Electrostatics

Definition of Electric Field

$$E = \frac{F_{on\,q}}{q}$$

Electric Field of a Point Charge

$$E = \frac{K|q|}{r^2}$$

Electric Field of a Charged Sphere

$$E = \frac{KQ}{r^2} \text{ where } r \geq R_{sphere}$$

Electric Field of a Charged Rod

$$E = \frac{2K|\lambda|}{r}$$

Electric Field of a Charged Plane

$$E = \frac{|\eta|}{2\varepsilon_0}$$

Gauss's Law

$$\Phi = \oint E\,dA = \frac{Q}{\varepsilon_0}$$

Electric Field of a Capacitor

$$E = \frac{Q}{\varepsilon_0 A}$$

Coulomb's Law

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

Linear Charge Density

$$\lambda = \frac{Q}{L}$$

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

Surface Charge Density

$$\eta = \frac{Q}{A}$$

Electric Flux

$$\Phi = EA\cos(\theta)$$

Voltage in Uniform Electric Field

$$\Delta V = E\Delta s$$

Kinetic Energy

$$KE = \frac{1}{2}mv^2$$

Electric Potential Energy

$$U = \frac{Kq_1q_2}{r}$$

Electric Potential of a Point Charge

$$V = \frac{Kq}{r}$$

Definition of Electric Potential

$$V = \frac{U_{of\,q}}{q}$$

Currents

Parallel (top) and Series Resistors

$$R_{eq} = \left(\frac{1}{R_1} + \frac{1}{R_2} + \ldots + \frac{1}{R_N}\right)^{-1}$$

$$R_{eq} = R_1 + R_2 + \ldots + R_N$$

Current

$$I = \frac{\Delta q}{\Delta t}$$

Ohm's Law

$$I = \frac{\Delta V}{R}$$

Resistance

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

Power

$$P = \frac{\Delta U}{\Delta t} = I\Delta V = I^2R = \frac{\Delta V^2}{R}$$

Capacitance

$$C = \frac{\kappa\varepsilon_0 A}{d}$$

Kirchhoff's Junction Law

$$\sum I_{in} = \sum I_{out}$$

Charge on a Capacitor

$$Q = C\Delta V$$

Kirchhoff's Loop Law

$$\Delta V_{Loop} = \sum_i \Delta V_i = 0$$

Constants

m_{proton} = 1.67 x 10^{-27} kg

$m_{electron}$ = 9.1 x 10^{-31} kg

$q_{elementary}$ = +/- 1.6 x 10^{-19} C

K = 9.0 x 10^{9} Nm^2 / C^2

ε_0 = 8.85 x 10^{-12} $C^2 / (Nm^2)$

μ_0 = 4π x 10^{-7} Tm / A

c = 3.0 x 10^{8} m/s

Magnetism

Magnetic Field of a Straight Wire

$$B_{line} = \frac{\mu_0 I}{2\pi r}$$

Magnetic Field of a Loop

$$B_{loop} = \frac{\mu_0 NI}{2R}$$

Magnetic Field of a Solenoid

$$B_{solenoid} = \frac{\mu_0 NI}{L}$$

Cyclotron Motion

$$r = \frac{mv}{qB}$$

Ampere's Law

$$\oint B\,ds = \mu_0 I$$

Motional emf*

$$\Delta V = vLB$$

*This voltage is an emf

Current Due to Motional emf

$$I = \frac{vLB}{R}$$

Magnetic Flux

$$\Phi = ABcos(\theta)$$

Force on a Straight Wire

$$F_{on\,I} = ILB$$

Faraday's Law*

$$\Delta V = \left|\frac{\Delta\Phi}{\Delta t}\right|$$

Magnetic Force on a Charged Particle

$$F_{on\,q} = |q|vB\sin(\theta)$$

Magnetic Force on Parallel Wires

$$F_{//wires} = \frac{\mu_0 L I_1 I_2}{2\pi d}$$

Waves & Optics

Displacement of a Medium

$$D(x,t) = A\sin(kx - \omega t + \phi_0)$$

Image Height

$$h' = mh$$

----- Standing Waves -----

$$\lambda = \frac{2L}{m}$$

$$f = m\left(\frac{v}{2L}\right)$$

Magnification

$$m = -\frac{s'}{s}$$

Thin Lenses

$$\frac{1}{f} = \frac{1}{s} + \frac{1}{s'}$$

Central Fringe (single slit)

$$w = \frac{2\lambda L}{a}$$

Single Slit Diffraction

$$y = \frac{p\lambda L}{a}$$

Double Slit Diffraction

$$y = \frac{m\lambda L}{d}$$

Angular Frequency

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

Wave Number

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

Frequency & Period

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

Wave Intensity

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

Snell's Law

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

Wave Speed

$$v_{wave} = \lambda f$$

Path Length Difference

$$\Delta r = m\lambda$$

------------ Refraction ------------

$$n = \frac{c}{v}$$

$$\lambda_{material} = \frac{\lambda_{vacuum}}{n}$$

Critical Angle

$$\theta_{critical} = \sin^{-1}\left(\frac{n_2}{n_1}\right)$$