Contemporary Physics I – HW 5

HW 5

Due November 10, 2006

Please answer all questions clearly and concisely. While you need not transcribe the question completely, it should be clear from your answer alone what you are talking about.

You are strongly encouraged to discuss the homework with your classmates, but you must complete the written homework by yourself, and of course, the material you submit must be your own.

Remember, show all of your work!

1) 4.17

2) You and I each observe two events. First, at t=0, I see a bird fly by my head ($x = 0$). Shortly thereafter ($t = 2s$), I see the bird crash into a building well outside out earth's atmosphere ($x = 0.5\ ls$). You are traveling at 0.9c to my right.

a. How fast is the bird traveling according to me?

b. What distance do you measure between the two events?

c. What time do you measure between the two events?

d. How fast do you judge the bird to be flying?

3) You are at rest in a space station. You have a friend who, according to you, is flying to the right in a spaceship at 0.5c. According to your friend, his spaceship is 10m long.

a. Draw a spacetime diagram in your frame showing a radio communication between you and your friend. You should each send two messages (send-receive-send-receive). Make sure to include both you and your friend in the diagrams.

b. Draw the same sequence of events in your friend's frame.

c. When your friend's ship passes your station, how long do you measure it to be?

d. You notice your friend's clock ticking away. According to you, how long does it take for the clock to tick once? (1 sec. according to him).

e. Your friend notices your clock ticking away. According to him, how long does it take for *your* clock to tick once?

4) A particle is at rest and has a mass of $1.6749 \times 10^{-27} kg$ (let's call the particle a neutron).

a. What is the rest energy of a neutron?

b. At some time later, the neutron decays into a proton ($m_P = 1.6726 \times 10^{-27} kg$), an electron ($m_e = 9.11 \times 10^{-31} kg$), an antineutrino (mass is too small to matter), and photons.

c. What is the total mass energy of the electron and the proton?

(over)

d. How much energy is converted in this reaction to kinetic energy?

e. Imagine that 20% of the released energy went into the electron. What would the γ of the electron be?

f. What would the speed of the electron be?