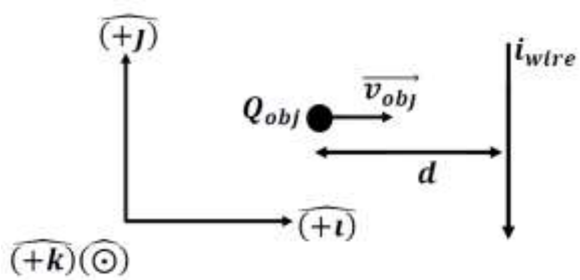
Quiz Average 4.0 **Quiz High Score** 8

PH 221 **Quiz # 07 (10 pts)** **Name** Solution



As shown on the left an object has a charge $(Q_{obj} = +5.97\ mC)$ and a mass $(m_{obj} = 0.446\ kg)$ is moving with a velocity $(\overrightarrow{v_{obj}} = 7.61\ x\ 10^4\ {}^{m}/_{s}\ \widehat{(+i)})$. When the object is a distance $(d = 9.21\ x\ 10^{-2}\ m)$ from a current carrying wire, what is the magnetic force acting on the object due to the presence of the current $(i_{wire} = 47.5\ A)$ flowing in the wire going in the $(\widehat{(-j)})$ direction?

A. $4.69\ x\ 10^{-2}\ N\ \widehat{(-j)}$

B. $1.47\ x\ 10^{-1}\ N\ \widehat{(-j)}$

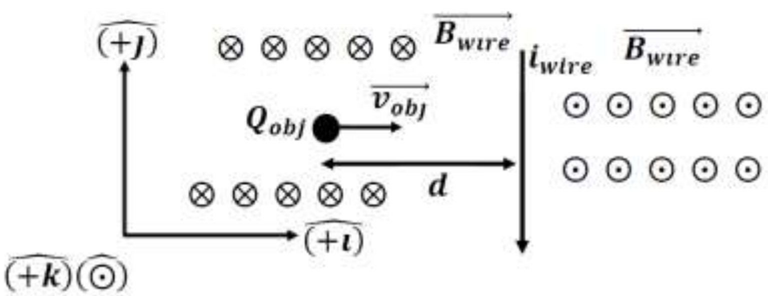
C. $\mathbf{4.69\ x\ 10^{-2}\ N\ \widehat{(+j)}}$

D. $1.47\ x\ 10^{-1}\ N\ \widehat{(+j)}$

$$\overrightarrow{F_B} = Q_{obj}\overrightarrow{v_{obj}}\ x\ \overrightarrow{B_{wire}}$$

$$\overrightarrow{B_{wire}} = \frac{\mu_0 i_{wire}}{2\pi d}\ (\widehat{\otimes})$$

$$\overrightarrow{F_B} = Q_{obj} v_{obj} \frac{\mu_0 i_{wire}}{2\pi d}\left(\widehat{(+i)}\ x\ (\widehat{\otimes})\right)$$

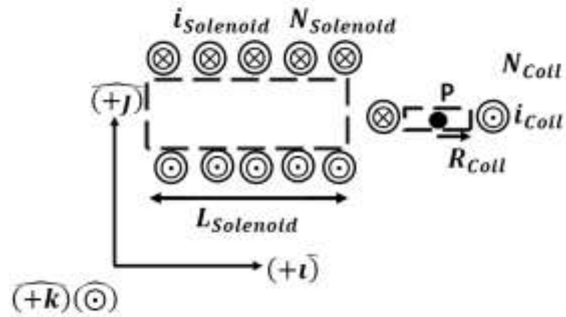


$$\overrightarrow{F_B} = \frac{(+5.97\ x\ 10^{-3}\ C)(7.61\ x\ 10^4\ {}^{m}/_{s})(4\pi\ x\ 10^{-7}\ {}^{T\ m}/_{A})(47.5\ A)}{2\pi(9.21\ x\ 10^{-2}\ m)}\widehat{(+j)}$$

$$\overrightarrow{F_B} = \frac{2.712 x\ 10^{-2}\ C\ T\ m^2/_{s}}{5.787\ x\ 10^{-1}\ m}\widehat{(+j)} = 4.69\ x\ 10^{-2}\ N\ \widehat{(+j)}$$

So, the correct answer is C !

A circular coil has ($N_{Coil} = 300$ turns) and ($R_{Coil} = 0.125$ m) and carries a current ($i_{Coil} = 23.7$ A). At the center of the coil is a point P. Nearby there is a solenoid with ($N_{Solenoid} = 550$ turns) ($L_{Solenoid} = 0.330$ m), and carrying a current ($i_{Solenoid} = 16.1$ A). The situation is shown on the right. What is the resulting magnetic field due to both the coil and the solenoid at point P?

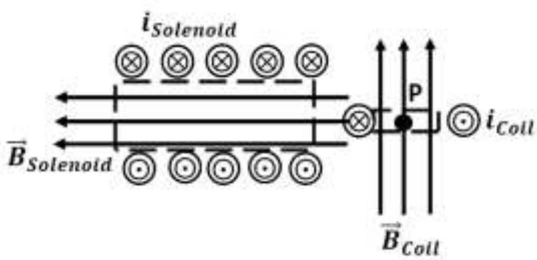


A. 4.94×10^{-2} T @ 46.2° above $\widehat{(-\imath)}$

C. 4.94×10^{-2} T @ 46.2° above $\widehat{(+\imath)}$

B. $\mathbf{4.94 \times 10^{-2}}$ **T @** $\mathbf{46.2°}$ **below** $\widehat{(-\imath)}$

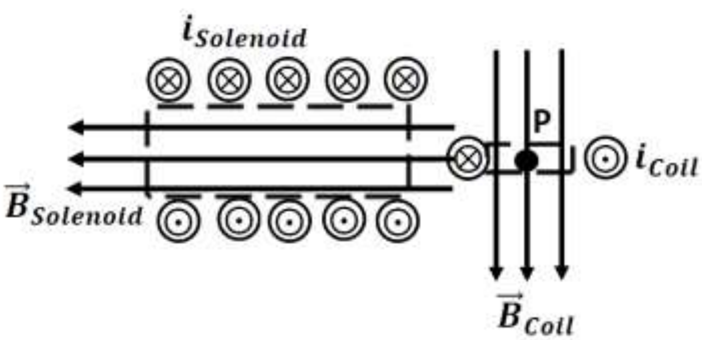
D. 4.94×10^{-2} T @ 46.2° below $\widehat{(+\imath)}$



On the left we draw in the magnetic fields created by these currents.

$$\overrightarrow{B_P} = \overrightarrow{B_{Solenoid}} + \overrightarrow{B_{Coil}}$$

$$\overrightarrow{B_{Solenoid}} = \frac{\mu_0 N_{Solenoid} i_{Solenoid}}{L_{Solenoid}} \widehat{(-\imath)}$$



My original solution is in error as the magnetic field created in the circular coil should go down and not up as my first diagram indicated. So this changes the answer to below $\widehat{(-\imath)}$ instead of my original above $\widehat{(-\imath)}$ answer. So I will give credit to either above or below $\widehat{(-\imath)}$

$$\overrightarrow{B_{Solenoid}} = \frac{(4\pi \times 10^{-7}\ {}^{T\,m}/_{A})(550)(16.1\ A)}{0.330\ m} \widehat{(-\imath)} = \frac{1.13 \times 10^{-2} T\ m}{0.330\ m} \widehat{(-\imath)}$$

$$\overrightarrow{B_{Solenoid}} = 3.42 \times 10^{-2}\ T\ \widehat{(-\imath)}$$

$$\overrightarrow{B_{Coil}} = \frac{\mu_0 N_{Coil} i_{Coil}}{2L_{Coil}} \widehat{(+j)} = \frac{(4\pi\ x\ 10^{-7}\ {}^{T\,m}/_{A})(300)(23.7\ A)}{2(0.125\ m)} \widehat{(+j)} = \frac{8.93\ x\ 10^{-3} T\ m}{0.250\ m} \widehat{(+j)}$$

$$\overrightarrow{B_{Coil}} = 3.57\ x\ 10^{-2}\ T\ \widehat{(+j)}$$

$$\overrightarrow{B_P} = \overrightarrow{B_{Solenoid}} + \overrightarrow{B_{Coil}} = 3.42\ x\ 10^{-2}\ T\ \widehat{(-\imath)} + 3.57\ x\ 10^{-2}\ T\ \widehat{(+j)}$$

$$B_P = \sqrt{B_{Solenoid}^2 + B_{Coil}^2} = \sqrt{(3.42\ x\ 10^{-2}\ T)^2 + (3.57\ x\ 10^{-2}\ T)^2}$$

$$B_P = \sqrt{1.170\ x\ 10^{-3}\ T^2 + 1.274\ x\ 10^{-3}\ T^2} = \sqrt{2.444\ x\ 10^{-3}\ T^2} = 4.94\ x\ 10^{-2}\ T$$

$$\theta = tan^{-1}\left(\frac{B_{Coil}}{B_{Solenoid}}\right) = tan^{-1}\left(\frac{3.57\ x\ 10^{-2}\ T}{3.42\ x\ 10^{-2}\ T}\right) = tan^{-1}(1.044) = 46.2°$$

$$\overrightarrow{B_P} = 4.94\ x\ 10^{-2}\ T\ @\ 46.2°\ above\ \widehat{(-\imath)}$$

So, the correct answer is A !

You want a uniform magnetic field $\left(\overrightarrow{B_{Uniform}} = 0.0478\ T\ \widehat{(+\imath)}\right)$. You decide to use a solenoid. The solenoid has a turns per length ratio $\left(n = 1.20\ x\ 10^4\ {}^{turns}/_{m}\right)$. The ends of the solenoid lie on your right and left. At the top of the solenoid, what is the current and its direction (In or Out of the page)needed to produce this magnetic field?

A. 3.17 A $\widehat{(\otimes)}$

B. **3.17 A** $\widehat{(\odot)}$

C. 0.32 A $\widehat{(\otimes)}$

D. 0.32 A $\widehat{(\odot)}$

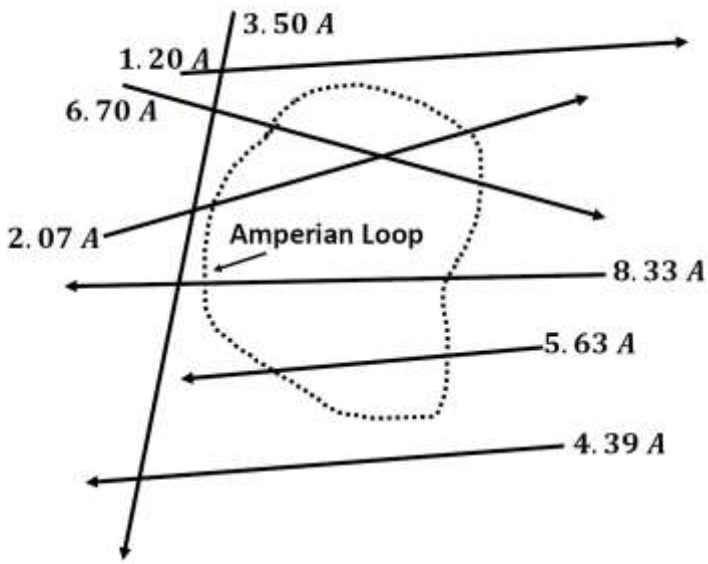
$$B_{Solenoid} = \mu_0 n i$$

Solve for current

$$i = \frac{B_{Solenoid}}{\mu_0 n} = \frac{0.0478\ T}{(4\pi\ x\ 10^{-7}\ {}^{T\,m}/_{A})(1.20\ x\ 10^4\ {}^{turns}/_{m})} = \frac{0.0478\ T}{1.508\ x\ 10^{-2}\ {}^{T}/_{A}} = 3.17\ A$$

To get magnetic field pointing to the right $\widehat{(+\imath)}$ the current at the top must come out of paper!

So, the correct answer is B !



On the left is a set of currents and an Amperian Loop. What is the magnitude of the expression $\oint \vec{B} \cdot d\vec{S}$ calculated around the Amperian Loop?

A. $4.00 \text{ x } 10^{-5} \text{ T m}$

B. $1.49 \text{ x } 10^{-5} \text{ T m}$

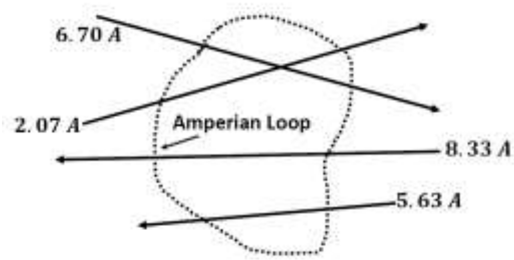
C. $2.86 \text{ x } 10^{-5} \text{ T m}$

D. $\mathbf{6.52 \text{ x } 10^{-6} \text{ T m}}$

Ampere's Law tells us

$$\oint \vec{B} \cdot d\vec{S} = \mu_0 i_{enclosed}$$

The diagram on the right shows which currents are "enclosed" So we can evaluate the integral as



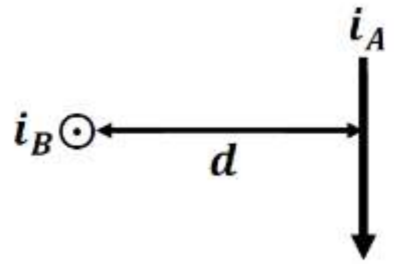
$$\oint \vec{B} \cdot d\vec{S} = \mu_0 i_{enclosed} = \mu_0 (6.70\ A + 2.07\ A - 8.33\ A - 5.63 A) = \mu_0(-5.19 A)$$

Minus sign is directional, not needed for magnitude.

$$\oint \vec{B} \cdot d\vec{S} = \left(4\pi \ x \ 10^{-7} \ {}^{T\,m}/_{A}\right)(5.19 A) = 6.52 \ x \ 10^{-6} \ T\,m$$

So, the correct answer is D !

There are two wires as shown on the right. Wire A has length ($L_A = 10.0$ m) and is carrying current ($i_A = 23.5$ A) which is going down as shown. Wire B has length ($L_B = 25.0$ m) and is carrying current ($i_B = 17.8$ A) which is coming out of the paper as shown. Wire B is a distance ($d = 15.7$ m) to the left of wire A. What is the magnitude of the magnetic force wire B exerts on wire A?



A. 2.09×10^{-4} N

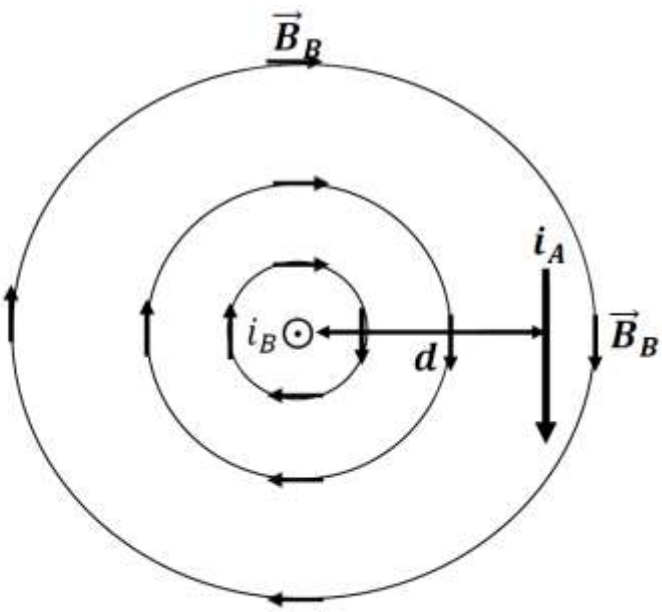
B. $\mathbf{0.00 \times 10^{0}}$ **N**

C. 1.33×10^{-4} N

D. 5.33×10^{-5} N

$$\overrightarrow{F_{B_{B \to A}}} = i_A \overrightarrow{L_A} \times \overrightarrow{B_B}$$

Here is what the magnetic field of B looks like



As we can see $\overrightarrow{L_A}$ is parallel to $\overrightarrow{B_B}$ at that point, so $\overrightarrow{L_A} \times \overrightarrow{B_B} = 0$

$$\overrightarrow{F_{B_{B \to A}}} = 0$$

So, the correct answer is B !

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Dr. Donovan's PH 221 Lecture Quiz & Exam Solutions

Please send any comments or questions about this page to ddonovan@nmu.edu

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