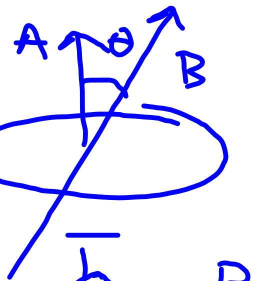
Magnetic flux

$\Phi = \vec{B} \cdot \vec{A}$ = magnetic flux through loop with area A



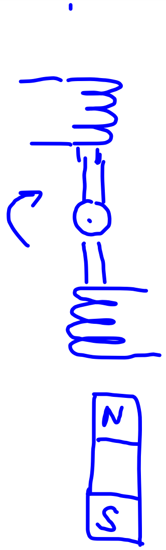
$\Phi = BA\cos\theta$

Faraday's Law

$$E \cdot \ell = \left|\frac{\Delta\Phi}{\Delta t}\right| = \mathcal{E}$$

$\mathcal{E}$ ← electromotive force

ℓ = length of loop

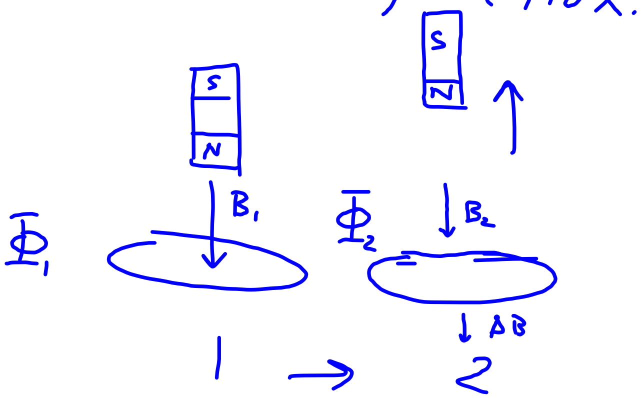


Alternator

in your car

Lenz's Law

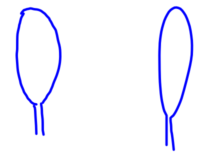
Current induced by changing magnetic flux through a loop will create a magnetic field that opposed the charge in magnetic flux.



$\Phi_2 < \Phi_1$

$B_2 < B_1$

Mutual Inductance



$\mathcal{E}_1 = \left|\frac{\Delta \Phi_1}{\Delta t}\right|$ $\mathcal{E}_2 = \left|\frac{\Delta \Phi_2}{\Delta t}\right|$

$\mathcal{E}_2 = -M_{21}\left|\frac{\Delta I_1}{\Delta t}\right|$ $\Delta I_1 \Rightarrow \Delta \Phi_1$

Changing current in loop 1 → changing mag flux in loop 1 ⇒ changing mag flux in loop 2 ⇒ Electric field in loop 2 ⇒ a Voltage around loop 2 = $\mathcal{E}_2$

$\therefore \mathcal{E}_2 = -M_{21}\left|\frac{\Delta I_1}{\Delta t}\right|$

M_{21} = constant of proportionality = "mutual Inductance"

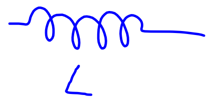
Self Inductance

$\mathcal{E} = -L\left|\frac{\Delta I}{\Delta t}\right|$ only 1 loop (coil)

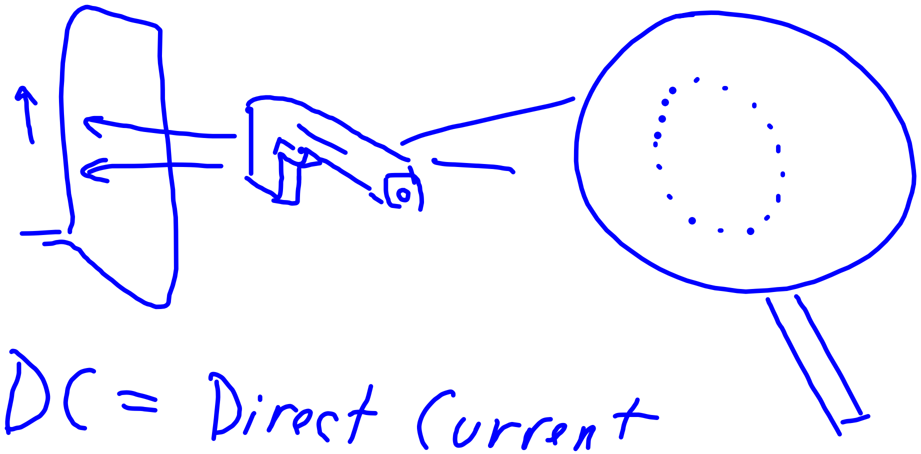
translation: change in current in a loop ⇒ "backward" voltage in loop

Circuit element: Inductor

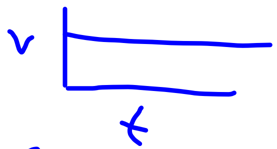
symbol:



Metal Detector



DC = Direct Current
(voltage does not change with time)



AC = Alternating Current
(voltage changes in periodic way)