$$\vec{A} \to \vec{A} + \nabla\Lambda \qquad \vec{E} \to \vec{E}$$

$$\phi \to \phi - \frac{\partial \Lambda}{\partial t} \qquad \vec{B} \to \vec{B}$$

$$v_p v_g = c^2 \Longleftarrow$$ in wave guides. $\omega^2 = c^2k^2 + \text{constant}$

$$\vec{E} = -\nabla\phi - \frac{1}{c}\frac{\partial \vec{A}}{\partial t}$$

$$a(t) = a(0)\,e^{t/2}$$

Relativity

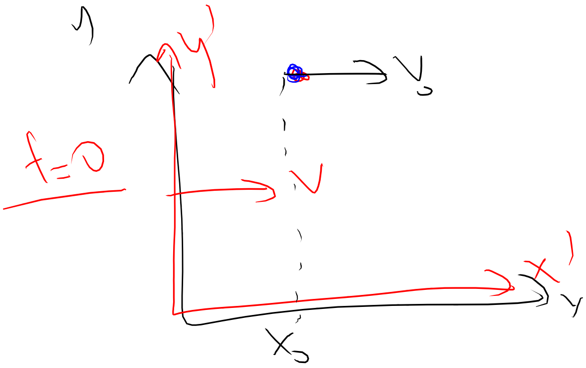
- Lorentz transformations
- Time dilation
- Length contraction
- Two postulates
- Time line

S.T. of relativity

- The laws of physics should be the same for <u>every inertial</u> observer.
- The speed of light is the same for every observer.

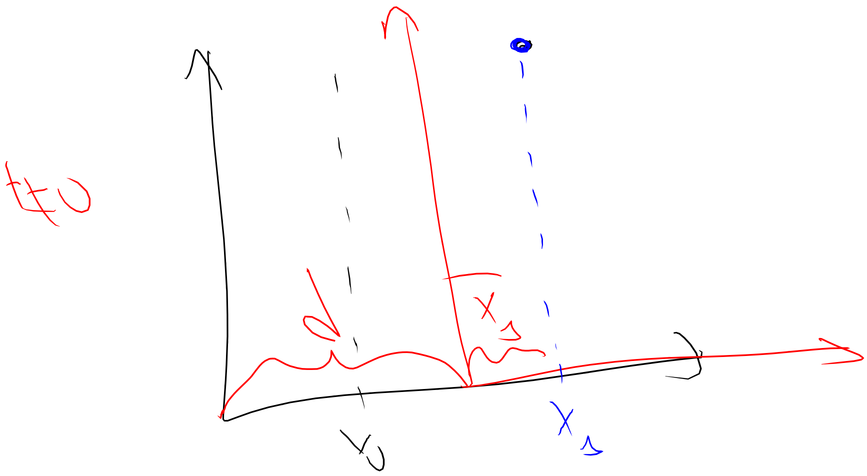
Galilean relativity

at $t=0$, both ref. frames are at the same point.



$$\Delta x = x_1 - x_0$$

$$\frac{\Delta x}{\Delta t} = \frac{x_1 - x_0}{\Delta t} = v_0$$



$$\Delta \bar{x} = x_0 - \bar{x}_1$$

$$\bar{v}_0 = \frac{-x_0 + \bar{x}_1}{\Delta t}$$

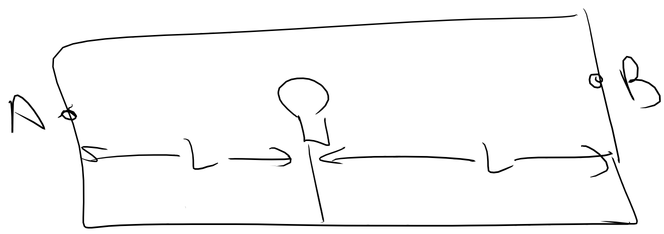
$$d + \bar{x}_1 = x_1 \Rightarrow \bar{x}_1 = x_1 - d$$

$$\bar{v}_0 = \frac{-x_0 + x_1 - d}{\Delta t}$$

$$= \frac{x_1 - x_0}{\Delta t} - \frac{d}{\Delta t}$$

$$\boxed{\bar{v}_0 = v_0 - v}$$

Simultaneaty is frame dependent.

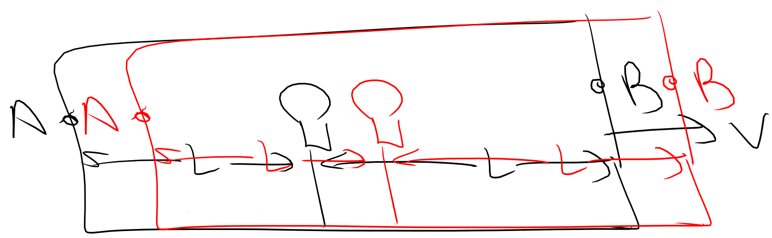


if you turn off the switch at

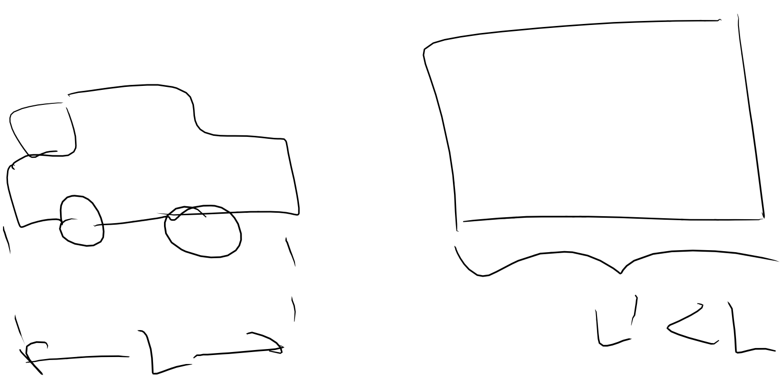
train

t=0. for an observer on the train, light reaches points A & B simultaneously!

For an observer at rest in the station:



light reaches point A <u>before</u> reaching point B

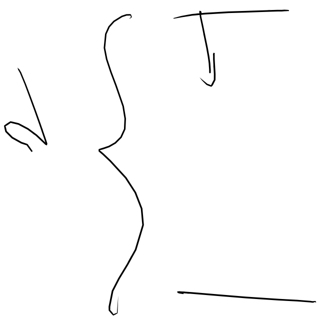


$\vec{E}'(\vec{E},\vec{B})$

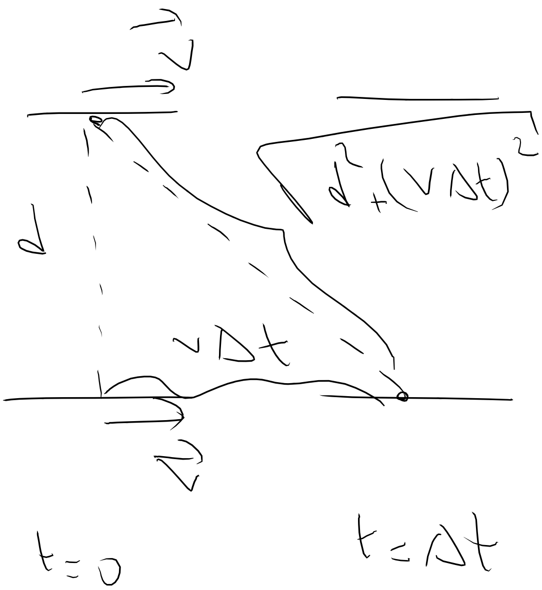
$\vec{B}'(\vec{E},\vec{B})$

$(\rho,\vec{J})$

Time Dilation



$$\boxed{\overline{\Delta t} = \frac{d}{c}}$$



$$\Delta t = \frac{\sqrt{d^2+(v\Delta t)^2}}{c}$$

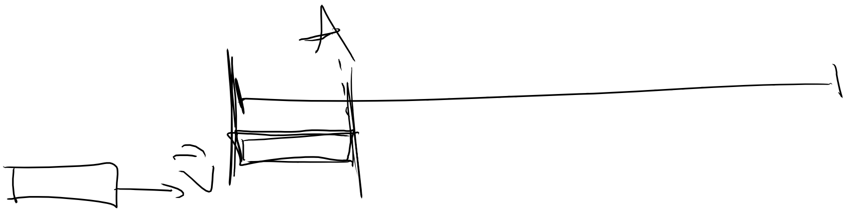
$$(\Delta t)^2 = (\overline{\Delta t})^2 + \frac{v^2}{c^2}(\Delta t)^2$$

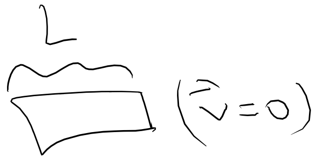
$$(\Delta t)^2 = \frac{1}{\left(1-\frac{v^2}{c^2}\right)}(\overline{\Delta t})^2$$

$$\gamma = \frac{1}{\sqrt{1-v^2/c^2}}$$

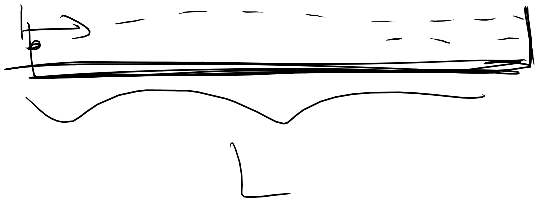
$$\Delta t = \gamma\,\overline{\Delta t} \iff \overline{\Delta t} = \frac{1}{\gamma}(\Delta t)$$

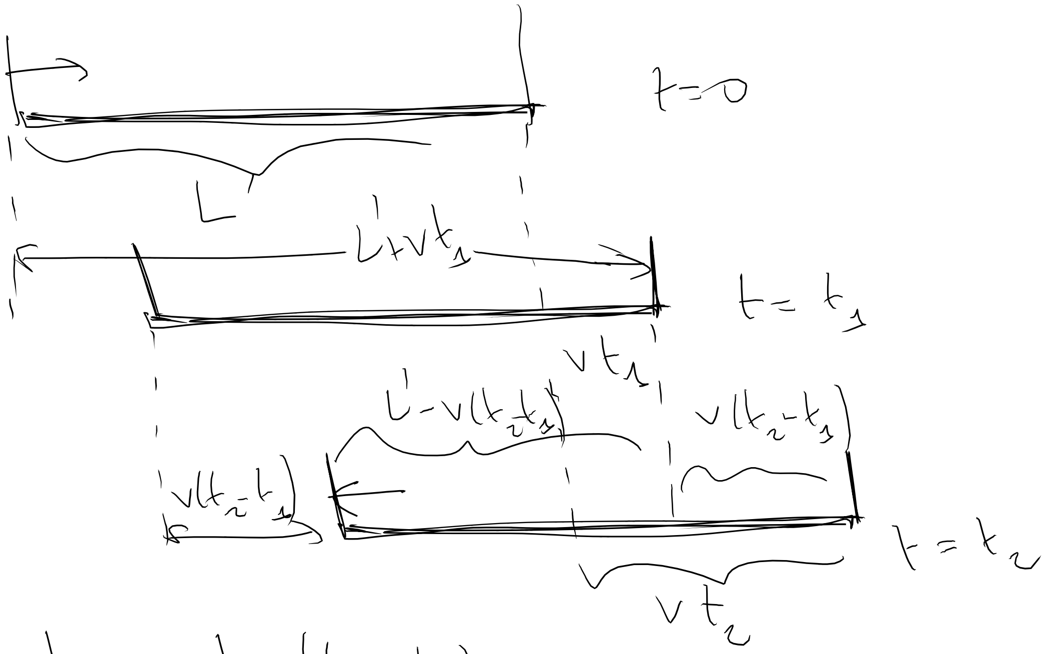
Length Contraction





$$\boxed{\Delta t = \frac{2L}{c}}$$





$$\Delta t = t_2 = t_1 + (t_2 - t_1)$$

$$= L' + vt.$$

$$t_1 = \frac{L' + vt_1}{c} \Longrightarrow t_1\left(1 - \frac{v}{c}\right) = L'$$

$$\boxed{t_1 = \frac{L'}{c\left(1 - \frac{v}{c}\right)}}$$

$$t_2 - t_1 = \frac{L' - v(t_2 - t_1)}{c} \Rightarrow t_2 - t_1 = \frac{L'}{c\left(1 + \frac{v}{c}\right)}$$

$$\Delta t = t_2 = t_1 + (t_2 - t_1) = \frac{L'}{c\left(1 - \frac{v}{c}\right)} + \frac{L'}{c\left(1 + \frac{v}{c}\right)}$$

$$\Delta t = \frac{L'}{1 - \frac{v^2}{c^2}} = 2\gamma^2 \frac{L'}{c}$$

$$\boxed{\overline{\Delta t} = \frac{1}{\gamma} \Delta t}$$

$$\overline{\Delta t} = \frac{2L}{c}$$

$$\frac{\cancel{2}L}{\cancel{c}} = \frac{1}{\cancel{\gamma}} \cancel{2}\gamma^{\cancel{2}} \frac{L'}{\cancel{c}} \qquad \Leftarrow$$

$$L = \gamma L' \Rightarrow L' = \frac{1}{\gamma} L = \sqrt{1 - \frac{v^2}{c^2}}\, L$$

$$\boxed{L' = \left(\sqrt{1 - \frac{v^2}{c^2}}\right) L}$$