PHYS420 (Spring 2002)
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Equation Sheet for Exam #1
(Friday, March 1st, 2002)

Lorentz Transformations

$$\left\{\begin{aligned} x' &= \gamma(x - vt) \\ y' &= y \\ z' &= z \\ t' &= \gamma\left(t - \frac{v}{c^2}x\right) \end{aligned}\right\} \text{ where } \gamma \equiv \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Velocity Transformation

$$u'_x = \frac{u_x - v}{1 - \frac{u_x v}{c^2}}, \quad u'_y = \frac{1}{\gamma}\frac{u_y}{1 - \frac{u_x v}{c^2}}, \quad u'_z = \frac{1}{\gamma}\frac{u_z}{1 - \frac{u_x v}{c^2}}$$

Time Dilation

$$t = \gamma t_0 = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}}$$

Length Contraction

$$L = \frac{L_0}{\gamma} = L_0\sqrt{1 - \frac{v^2}{c^2}}$$

Doppler Shift

$$f_{observer} = \frac{\sqrt{1 + (v/c)}}{\sqrt{1 - (v/c)}} f_{source}, \textit{ approaching source}$$

Momentum

$$p \equiv \frac{mu}{\sqrt{1 - \frac{u^2}{c^2}}}$$

Energy

$$E_{total} = \frac{mc^2}{\sqrt{1 - \frac{u^2}{c^2}}} = KE + E_{rest}; \qquad E_{rest} = mc^2$$

$$KE = \frac{mc^2}{\sqrt{1 - \frac{u^2}{c^2}}} - mc^2 = E_{total} - E_{rest}; \qquad E_{total}^2 = p^2c^2 + (mc^2)^2$$