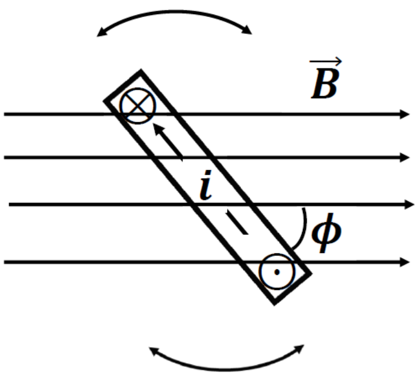
Quiz Average **4.1** **Quiz High Score** **8**

PH 202 **Quiz # 06 (10 pts)** **Name** **Solution**



On the left you see a coil that can rotate either clockwise or counter-clockwise about an axis that goes in and out of the plane of the paper. As shown the current going around this coil goes up and to the left on the side of the coil in front of the screen. Obviously, the current would go into the screen at the top left, and out of the screen at the bottom right and it would go from top left down to bottom right behind the screen. The magnetic field is going to the right as shown and has a magnitude of $150.\text{T}$. It makes an angle $\phi = 35.0°$ between the magnetic field and the surface of the coil as shown. The area of the coil is $\text{A} = 4.76 \text{ x } 10^{-3} \text{ m}^2$ and it contains 679 turns of wire which is carrying a current of 7.98 A. What is the magnitude and direction of the torque created on the coil by the magnetic field?

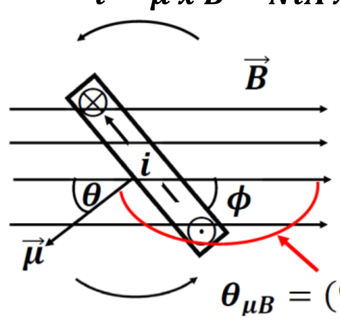
A. $3.17 \text{ x } 10^3 \text{m N } (\widehat{\text{CW}})$

C. $\mathbf{3.17 \text{ x } 10^3 \text{m N } (\widehat{\text{CCW}})}$

B. $2.22 \text{ x } 10^3 \text{m N } (\widehat{\text{CW}})$

D. $2.22 \text{ x } 10^3 \text{m N } (\widehat{\text{CCW}})$

$$\vec{\tau} = \vec{\mu} \, x \, \vec{B} = Ni\vec{A} \, x \, \vec{B}$$



As shown above the right-hand rule puts the area down to the left. The cross product therefore results in a counter-clockwise rotation as shown. So, we see the coil will rotate counter-clockwise. The magnitude of the torque is

$$\tau = NIAB \sin(\theta_{\mu B}) = NIAB \sin(90° + \phi)$$

$$\tau = (679)(7.98 \, A)(4.76 \, x \, 10^{-3} m^2)(150. T) \sin(90° + 35.0°)$$

$$\tau = (3.87 \, x \, 10^3 m \, N) \sin(125.0°) = 3.17 \, x \, 10^3 m \, N$$

So, the correct answer is C !

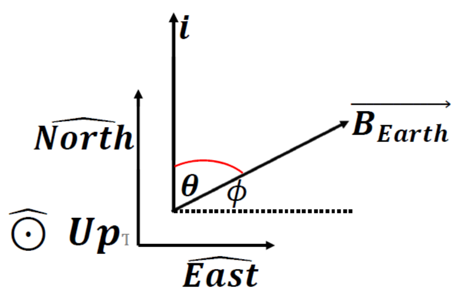
A $1000.\,\mathrm{m}$ length of a power line exists in a north-south direction. It is carrying a current of $360.\,\mathrm{A}\ (\widehat{\mathrm{North}})$. The Earth's magnetic field in this area is measured to be $\overrightarrow{\mathrm{B}_{\mathrm{Earth}}} = 1.75 \times 10^{-5}\ \mathrm{T} @ 63.0° \ (\widehat{\mathrm{North}})$ of $(\widehat{\mathrm{East}})$. What is the magnitude and direction of the magnetic force acting on the wire?

A. $6.30\ \mathrm{N}\ (\widehat{\mathrm{Down}})$

B. $13.9\ \mathrm{N}\ (\widehat{\mathrm{Up}})$

C. $\mathbf{2.86\ N\ (\widehat{Down})}$

D. $5.61\ \mathrm{N}\ (\widehat{\mathrm{Up}})$



Pictured above is the situation as described in the problem. The magnetic force is found from:

$$\overrightarrow{F_B} = i\vec{L} \times \vec{B}$$

The magnitude is found from:

$$\left|\overrightarrow{F_B}\right| = iLB\sin(\theta) = iLB\sin(90° - \phi) = iLB\sin(90° - 63.0°)$$

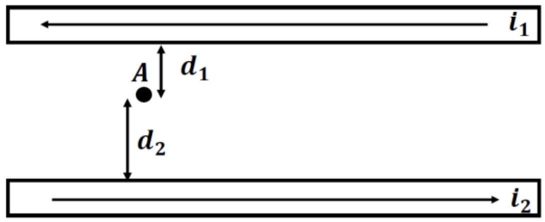
$$\left|\overrightarrow{F_B}\right| = (360.\,A)(1000.\,m)(1.75 \times 10^{-5}\ T)\sin(27.0°) = 2.86\ N$$

Now using the Right-Hand Rule for Cross Products, and the coordinates presented in the diagram

$$(\widehat{North}) \times \left(63.0°\ (\widehat{\mathrm{North}})\ \mathrm{of}\ (\widehat{\mathrm{East}})\right) = (\widehat{Down})$$

So, the correct answer is C !

Two long straight wires are shown below. Wire 1 has a current $\mathrm{i}_1 = 12.8\ \mathrm{A}$ going to the left as shown. Wire 2 has a current $\mathrm{i}_2 = 22.3\ \mathrm{A}$ going to the right. What is the magnitude and direction of the magnetic field at Point A located a distance $\mathrm{d}_1 = 1.92 \times 10^{-1}\ \mathrm{m}$ below wire 1, and it is a distance $\mathrm{d}_2 = 3.74 \times 10^{-1}\ \mathrm{m}$ above wire 2?



A. $1.41 \times 10^{-6}\ \mathrm{T}\ (\widehat{\otimes})$

B. $1.41 \times 10^{-6}\ \mathrm{T}\ (\widehat{\odot})$

C. $2.53 \times 10^{-5}\ \mathrm{T}\ (\widehat{\otimes})$

D. $\mathbf{2.53 \times 10^{-5}\ T\ (\widehat{\odot})}$

For a long straight wire magnetic field is calculated by:

$$\overrightarrow{B_{Long\ Straight\ Wire}} = \frac{\mu_0 i}{2\pi r}\ (RT - \widehat{Hand\ Rule})$$

Using the law of Superposition

$$\overrightarrow{B_A} = \overrightarrow{B_{1A}} + \overrightarrow{B_{2A}} = \frac{\mu_0 i_1}{2\pi d_1}\ (\widehat{\odot}) + \frac{\mu_0 i_2}{2\pi d_2}\ (\widehat{\odot}) = \frac{\mu_0}{2\pi}\left(\frac{i_1}{d_1} + \frac{i_2}{d_2}\right)(\widehat{\odot})$$

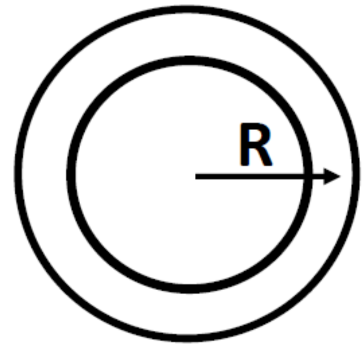
$$\overrightarrow{B_A} = \frac{\mu_0}{2\pi}\left(\frac{i_1}{d_1} + \frac{i_2}{d_2}\right)(\widehat{\odot}) = \left(\frac{4\,\pi\ x\ 10^{-7}\ {}^{T\,m}/_{A}}{2\,\pi}\right)\left(\frac{12.8\ A}{1.92\ x\ 10^{-1}\ m} + \frac{22.3\ A}{3.74\ x\ 10^{-1}\ m}\right)(\widehat{\odot})$$

$$\overrightarrow{B_A} = (2\ x\ 10^{-7}\ {}^{T\,m}/_{A})(66.67\ {}^{A}/_{m} + 59.63\ {}^{A}/_{m})\ (\widehat{\odot})$$

$$\overrightarrow{B_A} = (2\ x\ 10^{-7}\ {}^{T\,m}/_{A})(126.3\ {}^{A}/_{m})\ (\widehat{\odot}) = 2.526\ x\ 10^{-5}\ T\ (\widehat{\odot})$$

So, the correct answer is D !

On the right there is a circular coil with a radius, $\mathrm{R} = 0.850\ \mathrm{m}$ and has 2048 turns of wire. At the center of the coil we measure a magnetic field $\overrightarrow{\mathrm{B}_{\mathrm{Coil}}} = 3.77\ \mathrm{T}\ (\widehat{\odot})$. What is the magnitude of the current flowing through the coil and in which direction is it flowing to create that magnetic field.



A. $\mathbf{2.49\ x\ 10^3\ A\ (\widehat{CCW})}$

B. $7.82\ \mathrm{x}\ 10^3\ \mathrm{A}\ (\widehat{\mathrm{CW}})$

C. $2.49\ \mathrm{x}\ 10^3\ \mathrm{A}\ (\widehat{\mathrm{CW}})$

D. $7.82\ \mathrm{x}\ 10^3\ \mathrm{A}\ (\widehat{\mathrm{CCW}})$

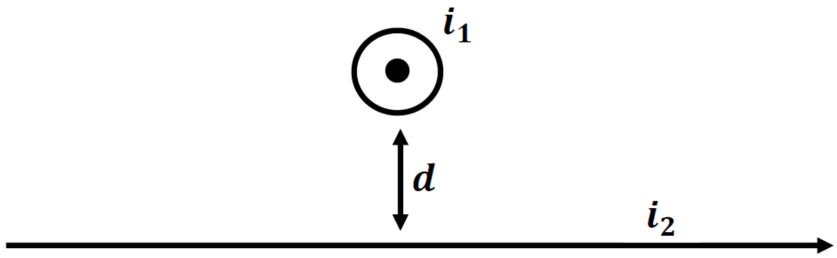
Using the right-hand rule to create a magnetic field coming out of the paper at the center, the current must flow counter-clockwise. The magnitude of current is found from

$$\boldsymbol{B_{Circular\ Coil} = \frac{\mu_0 N i}{2R}}$$

Solve for current

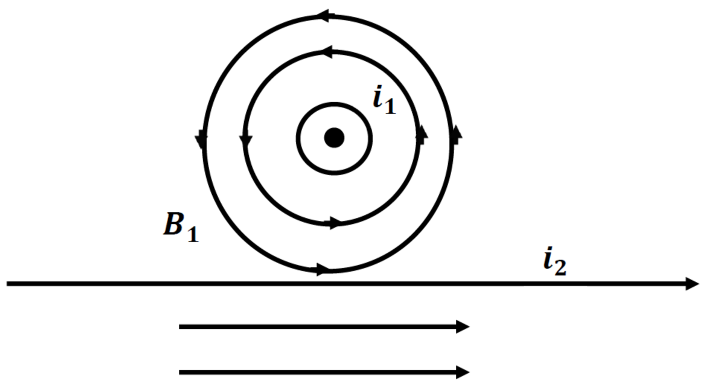
$$\boldsymbol{i = \frac{2RB}{\mu_0 N} = \frac{2(0.850\ m)(3.77\ T)}{(4\pi\ x\ 10^{-7}\ T\ m/_A)(2048)} = \frac{6.409\ T\ m}{2.574\ x\ 10^{-3}\ T\ m/_A} = 2.490\ x\ 10^3\ A}$$

So, the correct answer is A !



Two wires are shown above. Wire 1 carries a current $i_1 = 15.0$ A straight out of the paper. The wire has a length of $L_1 = 1.78$ m. Wire 2 carries a current $i_2 = 27.0$ A going to the right. The wire has a length of $L_2 = 4.92$ m. Wire 1 is located above wire 2 by a distance of $d = 0.39$ m. What is the magnitude of the magnetic force that Wire 1 exerts on Wire 2.

A. 3.70×10^{-4}N **B.** $\mathbf{0.00\ N}$ **C.** 1.02×10^{-3}N **D.** 1.82×10^{-3}N



The B field for Wire 1 is concentric circles going counter-clockwise as shown above. The magnetic force of wire 1 on wire 2 is given by

$$\overrightarrow{F_{1\to 2}} = i_2 \overrightarrow{L_2} x\, \overrightarrow{B_1}$$

Since $\overrightarrow{B_1}$ is parallel to $\overrightarrow{L_2}$, $\overrightarrow{L_2} x\, \overrightarrow{B_1} = 0$!

So $\overrightarrow{F_{1\to 2}} = i_2 \overrightarrow{L_2} x\, \overrightarrow{B_1} = 0.00\ N$

So, the correct answer is B !

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