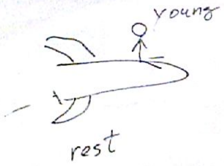
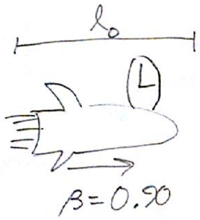


accel.

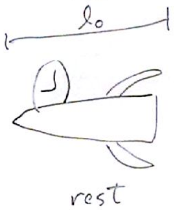


contraction $l = l_0/\gamma$

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

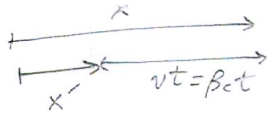
$$\gamma = \frac{1}{\sqrt{1-\beta^2}} = 2.3$$

decel.



What we thought 150 years ago:

$$\begin{bmatrix} x \\ ct \end{bmatrix} = \begin{bmatrix} x' + \beta c t' \\ ct' \end{bmatrix} = \begin{bmatrix} 1 & \beta \\ 0 & 1 \end{bmatrix} \begin{bmatrix} x' \\ ct' \end{bmatrix}$$



What we think today:

$$\begin{bmatrix} x \\ ct \end{bmatrix} = \gamma \begin{bmatrix} 1 & \beta \\ \beta & 1 \end{bmatrix} \begin{bmatrix} x' \\ ct' \end{bmatrix}$$

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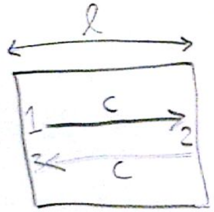
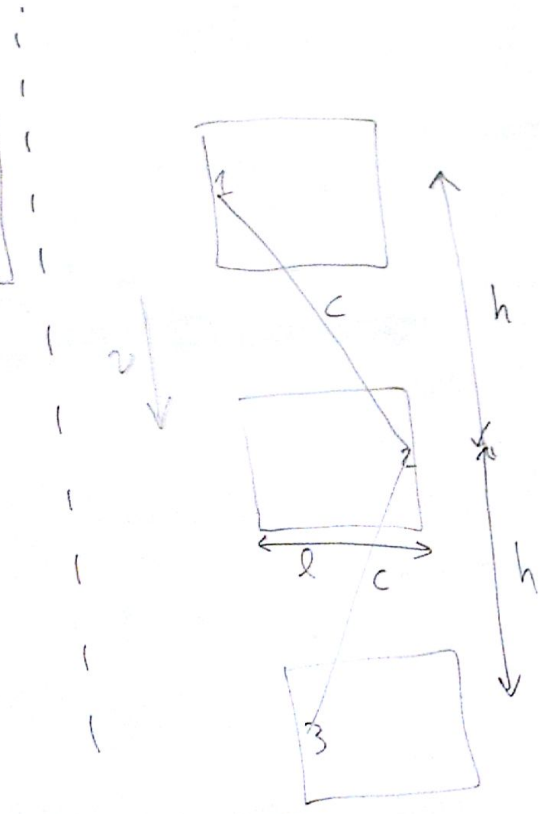
✓ (p. 972)



$\Delta t_0 = \frac{2l}{c}$



Time dilation $\frac{\Delta t}{\Delta t_0} = \frac{1}{\sqrt{1-v^2/c^2}} = \gamma \geq 1$

$v/c = \beta$

$\Delta t = \frac{2\sqrt{h^2+l^2}}{c}$

$\Delta t = \frac{2h}{v}$

$\frac{h}{v} = \frac{\sqrt{h^2+l^2}}{c} \rightarrow \frac{h^2}{v^2} = \frac{h^2+l^2}{c^2} \rightarrow h^2c^2 = v^2h^2 + v^2l^2$

$h^2(c^2-v^2) = v^2l^2$

$\frac{\Delta t}{\Delta t_0} = \frac{2l/\sqrt{c^2-v^2}}{2l/c} \Leftarrow \frac{2l}{\sqrt{c^2-v^2}} = \frac{2h}{v} = \Delta t \leftarrow h = \frac{lv}{\sqrt{c^2-v^2}}$

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All observers agree

on $(\Delta x)^2 - (c\Delta t)^2 = (\Delta s)^2$

All observers also agree

on $E^2 - (pc)^2 = (mc^2)^2$

$p = \gamma m v$

energy $E = \gamma mc^2 = \underbrace{mc^2}_{\text{rest mass}} + \underbrace{(\gamma - 1)mc^2}_{K}$

rest mass ↑ includes internal potential energy

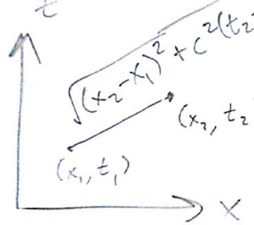
K: kinetic energy

$\Delta\tau$ = "wristwatch time"

Δs = "meter-stick length"

$(c\Delta t)^2 - (\Delta x)^2 = (c\Delta\tau)^2$

$\sqrt{(x_2-x_1)^2 + c^2(t_2-t_1)^2}$ = "distance"



$v \ll c \Rightarrow K \approx \frac{1}{2}mv^2$

PHYS 2326-102
David Milovich

$(\Delta s)^2 > 0$: spacelike separated

$(\Delta s)^2 = 0$: lightlike separated

$(\Delta s)^2 < 0$: timelike separated

$E^2 - (pc)^2 > 0$: positive mass

$E^2 - (pc)^2 = 0$: 0 mass, e.g., photons $p = \frac{E}{c}$

$E^2 - (pc)^2 < 0$: not observed yet

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