How Things Work II
(Lecture #19)

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Course web site available through COD and Toolkit
or at http://people.virginia.edu/~gdc4k/phys106/spring07

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Announcements

• The midterm has been postponed until Wednesday, March 14th.
  - The midterm will cover everything up to and including chapter 11, and some of chapter 12 (Probably section 12.1).
• Problem Set #3 is posted, and is due this coming Friday, March 2nd, at roughly 11:59PM.
Electronics and power adapters
P-N junctions

- With doped semiconductors you have an excess of either holes (p-type) or electrons (n-type).
- At a junction of p-type and n-type semiconductors, electrons drop down to fill the holes until Coulombic repulsion stops the process.
- In the depletion region, the orchestra is once again filled, and no one can move.
If you add electrons from the right and pull them off from the left, (forward bias the diode), you replenish the electrons in the n-type semiconductor, replenish the holes in the p-type semi-conductor, and eliminate the depletion region. Now electrons can flow.

If, on the other hand, you pull electrons from the right and push them in from the left, the depletion region grows and no current can flow.
What can you do with one diode?

Half-Wave Voltage Rectifier .... AC to DC
“Full-wave” rectifier with four diodes

The diode bridge ensures that, regardless of whether the transformer is on a positive or negative cycle, positive charge is routed to the top wire.
Current path when top leg is positive

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"Medium quality" power adaptor circuit

- The circuit contains:
  - a transformer,
  - four diodes,
  - and a capacitor.
Capacitors

- Can be thought of as two parallel plates.
- When voltage is applied to them, charge flows onto the plates.
- When the voltage is disconnected, they store the charge.
- In some ways, they can almost act like a battery.
Capacitors

- The larger the capacitance, the more charge you can put on it without building up too much voltage.

\[ V = \frac{q}{C} \]

- The bigger the plates, the larger the capacitance.
- The closer the plates, the larger the capacitance.

\[ C = \frac{A \varepsilon_0}{d} \]
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- Put these together, and you can see that for fixed charge, the voltage should change depending on, for instance, separation.
Capacitors

- Capacitors can store energy.

\[ U = \frac{q^2}{2C} = \frac{1}{2} CV^2 \]
“Full-wave” rectifier with four diodes

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