PHYSICS 122 WORKSHEET 6 3/12/2018

NAME: SECTION:

1. Calculate all 9 cross products of unit vectors:

$\hat{\boldsymbol{x}} \times \hat{\boldsymbol{x}}$; $= 0$
$\hat{\boldsymbol{x}} \times \hat{\boldsymbol{y}}$; $= \hat{z}$
$\hat{\boldsymbol{x}} \times \hat{\boldsymbol{z}}$; $= -\hat{y}$
$\hat{\boldsymbol{y}} \times \hat{\boldsymbol{x}}$; $= -\hat{z}$
$\hat{\boldsymbol{y}} \times \hat{\boldsymbol{y}}$; $= 0$
$\hat{\boldsymbol{y}} \times \hat{\boldsymbol{z}}$; $= \hat{x}$
$\hat{\boldsymbol{z}} \times \hat{\boldsymbol{x}}$; $= \hat{y}$
$\hat{\boldsymbol{z}} \times \hat{\boldsymbol{y}}$; $= -\hat{x}$
$\hat{\boldsymbol{z}} \times \hat{\boldsymbol{z}}$. $= 0$

2. A current I lies along a line segment of length L and flows in the $-\hat{\boldsymbol{x}}$ direction. A magnetic field of magnitude B lies along the $+\hat{\boldsymbol{y}}$ direction. Draw a coordinate system indicating each vector quantity, then calculate the resulting magnetic force $\boldsymbol{F}$.

$I = I(-\hat{x})$; $B = B\hat{y}$

$F = L\vec{I} \times \vec{B} = ILB(-\hat{x}) \times \hat{y} = -ILB\hat{z}$

3. Now let $\boldsymbol{I} = I(\hat{\boldsymbol{x}} - \hat{\boldsymbol{y}})$ and $\boldsymbol{B} = B\hat{\boldsymbol{x}}$. What is $\boldsymbol{F}$? Draw a diagram.

$\vec{I} \times \vec{B} = IB(\hat{x} - \hat{y}) \times (\hat{x})$

$= \ldots (\hat{x} \times \hat{x} - \hat{y} \times \hat{x})$

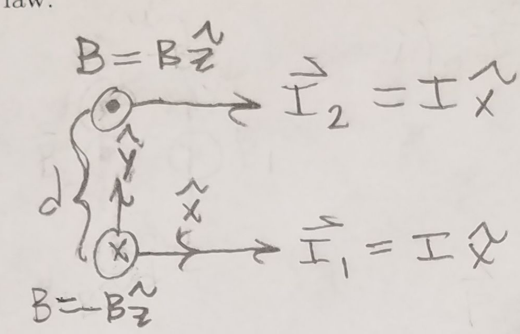
$= \ldots (0 - (-\hat{z}))$

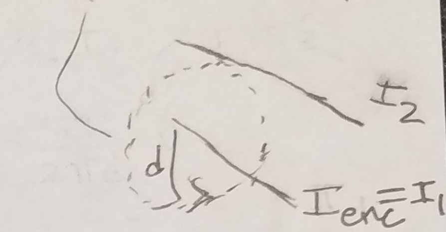
$\vec{F} = ILB\hat{z}$

4. A wire of length L located along the x-axis and carries current I along the $+\hat{x}$ direction. A second wire, also of length L and carrying current I is located a distance d along the y-axis, parallel to the first. Calculate the force of one wire on the other if:
i) the current in the second wire flows along the $+\hat{x}$ direction.
ii) the current in the second wire flows along the $-\hat{x}$ direction.
Hint: use Ampere's law.

⊙ = out of page

⊗ = into page



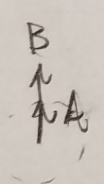


The mag. field on wire 1 due to wire 2 : $B 2\pi d = \mu_0 I_2$

So $B_{2\text{ on }1} = \frac{\mu_0 I_2}{2\pi d}$ & $F_{2\text{ on }1} = L\vec{I}_1 \times \vec{B} = L I^2 \frac{\mu_0}{2\pi d}\hat{z} \times \hat{x} = \frac{\mu_0 I^2 L}{2\pi d}\hat{y}$

If we switch I_2, F along $-\hat{y}$

5. A circular loop of wire lies in the xy plane under the influence of a $3T$ magnetic field pointing along the $+\hat{z}$ direction. The loop's diameter changes from $100cm$ to $60cm$ in $0.5s$.
i) What is the magnitude of the average induced EMF?
ii) What is the direction of the induced current?
iii) If the loop's resistance is 0.05Ω, what is the average induced current?
Hint: use Faraday's law and Lenz's law.



$-\frac{\Delta\Phi}{\Delta t} = \mathcal{E}$; $\Phi = BA$; $\frac{\Delta\Phi}{\Delta t} = \frac{\Delta(BA)}{\Delta t} = B\frac{\Delta A}{\Delta t}$

$\Delta A = \frac{\pi}{4}(d_2^2 - d_1^2) \rightarrow \mathcal{E} = \frac{\frac{\pi}{4}(d_1^2 - d_2^2)}{\Delta t} B$

$\mathcal{E}$ positive : ccw

$\mathcal{E} = IR \rightarrow I = \frac{\mathcal{E}}{R} = \frac{B\frac{\pi}{4}(d_1^2 - d_2^2)}{R\Delta t}$

$d_1 = 100\,cm = 1.00\,m$, $d_2 = 60\,cm = 0.60\,m$