Exam Average **53.0** **Exam High Score** **75**

PH 221 **Exam # 02 (100 pts)** **Name** **Solution**

1

An object has a mass $(\mathrm{m} = 8.82 \text{ x } 10^{-2} \text{ kg})$, a charge (Q) and is traveling with a velocity $\left(\vec{v} = 7.11 \text{ x } 10^{4} \text{ m}/\text{s } (\widehat{\text{East}})\right)$. It enters a magnetic field $\left(\vec{B} = 0.419 \text{ T } (\widehat{\text{Up}})\right)$. This results in a magnetic force $\left(\overrightarrow{F_B} = 126. \text{ N } (\widehat{\text{North}})\right)$ acting on the object. What is the charge of the object?

A. $\mathbf{-4.23 \text{ mC}}$ **B.** -8.42 mC **C.** $+8.42 \text{ mC}$ **D.** $+4.23 \text{ mC}$

$$\overrightarrow{F_B} = Q\vec{v} \text{ x } \vec{B}$$

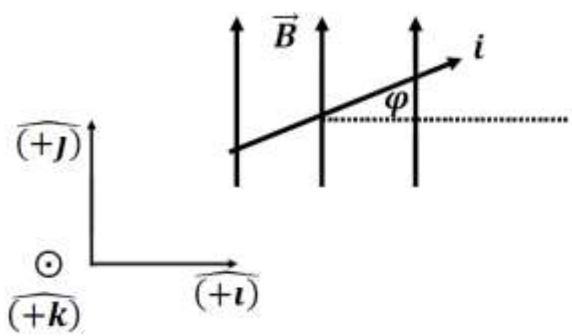
Solve for charge

$$Q = \frac{\overrightarrow{F_B}}{\vec{v} \text{ x } \vec{B}} = \frac{126. N\ (\widehat{North})}{\left(7.11 \text{ x } 10^4\ {}^{m}/_{s}\ (\widehat{East})\right) \text{ x } \left(0.419\ T\ (\widehat{Up})\right)} = \frac{126. N\ (\widehat{North})}{2.979 \text{ x } 10^4\ {}^{m\,T}/_{s}\ (\widehat{South})}$$

$$Q = 4.23 \text{ x } 10^{-3}\ C\ \frac{(\widehat{North})}{(\widehat{South})} = -4.23\ mC$$

So, the correct answer is A !

2



A wire has a length $(\mathrm{L} = 8.74 \text{ m})$ is carrying a current $(\mathrm{i} = 13.3 \text{ A})$ which is directed at an angle $(\varphi = 23.0°)$ with respect to the x – axis $\left(\widehat{(+\imath)}\right)$. There is a magnetic field $\left(\vec{B} = 0.0276 \text{ T } \widehat{(+\jmath)}\right)$ which surrounds the wire. What is the magnetic force acting on the wire?

A. $1.25 \text{ N } \widehat{(+k)}$ **B.** $\mathbf{2.95 \text{ N } \widehat{(+k)}}$ **C.** $2.95 \text{ N } \widehat{(-k)}$ **D.** $1.25 \text{ N } \widehat{(-k)}$

$$\overrightarrow{F_B} = i\vec{L} \text{ x } \vec{B} = iLB\sin(\theta)\ (\widehat{Rt - Hand}) = iLB\sin(90° - \varphi)\ (\widehat{Rt - Hand})$$

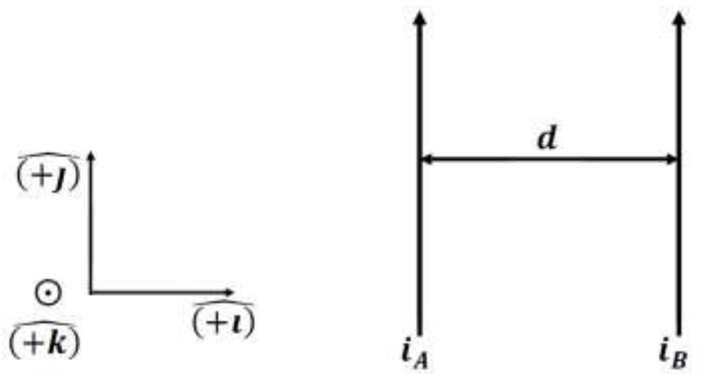
$$F_B = (13.3\ A)(8.74\ m)(0.0276\ T)\sin(90° - 23.0°) = 3.208\ N \sin(67.0°) = 2.95\ N$$

Right-Hand rule gives the direction of magnetic force as out of paper or $\widehat{+\mathbf{k}}$ direction.

So, the correct answer is B !

3

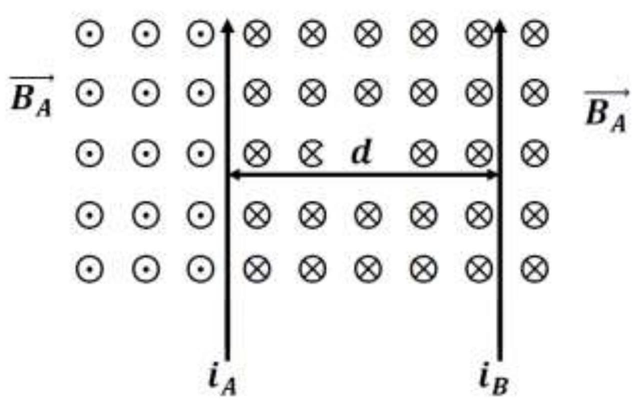
Two wires are carrying current in the positive y axis direction $(\widehat{(+\jmath)})$. Wire A has current $(i_A = 17.9 \text{ A})$, while wire B has current $(i_B = 7.37 \text{ A})$. The two wires are separated by a distance $(d = 2.46 \text{ m})$. What is the magnetic force wire A exerts on a $(L_B = 12.3 \text{ m})$ length of wire B?



A.	$1.32 \text{ x } 10^{-4} \text{ N } \widehat{(+\imath)}$	**C.**	$\mathbf{1.32 \text{ x } 10^{-4} \text{ N } \widehat{(-\imath)}}$
B.	$4.14 \text{ x } 10^{-4} \text{ N } \widehat{(+\imath)}$	**D.**	$4.14 \text{ x } 10^{-4} \text{ N } \widehat{(-\imath)}$

$$\overrightarrow{F_{BA\to B}} = i_B \overrightarrow{L_B} \; x \; \overrightarrow{B_A}$$

Here is what the magnetic field of A looks like



So, using the right – hand rule, the magnetic force is to the left or $(\widehat{(-\imath)})$

$$F_{B\,A\to B} = i_B L_B B_A = \frac{\mu_0 i_A i_B L_B}{2\pi d} = \frac{(4\pi \; x \; 10^{-7} \, {}^{T\,m}/_{A})(17.9\,A)(7.37\,A)(12.3\,m)}{2\pi(2.46\,m)}$$

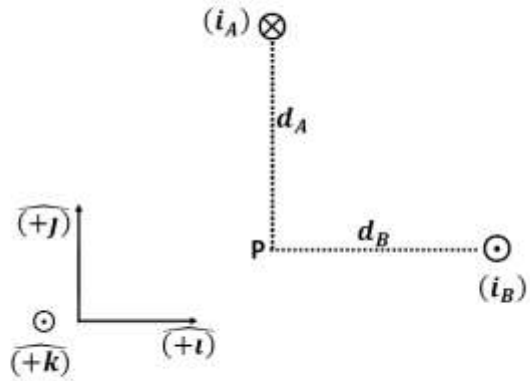
$$F_{B\,A\to B} = \frac{2.039 \; x \; 10^{-3} Tm^2 A}{15.46\,m} = 1.32 \; x \; 10^{-4}\,N$$

$$\overrightarrow{F_{B\,A\to B}} = 1.32 \; x \; 10^{-4}\,N\,\widehat{(-\imath)}$$

So, the correct answer is C !

4

What is the total magnetic field at point P due to two currents as shown on the right? Current A ($i_A = 34.2$ A) is going into the plane of the paper and it is a distance ($d_A = 9.15 \text{ x } 10^{-4}$ m) directly above the point P in the $\widehat{(+\jmath)}$ direction. Current B ($i_B = 18.7$ A) is coming out of the paper and it is a distance ($d_B = 7.33 \text{ x } 10^{-4}$ m) directly to the right of point P in the $\widehat{(+\imath)}$ direction.

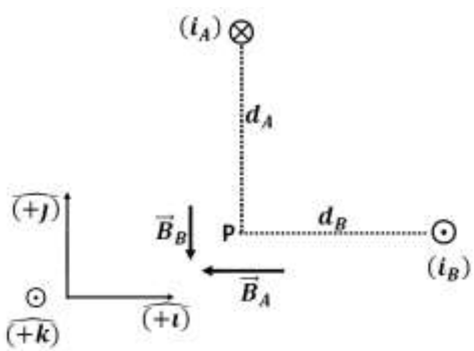


A. $9.04 \text{ x } 10^{-3}$ T @ 34.3° above $\widehat{(+\imath)}$

B. $9.04 \text{ x } 10^{-3}$ T @ 34.3° above $\widehat{(-\imath)}$

C. $9.04 \text{ x } 10^{-3}$ T @ 34.3° below $\widehat{(+\imath)}$

D. $\mathbf{9.04 \text{ x } 10^{-3}}$ **T @ 34.3° below** $\widehat{(-\imath)}$



$$\overrightarrow{B_P} = \overrightarrow{B_{A\to P}} + \overrightarrow{B_{B\to P}}$$

$$\overrightarrow{B_{A\to P}} = \frac{\mu_0 i_A}{2\pi d_A}\widehat{(-\imath)}$$

$$\overrightarrow{B_{B\to P}} = \frac{\mu_0 i_B}{2\pi d_B}\widehat{(-\jmath)}$$

$$\overrightarrow{B_{A\to P}} = \frac{(4\pi \text{ x } 10^{-7}\ {T\,m}/{A})(34.2\ A)}{2\pi(9.15 \text{ x } 10^{-4}\ m)}\widehat{(-\imath)}$$

$$\overrightarrow{B_{A\to P}} = \frac{4.297 \text{ x } 10^{-5}\ T\,m}{5.749 \text{ x } 10^{-3}\ m}\widehat{(-\imath)}$$

$$\overrightarrow{B_{A\to P}} = 7.47 \text{ x } 10^{-3}\ T\ \widehat{(-\imath)}$$

$$\overrightarrow{B_{B\to P}} = \frac{(4\pi \text{ x } 10^{-7}\ {T\,m}/{A})(18.7\ A)}{2\pi(7.33 \text{ x } 10^{-4}\ m)}\widehat{(-\jmath)} = \frac{2.350 \text{ x } 10^{-5}\ T\,m}{4.606 \text{ x } 10^{-3}\ m}\widehat{(-\jmath)} = 5.10 \text{ x } 10^{-3}\ T\ \widehat{(-\jmath)}$$

$$\overrightarrow{B_P} = \overrightarrow{B_{A\to P}} + \overrightarrow{B_{B\to P}} = 7.47 \text{ x } 10^{-3}\ T\ \widehat{(-\imath)} + 5.10 \text{ x } 10^{-3}\ T\ \widehat{(-\jmath)}$$

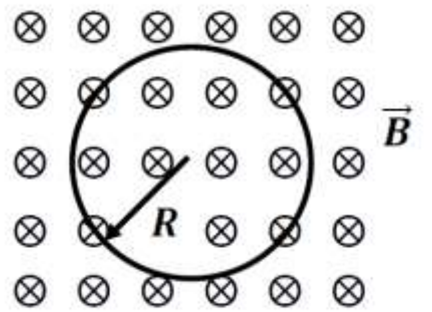
$$B_P = \sqrt{(7.47 \text{ x } 10^{-3}\ T)^2 + (5.10 \text{ x } 10^{-3}\ T)^2} = 9.04 \text{ x } 10^{-3}\ T$$

$$\theta = tan^{-1}\left(\frac{B_{Py}}{B_{Px}}\right) = tan^{-1}\left(\frac{B_B}{B_A}\right) = tan^{-1}\left(\frac{5.10 \text{ x } 10^{-3}\ T}{7.47 \text{ x } 10^{-3}\ T}\right) = tan^{-1}(0.6827) = 34.3°$$

$$\overrightarrow{B_P} = 9.04\ x\ 10^{-3}\ T\ @\ 34.3^\circ\ below\ \widehat{(-\imath)}$$

So, the correct answer is D !

5



An object has mass $(\mathrm{m} = 9.66 \times 10^{-6}\ \mathrm{kg})$ and a charge $(\mathrm{Q} = -1.79\ \mathrm{mC})$. It is traveling in a circular orbit with a speed $(\mathrm{v} = 5.51 \times 10^{3}\ \mathrm{m}/_{\mathrm{s}})$ inside of a magnetic field $\left(\vec{\mathrm{B}} = 1.46\ \mathrm{T}\ (\widehat{\otimes})\right)$ as shown on the left. What is the radius (R) of the circular orbit and is the object making Clockwise or Counter-Clockwise orbits?

A. $20.4\ \mathrm{m}$, Counter-Clockwise

B. $0.049\ \mathrm{m}$, Counter-Clockwise

C. $0.049\ \mathrm{m}$, Clockwise

D. $\mathbf{20.4\ m}$**, Clockwise**

$$F_B = QvB = \frac{mv^2}{R}$$

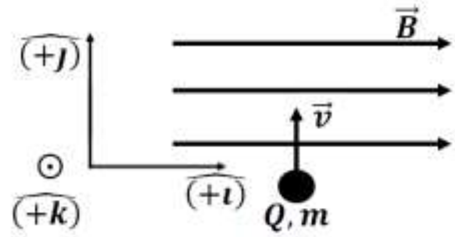
$$\mathrm{R} = \frac{\mathbf{mv}}{\mathbf{QB}} = \frac{(\mathbf{9.66\ x\ 10^{-6}\ kg})(\mathbf{5.51\ x\ 10^{3}\ m}/_{\mathbf{s}})}{(\mathbf{1.79\ x\ 10^{-3}\ C})(\mathbf{1.46\ T})} = \frac{\mathbf{5.323\ x\ 10^{-2}\ kg\ m}/_{\mathbf{s}}}{\mathbf{2.613\ x\ 10^{-3}\ C\ T}} = \mathbf{20.4\ m}$$

Consider the object to be at 6 O Clock. The force must point to the center of the circle. So, if velocity goes to the right cross that with the magnetic field pointing into paper we get a force up but since the charge is negative it would actually be a force down. So, the velocity at 6 O Clock must be to the left which means the object makes Clockwise orbits!

So, the correct answer is D !

6

An object has a mass $(\mathrm{m} = 7.09 \text{ x } 10^{-6} \text{ kg})$ and a charge $(\mathrm{Q} = +3.82\ \mu\mathrm{C})$ and is traveling with a velocity $\left(\vec{\mathrm{v}} = 6.39 \text{ x } 10^{4}\ {}^{\mathrm{m}}/_{\mathrm{s}}\ \widehat{(+\jmath)}\right)$. When it enters a magnetic field $\left(\vec{\mathrm{B}} = 0.813 \text{ T } \widehat{(+\imath)}\right)$, it experiences a magnetic force which will change its trajectory. What is the magnitude and direction of an electric field that should also be introduced so that the velocity of the object remains constant and does not deflect in its trajectory?



A. $5.20 \text{ x } 10^{4}\ {}^{\mathrm{N}}/_{\mathrm{C}}\ \widehat{(-\imath)}$

C. $\mathbf{5.20 \text{ x } 10^{4}\ {}^{N}/_{C}\ \widehat{(+k)}}$

B. $5.20 \text{ x } 10^{4}\ {}^{\mathrm{N}}/_{\mathrm{C}}\ \widehat{(-\mathrm{k})}$

D. $5.20 \text{ x } 10^{4}\ {}^{\mathrm{N}}/_{\mathrm{C}}\ \widehat{(+\imath)}$

$$\boldsymbol{\vec{F_E} = Q\vec{E} = -\vec{F_B} = -Q\vec{v} \text{ x } \vec{B}}$$

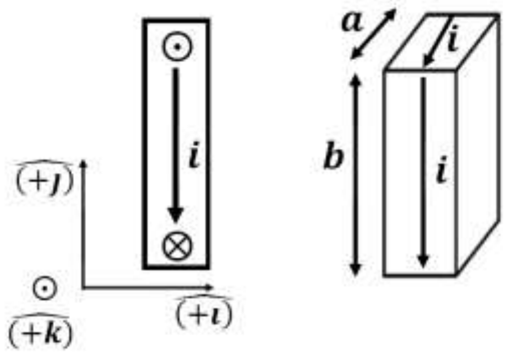
Solve for $\boldsymbol{\vec{E}}$

$$\boldsymbol{\vec{E} = -\left(\vec{v} \text{ x } \vec{B}\right) = -\left(6.39 \text{ x } 10^{4}\ {}^{m}/_{s}\ \widehat{(+\jmath)} \text{ x } 0.813\ T\ \widehat{(+\imath)}\right) = -\left(5.20 \text{ x } 10^{4}\ {}^{N}/_{C}\right)\left(\widehat{(+\jmath)} \text{ x } \widehat{(+\imath)}\right)}$$

$$\boldsymbol{\vec{E} = -5.20 \text{ x } 10^{4}\ {}^{N}/_{C}\ \widehat{(-k)} = 5.20 \text{ x } 10^{4}\ {}^{N}/_{C}\ \widehat{(+k)}}$$

So, the correct answer is C !

7



A rectangular coil has dimensions ($a = 0.240$ m), ($b = 0.360$ m), and ($N = 35.0$) turns of wire. As indicated on the left a current ($i = 1.57$ A) going around the coil as shown. What is the magnitude and direction of the magnetic dipole moment of the coil?

A. $7.12\ \mathrm{A\,m^2}\ \widehat{(+\imath)}$

B. $\mathbf{4.75\ A\,m^2}\ \widehat{(+\imath)}$

C. $7.12\ \mathrm{A\,m^2}\ \widehat{(-\imath)}$

D. $4.75\ \mathrm{A\,m^2}\ \widehat{(-\imath)}$

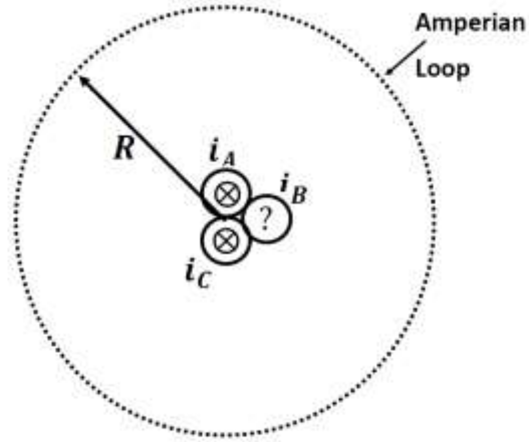
$$\vec{\mu} = Ni\vec{A}$$

Using the right – hand rule for dipole moments, the direction from the current is $\widehat{(+\imath)}$

$$\vec{\mu} = Ni\vec{A} = Niab\widehat{(+\imath)} = (35.0)(1.57\ A)(0.240\ m)(0.360\ m)\widehat{(+\imath)} = 4.75\ A\ m^2\ \widehat{(+\imath)}$$

So, the correct answer is B !

Three long straight wires are closely spaced as shown on the right. Wire A carries current ($i_A = 4.62$ A) into the plane of the paper and Wire C carries current ($i_C = 5.50$ A) also into the plane of the paper. At a distance ($R = 2.25$ m), the magnetic field due to all three wires is found to be $\left(\overrightarrow{B_{ABC}} = 6.96 \text{ x } 10^{-7} \text{ T } (\widehat{\text{Clockwise}})\right)$. What is the magnitude and direction of the current in Wire B?



A. **2.29 A Out of Paper**

B. 7.83 A Out of Paper

C. 7.83 A Into Paper

D. 2.29 A Into Paper

Using Ampere's Law

$$\oint \vec{B} \cdot d\vec{S} = B2\pi R = \mu_0 i_{Enclosed}$$

Since $\overrightarrow{B_{ABC}}$ is clockwise, we know the $i_{Enclosed}$ must point into the paper.

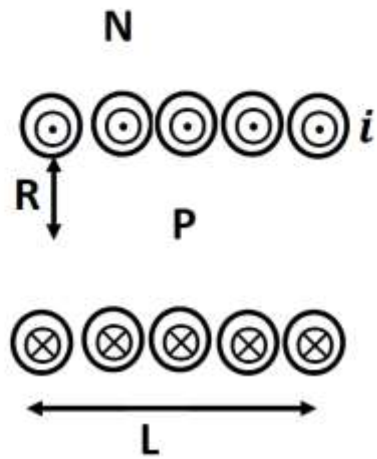
$$\mathbf{i_{Enclosed}} = \frac{\mathbf{B2\pi R}}{\mathbf{\mu_0}} = \frac{\mathbf{(6.96 \text{ x } 10^{-7}\ T)2\pi(2.25\ m)}}{\mathbf{4\pi \text{ x } 10^{-7}\ T\ m/A}} = \frac{\mathbf{9.839 \text{ x } 10^{-6}\ T\ m}}{\mathbf{4\pi \text{ x } 10^{-7}\ T\ m/A}} = \mathbf{7.83\ A}$$

$$\boldsymbol{i_{Enclosed} = 7.83\ A\ \widehat{\otimes} = i_A + i_B + i_C = 4.62\ \widehat{\otimes} + i_B + 5.50\ \widehat{\otimes} = 10.12\ A\ \widehat{\otimes} + i_B}$$

$$\boldsymbol{i_B = 7.83\ A\ \widehat{\otimes} - \ 10.12\ A\ \widehat{\otimes} = -2.29\ 10.12\ A\ \widehat{\otimes} = 2.29\ A\ \widehat{\odot}}$$

So, the correct answer is A !

9



A solenoid as shown on the left has $(\mathrm{N} = 234)$ turns of wire. It has dimensions of a radius $(\mathrm{R} = 0.124\ \mathrm{m})$ and a length $(\mathrm{L} = 0.684\ \mathrm{m})$. A current $(\mathrm{i} = 0.678\ \mathrm{A})$ is flowing with the current coming out of the page at the top of the solenoid and going into the page at the bottom as indicated in the diagram. What is the magnitude and direction of the magnetic field created by this solenoid inside the solenoid at its center P?

A. $\mathbf{2.92\ x\ 10^{-4}\ T\ (\widehat{Right})}$

B. $1.61\ \mathrm{x}\ 10^{-3}\ \mathrm{T}\ (\widehat{\mathrm{Right}})$

C. $1.61\ \mathrm{x}\ 10^{-3}\ \mathrm{T}\ (\widehat{\mathrm{Left}})$

D. $2.92\ \mathrm{x}\ 10^{-4}\ \mathrm{T}\ (\widehat{\mathrm{Left}})$

Using the right – hand rule, we can see the magnetic field created will go to the right.

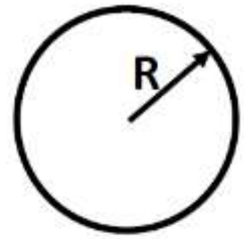
$$\vec{B} = \frac{\mu_0 N i}{L}\ (\widehat{Right}) = \frac{(4\pi\ x\ 10^{-7}\ {}^{T\,m}/_{A})(234)(0.678\ A)}{0.684\ m}(\widehat{Right})$$

$$\vec{B} = \frac{1.994\ x\ 10^{-4}\ T\ m}{0.684\ m}(\widehat{Right}) = 2.92\ x\ 10^{-4}\ T\ (\widehat{Right})$$

So, the correct answer is A !

10

A circular coil has $(\mathrm{N} = 727)$ turns of wire and a radius $(\mathrm{R} = 0.394\ \mathrm{m})$ is found to have a magnetic field $\vec{\mathrm{B}} = 7.72 \text{ x } 10^{-3}\ \mathrm{T}\ (\widehat{\odot})$ at the center of the coil. What is the magnitude and direction of the current flowing in the coil that creates this field?



A. 20.9 A, Counter-Clockwise

B. **6.66 A, Counter-Clockwise**

C. 20.9 A, Clockwise

D. 6.66 A, Clockwise

Using the right – rule, for a magnetic field to be out of the paper in the center of the coil, the current must go around the coil counter-clockwise!

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

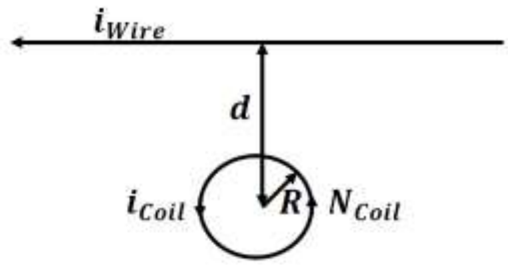
Solving for i

$$\mathbf{i = \frac{2RB}{\mu_0 N} = \frac{2(0.394\ m)(7.72 \text{ x } 10^{-3}\ T)}{(4\pi \text{ x } 10^{-7}\ ^{T\,m}/_{A})(727)} = \frac{6.083 \text{ x } 10^{-3}\ T\,m}{9.136 \text{ x } 10^{-4}\ ^{T\,m}/_{A}} = 6.66\ A}$$

So, the correct answer is B !

11

A long straight wire has a current ($i_{Wire} = 47.4\ A$) going to the left and is located a distance ($d = 0.876\ m$) above the center of a circular coil as shown below. The circular coil has a radius ($R = 0.276\ m$), a number ($N_{Coil} = 12$) of turns of wire, and it is carrying a current ($i_{Coil} = 1.23\ A$) going counter-clockwise. What is the magnitude and direction of the magnetic field at the center of the circular coil?



A. $4.44 \text{ x } 10^{-5}\ T\ (\widehat{\otimes})$

B. $2.28 \text{ x } 10^{-5}\ T\ (\widehat{\otimes})$

C. $\mathbf{4.44 \text{ x } 10^{-5}\ T}\ (\widehat{\odot})$

D. $2.28 \text{ x } 10^{-5}\ T\ (\widehat{\odot})$

$$\overrightarrow{B_{Total}} = \overrightarrow{B_{Wire}} + \overrightarrow{B_{Coil}}$$

We use the right – hand rule to determine the directions for each magnetic field.

$$\overrightarrow{B_{Wire}} = \frac{\mu_0 i_{Wire}}{2\pi d}(\widehat{\odot}) = \frac{(4\pi\ x\ 10^{-7}\ {T\ m}/_{A})(47.4\ A)}{2\pi(0.876\ m)}(\widehat{\odot}) = \frac{5.956\ x\ 10^{-5}\ T\ m}{5.504\ m}(\widehat{\odot})$$

$$\overrightarrow{B_{Wire}} = 1.082\ x\ 10^{-5}\ T\ (\widehat{\odot})$$

$$\overrightarrow{B_{Coil}} = \frac{\mu_0 N i_{Coil}}{2R}(\widehat{\odot}) = \frac{(4\pi\ x\ 10^{-7}\ {T\ m}/_{A})(12)(1.23\ A)}{2(0.276\ m)}(\widehat{\odot}) = \frac{1.855\ x\ 10^{-5}\ T\ m}{0.552\ m}(\widehat{\odot})$$

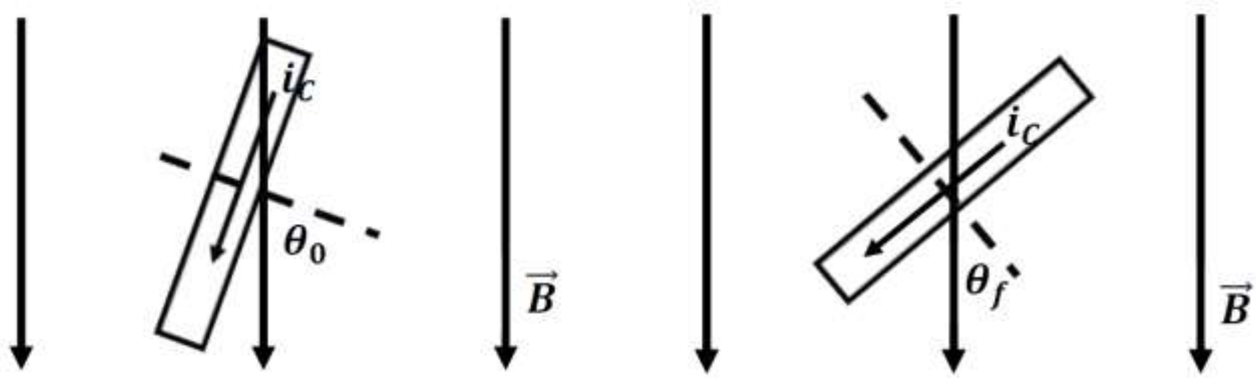
$$\overrightarrow{B_{Coil}} = 3.361\ x\ 10^{-5}\ T(\widehat{\odot})$$

$$\overrightarrow{B_{Total}} = \overrightarrow{B_{Wire}} + \overrightarrow{B_{Coil}} = 1.082\ x\ 10^{-5}\ T\ (\widehat{\odot}) + 3.361\ x\ 10^{-5}\ T(\widehat{\odot}) = 4.44\ x\ 10^{-5}\ T\ (\widehat{\odot})$$

So, the correct answer is C !

12

Shown below we have a rectangular coil which has $(N = 567)$ turns of wire and has an area $(A = 0.464\ m^2)$. The current in the coil is $(i = 4.48\ A)$. The coil is sitting in a magnetic field $\left(\vec{B} = 2.67\ T\ \widehat{(-j)}\right)$. Initially the angle between the magnetic field and the perpendicular to the area of the coil is $(\theta_0 = 73.0°)$. Later, the angle between the magnetic field and the perpendicular to the area of the coil is $(\theta_f = 23.0°)$. How much work was done by an external force to rotate the coil from the initial position to its final position?



A. $+1.98 \times 10^3\ J$ **B.** $+1.78 \times 10^3\ J$ **C.** $-1.78 \times 10^3\ J$ **D.** $\mathbf{-1.98 \times 10^3\ J}$

$$W_{Ext} = +\Delta U = U_f - U_o = \left(-\vec{\mu}\cdot\vec{B}\right)_f - \left(-\vec{\mu}\cdot\vec{B}\right)_0 = -\mu B\cos(\theta_f) + \mu B\cos(\theta_0)$$

$$W_{Ext} = \mu B\left(\cos(\theta_0) - \cos(\theta_f)\right) = NiAB\left(\cos(\theta_0) - \cos(\theta_f)\right)$$

$$W_{Ext} = (567)(4.48\ A)(0.464\ m^2)(2.67\ T)(\cos(73.0°) - \cos(23.0°))$$

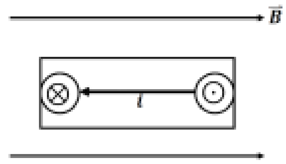
$$W_{Ext} = 3.147 \times 10^3\ J(-0.6281) = -1.98 \times 10^3\ J$$

Note: The coil wants to go in the direction the coil rotates so that is a reduction of potential energy. So, the external work should be negative.

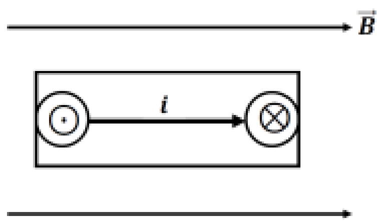
So, the correct answer is D !

13

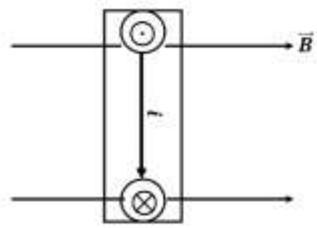
Pictured below is a rectangular coil carrying a current i which is going to the left for the side of the coil nearest you as indicated. The coil is oriented sideways with two sides perpendicular to the paper, one side behind the paper and the other in front of the paper. In the side to the right, the current comes out of the paper and on the left, it goes into the paper. A magnetic field $\vec{B}$ is applied going to the right as shown. The coil is allowed to rotate. Which of the following is the final orientation that will result?



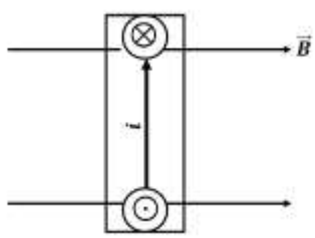
A.



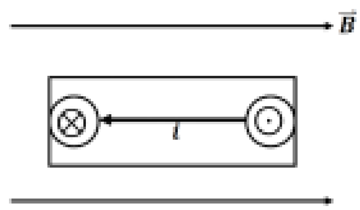
C.



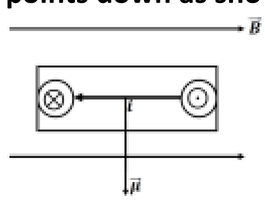
B.



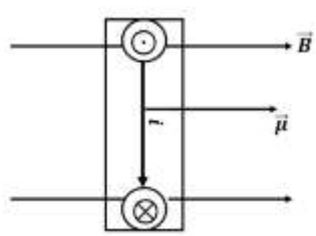
D.



Using the right hand-rule, we can find the direction of the magnetic moment of the coil due to the current going as indicated and we find it points down as shown below



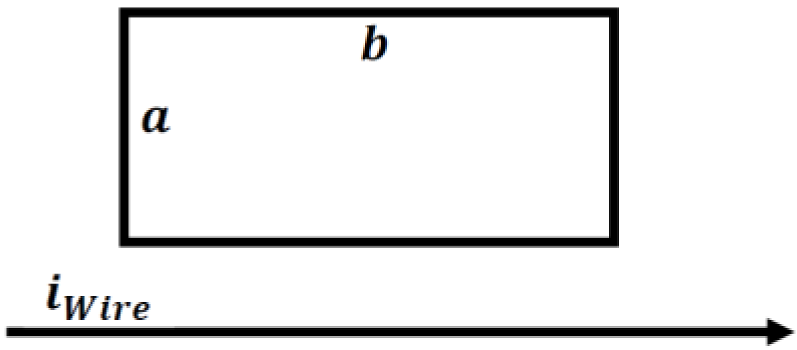
The torque created by the magnetic field wants to align the magnetic moment with the magnetic field. So, the magnetic moment will be turned counter-clockwise to the position shown above



So, the correct answer is C !

14

A single loop of wire is above a long straight wire which is carrying a current (i_{Wire}) to the right as shown below. If the current in the wire is increased over time, a current may be induced in the loop. Which answer best describes this situation?

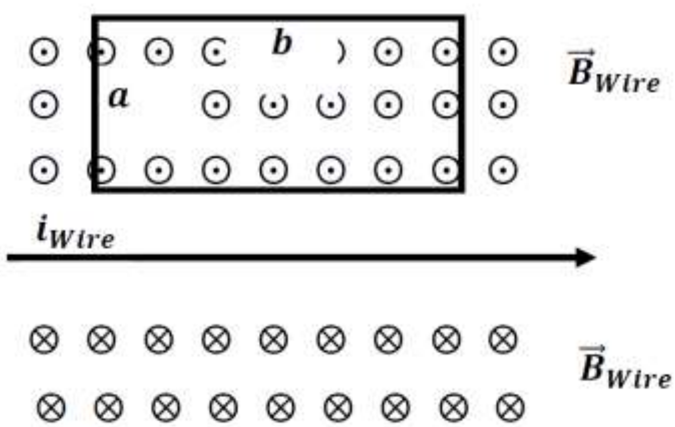


A. There is no Induced Loop current

B. The Induced Loop current must alternate between Clockwise and Counter-Clockwise

C. The Induced Loop current must go Counter-Clockwise

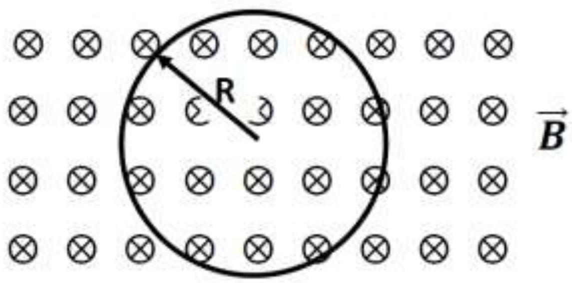
D. The Induced Loop current must go Clockwise



The magnetic field created by the wire is as shown. If the current is increasing, the magnetic field is increasing. Therefore, the magnetic flux through the loop is increasing. So, the induced Loop Current must create a magnetic field to oppose the increasing flux. It must go into the paper. Thus, the Induced Loop current must go Clockwise

So, the correct answer is D !

15



A circular coil has $(\mathrm{N} = 471)$ turns of wire around a radius $(\mathrm{R} = 0.154\ \mathrm{m})$ and a total resistance $(\mathrm{R}^* = 32.0\ \Omega)$. A magnetic field is going into the paper as shown on the left. If the magnetic field is changing by $\left(\frac{\Delta \mathrm{B}}{\Delta \mathrm{t}} = -2.89 \text{ x } 10^{-3}\ \mathrm{T}/_{\mathrm{s}}\right)$, what is the magnitude and direction of the current induced in the circular coil?

A. $2.08 \text{ x } 10^{-2}$ A, Clockwise

B. **$\mathbf{3.17 \text{ x } 10^{-3}}$ A, Clockwise**

C. $2.08 \text{ x } 10^{-2}$ A, Counter-Clockwise

D. $3.17 \text{ x } 10^{-3}$ A, Counter-Clockwise

$$\boldsymbol{i = \frac{\varepsilon}{R^*} = \frac{N\frac{\Delta\Phi_B}{\Delta t}}{R^*} = \frac{N}{R^*}A\frac{\Delta B}{\Delta t} = \frac{N\pi R^2}{R^*}\frac{\Delta B}{\Delta t} = \frac{(471)\pi(0.154\ m)^2}{32.0\ \Omega}\left(2.89\ x\ 10^{-3}\ {}^{T}/_{s}\right)}$$

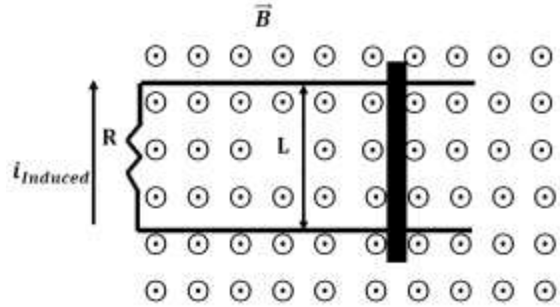
$$\boldsymbol{i = \frac{35.09\ m^2}{32.0\ \Omega}\left(2.89\ x\ 10^{-3}\ {}^{T}/_{s}\right) = \left(1.097\frac{m^2}{\Omega}\right)\left(2.89\ x\ 10^{-3}\ {}^{T}/_{s}\right) = 3.17\ x\ 10^{-3}\ A}$$

Since the magnetic field is decreasing over time, the magnetic flux is decreasing going into the paper. To oppose this change, the induced field should also go into the paper, so the induced current is Clockwise.

So, the correct answer is B !

16

As shown on the right, a bar has a length $(L = 0.936\text{ m})$ is moving along conductive rails with a constant velocity. Assume there is no friction between the bar and the rails. There is a magnetic field $\left(\vec{B} = 0.613\text{ T }(\widehat{\odot})\right)$ as shown. There is a resistance $(R = 19.7\ \Omega)$ on the end of the rails as indicated. A current $(i_{\text{Induced}} = 0.248\text{ A})$ is induced that goes from the bottom of the resistance to the top as shown. What is the magnitude and direction of the constant velocity of the bar creating this induced current?



A. $\mathbf{8.52\ {}^{m}/_{s}\ (\widehat{Right})}$

B. $45.6\ {}^{m}/_{s}\ (\widehat{Right})$

C. $8.52\ {}^{m}/_{s}\ (\widehat{Left})$

D. $45.6\ {}^{m}/_{s}\ (\widehat{Left})$

An induced current going up as shown means the induced magnetic field is into the paper. This is opposing the original magnetic field. So, the magnetic flux must be increasing, which means the bar is moving to the right.

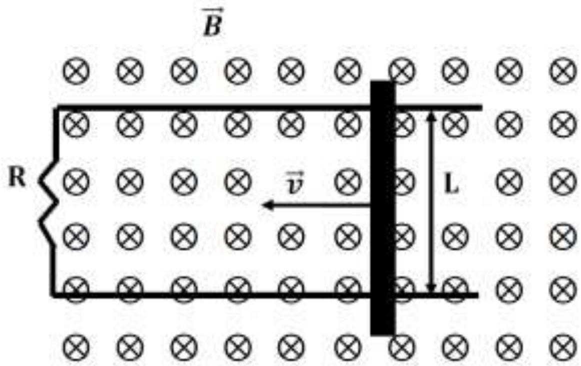
$$\boldsymbol{i_{Induced} = \frac{\varepsilon}{R} = \frac{BLv}{R}}$$

Solve for velocity

$$\boldsymbol{v = \frac{i_{Induced}R}{BL} = \frac{(0.248\ A)(19.7\ \Omega)}{(0.613\ T)(0.936\ m)} = \frac{4.886\ V}{0.5738\ T\ m} = 8.52\ {}^{m}/_{s}}$$

So, the correct answer is A !

17



As shown on the left a bar $(L = 1.19\ m)$ is moving on conductive rails with a constant velocity $\left(\vec{v} = 4.74\ {}^{m}/_{s}\ (\widehat{Left})\right)$. A magnetic field $\left(\vec{B} = 0.738\ T\ (\widehat{\otimes})\right)$ is present as indicated. The resistance of the rails is $(R = 4.81\ \Omega)$. A current $(i_{Induced} = 0.865\ A)$ is induced in the rails in a clockwise direction. What is the magnitude and direction of the magnetic force acting on the induced current in the bar?

A. $\mathbf{0.760\ N\ (\widehat{Right})}$

B. $4.16\ N\ (\widehat{Right})$

C. $0.760\ N\ (\widehat{Left})$

D. $4.16\ N\ (\widehat{Left})$

$$\overrightarrow{F_B} = i_{Induced}\vec{L}\ x\ \vec{B} = i_{Induced}LB\left((\widehat{Down})\ x\ (\widehat{\otimes})\right) = (0.865\ A)(1.19\ m)(0.738\ T)(\widehat{Right})$$

$$\overrightarrow{F_B} = 0.760\ N\ (\widehat{Right})$$

So, the correct answer is A !

18

An electrical generator is composed of a circular coil $(R = 0.364\ m)$ rotating in a magnetic field $(B = 1.37\ x\ 10^{-3}\ T)$ at a rotation rate of $\left(471.\ {}^{rad}/_{s}\right)$. The peak generated emf is 95.6 V . How many turns of wire are in the coil?

A. 130 Turns **B.** **356 Turns** **C.** 1120 Turns **D.** 65 Turns

Peak emf

$$\varepsilon_0 = NBA\omega = NB\pi R^2\omega$$

Solve for number of turns

$$N = \frac{\varepsilon_0}{\pi R^2 B\omega} = \frac{95.6\ V}{\pi(0.364\ m)^2(1.37\ x\ 10^{-3}\ T)\left(471.\ {}^{rad}/_{s}\right)} = \frac{95.6\ V}{0.2686\ V} = 356\ Turns$$

So, the correct answer is B !

19
An AC motor used in a device (possibly a refrigerator or an air conditioner) requires a current of $\left(\mathrm{i_{Start-up}} = 20.00\ \mathrm{A}\right)$ when hooked up to a wall socket with a voltage $\left(\mathrm{V_{Applied}} = 120.0\ \mathrm{V}\right)$. Once the motor is running at steady state, it draws a current of $(\mathrm{i_{Run}} = 2.000\ \mathrm{A})$. What is the back emf that is being created in the motor?

A. $100.0\ \mathrm{V}$ **B.** $120.0\ \mathrm{V}$ **C.** $\mathbf{108.0\ V}$ **D.** $60.00\ \mathrm{V}$

$$\boldsymbol{i_{Run} = \frac{V_{App} - \varepsilon_{Back}}{R}}$$

$$\boldsymbol{i_{Start-Up} = \frac{V_{App}}{R}}$$

So, Resistance is

$$\boldsymbol{R = \frac{V_{App}}{i_{Start-Up}} = \frac{120.0\ V}{20.0\ A} = 6.00\ \Omega}$$

Solving for ε_{Back}

$$\boldsymbol{\varepsilon_{Back} = V_{App} - i_{Run}R = 120.0\ V - (2.00\ A)(6.00\ \Omega) = 108.0\ V}$$

So, the correct answer is C !

20
A transformer has a primary coil with 100 turns of wire and a secondary coil with 10,000 turns of wire. If the primary coil has a current of 60.0 A running through it, what is the current induced in the secondary and is the transformer a step-up or a step-down transformer?

A. 0.600 A, Step-Down

B. 6000. A, Step-Down

C. 6000. A, Step-Up

D. **0.600 A, Step-Up**

The Transformer equation is

$$\boldsymbol{\frac{\varepsilon_S}{\varepsilon_P} = \frac{N_S}{N_P} = \frac{i_P}{i_S}}$$

Now a step-up transformer is when $N_S > N_P$ so since

$$\boldsymbol{N_S = 10,000\ turns > N_P = 100\ turns}$$

This is a Step-Up Transformer

$$\boldsymbol{i_S = \left(\frac{N_P}{N_S}\right) i_P = \left(\frac{100}{10,000}\right)(60.0\ A) = \frac{1}{100}(60.0\ A) = 0.600.A}$$

So, the correct answer is D !

Dr. Donovan's Classes Page	**Dr. Donovan's PH 221 Lecture Quiz & Exam Solutions**
NMU Physics Department Web Page	NMU Main Page

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

This page last updated on November 8, 2024