Homework Assignment #3

Due Date: January 31, 2019 (Thursday)

In these problems, when the problem asks for mass, energy, and momentum, please write your answers in units of:

Mass $\rightarrow MeV/c^2$ not kilograms !!

Momentum $\rightarrow MeV/c$ not kilograms·meters/sec !!

Energy $\rightarrow MeV$ not joules !!

unless otherwise specified.

When you are asked for velocities, always quote your answers in units of "c," the speed of light—unless otherwise specified.

velocity = $\boldsymbol{\beta}$ *c*

Problems: From "Modern Physics" by Kenneth Krane

2.12 Emission lines from a distant galaxy

2.13 Physics professor goes through a "red light" because it appears "green."

2.17 A neutral K meson at rest decays into two π mesons, which travel in opposite directions along the *x* axis with speeds of 0.828 *c*.

2.18 A rod in the reference frame of observer *O* makes an angle of 31° . . .

2.23 (modified) Suppose Amelia travels at a speed of 0.60*c* to a star that (according to Casper on Earth) is 8.0 light-years away. Upon her arrival to the star, she immediately jumps back into a space ship traveling 0.60*c* towards earth. Upon her arrival at Earth, (a) what is Amelia's age? And (b) What is Casper's age? ***Please include a space-time diagram illustrating the world lines for Amelia and Casper.***

Problem 6: The kinetic energy of a proton in the LHC is 7.0 TeV and its β value is very very close to unity. Find how close it is to "unity" by making an explicit calculation of
$1 - \beta$.

Problem 7: (Extra Credit—2 points) A particle of mass *M* at rest decays into two unequal masses m_1 and m_2. Show that the square of the momentum of each of the final particles is given by:

$$p^2 = \frac{[M^2 - (m_1 + m_2)^2]\,[M^2 - (m_1 - m_2)^2]}{4M^2}\,c^2$$