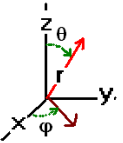
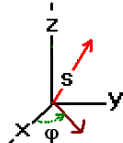


## I think you'll find this useful

Spherical Coordinates		Cylindrical Coordinates	
$\vec{A} = A_r \hat{r} + A_\theta \hat{\theta} + A_\varphi \hat{\phi}$		$\vec{A} = A_s \hat{s} + A_\varphi \hat{\phi} + A_z \hat{z}$	
$\hat{r} = \sin(\theta) \cos(\varphi) \hat{x} + \sin(\theta) \sin(\varphi) \hat{y} + \cos(\theta) \hat{z}$ $\hat{\theta} = \cos(\theta) \cos(\varphi) \hat{x} + \cos(\theta) \sin(\varphi) \hat{y} - \sin(\theta) \hat{z}$ $\hat{\phi} = -\sin(\varphi) \hat{x} + \cos(\varphi) \hat{y}$		$\hat{s} = \cos(\varphi) \hat{x} + \sin(\varphi) \hat{y}$ $\hat{\phi} = -\sin(\varphi) \hat{x} + \cos(\varphi) \hat{y}$ $\hat{z} = \hat{z}$	
$\hat{x} = \sin(\theta) \cos(\varphi) \hat{r} + \cos(\theta) \cos(\varphi) \hat{\theta} - \sin(\varphi) \hat{\phi}$ $\hat{y} = \sin(\theta) \sin(\varphi) \hat{r} + \cos(\theta) \sin(\varphi) \hat{\theta} + \cos(\varphi) \hat{\phi}$ $\hat{z} = \cos(\theta) \hat{r} - \sin(\theta) \hat{\theta}$		$\Rightarrow \hat{y} = \hat{s} \sin(\varphi) + \hat{\phi} \cos(\varphi)$ $\Rightarrow \hat{x} = \hat{s} \cos(\varphi) - \hat{\phi} \sin(\varphi)$	
	$x = r \sin(\theta) \cos(\varphi)$ $y = r \sin(\theta) \sin(\varphi)$ $z = r \cos(\theta)$		$x = s \cos(\varphi)$ $y = s \sin(\varphi)$ $z = z$
$d\vec{A} = r^2 \sin(\theta) d\theta d\varphi \hat{r}$		$d\vec{A} = s d\varphi ds \hat{z}$	
$d\tau = r^2 \sin(\theta) dr d\theta d\varphi$ $[r : 0 \rightarrow +\infty], [\theta : 0 \rightarrow \pi], [\varphi : 0 \rightarrow 2\pi]$		$d\tau = s ds d\varphi dz$ $[s : 0 \rightarrow +\infty], [\varphi : 0 \rightarrow 2\pi], [z : -\infty \rightarrow +\infty]$	
$d\vec{l} = dr \hat{r} + r d\theta \hat{\theta} + r \sin(\theta) d\varphi \hat{\phi}$		$d\vec{l} = ds \hat{s} + s d\varphi \hat{\phi} + dz \hat{z}$	
$\vec{\nabla} T = \frac{\partial T}{\partial r} \hat{r} + \frac{1}{r} \frac{\partial T}{\partial \theta} \hat{\theta} + \frac{1}{r \sin(\theta)} \frac{\partial T}{\partial \varphi} \hat{\phi}$		$\vec{\nabla} T = \frac{\partial T}{\partial s} \hat{s} + \frac{1}{s} \frac{\partial T}{\partial \varphi} \hat{\phi} + \frac{\partial T}{\partial z} \hat{z}$	
$\vec{\nabla} \cdot \vec{V} = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 V_r) + \frac{1}{r \sin(\theta)} \frac{\partial}{\partial \theta} (\sin(\theta) V_\theta) + \frac{1}{r \sin(\theta)} \frac{\partial V_\varphi}{\partial \varphi}$		$\vec{\nabla} \cdot \vec{V} = \frac{1}{s} \frac{\partial (s V_s)}{\partial s} + \frac{1}{s} \frac{\partial V_\varphi}{\partial \varphi} + \frac{\partial V_z}{\partial z}$	
$\vec{\nabla} \times \vec{V} = \frac{1}{r \sin(\theta)} \left[ \frac{\partial (\sin(\theta) V_\varphi)}{\partial \theta} - \frac{\partial V_\theta}{\partial \varphi} \right] \hat{r} + \frac{1}{r} \left[ \frac{\partial V_r}{\partial \varphi} - \frac{\partial (r V_\varphi)}{\partial r} \right] \hat{\theta} + \frac{1}{r} \left[ \frac{\partial (r V_\theta)}{\partial r} - \frac{\partial V_r}{\partial \theta} \right] \hat{\phi}$		$\vec{\nabla} \times \vec{V} = \left( \frac{1}{s} \frac{\partial V_z}{\partial \varphi} - \frac{\partial V_\varphi}{\partial z} \right) \hat{s} + \left( \frac{\partial V_s}{\partial z} - \frac{\partial V_z}{\partial s} \right) \hat{\phi} + \frac{1}{s} \left[ \frac{\partial (s V_\varphi)}{\partial s} - \frac{\partial V_s}{\partial \varphi} \right] \hat{z}$	
$\vec{\nabla}^2 T = \frac{1}{r^2} \frac{\partial}{\partial r} (r^2 \frac{\partial T}{\partial r}) + \frac{1}{r^2 \sin(\theta)} \frac{\partial}{\partial \theta} (\sin(\theta) \frac{\partial T}{\partial \theta}) + \frac{1}{r^2 \sin^2(\theta)} \frac{\partial^2 T}{\partial \varphi^2}$		$\vec{\nabla}^2 T = \frac{1}{s} \frac{\partial}{\partial s} (s \frac{\partial T}{\partial s}) + \frac{1}{s^2} \frac{\partial^2 T}{\partial \varphi^2} + \frac{\partial^2 T}{\partial z^2}$	

### Fundamental Theorems

<p><b>Gradients:</b> if <math>dT = (\vec{\nabla} T) \cdot d\vec{l}</math> then <math>\int_{\text{path}}^b (\vec{\nabla} T) \cdot d\vec{l} = T(b) - T(a)</math></p> <p><b>Corollaries:</b></p> <p><math>\int_a^b (\vec{\nabla} T) \cdot d\vec{l}</math> is path independent from a to b <b>and</b> <math>\oint (\vec{\nabla} T) \cdot d\vec{l} = 0</math></p>
<p><b>Divergences: (Gauss's, Green's or Divergence theorem)</b></p> $\int_{\text{volume}} (\vec{\nabla} \cdot \vec{V}) d\tau = \oint_{\text{surface}} \vec{V} \cdot d\vec{A}$ <p><b>A is the area bounding the surface.</b></p>
<p><b>Curls: (Stokes' Theorem)</b></p> $\int_{\text{surface}} (\vec{\nabla} \times \vec{V}) \cdot d\vec{A} = \oint_{\text{path}} \vec{V} \cdot d\vec{l}$