Name: _____ Section: ____

Tuesday, November 3

Quiz 10A

A circular wire loop of radius 40 cm is in the plane of this paper. There is magnetic field with magnitude $B = \left(3.0\ \text{T/s}^2\right)t^2$ directed into the paper. At $t = 2.0$ s, a current of 2.0 A is observed in the wire.

a. What is the resistance of the wire?

$\Phi_B = B\pi r^2 \qquad |\mathcal{E}| = \pi r^2 \left|\frac{dB}{dt}\right| \qquad I = \frac{|\mathcal{E}|}{R}$

$R = \frac{|\mathcal{E}|}{I} = \frac{\pi r^2}{I}\left|\frac{dB}{dt}\right| = \frac{\pi(0.4\text{m})^2}{2.0\text{A}}(6\times 2)\frac{\text{T}}{\text{s}} = \boxed{3.0\,\Omega}$

b. In which direction does the current flow? Explain.

B is into the paper and increasing.
⇒ B_{in} should be out of the paper
⇒ I should be [CCW] (due to RHR)

c. If the same loop was reshaped to a square, the induced current would be (larger than/the same as/smaller than) with the circular loop. Explain.

This could be square with side $a = \frac{2\pi r}{4}$

and area $a^2 = \frac{4\pi^2 r^2}{16} = 0.785\,\pi r^2$

⇒ smaller area ⇒ smaller flux ⇒ smaller $\mathcal{E}$ and current

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Tuesday, November 3

Quiz 10B

A square wire loop of side 40 cm is in the plane of this paper. There is magnetic field with magnitude $B = \left(3.0\ \text{T/s}^2\right)t^2$ directed out of the paper. At $t = 2.0$ s, a current of 2.5 A is observed in the wire.

a. What is the resistance of the wire?

$\Phi_B = Ba^2 \qquad |\mathcal{E}| = a^2\left|\frac{dB}{dt}\right| \qquad I = \frac{|\mathcal{E}|}{R}$

$R = \frac{|\mathcal{E}|}{I} = \frac{a^2}{I}\left|\frac{dB}{dt}\right| = \frac{(0.4\text{m})^2}{2.5\text{A}}(6\times 2)\frac{\text{T}}{\text{s}}$

$= \boxed{0.77\,\Omega}$

b. In which direction does the current flow? Explain.

B is out of the page and increasing
⇒ B_{in} should be into the page
⇒ I must be $\boxed{\text{CW}}$ due to RHR

c. If the same loop was reshaped to a circle, the induced current would be (larger than/the same as/smaller than) with the square loop. Explain.

It would be a circle of radius $r = \frac{4a}{2\pi} = \frac{2a}{\pi}$

and area $\pi r^2 = \pi\frac{4a^2}{\pi^2} = 1.27a^2$

⇒ larger area ⇒ larger flux ⇒ larger emf and current.

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Quiz 10C

A circular wire loop of radius 20 cm is in the plane of this paper. There is magnetic field with magnitude $B = (3.0\ \text{T/s}^2)t^2$ directed into the paper. The resistance of the wire is 3.0 Ω.

a. What is the current in the wire at $t = 2.0$ s?

$\Phi_B = B\pi r^2 \qquad |\mathcal{E}| = \pi r^2 \left|\frac{dB}{dt}\right|$

$I = \frac{\mathcal{E}}{R} = \frac{\pi r^2}{R}\left|\frac{dB}{dt}\right| = \frac{\pi (0.2\text{m})^2}{3.0\Omega} 2\left(3.0\frac{\text{T}}{\text{s}^2}\right)t = \left(0.251\frac{\text{A}}{\text{s}}\right)t$

$I(t = 2.0\text{s}) = \boxed{0.50\text{A}}$

b. In which direction does the current flow? Explain.

$\vec{B}$ is into the page and increasing

$\Rightarrow \vec{B}_{in}$ should be out of the page

$\Rightarrow I_{in}$ should be $\boxed{\text{CCW}}$ due to RHR

c. If the same length of wire was used to make a double circular loop (2 turns), the induced current would be (larger than/the same as/smaller than) with the single loop. Explain.

The radius of these loops would be $r/2$

Total flux would then be

$\Phi_B' = NBA = 2B\pi\left(\frac{r}{2}\right)^2 = \frac{1}{2}B\pi r^2 = \frac{1}{2}\Phi_B$

$\Rightarrow$ Smaller flux $\Rightarrow$ smaller emf and current

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Quiz 10D

A circular wire loop of radius 20 cm is in the plane of this paper. There is magnetic field with magnitude $B = (2.0\ \text{T})\exp\left(-\frac{t}{2.0\ \text{s}}\right)$ directed into the paper. The resistance of the wire is 3.0 Ω.

a. What is the current in the wire at t = 2.0 s?

$\Phi_B = B\pi r^2 \qquad |\mathcal{E}| = \pi r^2 \left|\frac{dB}{dt}\right|$

$I = \frac{|\mathcal{E}|}{R} = \frac{\pi r^2}{R}\left|\frac{dB}{dt}\right| = \frac{\pi(0.20\,\text{m})^2}{3.0\,\Omega}\frac{(2.0\,\text{T})}{2.0\,\text{s}} e^{-t/2}$

$I(t = 2\text{s}) = \boxed{0.015\,\text{A}}$

b. In which direction does the current flow? Explain.

$\vec{B}$ is into the paper and decreasing

$\Rightarrow \vec{B}_{in}$ should be into the paper

$\Rightarrow$ I should be $\boxed{\text{CW}}$ due to RHR

c. If the same loop was reshaped to a square, the induced current would be (larger than/the same as/smaller than) with the circular loop. Explain.

The square would have side $a = \frac{2\pi r}{4} = \frac{\pi r}{2}$

and area $a^2 = \frac{\pi^2 r^2}{4} = \frac{\pi}{4}(\pi r^2) = 0.785\,\pi r^2$

$\Rightarrow$ smaller area $\Rightarrow$ smaller flux $\Rightarrow$ smaller emf and current.