Relativity

Everything is relative except the speed of light.

Time Dilation

Higher the speed, slower the time

$$\Delta t_p = \frac{\text{Distance}}{\text{Speed}} = \frac{2d}{c} \Rightarrow \text{Speed of light}$$

$$t_{\substack{\text{stationary}\\\text{observer}}} > t_{\text{observer}}$$

$\Delta t_p \Rightarrow$ Proper time $\Rightarrow$ Observer that sees the two events happen at the same position

$$\Delta t = \gamma \, \Delta t_p$$

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

$$\Delta t_p < \Delta t$$

$\Rightarrow$ Observer that sees the two events happen at different positions

Example

$$\Delta t = \frac{1}{\sqrt{1 - \frac{(0.96)^2 \cancel{c^2}}{\cancel{c^2}}}} \times 3$$

$$= \frac{3}{\sqrt{1-(0.96)^2}}$$

$= 10.714\,s$

Length Contraction

$$L = \frac{L_p}{\gamma}$$

Measured by the observer that sees the two ends moving

L_p : Proper Length — Measured by the observer who sees the two ends fixed

$\Delta L_p > L$

Doppler Effect

$$f' = \frac{\sqrt{1+v/c}}{\sqrt{1-v/c}}\, f$$

Lorentz Transformation

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

$$x = x' ($$

$$t' = \gamma\left(t - \frac{v}{c^2}x\right)$$