Cartesian Coordinates	*Cylindrical Coordinates*	*Spherical Coordinates*
(x, y, z)	(ρ, ϕ, z)	(r, θ, ϕ)
$(h_1 = h_2 = h_3 = 1)$	$(h_1 = 1,\ h_2 = \rho,\ h_3 = 1)$	$(h_1 = 1,\ h_2 = r,\ h_3 = r\sin\theta)$
$d\vec{\ell} = dx\vec{e}_x + dy\vec{e}_y + dz\vec{e}_z$	$d\vec{\ell} = d\rho\vec{e}_\rho + \rho d\phi\vec{e}_\phi + dz\vec{e}_z$	$d\vec{\ell} = dr\vec{e}_r + rd\theta\vec{e}_\theta + r\sin\theta d\phi\vec{e}_\phi$
$d\vec{S}_x = dydz\vec{e}_x$	$d\vec{S}_\rho = \rho d\phi dz\vec{e}_\rho$	$d\vec{S}_r = r^2\sin\theta d\theta d\phi\vec{e}_r$
$d\vec{S}_y = dxdz\vec{e}_y$	$d\vec{S}_\phi = d\rho dz\vec{e}_\phi$	$d\vec{S}_\theta = r\sin\theta drd\phi\vec{e}_\theta$
$d\vec{S}_z = dxdy\vec{e}_z$	$d\vec{S}_z = \rho d\rho d\phi\vec{e}_z$	$d\vec{S}_\phi = rdrd\theta\vec{e}_\phi$
$dV = dxdydz$	$dV = \rho d\rho d\phi dz$	$dV = r^2\sin\theta drd\theta d\phi$

$$\nabla A = gradA = \frac{1}{h_1}\frac{\partial A}{\partial u_1}\vec{e}_1 + \frac{1}{h_2}\frac{\partial A}{\partial u_2}\vec{e}_2 + \frac{1}{h_3}\frac{\partial A}{\partial u_3}\vec{e}_3$$

$$\nabla\cdot\vec{F} = div\vec{F} = \frac{1}{h_1h_2h_3}\left[\frac{\partial}{\partial u_1}h_2h_3F_1 + \frac{\partial}{\partial u_2}h_1h_3F_2 + \frac{\partial}{\partial u_3}h_1h_2F_3\right]$$

$$\nabla\times\vec{F} = rot\vec{F} = \frac{1}{h_1h_2h_3}\begin{vmatrix} h_1\vec{e}_1 & h_2\vec{e}_2 & h_3\vec{e}_3 \\ \dfrac{\partial}{\partial u_1} & \dfrac{\partial}{\partial u_2} & \dfrac{\partial}{\partial u_3} \\ h_1F_1 & h_2F_2 & h_3F_3 \end{vmatrix}$$

$$x = \rho\cos\phi \qquad \rho = \sqrt{x^2 + y^2}$$
$$y = \rho\sin\phi \qquad \phi = \tan^{-1}(y/x)$$
$$z = z \qquad z = z$$

$$x = r\sin\theta\cos\phi \qquad r = \sqrt{x^2 + y^2 + z^2}$$
$$y = r\sin\theta\sin\phi \qquad \theta = \tan^{-1}\left(\sqrt{x^2 + y^2}/z\right)$$
$$z = r\cos\theta \qquad \phi = \tan^{-1}(y/x)$$

$$\nabla\cdot(\nabla A) = div(gradA) = \nabla^2 A = \Delta A$$

$$\Delta A = \frac{\partial^2 A}{\partial x^2} + \frac{\partial^2 A}{\partial y^2} + \frac{\partial^2 A}{\partial z^2}$$

$$\Delta A = \frac{1}{\rho}\frac{\partial}{\partial\rho}\left(\rho\frac{\partial A}{\partial\rho}\right) + \frac{1}{\rho^2}\frac{\partial^2 A}{\partial\phi^2} + \frac{\partial^2 A}{\partial z^2}$$

$$\Delta A = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2\frac{\partial A}{\partial r}\right) + \frac{1}{r^2\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\frac{\partial A}{\partial\theta}\right) + \frac{1}{r^2\sin^2\theta}\frac{\partial^2 A}{\partial\phi^2}$$

$$\nabla\times(\nabla A) = rot(gradA) = 0$$

$$\nabla\cdot\left(\nabla\times\vec{F}\right) = div(rot\vec{F}) = 0$$

$$\int_S\left(\nabla\times\vec{F}\right)\cdot d\vec{s} = \oint_C\vec{F}\cdot d\vec{\ell}$$

$$\int_V\left(\nabla\cdot\vec{F}\right)\cdot dv = \oint_S\vec{F}\cdot d\vec{s}$$

$$\int\frac{dt}{[t^2 + c^2]^{3/2}} = \frac{1}{c^2}\frac{t}{\sqrt{t^2 + c^2}} \qquad \int\frac{tdt}{[t^2 + c^2]^{3/2}} = -\frac{1}{\sqrt{t^2 + c^2}}$$

$$\varepsilon_0 = \frac{10^{-9}}{36\pi}\ \text{[F/m]} \qquad \mu_0 = 4\pi 10^{-7}\ \text{[H/m]}$$