

Phys 420 Exam 2

Part I: Wave particle duality

1. If a wavefunction is to represent a particle, what conditions must it satisfy in order for it to be physically meaningful? (5 points)
2. A particle of mass m is confined to a one dimensional potential well of width L . The potential inside the well is zero and the potential outside of the well is infinite. Using simple arguments based on De-Broglie waves, show that the particle can only have discrete values and determine these values. (25 points)

Part II: Quantum mechanics

Consider two potential wells of width L . One has infinitely high walls as in Part I, the other has finite walls of height U .

1. For a particle with $E < U$, would you expect the allowed wavefunctions for stationary states to be different if it were confined to the finite versus the infinite well? If so, why? (10 points)
2. If the lowest state for the infinite well is described by $\psi = A \sin kx$ where A is a constant amplitude, write an expression for A . (10 points)
3. Write an expression for the average position of a particle in this state. (10 points)

Part III: Potential barriers

Consider the potential barrier with height U shown in Figure 1. A particle with energy $E < U$ approaches the barrier from the left.

1. Write the time independent Schrodinger equation for each of the regions I ($x < 0$) and II ($x > 0$). (5 points)
2. What is the form of the wavefunction in Region I? in Region II? How would your answer differ if $E > U$? (5 points)
3. What boundary conditions must the wavefunction satisfy at $x = 0$? (10 points)
4. Use Part 3 to find the reflection coefficient. (10 points)
5. Use the Schrodinger equation to write the wavenumbers in the wavefunctions in Part 2 in terms of the energy. (10 points)

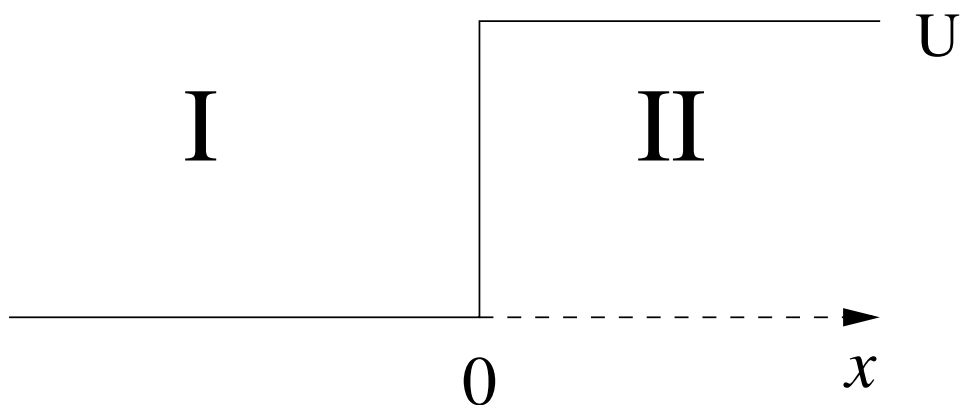


Figure 1: Potential for Part III.