

Physics 330, Spring 2009
Exam 1

1. **Problem 1 (30 points)** Consider a system of two particles, each with mass m . In one reference frame, one particle is at rest and the other moves directly towards the first with a velocity v , where v is a significant fraction of c .
 - (a) (10 points) What are the kinetic energy and momentum of each particle?
 - (b) (20 points) In the reference frame where the momentum of the system is zero, what is the energy of the system?

2. **Problem 2 (30 points)** A potential is described as $V(x) = 0$ for $x < 0$ and $V(x) = V$ for $x \geq 0$. The total energy of a particle is E , where $E > V$. The particle is incident on this step from the *right*.
 - (a) (5 points) Sketch the potential.
 - (b) (5 points) Sketch a possible wave function.
 - (c) (20 points) Can the particle reflect from this barrier? If so describe how to calculate the rate at which particles are reflected.

3. **Problem 3 (20 points)** The ground state wave function of the harmonic oscillator is given by $\psi(x) = Ae^{-m\omega^2 x^2/2\hbar}$. Use the Schrödinger equation to find the energy of the ground state.

4. **Problem 4 (20 points)** In the Franck-Hertz experiment, if Hydrogen gas is used instead of Mercury vapor, at what values of accelerating voltage would peak current occur? Explain.