PH 223 Week 9

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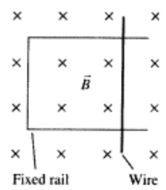
The first two problems are borrowed/adapted from Chapters 29 and 30 of the *Student Workbook* for *Physics for Scientists and Engineers*.

Activity 1

A metal wire is resting on a U-shaped conducting rail. The rail is fixed in position, but the wire is free to move.

(a) If the magnetic field is increasing in strength, does the wire:

i. Remain in place?
ii. Move to the right?
iii. Move to the left?
iv. Move up on the page?
v. Move down on the page?
vi. Move out of the plane of the page, breaking contact with the rail?
vii. Rotate clockwise?
viii. Rotate clockwise?
ix. Some combination of these? If so, which?

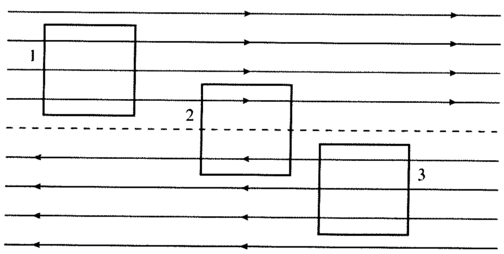


Explain your choice.

(b) If the magnetic field is decreasing in strength, which of the above happens? Explain.

Activity 2

The magnetic field above the dotted line is $\vec{B} = (2\text{ T, right})$. Below the dotted line, the field is $\vec{B} = (2\text{ T, left})$. Each closed loop is 1 m × 1 m.



(a) Let's evaluate the line integral of $\vec{B}$ around each of these closed loops by breaking the integration into four steps. We'll go around the loop in a *clockwise* direction. Pay careful attention to signs.

	Loop 1	**Loop 2**	**Loop 3**
$\int \vec{B} \cdot d\vec{s}$ along left edge			
$\int \vec{B} \cdot d\vec{s}$ along top			
$\int \vec{B} \cdot d\vec{s}$ along right edge			
$\int \vec{B} \cdot d\vec{s}$ along bottom			

The line integral *around* the loop is simply the sum of these four separate integrals:

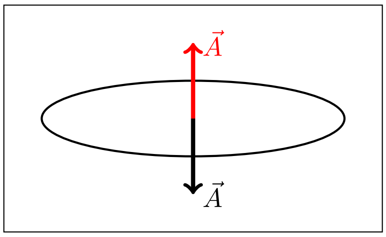
$\oint \vec{B} \cdot d\vec{s}$ around the loop			

(b) What is the current through loop 2, and what direction is it in?

Activity 3: Induction Table

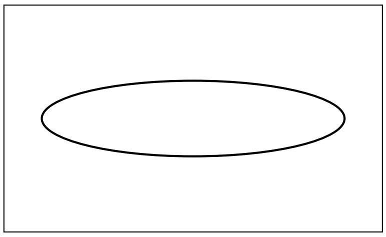
(a) For each case below, fill out the table with the corresponding information. If the quantity is a vector, draw an arrow indicating the direction of the vector. If it is a scalar, indicate the sign of the scalar with a +, −, or 0. Remember that $\vec{\mu} = I\vec{A}$.
On the loops, draw the up area vector in red and the down area vector in black. When you determine the current for each area vector, draw the direction of the current on the loop with the corresponding color. Case A has been completed as an example.

Case A



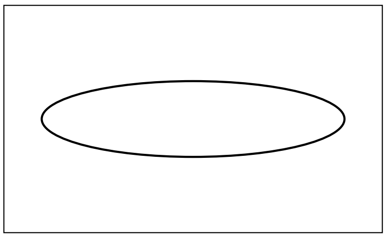
$\vec{B}$ points up and is constant.

Case B



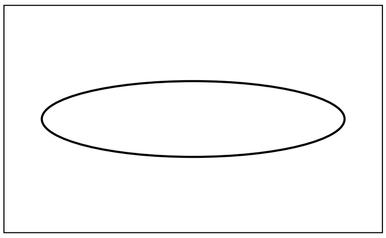
$\vec{B}$ points up and is increasing.

Case C



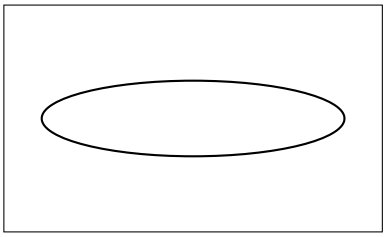
$\vec{B}$ points up and is decreasing.

Case D



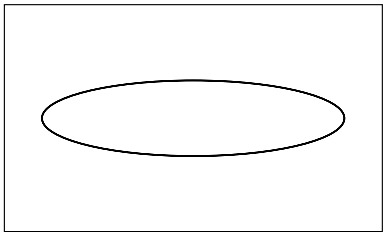
$\vec{B}$ points down and is constant.

Case E



$\vec{B}$ points down and is increasing.

Case F



$\vec{B}$ points down and is decreasing.

	Case A		Case B		Case C		Case D		Case E		Case F	
$\vec{A}$	$\uparrow$	$\downarrow$										
$\vec{B}$	$\uparrow$	$\uparrow$										
Φ_B	$+$	$-$										
$\frac{d\Phi_B}{dt}$	0	0										
V_{ind}	0	0										
I_{ind}	0	0										
$\vec{\mu}$	0	0										

(b) Does your choice of area vector change the final answer?

(c) How is the direction of $\vec{\mu}$ related to the direction of the change in the external magnetic field?