THE GUIDE TO ELECTRICITY

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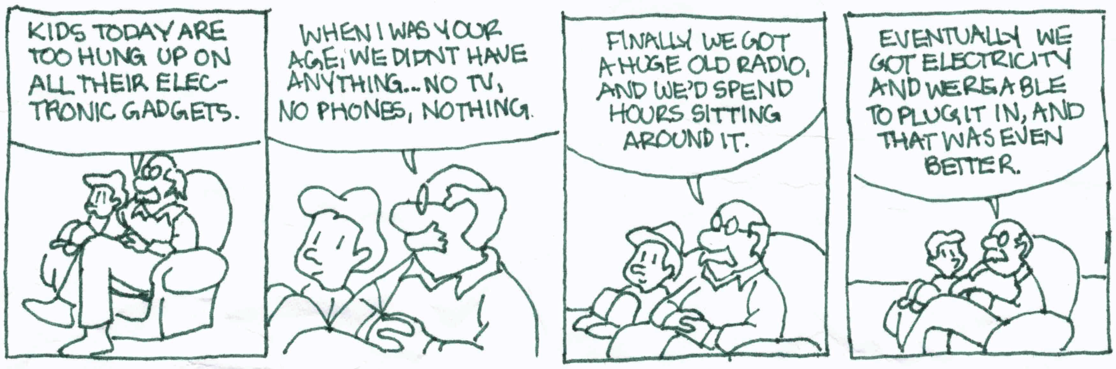
Period: E



Electric Charges

A property that causes subatomic particles such as protons or electrons to repel each other!

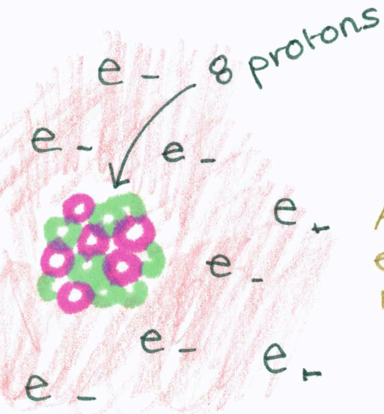


Fig. 1

According to Fig. 1, we see that there are an equal amount of protons to electrons, which means the atom is neutral

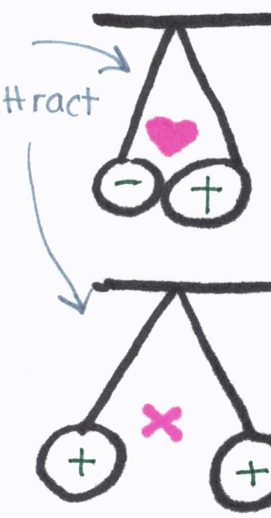
Simarly, we can say that we have a net electric charge when there is a excess or shortage of electrons!

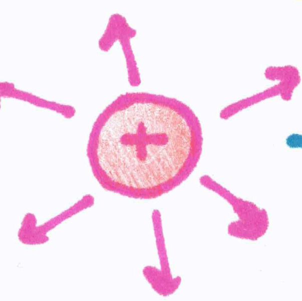
The SI unit of electric charge is the coulomb (C) It takes about 6.24×10^{18} electrons to produce a single coulomb

Charles Coulomb discovered electric charges is similar to universal law of gravitation!

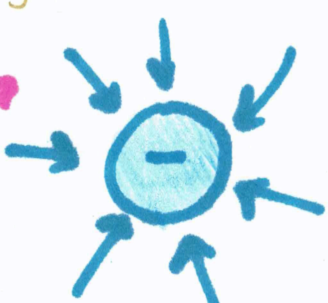
→ ex. the electric force between the objects: if you double that, you double the net charge! If you double the distance between the objects, the electric force is 1/4 as strong.

Like charges repel and opposite charges attract





Field of positive charge

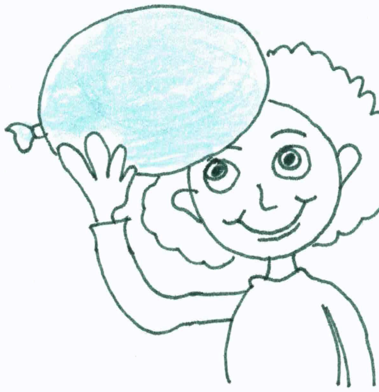


Field of negative charge

Static electricty = study of behavior of electric charges, including how charges are transferred between objects.

Charge can be transferred by friction, contact, and by induction!

Charging by friction



rubbing your hair against a balloon is charging by friction! The electrons from your hair move to the balloon since atoms in rubber have a greater attraction for electrons. Since your hair gave electrons it's positively charged and the balloon is negatively charged! Opposite charges attract!

why do I get a shock from the doorknob?

The spark you feel is static discharge! It occurs when the pathway through which charges can move forms suddenly!

Charging by contact

The man touches the metal sphere and his hairs stand up! This is charging by contact!

When the man touches the sphere (the sphere is already charged) he aqquires a charge large enough to make his hairs stand up!

Charging by induction

induction = transfer of charge without contact!

So to get to the doorknob the man walked accross his carpet! You have picked up electrons from the carpet so your hand is negatively charged. Your hand then repels the electrons in the doorknob! The electrons move to the base of the door knob, leaving the positive charge closest to the hand! The negative charges in your hand made the charges in the doorknob move around!

Electric Current

The 2 types of current are direct and alternating current!

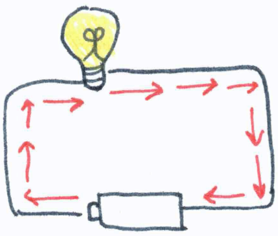


Fig. 7

→ The parts of this circuit make a continous path in which charge can flow. This path is electric current, as directed by the red arrows.

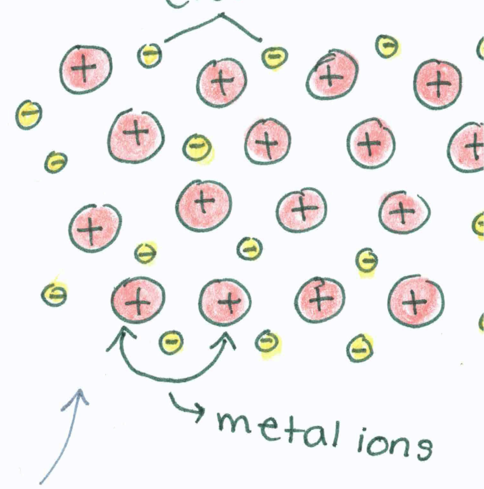
The SI unit for electric current is Amps (A)

Direct current: charge only flows in one direction. ex. flashlights or most battery opperated devices.

Alternating current: a flow of electric charge that regularly changes it direction. ex. toasters, refridgerators, dishwashers, etc.

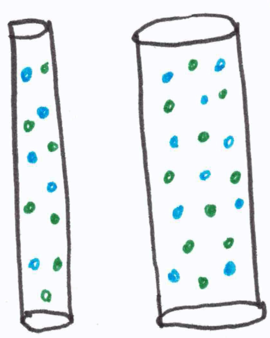
Why is a metal wire coated with plastic or rubber?

The metal wire is a electrical conductor meaning that it can have charge flow through it easily. Plastic and rubber are insulators meaning that it's harder for charge to pass through. The coating around a wire helps to control the current!



A metal is made of metal ions in a lattice and the ions are not free to move but each ion has a couple of electrons not tightly bound to it. This "sea of electrons" can conduct charge freely!

Using a thick straw to drink a milkshake is easier than using a thin straw since electrons flow more easily through a thick straw than a thin one!



Resistance

As electrons move through a conducting wire, they collide with other electrons and ions. These collisions convert the kinetic energy they have into thermal energy. Since there is less energy available to move electrons through the wire, the current is reduced!

The SI unit for resistence is ohms! It's represented by the greek letter 'omega' (Ω)

A material's thickness, length, and temprature can affect resistence.

ex. Resistence is greater in a longer wire because the charge travels farther.

When temprature increases, the resistence increases because electrons will collide more often!

Voltage

If you remove a battery in a flashlight — it won't shine! But why? This is because you removed a part of the continuous loop that kept the charge moving! Also the wires and bulb have resistence, so the charges can't flow on their own without a source of energy.

potential energy = the energy that something has relative to it's position. A object has the highest PE at it's highest point

→ Simarlily charges flow from areas of higher to lower potential energy

In a circuit diagram...

 = battery

 = resistor

 = switch (open)

 = switch (closed)

Potential difference = difference between the electric PE of 2 points on a field.

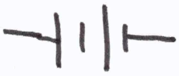
NOTE: this is also known as voltage!

The SI units for voltage is volts (V)

More on Circuit Diagrams

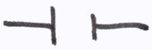
Down below are common symbols you might see!

 = conductor

 = battery

 = motor

 = resistor

 = capacitor

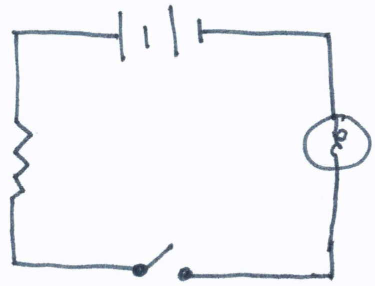
 = light

 = switch (open)

 = voltmeter

 = ammeter

Example of a circuit diagram:



This is a open circuit.

Circuit Diagrams use symbols to represent parts of a circuit, including a source of electrical energy and devices that are run by the electrical energy

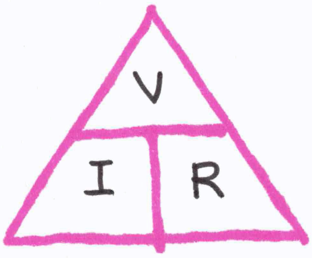
The symbol  is a switch. It shows places where the circuit can be opened. If the switch is open, the circuit is not a complete loop, and current stops. This is called a open circuit. When the swith is closed it's called a closed circuit.

QUICK REVIEW:

resistance: so resistors are anything that decreases current. By this, a light bulb is also a resistor!

Ohm's Law

The unit ohms (Ω) was named after the German scientist Georg Ohm (1789 - 1854) who discovered how resistance and current affect voltage!

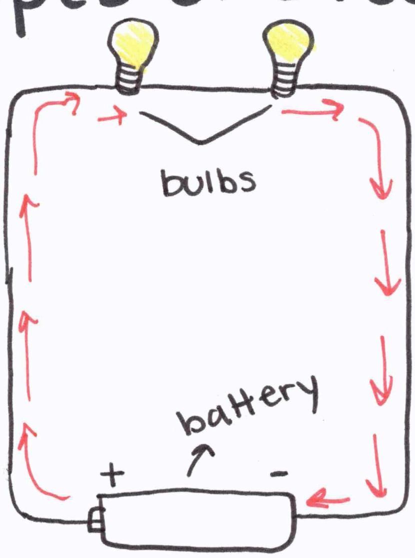


$$V = IR$$

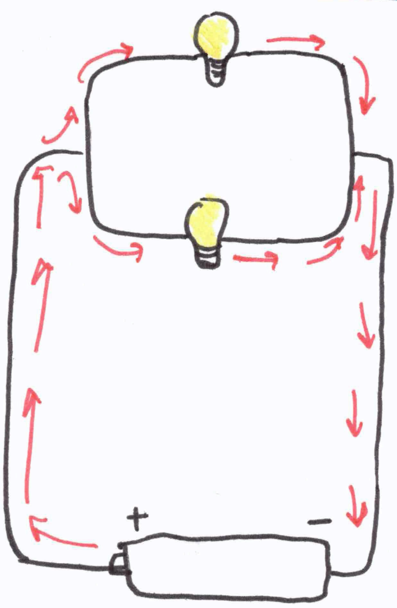
V = voltage. I = current. R = resistence.

You can examine all sorts of relationships from this equation! Like increasing resistence (voltage stays constant) will decrease current!

Types of circuits:



Series circuit



Parallel circuit

If a bulb in a seri circuit burns out the circuit will stop working.

If a bulb stops working in a parallel circuit it'll keep going since there are multiple paths!

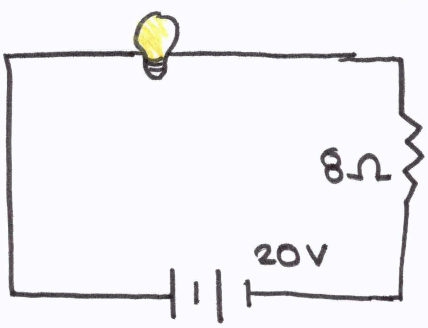
Relation between different types of circuits and Ohm's law

	Series	Parallel
Voltage (V)	$V_{tot} = V_1 + V_2 + V_3 \ldots$	$V_{total} = V_1 = V_2 = V_3 \ldots$
Current (A)	$I_{tot} = I_1 = I_2 = I_3 \ldots$	$I_{tot} = I_1 + I_2 + I_3 \ldots$
resistence (Ω)	$R_{eq} = R_1 + R_2 + R_3 \ldots$	$1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3 \ldots$

The above chart demonstrates all the needed formulas to compute the components of On'ms law for both a series and parallel circuit.

Problems with On'm's Law

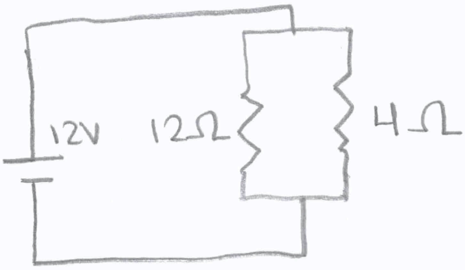
Sample problem 1: In the circuit shown below, how much current is there?



1) So we first identify this as a series circuit
2) Now to find each component:
   We know $R_{eq} = 8\,\Omega$ since there is only 1 resistor.
   We also know that the voltage across it is the same as the battery which is 20V.
3) Apply Ohm's Law.
   $20V = 8\Omega \cdot I$ so $I = 1.25A$.

Sample problem 2:

A 12V battery, a 12 ohm resistor and a 4 ohm resistor are connected as shown. The current in the 12 ohm resistor is ___ that of that in the 4 ohm resistor.

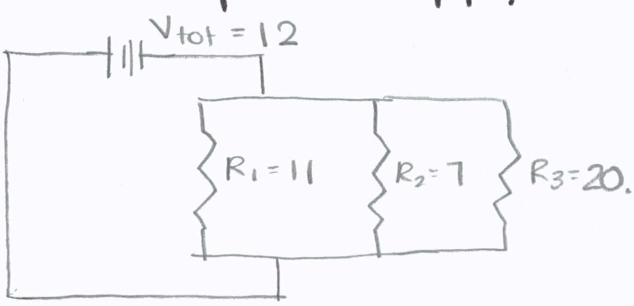


a. 1/3 b. 1/2 c. 2/3 d. same

Solution: In a parallel circuit, the voltage is the same throughout the circuit. The current in a resistor follows Ohm's Law: $I = \Delta V/R$. Since ΔV is same throughout, the current will be smallest where resistance is greatest.
we have $V = IR \Rightarrow V = I \cdot 12$ for the 12Ω resistor.
we have $V = I_1R \Rightarrow V = I_1 \cdot 4$ for the 4Ω resistor.
If we equate our expressions, we have $12I = 4I_1$ so
$I = \frac{1}{3}I_1$ which means choice A is our answer.

Sample problem 3:

3 resistors are connected in a parallel. If placed in a circuit with a 12V power supply. Determine the missing blanks.



$R_{eq} = 3.52$ $I_{tot} = 3.411\,A$
$I_1 = 1.091A$ $\Delta V_1 = 12\,V$
$I_2 = 1.714A$ $\Delta V_2 = 12\,V$
$I_3 = 0.6A$ $\Delta V_3 = 12\,V$

Solution: So we know $1/R_{eq} = 1/7 + 1/11 + 1/20 = \frac{77+140+220}{1540} \Rightarrow \frac{437}{1540} = 0.28$
so $1/R_{eq} = 0.28376623$. So $R_{eq} = 3.52\,\Omega$
Now we know R_{eq} we can find current in the battery from Ohm's Law.
$V = IR \Rightarrow 12V = I \cdot 3.52\Omega \Rightarrow I_{tot} = 3.41A$.
In a parallel circuit, we know the voltage is the same throughout.
So $V_{tot} = V_1 = V_2 = V_3 = 12V$.
The missing 3 values can be found with Ohm's Law.

$I_1 = 12V/11\Omega$ so $I_1 = 1.091A$.

$I_2 = 12V/7\Omega$ so $I_2 = 1.714A$

$I_3 = 12V/20\Omega$ so $I_3 = 0.6A$