卡氏座標

$$d\vec{l} = \hat{x}\,dx + \hat{y}\,dy + \hat{z}\,dz$$

$$d\tau = dx\,dy\,dz$$

$$\vec{\nabla} V = \hat{x}\frac{\partial V}{\partial x} + \hat{y}\frac{\partial V}{\partial y} + \hat{z}\frac{\partial V}{\partial z}$$

$$\vec{\nabla}\cdot\vec{E} = \frac{\partial E_x}{\partial x} + \frac{\partial E_y}{\partial y} + \frac{\partial E_z}{\partial z}$$

$$\vec{\nabla}\times\vec{E} = \hat{x}\left(\frac{\partial E_z}{\partial y} - \frac{\partial E_y}{\partial z}\right) + \hat{y}\left(\frac{\partial E_x}{\partial z} - \frac{\partial E_z}{\partial x}\right) + \hat{z}\left(\frac{\partial E_y}{\partial x} - \frac{\partial E_x}{\partial y}\right) = \begin{vmatrix} \hat{x} & \hat{y} & \hat{z} \\ \frac{\partial}{\partial x} & \frac{\partial}{\partial y} & \frac{\partial}{\partial z} \\ E_x & E_y & E_z \end{vmatrix}$$

$$\nabla^2 V = \frac{\partial^2 V}{\partial x^2} + \frac{\partial^2 V}{\partial y^2} + \frac{\partial^2 V}{\partial z^2}$$

球座標

$$d\vec{l} = \hat{r}\,dr + \hat{\theta}\,r\,d\theta + \hat{\phi}\,r\sin\theta\,d\phi$$

$$d\tau = r^2\sin\theta\,dr\,d\theta\,d\phi$$

$$\vec{\nabla} V = \hat{r}\frac{\partial V}{\partial r} + \hat{\theta}\frac{\partial V}{r\,\partial\theta} + \hat{\phi}\frac{\partial V}{r\sin\theta\,\partial\phi}$$

$$\vec{\nabla}\cdot\vec{E} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 E_r\right) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta\,E_\theta\right) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\phi}E_\phi$$

$$\vec{\nabla}\times\vec{E} = \frac{1}{r^2\sin\theta}\begin{vmatrix} \hat{r} & r\hat{\theta} & r\sin\theta\,\hat{\phi} \\ \frac{\partial}{\partial r} & \frac{\partial}{\partial\theta} & \frac{\partial}{\partial\phi} \\ E_r & rE_\theta & r\sin\theta\,E_\phi \end{vmatrix} = \hat{r}\left[\frac{1}{\sin\theta}\frac{\partial(\sin\theta\,E_\phi)}{r\,\partial\theta} - \frac{\partial E_\theta}{r\sin\theta\,\partial\phi}\right] + \hat{\theta}\left[\frac{\partial E_r}{r\sin\theta\,\partial\phi} - \frac{1}{r}\frac{\partial}{\partial r}(rE_\phi)\right] + \hat{\phi}\left[\frac{1}{r}\frac{\partial}{\partial r}(rE_\theta) - \frac{\partial E_r}{r\,\partial\theta}\right]$$

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

柱座標

$$d\vec{l} = \hat{s}\,ds + \hat{\phi}\,s\,d\phi + \hat{z}\,dz, \quad d\tau = s\,ds\,d\phi\,dz$$

$$\vec{\nabla} V = \hat{s}\frac{\partial V}{\partial s} + \hat{\phi}\frac{\partial V}{s\,\partial\phi} + \hat{z}\frac{\partial V}{\partial z}$$

$$\vec{\nabla}\times\vec{E} = \frac{1}{s}\begin{vmatrix} \hat{s} & s\hat{\phi} & \hat{z} \\ \frac{\partial}{\partial s} & \frac{\partial}{\partial\phi} & \frac{\partial}{\partial z} \\ E_s & sE_\phi & E_z \end{vmatrix} = \hat{s}\left(\frac{\partial E_s}{s\,\partial\phi} - \frac{\partial E_\phi}{\partial z}\right) + \hat{\phi}\left(\frac{\partial E_s}{\partial z} - \frac{\partial E_z}{\partial s}\right) + \hat{z}\left(\frac{1}{s}\frac{\partial}{\partial s}(sE_\phi) - \frac{\partial E_s}{s\,\partial\phi}\right)$$

$$\vec{\nabla}\cdot\vec{E} = \frac{1}{s}\frac{\partial}{\partial s}\left(s\,E_s\right) + \frac{\partial E_\phi}{s\,\partial\phi} + \frac{\partial E_z}{\partial z}$$

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

球座標

$$\vec{\nabla}\cdot\vec{E} = \frac{1}{r^2}\frac{\partial}{\partial r}\left(r^2 E_r\right) + \frac{1}{r\sin\theta}\frac{\partial}{\partial\theta}\left(\sin\theta E_\theta\right) + \frac{1}{r\sin\theta}\frac{\partial E_\phi}{\partial\phi}$$

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

柱座標

$$\vec{\nabla}\cdot\vec{E} = \frac{1}{s}\frac{\partial}{\partial s}\left(s E_s\right) + \frac{1}{s}\frac{\partial E_\phi}{\partial\phi} + \frac{\partial E_z}{\partial z}$$

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

球座標

$$\vec{\nabla}\times\vec{E} = \hat{r}\left[\frac{1}{\sin\theta}\frac{\partial}{r\partial\theta}\left(\sin\theta\, E_\phi\right) - \frac{\partial}{r\sin\theta\partial\phi}\left(E_\theta\right)\right] + \hat{\theta}\left[\frac{\partial}{r\sin\theta\partial\phi}\left(E_r\right) - \frac{1}{r}\frac{\partial}{\partial r}\left(r\,E_\phi\right)\right] + \phi\left[\frac{1}{r}\frac{\partial}{\partial r}\left(r\,E_\theta\right) - \frac{\partial}{r\partial\theta}\left(E_r\right)\right]$$

柱座標

$$\vec{\nabla}\times\vec{E} = \hat{s}\left[\frac{\partial}{s\partial\phi}\left(E_z\right) - \frac{\partial}{\partial z}\left(E_\phi\right)\right] + \hat{\phi}\left[\frac{\partial}{\partial z}\left(E_s\right) - \frac{\partial}{\partial s}\left(E_z\right)\right] + \hat{z}\left[\frac{1}{s}\frac{\partial}{\partial s}\left(s\,E_\phi\right) - \frac{\partial}{s\partial\phi}\left(E_s\right)\right]$$