J02Q.2—Wave Functions and Coordinate Frames

Problem

In this problem you will study the way in which a wave function changes from one coordinate frame to another and then apply it to a physical problem.

a)   A particle of mass m is described by a wave function $\psi(x,t)$ in the lab frame. What would be the wave function that describes the particle for an observer that moves with velocity v in the positive x direction?

     (**Hint:** One way to find the answer is by decomposing $\psi(x,t)$ into plane waves.)

b)   A hydrogen atom is at rest when a neutron collides with the nucleus and causes it to move with velocity v. What is the probability that the atom will remain in its ground state after the collision?

     Since the proton is much heavier than the electron, you may neglect corrections of the order m_e/m_p (the ratio of the electron to proton mass). You may also assume that the collision between the proton and neutron is instantaneous.