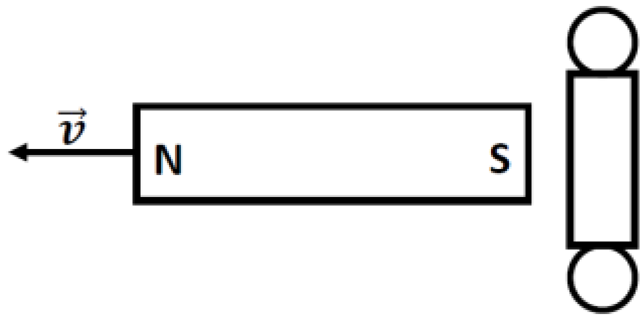
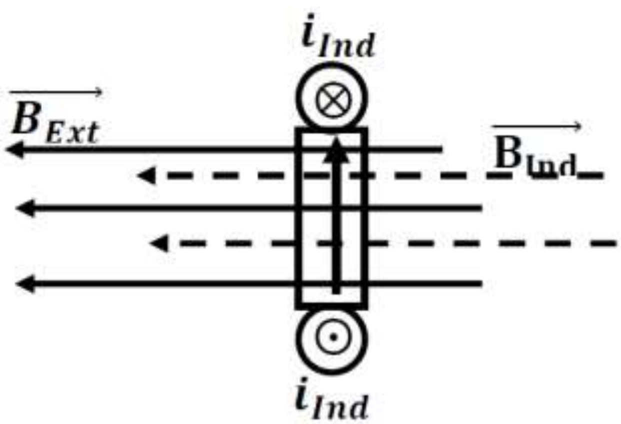
Quiz Average **5.2** **Quiz High Score** **8**

PH 221 **Quiz # 08 (10 pts)** **Name** **Solution**

As shown on the right, a bar magnetic is moved away from a coil. The circles at the top and the bottom represent the wires going into and out of the plane of the paper. At the top of the coil which way is the current induced?

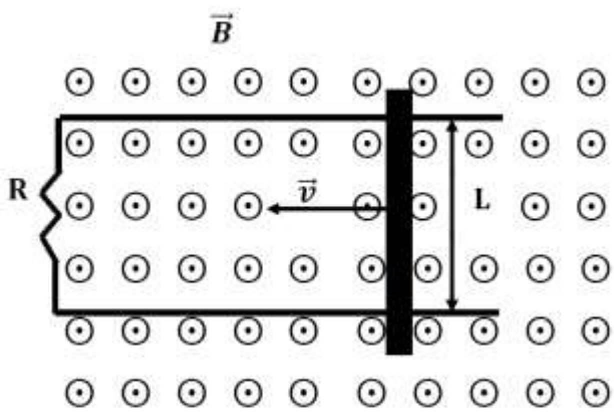


A. ⊗ **Into Paper** **B.** ⊙ Out of Paper **C.** No Current induced



The external magnetic field due to bar magnet has the field pointing to the left. Since the magnet is moving away from the coil, the strength of the magnetic field is decreasing. Therefore, the magnetic flux through the coil is decreasing. So, the induced magnetic field must also go to the left to strengthen the field and oppose the decrease in flux. Therefore, by the right-hand rule, the current must be induced going into the paper at the top and coming out of the paper at the bottom.

So, the correct answer is A !



As shown on the left, a bar has a length $(\mathrm{L} = 0.896\ \mathrm{m})$ is moving along conductive rails with a velocity $\left(\vec{\mathrm{v}} = 2.89\ {}^{\mathrm{m}}/_{\mathrm{s}}\ \widehat{(\mathrm{Left})}\right)$. Assume there is no friction between the bar and the rails. There is a magnetic field $\left(\vec{\mathrm{B}} = 0.413\ \mathrm{T}\ (\widehat{\odot})\right)$ as shown. There is a resistance $(\mathrm{R} = 13.7\ \Omega)$ on the end of the rails as indicated. What is the current that flows through this resistance due to the bar's motion and is the current going from top to bottom or bottom to top of the resistance?

A. 12.8 A Top to Bottom

B. **$\mathbf{0.078}$ A Top to Bottom**

C. 0.078 A Bottom to Top

D. 12.8 A Bottom to Top

$$\boldsymbol{i = \frac{\varepsilon}{R} = \frac{BLv}{R} = \frac{(0.413\ T)(0.896\ m)(2.89\ {}^{m}/_{s})}{13.7\Omega} = \frac{1.069\ V}{13.7\Omega} = 0.078\ A}$$

To get direction of current, there are at least two options. First consider change in magnetic flux of the loop. The bar moving to left is making the area of the loop smaller, so the flux is decreasing. The induced magnetic field would need to add to original magnetic field, so induced field is out of paper, a counter-clockwise current is needed to create that. So, the current is going from top to bottom of resistance.

Alternatively consider the magnetic force on the charges in the bar moving in the magnetic field. Using equation $\overrightarrow{F_B} = Q\vec{v}\ x\ \vec{B}, \vec{v}\ x\ \vec{B} = \widehat{Left}\ x\ \widehat{\odot} = \widehat{Up}$ the bar, so the top of the bar is more positive than bottom of bar. So current will go counter-clockwise around loop as before.

So, the correct answer is B !

A Learjet has a wing span $(\mathrm{L} = 13.34\ \mathrm{m})$ and is flying with a cruising velocity of $\left(\vec{\mathrm{v}} = 216.\ ^{\mathrm{m}}/_{\mathrm{s}}\ (\widehat{\mathrm{North}})\right)$. The vertical component of the Earth's magnetic field is $\left(\overrightarrow{\mathrm{B}_{\mathrm{Earth}}} = 5.65 \times 10^{-4}\ \mathrm{T}\ (\widehat{\mathrm{Down}})\right)$. What is the potential difference induced between the eastern and western edge of the wings? Which one is more positive?

A. $1.63\ \mathrm{V}$, East Edge more Positive

B. $0.614\ \mathrm{V}$, West Edge more Positive

C. $0.614\ \mathrm{V}$, East Edge more Positive

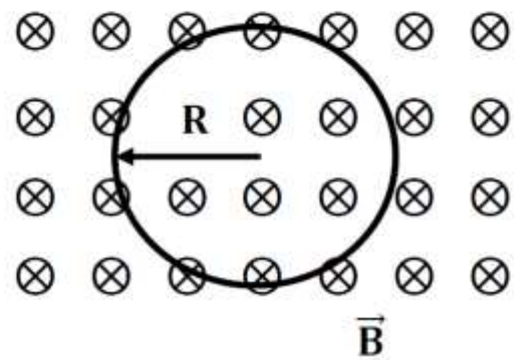
D. $\mathbf{1.63\ V}$**, West Edge more Positive**

$\overrightarrow{F_B} = Q\vec{v}\ x\ \vec{B}, \vec{v}\ x\ \vec{B} = \widehat{North}\ x\ \widehat{Down} = \widehat{West}$ **So, the Western edge is more positive.**

$$\varepsilon = BLv = (5.65\ x\ 10^{-4}\ T)(13.34\ m)(216.\ ^{m}/_{s}) = 1.63\ V$$

So, the correct answer is D !

A circular coil $(\mathrm{R} = 0.250\ \mathrm{m})$ has 1500 turns of wire around it. A magnetic field is passing into the area with the field lines making 90° angles with the surface of the area of the coil. As you face the coil, the magnetic field is going into the plane of the area as shown on the right. A current is induced in the coil with a value of $(\mathrm{i}_{\mathrm{induced}} = 0.530\ \mathrm{A})$ and it goes counter-clockwise around the coil. The resistance of the coil is $(\mathrm{R}^* = 100.\ \Omega)$. What is the rate of change for the magnetic field and is it increasing or decreasing in strength?



A. $5.56\ ^{\mathrm{T}}/_{\mathrm{m}}$ Increasing

B. $\mathbf{0.180\ ^{T}/_{m}}$ **Increasing**

C. $5.56\ ^{\mathrm{T}}/_{\mathrm{m}}$ Decreasing

D. $0.180\ ^{\mathrm{T}}/_{\mathrm{m}}$ Decreasing

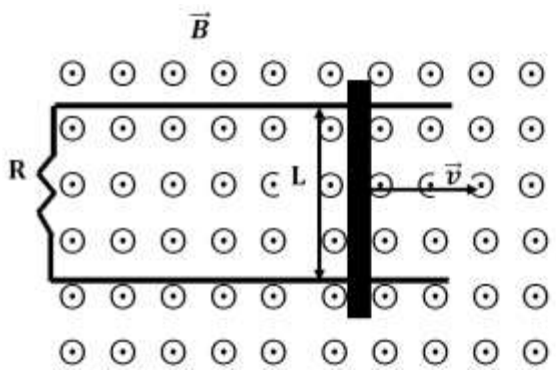
$$i_{Induced} = \frac{\varepsilon}{R^*} = \frac{-N_{Coil}\frac{\partial \Phi_B}{\partial t}}{R^*} = \frac{-N_{Coil}}{R^*}\left(A\frac{\partial B}{\partial t} + B\frac{\partial A}{\partial t}\right) = \frac{-N_{Coil}}{R^*}A\frac{\partial B}{\partial t}$$

Minus sign is Lenz's law and affects direction which we will determine below. Since the orientation and the area do not change those terms are dropped. We can determine the change in magnetic field from this relation

$$\frac{\partial B}{\partial t} = \frac{i_{Induced}R^*}{N_{Coil}\pi R^2} = \frac{(0.530\ A)(100.\ \Omega)}{(1500)\pi(0.250\ m)^2} = \frac{53.0\ V}{294.5\ m^2} = 0.180\ ^{T}/_{m}$$

The induced current going counter-clockwise means a magnetic field is induced coming out of the paper. This is opposite to the original field, so the opposing change means the flux was increasing so that the induced field goes the other way. So, the change in magnetic field is $\mathbf{0.180\ {}^{T}/_{m}}$ increasing!

So, the correct answer is B !



As shown on the left a bar $(\mathrm{L} = 1.409\ \mathrm{m})$ is moving on conductive rails with a constant velocity $\left(\vec{\mathrm{v}} = 3.14\ {}^{\mathrm{m}}/_{\mathrm{s}}\ (\widehat{\mathrm{Right}})\right)$. A magnetic field $\left(\vec{\mathrm{B}} = 0.643\ \mathrm{T}\ (\widehat{\odot})\right)$ is present as indicated. The resistance of the rails is $(\mathrm{R} = 14.1\Omega)$. A current $(\mathrm{i}_{\mathrm{Induced}} = 0.202\ \mathrm{A})$ is induced in the rails. What is the magnitude and direction of an external force which would need to be applied to the bar to keep it moving at constant velocity?

A. $2.84\ \mathrm{N}\ (\widehat{\mathrm{Right}})$

B. $2.84\ \mathrm{N}\ (\widehat{\mathrm{Left}})$

C. $\mathbf{0.183\ N\ (\widehat{Right})}$

D. $0.183\ \mathrm{N}\ (\widehat{\mathrm{Left}})$

Since the bar is going to the right, the magnetic flux is increasing. So, the induced magnetic field must go into the page to oppose this. To get magnetic field into the page, the current must go clockwise around the loop. The current in the bar goes from top to bottom of the bar. The force needed to keep the bar moving must be opposite to the magnetic force on the current.

$$\overrightarrow{F_{ext}} = -\overrightarrow{F_B} = -i_{Induced}\vec{L}\ x\ \vec{B} = -i_{Induced}LB\left(\widehat{Down}\ x\ \widehat{\odot}\right) = -i_{Induced}LB\ (\widehat{Left})$$

$$\overrightarrow{F_{ext}} = i_{Induced}LB\ (\widehat{Right}) = (0.202\ A)(1.409\ m)(0.643\ T)(\widehat{Right}) = 0.183\ N\ (\widehat{Right})$$

So, the correct answer is C !

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