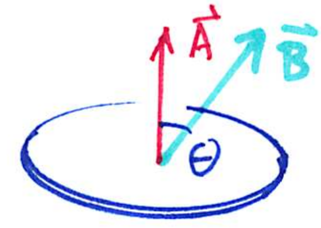
Faraday's Discovery:

A **B** field can induce a current and emf in a conductor if the magnetic flux



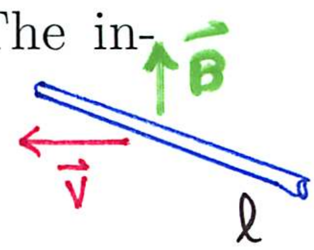
$$\Phi_B = AB\cos\theta$$

through the conductor changes with time for any reason.

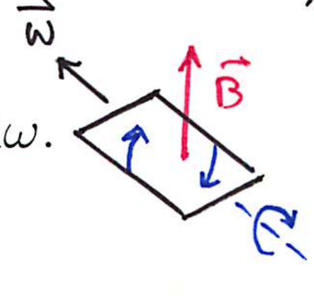
Faraday's Law of Induction: $\mathcal{E} = -N\frac{\Delta\Phi_B}{\Delta t}$.

Lenz Rule: Induced currents and induced emfs oppose any change that created them. [Thus for example if a current is induced by a **B** field that is increasing in magnitude, the induced current will generate a magnetic field that is in the opposite direction to the direction the original **B** field is increasing.]

Wire moving in uniform B field: The induced **E** satisfies $E = vB$. Also $\Delta V = Bv\ell$.



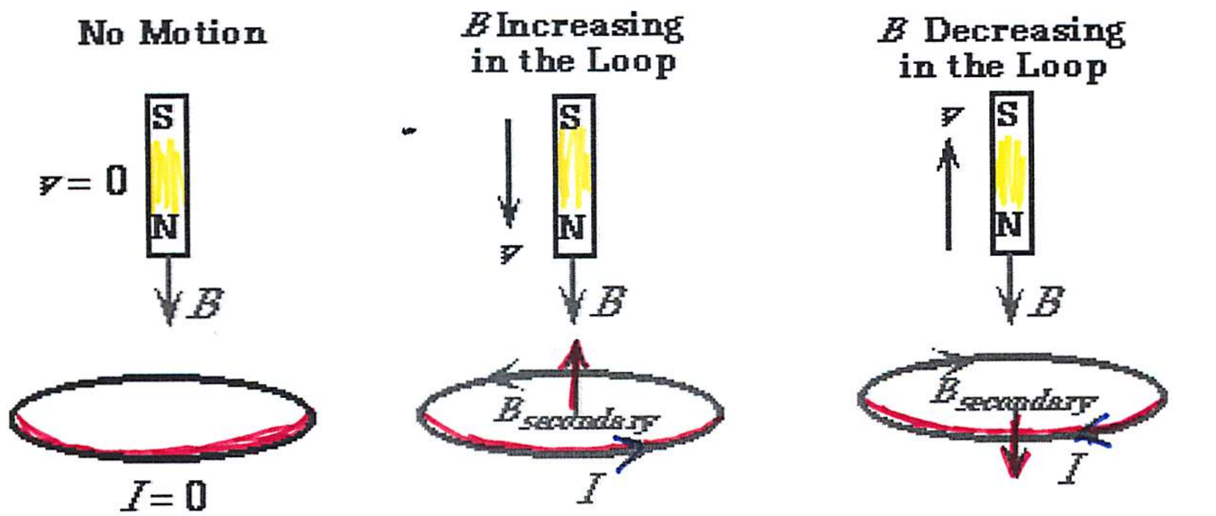
Generator:



$$\mathcal{E} = NBA\omega\sin(\omega t) \text{ so } \mathcal{E}_{\max} = NBA\omega.$$

Lenz's Law:

Any induced effect always *opposes* the change that created it. Thus, for example, increasing **B** fields induce **B** fields in the *opposite direction*, to try to cancel the increase. Thus induced currents give rise to such **B** fields. A decreasing magnetic flux Φ_B from any cause produces effects that tend to try to cancel the decrease. And so on.



Self-Inductance:
The inductance L is defined by $\mathcal{E} = -L(\Delta I)/(\Delta t)$. An easy way to find L is to use the relation $L = N\Phi_B/I$.

Self-Inductance of a solenoid:

$$L = \mu_0 A \ell n^2 = \mu_0 n^2 V.$$

Energy stored in an inductor:
$PE_L = (1/2)LI^2$, which leads to the energy per unit volume of a **B** field in vacuum being $(1/2)(B^2/\mu_0)$. Compare to the similar results for a capacitor, which are $PE_C = (1/2)C(\Delta V)^2$ and the energy per unit volume of an **E** field in vacuum, $(1/2)\epsilon_0 E^2$.

RL circuit:

$$I(t) = \frac{\mathcal{E}}{R}[1 - \exp(-tR/L)].$$