

ELECTRICITY



Ray

@SirEviscerate

I...do not understand how electricity works.



Hundreds lose power in Kalamazoo after tree falls on ice cream truck...

Electricity!

The work to power a *blender...

...Is done by over 25 ***quintillion*** electrons every second.

That's 25,000,000,000,000,000,000+ electrons.

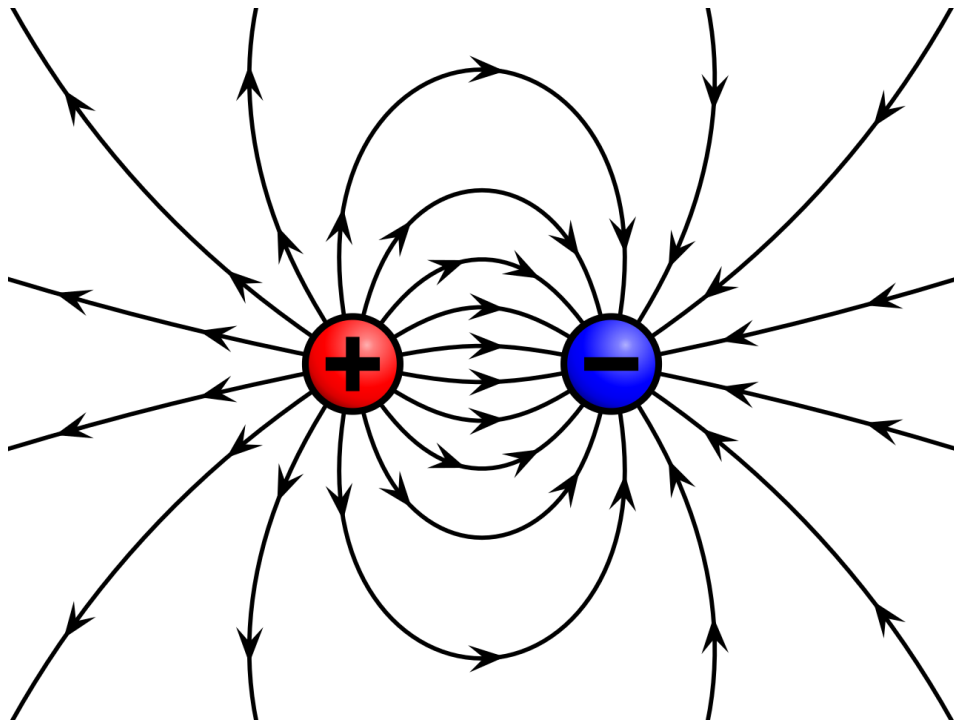


[adult swim]

Charged particle

A tiny thing that has an electric charge.

...An electron, a proton, an ion, etc.

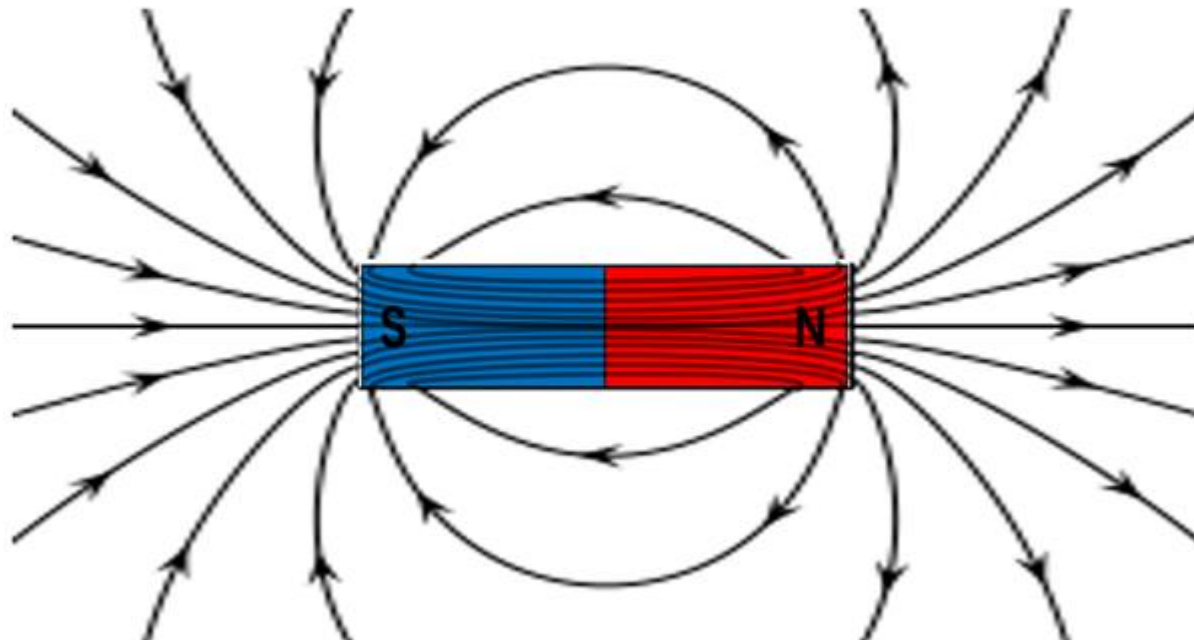


Electric field

A region of space where electric charge is present.

Magnetic field

A region of space where moving charges or magnets make forces.



Voltage

The difference in electric potential between two points.



Electromotive force

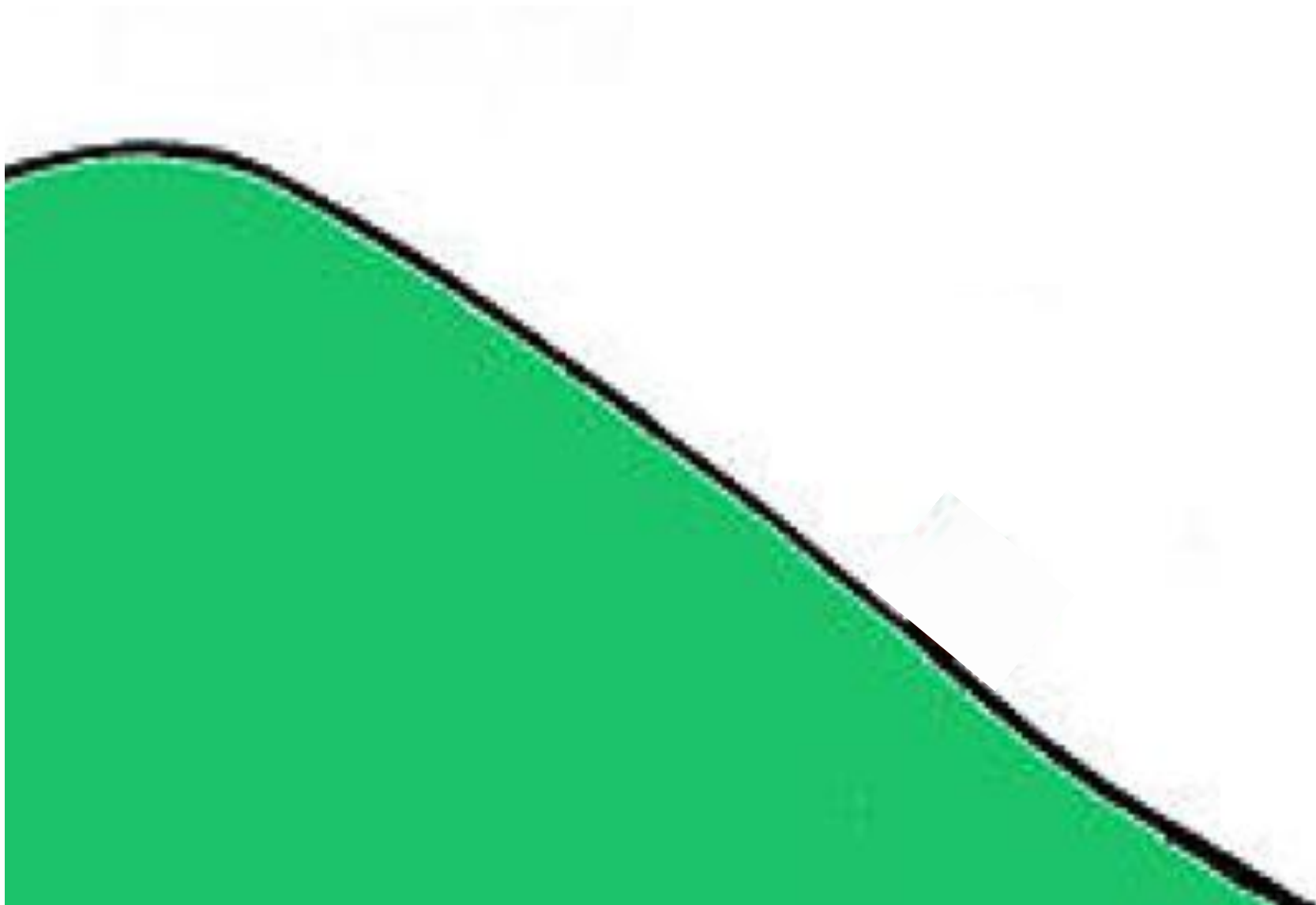
Electric potential

Potential energy per unit charge.



Electromotive force

An analogy: a hill



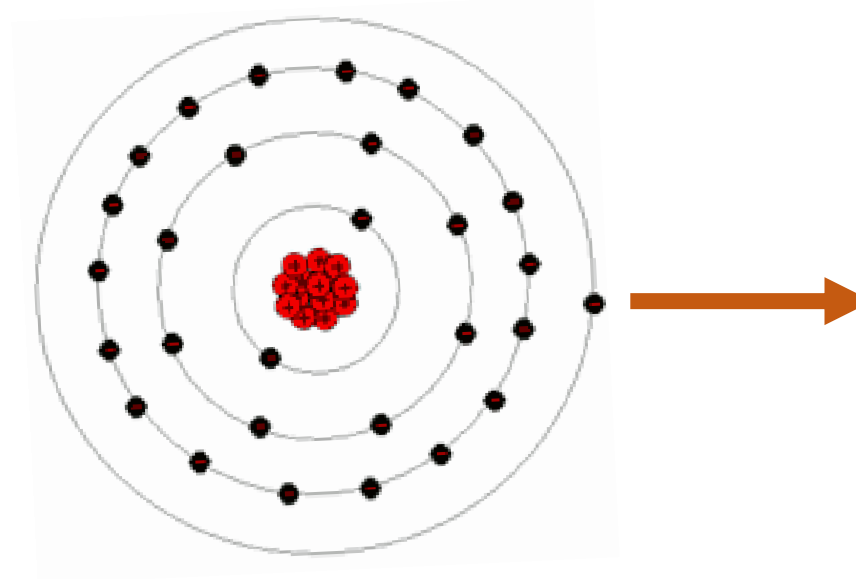
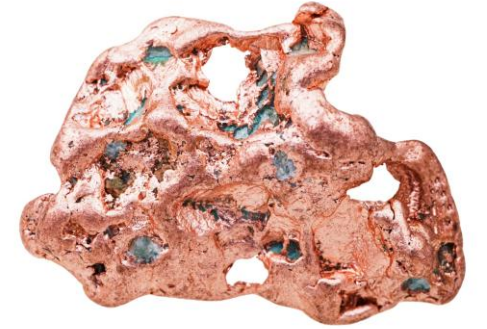
Voltage is relative



For example, between neutral and the **hot line**.

Current

The flow rate of an electric charge.



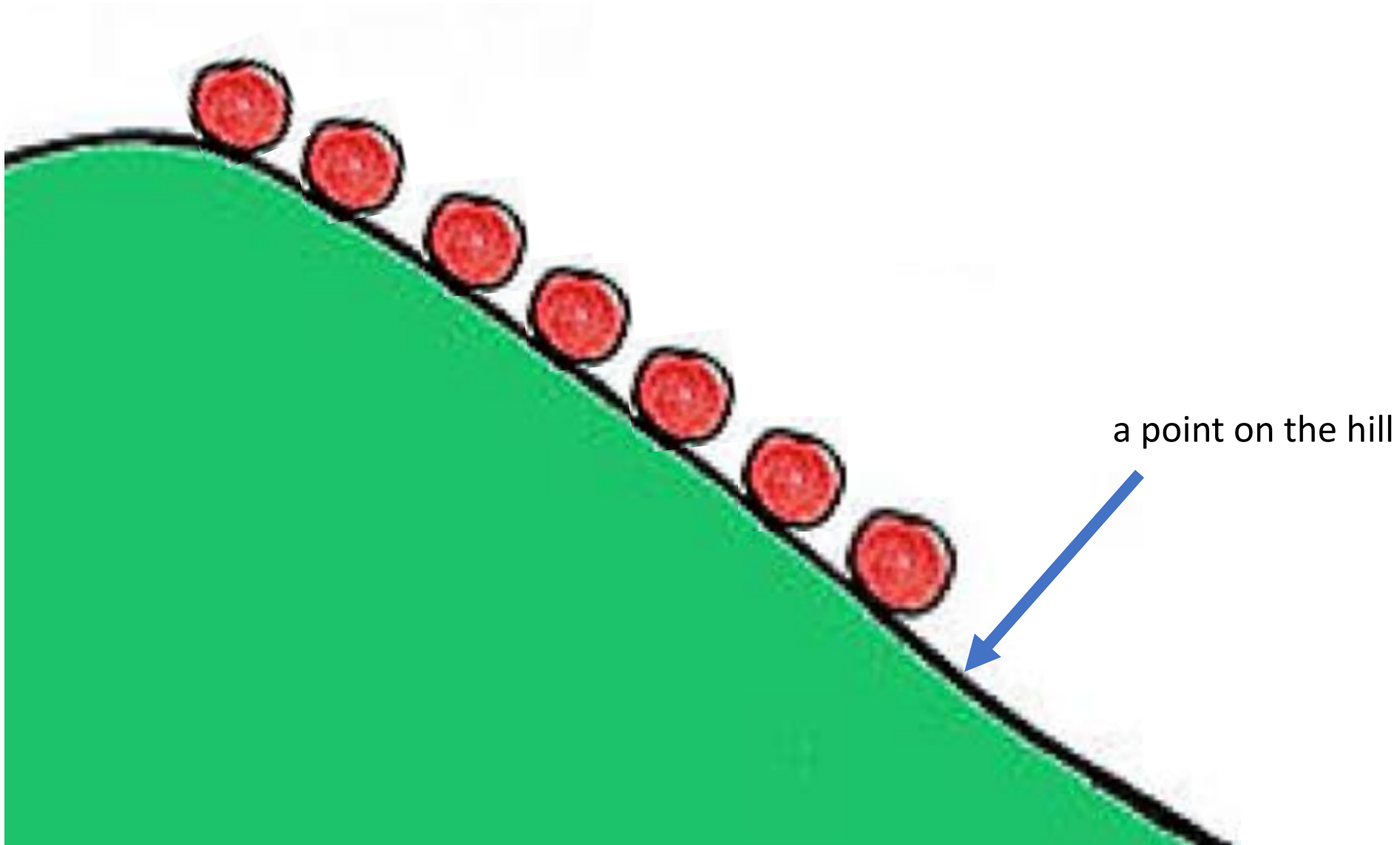
Copper has a free electron, that breaks away easily.

...Copper is a conductor.

Amperage
Amperes (amps)

Atom image: [Iowa State University](#)

An analogy: marbles on a hill

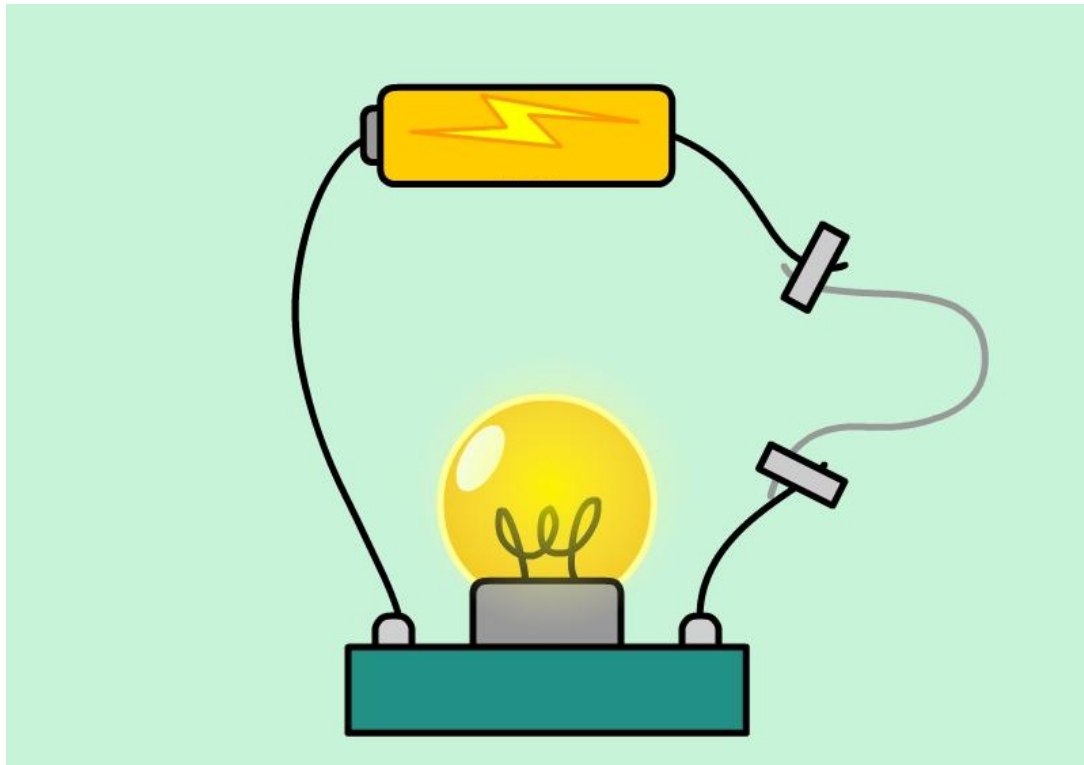


Voltage drop

The reduction of electric potential when energy transfers out of the field.

Voltage drop

The source is 1.5 volts. What's the light bulb's voltage drop?



Resistance

Matter's opposition to the flow of electric current.

smaller straw, more resistance



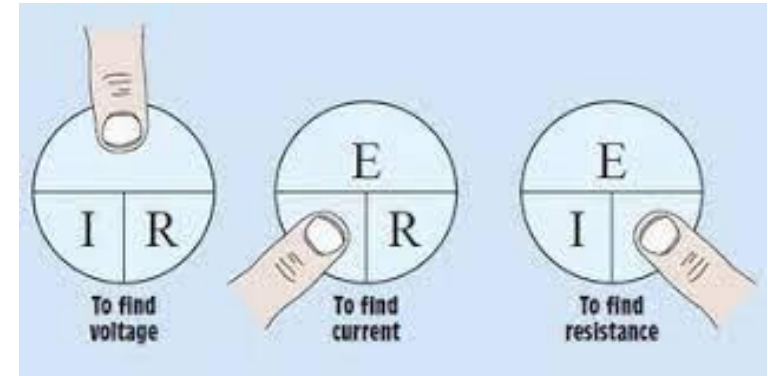
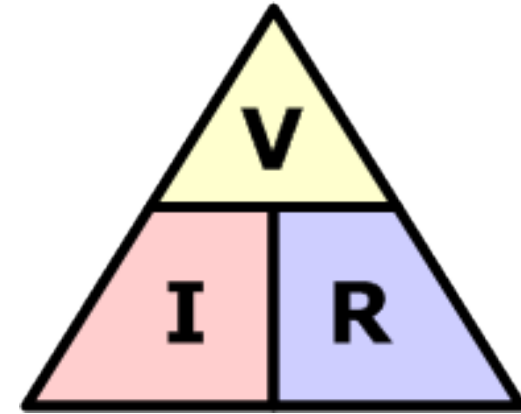
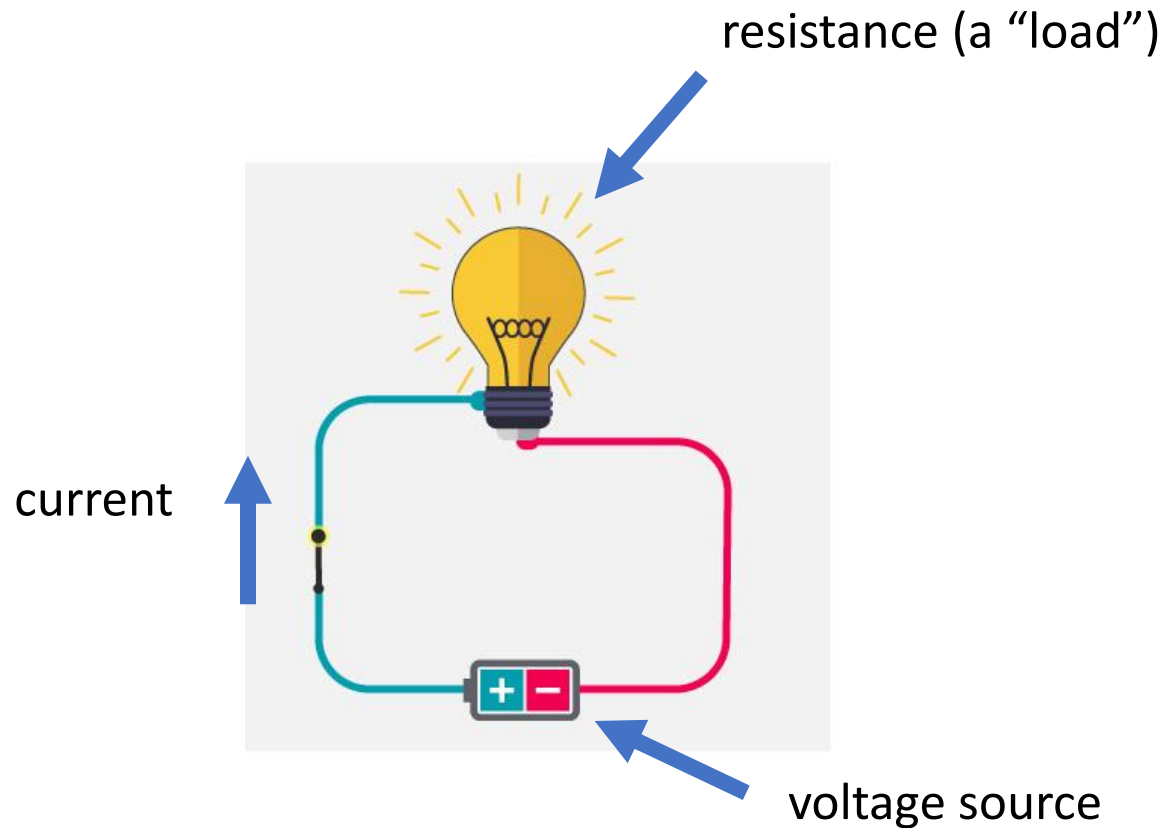
bigger straw, less resistance



Ohms

Ohm's law

Current equals voltage divided by resistance, etc.

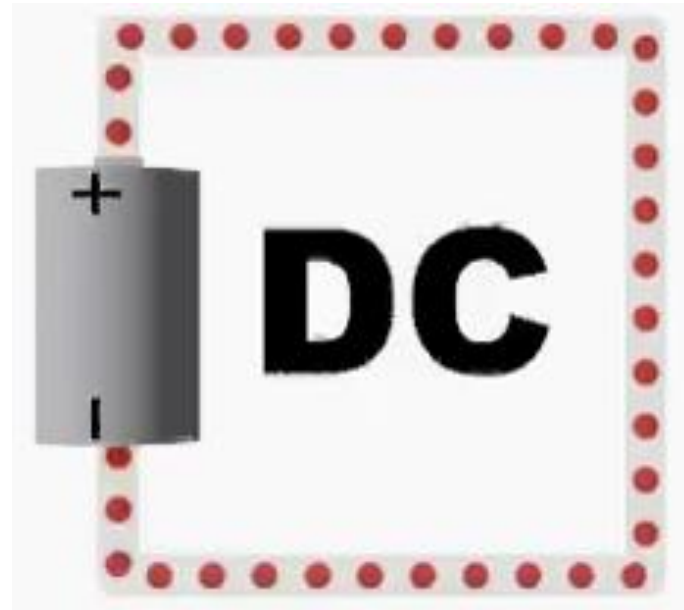


Circuit image: [BYJU'S](#)

Thumbs image: [HVAC Training Solutions](#)

Direct current (DC)

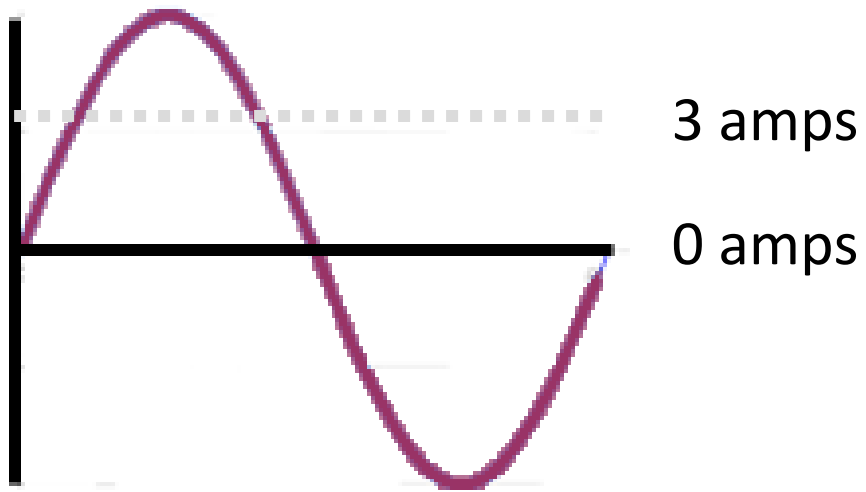
Current flows in one direction.



Alternating current (AC)

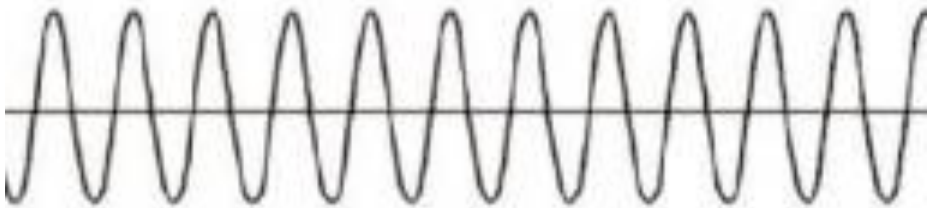
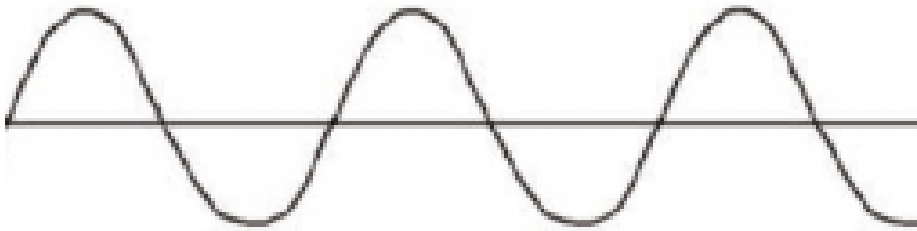
The current periodically changes direction.

The voltage and current is constantly changing.



Frequency

A signal's number of completed waves per second.



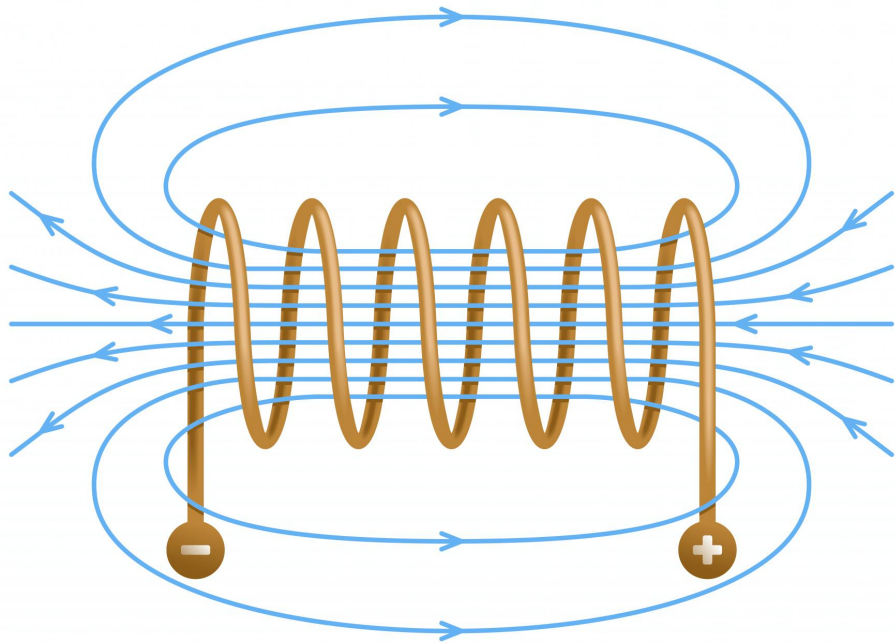
Frequency: A bike analogy



Thanks Mark Baldassari for this analogy

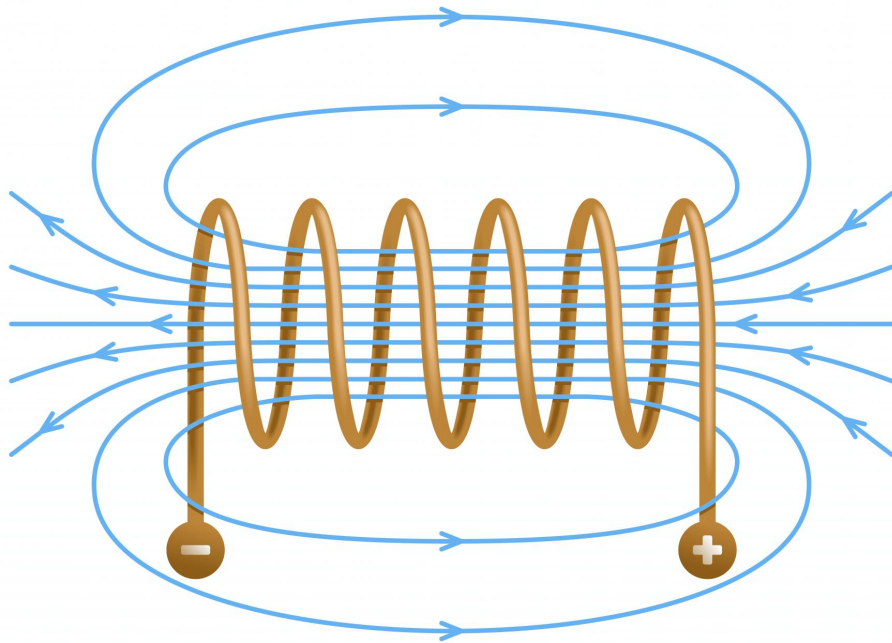
Inductance

The storage of energy in a magnetic field...

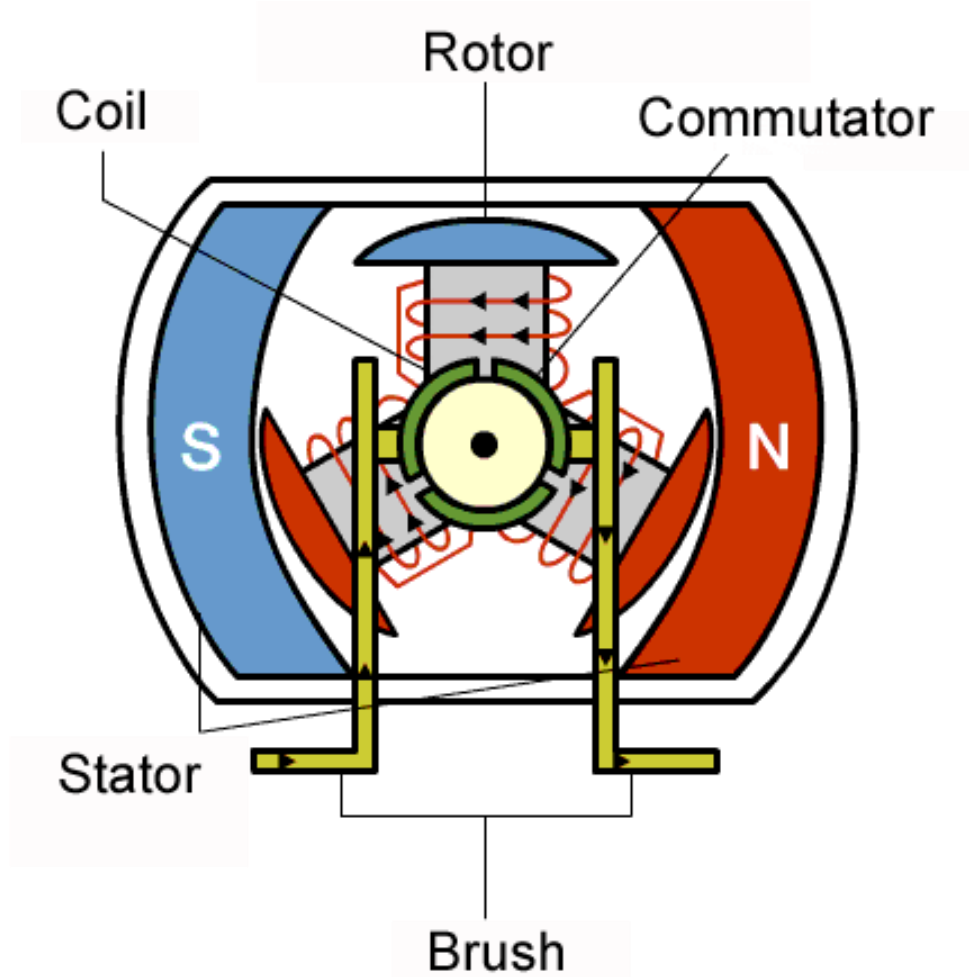


Inductance

...That opposes a change in the current.

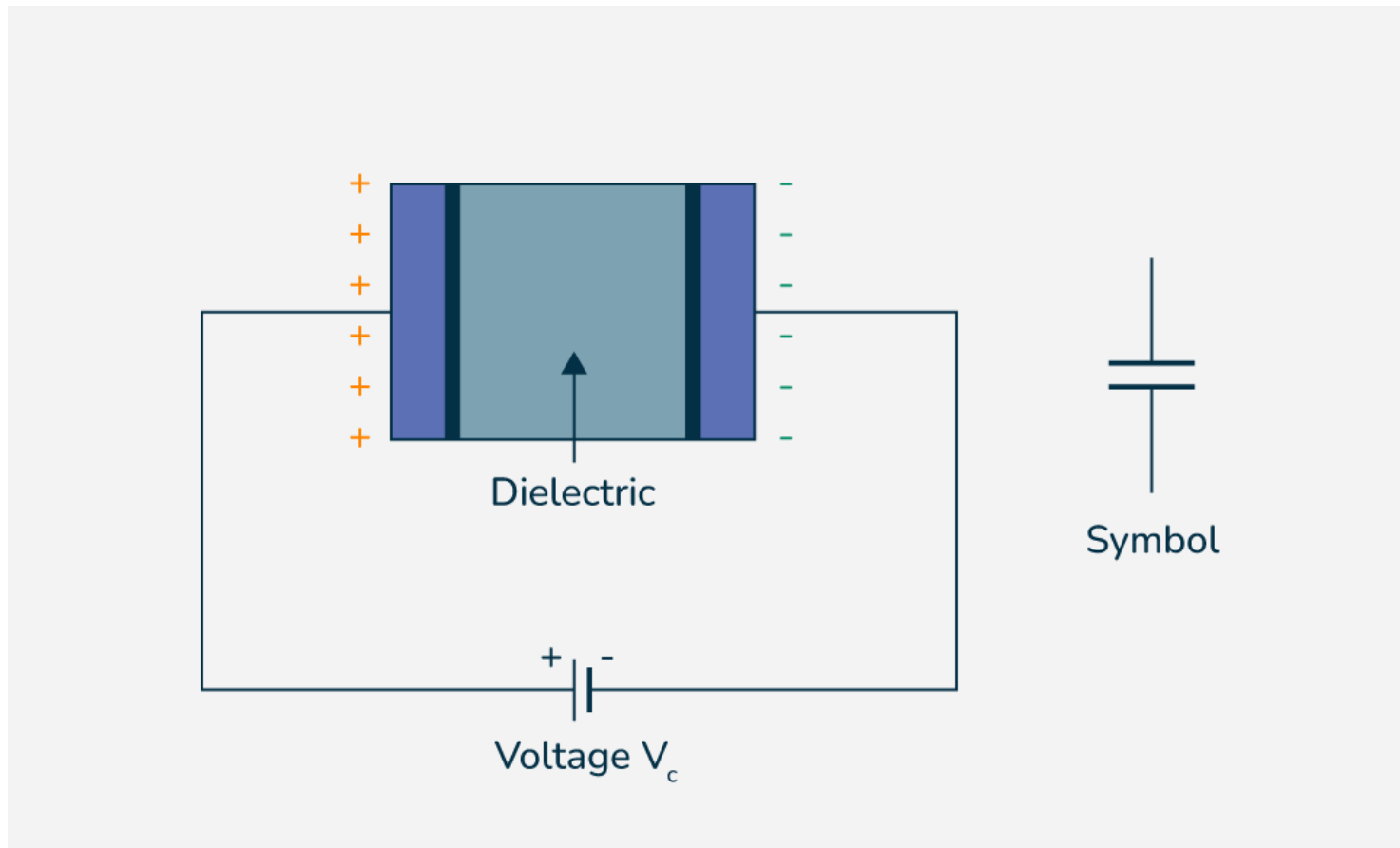


Inductance and motors



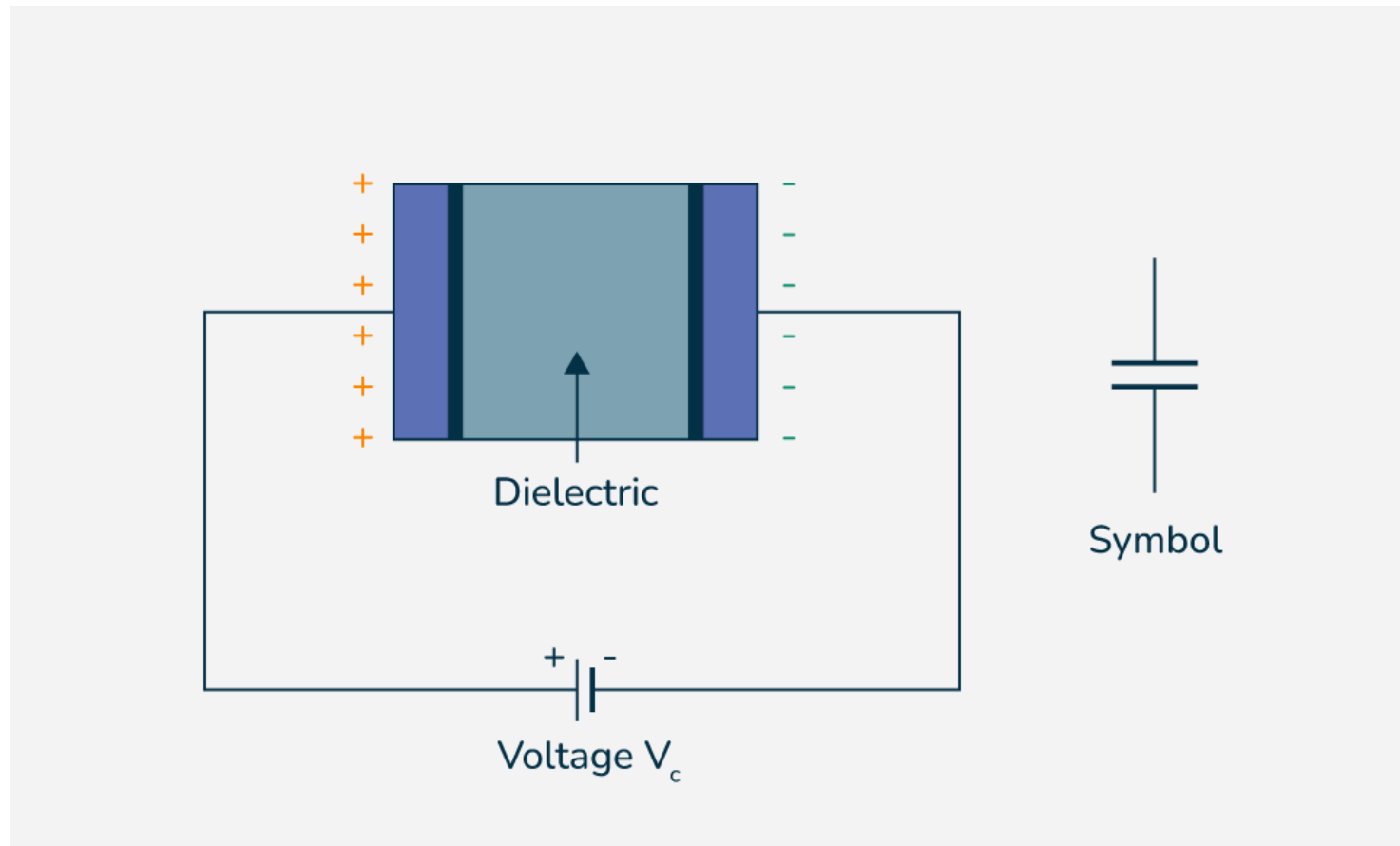
Capacitance

The storage of energy in an electric field...



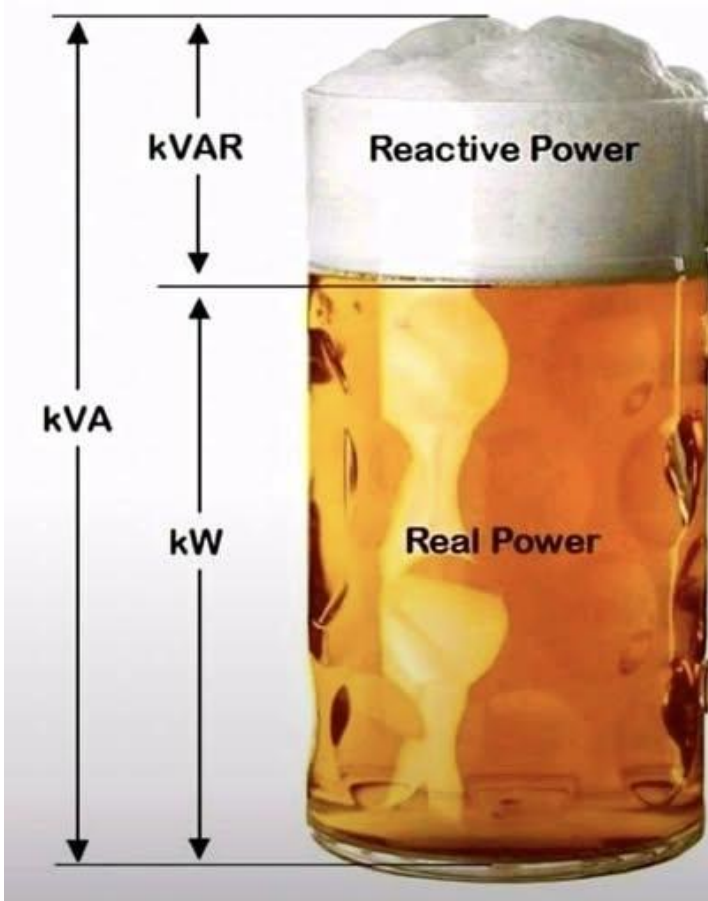
Capacitance

...That opposes a change in *voltage*.

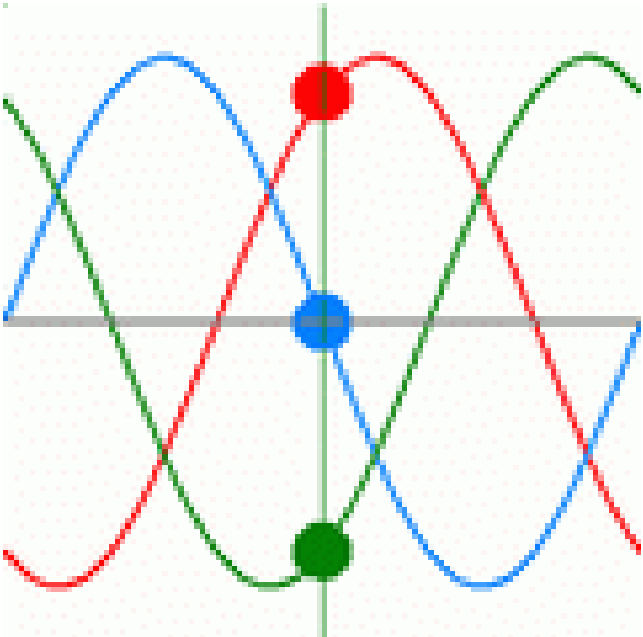
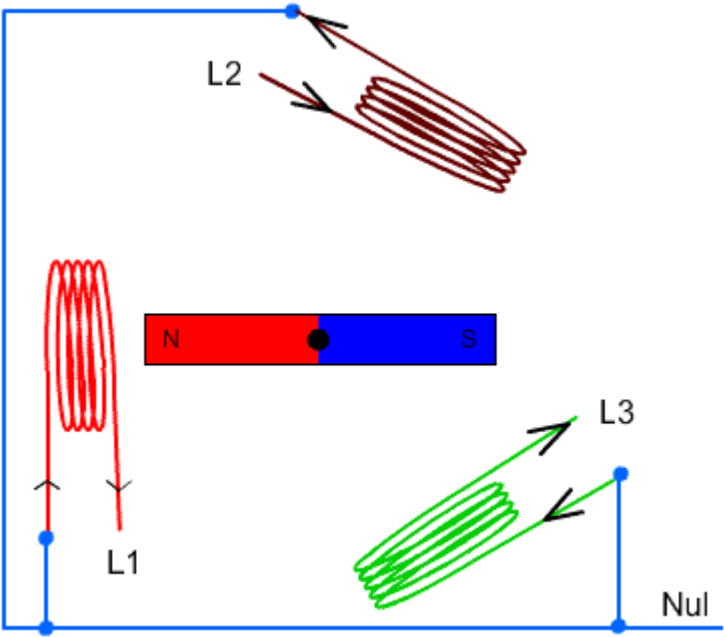
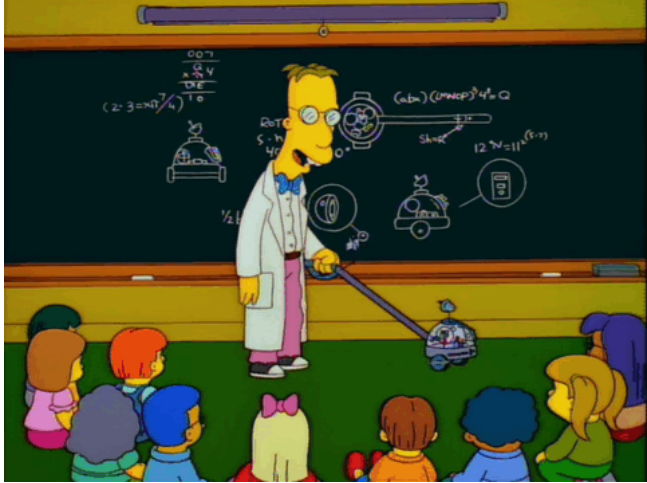


Power factor

The ratio of real power (doing work) to apparent power (sloshing).



Three-phase electricity



Power

The *rate* at which work is done.

A rate applies in a particular moment (not over time).



Live in the now.

— Garth Algar

Power



Less power



MORE POWER

Power

Current times voltage.

Watt

The standard unit of power.

Watt = one amp of current flowing under one volt of electric potential.

1 watt = 1 amp x 1 volt (Or 2 amps x 0.5 volts, 0.25 amps x 4 volts, etc.)

This unit of measurement is a little confusing...

Power \neq Energy

...a common mistake



How much energy have we generated so far today?

Yes Sir, um, 8,000 megawatts.



“Watt” is confusing



Cars:
Miles per hour.



Water:
Gallons per minute.



Natural gas:
Cubic feet per minute.



Electricity:
Watt. (per what??)

Watt = Joule per second

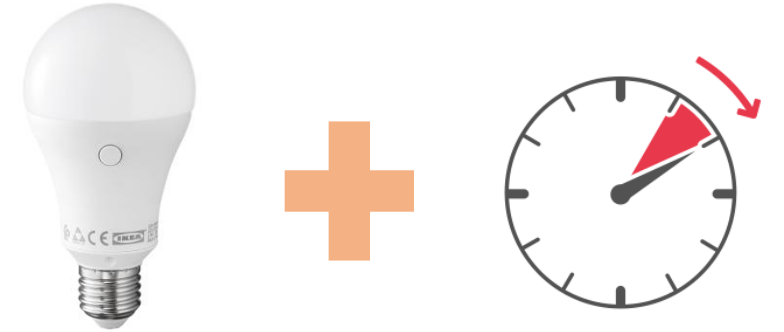
Burning a match releases about 1,000 joules of heat *energy*.



If a tiny match  burns for 1 second and releases 1 joule of heat energy...

What's the average rate of power (in watts)?

Energy



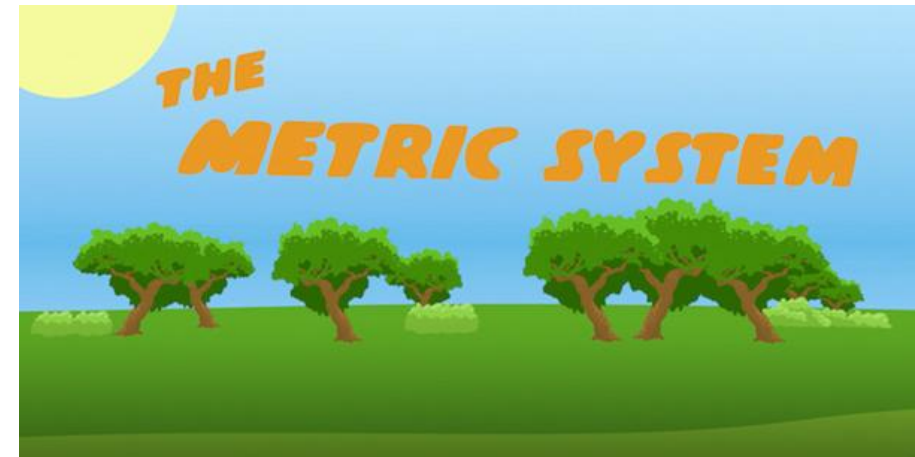
The amount of work done over time.

Watt-hour = One watt of power, doing work for one hour

(Or four watts of power doing work for 15 minutes, etc.)

“Kilo” = 1,000

The kilowatt-hour is the standard unit of energy.



Et tu, ChatGPT?



You

How much energy per day is generated by a typical nuclear power plant?



ChatGPT

A typical nuclear power plant generates about 1,000 megawatts (MW) of electricity per day. This amount can vary depending on the plant's capacity and operational efficiency. The energy produced by a nuclear plant is significant, as it can power hundreds of thousands of homes without emitting greenhouse gases during operation.



You

Isn't megawatts a unit of power, not energy?



ChatGPT

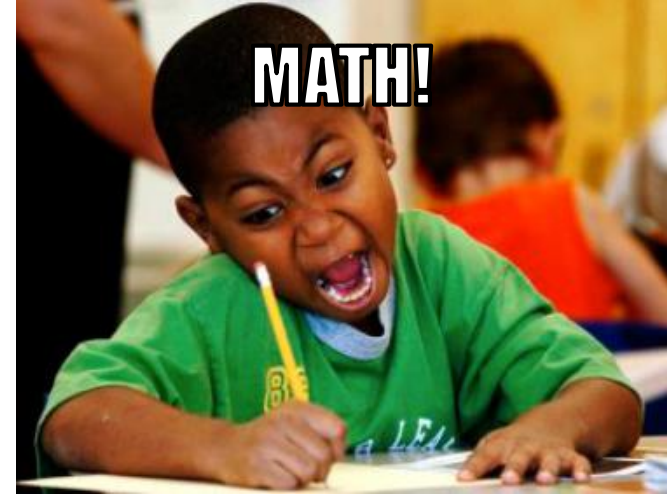
Yes, you're correct. Megawatts (MW) is indeed a unit of power, which measures the rate of energy production or consumption. When referring to the amount of energy generated by a nuclear power plant, it should be described in terms of megawatt-hours (MWh), which is a unit of energy. For example, a nuclear power plant with a capacity of 1,000 MW operating at full capacity for 24 hours would generate 24,000 MWh (or 24 GWh) of energy in one day.

Unit conversion

? 1 kilowatt-hour = _____ watt-hours ?

Energy cost exercise 1 of 2

? 2¢ per watt-hour = \$ _____ per kilowatt-hour?



Energy cost exercise 1 of 2

? 2¢ per watt-hour = \$ _____ per kilowatt-hour?

How many cents per kWh? ...Multiply by 1,000 (watt-hours per kWh).

2,000¢

What's that in dollars? Divide by 100 (cents per dollar).

\$20

Energy cost exercise 2 of 2



10 watt LED bulb



LED-bulb energy cost?



Both on for 10 hours
10¢ per kWh



20 watt CFL bulb



CFL-bulb energy cost?

Energy cost exercise 2 of 2



10 watts x 10 hours = 100 watt-hours

10¢ per kWh (1,000 watt-hours) = 1¢ for 100 watt-hours of energy



20 watts x 10 hours = 200 watt-hours

10¢ per kWh (1,000 watt-hours) = 2¢ for 200 watt-hours of energy

ELECTRICITY

