Physics 2320: Spring 2007: Problem Set 2

1. The S' inertial frame has its x, y, and z axes aligned with those of the S inertial frame and moves along the x axis of the S frame with a velocity v. The coordinates are arranged so that the origins coincide at $t = t' = 0$. Experimenters are located in the S frame at (x_A, o, o) and (x_B, o, o) and each holds a ping-pong ball. They plan to drop these ping-pong balls at different times so that the two events are simultaneous for observers in the S' frame. Calculate what the difference in time of their actions must be.

2. The S' inertial frame is aligned and moves relative to the S inertial frame as described in problem 1. Here the velocity $v = 0.96$ c. Particles with a mean life of 10^{-6} seconds in their rest frames are located at the origin of the S' frame. Calculate the apparent mean life that an experimenter in the S frame would measure.

3. The S' inertial frame is aligned and moves relative to the S inertial frame as described in problem 1. Here the velocity $v = 0.64$ c. A meter stick lies along the x axis of the S' frame. Calculate its apparent length as observed by experimenters in the S frame.

4. The S' inertial frame is aligned and moves relative to the S inertial frame as described in problem 1. A clock is placed at the origin of the S inertial frame. Demonstrate the time dilation of this clock as viewed by an observer in the S' frame using the technique shown in lecture.

5. The S' inertial frame is aligned and moves relative to the S inertial frame as described in problem 1. The experimenters in the S frame place a rod of length L(0) along the x axis. Demonstrate the contraction in the length of this rod as viewed by two observers in the S' frame using the technique shown in lecture.

6. The S' inertial frame is aligned and moves relative to the S inertial frame as described in problem 1. In lecture we derived formulas to transform a velocity u_x, u_y, u_z in the S frame to a velocity in the S' frame. A beam of light moves in the S frame; hence

$$u_x^2 + u_y^2 + u_z^2 = c^2 .$$

Use the formula from lecture to transform the velocity to the S' frame and show that

$$u'_x{}^2 + u'_y{}^2 + u'_z{}^2 = c^2 .$$

7. The S' inertial frame is aligned and moves relative to the S inertial frame as described in problem 1. If one knows the velocity u'_x, u'_y, u'_z in the S' frame, derive formulas to transform these to the S frame using the technique shown in lecture.