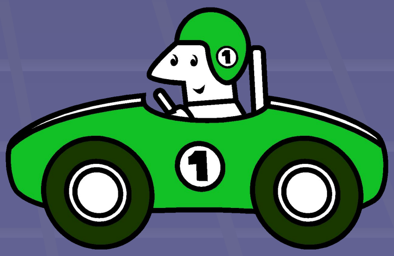
Special Theory of Relativity

V= 0,9 c



Postulates

- The laws of physics are the same in all inertial reference frames. No experiment can be perfomed to decide who in a set of inertial frames is moving and who is at rest.
- The speed of light in empty space is the same in all inertial frames

The Lorentz transformations

Inertial frame at rest: O (x,y,z,t)

Inertial frame moving with velocity v: O´ (x´,y´,z´,t´)

$x' = \gamma\,(x - vt)$

$t' = \gamma\,(t - vx/c^2)$

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

$y' = y \qquad z' = z$

$V_x' = (V_x - V)/(1 - V_x V/c^2)$

$x = \gamma\,(x' + vt')$

$t = \gamma\,(t' + vx'/c^2)$

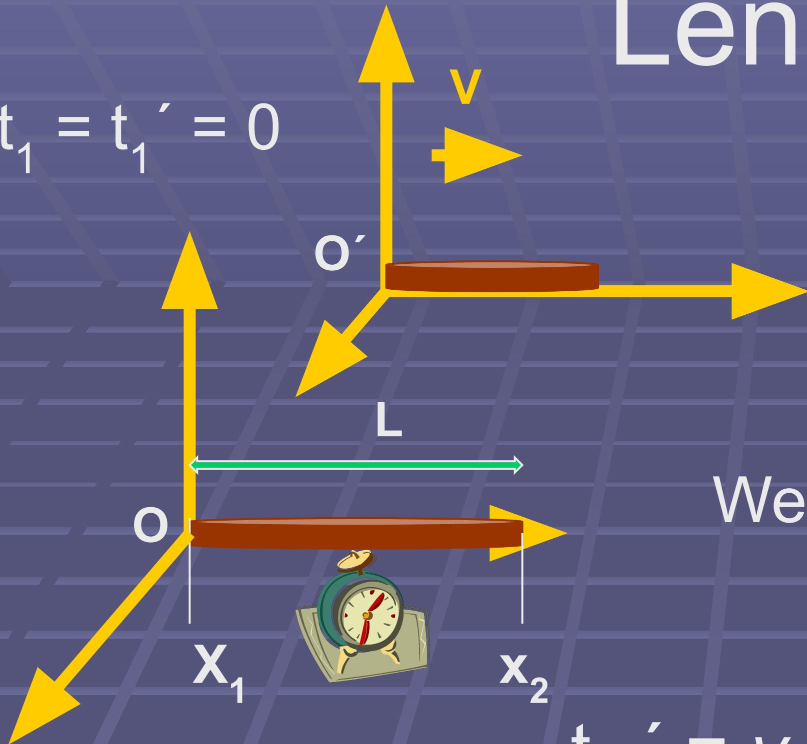
$\gamma = 1/\sqrt{(1-v^2/c^2)}$

$y = y' \qquad z = z'$

$V_x = (V_x' + V)/(1 + V_x' V/c^2)$

Length constriction

$t_1 = t_1' = 0$



We measure $L = X_2 - X_1$

at $t_1 = t_2 = 0$

We have to calculate L' at $t_1' = t_2' = 0$

$$t_1' = \gamma (t_1 - vx_1/c^2) = 0$$

$$t_2' = \gamma (t_2 - vx_2/c^2) = \gamma (t_2 - v L/ c^2) = 0$$

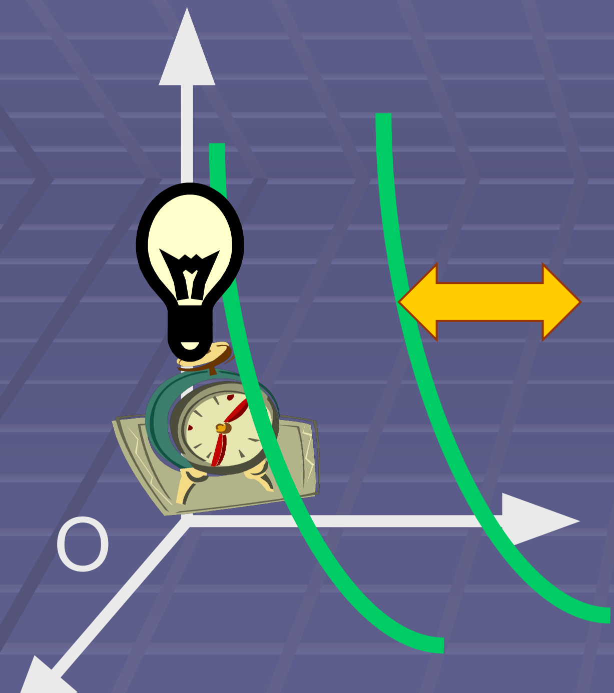
$$t_1 = 0 \quad and \; t_2 = v L/ c^2$$

$$x_1' = \gamma (x_1 - vt_1) = 0$$

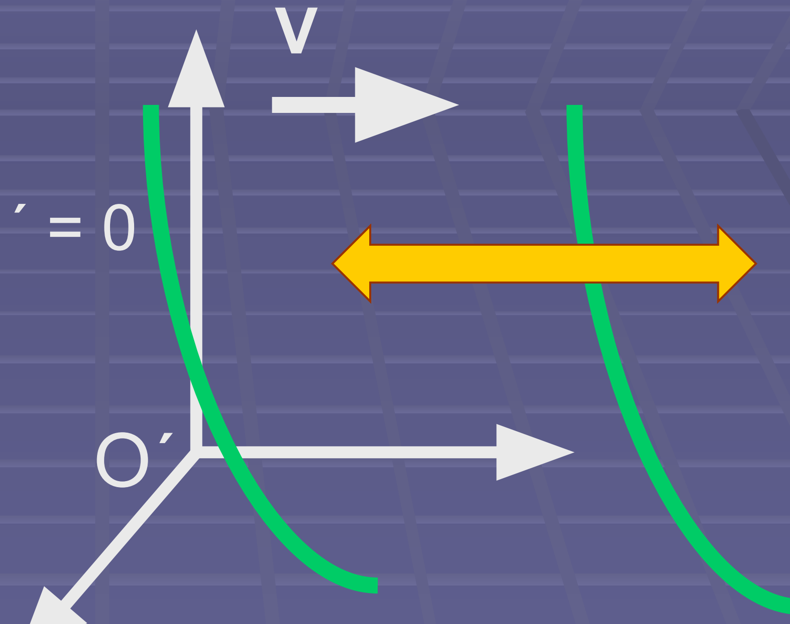
$$x_2' = \gamma (x_2 - vt_2) = \gamma (L - v^2 L/c^2) = \gamma L(1-v^2/c^2) = L / \gamma$$

$$L' = x_2' - x_1' = L / \gamma$$

Time dilation



$t_1 = t_1' = 0$



2 light flashes

At $t_1 = 0$, and t_2

$X_1 = X_2 = 0$

$t_1' = \gamma\, (t_1 - V x_1 / c^2) = 0$

$t_2' = \gamma\, (t_2 - V x_2 / c^2) = \gamma\, t_2$

$t_1' - t_2' = \gamma\, (t_1 - t_2)$

Momentum and energy

The relativistic momentum:

$$P = mV / \sqrt{(1-v^2/c^2)} = \gamma\, mv$$

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

The relativistic energy:

$$E = mc^2 / \sqrt{(1-v^2/c^2)} = \gamma\, mc^2$$

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

The energy and momentum are related by:

$$E = \sqrt{p^2 c^2 - m^2 c^4}$$