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Physics 194 - Lecture 24

Welcome!

Have a question during class? Please ask it right away, even if it means interrupting in the middle of a thought. I want you to!

Agenda

- Mysteries about the speed of light

- Time dilation

- Interstellar travel

Class Starts @ 2:15 pm

Electric & magnetic fields predict

$$c = \sqrt{\frac{2k}{k_m}}$$

$$E = k \frac{|q|}{r^2} \qquad k = 9 \times 10^9 \, Nm^2/c^2$$

$$B = k_m \frac{I}{r} \qquad k_m = 2 \times 10^{-7} \, Tm/A$$

$$= \boxed{3 \times 10^8 \, m/s}$$

what is this measured w.r.t.?

$$V_{sound \, in \, air} = \boxed{340 \, m/s} = 700 \, mph$$

$$V_{SE} = 0.9c$$

$$V_{LS} = c$$

Earth

derivable from $\vec{a} = \frac{1}{m} \Sigma \vec{F}$

?

$$V_{LE} = V_{LS} + V_{SE} = 1.9c$$

?

1.0c

What are the consequences of taking seriously
the idea that the speed of light is a true constant?

Friend

distance traveled = speed × time interval
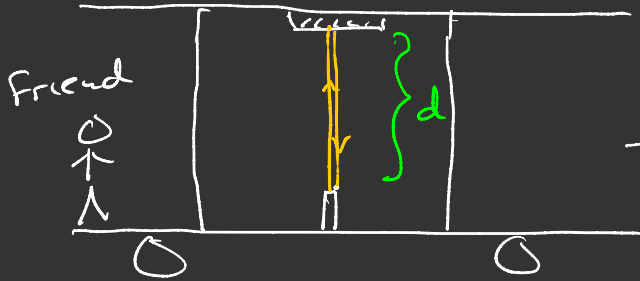
$$2d = c \, \Delta t_F$$

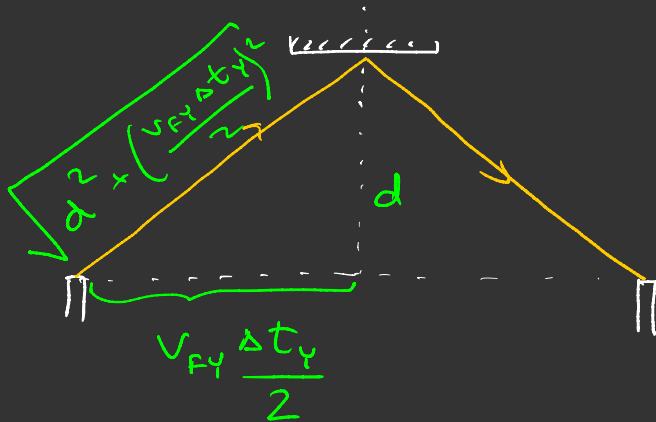$$\rightarrow \boxed{\Delta t_F = \frac{2d}{c}}$$

$$d = \frac{c \Delta t_F}{2}$$

$v_{FY} = 0.9c$

You

$$\boxed{\Delta t_Y = \frac{>2d}{c}}$$

$$\Delta t_Y > \Delta t_F$$

$$\sqrt{d^2 + \left(\frac{v_{FY} \Delta t_Y}{2}\right)^2}$$

d

$$v_{FY} \frac{\Delta t_Y}{2}$$

Friend

$$\Delta t_y = \frac{2\sqrt{d^2 + \left(\frac{v_{FY}\Delta t_y}{2}\right)^2}}{c}$$

$$\Delta t_y = \frac{2}{c}\sqrt{\left(\frac{c\Delta t_F}{2}\right)^2 + \left(\frac{v_{FY}\Delta t_y}{2}\right)^2}$$

Solve for Δt_y

$$\Delta t_y = \frac{\Delta t_F}{\sqrt{1 - (v_{FY}/c)^2}}$$

SSmin ←

? ←

Time dilation

If $v_{FY} = 0$

$\rightarrow \Delta t_y = \Delta t_F$

What about during a SSmin class?

$$\Delta t_F = \Delta t_y \sqrt{1 - (v_{FY}/c)^2}$$

$$\Delta t_F = (55 \text{ min}) \sqrt{1 - \left(\frac{1\text{m/s}}{3\times10^8\text{m/s}}\right)^2}$$

$$= 55 \text{ min} \qquad = 1 - 10^{-17}$$

$$= 54.99999999999997 \text{ min}$$

10 hours @ ~500 mph.

The atomic clock on
the plane should be
~3 ns slower.

California

Military
base in
NJ