Coulomb's Law: $\mathbf{F} = \frac{1}{4\pi\epsilon_0}\frac{q_1 q_2}{|\mathbf{r}|^2}\hat{\mathbf{r}}$
Electric Field: $\mathbf{E} = \frac{1}{4\pi\epsilon_0}\frac{q}{|\mathbf{r}|^2}\hat{\mathbf{r}}$
Gauss's Law: $\oint \mathbf{E}\cdot d\mathbf{A} = \frac{Q_{\text{enc}}}{\epsilon_0}$
Electric Potential: $V = -\int \mathbf{E}\cdot d\mathbf{l}$
E and V: $\mathbf{E} = -\nabla V$
Laplace's Equation: $\nabla^2 V = 0$
Poisson's Equation: $\nabla^2 V = -\frac{\rho_v}{\epsilon}$

Current Density: $\mathbf{J} = \sigma\mathbf{E}$
Continuity Eq: $\nabla\cdot\mathbf{J} = -\frac{\partial\rho_v}{\partial t}$
Ohm's Law: $V = IR$
Biot-Savart Law: $\mathbf{B} = \frac{\mu_0}{4\pi}\int\frac{Id\mathbf{l}\times\hat{\mathbf{r}}}{|\mathbf{r}|^2}$
Ampere's Law: $\oint \mathbf{H}\cdot d\mathbf{l} = I_{\text{enc}}$
Magnetic Flux Density: $\mathbf{B} = \mu\mathbf{H}$
Faraday's Law: $\mathcal{E} = -\frac{d\Phi}{dt}$

Induced E-Field: $\nabla\times\mathbf{E} = -\frac{\partial\mathbf{B}}{\partial t}$
Wave Equation: $\nabla^2\mathbf{E} - \mu\epsilon\frac{\partial^2\mathbf{E}}{\partial t^2} = 0$
Wave Speed: $v = \frac{1}{\sqrt{\mu\epsilon}}$
Transmission Coeff: $T = 1 + \Gamma$
Impedance: $Z = \sqrt{\frac{\mu}{\epsilon}}$
Snell's Law: $\frac{\sin\theta_1}{\sin\theta_2} = \frac{v_1}{v_2}$
Poynting vector: $\mathbf{S} = \mathbf{E}\times\mathbf{H}$

Normal Incidence Reflection Coeff: $\Gamma = \frac{Z_2 - Z_1}{Z_2 + Z_1}$ **Lorentz force**: $\mathbf{F} = q(\mathbf{E} + \mathbf{v}\times\mathbf{B})$
Maxwell's Equations: $\nabla\cdot\mathbf{E} = \frac{\rho_v}{\epsilon_0}$, $\nabla\cdot\mathbf{B} = 0$, $\nabla\times\mathbf{E} = -\frac{\partial\mathbf{B}}{\partial t}$, $\nabla\times\mathbf{H} = \mathbf{J} + \frac{\partial\mathbf{D}}{\partial t}$
General Interface Conditions: $E_{1t} = E_{2t}, D_{1n} - D_{2n} = \rho_s; H_{1t} - H_{2t} = J_s^*, B_{1n} = B_{2n}$
* Dielectric–Dielectric $\implies \rho_s = J_s = 0.$ Dielectric–Conductor $\implies E_t = B_n = 0, D_{1n} = \rho_s, H_{1t} = J_s^*.$

$\int\frac{1}{(a^2\pm x^2)^{3/2}}dx = \frac{x}{a^2\sqrt{a^2\pm x^2}}$, $\int\frac{xdx}{(a^2+x^2)^{3/2}} = \frac{-1}{\sqrt{a^2+x^2}}$, $\int\frac{1}{x^2+a^2} = \frac{1}{a}\tan^{-1}\left(\frac{x}{a}\right)$, $\int\frac{x^2dx}{(a^2+x^2)^{3/2}} = \frac{-x}{\sqrt{a^2+x^2}} + \ln(x + \sqrt{a^2+x^2})$

Cylindrical Coordinates:

$\nabla f = \frac{\partial f}{\partial r}\hat{\mathbf{r}} + \frac{1}{r}\frac{\partial f}{\partial\theta}\hat{\boldsymbol{\theta}} + \frac{\partial f}{\partial z}\hat{\mathbf{k}}$

$\nabla\cdot\mathbf{F} = \frac{1}{r}\frac{\partial}{\partial r}(rF_r) + \frac{1}{r}\frac{\partial F_\theta}{\partial\theta} + \frac{\partial F_z}{\partial z}$

$$\nabla\times\mathbf{F} = \frac{1}{r}\begin{vmatrix}\hat{\mathbf{r}} & r\hat{\boldsymbol{\theta}} & \hat{\mathbf{z}}\\ \frac{\partial}{\partial r} & \frac{\partial}{\partial\theta} & \frac{\partial}{\partial z}\\ F_r & rF_\theta & F_z\end{vmatrix}$$

$\nabla^2 f = \frac{1}{r}\frac{\partial}{\partial r}(r\frac{\partial f}{\partial r}) + \frac{1}{r^2}\frac{\partial^2 f}{\partial\theta^2} + \frac{\partial^2 f}{\partial z^2}$

Spherical Coordinates:

$\nabla f = \frac{\partial f}{\partial r}\hat{\mathbf{r}} + \frac{1}{r}\frac{\partial f}{\partial\theta}\hat{\boldsymbol{\theta}} + \frac{1}{r\sin\theta}\frac{\partial f}{\partial\phi}\hat{\boldsymbol{\phi}}$

$\nabla\cdot\mathbf{F} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2F_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\sin\theta F_\theta) + \frac{1}{r\sin\theta}\frac{\partial F_\phi}{\partial\phi}$

$$\nabla\times\mathbf{F} = \frac{1}{r^2\sin\theta}\begin{vmatrix}\hat{\mathbf{r}} & r\hat{\boldsymbol{\theta}} & r\sin\theta\hat{\boldsymbol{\phi}}\\ \frac{\partial}{\partial r} & \frac{\partial}{\partial\theta} & \frac{\partial}{\partial\phi}\\ F_r & rF_\theta & r\sin\theta F_\phi\end{vmatrix}$$

$\nabla^2 f = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2\frac{\partial f}{\partial r}) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial\theta}(\sin\theta\frac{\partial f}{\partial\theta}) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 f}{\partial\phi^2}$

Vector Theorems:

$\int_V(\nabla\cdot\mathbf{F})\,dV = \int_S\mathbf{F}\cdot\hat{\mathbf{n}}\,dA$

$\int_S(\nabla\times\mathbf{F})\cdot\hat{\mathbf{n}}\,dA = \int_C\mathbf{F}\cdot d\mathbf{r}$

Vector Identities:

$\nabla\cdot(\nabla\times\mathbf{F}) = 0$

$\nabla\times(\nabla f) = 0$

$\nabla\cdot(\nabla f) = \nabla^2 f$

$\nabla\times(\nabla\times\mathbf{F}) = \nabla(\nabla\cdot\mathbf{F}) - \nabla^2\mathbf{F}$
