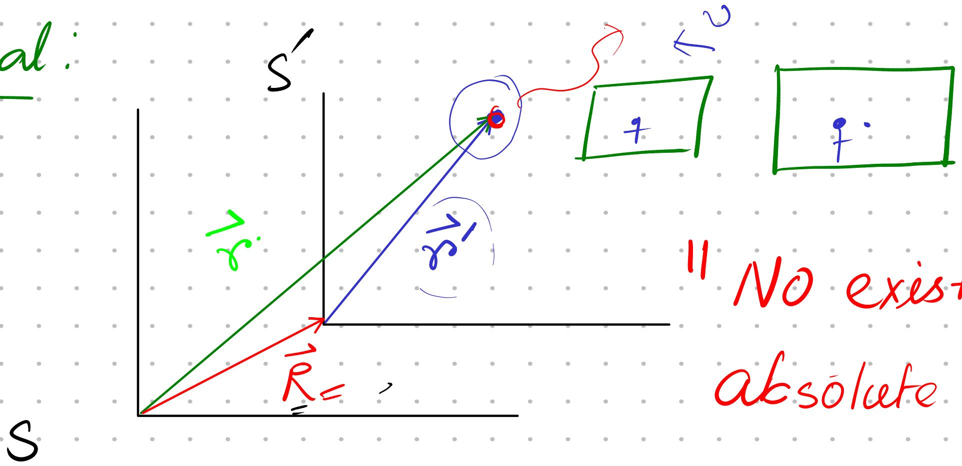
- Postulate relativity

Inertial:



"No existance of absolute frame"

$$\vec{R} + \vec{r}' = \vec{r}$$

$$\Rightarrow \frac{d\vec{R}}{dt} + \frac{d\vec{r}'}{dt} = \frac{d\vec{r}}{dt}$$

$$\Rightarrow \underline{v} + \frac{d\vec{r}'}{dt} = \frac{d\vec{r}}{dt}$$

$$\Rightarrow \underbrace{\cancel{\frac{dv}{dt}}}_{0} + \frac{d^2\vec{r}'}{dt^2} = \frac{d^2\vec{r}}{dt^2}$$

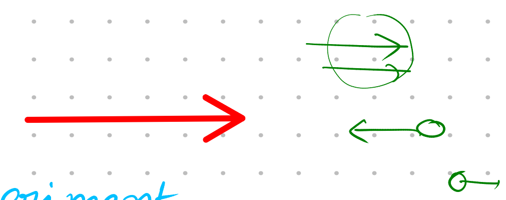
$$\frac{d^2\vec{r}'}{dt^2} = \frac{d^2\vec{r}}{dt^2} \Rightarrow \boxed{\vec{a}' = \vec{a}}$$

$$m\vec{a}' = m\vec{a}$$

$$\vec{F}' = \vec{F}$$

1. Laws of Physics are invarient in inertial frames.

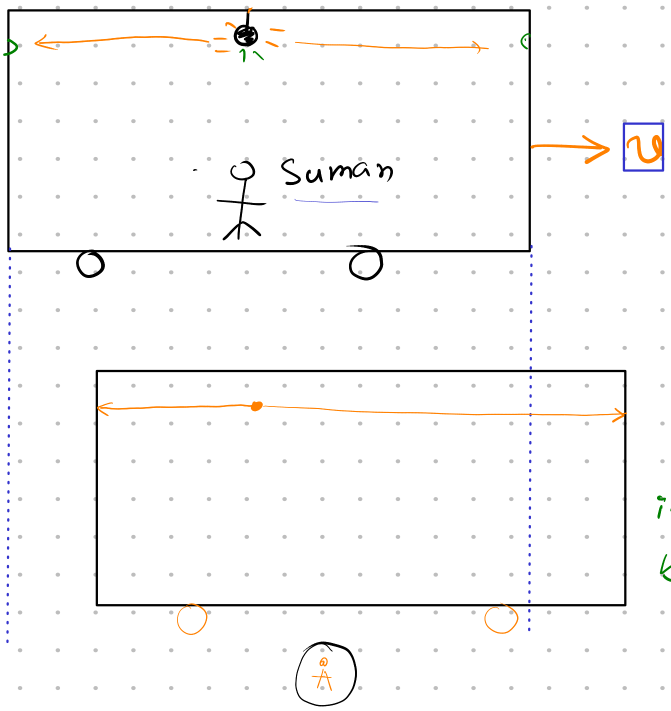
2. Speed of light in vaccume is constant in all inertial frame.



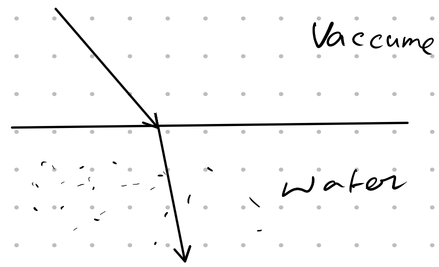
Michelson - Morley experiment

Thought Experiment:

- Relativity of Simultaneity



" Turn off Intuition"



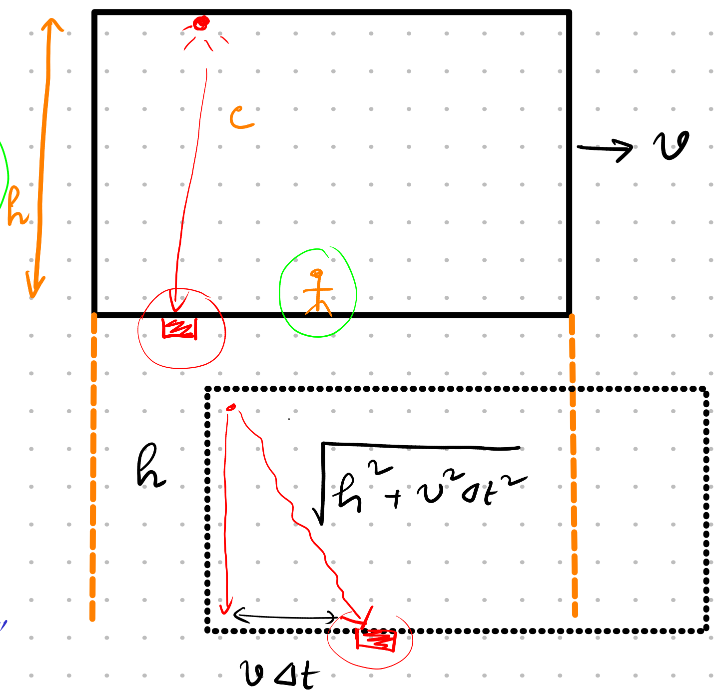
$v \sim c = 3\times 10^8\ m/s$

- Two events are simultaneous in one inertial frame, may not be simultaneous in other frame

- Time dilation

rest clock

$\Delta t' = \frac{h}{c}$



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

$$c^2\Delta t^2 = h^2 + v^2\Delta t^2$$

$$\Rightarrow (c^2-v^2)\Delta t^2 = h^2$$

$$\therefore \Delta t = \frac{h}{\sqrt{c^2-v^2}}$$

moving clock

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

"Twin paradox"

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

$v < c$

moving

$\Delta t > \Delta t'$

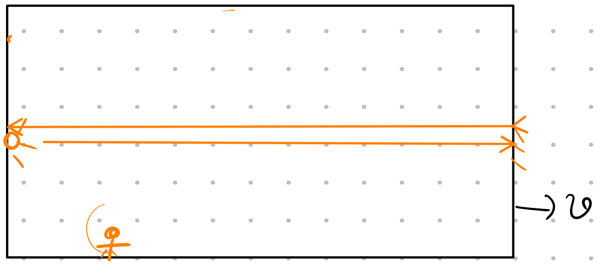
rest

* "Moving clocks run slow."

Length Construction:

How long does the signal take to complete the round trip,

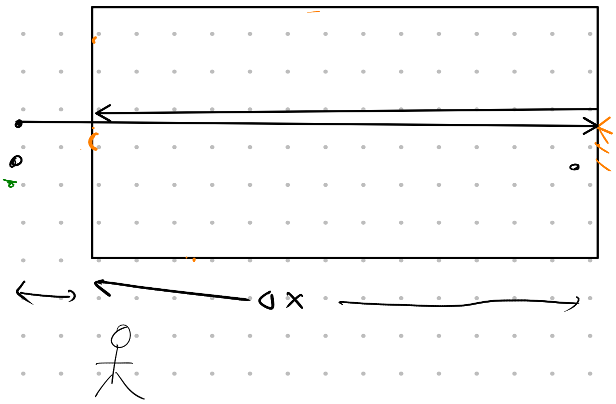
$$\Delta t' = 2\frac{\Delta x'}{c}$$ rest length



$$\Delta t_1 = \frac{\Delta x + v\Delta t_1}{c}$$

$$\Rightarrow \left(1-\frac{v}{c}\right)\Delta t_1 = \frac{\Delta x}{c}$$

$$\therefore \quad \Delta t_1 = \frac{\Delta x}{c-v}$$ moving length



$$\Delta t_2 = \frac{\Delta x - v\Delta t_2}{c}$$ moving time

$$\Delta t_2 = \frac{\Delta x}{c+v}.$$

$$\Delta t = \Delta t_1 + \Delta t_2$$

$$= \Delta x\left(\frac{1}{c-v} + \frac{1}{c+v}\right)$$

rest clock

$$\Delta t' = 2\frac{\Delta x'}{c}$$

moving clock

$$\Delta t = \frac{2c\Delta x}{c^2-v^2}$$

$$\checkmark \quad \Delta t = \frac{\Delta t'}{\sqrt{1-v^2/c^2}} \Rightarrow \frac{2c\Delta x}{c^2-v^2} = \frac{2\Delta x'}{c\sqrt{1-v^2/c^2}}$$

$$\frac{\cancel{2}\, c\,\Delta x}{c^2-v^2} = \frac{\cancel{2}\,\Delta x'}{c\sqrt{1-v^2/c^2}}$$

$$\frac{c\,\Delta x}{c^2-v^2} = \frac{\Delta x'}{\sqrt{c^2-v^2}}$$

$$\Rightarrow c\,\Delta x = \sqrt{c^2-v^2}\,\Delta x'$$

$$\Rightarrow \Delta x = \underline{\sqrt{1-v^2/c^2}}\,\Delta x'$$

moving length

rest length

$$\Delta x < \Delta x'$$

* "Moving length contracted"

"Barn Ladder"