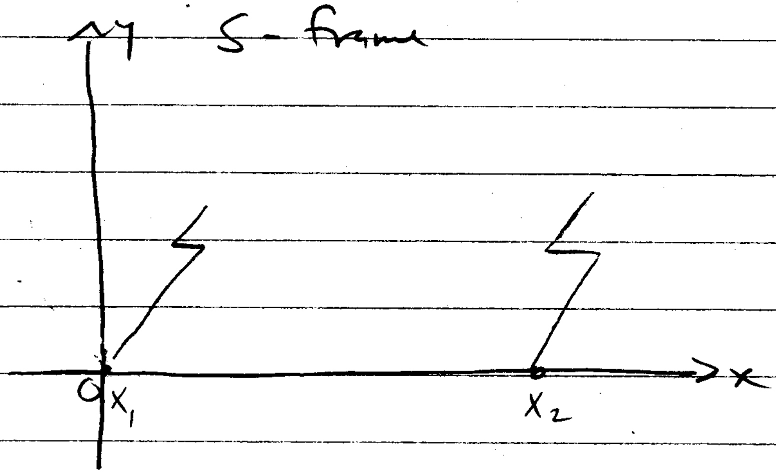
1-23 $3\frac{v^2}{c^2}$

~~1-24~~



We have 2 events, with 4-coordinates $\begin{pmatrix}0\\0\\0\\0\end{pmatrix}$ and $\begin{pmatrix}100\text{m}\\0\\0\\0\end{pmatrix}$, as measured in the S-frame.

a) We transform the interval between the event to the S' frame. The relative velocity of the S' frame is $0.70c\,\hat{x}$.

i) 1st event

We'll say the S + S' frames coincide so $x_1' = x_1 = 0$, $y_1' = y_1 = 0$, $z_1' = z_1 = 0$ and $t_1' = t_1 = 0$.

ii) 2nd event

$$\begin{pmatrix}x_2'\\y_2'\\z_2'\\t_2'\end{pmatrix} = \begin{pmatrix}\gamma & 0 & 0 & -\gamma v\\0 & 1 & 0 & 0\\0 & 0 & 1 & 0\\-\frac{\gamma v}{c^2} & 0 & 0 & \gamma\end{pmatrix}\begin{pmatrix}x_2\\y_2\\z_2\\t_2\end{pmatrix}$$

$x_2' = \gamma x_2 - \gamma v t_2 = \gamma x_2 =$

$y_2' = y_2 = 0$

$z_2' = z_2 = 0$

$t_2' = \gamma\left(- \frac{v x_2}{c^2}\right).$

1-23 3rd ed.

~~1-24~~ con't

Now, $\gamma = \dfrac{1}{\sqrt{1-\frac{v^2}{c^2}}}$, so with $v = 0.7c$,

$$\gamma = \frac{1}{\sqrt{1-.49}} = 1.40$$

So,
$$x_2' = 1.40(100\,m) = 140\,m$$
$$y_2' = 0$$
$$z_2' = 0$$
$$t_2' = 1.4\left(-0.7c\,\frac{100\,m}{c^2}\right) = \frac{-98\,m}{c} \quad (= -3.26\times10^{-7}\,sec)$$

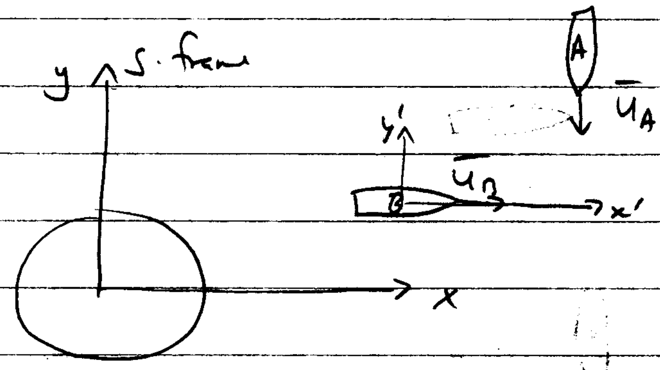
b) In the S' frame, the lightning strikes are $x_2' - x_1' = 140\,m - 0\,m = 140\,m$ apart.

c) In the S' frame, the strike at $\underline{x_2'}$ is seen to occur before the strike at x_1', since $t_2' < t_1'$.

$\Delta t' = 3.26\times10^{-7}\,sec$

1-24 3rd ed

~~1.25~~



In the S-frame, $\bar{u}_B = 0.90c\,\hat{x}$ and $\bar{u}_A = -0.90c\,\hat{y}$.

We want to transform the velocity of ship A to the frame of ship B. The relative velocity of the S + S'-frame is $\bar{v} = \bar{u}_B = 0.90c\,\hat{x}$.
We'll have $\hat{x}'$ and $\hat{y}'$ components possibly.

eg

$$u'_{Ax} = \frac{u_{Ax} - v}{1 - \frac{u_{Ax} v}{c^2}} \quad \text{and}$$

$$u'_{Ay} = \frac{u_{Ay}}{\gamma\left(1 - \frac{u_{Ax} v}{c^2}\right)}$$

Plug in the given speeds

$$u'_{Ax} = \frac{0 - 0.90c}{1 - 0} = -0.9c$$

$$u'_{Ay} = \frac{-0.9c}{\gamma(1-0)} = -0.9c\sqrt{1-\frac{v^2}{c^2}} = -0.9c(.431)$$

$$u'_{Ay} = -0.39c$$

The speed of A in the S'-frame is $u'_A = 0.98c$

Phys 203

Question 2-3

$$\bar{p} = \gamma m \bar{u}.$$

$$p = \frac{1}{\sqrt{1-\frac{u^2}{c^2}}} m u$$

Now, as $u \to c$, $\gamma \to \infty$; therefore while there is an upper bound on u, there is no bound on p.