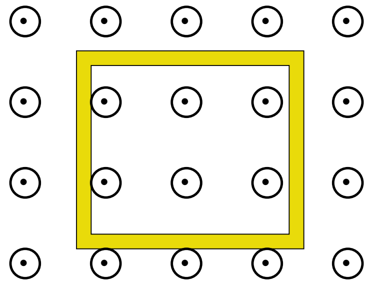
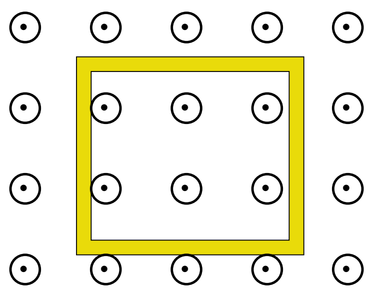
Problem 20.1

Determine the magnetic flux through a rectangular coil (face in the plane of the page) due to a .5 tesla B-fld oriented perpendicular to the page. Assume the coil's dimensions are .08 meters by .12 meters.



Problem 20.1



$B = .5\ \text{T}$

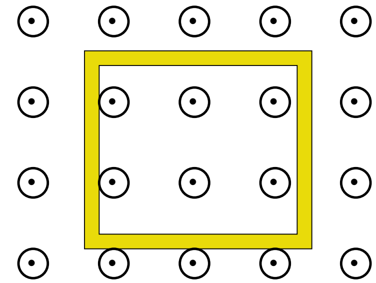
$A = (.08\ \text{m})(.12\ \text{m}) = 9.6\text{x}10^{-3}\ \text{m}^2$

The magnetic flux?

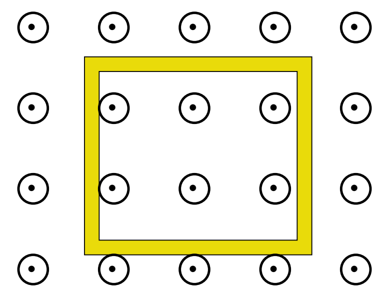
$$\begin{aligned}\phi_B &= B \bullet A \\ &= B\ A\cos 0^\circ (.08\ \text{m})(.12\ \text{m}) = 9.6\text{x}10^{-3}\ \text{m}^2 \\ &= (.5\ \text{T})\ (9.6\text{x}10^{-3}\ \text{m}^2) \\ &= 4.8\text{x}10^{-3}\ \text{Webers}\end{aligned}$$

(additional problem)

a.) For the sake of amusement, what would the induced EMF in the coil be if the magnetic field was turned off over a .2 second period?



a.) For the sake of amusement, what would the induced EMF in the coil be if the magnetic field was turned off over a .2 second period?



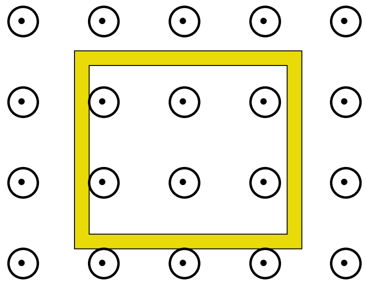
$$\begin{aligned}\varepsilon_{induced} &= -N\frac{\Delta\phi_B}{\Delta t} \\ &= -N\frac{\Delta(B\ A\cos\theta)}{\Delta t} \\ &= -N\ A\cos 0^\circ\frac{\Delta(B)}{\Delta t} \\ &= -(1)\ (9.6\text{x}10^{-3})\frac{(0-.5\ \text{T})}{(.2\ \text{sec.})} \\ &= 2.4\text{x}10^{-2}\ \text{volts}\end{aligned}$$

OR

$$\begin{aligned}\varepsilon_{induced} &= -N\frac{\Delta\phi_B}{\Delta t} \\ &= -(1)\frac{(0-4.8\text{x}10^{-3}\ \text{W})}{(.2\ \text{sec})} \\ &= 2.4\text{x}10^{-2}\ \text{volts}\end{aligned}$$

(additional problem)

b.) Continuing with the amusement, if the coil's resistance was R=30 ohms, what would the induced current in the coil be?



c.) For how long would the induced current flow?

d.) In what direction would the induced current flow, clockwise or counterclockwise?

(additional problem)

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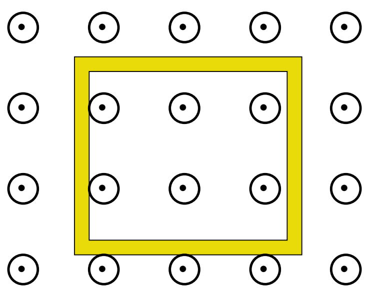


$$\varepsilon_{induced} = i_{induced} R$$

$$\Rightarrow \quad i_{induced} = \frac{\varepsilon_{induced}}{R}$$

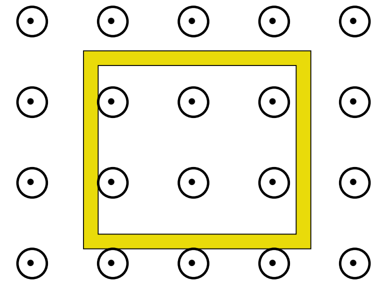
$$\Rightarrow \quad i_{induced} = \frac{2.4\text{x}10^{-2} \text{ volts}}{30\ \Omega}$$

$$\Rightarrow \quad i_{induced} = 8\text{x}10^{-4} \text{ amps} \quad (= .8 \text{ milli-amps})$$

(additional problem)

c.) For how long would the induced current flow?

For as long as the magnetic flux continued to change. In this case, that would be .2 seconds.



d.) In what direction would the induced current flow, clockwise or counterclockwise?

Using Lenz's Law:
1.) The external B-fld is out of the page.
2.) The external magnetic flux is diminishing.
3.) As such, the induced B-fld must be in the same direction as the external flux. A current counterclockwise would produce the appropriate induced B-fld.