Electric Current

$$I_{avg} = \frac{\Delta Q}{\Delta t}$$

$$I_{ins} = \frac{dQ}{dt}$$

$$\Delta Q = (nA\Delta x)q$$

$$\Delta x = V_d \Delta t$$

$$\Delta Q = nAV_d \Delta t q$$

$$I_{av} = nqV_d A$$

$$V = IR$$

$$J = \frac{I}{A}$$

$$J = nqV_d$$

$$J = \sigma E$$

$$\Delta V = El$$

$$R = \frac{\rho l}{A}$$

$$R = \frac{l}{\sigma A}$$

$$\rho = \rho_0[1 + \alpha(T - T_0)]$$

$$\alpha = \frac{1}{\rho_0}\frac{\Delta \rho}{\Delta T}$$

$$\boxed{R = R_0[1 + \alpha(T - T_0)]}$$

$$P = I\Delta V$$

$$P = I^2 R$$

$$P = \frac{V^2}{R}$$

$$P = I\mathcal{E}$$

$$I = \mathcal{E}/R$$

Electrostatics

$$e^- = 1.60 \times 10^{-19}\, C$$

$$m_{e^-} = 9.1 \times 10^{-31}\, kg$$

$$m_{p^+} = 1.6\cancel{39}^{73} \times 10^{-27}\, kg$$

$$m_{N^0} = 1.675 \times 10^{-27}\, kg$$

$$F = k\frac{q_1 q_2}{r^2}$$

$$k = \frac{1}{4\pi\varepsilon_0}$$

$$k = \frac{1}{4\pi\varepsilon_0\varepsilon_r}$$

$$\varepsilon = \varepsilon_0\varepsilon_r$$

$$E = \frac{F}{q}$$

$$E = \frac{kq}{r^2}$$

$$F = qE$$

$$E = \frac{1}{2\pi\varepsilon_0}\frac{qd}{r^3}$$

$$\phi = E \cdot dA$$

$$\phi = EA\cos\theta$$

$$\phi = \frac{q}{\varepsilon_0}$$

$$E = \frac{\lambda}{2\pi\varepsilon_0 r} \rightarrow \lambda = ql$$

$$E = \frac{\sigma}{2\varepsilon_0} \rightarrow \text{infinite sheet}$$

$$E = \frac{\sigma}{\varepsilon_0} \rightarrow \text{two parallel sheet}$$

$$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{R^2} \rightarrow \text{At a surface}$$

~~Oscillations~~ Oscillations

$F = -Kx$

$a = -\frac{k}{m}x$

$T = \frac{1}{f}$

$x(t) = x_m \cos(\omega t + \phi)$

$\omega = \frac{2\pi}{T}$

$\omega = 2\pi f$

$v(t) = -\omega x_m \sin(\omega t + \phi)$

$v_m = -\omega x_m$

$a(t) = -\omega^2 x_m \cos(\omega t + \phi)$

$a_m = -\omega^2 x_m$

$\omega = \sqrt{\frac{k}{m}}$ → Spring

$T = 2\pi\sqrt{\frac{m}{k}}$ → Spring

$U(t) = \frac{1}{2}kx^2 = x_m^2 \cos^2(\omega t + \phi)$

$K(t) = \frac{1}{2}mv^2 = \frac{1}{2}m\omega^2 x_m^2 \sin^2(\omega t + \phi) = \frac{1}{2}k x_m^2 \sin^2(\omega t + \phi)$

$E = U + K = \frac{1}{2}K x_m^2$

$\tau = -L(F_g \sin\theta) = I\alpha$

$T = 2\pi\sqrt{\frac{L}{g}}$ → Pendulum

$T = 2\pi\sqrt{\frac{I}{k}}$ → Torsion Pendulum

$x(t) = x_m e^{-bt/2m} \cos(\omega' t + \phi)$

$\omega' = \sqrt{\frac{k}{m} - \frac{b^2}{4m^2}}$

Waves

$$y(x,t) = y_m \sin(kx - \omega t)$$

$$\omega = \frac{2\pi}{T}$$

$$f = \frac{1}{T} = \frac{\omega}{2\pi}$$

$$T = \frac{2\pi}{\omega}$$

$$k = \frac{2\pi}{\lambda}$$

$$\lambda = \frac{2\pi}{k}$$

$$v = \frac{\omega}{k} = \frac{\lambda}{T} = \lambda f$$

$$u = -\omega y_m \cos(kx - \omega t)$$

$$a_y = -\omega^2 y_m \sin(kx - \omega t)$$

$$y'(x,t) = \underbrace{\left[2 y_m \cos \frac{1}{2}\phi\right]}_{\text{Magnitude}} \underbrace{\sin\left(kx - \omega t + \frac{1}{2}\phi\right)}_{\text{Oscillating term}}$$