$$\Delta L = \frac{\Delta L'}{\gamma} \qquad \Delta t = \gamma \Delta t' \qquad x' = \gamma(x - vt) \qquad t' = \gamma(t - \frac{v}{c^2}x)$$

$$u_x' = \frac{u_x - v}{1 - (\frac{u_x v}{c^2})} \qquad u'_{y,z} = \frac{u_{y,z}}{\gamma\left[1 - (\frac{u_x v}{c^2})\right]} \qquad f_{obs} = \frac{\sqrt{1 \pm (v/c)}}{\sqrt{1 \mp (v/c)}} f_{source}$$

$$E = \gamma m_o c^2 = K + m_o c^2 \qquad p = \gamma m_o u$$

$$\lambda' - \lambda = \frac{h}{m_e c}(1 - \cos\theta) \qquad eV_s = hf - \phi \qquad e = \sigma T^4 \qquad E = nhf$$

$$\frac{e}{m} = \frac{V\theta}{B^2 ld} \qquad q = (\frac{mg}{E})(\frac{v + v'}{v}) \qquad m_e vr = n\hbar \qquad r_n = \frac{n^2 a_0}{Z}$$

$$E_n = \frac{-13.6\ Z^2}{n^2} \qquad \Delta n = \frac{k^2 Z^2 e^4 NnA}{4R^2 K \sin^4(\frac{\phi}{2})} \qquad \lambda = \frac{h}{p} \qquad v_g = \frac{dw}{dk}$$

$$\Delta p_x \cdot \Delta x \ge \frac{\hbar}{2} \qquad \Delta E \cdot \Delta t \ge \frac{\hbar}{2}$$

$$\int_{+\infty}^{-\infty} |\psi|^2\, dx = 1 \qquad \langle Q \rangle = \int_{-\infty}^{+\infty} \psi^* [Q] \psi\, dx$$

$$\psi_n(x) = \sqrt{\frac{2}{L}} \sin(\frac{n\pi}{L}x) \qquad E_n = \frac{n^2 \pi^2 \hbar^2}{2mL^2}$$

$$\psi_0(x) = (\frac{m\omega}{\pi\hbar})^{1/4} e^{-m\omega x^2/2\hbar} \qquad E_n = (n + \frac{1}{2})\hbar\omega$$

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

$$[p_x] = \frac{\hbar}{i}\frac{\partial}{\partial x} \qquad [E] = i\hbar\frac{\partial}{\partial t} \qquad [K] = -\frac{\hbar^2}{2m}\frac{\partial^2}{\partial x^2} \qquad [H] = -\frac{\hbar 2}{2m}\frac{\partial^2}{\partial x^2} + U(x)$$

$$T(E) = \left\{1 + \frac{1}{4}\left[\frac{U^2}{E(U - E)}\right]\sinh^2 \alpha L\right\}^{-1}$$

$$\alpha = \frac{\sqrt{2m(U - E)}}{\hbar}$$

$$E = \frac{\pi^2 \hbar^2}{2mL^2}(n_1^2 + n_2^2 + n_3^2)$$

$$|\vec{L}| = \sqrt{l(l+1)}\,\hbar \qquad L_z = m_l \hbar$$

$$\psi_{nlm}(r,\theta,\phi) = R_{nl}(r) Y_l^{ml}(\theta,\phi) \qquad E_n = (-13.6\,eV)\frac{Z^2}{n^2}$$

$$P(r) = r^2 |R_{nl}(r)|^2 \qquad \int_0^\infty P(r)dr = 1 \qquad \langle f \rangle = \int_0^\infty f(r)P(r)dr$$

$$\int_0^\infty z^n e^{-z} dz = n! \qquad \int_0^\infty z^2 e^{-az^2} dz = \frac{1}{4a}\sqrt{\frac{\pi}{a}} \quad a > 0$$

$$\vec{\mu}_o = -\frac{e}{2m_e}\vec{L} \qquad \omega_L = \frac{eB}{2m_e} \qquad U = \hbar\omega_L m_l \qquad U = -\vec{\mu}\cdot\vec{B}$$

$$\left|\vec{S}\right| = \sqrt{s(s+1)}\hbar \qquad S_z = m_s\hbar \qquad \vec{\mu}_s = -\frac{e}{m_e}g\vec{S} \qquad \vec{J} = \vec{L}+\vec{S}$$

$$\left|\vec{J}\right| = \sqrt{j(j+1)}\hbar \qquad J_z = m_j\hbar$$

$$E_{rot} = \frac{\hbar^2}{2I_{cm}}l(l+1) \quad l = 0,1,2,3... \quad E_{vib} = (\upsilon+\frac{1}{2})\hbar\omega \qquad \upsilon = 0,1,2,3....$$

$$\sigma = \frac{ne^2\tau}{m_e} \qquad K = \frac{k_B n v_{rms} L}{2} \qquad v_{rms} = \sqrt{\frac{3k_BT}{m_e}}$$

$$J = nev_d$$

Constants :

$e = 1.6\times10^{-19}\ C$ $\qquad m_e = 9.1\times10^{-31}\ kg$ $\qquad \hbar = 1.05\times10^{-34}\ J\cdot s$

$m_p = 1.67\times10^{-27}\ kg$ $\qquad c = 3\times10^{8}\ m/s$ $\qquad 1u = 1.66\times10^{-27}\ kg$

$\mu_B = 9.278\times10^{-24}\ J/T$ $\qquad k_B = 1.38\times10^{-23}\ J/K$ $\qquad k = 9\times10^{9}\ N\cdot m^2C^2$

$m_ec^2 = 0.511\ MeV$ $\qquad m_pc^2 = 938\ MeV$ $\qquad hc=12400\ eV\cdot A$