Warmup

Is it possible to have a voltage without a current?

Respond at **pollev.com/stevenbell**

Warmup

Is it possible to have a voltage without a current?

Is it possible to have a current without a voltage?

Respond at **pollev.com/stevenbell**

Circuits	Marble machine	Spintronics
charge	mass	
electric field	gravity	
electrical potential energy	potential energy	
voltage	height	chain tension
current (charge/second)	marbles/second	chain speed (links/second)

EN 1: Engineering in the Kitchen

Steven Bell

11 September 2023

Tufts
UNIVERSITY

By the end of class today, you should be able to:

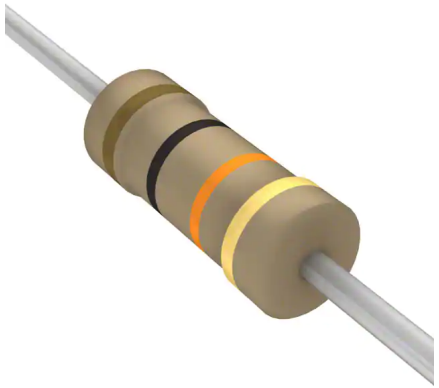
- Explain what resistance is, and measure it with your DMM
- Use Ohm's law to calculate V/I/R
- Explain what power is, and how it's different from energy
- Explain why electricity is dangerous, and under what circumstances
- Use Watt's law to calculate power

Marble-track resistor

From the fantastic engineering/woodworking site woodgears.ca

DC Volts

Resistance (Ohms Ω)



Fixed resistor

Photoresistor

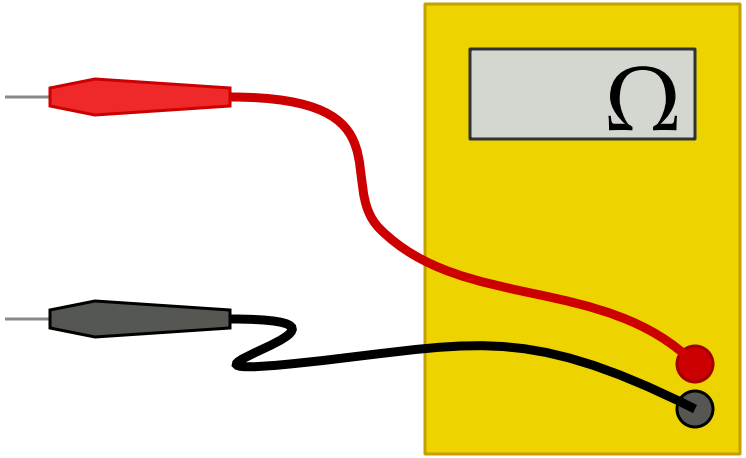
Measuring resistance

1) Pick an appropriate resistance scale

2) Put the **black** lead on one side

3) Put the **red** lead on the other side

4) Read the result!



What happens if you use the wrong scale?

What happens if you swap the leads?

Why do you need two leads, anyway?

Ohm's Law

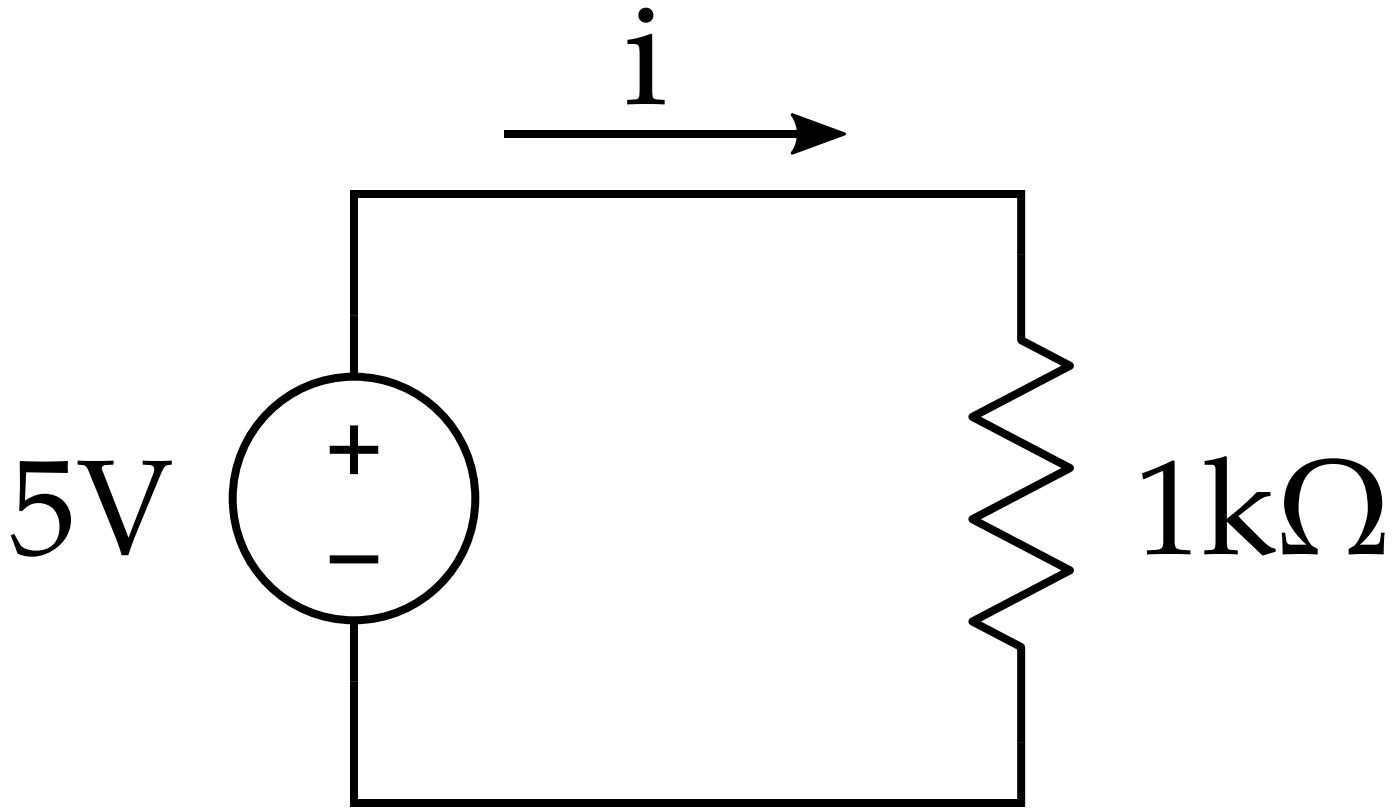
For a resistor (and only a resistor):

$$I = \frac{V}{R}$$

R is the resistance, measured in Ohms

Represented with the schematic symbol:

What is the current i?



WARNING WARNING WARNING!

Not everything behaves like a resistor.

For example:

- Diodes (and light-emitting diodes, LEDs)
- Capacitors and inductors, which store energy
- Batteries

Don't just blindly apply Ohm's law!

Warmup, part 2

Introduce yourself to someone you haven't met (move around!).

Tell them about something you do
often because you love to do it.

Some problems with grades

There are a number of problems with traditional grades

- Grades are the ultimate extrinsic motivator, i.e., they suck all the fun out of learning.
- Adding up assignment scores is a 1-dimensional representation of your learning (at best)

This course has no grades

There will be **zero** graded assignments in this course

Instead:

- Teaching staff will give copious feedback on projects
- There will be self-graded homework exercises
- We'll regularly engage in "metacognitive" excersises
- You and I will agree on your final letter grade by consensus

But what about...?

Many of you depend on numerical and letter grades...

- to know "how well you are doing"

But what about...?

Many of you depend on numerical and letter grades...

- to know "how well you are doing"
- for your sense of self-worth

Stanford d.school atrium, via stunningproof.com

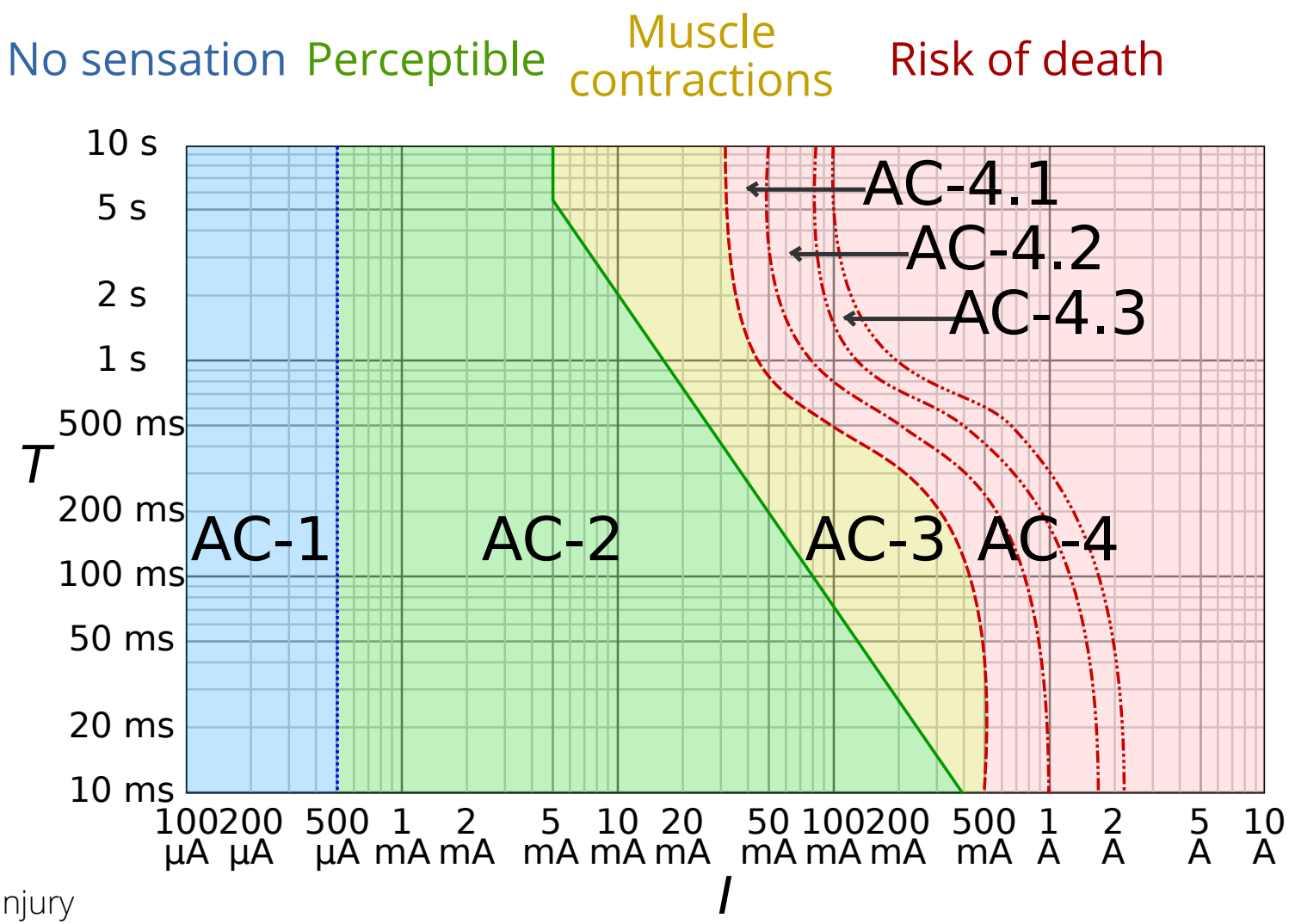
Let's talk about safety

Electricity can kill you.[citation needed]

But how? And is it the voltage or current that's dangerous?

StyroPyro explains: youtube.com/shorts/8Wx6-ysokJU

Effect of electricity on the body

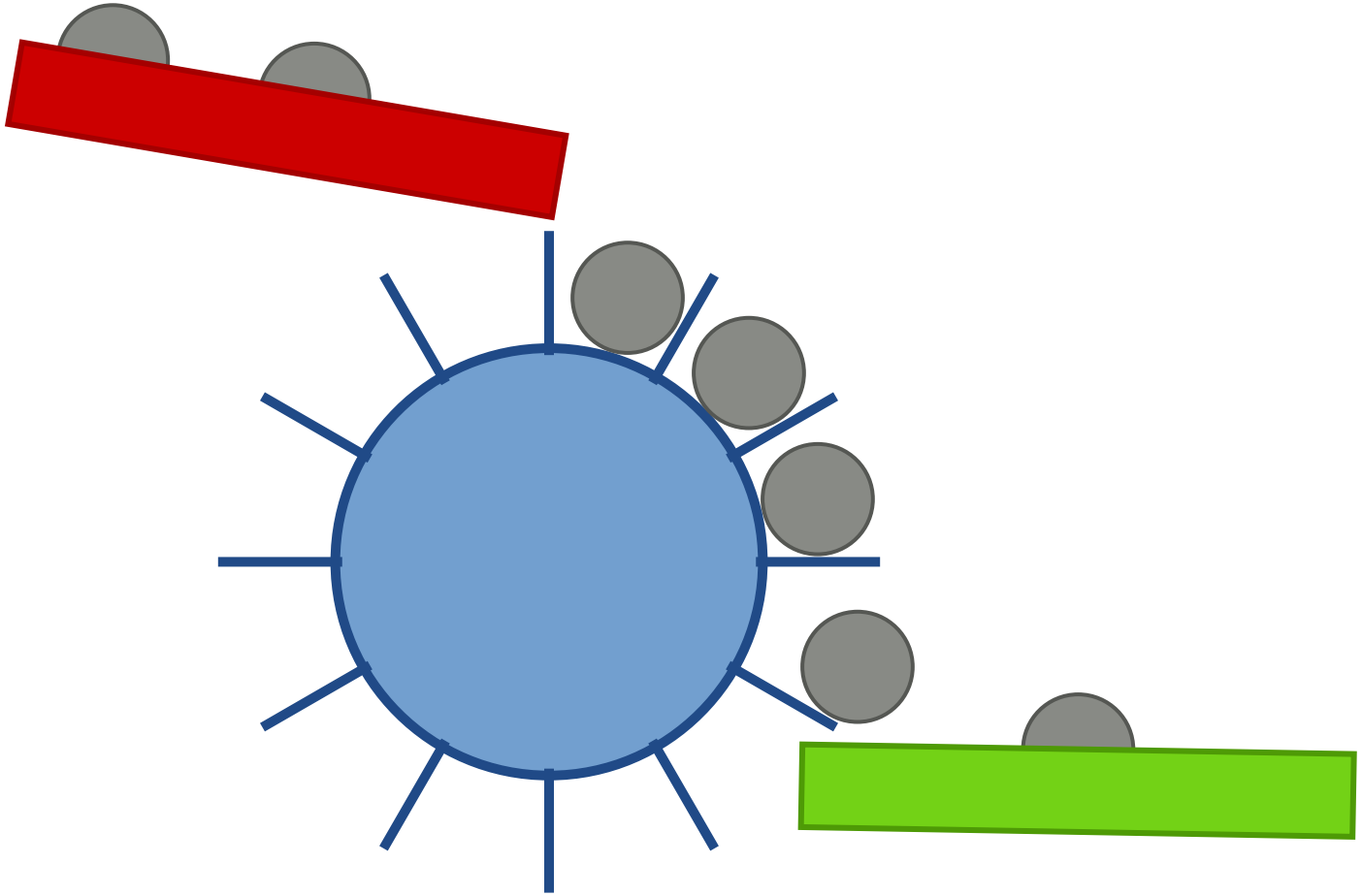


Wikipedia - Electrical injury

Ok, so what *voltage* is dangerous?

A phone charges at 1A or more, so why isn't that dangerous? (Or is it?)

Collecting energy from marbles



What determines how much energy I get?

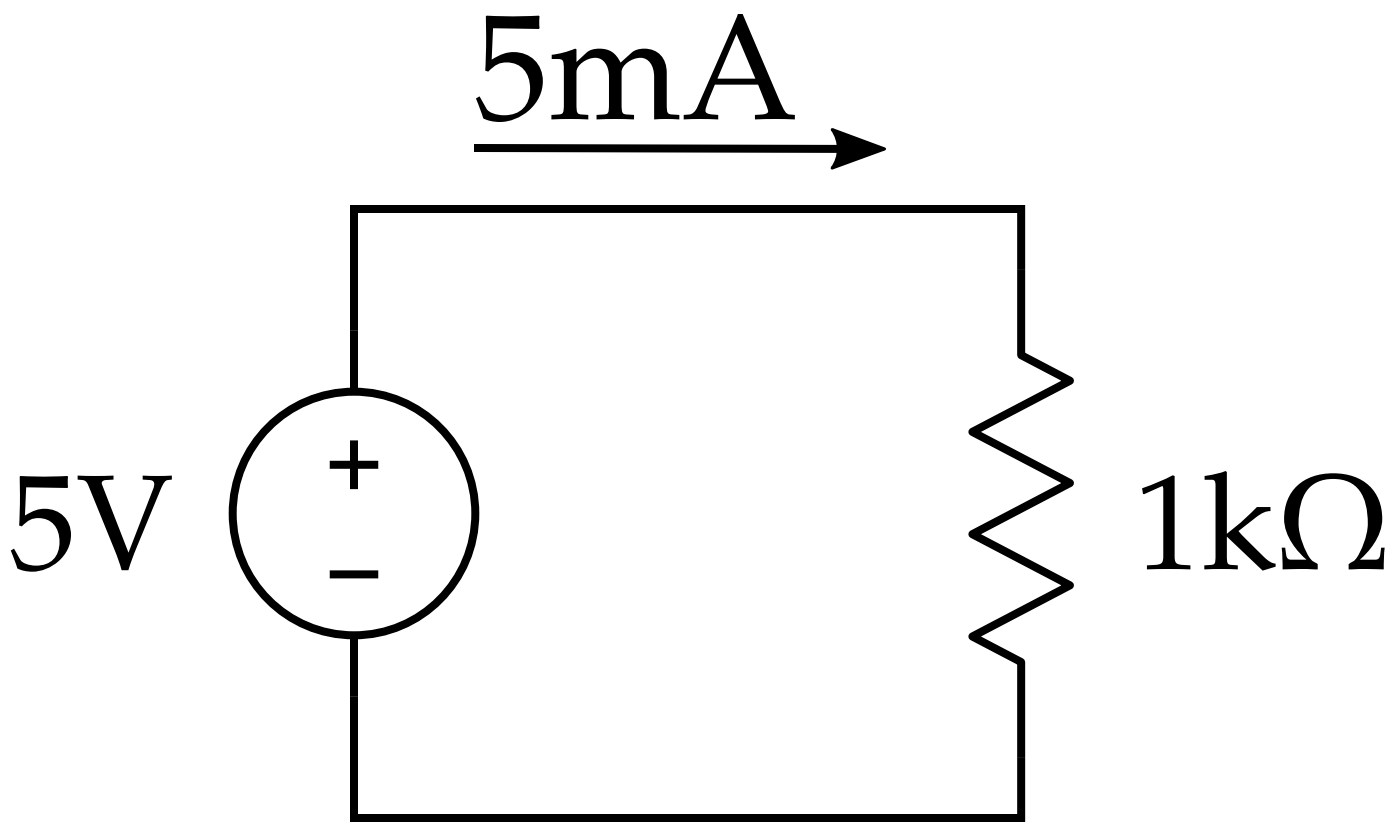
$$V = \frac{\text{Joules}}{\text{Coloumb}} \qquad I = \frac{\text{Coloumbs}}{\text{second}}$$

$$V \cdot I = \frac{\text{Joules}}{\text{Coloumb}} \; \frac{\text{Coloumbs}}{\text{second}} = \frac{\text{Joules}}{\text{second}}$$

Joules/sec is called a **Watt**, abbreviated **W**.

How much power does a light bulb use, if it is connected to 120V and draws 0.5 A?

How much power does the resistor dissipate?



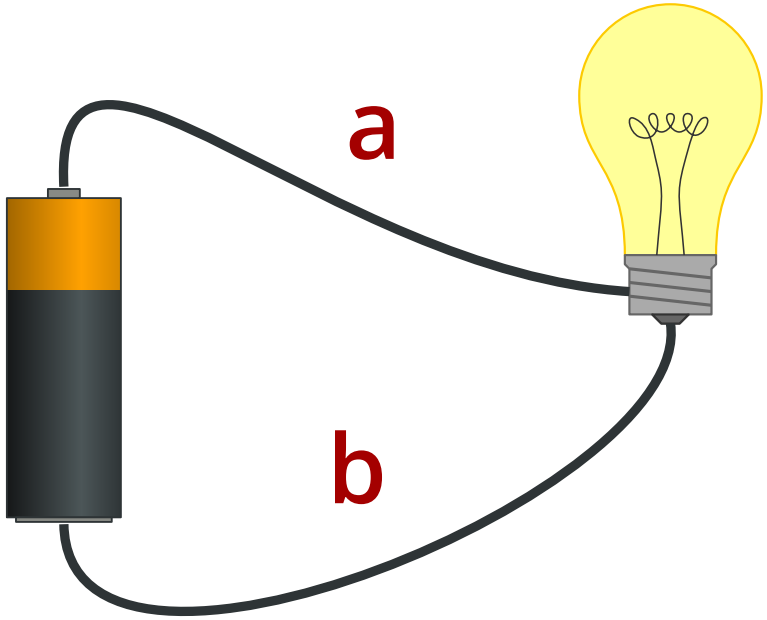
A more exciting example

Presto Hot Dogger

youtube.com/watch?v=n2ZZbuOeNmw

What happens if you run the Hot Dogger at 240V instead of 120V?

Compare the currents



1) The currents are always equal
2) (a) is larger for a split second while electricity flows into the bulb, then the currents are equal
3) (b) is less than (a) because some current is turned into light + heat
4) (a) is less than (b) because electrons flow the opposite way to current

Wrapping up

PollEverywhere: what is one question you have after today's class?