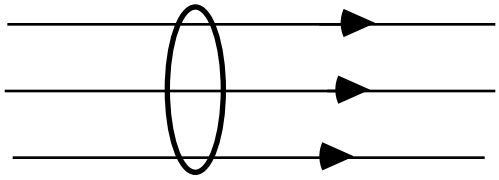
Magnetic Flux : Notes/W.S.-20

When investigating induced emfs, it is convenient to introduce the concept of **magnetic flux** .

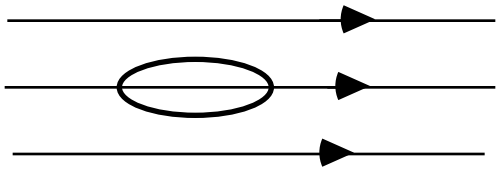
If we have a wire loop with an area A, in a magnetic field B, then the flux Ø, is given by A multiplied by the component of B that is perpendicular to the plane of the loop. The units for flux are Webers (Wb or T m^2). The formula for the flux through a loop is given by:

$$\Phi = B\ A\ \cos\theta$$



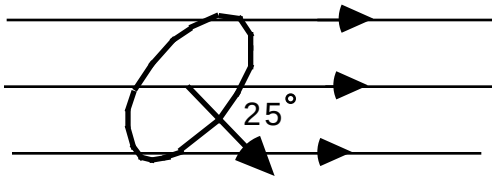
loop of area A oriented perpendicular to field B

flux = BxA



loop of area A oriented parallel to field B

flux = zero



loop of area A oriented
at 25 degrees to field B

flux = BxAxcos25

If the flux through a loop changes, an emf is induced in the loop. The emf is given by **Faraday's Law** :

$$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$$

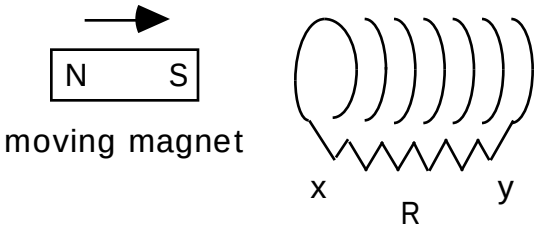
The electromotive force for one loop equals the rate of change of flux. If the number of loops is increased to N, then the emf is multiplied by N.

The negative sign indicates that the induced emf will be in a direction such that, the magnetic field produced, will oppose the change in the flux. This called "**Lenz's Law** ".

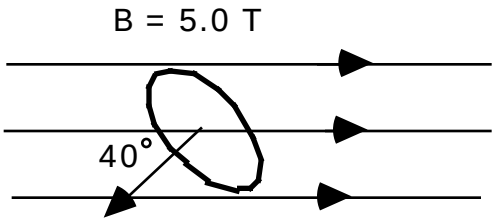
Problems:

1) Give the SI units (using; m, kg, s, A) for the Weber.

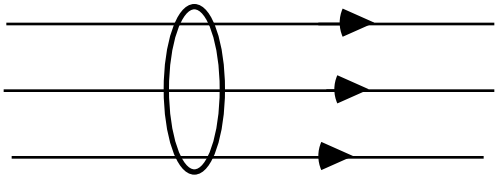
2) Find the direction of the conventional current through the resistor R.



3) Find the flux through the loop. The radius is 3.1 cm.



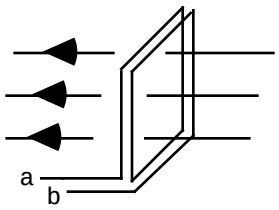
4) The loop below is rotated 1/4 of a turn in 0.010 s. Find the magnitude of the emf.



B = 1.3 T

area = 2.5 cm^2

5)a) Find the flux (there are two loops, N = 2).



B = 4.1 T

width = 1.0 cm length = 2.0 cm

b) The field is decreased to zero in a time of 0.030 s. Find:

i) $\Delta\Phi$ ii) $\mathcal{E}$

c) Using Lenz's Law, will the end of the loop at "a", be positively or negatively charged?

Answers: 1) Wb = V s = J/C s = J A^{-1} = N m A^{-1} = kg m^2 s^{-2} A^{-1}., 2) y to x, 3) 0.012 Wb, 4) 0.033 volts, 5)a) - 8.2×10^{-4} Wb, b)i) 8.2×10^{-4} Wb, ii) 0.055 volts, c) negative.