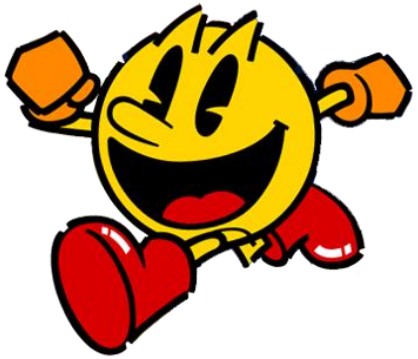
Electrical Engineering I

Andrew Hu

Administrivia

- Attendance is still http://tinyurl.com/uwigem/18sp/attendance
- William is starting on coding the wiki, and is looking for anyone interested in front-end web development
- Github organization, did you get the email?
- Anonymous Feedback, still a thing: http://tinyurl.com/uwigem/18sp/feedback

Administrivia 2: Trivia Harder



- First software project (Pacman) is up and ready
- Assignment details were posted on #drylab/Announcements
- We'll talk about it if we have time, near the end
- Recommended to meet with your group at least once before you turn in your spec

Overview

- How does electricity work?
- How can this be used?
- How can we use it to create a device and control it from a computer?

Preface

- No prior knowledge is assumed
- Don’t be scared!
- I will teach you like a non-major, because neither am I
  - Technically, I have no formal education in EE :D
- We’ll cover just a few core EE concepts, and go right into applications

The Basics

- What is electricity?

The flow of electrons

- What can it flow through?

Easily through conductors, potentially through insulators if voltage is high enough

The Basics

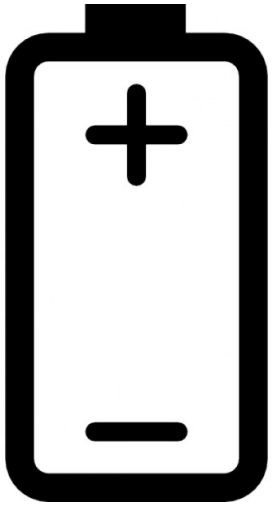
- What causes electricity to start to flow?
  - What are some examples?
  - What is similar across these situations?

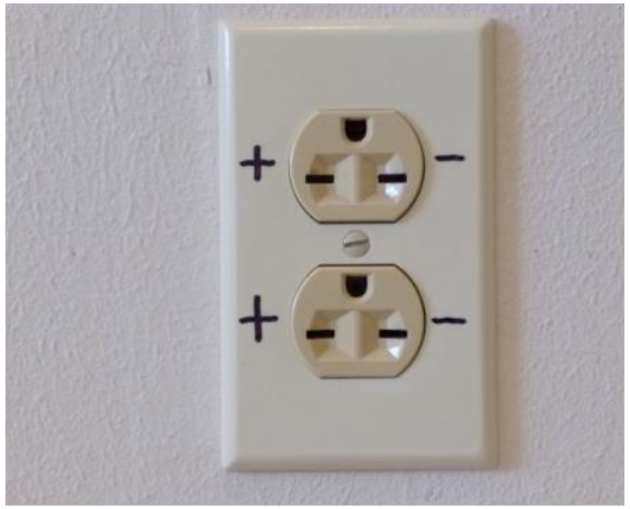
Plugging electronics into batteries or electrical outlets

Batteries and electrical outlets have (at least) two ends, the positive and negative

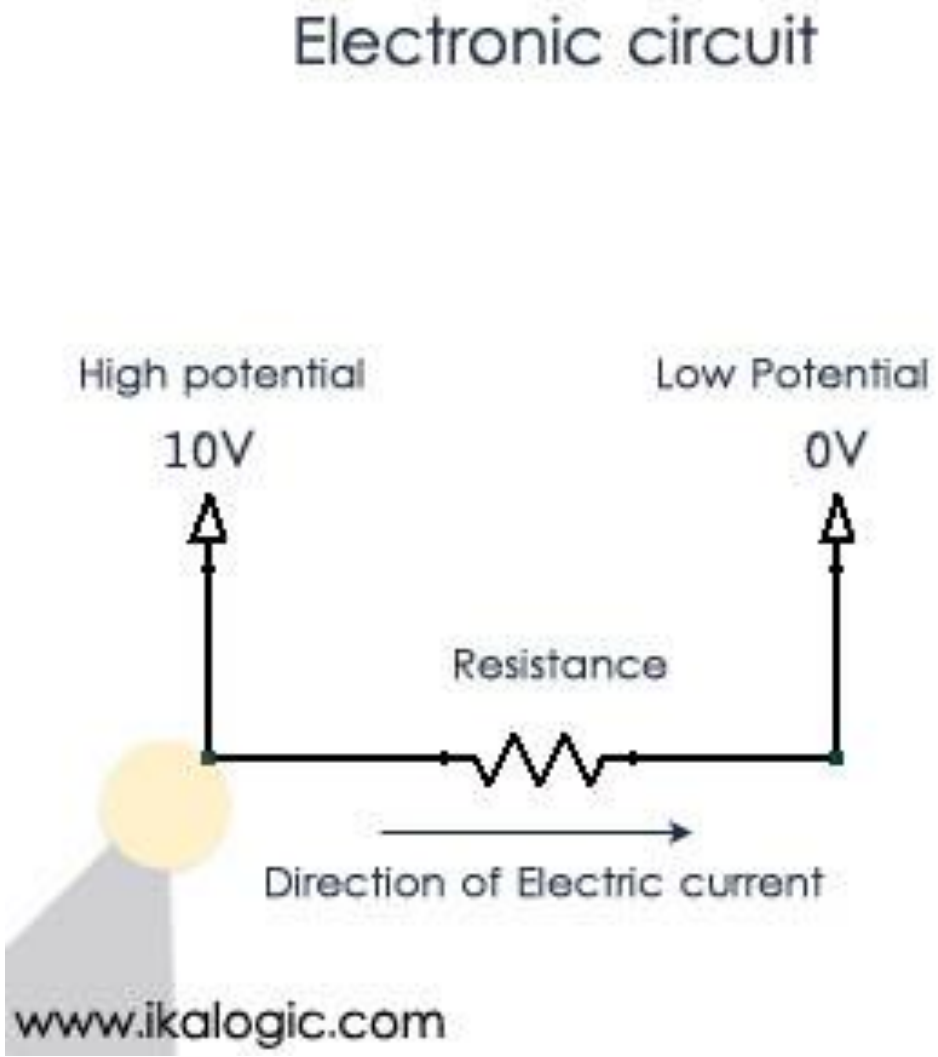
Positive & Negative

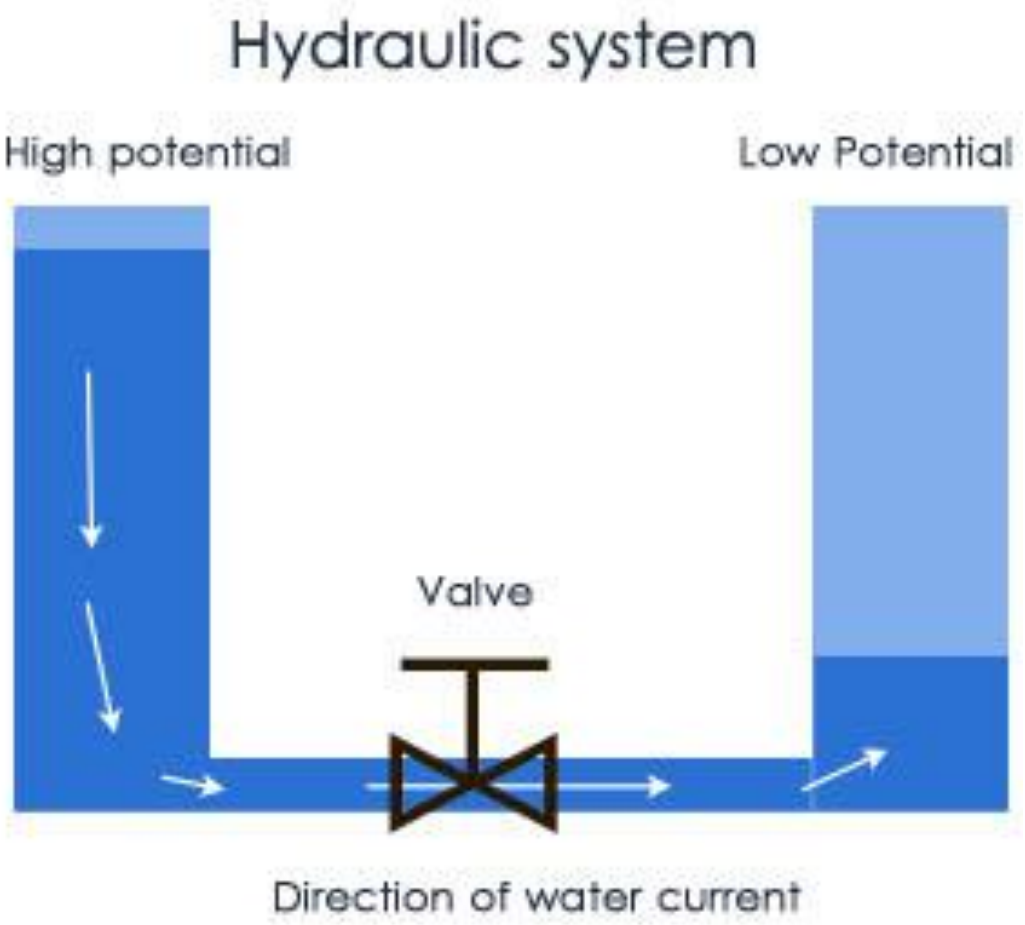
- High electrical potential
- Low electrical potential
- When connected, electricity flows from high to low





Water Flow Visualization





The Basics

- How “fast” is the current flowing?

Depends on the material it has to cross through

Ohm's Law

- What did we say the "speed" of the current is?
  - It depends on the medium it's travelling through

- Ohm discovered the equation that relates the speed of electrical current, the "power" of the electrical source, and the medium of travel

Ohm's Law

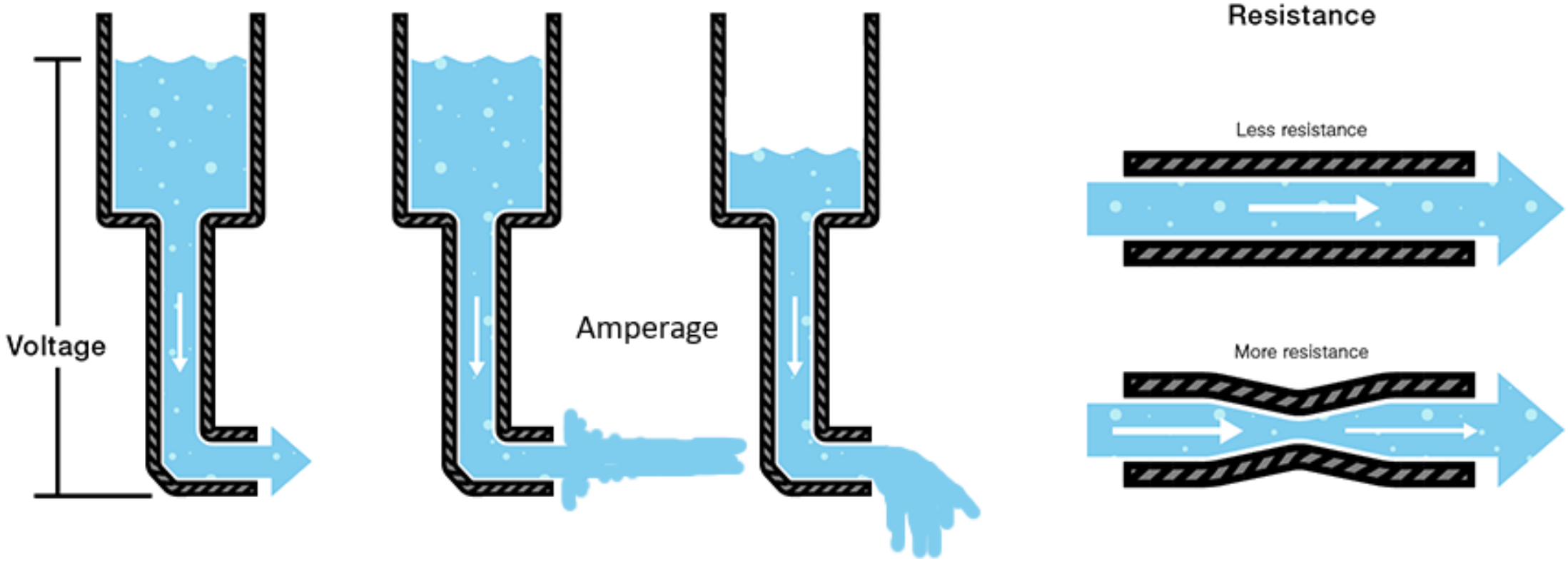
$$V = IR$$

$$\text{Volts} = \text{Amps} * \text{Ohms}(\Omega)$$

- "V" means voltage of the electrical power source
- "I" means the current of electrical flow
- "R" means the resistance of the medium of travel

Ohm's Water Slide

$$V = IR$$



Ohm's Law: Rates

$$V = IR$$

- When voltage is increased, what happens to the current (I) if the resistance is held constant?

The current will increase

- When resistance is increased, what happens to the current (I) if the voltage is held constant?

The current will decrease

Water Pressure Over Distance

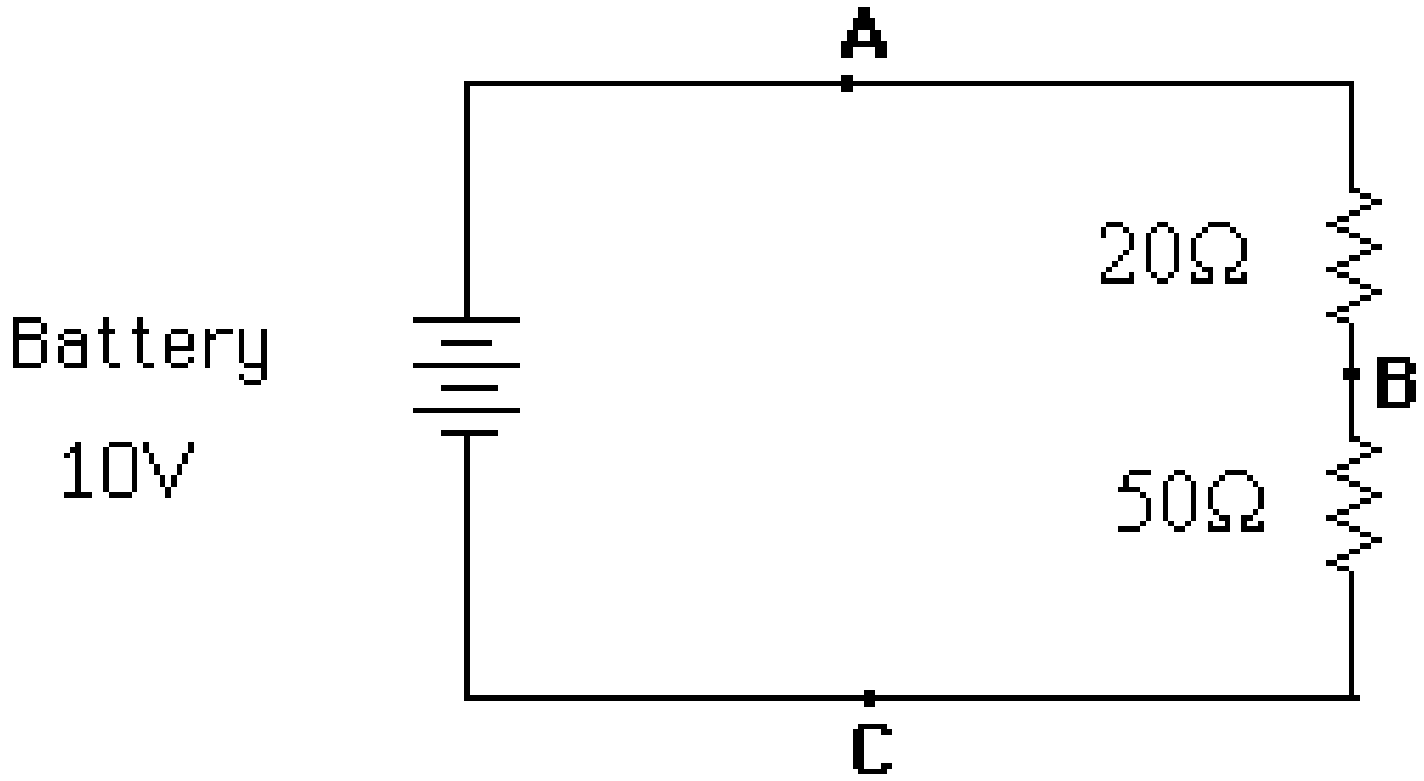
- You are going out to wash your car, but the hose is in the back yard
- You test the hose on full blast in the backyard
- You run the hose to the driveway, and turn it on full blast
- Is the force of the water any different?

No, each water molecule pushes on each other in a line, so as long as there aren't any obstructions, the force stays the same

Preservation of Voltage Over Distance

- No matter the distance of wire, the voltage will be the same
- Each water molecule pushes on each other in a line
- Similarly, each electron pushes on each other in a circuit

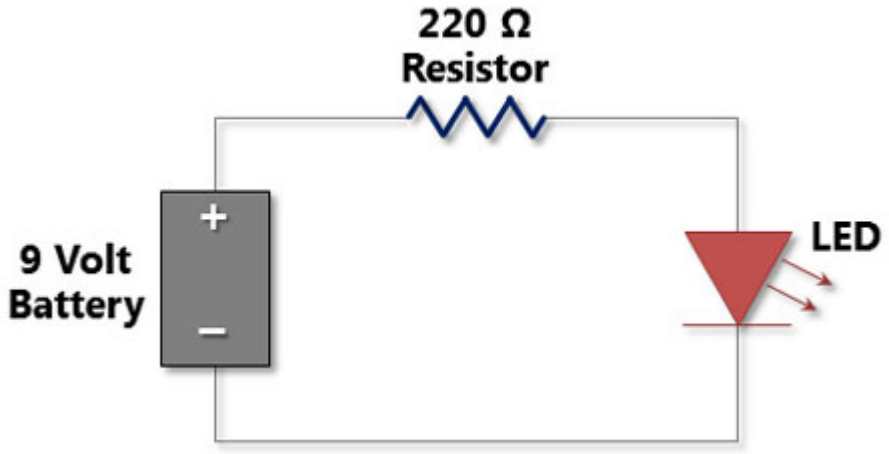
Circuit Diagrams



We assume that normal wire has negligible resistance

Resistance is Futile

$$V = IR$$

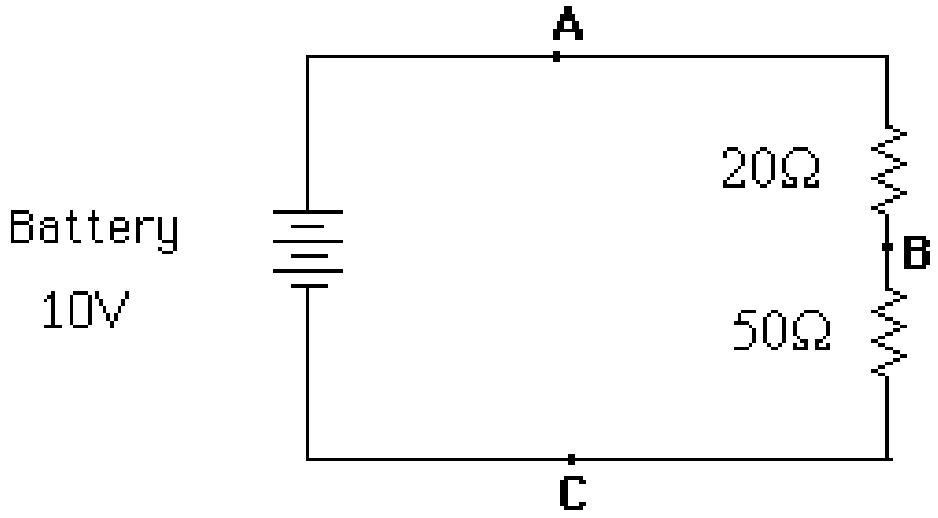


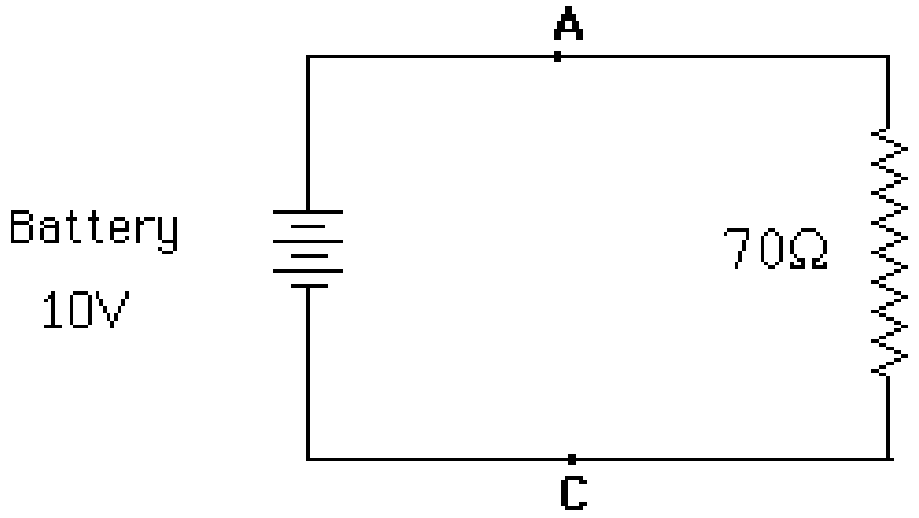
- What is the speed of the current in this circuit? (assume LED has ~0 Ohm resistance)

$$9V = 220\Omega * R$$
$$R = 9/220 = 41mA$$

Series Connections

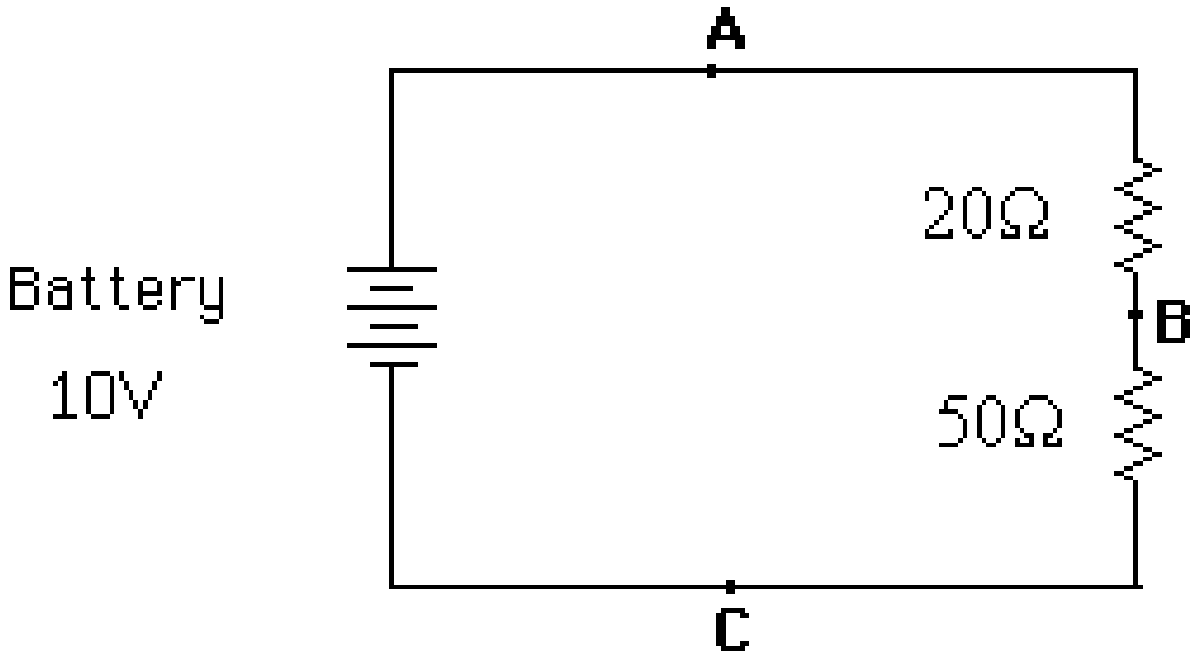
- When elements are in a line on the wire, they are “in series”
- Resistors in series act as one big resistor





Le Piece de Resistance

$$V = IR$$

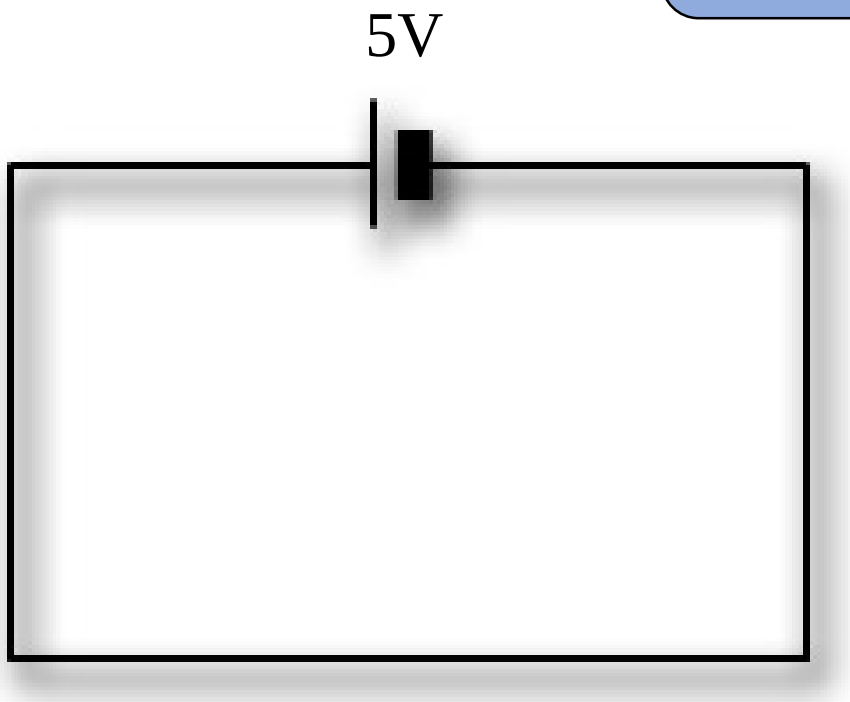


- What is the current in each of these points?

No Resistors?

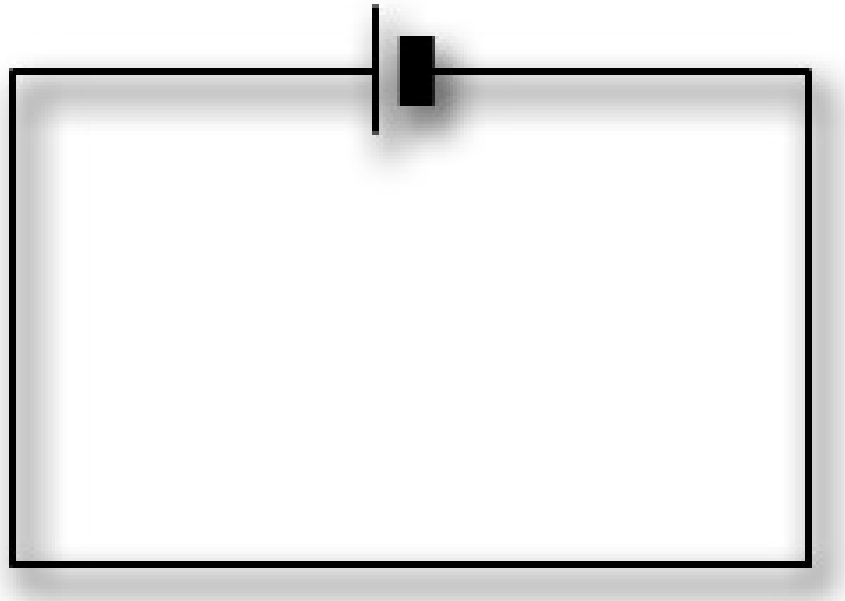
- What is the current in this circuit?

Very high!
(short circuit)



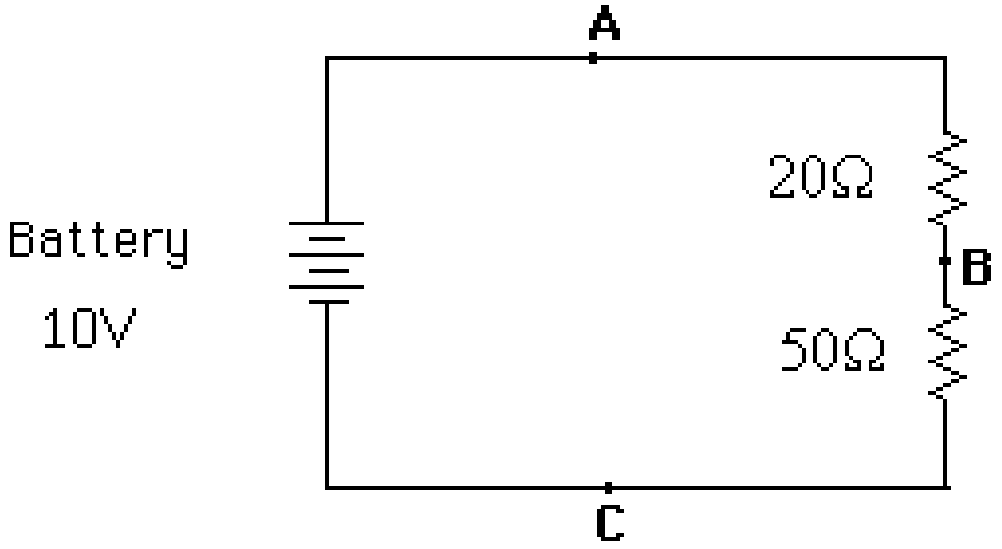
Short Circuits

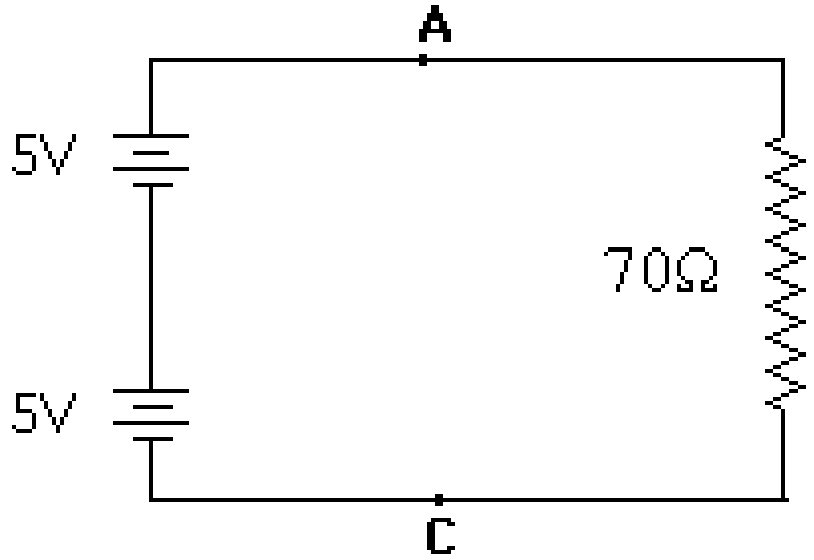
- Caused by having very little resistance
- Electricity flows very quickly
- Drains your power source
- The cause of 99% of your safety risks!



Series

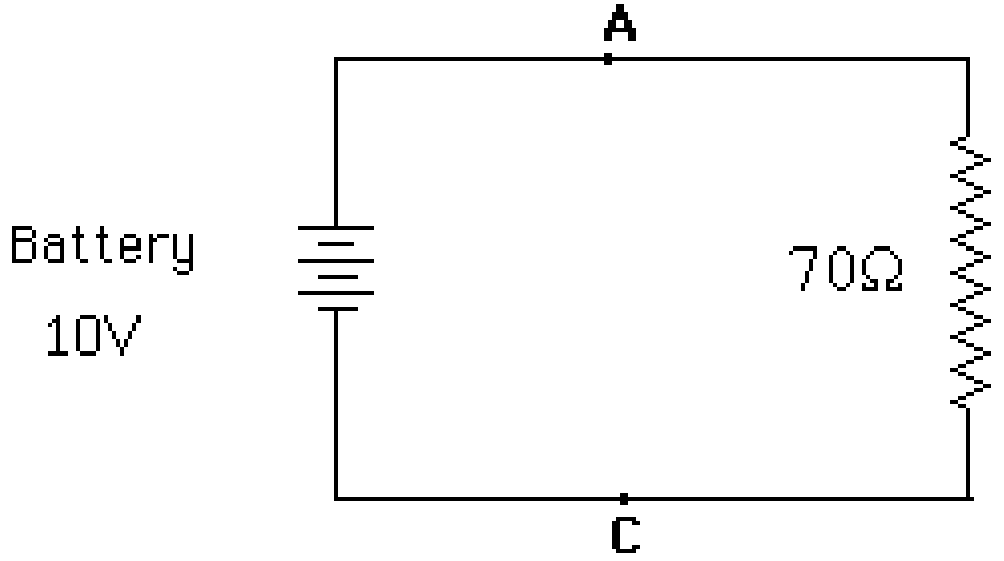
Voltage is also added in series

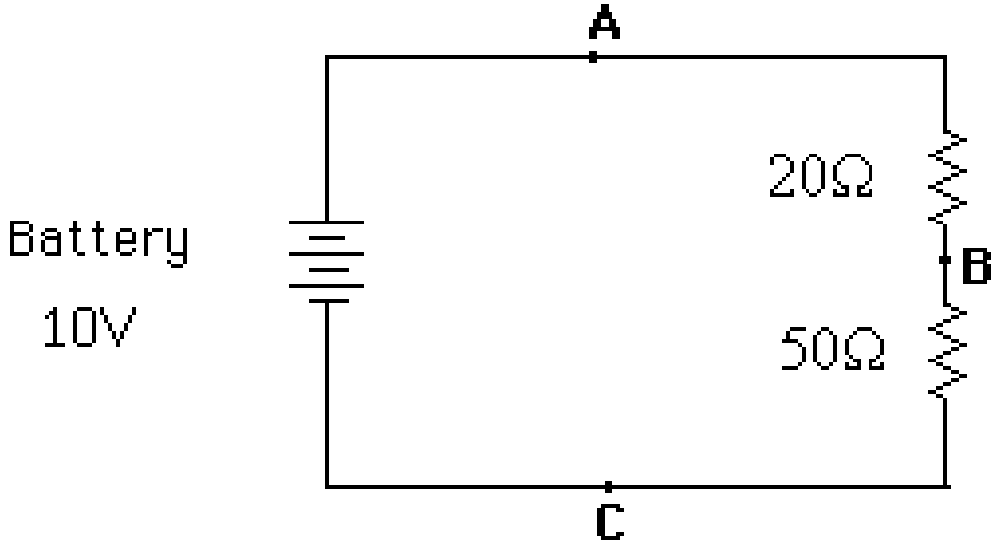


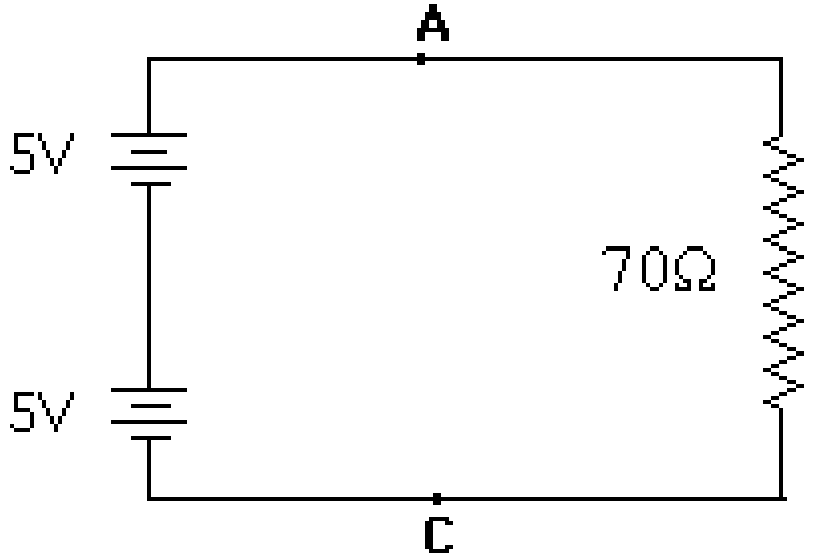


Series

All equal!







Safety

- It takes 100mA to stop your heart
- Your body* has ~1,000 Ohms of resistance
- You do the math: 100V can kill you
  - 11 9-Volt batteries linked in series
  - **ANY** appliance hooked up to the wall can kill you if you drop it in the bathtub

Software: Pacman Project

- Project details posted on Zulip, groups have been assigned
- Week 1: Write the spec!
  - Meet with your group to discuss how to divide up the work
  - Make design decisions about what work will be handled by which parts
  - Write the method signatures
  - Comment them with Javadoc-style comments
    - I have a script to generate Javadoc for Processing files, you don’t need to do it yourself