Prob. 1

(a) $\vec{F} = q\, \vec{v} \times \vec{B}$

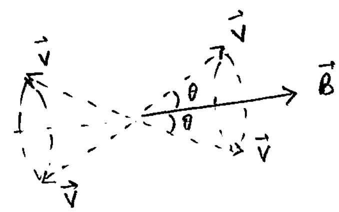
$F = q\, v\, B \sin\theta$

$$\sin\theta = \frac{F}{q v B} = \frac{8.00 \times 10^{-13}}{(1.6\times10^{-19})\times(4.5\times10^{6})(1.76)} = 0.631$$

$$\theta = \sin^{-1}(0.631) = 39.2^\circ$$

(b) $\sin\theta = \sin(\pi - \theta)$

Thus, $\theta = 180 - 39.2 = 140.9$ is also a solution.

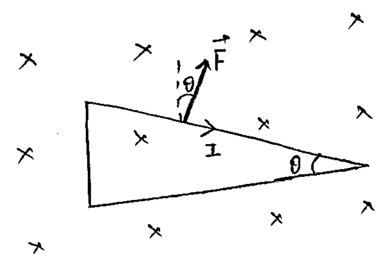


all these are solutions

There are infinite solutions.

Prob. 2

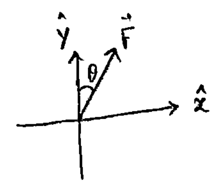
$\vec{F}_3 = I\, \vec{L}_3 \times \vec{B}$



magnitude: $F_3 = I\, L_3\, B \sin 90$

$= 2.00 \times \sqrt{3.00^2 + 2.00^2} \times 10^{-2} \times 0.300$

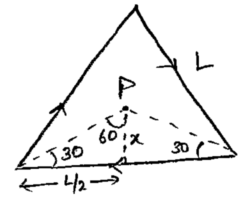
$= 2.16 \times 10^{-2}$ N



direction: $\theta = \tan^{-1}\left(\frac{2.00}{3.00}\right) = 33.69^\circ$ with respect to $\hat{y}$.

33.69° clockwise

Prob. 3



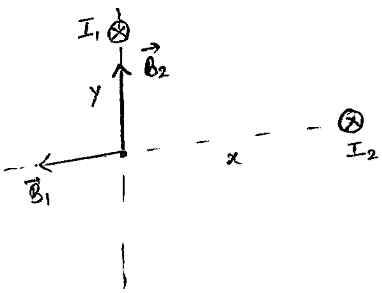
direction of $\vec{B}$ at point P $\Big\}$ = into the page $\otimes$

$x = \frac{L}{2}\tan 30 = 0.577\text{cm}$
$= \frac{L}{2}\cot 60$

$\frac{\sin 60}{\cot 60} = \frac{3}{2}$

$$\begin{aligned}
B_{tot} &= B_1 + B_2 + B_3 \\
&= 3B_1 \\
&= 3\,\frac{\mu_0 I}{4\pi x}\left(\sin 60 + \sin 60\right) \\
&= 3\,\frac{\mu_0 I}{4\pi \frac{L}{\cancel{2}}}\,\frac{\cancel{2}\sin 60}{\cot 60} = \frac{9\mu_0 I}{2\pi L} \\
&= \frac{9 \times 4\pi \times 10^{-7} \times 2.00}{2\pi \times 1.00 \times 10^{-2}} = 3.6 \times 10^{-4}\ \text{T}
\end{aligned}$$

Prob. 4



$$|\vec{B}_1| = \frac{\mu_0 I_1}{2\pi y} = \frac{4\pi \times 10^{-7} \times 1.0}{2\pi \times 4.0 \times 10^{-2}} = 5.0 \times 10^{-6}\ \text{T}$$

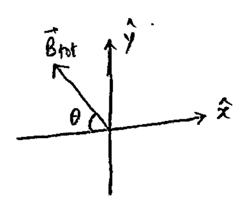
$$|\vec{B}_2| = \frac{\mu_0 I_2}{2\pi x} = \frac{4\pi \times 10^{-7} \times 2.0}{2\pi \times 6.0 \times 10^{-2}} = 6.7 \times 10^{-6}\ \text{T}$$

$$\vec{B}_1 = -\hat{i}\ 5.0 \times 10^{-6}\ \text{T} + 0\,\hat{j}$$

$$\vec{B}_2 = \hat{i}\ 0 + 6.7 \times 10^{-6}\,\hat{j}$$

$$\vec{B}_{tot} = \left(-5.0 \times 10^{-6}\,\hat{i} + 6.7 \times 10^{-6}\,\hat{j}\right)\ \text{T}$$

magnitude : $|\vec{B}_{tot}| = \sqrt{(-5.0 \times 10^{-6})^2 + (6.7 \times 10^{-6})^2} = 8.36 \times 10^{-6}\ \text{T}$



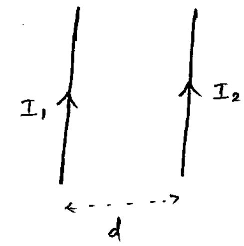
direction : $\theta = \tan^{-1}\left(\frac{6.7}{5.0}\right) = 53.3^\circ$

53.3° clockwise with respect to $-\hat{x}$

Prob. 5

$$\frac{F}{L} = \frac{\mu_0 I_1 I_2}{2\pi d}$$

$$= \frac{4\pi \times 10^{-7} \times 4.00 \times 8.00}{2\pi \times 14.0 \times 10^{-2}} = 4.57 \times 10^{-5}\ \frac{N}{m}$$



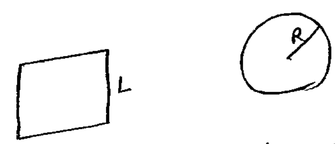
The two wires attract each other.

Prob. 6

$$B = \mu_0 I n \qquad n = \frac{N}{L}$$

$$I = \frac{BL}{\mu_0 N} = \frac{(1.00 \times 10^{-4}\ T)(0.390\ m)}{\left(4\pi \times 10^{-7}\ \frac{Tm}{A}\right)(1070)} = 29.0\ mA$$

Prob. 7



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

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

Since the perimeter remains the same, we have

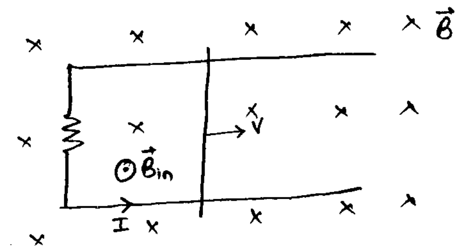
$$4L = 2\pi R \Rightarrow \frac{R}{L} = \frac{2}{\pi}$$

Dividing the two we have

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

$$\Phi_{circle} = \frac{4}{\pi} \Phi_{square} = \frac{4}{\pi} \times 3.9 \times 10^{-3}\ Wb = 4.97 \times 10^{-3}\ Wb$$

Prob. 8



(a) increasing

(b) counterclockwise

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

$= \frac{0.200 \times 10.0 \times 10^{-2} \times 5.0}{4.0\,\Omega}$

$= 25\ mA$