

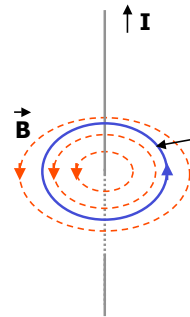
News

- Quiz #3 next Mon, 4/11, 10AM
- Exp MF, Pset 8 due Fri, 4/8
- Review in class, Fri, 4/8 10AM
- No evening review
- Tutoring session, Sun, 3-8PM

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Ampere's Law



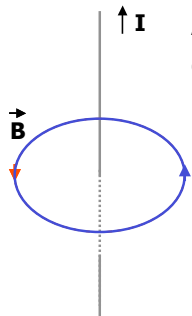
- Ampere's idea:
Relate Field \vec{B} to its Source: I
Closed Line instead of closed surface!

$$\oint_L \vec{B} \cdot d\vec{l} = \mu_0 I_{encl}$$

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Ampere's Law



Ampere's Law helps because we can choose integration path!

$$\begin{aligned} \oint_L \vec{B} \cdot d\vec{l} &= \\ B \oint_L dl &= \\ B 2\pi r &= \mu_0 I_{encl} \\ \Rightarrow B &= \mu_0 \frac{I}{2\pi r} \end{aligned}$$

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Faradays Law

$$\Phi_B = \int_A \vec{B} \cdot d\vec{A}$$

Magnetic Flux
(usually, A not closed surface)

$$\xi_{ind} = -\frac{d\Phi_B}{dt}$$

Faradays Law

$$\Rightarrow I_{ind} = \frac{\xi_{ind}}{R}$$

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Faradays Law

- Φ_B can change because
 - $|B|$ changes
 - Angle between \vec{B} and \vec{A} changes
 - $|A|$ (size of circuit in B) changes

Lenz' Rule

$$\xi_{ind} = -\frac{d\Phi_B}{dt}$$

$$\Rightarrow I_{ind} = \frac{\xi_{ind}}{R}$$

Lenz' Rule:

Sign of I_{ind} such that it opposes the flux change that generated it

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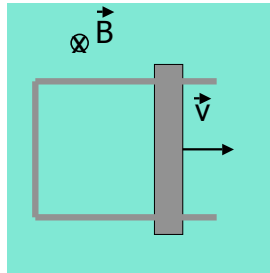
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Use of Faradays Law

- To find direction of I_{ind} :

- Determine Φ_B
- Does $|\Phi_B|$ increase or decrease?
- Find sign of I_{ind} using Lenz' rule



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Lenz' Rule

Field of I_{ind} **DOES NOT** necessarily oppose Φ_B

Field of I_{ind} **DOES** oppose change of $\Phi_B (= d\Phi_B/dt)$

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Lenz' Rule redux

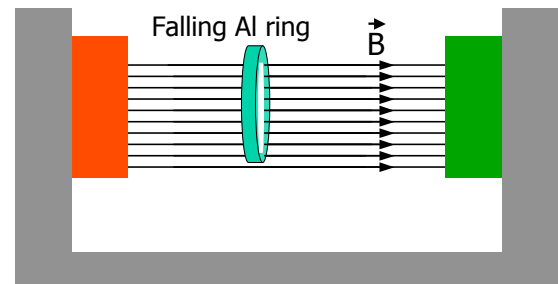
In most cases:

- If $|\Phi_B|$ **increases**:
 $B(I_{\text{ind}})$ **opposite** direction to B_{ext}
- If $|\Phi_B|$ **decreases**:
 $B(I_{\text{ind}})$ **same** direction as B_{ext}

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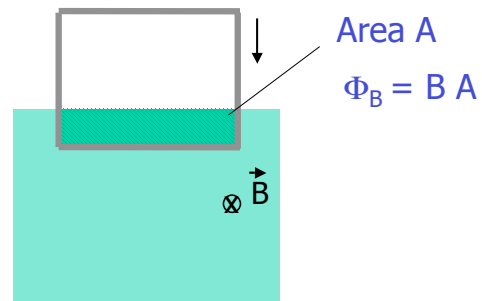
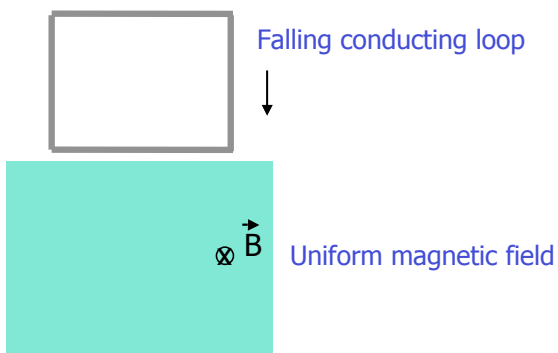
My favorite Demo



- Falling Al ring is slowed down in B-Field

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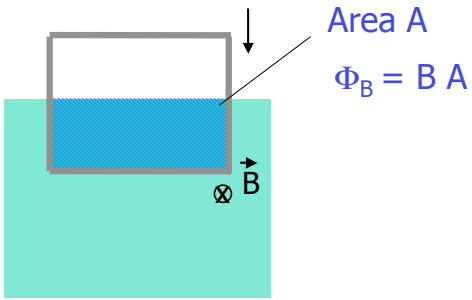


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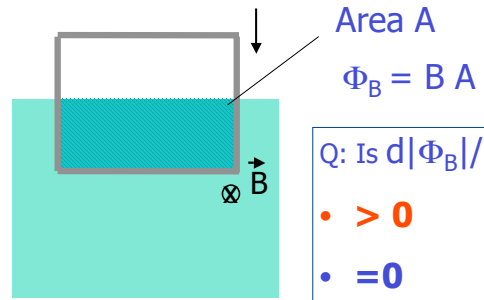
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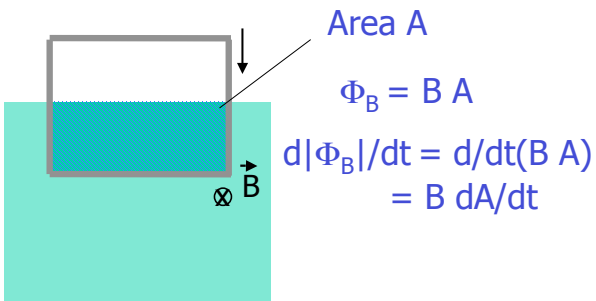


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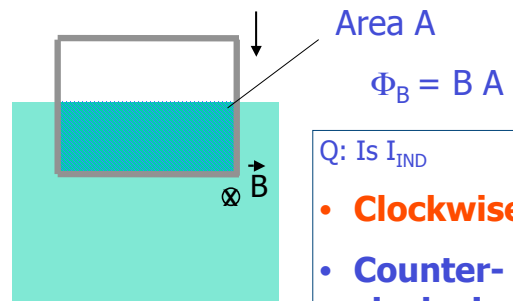
Q: Is $d|\Phi_B|/dt$

- > 0
- $= 0$
- < 0



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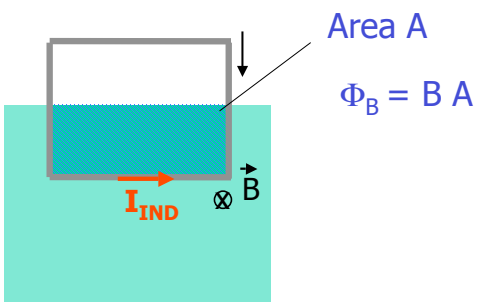


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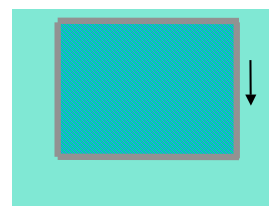
Q: Is I_{IND}

- **Clockwise**
- **Counter-clockwise**
- **Zero**



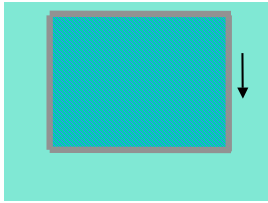
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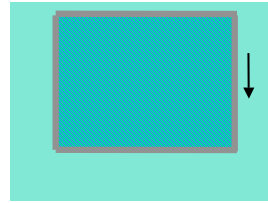


Q: Is $d|\Phi_B|/dt$

- > 0
- $= 0$
- < 0

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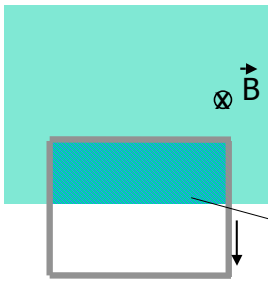
$$\Phi_B = B A$$

$$d\Phi_B/dt = 0$$

$$\rightarrow I_{IND} = 0$$

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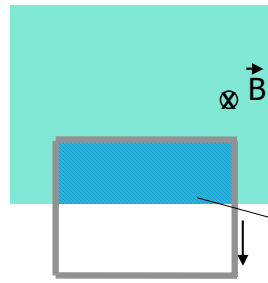
Q: Is $d|\Phi_B|/dt$

- > 0
- $= 0$
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Area A

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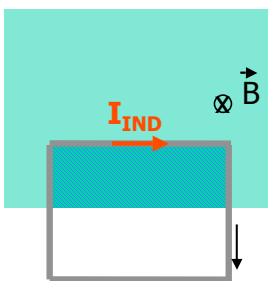
Q: Is I_{IND}

- **Clockwise**
- **Counter-clockwise**
- **Zero**

Area A

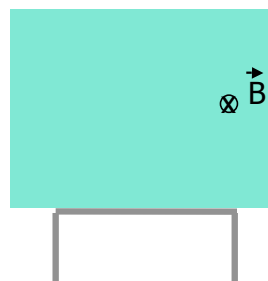
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