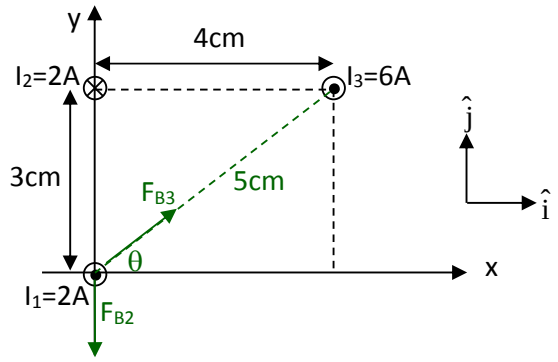
Name: _____

PHY 232 Summer 2016 Class Work

Class 30. Ampere's Law

Consider three infinite long wires parallel to each other:



(a) What is the magnetic force per unit length acting on I_1 due to I_2? Please use $\hat{i}, \hat{j}, \hat{k}$ notation.

$$\vec{B}_2 = -\frac{\mu_0 I_2}{2\pi R}\hat{k}$$

$$\therefore F_{B2} = -\frac{\mu_0 I_1 I_2 L}{2\pi R}\hat{j} \Rightarrow \frac{F_{B2}}{L} = -\frac{\mu_0 I_1 I_2}{2\pi R}\hat{j} = -\frac{4\pi\times10^{-7}\times2\times2}{2\pi\times0.03}\hat{j} = \underline{\underline{-2.667\times10^{-5}\ \hat{j}\ \text{N/m}}}$$

(b) What is the magnetic force per unit length acting on I_1 due to I_3? Please use $\hat{i}, \hat{j}, \hat{k}$ notation.

$$|\vec{B}_3| = \frac{\mu_0 I_3}{2\pi R}$$

$$\therefore |F_{B3}| = \frac{\mu_0 I_1 I_3 L}{2\pi R} \Rightarrow \frac{F_{B3}}{L} = -\frac{\mu_0 I_1 I_3}{2\pi R}\hat{j} = \frac{4\pi\times10^{-7}\times2\times6}{2\pi\times0.05}\hat{j} = 4.8\times10^{-5}\ \text{N/m}$$

$$F_{B3,x} = |F_{B3}|\cos\theta = 4.8\times10^{-5}\cdot\frac{4}{5} = 3.84\times10^{-5}\ \text{N/m}$$

$$F_{B3,y} = |F_{B3}|\sin\theta = 4.8\times10^{-5}\cdot\frac{3}{5} = 2.88\times10^{-5}\ \text{N/m}$$

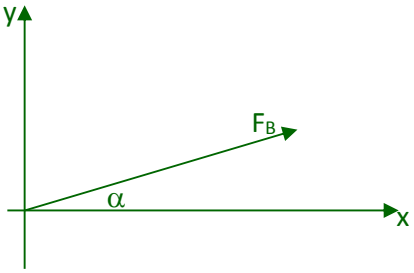
$$\therefore \vec{F}_{B3} = \underline{\underline{3.84\times10^{-5}\ \hat{i}\ \text{N/m} + 2.88\times10^{-5}\ \hat{j}\ \text{N/m}}}$$

(c) What is the total magnetic force per unit length acting on I_1? Please use $\hat{i}, \hat{j}, \hat{k}$ notation.

$$\vec{F}_B = \vec{F}_{B2} + \vec{F}_{B3} = (3.84\times10^{-5}\ \hat{i}\ \text{N/m} + 2.88\times10^{-5}\ \hat{j}\ \text{N/m}) + (-2.667\times10^{-5}\ \hat{j}\ \text{N/m})$$

$$= \underline{\underline{3.84\times10^{-5}\ \hat{i}\ \text{N/m} + 2.13\times10^{-6}\ \hat{j}\ \text{N/m}}}$$

(d) What is the magnitude of the total magnetic force per unit length acting on I_1? What is its direction (with respect to the +x axis)?



$$|\vec{F}_B| = \sqrt{(3.84\times10^{-5})^2 + (2.13\times10^{-6})^2}$$

$$= \underline{\underline{3.85\times10^{-5}\ \text{N/m}}}$$

$$\alpha = \tan^{-1}\left(\frac{2.13\times10^{-6}}{3.84\times10^{-5}}\right) = \underline{\underline{3.17^{o}}}$$