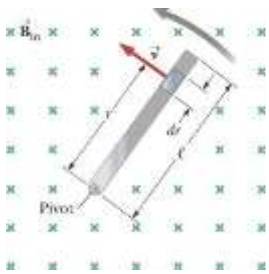
Extra practice questions Ch. 30

Physics 250 Prof. Menningen 11/07/18 Name: ________KEY____________________

1. (2 pts) The inductance of a coil depends upon the rate of change of current in the coil. TRUE **(FALSE)** (circle one)

2. (2 pts) A magnetic field points into this page and is decreasing in magnitude. The induced electric field
   a. is zero **(b. circulates clockwise)** c. circulates counterclockwise

3. (4 pts) A helicopter has blades with a length of 4.50 m extending outward from a central hub and rotating at 180 revolutions per minute (6π rad/s). If the vertical component of the Earth's magnetic field is 50.0 μT, what is the emf induced between the blade tip and the center hub? {*Hint*: the speed along the blade is not constant, recall $v = r\omega$ and let $d\mathcal{E} = vB\,dr$ be the emf across a small segment of the blade.}

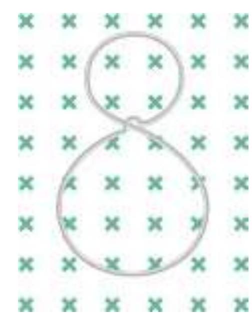


The emf $d\mathcal{E}$ of a small section dr of the blade depends upon its speed:

$$\mathcal{E} = \int_0^L d\mathcal{E} = \int_0^{4.50\text{ m}} vB\,dr = \int_0^{4.50\text{ m}} (\omega r)B\,dr = \omega B\left[\tfrac{1}{2}r^2\right]_0^{4.50\text{ m}}$$

$$= (6\pi\text{ rad/s})(50.0\times10^{-6}\text{ T})\tfrac{1}{2}(4.50\text{ m})^2$$

$$\mathcal{E} = 0.00954\text{ V} = \boxed{9.54\text{ mV}}$$



A piece of insulated wire is shaped into a figure eight as shown. For simplicity, model the two halves of the figure eight as circles. The radius of the upper circle is 5.00 cm and that of the lower circle is 9.00 cm. The wire has a uniform resistance per unit length of 3.00 Ω/m. The depicted magnetic field is increasing at a constant rate of 2.00 T/s. Find the following.

4. (2 pts) The total resistance of the figure eight

5. (4 pts) The magnitude of the induced current in the wire

6. (2 pts) The direction of the induced current: A. clockwise in the larger circle
   B. counterclockwise in the larger circle

$$R = \left(\frac{dR}{ds}\right)L = \left(\frac{dR}{ds}\right)2\pi(r_1 + r_2) = (3.00\ \Omega/\text{m})2\pi(0.14\text{ m}) = \boxed{2.64\ \Omega}$$

$$|\mathcal{E}| = \frac{d\Phi_B}{dt} = \frac{dB}{dt}[A_2 - A_1] = \frac{dB}{dt}\pi\left[r_2^2 - r_1^2\right]$$

$$= (2.00\text{ T/s})\pi\left[(0.0900\text{ m})^2 - (0.0500\text{ m})^2\right] = 0.0352\text{ V}$$

$$I = \frac{|\mathcal{E}|}{R} = \frac{0.0352\text{ V}}{2.64\ \Omega} = 0.0133\text{ A} = \boxed{13.3\text{ mA}}$$

7. (4 pts) A coil has an inductance of 3.00 mH, and the current in it changes from 0.200 A to 1.50 A in a time interval of 0.200 s. Find the magnitude of the average induced emf in the coil during this time interval.

$$\mathcal{E} = -L\frac{dI}{dt} \quad \Rightarrow |\mathcal{E}| = L\frac{\Delta I}{\Delta t} = (0.003\text{ H})\frac{1.50 - 0.20\text{ A}}{0.200\text{ s}} = \boxed{0.0195\text{ V}}$$