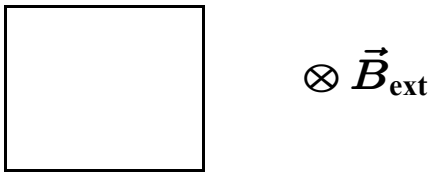
Class Exercise #15 - 13 July 2005

A circuit loop with cross-sectional area 0.060 m^2 and resistance 3.0 Ω is shown in a uniform external magnetic field $\vec{B}$ of initial magnitude 0.5 T.



(a) Determine the initial magnitude of the magnetic flux through the loop.

The magnetic flux through the loop is

$$\Phi = BA\cos\theta = (0.5\text{ T})(0.060\text{ m}^2)(\cos 0°) = 0.030\text{ T}\cdot\text{m}^2$$

(b) Determine in the magnitude and direction (clockwise or counterclockwise) of the induced current in the loop, if the magnitude B of the magnetic field is *decreasing* at a rate of 0.02 T/s.

The magnetic field is down (into the plane of the page) and decreasing, so by Lenz' law the induced current will have a magnetic field that is down, to counteract the decrease. This means the induced current is clockwise as viewed from above the page.

The current is given by

$$I = (\Delta\Phi/\Delta t)/R = (A\cos\theta)(\Delta B/\Delta t)/R$$
$$= (0.060\text{ m}^2\cos 0°)(0.02\text{ T/s})/(3.0\ \Omega) = 0.00040\text{ A or }0.40\text{ mA}.$$