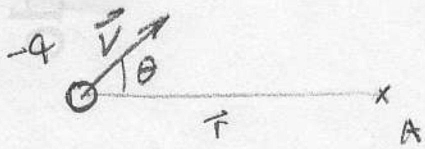
PHYS 115 HW #1

17.43]



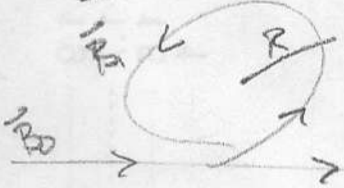
$\vec{V} = V\left(\cos\theta\,\hat{i} + \sin\theta\,\hat{j}\right)$ $\quad \hat{r} = \hat{i}$

$\vec{V}\times\hat{r} = V\begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \cos & \sin & 0 \\ 1 & 0 & 0 \end{vmatrix} = V\sin\theta\,\hat{k}$

$$\vec{E} = \frac{1}{4\pi\epsilon_0}\frac{-q}{r^2}\hat{i} = -5.76\cdot 10^{9}\ N/C\ \hat{i}$$

$$\vec{B} = \frac{\mu_0}{4\pi}\frac{(-q)\,\vec{V}\times\hat{r}}{r^2} = -\frac{\mu_0}{4\pi}\frac{q}{r^2}V\sin\theta\,\hat{k} = .166\ T\ \hat{k}$$

17.48]



$\vec{B}_0 \equiv$ B of straight wire

$\vec{B}_1 \equiv$ B of loop

$\odot$ is out of the page

$$\vec{B}_0 = \frac{\mu_0}{4\pi}\frac{2I}{R}\odot$$

$$\vec{B} = \vec{B}_1 + \vec{B}_0$$

$$\vec{B}_1 = \frac{\mu_0}{4\pi}\frac{2\pi I}{R}\odot$$

$$\vec{B} = \frac{\mu_0}{4\pi}\frac{I}{R}\left(2+2\pi\right)\odot$$

17.49]

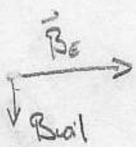
$$\vec{B}_{coil} = 3\vec{B}_{loop} = 3\frac{\mu_0}{4\pi}\frac{2\pi I}{R}\otimes$$

$\otimes$ is into the ground

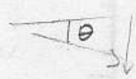
assume wires are all close, i.e. they all have same R and z = 0

$$= 3.14\cdot 10^{-6}\ T$$

$$\vec{B}_{net} = \vec{B}_{earth} + \vec{B}_{coil}$$

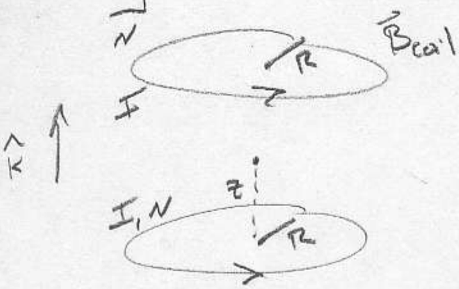


The magnitude of the deflection is $\vec{B}\cdot\hat{y} = B_{coil}$ at an angle of



$\tan\theta = \frac{B_{coil}}{B_{earth}} \Rightarrow \theta = 8.9°$

[7.52]



In this case both loops will add to $\vec{B}_{total}$ at the center, with the direction given as $(+\hat{k})$.

$z = .1 m$
$R = .03 m$
$N = 10$
$I = 2\ A$

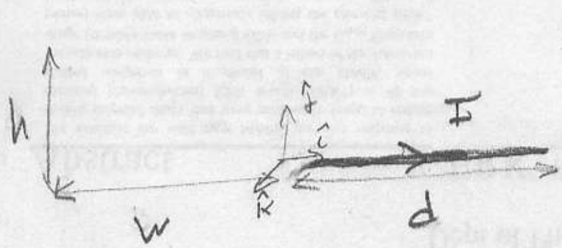
$$B_{total} = \frac{2\mu_0}{4\pi} N \frac{2\pi R^2 I}{(z^2+R^2)^{3/2}} = 1.99 \cdot 10^{-5}\ T$$

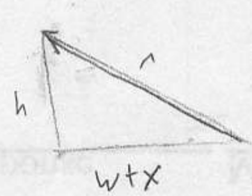
$$B_{approx} \approx 2\frac{\mu_0}{4\pi} N \frac{2\pi R^2 I}{z^3} = 2.26 \cdot 10^{-5}\ T$$

$$\frac{B_{approx} - B_{total}}{B_{total}} = \frac{\left(\frac{1}{z^3} - \frac{1}{(z^2+R^2)^{3/2}}\right)}{\left(\frac{1}{z^2+R^2}\right)^{3/2}} \approx 13\%$$

If coils were anti $\parallel$ then there would be no net $\vec{B}$, they cancel out.

[7.55] Part a can be found by simplifying part b.





$\vec{r} = -(w+x)\hat{i} + h\hat{j}$

$r = \left((w+x)^2 + h^2\right)^{1/2}$

$\hat{r} = \frac{-(w+x)}{r}\hat{i} + \frac{h}{r}\hat{j}$

$$d\vec{L} \times \hat{r} = \begin{vmatrix} \hat{i} & \hat{j} & \hat{k} \\ \frac{-w+x}{r} & h/r & 0 \\ dx & 0 & 0 \end{vmatrix} = -\frac{h}{r}dx\ \hat{k}$$

$d\vec{L} = dx\ \hat{i}$

$$|\vec{B}| = \int_0^d \frac{\mu_0}{4\pi} I \frac{-h}{r^3} dx = \frac{-\mu_0 I h}{4\pi}\int_0^d \frac{dx}{((w+x)^2+h^2)^{3/2}} = \frac{-\mu_0 I}{4\pi h}\left[\frac{w+x}{((w+x)^2+h^2)^{1/2}}\right]_{x=0}^{x=d}$$

$$= \frac{-\mu_0 I}{4\pi h}\left[\frac{w+d}{((w+d)^2+h^2)^{1/2}} - \frac{w}{(w^2+h^2)^{1/2}}\right]$$

$\vec{B}$ is out of the page, $(+\hat{k})$

observe when $h=0$ $|\vec{B}| \to 0$ part a