Lorentz Transormation:

$$x' = \gamma(x - vt)$$
$$y' = y$$
$$z' = z$$
$$t' = \gamma(t - vx/c^2)$$

Inverse Lorentz Tranformation:

$$x = \gamma(x' + vt')$$
$$y = y'$$
$$z = z'$$
$$t = \gamma(t' + vx'/c^2)$$

Relativistic transformation of velocities

$$u'_x = (u_x - v)/(1 - u_x v/c^2)$$
$$u'_y = u_y/\gamma(1 - u_x v/c^2)$$

Inverse Transformation:

$$u_x = (u'_x + v)/(1 + u'_x v/c^2)$$
$$u_y = u'_y/\gamma(1 + u'_x v/c^2)$$

Relativistic Doppler Effect:

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

Relativistic Momentum

$p_x = \gamma m u_x$; similarly for y- and z-components

$$\gamma = \frac{1}{\sqrt{1 - u^2/c^2}}$$

Kinetic Energy $K = \gamma mc^2 - mc^2$

Total Energy $E = \gamma mc^2 = K + mc^2$

$E^2 = p^2c^2 + m^2c^4$

Force due to Electric field : $\mathbf{F} = q\mathbf{E}$

Force due to Magnetic Field: $\mathbf{F} = q\mathbf{v}\mathbf{x}\mathbf{B}$

Particle of charge q moving in magnetic field B in circle of radius r has relativistic momentum $p = qBr$

Stefan's Law $e_t = \sigma T^4$ σ = 5.67.10^{-8} Wm^{-2}K^{-4}

Planck's Blackbody radiation formula: $u(f,T)df = \frac{8\pi hf^3}{c^3}(\frac{1}{e^{hf/kT}-1})df$

De Broglie wavelength λ = h/p

Energy of photon E =hf

For photon λf = c

Compton formula λ′ - λ = (h/m_ec)(1 – cos φ)

Bragg's Law   n λ =2 d sin θ (n=1,2,……)

Drag Force on drop of radius α and velocity ν in medium of viscosity η (always opposite to direction of v) : $D = 6\pi\alpha\eta v = Cv$

Rutherford's formula for scattering of alpha particles from nucleus of charge Z:

$$\Delta n = \frac{k^2 Z^2 e^4 NnA}{4R^2(\frac{1}{2}m_\alpha v^2{}_\alpha)^2 \sin^4(\phi/2)}$$

Bohr's quantization for Angular momentum $mvr = n\hbar$

Energy levels of Bohr atom

$$E_n = -\frac{ke^2}{2a_0}(\frac{1}{n^2}) = -\frac{13.6}{n^2}eV$$

Bohr Radius $a_0 = \frac{\hbar^2}{me^2k}$ = 0.5292. 10^{-10} m

Rydberg Constant $R = \frac{ke^2}{2a_0hc} = 1.097.10^7 m^{-1}$

linear momentum operator $p_x = -i\hbar\frac{\partial}{\partial x}$

Angular momentum operator about z-axis $L_z = -i\hbar\frac{\partial}{\partial\phi}$

Heisenberg Uncertainty principles: $\Delta p_x \Delta x \geq \hbar/2$
$\Delta E \Delta t \geq \hbar/2$

One-dimensional time-independent Schrodinger Equation $-\frac{\hbar^2}{2m}\frac{d^2\psi}{dx^2} + U(x)\psi = E\psi$

3-dimensional time-independent Schrodinger Equation $-\frac{\hbar^2}{2m}\nabla^2\psi + U\psi = E\psi$

$$\nabla^2 = \frac{\partial^2}{\partial x^2} + \frac{\partial^2}{\partial y^2} + \frac{\partial^2}{\partial z^2} = \frac{\partial^2}{\partial r^2} + (\frac{2}{r})\frac{\partial}{\partial r} + \frac{1}{r^2}[\frac{\partial^2}{\partial \theta^2} + \cot\theta\frac{\partial}{\partial \theta} + \csc^2\theta\frac{\partial^2}{\partial \phi^2}]$$

The expectation value of some function of x , f(x) is given by $\int_{-\infty}^{\infty} dxP(x)f(x)$ where P(x)dx is the (normalized) probability distribution for getting a value of x between x and x + dx.

Expectation value of some quantum mechanical operator O:

$$\langle O\rangle = \int_{-\infty}^{\infty} dx\psi^*(x)O\psi(x)$$

Relation between eigenfunctions, operators,and eigenvalues:

$$O\psi_n(x) = o_n\psi_n(x)$$

Standard deviation error for a variable represented by operator O:

$$\Delta O = \sqrt{\langle O^2\rangle - \langle O\rangle^2}$$

Electron current through unit area for free electrons = v $|A|^2$; v = velocity of electrons; A =amplitude of plane wave.

$e = 1.6x10^{-19}C$

proton mass = $1.675.10^{-27}$ kg = 939.6 MeV/c^2

electron mass

$m_e = 9.1x10^{-31}Kg = 0.511MeV/c^2$

$c = 3x10^8 m/s$

$1MeV = 1.6x10^{-13}J$

$1MeV/c^2 = 1.78x10^{-30}Kg$

$1MeV/c = 5.344x10^{-22}Kg.m/s$

1 eV = 1.6. 10^{-19} J

h = 6.626 . 10^{-34} J.s = 4.136. 10^{-15} eV.s

$\hbar = h/2\pi = 1.055.10^{-34}J.s = 6.582.10^{-16}eV.s$

Coulomb's constant $k = 1/(4\pi\varepsilon_0) = 8.99.10^9 N.m^2/kg^2$

Bohr radius a_0 =0.529. 10^{-10} m

1 Rydberg (Energy required to ionize hydrogen atom) =13.6 eV

Rydberg Constant R = 1.097. 10^7 m^{-1}