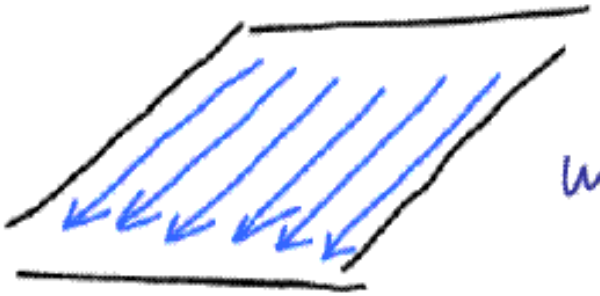
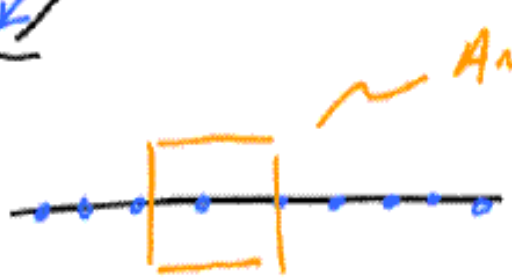
Physics 114 - March 18, 2010

- Exam Next Tuesday
  - 8 AM
  - Hoyt unless I email you otherwise
- Q+A session Monday
  - Time/Loc TBA via email

Last Time:

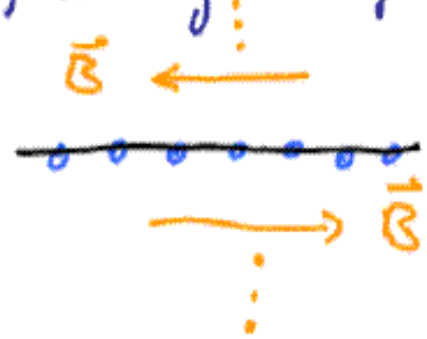


∞ current sheet with linear uniform current density j



use Ampere's Law + Symmetry to get

$$|B| = \frac{\mu_0 j}{2}$$



$\vec{B}$ uniform + ∞

Infinite Solenoid

$\vec{B}$ field

B_{TOP}

$B = 0$

B_{BOTT}

current out

$B = \mu_0 i n$ uniform B_{TOP} B_{BOTT}

current in

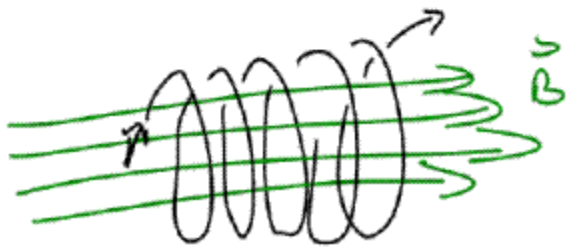
$B = 0$

B_{TOP}

B_{BOTT}

B_{BOTT}

$n \equiv$ Turns/length

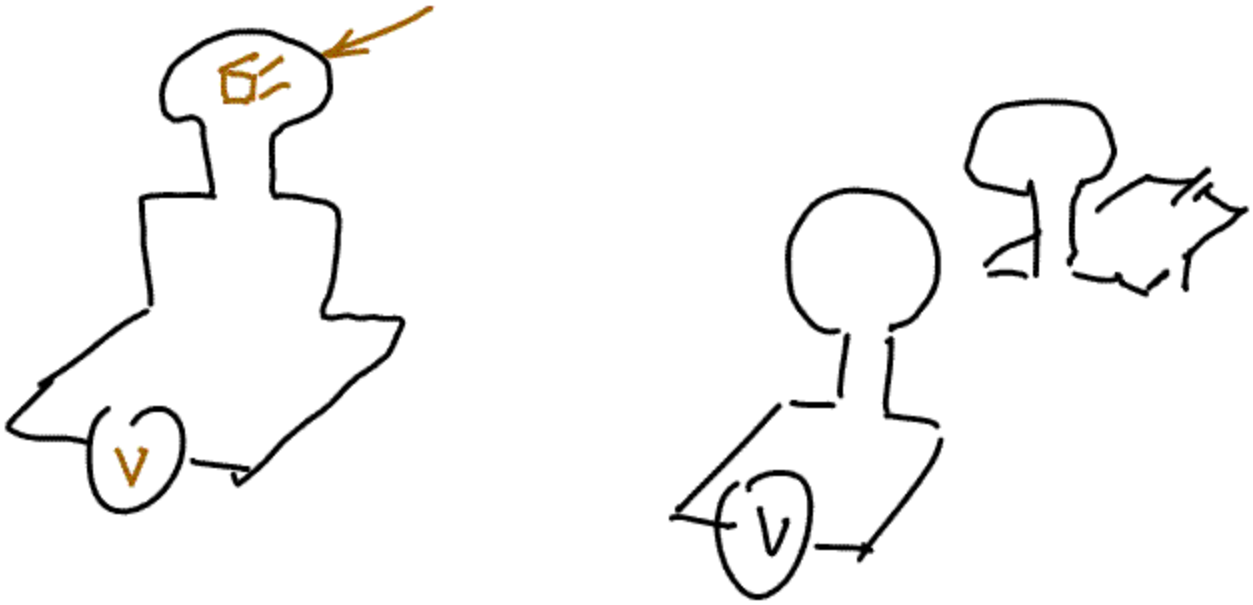


~~Seduction~~

Induction

A changing Magnetic field induces an EMF

a changing electric field



Michael Faraday
(1791–1867)

British physicist
+
chemist

Discovered
Magnetic induction

Farad named
after Faraday

Also invented the
Bunsen Burner

No changing fields
Magnetostatics

Kirchoff

$$\sum V\Big|_{\substack{\text{closed}\\ \text{loop}}} = 0$$

$$E \sim -\frac{dV}{dx}$$

$$E \cdot dl \sim V$$

$$\oint \vec{E} \cdot d\vec{l} = 0$$

Kirchoff in free space

Changing fields

$$\mathcal{E} = \oint_{\text{closed loop}} \vec{E} \cdot d\vec{l} = -\frac{d\Phi_M}{dt}$$

$$\Phi_M = \int_{\text{surf}} \vec{B} \cdot d\vec{A}$$

Faraday's Law

wires

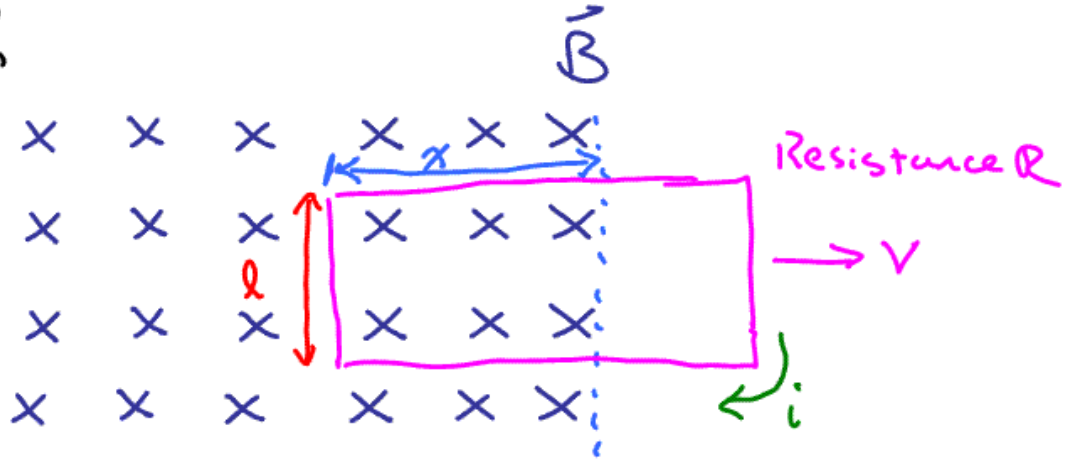
Free space

Materials

...

Lenz's law – The induced current opposes the change that produced it

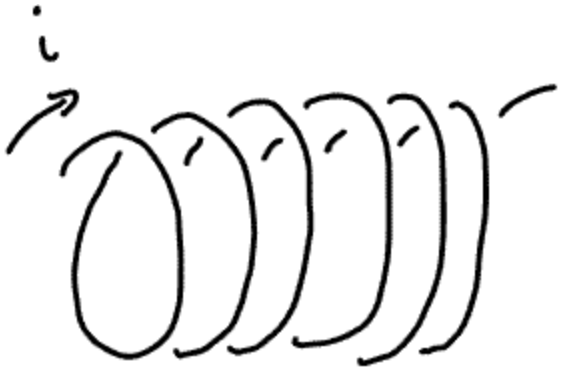
What is i?



$$\mathcal{E} = -\frac{d\Phi_M}{dt} = -\frac{d(B\ell x)}{dt} = -B\ell\frac{dx}{dt} = -B\ell v$$

$$\mathcal{E} = iR \qquad |i| = \frac{\mathcal{E}}{R} = \frac{B\ell v}{R}$$

inductor without a date



$\Phi_M \propto i$

$\Phi_M = BA$ (A: x sect Area)

$\Phi_M = (\mu_0 n i) A$ $\quad \Phi_M \propto i$

length of solenoid $\equiv \ell$

loops $= n\ell$

$$\Phi_M = (\mu_0 n i A) n \ell$$

length ℓ

$$= [\mu_0 n^2 A \ell]\, i$$

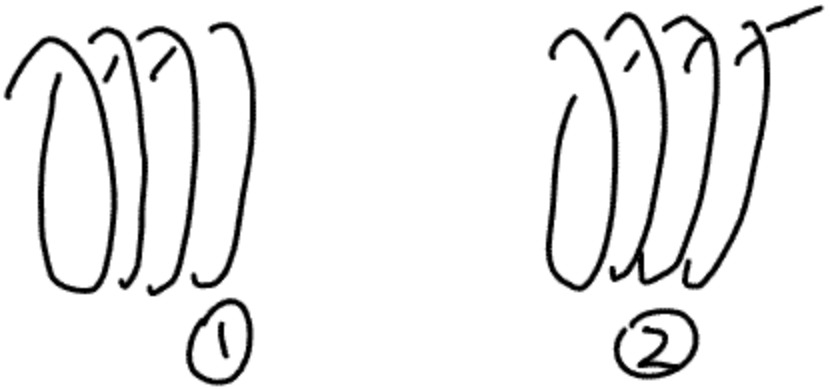
geometry

$$\Phi_M = L i$$

L: CONSTANT of self-inductance

$$\frac{di}{dt} \rightarrow \frac{d\Phi_M}{dt} \rightarrow \mathcal{E}$$

$$\Phi_M = L i \qquad \mathcal{E} = -\frac{d\Phi_M}{dt} = -L\frac{di}{dt}$$



get a similar effect when one circuit "talks" to another

... mutual inductance