# Before Lab This Week

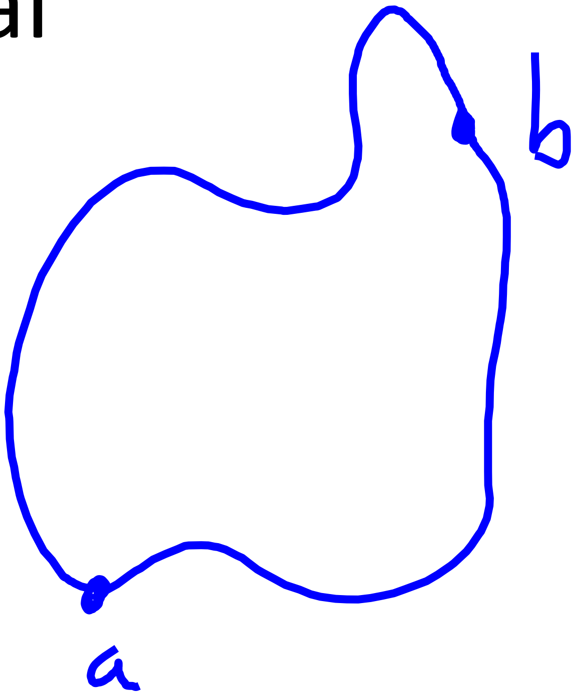
- Read through the entirety of Lab 6 - RLC Circuits in the manual.
- Pay special attention to all of Section 6.1.
- Do Exercises 1 and 2 and bring these with you to lab.

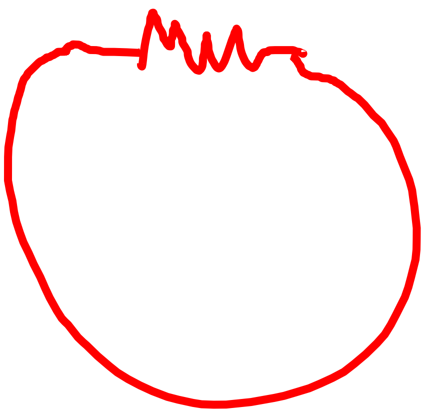
M.C. Escher, Waterfall
http://en.wikipedia.org/wiki/Waterfall_%28M._C._Escher%29

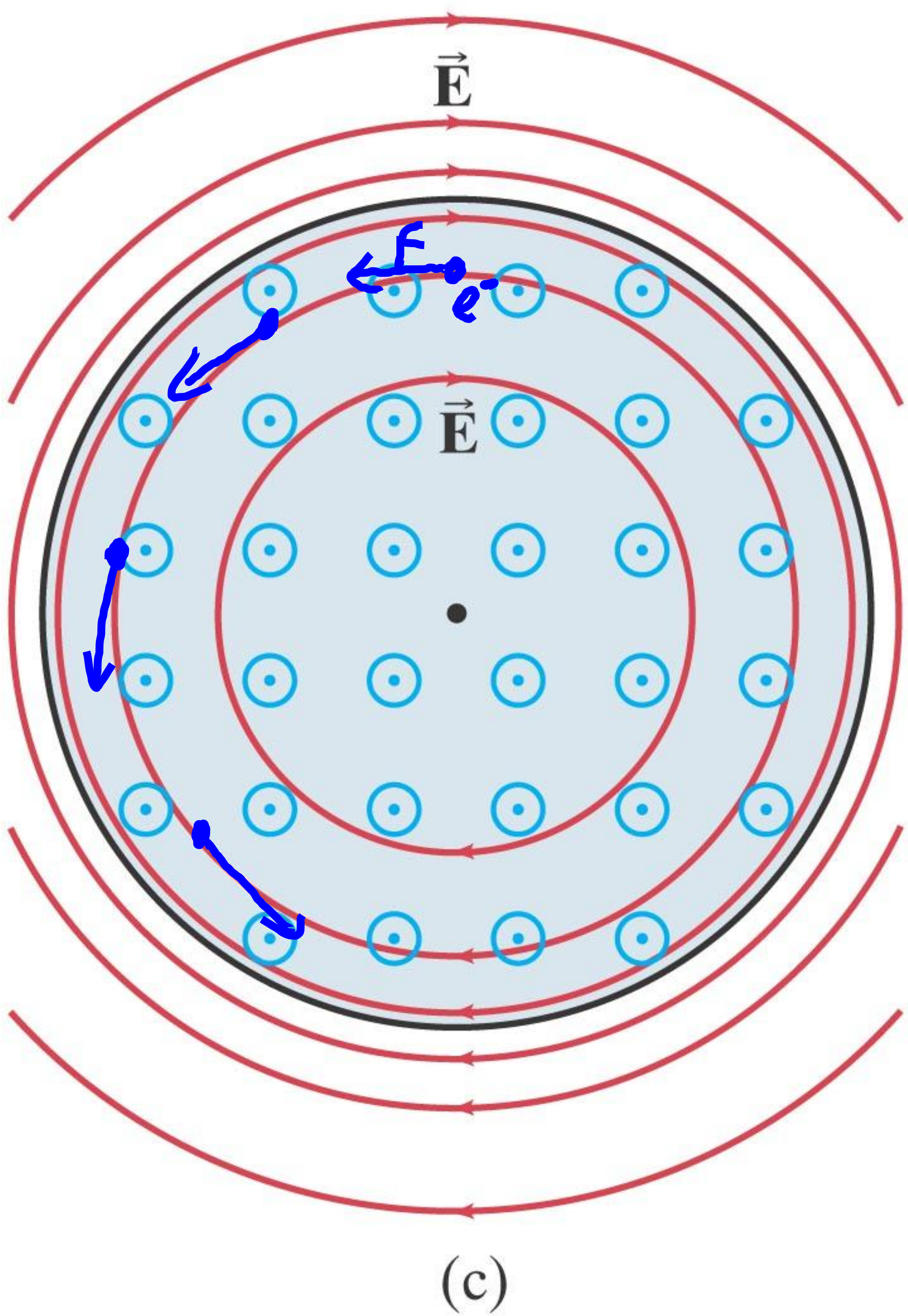
# Electric Potential

$$V_b - V_a = \Delta V = -\int_a^b \vec{\mathbf{E}}\bullet d\vec{\mathbf{l}}$$

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






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



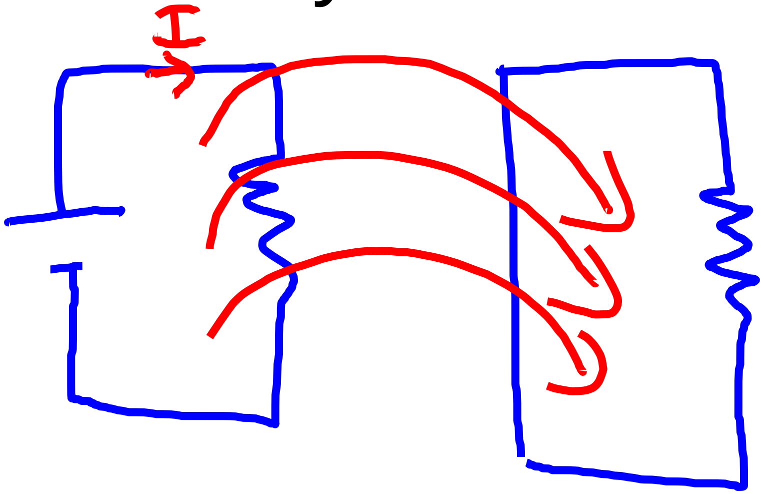
Figure 29.27c

# Faraday's Law

- A changing magnetic field induces a *curly* electric field – one for which you cannot define a potential *V*.

$$\mathcal{E} = \oint \vec{\mathbf{E}} \bullet d\vec{\mathbf{l}} = -\frac{d}{dt}\int \vec{\mathbf{B}} \bullet \hat{\mathbf{n}}\, dA$$

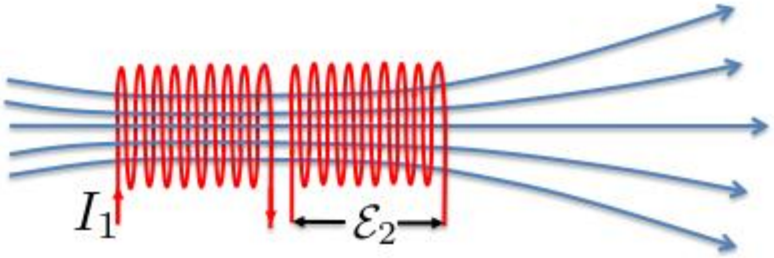
For the current in a stationary circuit to induce a current in an independent stationary circuit, it is necessary for the first circuit to have




1) a steady current.
2) a large current.
3) no current.
4) a changing current.
5) None of these is correct.

# Mutual Inductance

- Emf will be induced in a coil when the flux through that coil is changing: $\varepsilon = -\frac{d}{dt}\int \vec{\mathbf{B}} \bullet \hat{\mathbf{n}} \, dA$
- That flux could be produced by current in a different coil: $B \propto I \Rightarrow \frac{dB}{dt} \propto \frac{dI}{dt}$
- So, a changing current in one coil, induces an emf in another coil: $\varepsilon_2 = M \frac{dI_1}{dt}$
- *M* = mutual inductance, a geometric and materials property.




http://www.ic.sunysb.edu/Class/phy141md/doku.php?id=phy142:lectures:23

# Self Inductance

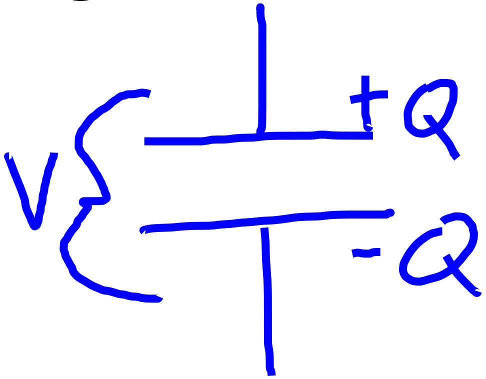
- A changing current in one part of a current-carrying circuit can induce an emf *in the same circuit*.

$$\varepsilon = -L\frac{dI}{dt}$$

- *L* = self inductance, a geometric and materials property.
- Units – Henry (H) = Vs/A = $\Omega$s

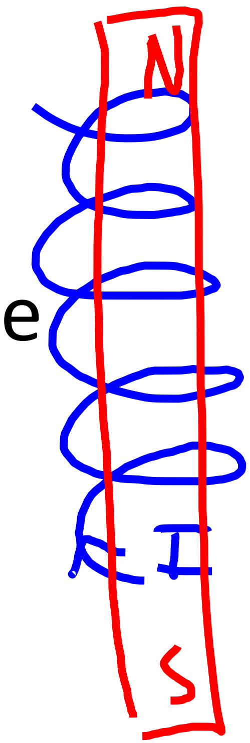
# Capacitor

- Two conductors with opposite charges on them.
- Stores charge and energy.




- Capacitance:
  - Charge “moved” from one conductor to the other is proportional to the potential difference between the conductors: $Q = CV$
  - Capacitance is a geometric and materials property.

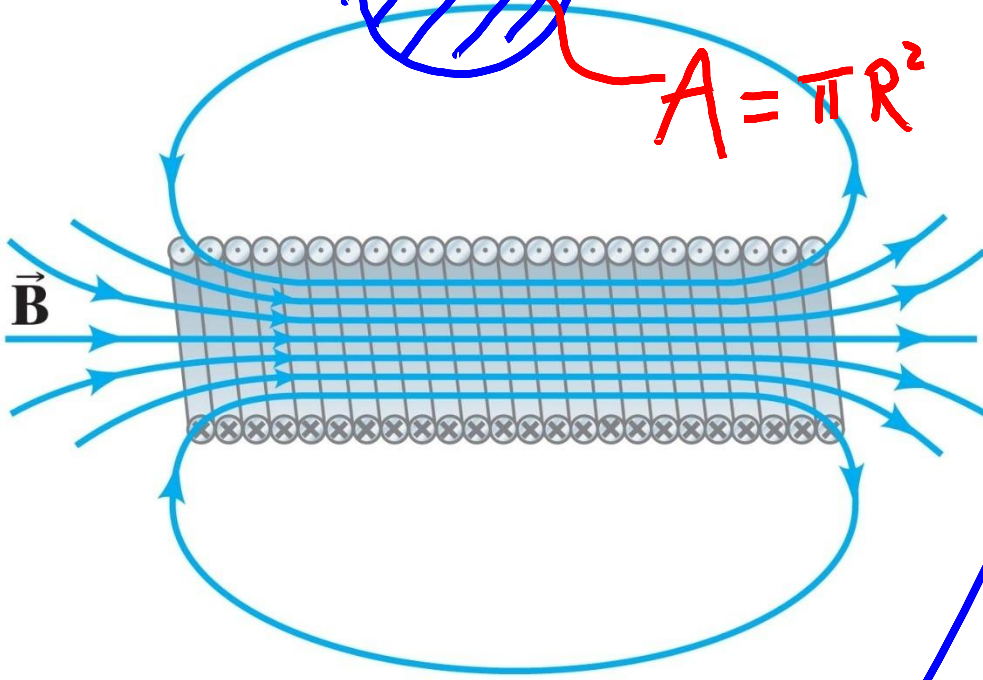
# Inductor




- A current-carrying wire formed into some geometric shape (e.g. a solenoid).
- Stores magnetic flux and energy.
- Inductance:
  - Magnetic flux inside the inductor is proportional to the current passing through it: $N\Phi_B = LI$
  - Constant of proportionality *L* is called *inductance*.
  - Inductance is a geometric and materials property.

$$\mathcal{E} = -N\frac{d\Phi_B}{dt} = -\frac{d(LI)}{dt} = -L\frac{dI}{dt}$$

# Solenoid




(b)



Figure 28.15b

$A = \pi R^2$

$N \Phi_B = L I$

$\frac{N \mu_0 N I A}{l} = L I$

$L = \frac{\mu_0 N^2 A}{l}$

$$B = \frac{\mu_0 N I}{l}$$

$\Phi_B = BA = \frac{\mu_0 N I A}{l}$

A solenoid is constructed with $N$ loops of wire tightly wrapped around an iron-filled center. Due to budget cuts, the current that ordinarily runs through this solenoid is cut in half. As a result, the inductance of the solenoid is

1) unchanged.
2) quartered.
3) halved.
4) doubled.
5) quadrupled.