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PHYS 102: General Physics 2 KOÇ UNIVERSITY Fall Semester 2015

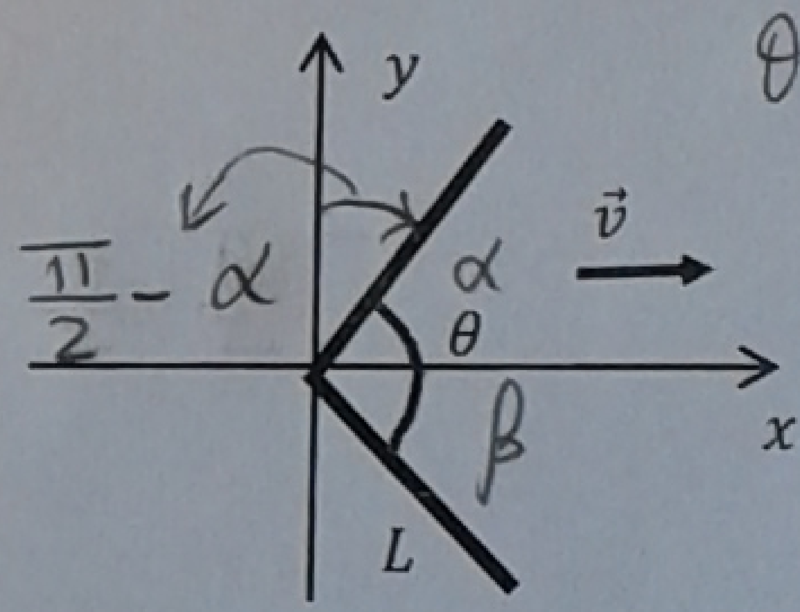
College of Arts and Sciences

Section Quiz 9 November 27, 2015

Closed book. No calculators are to be used for this quiz.
Quiz duration: 10 minutes

Name: **Student ID:** **Signature:**

A V-shaped bar with each arm of length L and tip angle θ in the x-y plane is moving with velocity $\vec{v} = v_0\hat{x}$ along the x-axis in a uniform magnetic field $\vec{B} = -B\hat{z}$. Find the induced emf between the ends of the V-shape. (Hint: $\varepsilon = \int(\vec{v}\times\vec{B})\cdot d\vec{l}$)



$\theta = \alpha + \beta$

First, let's determine $\vec{v}\times\vec{B}$:

$\vec{v}\times\vec{B} = (v_0\hat{x})\times(-B\hat{z}) = v_0 B\hat{y}$

Then, $\mathcal{E}_u = \int_0^L (\vec{v}\times\vec{B})\cdot d\vec{l}_u = \int_0^L v_0 B\hat{y}\cdot d\vec{l}_u = \int_0^L v_0 B\cos\left(\frac{\pi}{2}-\alpha\right) dl_u =$

$= \int_0^L v_0 B\sin\alpha \, dl_u = v_0 B L \sin\alpha$ at the end of upper arm

$\mathcal{E}_l = \int_0^L (\vec{v}\times\vec{B})\cdot d\vec{l}_l = \int_0^L v_0 B\cos\left(\frac{\pi}{2}+\beta\right) dl_l =$

$= \int_0^L (-v_0 B\sin\beta)\, dl_l = -v_0 B L\sin\beta$ at the end of lower arm

The induced emf between the ends of the V-shape:

$\Delta\mathcal{E} = \mathcal{E}_u - \mathcal{E}_l = v_0 B L(\sin\alpha + \sin\beta)$

where $\theta = \alpha + \beta$

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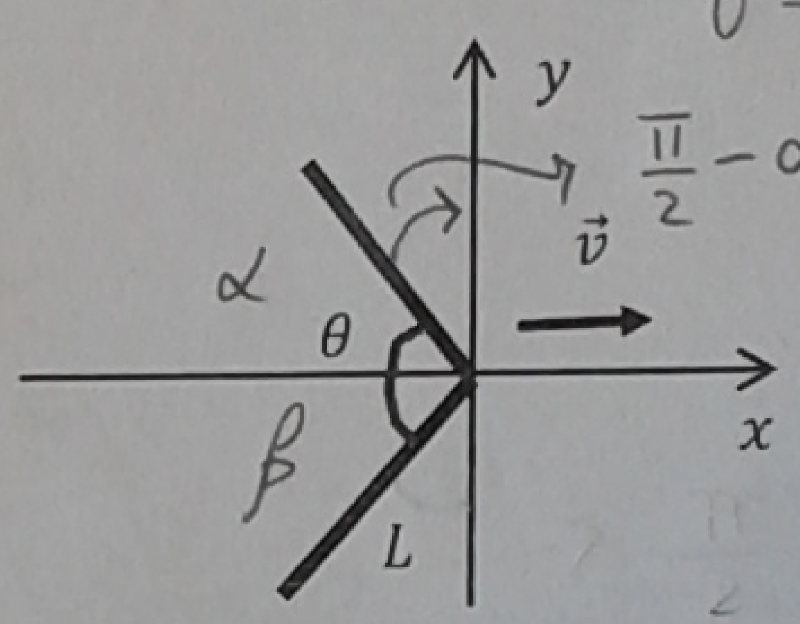
$\theta = \alpha + \beta$



First, $\vec{v} \times \vec{B} = (v_0\hat{x}) \times (B\hat{z}) = -v_0 B\hat{y}$

Then, $\varepsilon_u = \int_0^L (\vec{v} \times \vec{B}) \cdot d\vec{l}_u = \int_0^L (-v_0 B\hat{y}) \cdot d\vec{l}_u = \int_0^L (-v_0 B)\cos\left(\frac{\pi}{2} - \alpha\right) dl_u$

$= \int_0^L (-v_0 B)(\sin\alpha)\, dl_u = -v_0 B L \sin\alpha$

at the end of upper arm

$\varepsilon_l = \int_0^L (-v_0 B)\cos\left(\frac{\pi}{2} + \beta\right) dl_l = \int_0^L (-v_0 B)(-\sin\beta)\, dl_l$

$= v_0 B L \sin\beta$ " ... " lower arm

$\Rightarrow \Delta\varepsilon = \varepsilon_u - \varepsilon_l = -v_0 B L(\sin\alpha + \sin\beta)$

where $\theta = \alpha + \beta$

③

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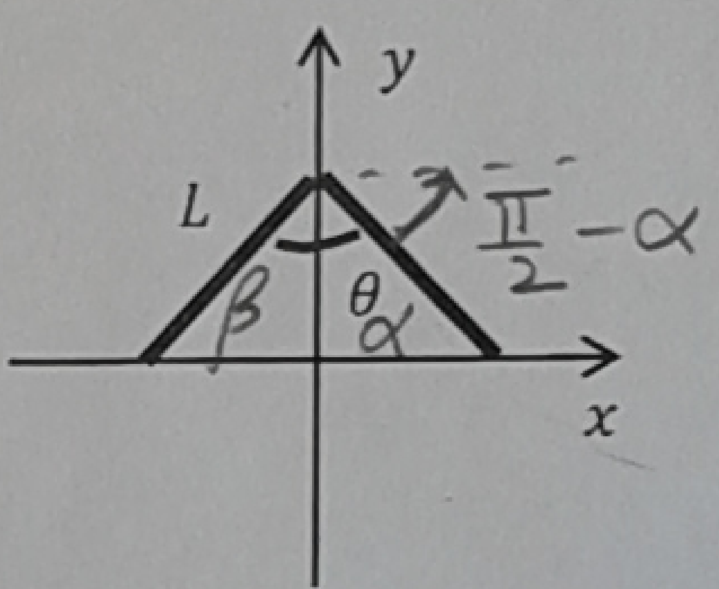
$\theta = \alpha + \beta$

A V-shaped bar with each arm of length L and tip angle θ in the x-y plane is moving with velocity $\vec{v} = v_0\hat{z}$ in a uniform magnetic field $\vec{B} = -B\hat{y}$. Find the induced emf between the ends of the V-shape. (Hint: $\varepsilon = \int(\vec{v} \times \vec{B}) \cdot d\vec{l}$)



First, $\vec{v} \times \vec{B} = (v_0 \hat{z}) \times (-B\hat{y}) = v_0 B \hat{x}$

Then, $\mathcal{E}_u = \int_0^L (\vec{v} \times \vec{B}) \cdot d\vec{l_u} = \int_0^L v_0 B \cos\left(\frac{\pi}{2} - \alpha\right) dl_u =$

$= v_0 B L \sin\alpha$ at the end of upper arm

$\mathcal{E}_\ell = \int_0^L v_0 B \cos\left(\frac{\pi}{2} + \beta\right) dl_\ell = \int_0^L v_0 B (-\sin\beta) dl_\ell =$

$= -v_0 B L \sin\beta$ " . . . . " lower arm

$\Rightarrow \Delta\mathcal{E} = \mathcal{E}_u - \mathcal{E}_\ell = v_0 B L (\sin\alpha + \sin\beta)$

where $\theta = \alpha + \beta$