PHSX 343: Assignment 4

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Problem 1

a) The unprimed frame provides the spacetime interval, as it provides both an inertial frame and has the two events at the same spacial coordinates.

b) $(c\Delta s)^2 = (c\Delta t)^2 - (\Delta x)^2 - (\Delta y)^2 - (\Delta z)^2$ Metric Equation

$$(c * 32ns)^2 = (c\Delta t)^2 - (13.2m)^2$$
$$\Delta t = \frac{\sqrt{(c * 32 \times 10^{-9})^2 + (13.2m)^2}}{c}$$
$$\Delta t = 5.440 \times 10^{-8}s = 54.40ns$$

c) For S': $\Delta t' = 54.40ns$ and $\Delta x' = 13.2m$, so $v' = \frac{\Delta x'}{\Delta t'} = \frac{13.2m}{54.40 \times 10^{-9}s} = 2.425 \times 10^8 \frac{m}{s} = 0.8088c$

d) There are two approaches to this: either take length contraction to not be a thing and get a very confusing solution, or follow what we know from physics 3 and go from there. Since the question doesn't clarify, I will continue by saying that there is length contraction. This assumption leads to the conclusion that the speed of S' as seen by S is the same as the s speed of S as seen by S'. So: $v = -v' = -0.8088c$.

e) `Homework4/homework 4.PNG`

f) When we assume that there is length contraction then Eq. 1.8 works out. If we didn't use than assumption then there is some confusion about which velocity to use, etc.

$$\Delta t = \frac{\Delta t'}{\sqrt{1-(\frac{v}{c})^2}} \text{ (Eq. 1.8)}$$

Using our values:

$$\frac{32ns}{\sqrt{1-(\frac{0.8088c}{c})^2}} = \frac{32ns}{\sqrt{1-0.8088^2}} = 54.4ns$$

So the equation works for our calculations.