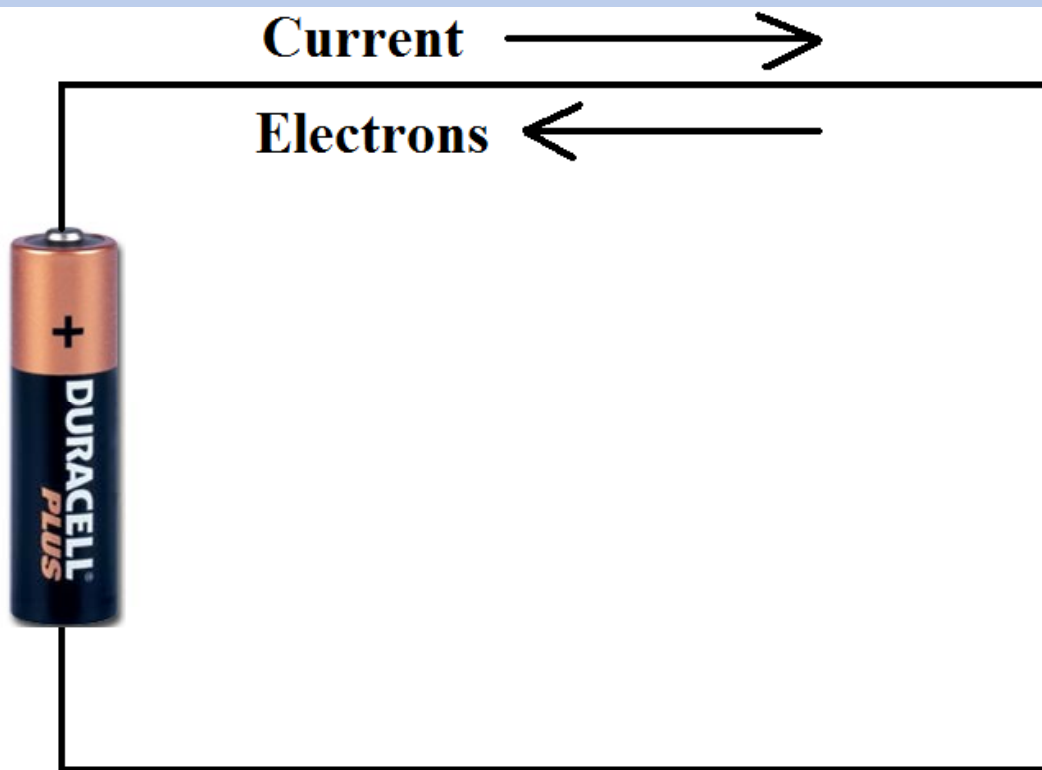# Traditional: 09-01
Themed: 06-01

Ohm's law and parallel and series resistors

Simplest possible circuit

- Voltage source shorted with a wire
- Current: Flow of positive charge (opposite of what's really flowing (electrons))

Current ⟶

Electrons ⟵

When we say charge flows from one point to another, we really mean the anti-flow of electrons, don't let this confuse you! (keep in the back of your mind)

More realistic circuit

- Voltage source pushes electrons through resistance
- Bulb is a resistor you'll use for six days.
- Understand charge flows through bulb going in the bottom and out the side

Current →
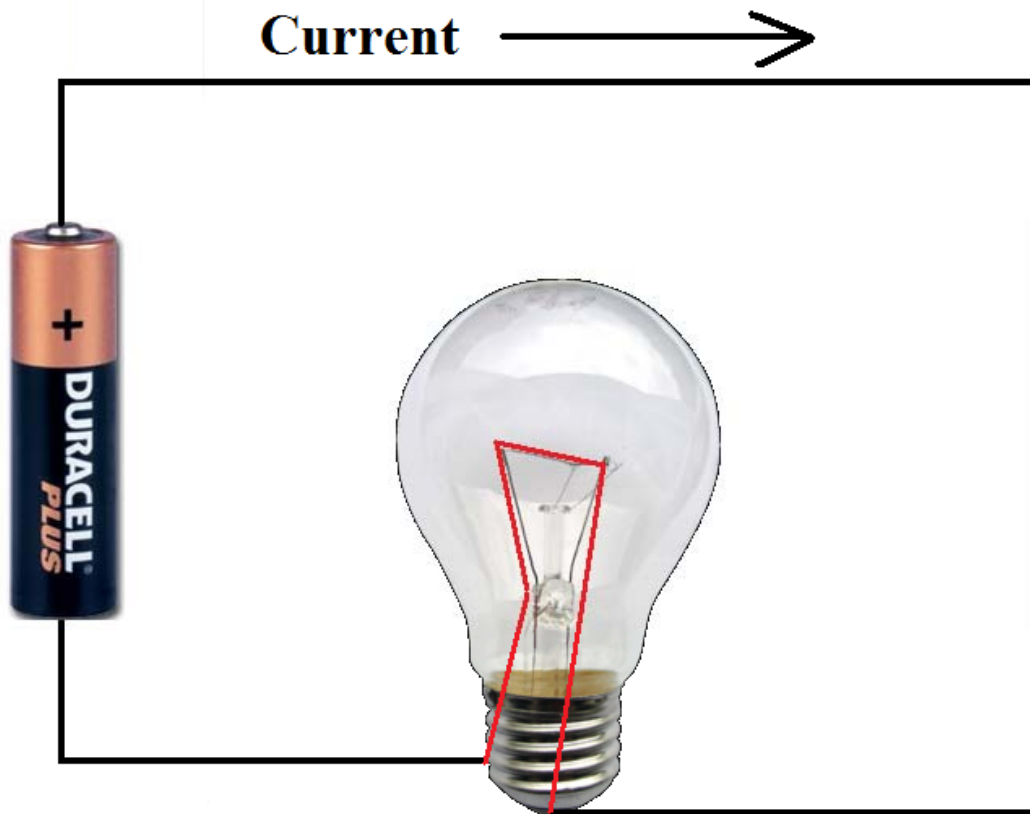
Without resistance, electrons flow too fast and wire heats up a "short circuit" (previous picture of "simplest circuit")

Filament

- Thin wire in bulb is called the filament
- Wire bulbs are incandescent, meaning they are so hot they glow – most energy is wasted in heat

Current ⟶
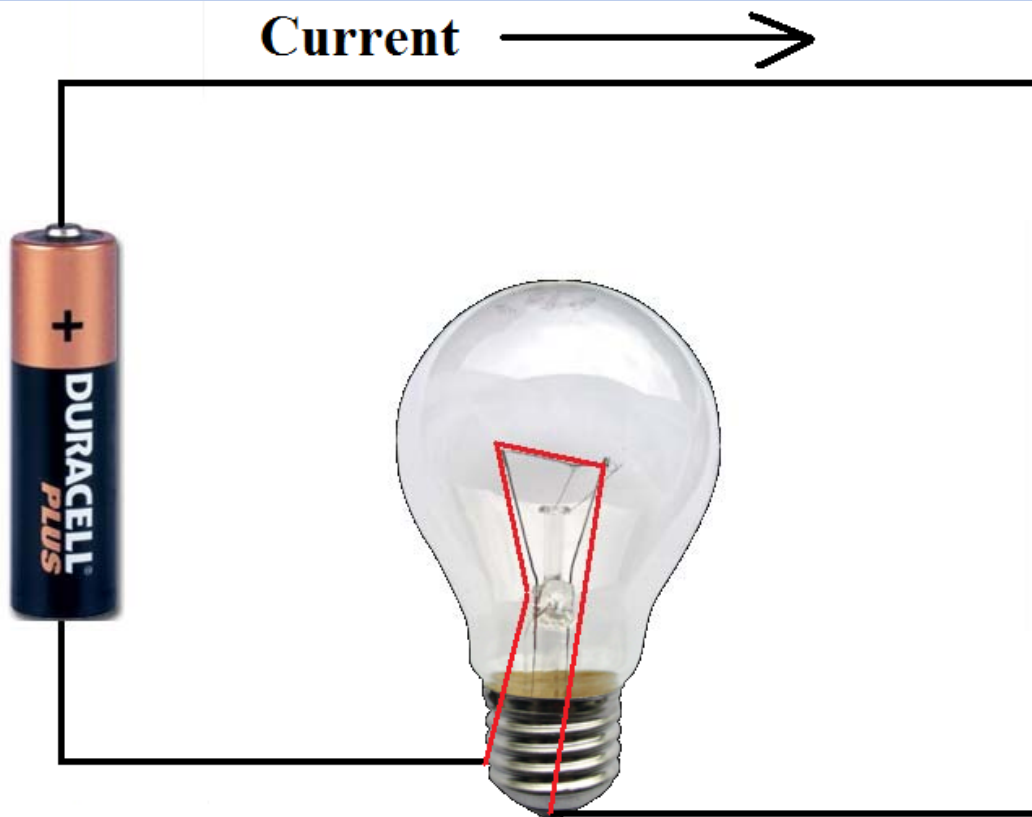
•Thick filaments are bright (lots of room for many electrons)
•Thin filaments are dim (narrow, few electrons can flow)

Schematic

- Rather than drawing realistic-looking bulbs and batteries, we use symbols
- Batteries, or voltage sources have a wide positive and a narrow negative
- Resistors have a sawtooth symbol, sometimes put a circle around resistor symbol to symbolize a bulb

Current ⟶

Current ⟶

+

-
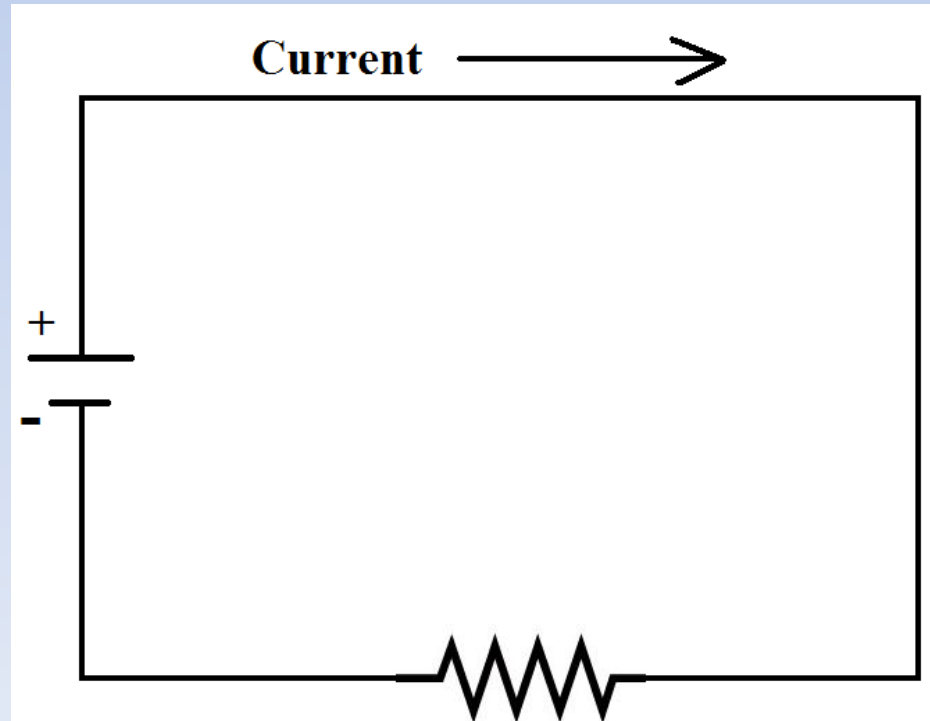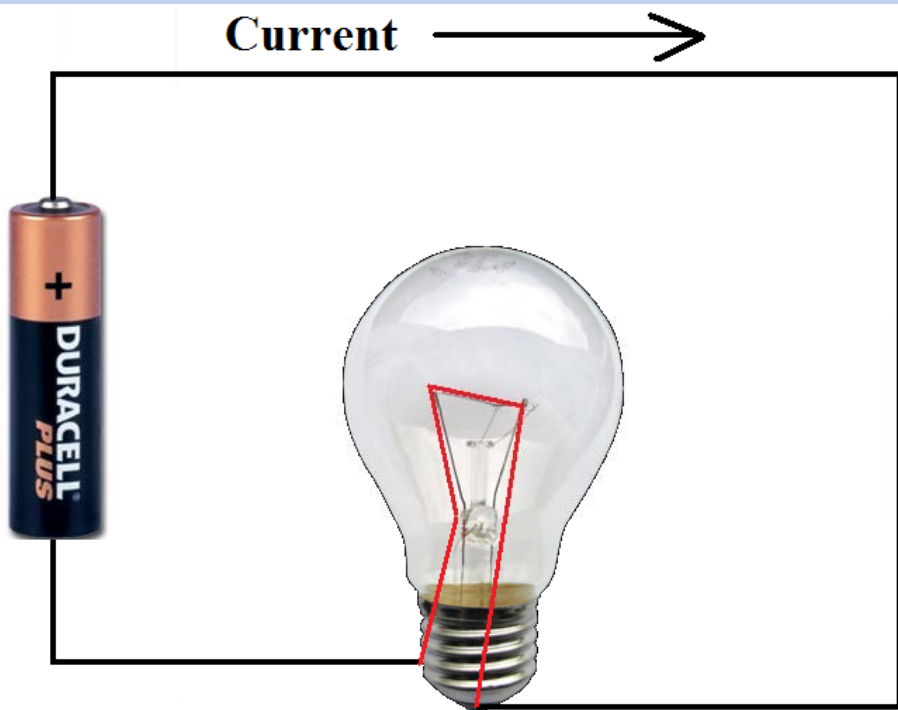
What Resistors & batteries do

- Resistors resist flow of charge

- Resistance (R) is measured in ohms (Ω)

- More ohms = more resistance to flow of charge

- Battery "push" voltage (V) measured in volts (V)

- Current (i) measure in amps (A)

R1 = 10 ohms

+

1.5 V

-

R2 = 20 ohms

i = 0.05 A
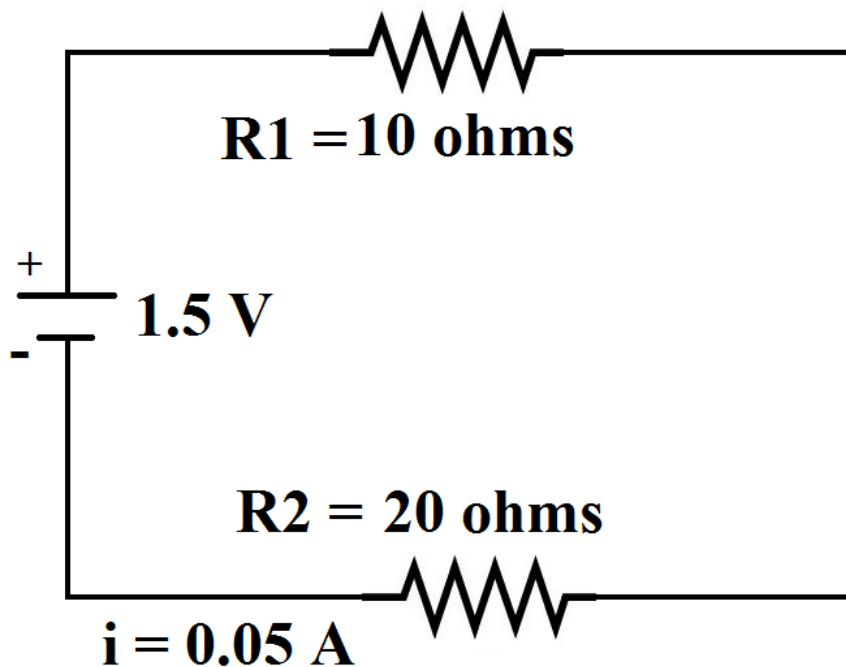
- 1 amp = 1 coulomb of charge flowing by any particular point in a wire each second

- In calculations, Copper wire is usually assumed to have no resistance

Resistors in series – shopping analogy

- Imagine you're doing holiday shopping

- First: Wait in check out line

- Second: Wait in gift box line

- Do two consecutive lines speed flow of shoppers?

- Two consecutive resistors are in "series"
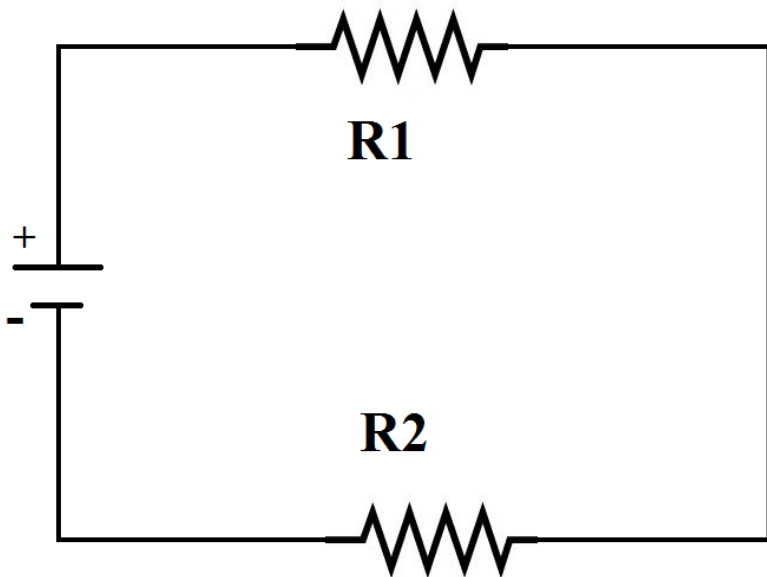
- Resistors in series have more resistance
- We'll learn the math for series and parallel resistors later

What is current?

- Conventional Current is the flow of positive charge
- Electrons flow the opposite way
- Measure in Amps, short for amperes
- Symbol for current is I
- $I = Q/t$
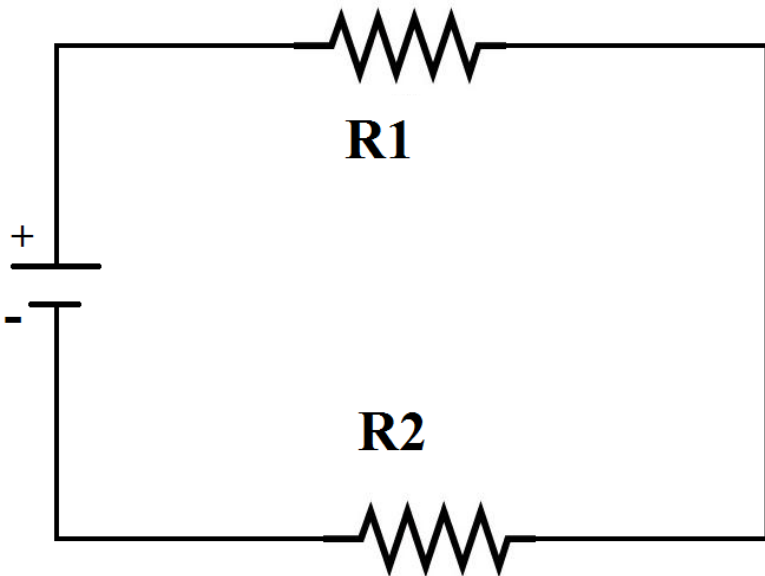
- What direction does current flow?
- What direction do electrons flow?

What is voltage?

- Voltage is the push of charge toward lower voltage

- Think of +/- as elevation, charge goes downhill

- AKA: emf (electromotive force)

- Schematic shows wide end as +, narrow as –

- Voltage drops across resistance ONLY

- In calculations, we assume wire has zero resistance
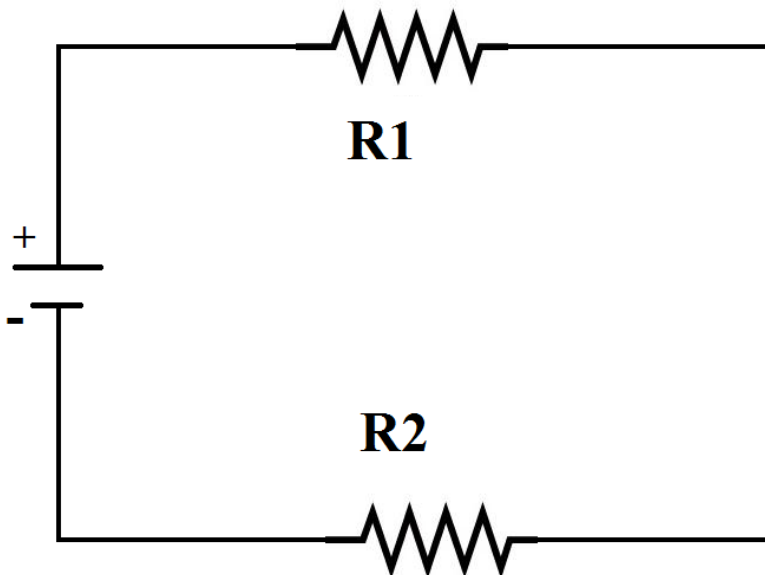
- Which has higher voltage, left of R1 or right of R1?
- Which has higher voltage, left of R2 or right of R2?

R1

+

-

R2

Ohm's law

- The relationship between voltage, current and resistance is called Ohm's law and is the cornerstone of current electricity:

$\Delta V = iR$ (voltage drop = current flow x resistance to current flow)

Example: how much current flows when a 12 volt battery is wired to a 4 ohm resistor? (draw a schematic & solve)

(3A)