$$\Phi_B = \int \vec{B}.d\vec{A}$$

$$\Phi = BA$$

$$\mathcal{E} = -\frac{d\Phi_B}{dt}$$

$$\mathcal{E} = \oint \vec{E}.d\vec{s}$$

$$\oint \vec{E}.d\vec{s} = -\frac{d\Phi_B}{dt}$$

$$L = \frac{N\Phi_B}{i}$$

$$\frac{L}{l} = \mu_0 n^2 A$$

$$\mathcal{E}_L = -L\frac{di}{dt}$$

$$i = \frac{\mathcal{E}}{R}\left(1 - e^{-\frac{t}{\tau_L}}\right)$$

$$i = i_0 e^{-t/\tau_L}$$

$$U_B = \frac{1}{2}Li^2$$

$$u_B = \frac{B^2}{2\mu_0}$$

$$\mathcal{E}_2 = -M\frac{di_1}{dt}$$

$$\mathcal{E}_1 = -M\frac{di_2}{dt}$$

$$U = U_E + U_B$$

$$U_{E=} \frac{q^2}{2C}$$

$$U_{B=} \frac{L\,i^2}{2}$$

$$L\frac{d^2q}{dt^2} + \frac{1}{C}q = 0$$

$$q = Q\cos(\omega t + \phi)$$

$$\omega = \frac{1}{\sqrt{LC}}$$

$$i = -\omega Q \sin(\omega t + \phi)$$

$$L\frac{d^2q}{dt^2} + R\frac{dq}{dt} + \frac{1}{C}q = 0$$

$$q = Qe^{-Rt/2L}\cos(\dot{\omega}t + \phi)$$

$$\dot{\omega} = \sqrt{\omega^2 - \left(\frac{R}{2L}\right)^2}$$

$$\varepsilon = \varepsilon_m \sin \omega_d t$$

$$i = I \sin(\omega_d t - \phi)$$

$$I = \varepsilon_m / R$$

$$V_R = I\,R$$

$$V_C = I\,X_c$$

$$V_L = I\,X_L$$

$$X_L = \omega_d L$$

$$I = \frac{\varepsilon m}{\sqrt{R^2 + (Xl - Xc)^2}}$$

$$\tan\phi = \frac{Xl - Xc}{R}$$

$$Z = \sqrt{R^2 + (Xl - Xc)^2}$$

$$P_{avg} = I^2_{rms}R = \varepsilon_{rms} I_{rms} \cos\phi$$

$$I_{rms} = I/\sqrt{2} \qquad \varepsilon_{rms} = \varepsilon/\sqrt{2}$$

$$V_{rms} = V/\sqrt{2}$$

$$V_s = V_p \frac{Ns}{Np}$$

$$I_s = I_p \frac{Np}{Ns}$$

$$R_{eq} = \left(\frac{Np}{Ns}\right)^2$$

$$\mu_B = \frac{eh}{4\pi m} = 9.27 \times 10^{-24}\ \text{J/T}.$$

$$\mu_{s,z} = \pm\frac{eh}{4\pi m} = \pm\mu_B,$$

$$S_z = m_s \frac{h}{2\pi}, \quad \text{for } m_s = \pm\tfrac{1}{2},$$

$$\vec{\mu}_s = -\frac{e}{m}\vec{S}.$$

$$i_d = \varepsilon_0 \frac{d\Phi_E}{dt}.$$

$$U = -\vec{\mu}_{orb} \cdot \vec{B}_{ext} = -\mu_{orb,z} B_{ext}.$$

$$\oint \vec{B} \cdot d\vec{s} = \mu_0 i_{enc}$$

$$\Phi_E = \oint \vec{E} \cdot d\vec{A} = \frac{q_{enc}}{\varepsilon_0}$$

$$\Phi_B = \oint \vec{B} \cdot d\vec{A} = 0$$

$$\oint \vec{E} \cdot d\vec{s} = -\frac{d\Phi_B}{dt}$$

$$\oint \vec{B} \cdot d\vec{s} = \mu_0\varepsilon_0 \frac{d\Phi_E}{dt} + \mu_0 i_{enc}$$

$$M = C\frac{B_{ext}}{T}$$

$$M_{max} = N\mu/V.$$

$$E = E_m \sin(kx - \omega t)$$

$$B = B_m \sin(kx - \omega t)$$

$$c = \frac{E}{B} = \frac{1}{\sqrt{\mu_0\,\varepsilon_0}}$$

$$\vec{S} = \frac{1}{\mu_0}\vec{E} \times \vec{B}$$

$$I = \frac{1}{c\,\mu_0} E^2_{rms}$$

$$I = \frac{P_s}{4\pi r^2}$$

$$F = \frac{IA}{c} \qquad F = \frac{2IA}{c}$$

$$P_r = \frac{I}{c} \qquad P_r = \frac{2I}{c}$$

$$I = \frac{1}{2} I_0$$

$$I = I_0 \cos^2\theta$$

$$n_2 \sin\theta_2 = n_1 \sin\theta_1$$

$$\theta_c = \sin^{-1}\frac{n_2}{n_1}$$

$$\theta_B = \tan^{-1}\frac{n_2}{n_1}$$

$$\frac{1}{P} + \frac{1}{i} = \frac{1}{f} = \frac{2}{r}$$

$$\frac{n_1}{P} + \frac{n_2}{i} = \frac{n_2 - n_1}{r}$$

$$\frac{1}{P} + \frac{1}{i} = \frac{1}{f} = (n-1)\left(\frac{1}{r_1} - \frac{1}{r_2}\right)$$

$$m = -\frac{i}{p} \qquad |m| = \frac{h'}{h}$$

**CONSTANTS**

| | |
|---|---|
| $\varepsilon_o = 8.854\times10^{-12}\ C^2/N\cdot m^2$ | |
| $N_A = 6.022\times10^{23}\ \text{mole}^{-1}$ | |
| $\sigma = 5.6704\times10^{-8}\ W/m^2\cdot K^4$ | |
| $1\,atm = 1.01\times10^5\ N/m^2$ | |
| $1\,eV = 1.602\times10^{-19}\ J$ | $v_{air} = 343\ m/s$ |
| $\lvert e\rvert = 1.602\times10^{-19}\ C$ | $I_o = 10^{-12}\ W/m^2$ |
| $\mu_o = 4\pi\times10^{-7}\ T\cdot m/A$ | $m_e = 9.11\times10^{-31}\ kg$ |
| $m_p = 1.673\times10^{-27}\ kg$ | $g = 9.8\ m/s^2$ |
| $R = 8.314\ J/mole.K$ | $1\ L = 10^{-3}\ m^3$ |
| $k = 1.381\times10^{-23}\ J/K$ | $1\,cal = 4.1868\ J$ |

**FOR WATER**

| | |
|---|---|
| $c = 4187\ J/kg.K$ | $\rho = 1000\ kg/m^3$ |
| $L_V = 2256\ kJ/kg$ | $L_F = 333\ kJ/kg$ |

**PREFIXES**

| | |
|---|---|
| $k = kilo = 10^3$ | $m = milli = 10^{-3}$ |
| $M = mega = 10^6$ | $\mu = micro = 10^{-6}$ |
| $G = giga = 10^9$ | $n = nano = 10^{-9}$ |
| $T = tera = 10^{12}$ | $p = pico = 10^{-12}$ |