find the probability density to the right of the step potential and explain its physical significance.