Cylindrical $\nabla \times \mathbf{A} = \left[\frac{1}{s}\frac{\partial A_z}{\partial \phi} - \frac{\partial A_\phi}{\partial z}\right]\hat{\mathbf{s}} + \left[\frac{\partial A_s}{\partial z} - \frac{\partial A_z}{\partial s}\right]\hat{\phi} + \frac{1}{s}\left[\frac{\partial (sA_\phi)}{\partial s} - \frac{\partial A_s}{\partial \phi}\right]\hat{\mathbf{z}}$ $\quad \vec{\nabla} f = \hat{\mathbf{s}}\frac{\partial f}{\partial s} + \hat{\phi}\frac{1}{s}\frac{\partial f}{\partial \phi} + \hat{\mathbf{z}}\frac{\partial f}{\partial z}$

$\nabla \cdot \mathbf{A} = \frac{1}{s}\frac{\partial (sA_s)}{\partial s} + \frac{1}{s}\frac{\partial A_\varphi}{\partial \varphi} + \frac{\partial A_z}{\partial z}$ $\quad d\tau = s\, ds\, d\phi\, dz \quad da = s\, d\phi\, dz \quad d\mathbf{l} = ds\,\hat{\mathbf{s}} + s\, d\phi\,\hat{\boldsymbol{\phi}} + dz\,\hat{\mathbf{z}}$

$\nabla^2 V = \frac{1}{s}\frac{\partial}{\partial s}\left(s\frac{\partial V}{\partial s}\right) + \frac{1}{s^2}\frac{\partial^2 V}{\partial \phi^2} + \frac{\partial^2 V}{\partial z^2}$ $\quad d\mathbf{l} = dr\,\hat{\mathbf{r}} + r\, d\theta\,\hat{\boldsymbol{\theta}} + r\sin\theta\, d\phi\,\hat{\boldsymbol{\phi}}$

Polar (2d) $da = r\, dr\, d\theta$

Spherical $\vec{\nabla} = \hat{r}\frac{\partial f}{\partial r} + \hat{\theta}\frac{1}{r}\frac{\partial f}{\partial \theta} + \hat{\phi}\frac{1}{r\sin\theta}\frac{\partial f}{\partial \phi}$ $\quad da = r^2\, d\theta\, \sin\theta\, d\phi \quad d\tau = dr\, da = r^2\, dr\, d\theta\, \sin\theta\, d\phi$

$\nabla \times \mathbf{A} = \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial \theta}\sin\theta A_\phi - \frac{\partial A_\theta}{\partial \phi}\right]\hat{\mathbf{r}} + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial A_r}{\partial \phi} - \frac{\partial}{\partial r}(rA_\phi)\right]\hat{\theta} + \frac{1}{r}\left[\frac{\partial (rA_\theta)}{\partial r} - \frac{\partial A_r}{\partial \theta}\right]\hat{\phi}$

$\nabla \cdot \mathbf{A} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 A_r\right) + \frac{1}{r\sin\theta}\frac{\partial}{\partial \theta}\left(\sin\theta\, A_\theta\right) + \frac{1}{r\sin\theta}\frac{\partial A_\phi}{\partial \phi}$

Cartesian $\nabla \cdot \mathbf{A} = \frac{\partial A_x}{\partial x} + \frac{\partial A_y}{\partial y} + \frac{\partial A_z}{\partial z}$ $\quad \vec{\nabla} f = \hat{\mathbf{x}}\frac{\partial f}{\partial x} + \hat{\mathbf{y}}\frac{\partial f}{\partial y} + \hat{\mathbf{z}}\frac{\partial f}{\partial z}$ $\quad \nabla \times \mathbf{A} = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \partial/\partial x & \partial/\partial y & \partial/\partial z \\ A_x & A_y & A_z \end{vmatrix}$ $\quad d\tau = dx\, dx\, dz$

$d\mathbf{l} = dx\,\hat{\mathbf{x}} + dy\,\hat{\mathbf{y}} + dz\,\hat{\mathbf{z}}$ $\quad$ *Laplacian* $\nabla^2 V = \nabla \cdot (\nabla V)$

Electrostatics $\mathbf{E} = \frac{q}{4\pi\varepsilon_0}\frac{\hat{\mathbf{r}}}{r^2}$ $\quad \nabla^2 V = -\frac{\rho}{\varepsilon_0}$ $\quad \mathbf{E} = -\nabla V$ $\quad \mathbf{E} = \frac{1}{4\pi\varepsilon_0}\int \frac{\hat{\zeta}}{\zeta^2}\rho(r')d\tau'$ *where* $\vec{\zeta} = \mathbf{r} - \mathbf{r}'$

$V(\mathbf{r}) = \frac{1}{4\pi\varepsilon_0}\int_{surface}\frac{\sigma(\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|}da'$ $\quad V(\mathbf{r}) = \frac{1}{4\pi\varepsilon_0}\int_{volume}\frac{\rho(\mathbf{r}')}{|\mathbf{r}-\mathbf{r}'|}d\tau'$ $\quad V(r,\theta) = \sum_{l=0}^{\infty}\left(A_l r^l + \frac{B_l}{r^{l+1}}\right)P_l(\cos\theta)$

$\nabla^2 V = 0 \Rightarrow \frac{1}{X}\frac{d^2X}{dx^2} + \frac{1}{Y}\frac{d^2Y}{dy^2} + \frac{1}{Z}\frac{d^2Z}{dz^2} = 0$ $\quad dq = \rho\, d\tau = \sigma\, da = \lambda\, dx$ $\quad W = \frac{\varepsilon_0}{2}\int_{all\, space} E^2 d\tau$

Gauss's Law: $\nabla \cdot \mathbf{E} = \frac{\rho}{\varepsilon_0}$ $\quad V(r_b) - V(r_a) = -\int_{r_a}^{r_b}\mathbf{E}\cdot d\mathbf{l}$ $\quad E_\perp^{above} - E_\perp^{below} = \frac{\sigma}{\varepsilon_0}$

Magnetostatics $\boldsymbol{I} = \lambda\boldsymbol{v}$ $\quad \boldsymbol{K} = \sigma\boldsymbol{v}$ $\quad \boldsymbol{J} = \rho\boldsymbol{v}$ $\quad \boldsymbol{K}_b = \boldsymbol{M}\times\boldsymbol{n}$ $\quad \mathbf{J}_b = \text{curl}(\mathbf{M})$

$\mathbf{B} = \nabla\times\mathbf{A}$ $\quad \mathbf{H} = \frac{\mathbf{B}}{\mu_0} - \mathbf{M}$ $\quad \nabla\times\mathbf{H} = \mathbf{J}_{free}$

$\mathbf{B}(\mathbf{r}) = \frac{\mu_0}{4\pi}\int\frac{I d\boldsymbol{\ell}\times\hat{\varsigma}}{\varsigma^2} = \frac{\mu_0}{4\pi}\int\frac{\mathbf{J}\times\hat{\varsigma}}{\varsigma^2}d\tau$ *where* $\vec{\varsigma} = \mathbf{r} - \mathbf{r}'$ $\quad \nabla^2\mathbf{A} = -\mu_0\mathbf{J}$ $\quad I_{enc} = \int \mathbf{J}\cdot d\mathbf{a}$

$\nabla\times\mathbf{B} = \mu_0\mathbf{J} \rightarrow \oint \mathbf{B}\cdot d\ell = \mu_0 I_{enc}$ $\quad \nabla\cdot\mathbf{B} = 0$ $\quad \mathbf{B}_{dip} = \frac{\mu_0 m}{4\pi r^3}\left(2\cos\theta\,\hat{\mathbf{r}} + \sin\theta\,\hat{\theta}\right)$

$\mathbf{F} = Q\mathbf{v}\times\mathbf{B}$ $\quad d\mathbf{F} = I\, d\ell\times\mathbf{B} = da\,\mathbf{K}\times\mathbf{B} = d\tau\,\mathbf{J}\times\mathbf{B}$

Dipoles etc. $\mathbf{p} = \int_{volume}\mathbf{r}'\rho(\mathbf{r}')d\tau' = \sum_i \mathbf{r}_i q_i$ $\quad V(\mathbf{r}) = \frac{1}{4\pi\varepsilon_0}\sum_{n=0}^{\infty}\frac{1}{r^{n+1}}\int_{volume}d\tau'(r')^n P_n(\cos(\theta'))\rho(\mathbf{r}')$ $\quad V_{dipole}(\mathbf{r}) = \frac{1}{4\pi\varepsilon_0}\frac{\mathbf{p}\cdot\hat{\mathbf{r}}}{r^2}$

$\sigma_b = \mathbf{P}\cdot\hat{\mathbf{n}}$ $\quad \rho_b = -\nabla\cdot\mathbf{P}$ $\quad \mathbf{N} = \mathbf{p}\times\mathbf{E}$ *or* $\mathbf{N} = \mathbf{m}\times\mathbf{B}$, $\mathbf{F} = \nabla(\mathbf{p}\cdot\mathbf{E})$ *or* $\nabla(\mathbf{m}\cdot\mathbf{B})$

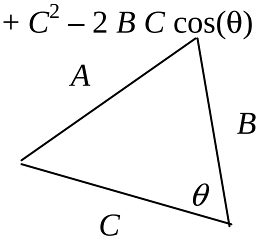
$\mathbf{E}_{dip} = \frac{p}{4\pi\varepsilon_0 r^3}\left(2\cos\theta\,\hat{\mathbf{r}} + \sin\theta\,\hat{\theta}\right)$ $\quad$ Linear dielectric: $\mathbf{P} = \chi_e\varepsilon_0\mathbf{E}$, where $\boldsymbol{p} = \mathbf{P}\, d\tau$

$\mathbf{D} = \varepsilon_0\mathbf{E} + \mathbf{P}$ $\quad \nabla\cdot\mathbf{D} = \rho_{free}$ $\quad \mathbf{P} = \varepsilon_0\chi_e\mathbf{E}$ $\quad$ (*linear dielectrics*) $\quad \mathbf{D} = \varepsilon_0(1+\chi_e)\mathbf{E} = \varepsilon\mathbf{E}$

Theorems, constants, etc. $\varepsilon_0 = 8.85\times10^{-12}\ C^2/Nm^2$ $\quad \mu_0 = 4\pi\times10^{-7}\ N/A^2$ $\quad A^2 = B^2 + C^2 - 2BC\cos(\theta)$

Stokes Theorem → $\int(\nabla\times\mathbf{A})\cdot d\mathbf{a} = \oint\mathbf{A}\cdot d\mathbf{l}$ $\quad \int_{volume}\nabla\cdot\mathbf{A}\, d\tau = \oint_{surface}\mathbf{A}\cdot d\mathbf{a}$

$P_0(x) = 1,\quad P_1(x) = x,\quad P_2(x) = \frac{1}{2}\left(3x^2 - 1\right),\quad \ldots$ $\quad$ Divergence Theorem



Some integrals.

$$\int_0^{\pi} d(\cos\theta)P_m(\cos\theta)P_l(\cos\theta) = \begin{matrix} 0 \; if \;\; m \neq l \\ \dfrac{2}{2m+1} \; if \;\; m = l \end{matrix}$$

$$\int \sin^3 x\,dx = \frac{-1}{3}\cos(x)(\sin^2 x + 2) \qquad \int \sin^4 x = \frac{3x}{8} - \frac{\sin(2x)}{4} + \frac{\sin(4x)}{32}$$

$$\int \frac{dx}{\left(x^2+a^2\right)^{3/2}} = \frac{x}{a^2\sqrt{x^2+a^2}} \qquad \int_0^a \sin\left(\frac{n\pi x}{a}\right)\sin\left(\frac{m\pi x}{a}\right)dx = \begin{matrix} 0 \quad if \;\; n \neq m \\ a/2 \;\; if \;\; n = m \end{matrix}$$

$$\int \sin(kx)dx = \frac{-1}{k}\cos(kx) \qquad \int \frac{\sin(\theta)d\theta}{\sqrt{1-\cos(\theta)}} = 2\sqrt{1-\cos(\theta)} \qquad \int \cos(kx)dx = \frac{1}{k}\sin(kx)$$