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:

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

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

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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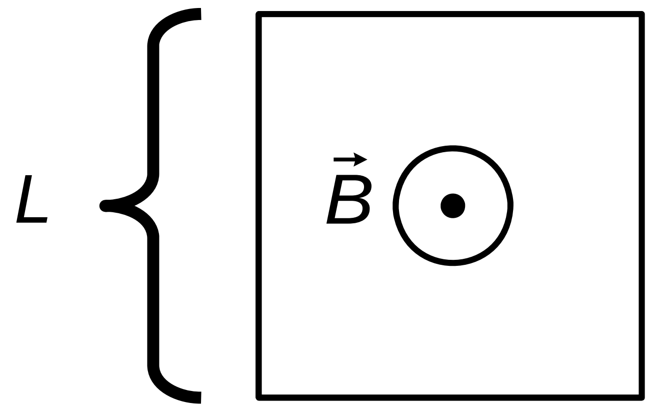

How could you create a spatially uniform magnetic field that changed as a function of time?

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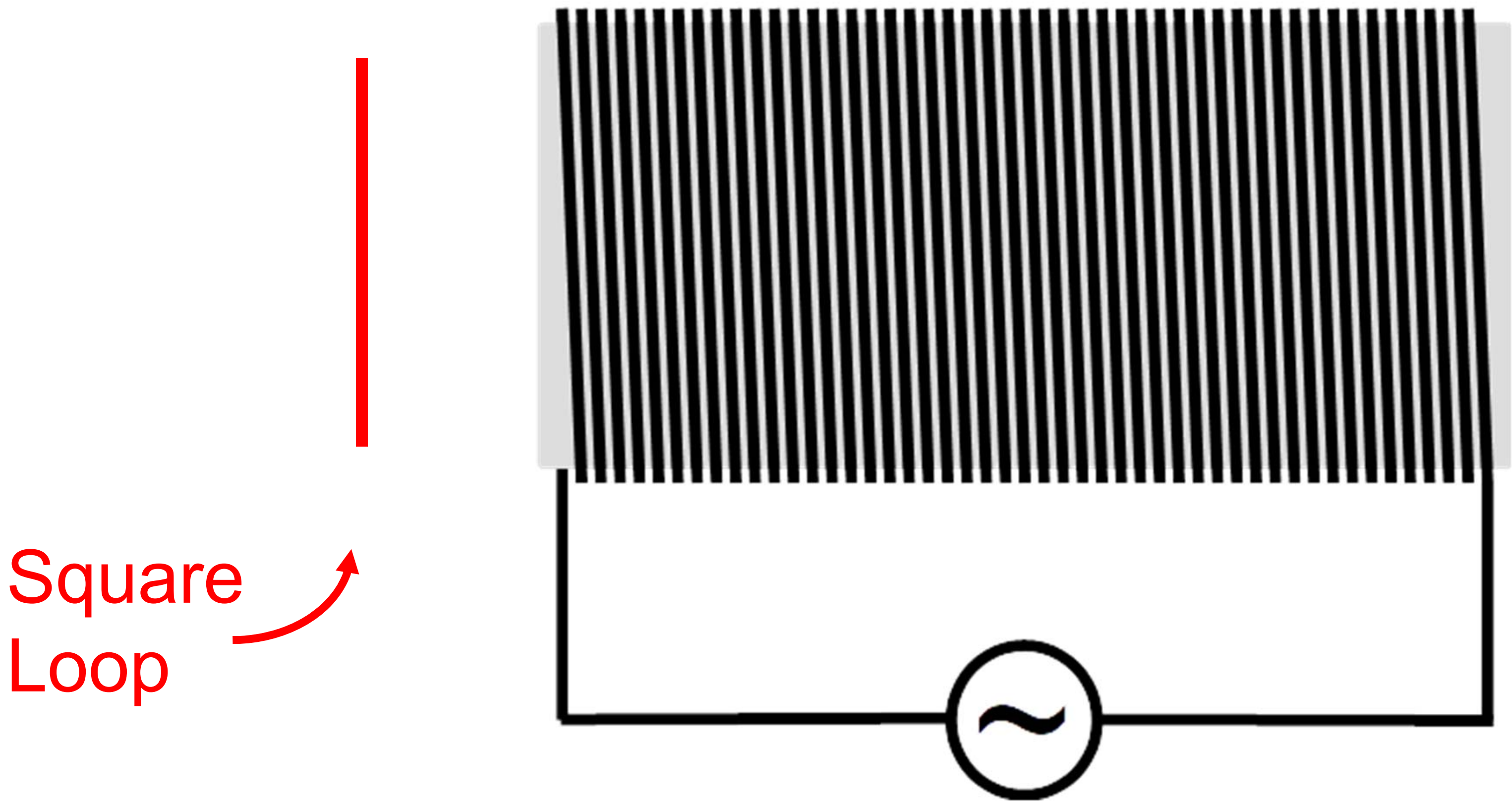

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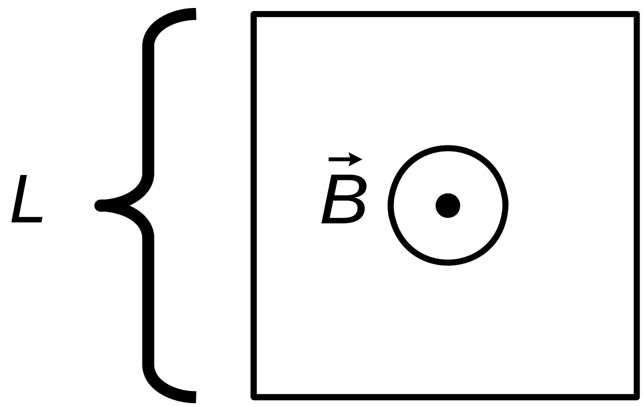

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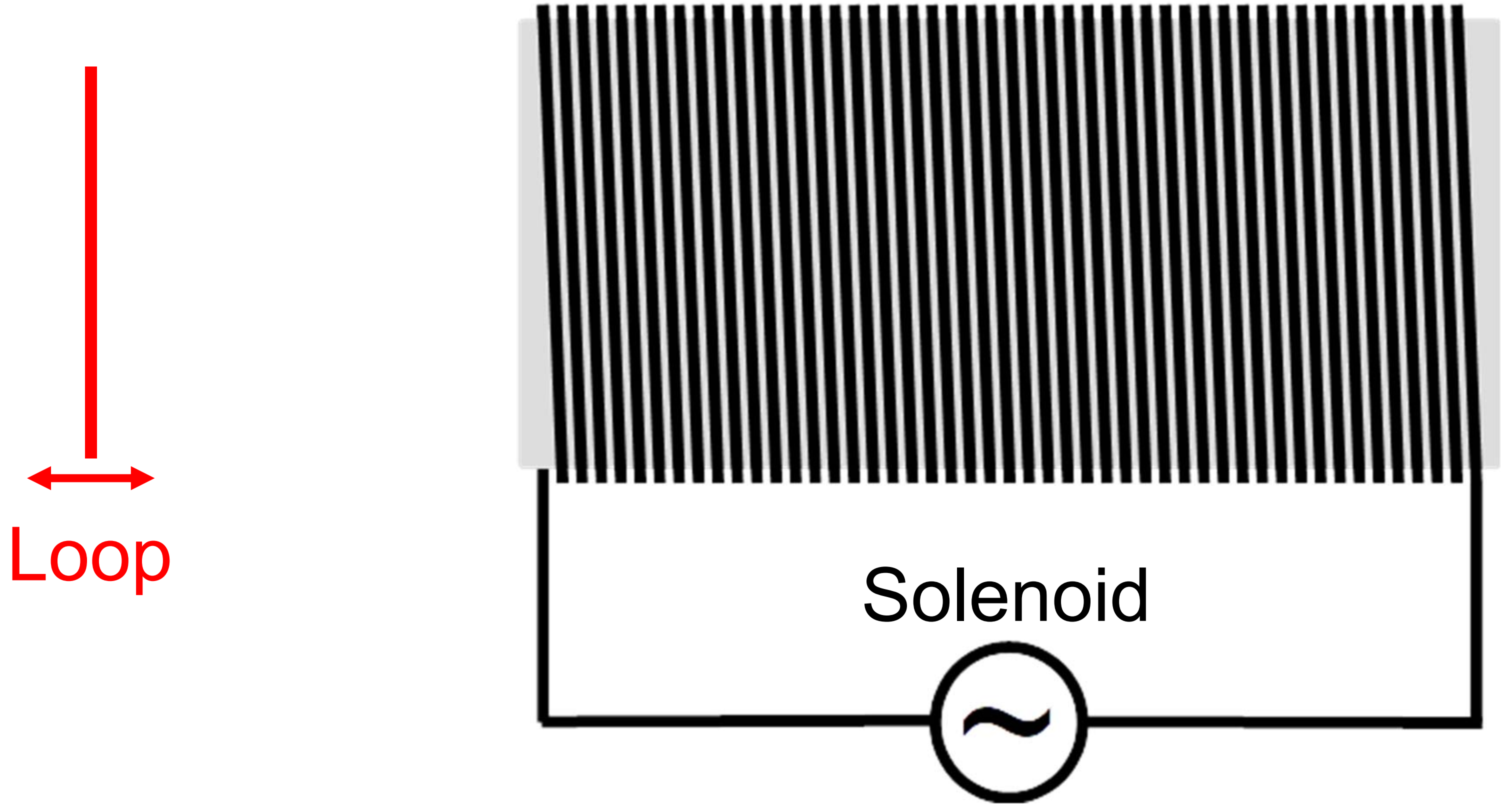

Could change location of loop relative to source of magnetic field.

Induction

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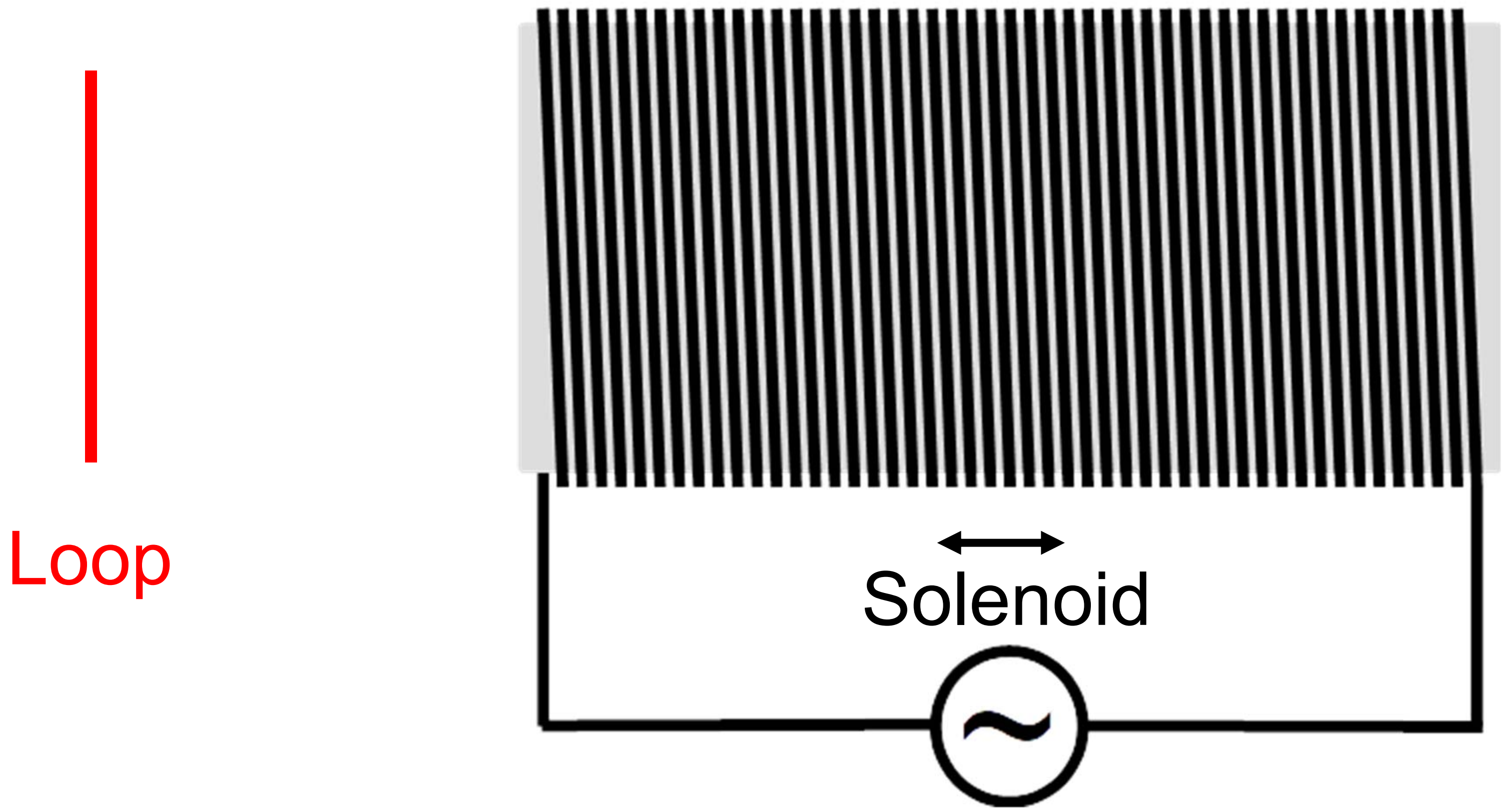

Could change location of loop relative to source of magnetic field.

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

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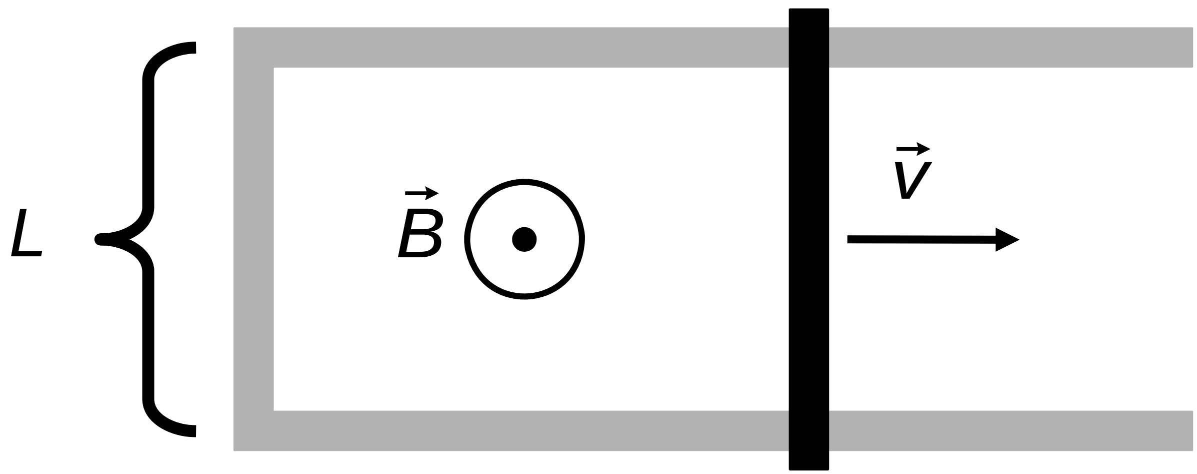

Example: A square conducting loop is moved into a region of uniform magnetic field such that the loop's area vector is parallel to the magnetic field.

- Changing size of loop relative to field

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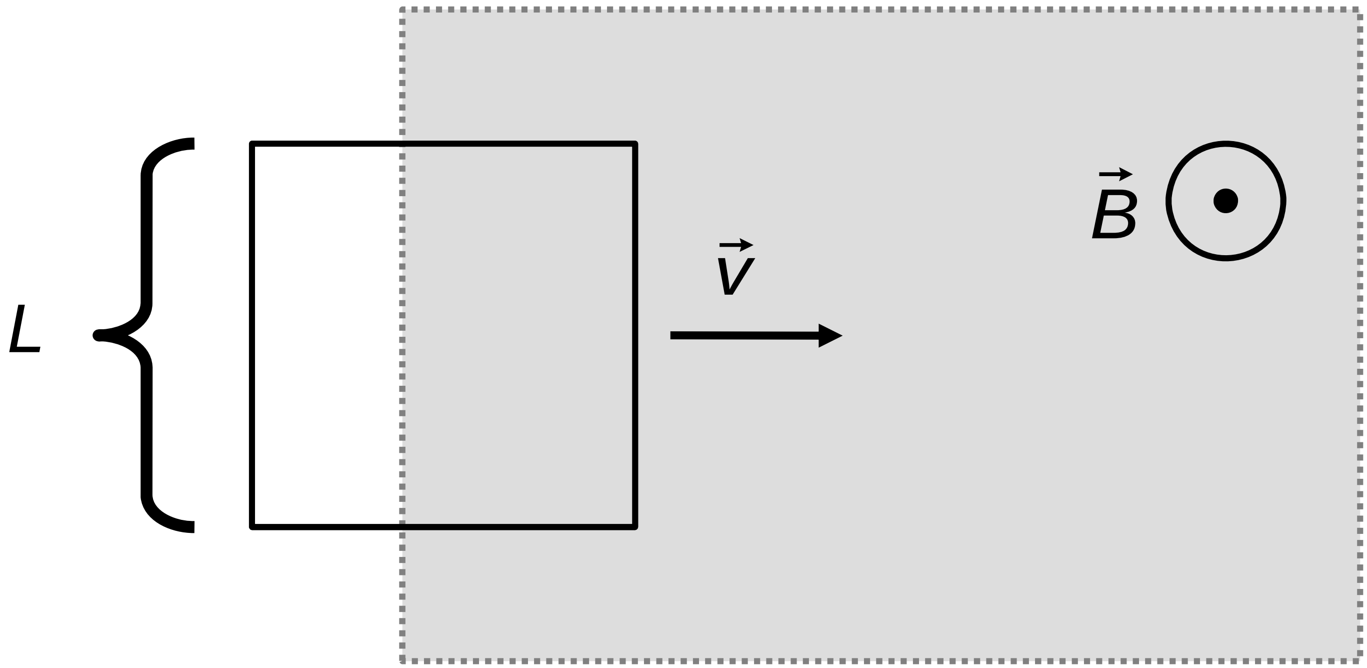

Example: A square conducting loop is rotated in a region with a uniform magnetic field.

- Changing loop direction relative to field

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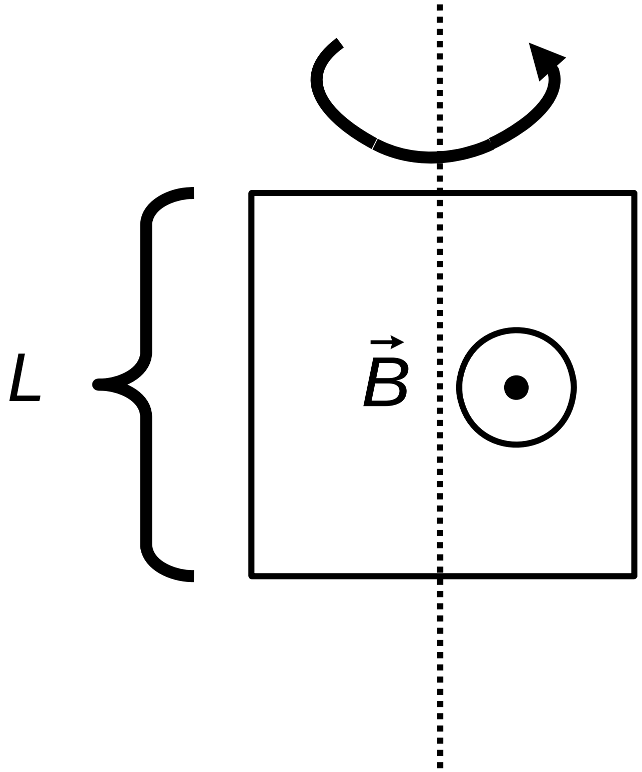

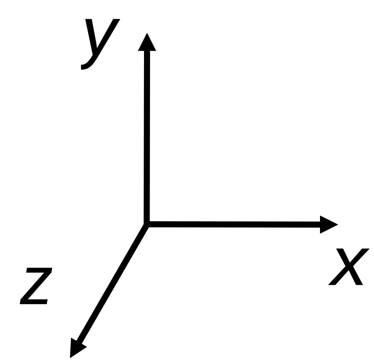

$$\vec{A} = L^2[\sin(\omega t)\hat{i} + \cos(\omega t)\hat{k}]$$

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

- Conductor moving in field

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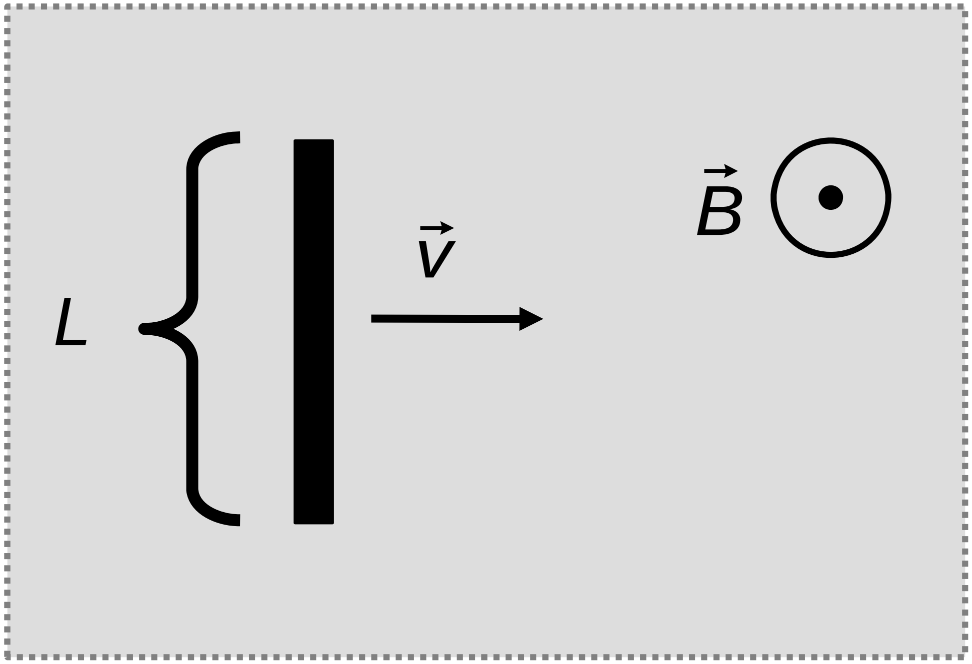

Induced $\mathcal{E}$

- 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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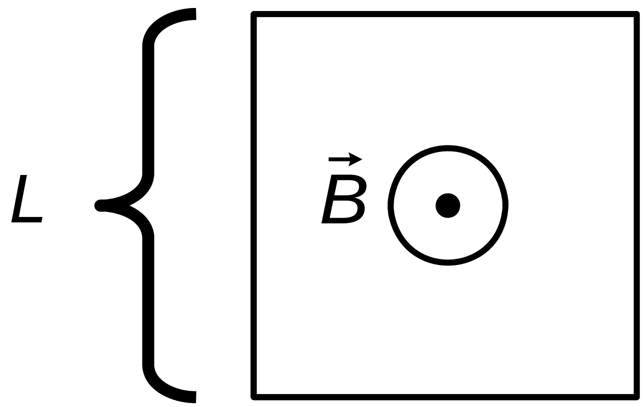
- Changing magnitude of field

Lenz's Law



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- Changing size of loop relative to field

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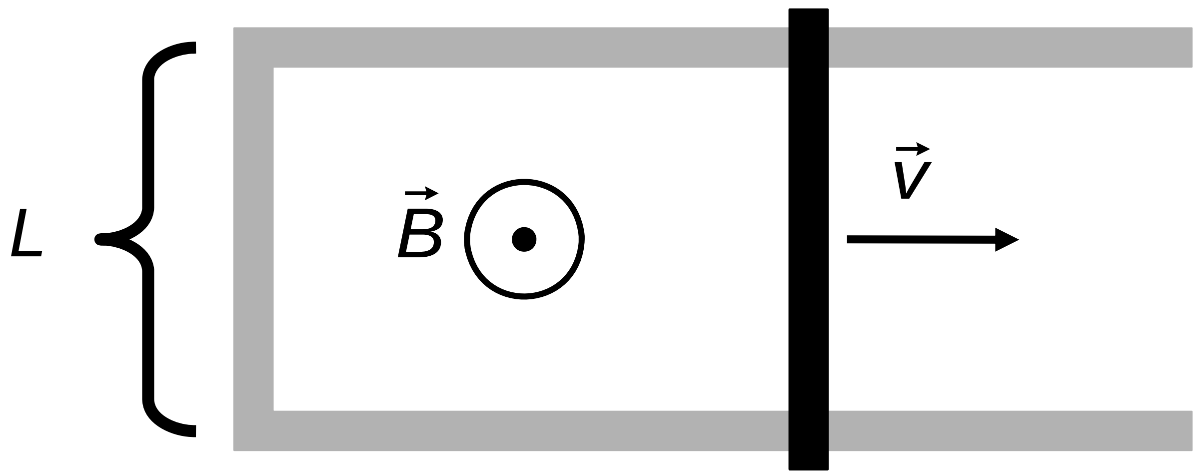

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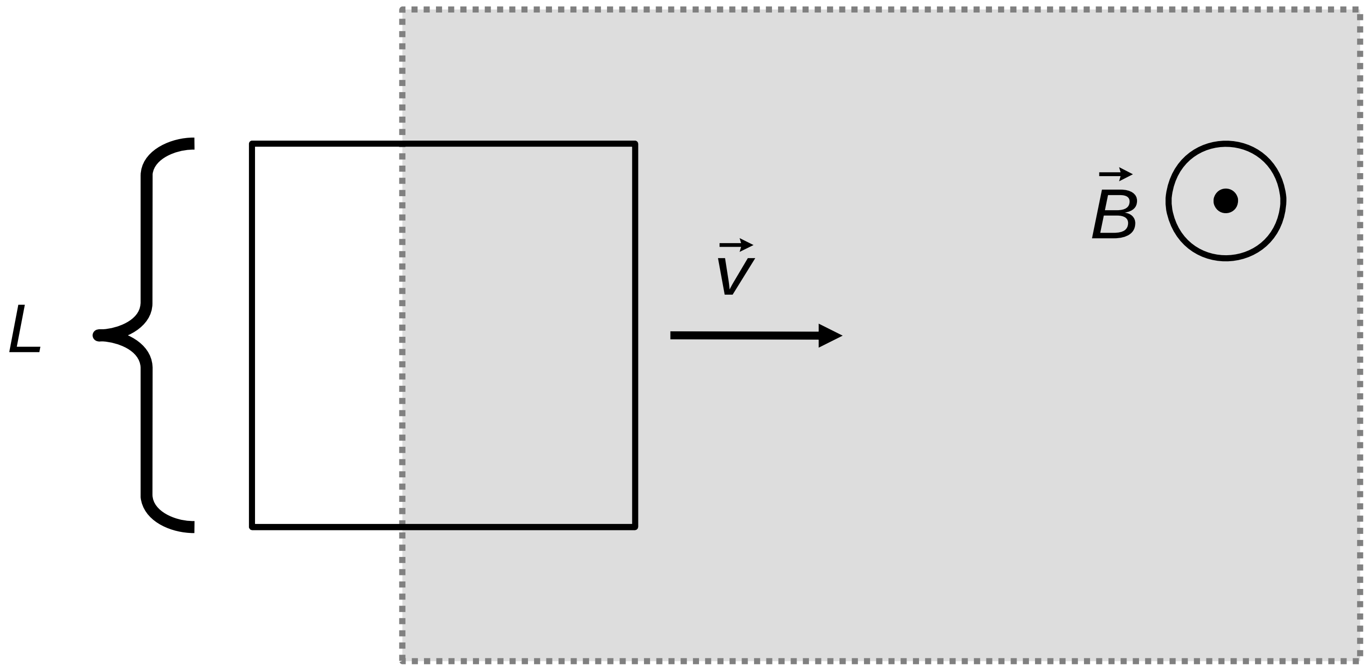

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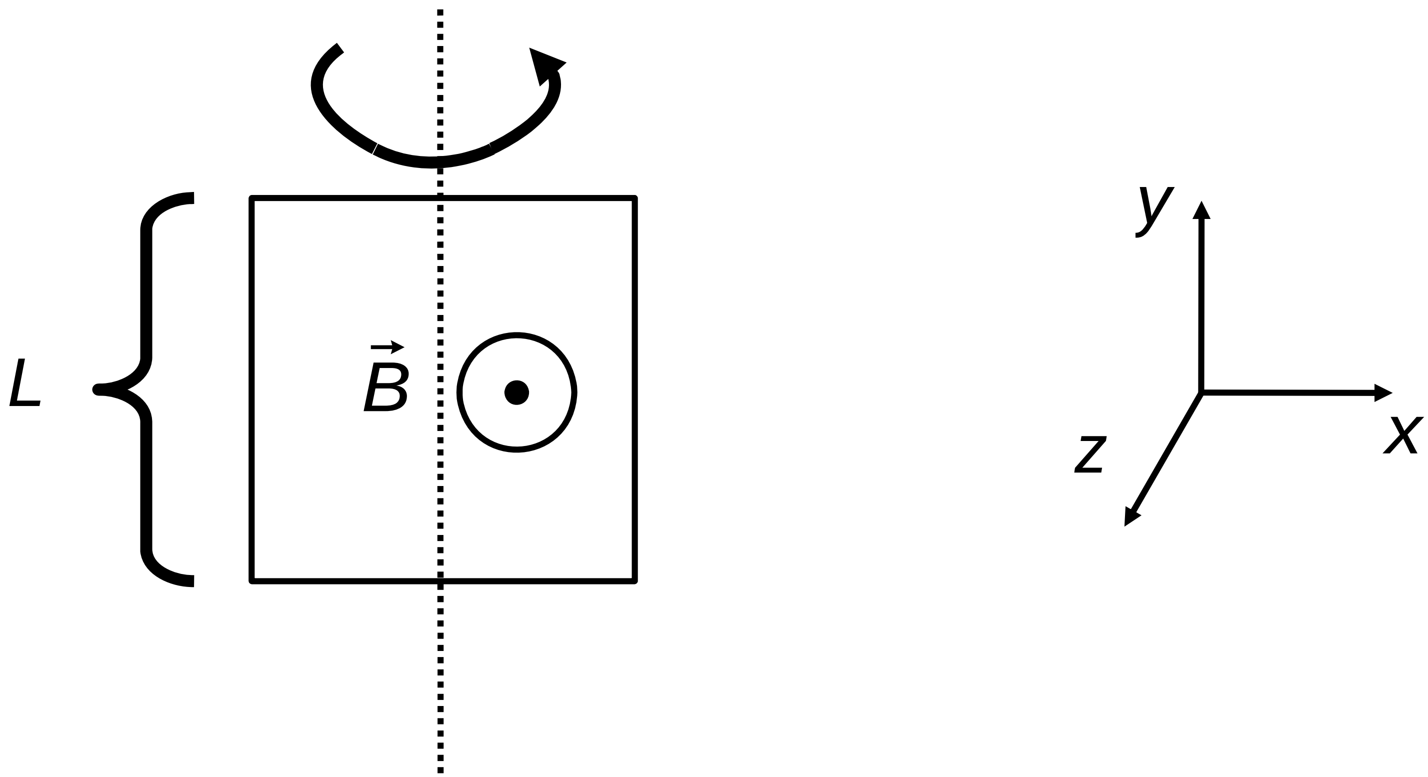

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