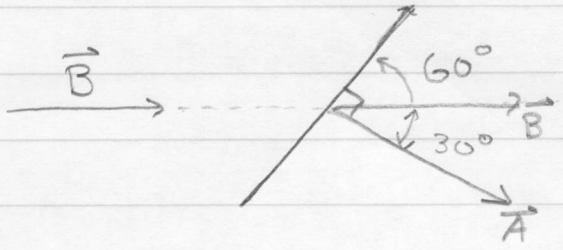
Physics 2b Quiz 7 Solutions #1 p.1

Wire wound on a square frame, 30 cm x 30 cm, 4 turns uniform $\vec{B} = 0.8T\,\hat{\imath}$, plane of the coils makes a 60° angle w/ $\vec{B}$, what is the flux?



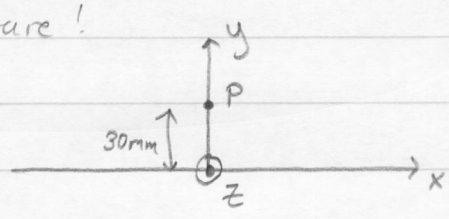

$$\Phi_{B,tot} = N\Phi_{B,single} = NBA\cos\theta = (4)(0.8T)(.3m \times .3m)\cos 30^\circ$$
$$= \boxed{0.25Wb} = 0.25\ Tm^2$$

The only "tricks" in this problem are remembering to include N, and getting the correct angle (between $\vec{B}$ and $\vec{A}$).

#2 p.1

A $\vec{I}$ on the x-axis makes a $\vec{B}$ @ (0, .03m, 0) of $-0.4\mu T\,\hat{k}$. What is the direction and magnitude of the current?

① Draw a picture!

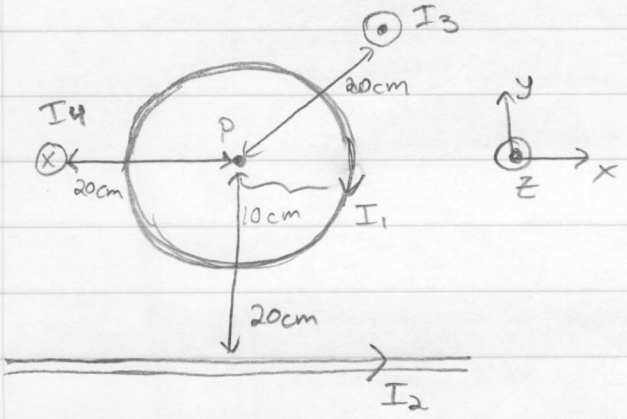



② The coordinate system must be right handed ⇒ z is out of the page.

③ You are told that the $\hat{k}$ component of $\vec{B}$ is negative, so for your fingers to curl into the page above the wire, your thumb must be pointing left ⇒ **negative**

④ Recall: $B = \frac{\mu_0 I}{2\pi y} \Rightarrow I = \frac{B 2\pi y}{\mu_0} = \frac{(0.4\mu T)\,2\pi\,(0.03m)}{\mu_0} = \boxed{60mA}$

Physics 2b Quiz 7 Solutions # 3




What is the z-component of $\vec{B}$ @ P?

① $I_3$ and $I_4$ have field lines in the plane of the page and therefore do not have a z-component.

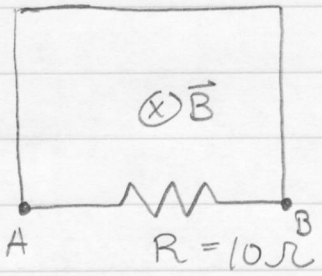
② By the right hand rule, $I_1$ has a negative z-component and $I_2$ has a positive z-component.

③ Recall: $B_{tot} = B_{wire} - B_{ring} = \frac{\mu_0 I_2}{2\pi y} - \frac{\mu_0 I_1}{2a}$

$$= \frac{\mu_0}{2}\left(\frac{20A}{\pi(0.2m)} - \frac{10A}{(0.1m)}\right)$$

$$= -4.2\times10^{-5}T, \text{ closest } \boxed{-40\mu T}$$

Note that the $\vec{B}$ fields @ P due to $I_1$ and $I_2$ only have a z-component, so we are justified in using the full expressions for $B_{wire}$ and $B_{ring}$.




uniform $\vec{B}$ through 20cm x 20cm circuit

$|\vec{B}|$ : 0.9T → 0.3T over 60ms

What is the magnitude and direction of the current induced through the resistor?

① Ohm's Law $I = \frac{\mathcal{E}}{R}$

② Faraday's law $|\mathcal{E}| = \frac{d\Phi_B}{dt} = \frac{\Delta\Phi_B}{\Delta t} = \frac{\overbrace{(0.9T - 0.3T)}^{\Delta B} \times \overbrace{(0.2m \times 0.2m)}^{A}}{(0.06s)}$

$= 0.4V$

$I = \frac{\mathcal{E}}{R} = \frac{0.4V}{10\Omega} = \boxed{40mA}$

③ Direction is given by Lenz's law: the induced current tries to oppose the change in flux.

- $\vec{B}$ is into the page and decreasing
- ⇒ $\vec{B}_{induced}$ is into the page
- ⇒ (by right hand rule) current is clockwise

$\underline{\boxed{b \text{ to } a}}$ (through the resistor)

Several people missed this question because they didn't see "through the resistor". If this were not specified then the question would be ambiguous and therefore impossible to answer.