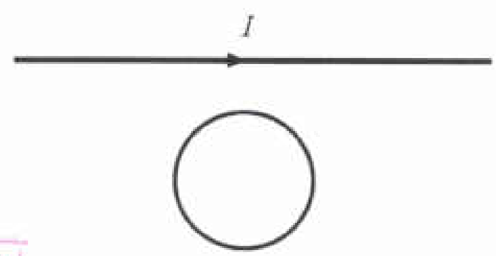
Name Units? Units?

Oct. 27, 2003

Phys 2020, Section 1
Quiz #4 — Fall 2003

1. A flat circular conducting loop lies near a long wire (in the same plane). The current in the wire is flowing to the right but it is *decreasing*.

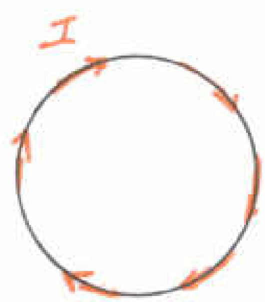


a) In what direction does the magnetic field due to the wire point, in the interior of the loop? How is this (primary) flux changing with time?

Using RHR-1, inside the loop $\vec{B}$ goes $\boxed{\text{into}}$ the page. And since the current is decreasing the magnitude of $\vec{B}$ (and also the flux) is $\boxed{\text{decreasing}}$.

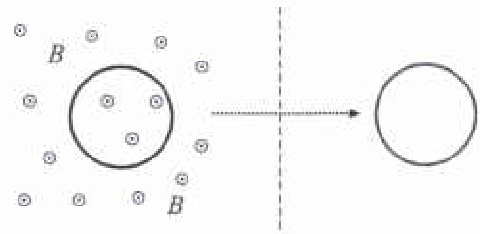
b) What is the direction of the induced current in the loop? Give the direction and *give your reasoning*.

To oppose the change in flux mentioned in (a) we need to produce a magnetic flux into the page. This will be brought about by an induced current in the $\boxed{\text{clockwise}}$ direction, because from RHR-2 applied to the loop current, the induced $\vec{B}$ field & flux go into the page.



→ Induced current goes clockwise!

2. A circular coil of wire of radius 2.00 cm has a resistance of 5.5 Ω. It is located in a magnetic field of 0.530 T directed at right angles to the plane of the coil. The coil is removed from the field in 0.392 s



a) What is the (average) induced emf in the coil?

The magnitude of the change in flux is

$$\Delta\Phi = A\Delta B = \pi R^2 (0.530\,\mathrm{T} - 0) = \pi(2.00\times10^{-2}\,\mathrm{m})^2(0.530\,\mathrm{T})$$
$$= 6.66\times10^{-4}\,\mathrm{T\cdot m^2}$$

so the magnitude of the induced emf is (with $N=1$ loop here)

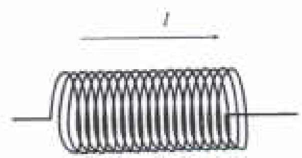
$$\bar{\mathcal{E}} = 1\cdot\frac{\Delta\Phi}{\Delta t} = \frac{6.66\times10^{-4}\,\mathrm{T\cdot m^2}}{0.392\,\mathrm{s}} = \boxed{1.70\times10^{-3}\,\mathrm{V}}$$

b) What is the average current which flows in the coil during this time?

Using Ohm's Law, average current is

$$\bar{I} = \bar{\mathcal{E}}/R = \frac{1.70\times10^{-3}\,\mathrm{V}}{5.5\,\Omega} = \boxed{3.1\times10^{-4}\,\mathrm{A}}$$

3. The current through a 2.00 mH inductor changes from 0.300 A to 2.00 A in 0.250 s.



Find the magnitude of the average induced emf in the inductor during this period.

Magnitude of the induced emf equals $L\frac{\Delta I}{\Delta t}$ for inductor so:

$$\bar{\mathcal{E}} = L\frac{\Delta I}{\Delta t} = (2.00\times10^{-3}\,\mathrm{H})\frac{(2.00-0.300)\,\mathrm{A}}{(0.250\,\mathrm{s})} = \boxed{1.36\times10^{-2}\,\mathrm{V}}$$

You must show all your work and include the right units with your answers!

$$k = \frac{1}{4\pi\epsilon_0} = 8.99\times10^9\,\frac{\mathrm{N\cdot m^2}}{\mathrm{C^2}} \qquad \epsilon_0 = 8.85\times10^{-12}\,\frac{\mathrm{C^2}}{\mathrm{N\cdot m^2}} \qquad e = 1.602\times10^{-19}\,\mathrm{C}$$

$$V = IR \qquad \mu_0 = 4\pi\times10^{-7}\,\frac{\mathrm{T\cdot m}}{\mathrm{A}} \qquad B = \frac{\mu_0 I}{2\pi r} \qquad B_{\mathrm{loop}} = \frac{\mu_0 I}{2R} \qquad B_{\mathrm{sol}} = \mu_0 n I$$

$$\mathcal{E} = -N\frac{\Delta\Phi}{\Delta t} \qquad \mathcal{E}_2 = -M_{21}\frac{\Delta I_1}{\Delta t} \qquad \mathcal{E} = -L\frac{\Delta I}{\Delta t} \qquad \mathcal{E} = NAB\omega\sin\omega t$$