Modern Physics - Exam 1 Name:_____

[Even if you can just write the answer down, **show me your work as well**. I need to see how you get to a result!]

1. Consider two events that take place at different points in the K system at the same instant t. If these two points are separated by a distance Δx, show that the events are not simultaneous in K' (which has a relative velocity v) and find the time interval $\Delta t'$ between them.

2. Two clocks, located at the origins of the K and K' frames (which have a relative velocity v), are synchronized when the origins coincide. After a time t, an observer at the origin of K observes the K' clock through a telescope. What does the K' clock read?

3. A particle of rest mass m_0 and kinetic energy $2m_0c^2$ strikes and sticks to a stationary particle of rest mass $2m_0$. Find the rest mass M_0 of the composite particle. (*Hint:* Remember that momentum is conserved in an inelastic collision, while relativity insists on energy conservation at the same time.)

4. Show that when the recoil kinetic energy of the atom, $p^2/2M$, is taken into account the frequency of a photon emitted in a transition between two atomic levels of energy difference ΔE is reduced by a factor which is approximately $(1 - \Delta E/2Mc^2)$. (Hint: The recoil momentum is $p = h\nu/c$.) Compare the wavelength of the light emitted from a hydrogen atom in the $3 \rightarrow 1$ transition when the recoil is taken into account to the wavelength without accounting for recoil.

5. A particle is trapped in an infinitely deep one-dimensional well of width L. If the particle is in its ground state (n=1) evaluate the probability of finding the particle between $x = 0$ and $x = L/3$? Between $x = L/3$ and $x = 2L/3$? Between $x = 2L/3$ and $x = L$?