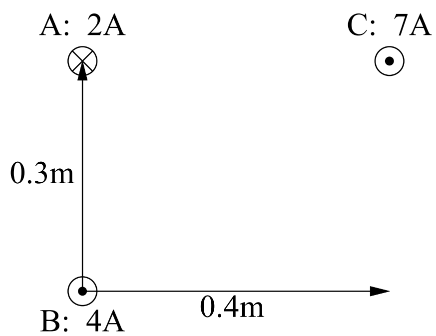
2. (20 pts.) Three long parallel wires are arranged as shown. Wire A has a current of 2A headed into the page, wire B has a current of 4A headed out of the page, and wire C has a current of 7A headed out of the page, as shown. Find the magnitude and direction of the net magnetic force per unit length on wire C.



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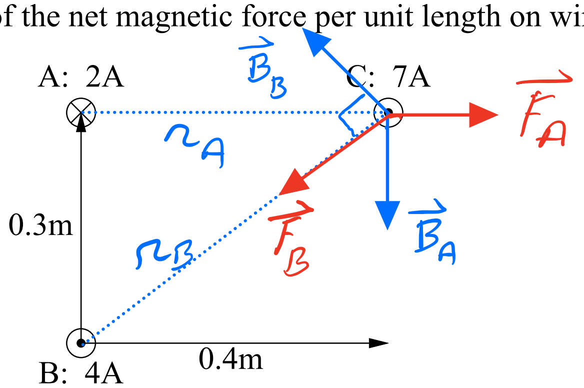

$r_A = 0.4m$

$r_B = \sqrt{(0.3m)^2 + (0.4m)^2}$

$r_B = 0.5m$

$\vec{B}_A$ = magnetic field due to wire A at wire C.

$\vec{B}_A = \dfrac{\mu_0 I_A}{2\pi r_A}$, down. ($\vec{B}_A$ goes in a clockwise circle around wire A.)

$\vec{B}_B$ = magnetic field due to wire B at wire C.

$\vec{B}_B = \dfrac{\mu_0 I_B}{2\pi r_B}$, up and left. ($\vec{B}_B$ goes in a counterclockwise circle around wire B.)

$\vec{F}_A = I_c \vec{L}_c \times \vec{B}_A \Rightarrow \dfrac{F_A}{L_c} = I_c B_A$, right.

$\vec{F}_B = I_c \vec{L}_c \times \vec{B}_B \Rightarrow \dfrac{\vec{F}_B}{L_c} = I_c B_B$, down and left.

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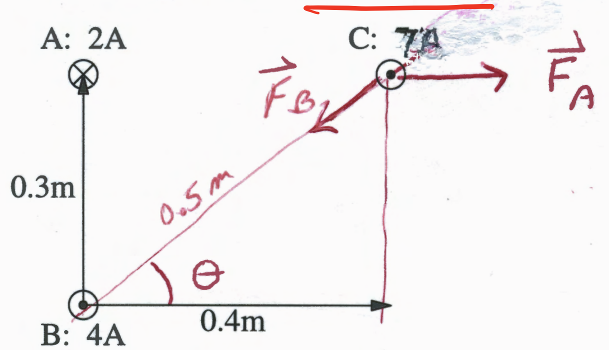

$\tan\theta = \frac{.3}{.4}$

$\theta = 36.9°$

$\frac{\vec{F}_A}{L_c} = \frac{\mu_0 I_A I_c}{2\pi r_{AC}}$ @ $0°$, $I_A = 2$, $I_c = 7$, $r_{AC} = 0.4$,

$\frac{\vec{F}_B}{L_c} = \frac{\mu_0 I_B I_c}{2\pi r_{BC}}$ @ $(180° + 36.9° = 216.9°)$.

$I_B = 4A$, $I_c = 7A$, $r_{BC} = 0.5$

$\vec{F}_{TOT} = \vec{F}_A + \vec{F}_B$

x - components

$$\frac{F_{TOT,x}}{L_c} = \frac{F_{Ax}}{L_c} + \frac{F_{Bx}}{L_c} = \frac{\mu_0 I_A I_c}{2\pi r_{AC}} + \frac{\mu_0 I_B I_c}{2\pi r_{BC}} \cos 216.9$$

$$= \frac{\mu_0 I_c}{2\pi}\left[\frac{I_A}{r_{AC}} + \frac{I_c}{r_{BC}} \cos 216.9\right]$$

$$= \frac{(4\pi \times 10^{-7})(7)}{2\pi}\left[\frac{2}{.4} + \frac{4}{.5}\cos 216.9\right] = -1.96 \times 10^{-6}\ N$$

$$\frac{F_{TOT,y}}{L_c} = \frac{F_{Ay}}{L_c} + \frac{F_{By}}{L_c} = 0 + \frac{\mu_0 I_B I_c}{2\pi r_{BC}} \sin 216.9 = \frac{(4\pi \times 10^{-7})(4)(7)}{2\pi(.5)}(-0.6)$$

$$= -6.72 \times 10^{-6}\ N$$

$$\boxed{\frac{F_{TOT}}{L_c} = 7.0 \times 10^{-6}\ N \text{ @ } -106°}$$