Coulomb's Law $\vec{F} = k_e \frac{q_1 q_2}{r^2}\hat{r}$ Electric field $\vec{E} \equiv \frac{\vec{F}}{q_0}$ Gauss Law $\Phi_E = \oint \vec{E}\cdot d\vec{A} = \frac{q_{in}}{\varepsilon_0}$

Electric potential energy and potential $-\Delta U = U_A - U_B = \int_A^B q_0 \vec{E}\cdot d\vec{s},\ \ V = \frac{U_E}{q}$

Capacitance and Capacitor $C \equiv \frac{Q}{\Delta V}$ $C = \varepsilon_0 \frac{A}{d}$ $U_E = \frac{Q^2}{2C} = \frac{1}{2}C(\Delta V)^2$

$$C_{eq} = C_1 + C_2 + \ldots ,\quad \frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \ldots$$

Resistance, resistors and circuits $I \equiv \frac{dq}{dt},\ R = \frac{\Delta V}{I},\ R = \rho\frac{l}{A},\ \rho = \rho_0\left[1 + \alpha\left(T - T_0\right)\right]$

$$R_{eq} = R_1 + R_2 + \ldots,\quad \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots$$

$$P = \Delta V\cdot I = I^2 R = \frac{(\Delta V)^2}{R}$$

Kirchhoff's rules $\sum_{\text{junction}} I = 0,\quad \sum_{\text{closed loop}} \Delta V = 0$

Bio-Savart's Law $d\vec{B} = \frac{\mu_0}{4\pi}\frac{I d\vec{s}}{r^2}\times\hat{r}$ Ampere's Law $\oint \vec{B}\cdot d\vec{s} = \mu_0 I$

Magnetic field generated by a straight long wire with current i: $\vec{B} = \frac{\mu_0 i}{2\pi r}$

The Lorentz force $\vec{F} = q\vec{E} + q\vec{v}\times\vec{B}$ Force on a wire with current i: $\vec{F} = i\vec{L}\times\vec{B}$

Faraday's Law of induction $\text{emf} = -\frac{d\Phi_B}{dt}$ Inductance L: induced $emf \equiv -L\frac{dI}{dt}$

RLC in an AC circuit $emf = V_m \sin(\omega t),\ \ i = emf/Z$

$$Z = \sqrt{R^2 + \left(X_L - X_C\right)^2},\ X_L = \omega L,\ X_C = 1/\omega C,\ \tan\phi = \frac{X_L - X_C}{R}$$

Laws of reflection and refraction: $\theta' = \theta,\quad n_1 \sin\theta_1 = n_2 \sin\theta_2$

Formulas in geometric optics: $f = \pm\frac{|R|}{2},\quad \frac{1}{f} = \left(\frac{n_{lens}}{n_{medium}} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$

$$\frac{1}{p} + \frac{1}{i} = \frac{1}{f},\quad M \equiv \frac{H_I}{H_o} = -\frac{i}{p}$$

Young's double slits: maximum intensity: $d\sin\theta = m\lambda$, for $m = 0,1,2,\ldots$
minimum intensity: $d\sin\theta = \left(m + \frac{1}{2}\right)\lambda$, for $m = 0,1,2,\ldots$

Reflection phase shift: ½ wavelength when reflecting off higher index material

This film interference: maximum intensity: $2L = (m + \text{reflection phase shifts})\lambda/n$, for $m = 0,1,2,\ldots$
minimum intensity: $2L = (m + 1/2 + \text{reflection phase shifts})\lambda/n$, for $m = 0,1,2,\ldots$

Constants: $\varepsilon_0 = 8.85\times 10^{-12}\,\text{C}^2/\text{Nm}^2,\quad \mu_0 = 4\pi\times 10^{-7}\,\text{Tm/A}.$