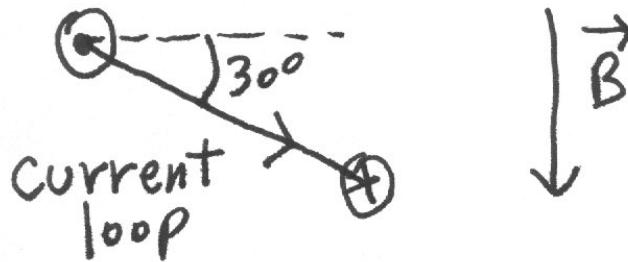


CLASS EXERCISE #14 - 12 July 2005

A square current loop with sides of length 0.5 m and total resistance 5Ω is placed as shown in a uniform magnetic field of magnitude $B = 0.4 \text{ T}$. You are viewing it edge-on, only the near side visible, but the current also indicated along the sides.



(a) What is the magnitude of the total magnetic flux through the loop?

The normal to the loop is directed up to the right, making a 150° angle with \vec{B} . (If the loop angle were 0° instead of 30° , there would be a 180° angle between the normal and \vec{B} ; now rotating 30° from that reduces the 180° angle to 150°).

Then the magnetic flux is

$$\begin{aligned}\Phi &= BA \cos \theta = (0.4 \text{ T})(0.5 \text{ m})^2 |\cos 150^\circ| = (0.1 \text{ T} \cdot \text{m}^2) |0.866| \\ &= 0.0866 \text{ T} \cdot \text{m}^2\end{aligned}$$

(b) If the loop rotates until the 30° angle has increased to 90° , what is the total magnetic flux at that position?

In this position, the angle $\theta = 90^\circ$, so the magnetic flux, which is proportional to $\cos \theta = \cos 90^\circ = 0$, must be zero.

(c) If this rotation takes place in 4.0 seconds, what is the average current induced in the loop during that time?

The average current is given by Faraday's law as

$$I = \frac{\Delta\Phi}{R\Delta t} = \frac{0.0866 \text{ T} \cdot \text{m}^2}{5 \Omega \times 4.0 \text{ s}} = 0.0043 \text{ A}.$$