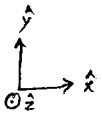
Solutions

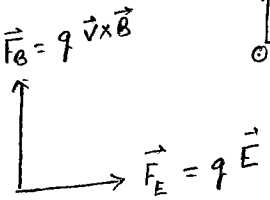
Midterm Exam 03, PHYS-2038-001, Spring 2017

Prob. 1

$|\vec{F}_E| = qE = (1.0\times10^{-6}\,C)(6.00\times10^{3}\,\frac{N}{C}) = 6.0\,mN$

$|\vec{F}_B| = qvB\sin 90 = (1.0\times10^{-6}C)(2.00\times10^{6}\,\frac{m}{s})(1.50\times10^{-3}\,T) = 3.0\,mN$





$\vec{F}_E = \hat{x}\ 6.0\,mN + 0\,\hat{y}$

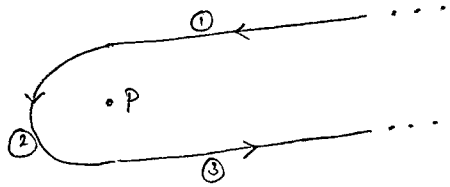
$\vec{F}_B = 0\,\hat{x} + \hat{y}\ 3.0\,mN$

$\vec{F}_{tot} = \hat{x}\ 6.0\,mN + \hat{y}\ 3.0\,mN$

magnitude: $|\vec{F}_{tot}| = \sqrt{(6.0\,mN)^2 + (3.0\,mN)^2}$

$= 6.7\,mN$

Prob. 2



direction: ⊙, coming out of page.

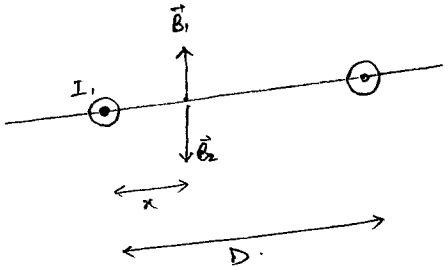
$B_{tot} = B_1 + B_2 + B_3$

magnitude: $B_{tot} = \frac{\mu_0 I}{4\pi a}(\sin 90 - \sin 0) + \frac{\mu_0 I}{4\pi a}\pi + \frac{\mu_0 I}{4\pi a}(\sin 90 - \sin 0)$

$= \frac{\mu_0 I}{4\pi a}[1 + \pi + 1]$

$= \frac{4\pi\times10^{-7}\times(1.00A)}{4\pi\times5.00\times10^{-2}m}[1+\pi+1] = 1.03\times10^{-5}\,T$

Prob. 3



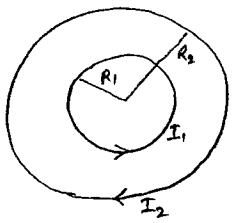
$|\vec{B}_1| = |\vec{B}_2|$

$\frac{\mu_0 I_1}{2\pi x} = \frac{\mu_0 I_2}{2\pi(D-x)}$

$\frac{1.0}{x} = \frac{4.0}{D-x}$

$D - x = 4.0\,x \Rightarrow x = \frac{D}{5.0} = \frac{10.0\ cm}{5.0} = 2.0\ cm$

Prob. 4



direction: opposite to inner coil.

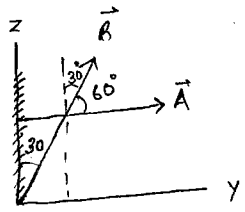
$$|\vec{B}_1| = |\vec{B}_2|$$

$$N_1 \frac{\mu_0 I_1}{2R_1} = N_2 \frac{\mu_0 I_2}{2R_2}$$

$$I_2 = \frac{N_1}{N_2}\frac{R_2}{R_1} I_1 = \frac{120}{160}\frac{0.016\,m}{0.012\,m}\,5.0A = 5.0\,A$$

↳ magnitude

Prob. 5

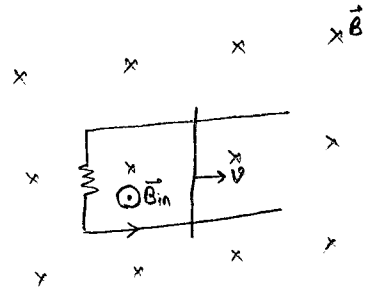


$$\Phi_{zz} = B A \cos\theta$$

$$= (1.0\,T)(1.00\times10^{-4}\,m^2)\cos 60$$

$$= 5.0\times10^{-5}\ \underbrace{T m^2}_{\text{↳ weber.}}$$

Problem 6



(a) increasing

(b) counter clockwise.

(c) $$I = \frac{V}{R} = \frac{B l v}{R}$$

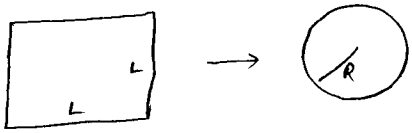
$$= \frac{(1.2\,T)(0.10\,m)(5.0\,\frac{m}{s})}{(0.40\,\Omega)}$$

$$= 1.5\,A$$

Prob. 7

$$\Phi_{square} = B A_{square} = B L^2$$

$$\Phi_{circle} = B A_{circle} = B \pi R^2$$



$$4L = 2\pi R$$

$$\Rightarrow \frac{L}{R} = \frac{\pi}{2}$$

$$\frac{\Phi_{square}}{\Phi_{circle}} = \frac{B L^2}{B \pi R^2} = \frac{1}{\pi}\left(\frac{L}{R}\right)^2 = \frac{1}{\pi}\left(\frac{\pi}{2}\right)^2 = \frac{\pi}{4} \approx 0.79$$

Prob. 8

$$B = \mu_0 I n$$

$$u = \frac{1}{2\mu_0} B^2 = \frac{1}{2\mu_0} (\mu_0 I n)^2$$

$$= \frac{1}{2} \mu_0 I^2 n^2$$

$$= \frac{1}{2} (4\pi \times 10^{-7}) (1.0\,A)^2 \left(\frac{200}{10^{-2}\,m}\right)^2$$

$$= 250 \ \frac{J}{m^3}$$