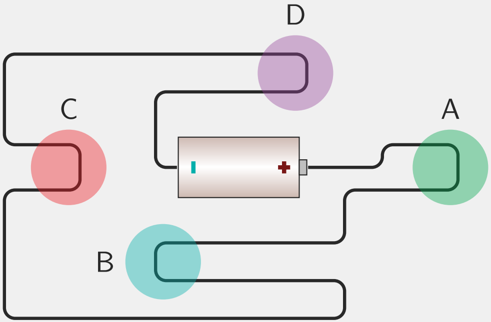
Announcements

- Homework
  - Webwork 13 due tonight
  - Webwork 14 will be due on Friday
- **Test 2 will be a week from Friday**
- I'll aim to have some study materials posted this weekend
- Polling: `rembold-class.ddns.net`

Review Problem

Given the circuit to the right, in what region would you expect an excess of negative charge to build up on the surface of the wire due to the electric field of the battery?

A. Region A
B. Region B
C. Region C
D. Region D

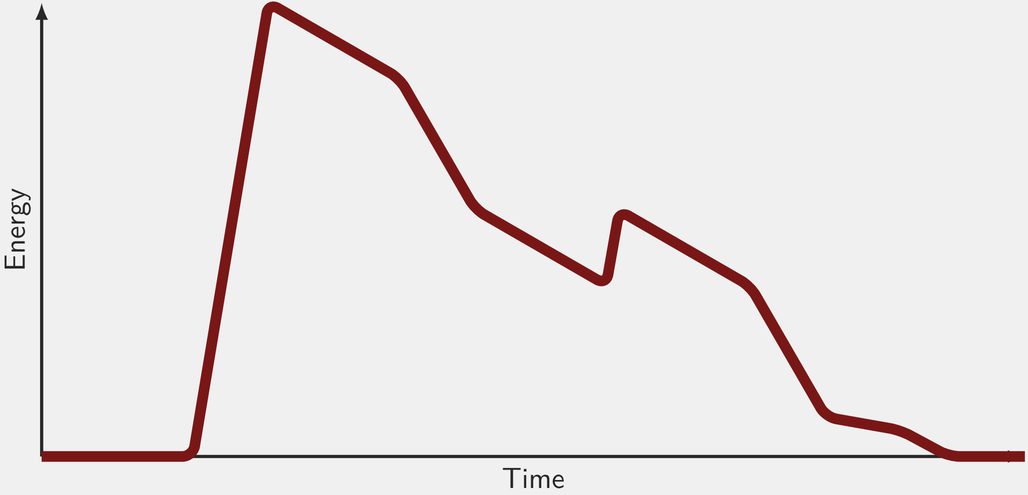


Solution: Region D

Not Always Negligible

Link: here

A Day in the Life



A Day in the Life

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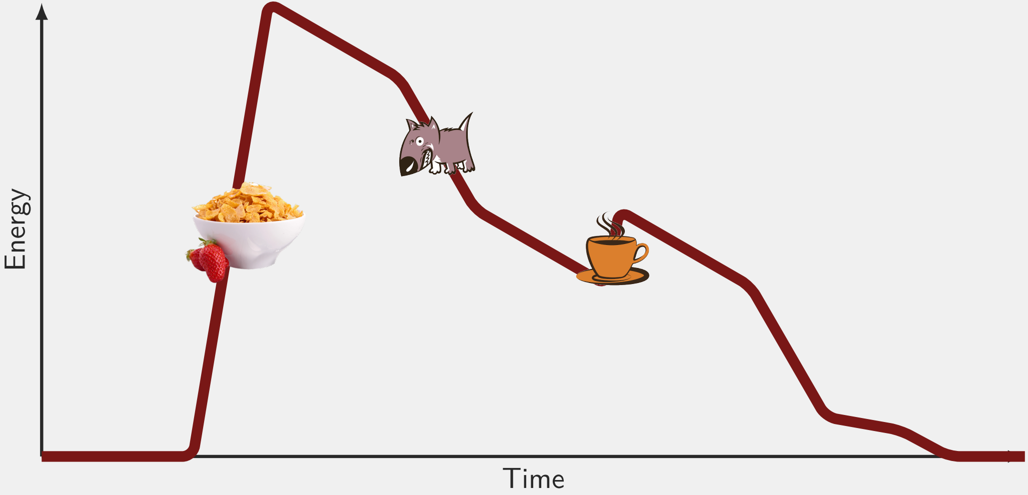
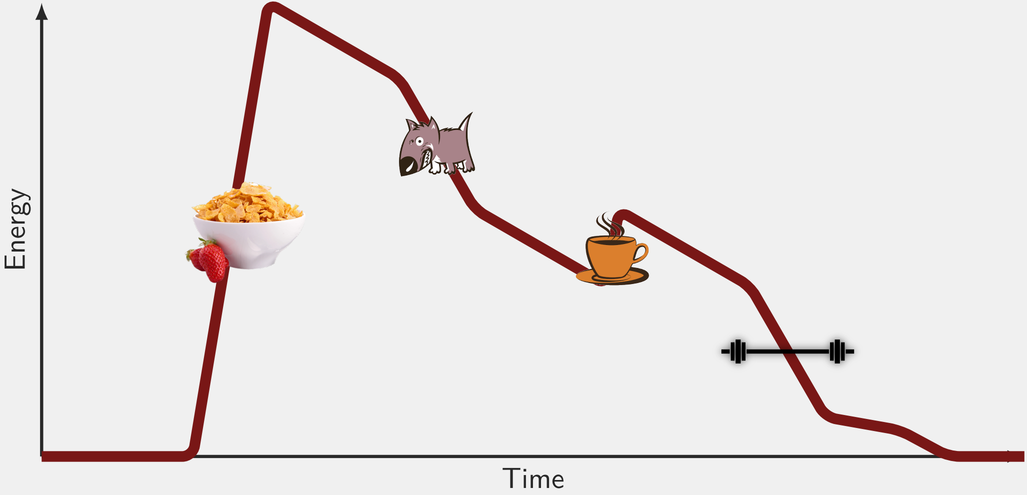


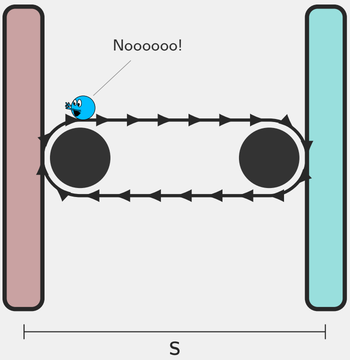
A Day in the Life



A Day in an Electron's Life

- Can think of an electron's "day" as its trip around the circuit
- Needs some initial energy source to start it off
  - The role of the battery
- Might come across various events that suck away its energy faster than others
  - Thin wires
  - Resistors
  - Capacitors
  - Inductors
- Can get "pick-me ups" along the way from more batteries
- Ends the day at the same point it started. Exhausted.

Batteries



- A battery works as a little engine to transport the electron to a place it doesn't want to be (the jerks. . .)
- Has to use some form of force to move the electron across the gap which separates the positives and negatives
- Change in potential energy:

$$\Delta U = F_{batt} s$$

- Change in potential:

$$\Delta V_{batt} = \frac{F_{batt} s}{e} = \mathcal{E} = \text{ emf}$$

Battery Facts

- As charge builds up on the negative plate, forces push back against the battery force
  - Means there is an upper limit to how much charge each battery can manage to convey across the gap
  - The battery then serves up maintain a potential difference equal to the emf of the battery
- Emf has units of potential (volts) but you should really think of it as the amount of energy per charge added by the battery
- Batteries can have designs where an electric field is created internally. We'll discuss this later as a source of internal resistance
- The potential across a battery increases when moving from the negative side to the positive

The Rest of the Circuit

- Through the rest of the circuit, we know a current is flowing
  - Also means an electric field is driving that current
- We know how to find ΔV's from electric fields!

$$\Delta V = -\int \vec{\mathbf{E}} \cdot d\vec{\mathbf{s}}$$

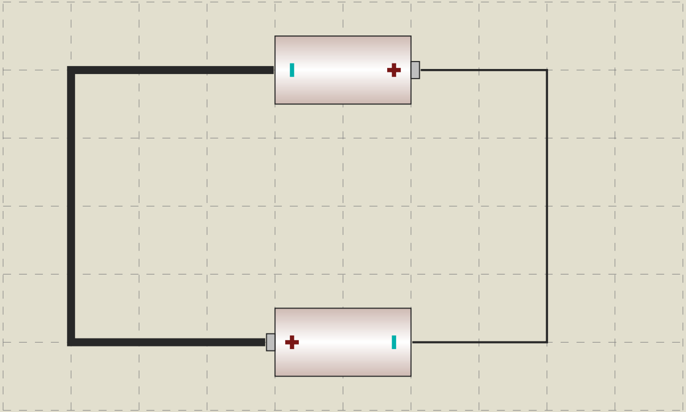
  - Since electric field points with the current, really just need to keep track of sign:

$$\Delta V = -EL \quad \text{if moving with the current}$$
$$\Delta V = EL \quad \text{if moving against the current}$$

where L is the length of that portion of wire

Loopy Example

Each battery below has an emf of $\mathcal{E}$. Determine an expression for the total change in potential around the circuit. The thin wire has half the diameter of the thicker wire.



Loopy Numbers

Suppose we add some values to the previous example, such that we want to find the current running through the circuit. So let:

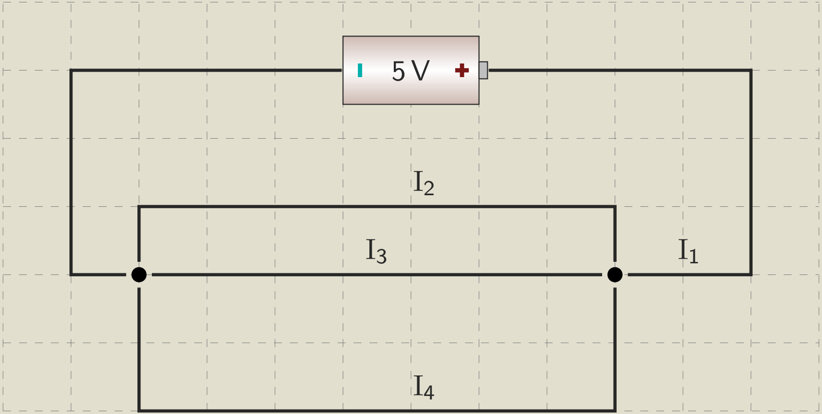
$$\begin{aligned} \mathcal{E} &= 1.5\,\mathrm{V} \\ n_{copper} &= 8.5 \times 10^{28}\,\mathrm{e/m^3} \\ u_{copper} &= 4.38 \times 10^{-3}\,(\mathrm{m/s})/(\mathrm{N/C}) \\ d_{thin} &= 1\,\mathrm{mm} \end{aligned}$$

and each grid line can be 1 meter.

Solution: 13.37 A

Putting it all together

Determine each of the currents in the circuit below if each grid line is 1 m and we have copper wire with a radius of 0.5 mm.



Solution: $I_1 = 11.75$ A, $I_2 = 3.78$ A, $I_3 = 4.869$ A, $I_4 = 3.099$ A