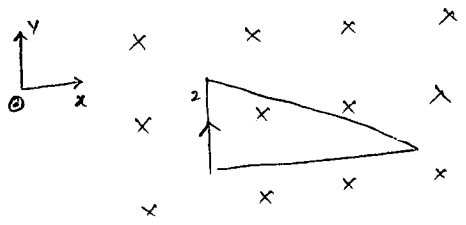
Solutions

Midterm Exam 03 , PHYS-203B-002 , Spring 2017

Prob. 1



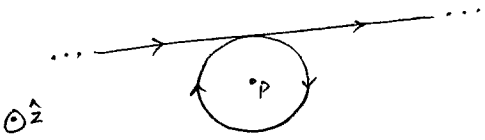
direction : $-\hat{x}$

magnitude : $F = I L_2 B \sin\theta$

$= (2.0\,A)(2.0\times10^{-2}\,m)(2.0\,T)\sin 90$

$= 0.080\ N$

Prob. 2



$\vec{B} = \vec{B}_{\text{infinite wire}} + \vec{B}_{\text{circle}}$

$= -\hat{z}\frac{\mu_0 I}{2\pi a} - \hat{z}\frac{\mu_0 I}{2a}$

$= -\hat{z}\frac{\mu_0 I}{2\pi a}(1+\pi)$

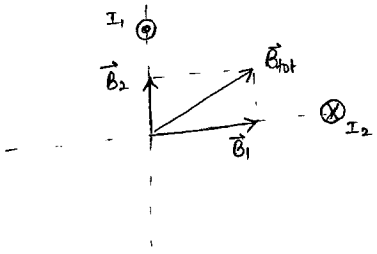
$= -\hat{z}\frac{\frac{2}{4\pi}\times10^{-7}\times(1.0\,A)}{2\pi\times(10.0\times10^{-2}\,m)}(1+\pi)$

$= -\hat{z}\ 8.3\times10^{-6}\ T$

direction : $-\hat{z}$ = into the page, $\otimes$

magnitude : $|\vec{B}| = 8.3\ \mu T$

Prob. 3



$\vec{B}_1 = +\hat{x}\frac{\mu_0 I_1}{2\pi y} + 0\,\hat{y}$

$= +\hat{x}\frac{4\pi\times10^{-7}\times(1.0\,A)}{2\pi(8.0\times10^{-2}\,m)} + 0\,\hat{y}$

$= \hat{x}\ 2.5\times10^{-6}\ T + 0\,\hat{y}$

$\vec{B}_2 = 0\,\hat{x} + \frac{\mu_0 I_2}{2\pi x}\hat{y}$

$= 0\,\hat{x} + \frac{4\pi\times10^{-7}\times(2.0\,A)}{2\pi(12\times10^{-2}\,m)}\hat{y}$

$= 0\,\hat{x} + \hat{y}\,3.3\times10^{-6}\ T$

$\vec{B}_{tot} = \vec{B}_1 + \vec{B}_2 = \hat{x}\ 2.5\,\mu T + \hat{y}\ 3.3\,\mu T$

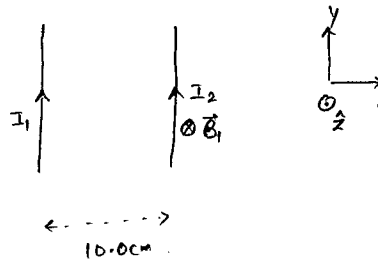
$|\vec{B}_{tot}| = \sqrt{(2.5\,\mu T)^2 + (3.3\,\mu T)^2}$

$= 4.1\ \mu T$

Prob. 4

(a) $|\vec{B}_1| = \frac{\mu_0 I_1}{2\pi r} = \frac{4\pi \times 10^{-7} \times 1.0\,A}{2\pi \times (10.0 \times 10^{-2}\,m)} = 2.0\,\mu T$

direction of $\vec{B}_1$: $\otimes$, into the page.



(b) $\vec{F}_{21} = I_2 \vec{L}_2 \times \vec{B}_1$

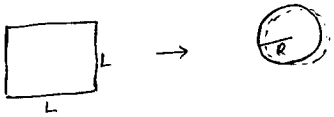
$= -\hat{x}\, I_2 L_2 B_1 \sin 90$

$\frac{|\vec{F}_{21}|}{L_2} = I_2 B_1 = (2.0\,A)(2.0\,\mu T)$

$= 4.0\ \frac{\mu N}{m}$

direction: I_2 is attracted towards I_1.

Prob. 5



$\phi_{circle} = N B A \cos 0$

$= 2 B \pi R^2$

$\phi_{square} = N B A \cos 0$

$= 1 B L^2$

$4L = 2 \times 2\pi R$

$\Rightarrow L = \pi R$

$\Rightarrow \frac{R}{L} = \frac{1}{\pi}$

$\frac{\phi_{circle}}{\phi_{square}} = \frac{2 B \pi R^2}{1 B L^2} = 2\pi \left(\frac{1}{\pi}\right)^2 = \frac{2}{\pi}$

$\phi_{circle} = \frac{2}{\pi} \phi_{square} = \frac{2}{\pi} 3.9 \times 10^{-3}\,Wb = 2.5 \times 10^{-3}\,Wb.$

Prob. 6

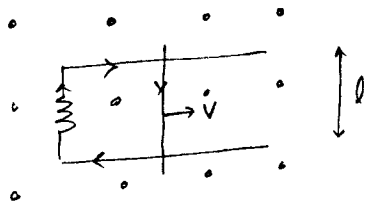
$V = N \left(\frac{\Delta B}{\Delta t}\right) A \cos\theta$

$= 50 \left(\frac{2.0\,T}{2.0\,s}\right) 25 \times 10^{-4}\,m^2 \cos 0$

$= 0.13\ V$

$I = \frac{V}{R} = \frac{0.13\ V}{100\,\Omega} = 1.3 \times 10^{-3}\,A = 1.3\,mA$

Prob. 7



(a) increasing

(b) clockwise.

(c) $I = \frac{V}{R} = \frac{Blv}{R}$

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

$= 1.5\ A$

Prob. 8

$V = L\frac{\Delta I}{\Delta t} = 6.00 \times 10^{-3}\ H \times \frac{(0.200 - 1.50)\ A}{0.350\ s}$

$= -22.3 \times 10^{-3}\ V$

$= -22.3\ mV$