Formula Sheet PHYS305 Sem211

$$\overrightarrow{\nabla T} = \frac{\partial T}{\partial r}\hat{r} + \frac{1}{r}\frac{\partial T}{\partial \theta}\hat{\theta} + \frac{1}{r\sin\theta}\frac{\partial T}{\partial \phi}\hat{\phi}$$

$$\vec{\nabla}.\vec{v} = \frac{1}{r^2}\frac{\partial}{\partial r}(r^2 v_r) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}(\sin\theta\ v_\theta) + \frac{1}{r\sin\theta}\frac{\partial v_\phi}{\partial\phi}$$

$$\vec{\nabla}\times\vec{v} = \frac{1}{r\sin\theta}\left[\frac{\partial}{\partial\theta}(\sin\theta\ v_\phi) - \frac{\partial v_\phi}{\partial\phi}\right]\hat{r} + \frac{1}{r}\left[\frac{1}{\sin\theta}\frac{\partial v_r}{\partial\phi} - \frac{\partial}{\partial r}(r v_\phi)\right]\hat{\theta} + \frac{1}{r}\left[\frac{\partial}{\partial r}(r v_\theta) - \frac{\partial v_r}{\partial\theta}\right]\hat{\phi}$$

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

$$\overrightarrow{\nabla T} = \left(\frac{\partial T}{\partial s}\right)\hat{s} + \frac{1}{s}\left(\frac{\partial T}{\partial\phi}\right)\hat{\phi} + \left(\frac{\partial T}{\partial z}\right)\hat{z}$$

$$\vec{\nabla}.\vec{\mathrm{v}} = \frac{1}{s}\frac{\partial}{\partial s}(s v_s) + \frac{1}{s}\frac{\partial}{\partial\phi}(v_\phi) + \frac{\partial v_z}{\partial z}$$

$$\vec{\nabla}\times\vec{\mathrm{v}} = \left(\frac{1}{s}\frac{\partial v_z}{\partial\phi} - \frac{\partial v_\phi}{\partial z}\right)\hat{s} + \left(\frac{\partial v_s}{\partial z} - \frac{\partial v_z}{\partial s}\right)\hat{\phi} + \frac{1}{s}\left(\frac{\partial}{\partial s}(s v_s) - \frac{\partial v_s}{\partial\phi}\right)\hat{z}$$

$$\nabla^2 T = \frac{1}{s}\frac{\partial}{\partial s}\left(s\frac{\partial T}{\partial s}\right) + \frac{1}{s^2}\left(\frac{\partial^2 T}{\partial\phi^2}\right) + \frac{\partial^2 T}{\partial z^2}$$

$$\vec{\nabla}.\frac{\hat{r}}{r^2} = 4\pi\delta^3(\vec{r})$$

$$e^{kx} + e^{-kx} = 2\cosh(kx)$$

$$V(r,\theta) = \sum_{l=0}^{\infty}\left(A_l r^l + \frac{B_l}{r^{l+1}}\right)P_l(\cos\theta)$$

$$V(r,\phi) = a_o\ln(r) + b_o + \sum_{m=1}^{\infty}\left[\left(A_m r^m + \frac{B_m}{r^m}\right)(C_m\cos(m\phi) + D_m\sin(m\phi))\right]$$

$$V(P) = \frac{1}{4\pi\varepsilon_o}\left[\frac{1}{r}\int\rho(r')\,d\tau' + \frac{1}{r^2}\int\rho(r')\,r'\cos\theta'\,d\tau' + \frac{1}{r^3}\int\rho(r')r'^2\left(\frac{3}{2}\cos^2\theta' - \frac{1}{2}\right)\,d\tau' + \cdots\right]$$

$$P_0(x) = 1$$

$$P_1(x) = x$$

$$P_2(x) = (3x^2-1)/2$$

$$P_3(x) = (5x^3-3x)/2$$

$$P_4(x) = (35x^4-30x^2+3)/8$$

$$P_5(x) = (63x^5-70x^3+15x)/8$$

$$\vec{p} = \int\rho(r')\,\vec{r}'d\tau'$$

$$\vec{D} = \varepsilon_o\vec{E} + \vec{P}\ ;\ \vec{P} = \varepsilon_o\chi_e\vec{E}\ ;\ \sigma_b = \vec{P}.\hat{n}\ ;\ \rho_b = \vec{\nabla}.\vec{P}$$

$$\rho_f = \vec{\nabla}.\vec{D}\ ;\quad W = \frac{\varepsilon_o}{2}\int E^2 d\tau = \frac{1}{2}\int\vec{D}.\vec{E}\,d\tau$$

$$\vec{F}_{mag} = \int I(d\vec{l}\times\vec{B})\ ;\ \vec{\nabla}.\vec{J} = -\frac{d\rho}{dt}\ ;$$

$$\vec{B}(\vec{r}) = \frac{\mu_o I}{4\pi}\int\frac{d\vec{l}\times\Delta\hat{r}}{\Delta r^2}$$

$$\vec{B}(P) = \frac{\mu_o I}{4\pi}\int\frac{\vec{K}\times\Delta\hat{r}}{\Delta r^2}da\ ;\ \vec{B}(P) = \frac{\mu_o I}{4\pi}\int\frac{\vec{J}\times\Delta\hat{r}}{\Delta r^2}d\tau$$

$$\oint\vec{B}\,.\,d\vec{l} = \mu_o i_{enclosed}\ ;$$

$$\vec{\mathrm{A}}(\vec{r}) = \frac{\mu_o}{4\pi}\int\frac{\vec{J}(\vec{r}')}{\Delta r}d\tau'\ ;\ \vec{\mathrm{A}} = \frac{\mu_o}{4\pi}\int\frac{\vec{K}(\vec{r}')}{\Delta r}da'\ ;$$

$$\vec{\mathrm{A}}(\vec{r}) = \frac{\mu_o I}{4\pi}\int\frac{d\vec{l}}{\Delta r}\ ;$$

$$\vec{B}_{above} - \vec{B}_{below} = \mu_o\vec{K}\times\hat{n}$$

$$\frac{1}{\Delta r} = \frac{1}{r}\sum_{n=0}^{\infty}\left(\frac{r'}{r}\right)^n P_n(\cos\theta')$$

$$\vec{\mathrm{A}} = \frac{\mu_o I}{4\pi}\left[\frac{1}{r}\oint d\vec{l}' + \frac{1}{r^2}\oint r'\cos\theta'\,d\vec{l}' + \frac{1}{r^3}\oint r'^2\left(\frac{3}{2}\cos^2\theta' - \frac{1}{2}\right)d\vec{l}' + \cdots\right]$$

$$\vec{A}(\vec{r}) = \frac{\mu_o}{4\pi}\int\frac{\vec{M}(\vec{r}')\times\Delta\hat{r}}{\Delta r^2}d\tau'$$

$$\vec{H} = \frac{1}{\mu_o}\vec{B} - \vec{M}$$