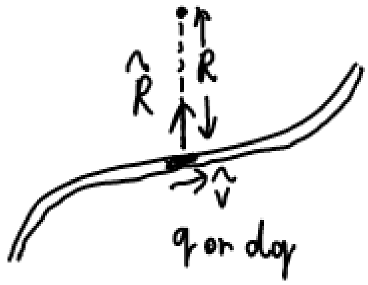
Magnetic Fields



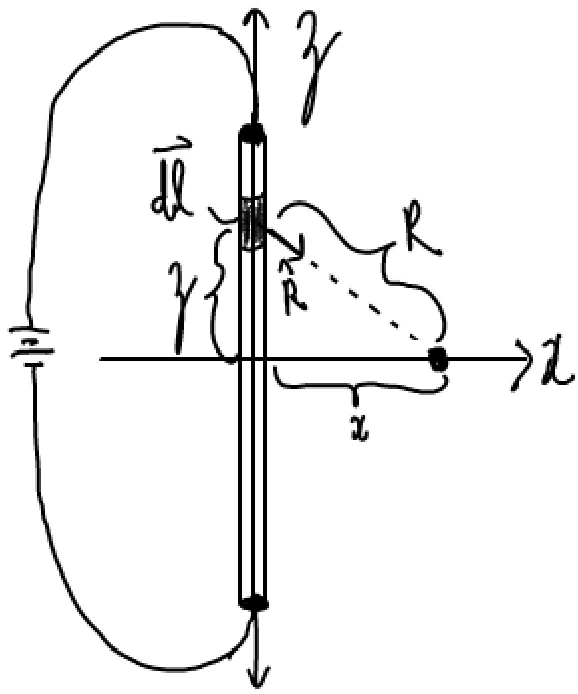
$$\boxed{\vec{B} = \frac{\mu_0}{4\pi}\frac{q\vec{v}\times\hat{R}}{R^2}} \Rightarrow d\vec{B} = \frac{\mu_0}{4\pi}\frac{dq\vec{v}\times\hat{R}}{R^2}$$

$$\boxed{d\vec{B} = \frac{\mu_0}{4\pi}\frac{I\,d\vec{l}\times\hat{R}}{R^2}}$$

$$dq\vec{v} = \frac{dq}{dt}\,\vec{v}\,dt$$

$$dq\vec{v} = I \cdot dl$$

$$\int_a^b f(x)\,\vec{dx} = \hat{x}\int f(x)\,dx$$



$$I\,d\vec{l} = I\,dz\,\hat{z} \quad (1)$$

$$\hat{R} = \frac{-z\hat{z}+x\hat{x}}{\sqrt{z^2+x^2}} \quad (2)$$

$$R = \sqrt{z^2+x^2} \quad (3)$$

* $I\,d\hat{l}\times\hat{R}$ will be in $+\hat{y}$ direction *

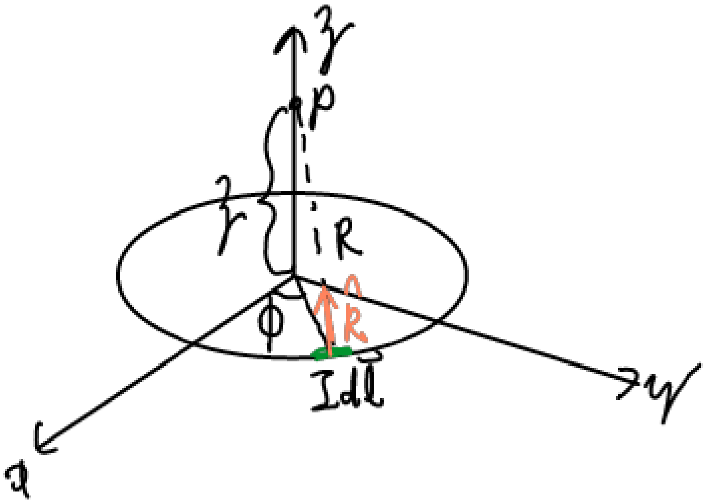
(1) × (2) ⇒

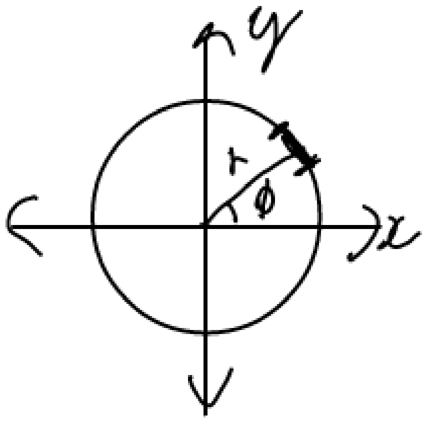
$$I\,dz\,\hat{z}\times\frac{\cancel{-z\hat{z}}+x\hat{x}}{\sqrt{z^2+x^2}} = \frac{I\,dz\,x\,\hat{y}}{\sqrt{z^2+x^2}} \quad (4)$$

$$d\bar{B} = \frac{\mu_0 I}{4\pi} \frac{dz\,\hat{x}}{(z^2+x^2)^{3/2}}\,\hat{y}$$

$$\bar{B} = \int_{\text{wire}} \frac{\mu_0 I}{4\pi} \frac{dz\,\hat{x}}{(z^2+x^2)^{3/2}}\,\hat{y}$$

$$= \frac{\mu_0 I}{4\pi} x\,\hat{y} \int_{-\infty}^{\infty} \frac{dz}{(z^2+x^2)^{3/2}}$$





$$I\,d\vec{l} = I\,r\,d\phi\,\hat{\phi} \quad (1)$$

$$\hat{R} = \frac{-r\hat{r} + z\hat{z}}{\sqrt{r^2+z^2}} \quad (2)$$

$$R = \sqrt{r^2+z^2} \quad (3)$$

$$d\vec{B} = \frac{\mu_0 I}{4\pi} \frac{d l \times \hat{R}}{R^2}$$

$$\vec{B} = \frac{\mu_0 I}{4\pi} \int_{\substack{\text{wire}\\ \text{loop}}} \frac{r\,d\phi\,\hat{\phi} \times (-r\hat{r} + z\hat{z})}{(r^2+z^2)^{3/2}}$$