

Induction

$$\mathcal{E} = -N \frac{d\Phi_B}{dt}$$

Induction

Production of emf due to Changing Flux

$\mathcal{E} = -N \frac{d\Phi_B}{dt}$

Faraday's Law

Induction

Some applications:

- Changing magnitude of field
- Changing size of loop relative to field
- Changing loop direction relative to field
- Conductor moving in field

$$\mathcal{E} = -N \frac{d\Phi_B}{dt}$$

Example: A square loop of wire has area vector, $\vec{A} = L^2 \hat{k}$, in a region with a magnetic field, $\vec{B} = B_0 \cos(\omega t) \hat{k}$.

- Changing magnitude of field

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How could you create a spatially uniform magnetic field that changed as a function of time?

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Solenoid

Could change location of loop relative to source of magnetic field.

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Solenoid

Could change location of loop relative to source of magnetic field.

Example: A conducting bar is slid along a U-shaped conductor such that the formed loop has an area vector parallel to a uniform magnetic field in the region.

- Changing size of loop relative to field

$$\mathcal{E} = -N \frac{d\Phi_B}{dt}$$

\vec{B}

\vec{v}

L

Example: A square conducting loop is moved into a region of uniform magnetic field such that the loop's area vector is parallel to the magnetic field.

- Changing size of loop relative to field

$$\mathcal{E} = -N \frac{d\Phi_B}{dt}$$

\vec{B}

\vec{v}

L

Example: A square conducting loop is rotated in a region with a uniform magnetic field.

- Changing loop direction relative to field

$$\mathcal{E} = -N \frac{d\Phi_B}{dt}$$

\vec{B}

x
 y
 z

$$\vec{A} = L^2 [\sin(\omega t) \hat{i} + \cos(\omega t) \hat{k}]$$

Example: A conducting rod is moved through a region of uniform magnetic field.

- Conductor moving in field

$$\mathcal{E} = -N \frac{d\Phi_B}{dt}$$

\vec{B}

\vec{v}

L

Induced \mathcal{E}

- Units of potential difference
- Not a potential difference between two locations
- Direction determined by Lenz's Law

Lenz's Law

The induced \mathcal{E} in a loop results in a current that produces a magnetic field. The direction of induced current is such that the induced magnetic flux opposes the change in magnetic flux.

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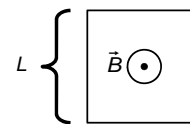
$$\text{IF } \frac{d\Phi_B}{dt} > 0 \quad \text{THEN } \Phi_{B_i} < 0$$

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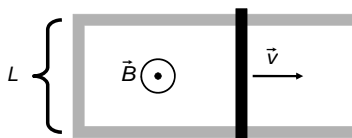
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- Changing size of loop relative to field

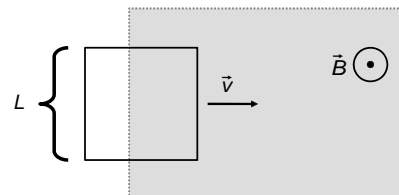
Lenz's Law



Example: A square conducting loop is moved into a region of uniform magnetic field such that the loop's area vector is parallel to the magnetic field.

- Changing size of loop relative to field

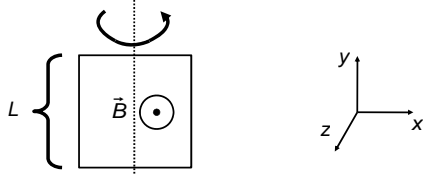
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