$$\left.\begin{array}{rcl} x'(x,y,z,t) &=& x - vt \\ y'(x,y,z,t) &=& y \\ z'(x,y,z,t) &=& z \\ t'(x,y,z,t) &=& t \end{array}\right\} \text{Galilean transforms} \tag{1}$$

$$\left.\begin{array}{rcl} x'(x,y,z,t) &=& \gamma(x - vt) \\ y'(x,y,z,t) &=& y \\ z'(x,y,z,t) &=& z \\ t'(x,y,z,t) &=& \gamma(t - \frac{vx}{c^2}) \end{array}\right\} \text{Lorentz transforms} \tag{2}$$

$$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1}{\sqrt{1 - \beta^2}} \tag{3}$$

$$\begin{pmatrix} ct' \\ x' \\ y' \\ z' \end{pmatrix} = \begin{pmatrix} \gamma & -\beta\gamma & 0 & 0 \\ -\beta\gamma & \gamma & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \end{pmatrix} \begin{pmatrix} ct \\ x \\ y \\ z \end{pmatrix} \tag{4}$$

The Lorentz transform also works with the energy-momentum 4-vector: $(p_0, p_1, p_2, p_3) = (E/c, p_x, p_y, p_z)$.

$$u'_x = \frac{dx'}{dt'} = \frac{u_x - v}{1 - \frac{u_x v}{c^2}} \tag{5}$$

$$u'_y = \frac{dy'}{dt'} = \frac{u_y}{\gamma(1 - \frac{u_x v}{c^2})} \tag{6}$$

To obtain the inverse transformations simply switch primed and unprimed and replace v with $-v$ in the formulas above.

$$\Delta t = \gamma\tau \tag{7}$$

$$L = \frac{L_0}{\gamma} \tag{8}$$

$$(\Delta s)^2 = (c\Delta t)^2 - (\Delta x)^2 - (\Delta y)^2 - (\Delta z)^2 \tag{9}$$

$$(\Delta s')^2 = (\Delta s)^2 \tag{10}$$

$$(\text{slope of } x'\text{-axis}) = \beta \tag{11}$$

$$(\text{slope of } ct'\text{-axis}) = \frac{1}{\beta} \tag{12}$$

$$E = mc^2 + E_K = p_0 c = \frac{mc^2}{\sqrt{1 - \frac{u^2}{c^2}}} \text{ if } m \neq 0 \tag{13}$$

$$\vec{p} = (p_1, p_2, p_3) = \frac{m\vec{u}}{\sqrt{1 - \frac{u^2}{c^2}}} \text{ if } m \neq 0 \tag{14}$$

$$E^2 = p^2c^2 + m^2c^4 \text{ for both } m = 0 \text{ and } m \neq 0 \tag{15}$$

$c = 3.00 \times 10^8$ m/s $\quad$ $m(\text{electron}) = 9.11 \times 10^{-31}$ kg$= 5.11 \times 10^5$ eV/c^2

$\sigma = 5.67 \times 10^{-8}$ W m^{-2} K^{-4} $\quad$ $k_B = 1.38 \times 10^{-23}$ J/K$= 8.63 \times 10^{-5}$ eV/K

1 eV$= 1.60 \times 10^{-19}$ J $\quad$ $e = 1.60 \times 10^{-19}$ C

$hc = 1240$ eV·nm