



Circuits

Pls don't run away I promise fyzeeks isn't that hard



Outline of da course

Day 1: Circuits!

Day 2: Work/energy

Day 3: Momentum/gyroscopes

Day 4: Planetary motion

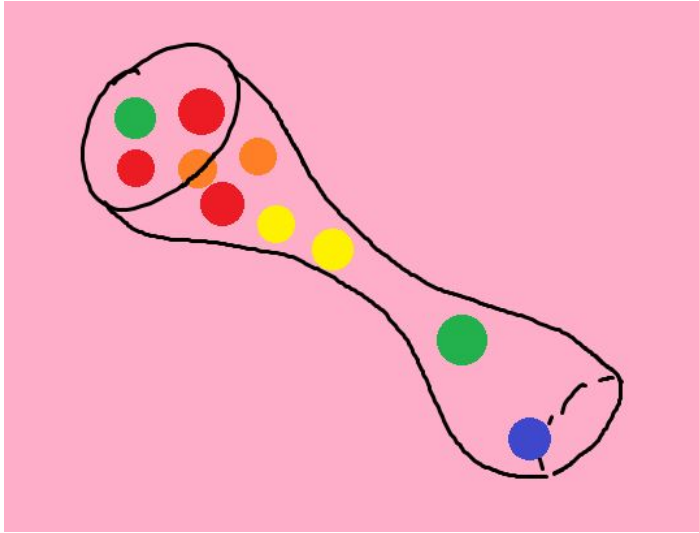
Day 5: Muzik

Day 6: Simple machines

Day 7: TBD

Day 8: Modern Fyzeeks

Circuits oversimplified



1. The more vertical we make the tube, the faster balls fall down through the tube.
2. We can measure the number of balls that pass through the tube per second.
3. The thin part of the tube slows down the balls.

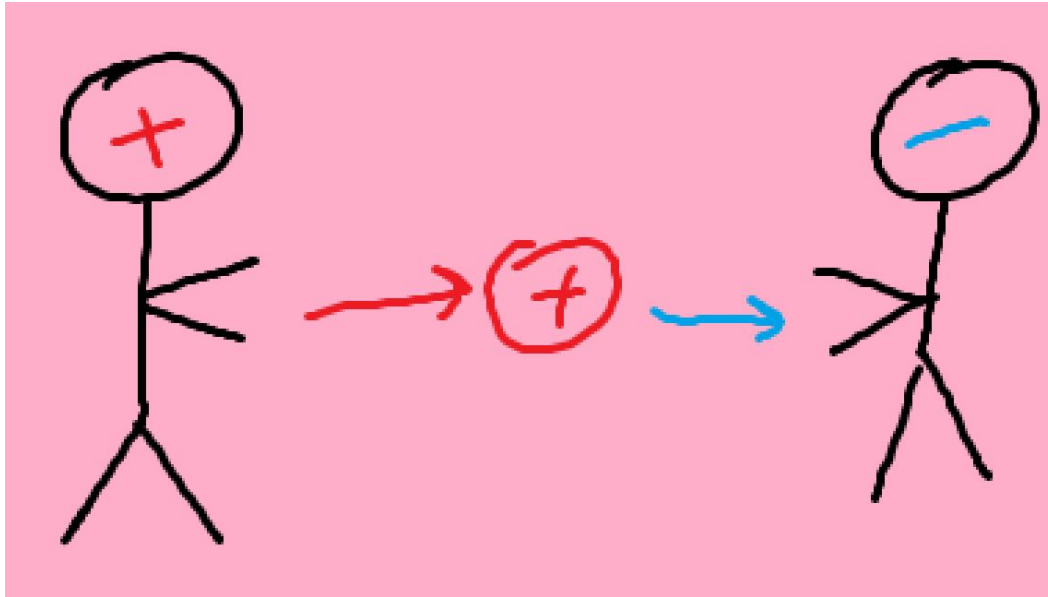


Now replace “balls” with electrons

1. The more vertical we make the tube, the faster balls fall down through the tube.
 2. We can measure the number of balls that pass through the tube per second.
 3. The thin part of the tube slows down the balls.
1. Voltage: the higher the voltage, the faster electrons move through a circuit.
 2. Current: the number of electrons that pass through the circuit per second.
 3. Resistance: objects with resistance slow down the electrons

Voltage

Electric potential



High potential objects have the “potential” to push positive charges to low potential objects.

The greater the difference in potential means the charges get pushed faster.

Voltage!



<- High potential

Voltage is the difference in potentials (the bigger it is, the faster charges get pushed)

<- Low potential

Current

Current

Charge over time

How many
electrons pass
through the wire
per second?

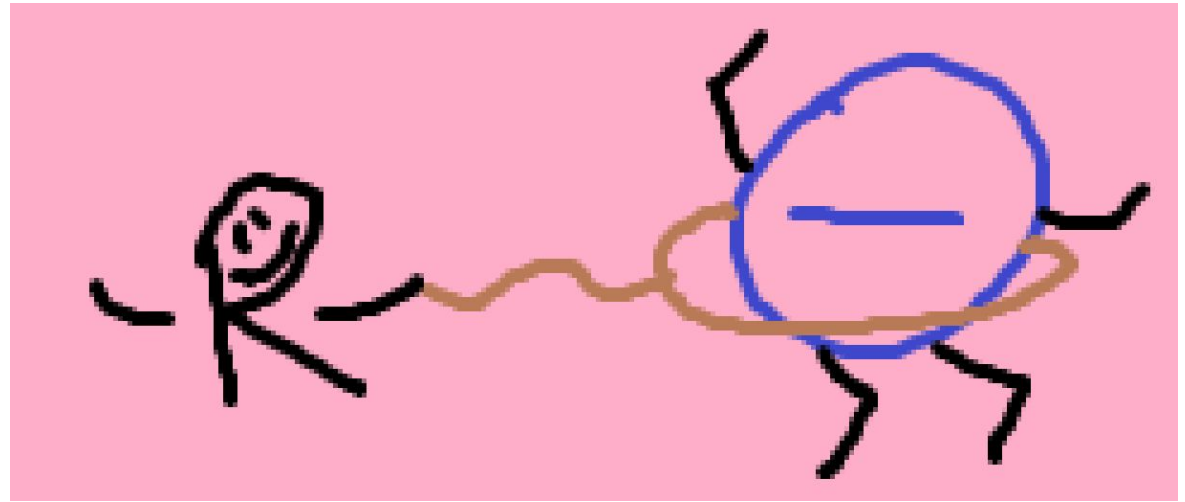


Resistance

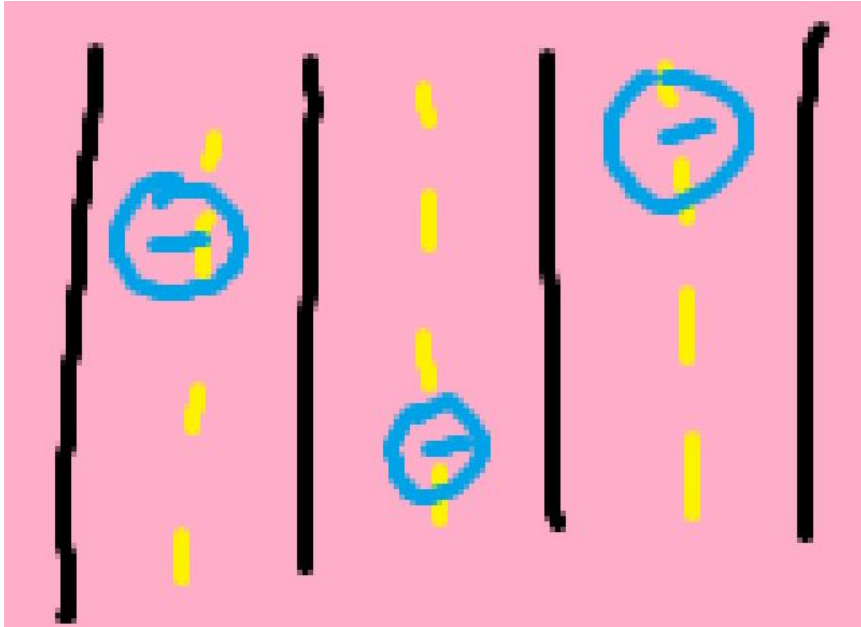
Resistance

Slows down the movement of electrons.

Now, what affects resistance?



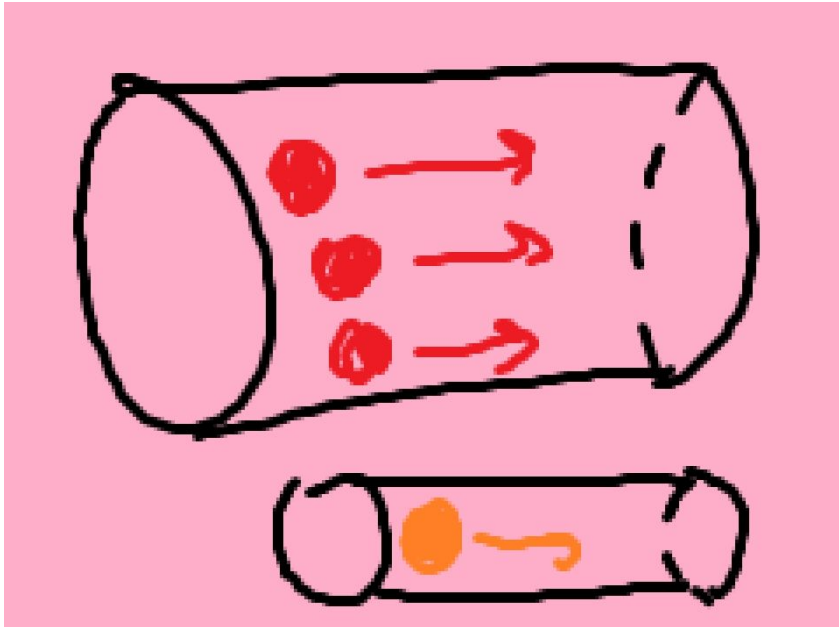
What affects resistance?



Think of a wire as a highway for electrons

Think of ways highway design could affect travel speeds.

Cross sectional area/how wide the wire is



- The thicker the wire, the more space electrons have to move.
- Resistance is smaller for wider objects.

Length of wire

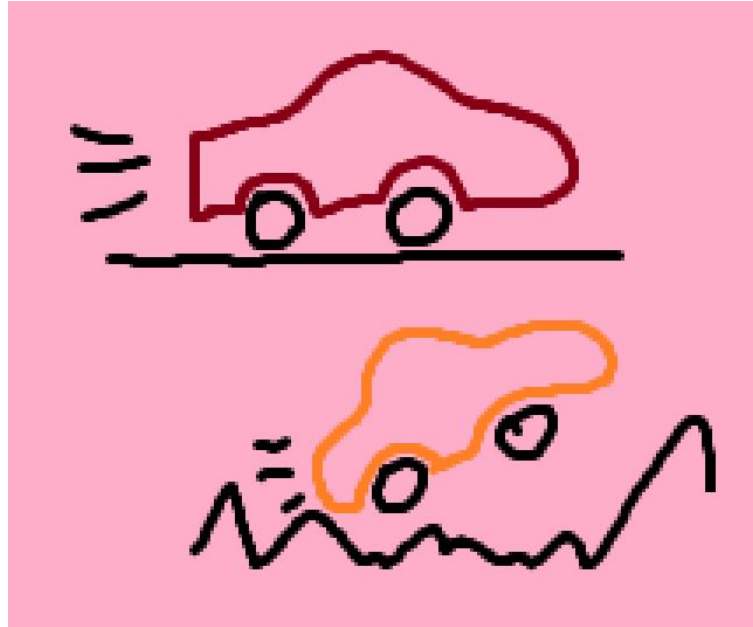
- Longer wires can hold more electrons.
- You're more likely to bump into other electrons in longer wires.
- "Bumping" slows down movement.
- Longer wires have more resistance.



Type of wire

Some roads are just hard to travel on.

We call how hard it is to travel through a wire “resistivity.”





Resistance (lots of word :(scary!)

$$R = \frac{\rho L}{A}$$

ρ = resistivity

L = length

A = cross sectional area

Resistivity: how much an object “resists” current

Length: uhh, just the length of the wire/object

Area: how thicc the object is (a hair has a very smol cross sectional area while a straw has a larger cross sectional area)



Review

What is voltage?

What is current?

What affects resistance?

Putting it all together



Symbols

Voltage (V) measured in Volts

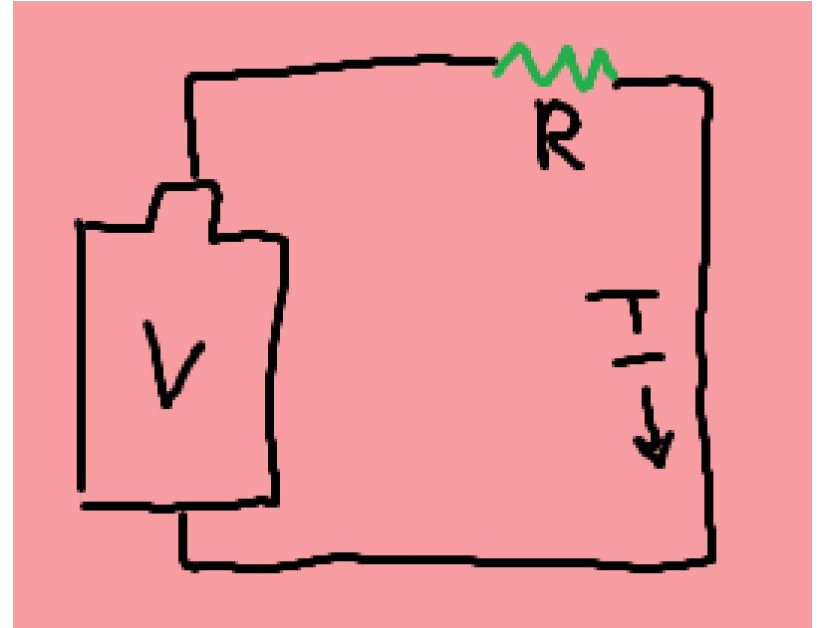
Current (I) measured in Amps

Resistance (R) measured in Ohms

Does anyone have any guesses
why current is I, not C?

How V, I, and R work

A battery provides us a voltage to drive electrons to move. Resistors and light bulbs (which also have resistances) slow down the electrons. The speed of the electrons is current.





Safety with circuits

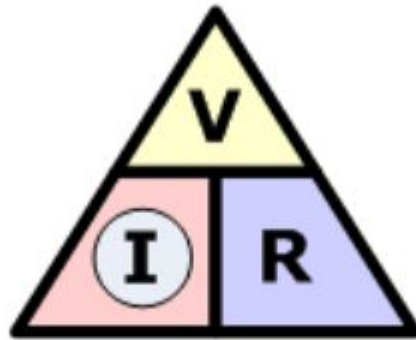
Passing high currents through your body will stop your heart.

As such, we should find a way to calculate current.

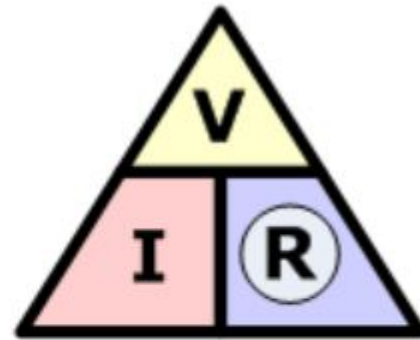
Ohm's law



$$\textcircled{\mathbf{V}} = I \times R$$



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

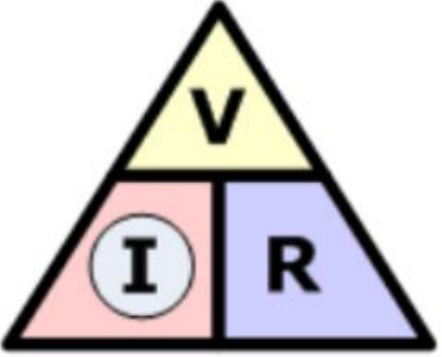


$$\textcircled{\mathbf{R}} = \frac{V}{I}$$

Intuitive sense

If we increase voltage, the electrons want to move faster, so I increases.

If we increase resistance, the electrons want to move slower, so I decreases.

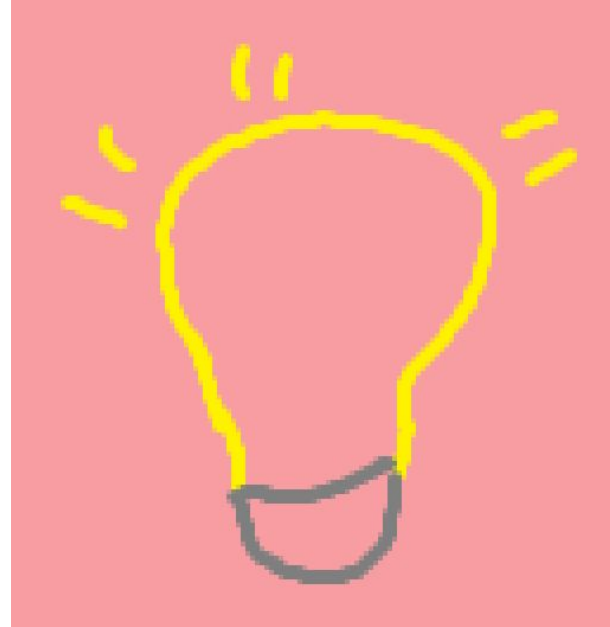

$$\textcircled{\mathbf{I}} = \frac{V}{R}$$

Power

What is power?

Energy transferred over time,
or the amount of “work” a
circuit does over time.

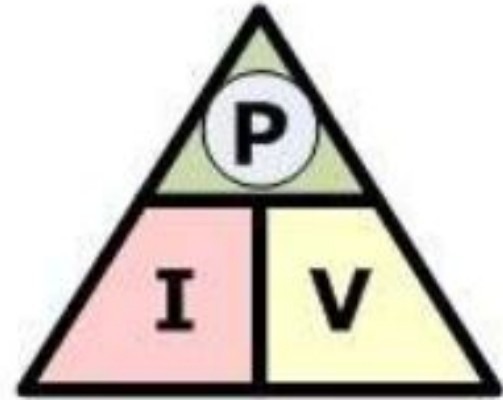
The more power we provide to
a bulb, the brighter it will shine.



What affects power?

Voltage tells us how much our circuit is “pushing” electrons; basically, it’s a measure of energy we’re giving to the electrons.

Current tells us how many electrons we’re “pushing” per second; this gives us the “over time” part from power.



$$\textcircled{P} = I \times V$$



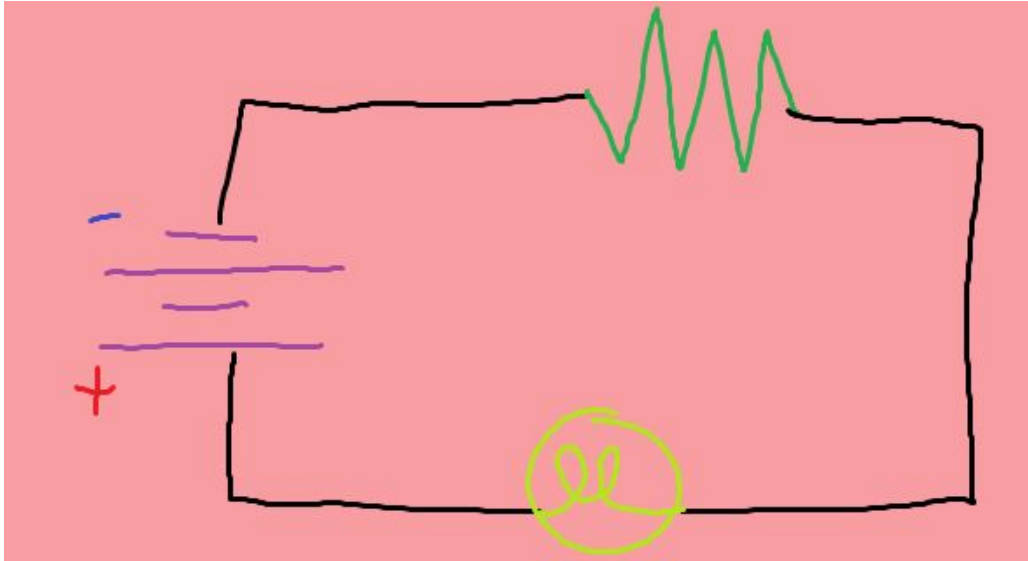
Review

What are the symbols for voltage, current, and resistance?

What is power?

Real world!

Drawing! That's fun right?



Purple: battery
Green: resistor
Lime: light bulb
Black: wire

Sample problem

A taser provides 50,000 volts across my arm, which has a resistance of 10,000 ohms. How many amps is the current that passes through my arm?

