Midterm Physics 9HB winter 2001

Use a law blue book. Closed book. One 3"x5" note card. PRINT your name on your blue book. To get credit, you must show your work. Be neat, clear, and organized. If we can't read it or figure it out, we can't give you any points.

1. (20) In the home frame, two events are simultaneous and are at x=1ns and x=3ns. The other frame (with our usual conventions) is observed by the home frame to be moving in the +x direction with speed 0.8. a) What is the coordinate time difference between the two events in the other frame? b) What is the spatial separation of the two events in the other frame? c) What is the spacetime separation of the two events?

2. (20) A stick is moving in the +x direction. The front end passes you when your clock reads t=0. At t=2ns, the back end of the stick passes you. At that moment, you send a light signal in the +x direction. That signal reflects off the front end of the stick and arrives back at you at t=5ns. a) Draw the spacetime diagram for your frame including the world lines of yourself, both ends of the stick, and the light. b) How fast is the stick moving? c) What is the rest length of the stick?

3.(20) Sitting at the origin of an inertial reference frame, you notice a bomb moving in the +x direction with speed 0.8. At t=0 in your frame, the bomb passes you, and you see a clock on the bomb that reads 0s at the moment. You know that the bomb is going to explode when its clock reads 10s. a) As described in your frame, when and where will the bomb explode? b) You are going to send a light signal to warn the person at the position of the explosion. What is the longest you can delay before sending the signal? c) A second bomb comes by under the same circumstances. This time you are prepared to catch it and disarm it. Just as it passes you, you set a timer that you will carry to t=0 and fire up your rocket to give chase. To figure out how much time you have left, you are watching your timer as you accelerate toward the bomb. As read on your timer, do you have 10s, more than 10s, or less than 10s to catch and disarm the bomb? Explain carefully.

4. (20) A particle is traveling down the x-axis. It decays into two photons. For photon 1, P_x=200MeV, P_y=100MeV, and P_z=0. For photon 2, P_x=(50MeV, and the data for P_y and P_z were lost. What is the mass (in MeV) of the particle that decayed?

5.(10) Consider a small lab set up to send light signals in the vertical direction and compare the wavelength of the received light with that of the transmitted light. First the lab is sitting on the floor of the room here in 55 Ro, and the light signal is sent downward. a) Is the received wavelength greater than, the same as, or less than the transmitted signal? Explain. Now the experiment is repeated while the little lab is falling from the ceiling to the floor. b) Is the received wavelength greater than, the same as, or less than the transmitted signal? Explain.

6. (10) You are sitting here on the surface of the earth with two identical watches - one in each hand. You toss one of them straight up. Just as you release it, both watches are at the same height and read the same time. You note the times on the two watches just as the tossed one passes back down by the one you are still holding. Which watch reads the larger elapsed time? Explain.