CH#37
H.W. Solution

#5. The length of the track relative to the Lab is $L = 1.05\,mm$.
The time took the particle to travell this distance relative to the lab is

$$\Delta t = \frac{L}{v} = \frac{1.05 \times 10^{-3}}{0.992 \times 3 \times 10^{8}} = 3.53 \times 10^{-12}\,sec$$

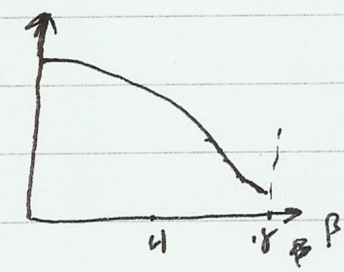
$$\gamma = \frac{1}{\sqrt{1-\beta^2}} = \frac{1}{\sqrt{1-(.992)^2}} = 7.92$$

$$\Delta t_0 = \frac{\Delta t}{\gamma} = \frac{3.53 \times 10^{-12}}{7.92} = 4.46 \times 10^{-13}\,sec$$

$$= 0.446 \times 10^{-12}\,sec$$

$$= 0.446\,ps.$$

#14.



let L_0 = prober length, that is the length of the rod relative to someone moving with the rod.
L = length of rod relative to someone watching the rod moving

$$\cancel{L = \frac{L_0}{\gamma} = L_0\sqrt{1-\beta^2}}$$

#43

a. Work = ΔKE

$= KE2 - KE1$

$KE = mc^2(\gamma - 1)$

$\therefore KE1 = mc^2(\gamma_1 - 1)$, $\gamma_1 = \frac{1}{\sqrt{1-\beta_1^2}} = 1.01660$

$KE2 = mc^2(\gamma_2 - 1)$, $\gamma_2 = \frac{1}{\sqrt{1-\beta_2^2}} = 1.0185$

$\therefore$ Work $= mc^2(\gamma_2 - \gamma_1) = 1.0\ KeV$

b. similar to above

work $= 1.1 \times 10^6\ eV = 1.1\ MeV$

#48 $KE = mc^2(\gamma - 1)$

$\gamma - 1 = \frac{KE}{mc^2}$

a. $\gamma = 1 + \frac{KE}{mc^2} = \frac{1\times10^3\ eV}{0.511\times10^6\ eV} + 1$

$= \cancel{0.001957}$

$\frac{1}{\sqrt{1-\beta^2}} = \gamma$ $\cancel{= 1.\ldots \times 10^{3}}$

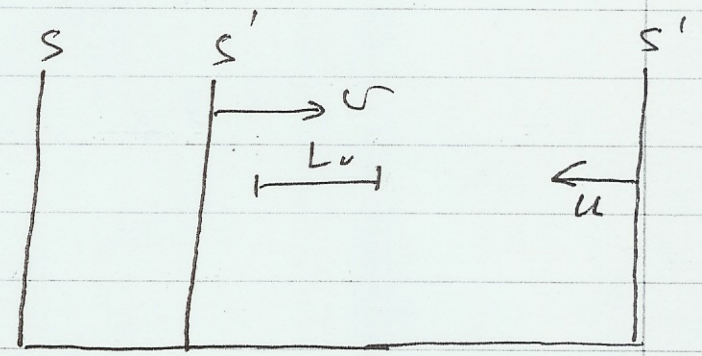
$\cancel{\beta^2 = \sqrt{1-\beta^2} = \frac{1}{\gamma}}$

$\cancel{1-\beta^2 = \frac{1}{\gamma^2}}$

$\cancel{\beta^2 = 1 - \gamma^2}$

$\gamma = 1.00196$

\# 31



$v = 0.82c$, $u = 0.82c$

velocity of frame s'' relative to frame s' is u'

$$u' = \frac{u+v}{1+\frac{uv}{c^2}} = 0.981\,C$$

$$\therefore \Delta t = \frac{350}{0.981\,C} = 1.19\ \mu s.$$

\# 35 $f_0 = 1\times10^8\ Hz. = 100\,MHz$

$$f = f_0\sqrt{\frac{1-\beta}{1+\beta}} = 1\times10^8\sqrt{\frac{1-0.9}{1+0.9}}$$

$$= 0.229\times10^8\ Hz$$

$$= 22.9\ MHz$$

10 Cont.

$$\therefore L_y = L_{oy} = L_o \sin 30 = 0.5 \text{ m}$$

$$L_x = \frac{L_{ox}}{\gamma} = \sqrt{1-\beta^2} \times L_o \cos 30$$

$$= \sqrt{1-(.9)^2} \times 1 \times \frac{\sqrt{2}}{2}$$

$$= 0.436 \times 0.707$$

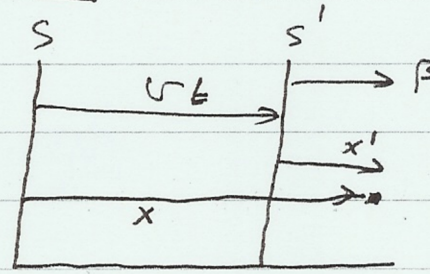
$$= 0.308$$

$$L = \sqrt{L_x^2 + L_y^2} = \sqrt{(.308)^2 + (0.5)^2}$$

$$= 0.587 \text{ m}$$

or $L = 58.7$ cm.

#16



$$x' = \gamma(x - vt) = \frac{3\times10^8 - .4\times3\times10^8\times2.5}{\sqrt{1-(.4)^2}} = \frac{3\times10^8}{0.917}$$

$$\cancel{t' = \gamma(t - \frac{vx}{c^2})}$$

$$x' = 3.27\times10^8 \text{ m.}$$

$$t' = \gamma(t - \frac{vx}{c^2}) = \frac{(2.5 - \frac{0.4\times3\times10^8}{3\times10^8})}{0.917}$$

$$t' = 2.29 \text{ sec.}$$

If S' moving in NEGATIVE x-direction Just change the sign in above eqs.

#19

$$\Delta t' = \gamma\left(\Delta t - \frac{v x}{c^2}\right)$$

$$\Delta t' = -\frac{\gamma v x}{c^2} \quad , \Delta t = 0$$

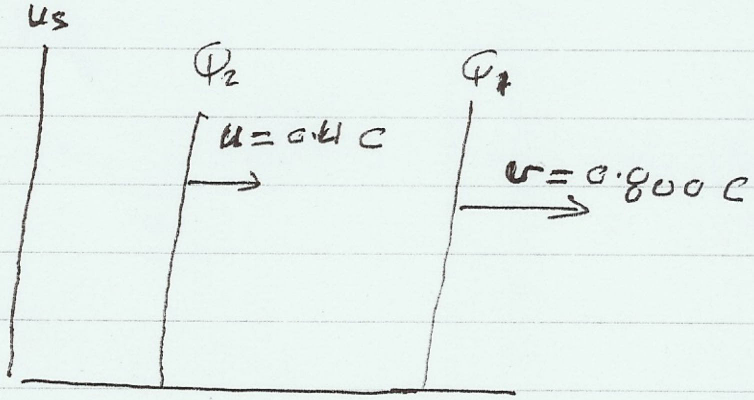
$$= -\frac{1.032 \times 0.25 \times 30 \times 10^{3}}{3 \times 10^{8}}$$

$$= -2.6 \times 10^{-5} \text{ sec}$$

$$= -26 \ \mu s.$$

Negative sign means Small flash happens before Big flash.

#28



u = velocity of Φ_2 relative to us

u' = velocity of Φ_2 relative to Φ_1

$$u' = \frac{u - v}{1 + \frac{uv}{c^2}} = \frac{0.4c - 0.8c}{1 + 0.4 \times 0.8} = -0.3\, c$$

So for Φ_1, Φ_2 is moving in the negative x-direction.

7.

a. $\Delta t_0 = 1.0 \text{ year}$

$$\cancel{\Delta t = \frac{\Delta t_0}{\gamma}}$$

$$\Delta t = \gamma \Delta t_0$$

$$\therefore \gamma = \frac{\Delta t}{\Delta t_0} = \frac{100}{1.0} = 100$$

$$\frac{1}{\sqrt{1-\beta^2}} = 100$$

$$\sqrt{1-\beta^2} = 0.01$$

$$1-\beta^2 = 0.0001$$

$$\beta^2 = 1.0 - 0.0001 = 0.9999$$

$$\beta = 0.99994999$$

b. Yeas it matters because is you travell in a curved bath it means you refrence frame is accelerated, so it is not an inertial frame.

#14 cont.

$$\therefore L = \frac{L_0}{\gamma} = \sqrt{1-\beta^2}\, L_0$$

$$\therefore \frac{L_1}{L_2} = \frac{L_0}{\gamma_1} \times \frac{\gamma_2}{L_0} = \frac{\gamma_2}{\gamma_1}$$

or $L_2 = \dfrac{L_1 \gamma_1}{\gamma_2}$

From the figure when $\beta = 0 \Rightarrow \gamma = 1$

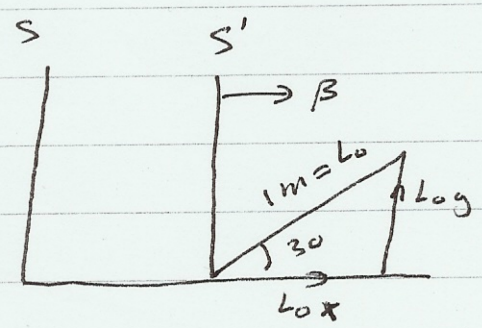
$L_1 = 0.8\ m = 80\ cm$

when $\beta_2 = 0.95c$, $\gamma_2 = \dfrac{1}{\sqrt{1-(.95)^2}} = 10.26$

$$\therefore L_2 = \frac{0.8}{10.26} = 0.078 = 7.8 \times 10^{-2}\ m$$

$$= 7.8\ cm$$

#10



The y-component of the meter stick will not be affected by the relative motion.

The x-component will be ~~not~~ affected

$$\therefore L_y = L_{oy}, \quad L_x = \frac{L_{ox}}{\gamma} = L_{ox}\sqrt{1-\beta^2}$$

#48 cont

$$\gamma = \frac{1}{\sqrt{1-\beta^2}} \quad ; \quad \beta^2 = 1 - \frac{1}{\gamma^2}$$

$$\beta = \sqrt{1 - \frac{1}{\gamma^2}} = 0.044$$

~~In~~ The rest of the problem is the same as above.