PHYSICS 232 – CHAPTER 37: RELATIVITY

Time dilation:

$$\Delta t = \frac{\Delta t_o}{\sqrt{1 - u^2/c^2}} = \gamma \Delta t_o \ , \quad \gamma = \frac{1}{\sqrt{1 - u^2/c^2}}$$

Length contraction:

$$l = \frac{l_o}{\gamma}$$

Lorentz transformation

$$\begin{aligned} x' &= \gamma(x - ut) \ , \\ y' &= y \ , \\ z' &= z \ , \\ t' &= \gamma(t - ux/c^2) \ . \end{aligned}$$

Addition of velocities:

$$v' = \frac{v - u}{1 - uv/c^2} \ , \quad v = \frac{v' + u}{1 + uv'/c^2}$$

Doppler effect: for a source emitting wave of frequency f_o as it moves toward the observer with speed u, the received frequency is

$$f = \sqrt{\frac{c + u}{c - u}} f_o$$

Momentum:

$$\vec{p} = \gamma m \vec{v}$$

Total energy:

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

Kinetic energy:

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

For $v \ll c$ (non-relativistic body),

$$K \approx \frac{1}{2} m v^2$$