Lesson 8.2 - Magnetic Flux

Unit 8: Electromagnetic Induction

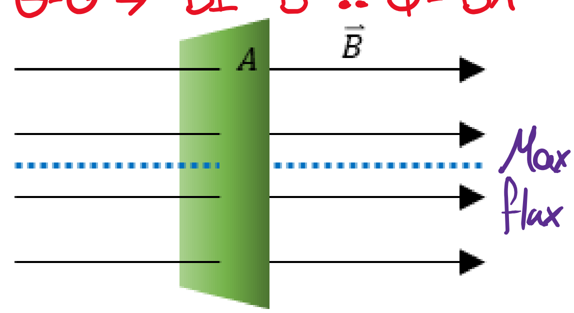
Magnetic Flux:

Flux is a measure of the amount of **magnetic field** lines that travel through a given **area**.

$$\boxed{\Phi = \vec{B}A}$$

Φ = magnetic flux ($T \cdot m^2$ = Wb = Weber)
$\vec{B}$ = magnetic field intensity (T)
A = area (m^2)

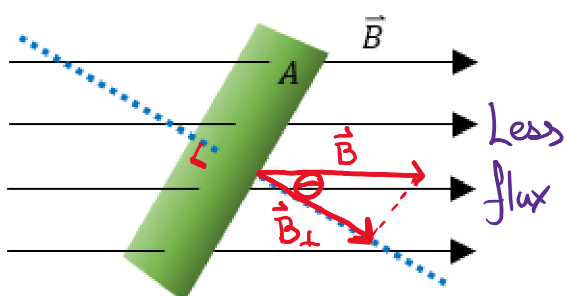
$\theta = 0 \Rightarrow \vec{B}_\perp = \vec{B} \therefore \Phi = \vec{B}A$



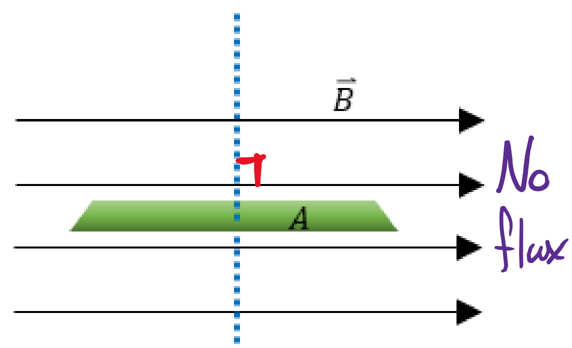
θ = angle between $\vec{B}$ the normal ($\perp$) to area.

General form:

$$\boxed{\Phi = BA\cos\theta}$$



$\vec{B}_\perp = \vec{B}\cos\theta \therefore \Phi = \vec{B}A\cos\theta$



$\theta = 90^\circ \Rightarrow \vec{B}_\perp = 0 \therefore \Phi = 0$

Example 1: Find the flux through a rectangular coil of wire with dimensions 12 cm x 5 cm which is perpendicular to a magnetic field of 0.20 T.

$A = 60 cm^2$, 5cm, 12cm

$60 cm^2 \times \frac{(1 m)^2}{(100 cm)^2} = 0.006 m^2$

$$\Phi = \vec{B}A$$
$$= 0.20T(0.006 m^2)$$
$$\boxed{= 1.2 \times 10^{-2} Wb}$$

Faraday's Law of Induction:

Induced EMF in a coil of wire depends on the **change** in magnetic flux.

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

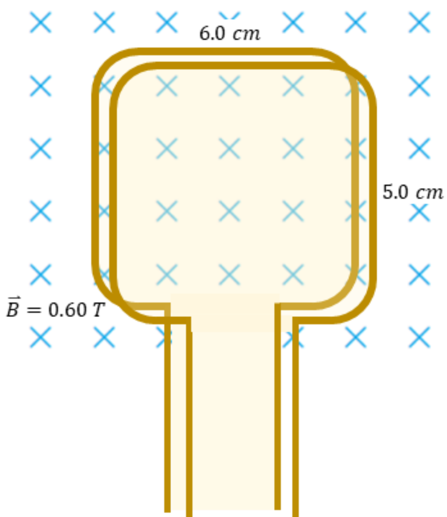
ε = Induced EMF (V)

N = # of turns/coils of wire

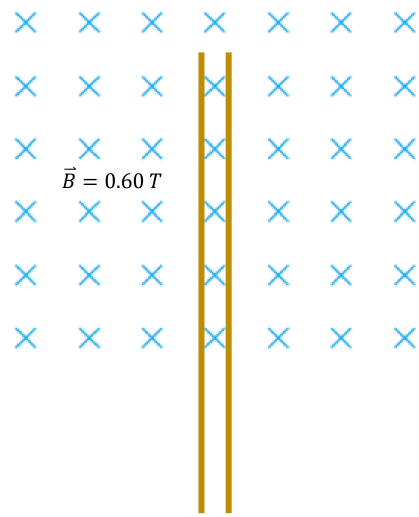
$\Delta\Phi$ = change in flux (Wb)

Δt = change in time (s)

Example 2: Find the induced EMF in the double coil shown making a 90° rotation in the magnetic field in 0.10 s.



Initial Condition



Final Condition.

$$\Phi_0 = BA\cos\theta$$
$$= (0.60T)(0.05m)(0.06m)\cos(0)$$
$$= 0.0018\ Wb$$

$$\Phi_f = BA\cos \cancel{90}\ 0$$
$$\Phi_f = 0$$

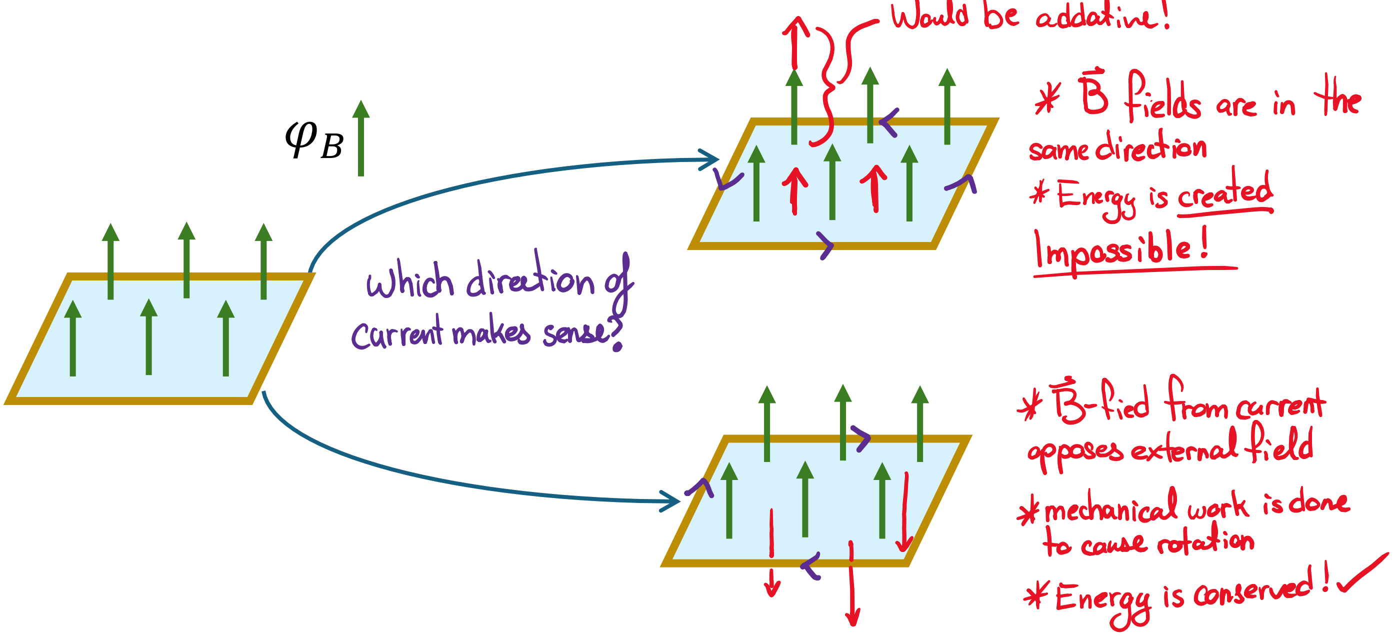
$$\varepsilon = -N\frac{\Delta\Phi}{\Delta t}$$
$$= -(2)\frac{(0 - 0.0018Wb)}{0.1s}$$
$$\boxed{= 3.6\times10^{-2}V}$$

*Moving a coil up/down or left/right will <u>not</u> change flux

↳ ∴ No ε

*Must have rotation!

Conceptualizing Lenz's Law:



Lenz's Law: The induced **current** produces a magnetic field that **opposes** the change in magnetic flux, ensuring that energy is **conserved** and external **work** is required to maintain motion.

****This opposition to change explains the negative symbol in Faraday's Law*

Example 3: Use Lenz's Law and the right-hand rule to determine the direction of conventional current for the images below: