NOTES FROM SEPTEMBER 3

Charge, (Electric) Current, and (Electric) Potential

We will now switch from water to electricity.

H_2O molecules electrons

We measure charge in Coulombs or C.

Unlike mass, charge can be positive or negative.

Mass is always positive and masses always attract.

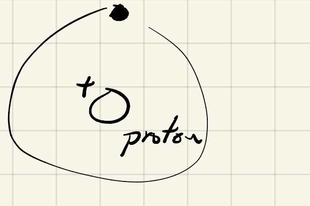
Positive charges repel each other.

Negative charges repel each other.

Positive charges and negative charges attract each other.

Unlike mass, charge never piles up!
almost

It repels too strongly. The simplest, most common combination of charges is the hydrogen atom:



The electron's charge is tiny and negative:
$-1.6\times10^{-19}C$

The proton's charge is tiny and exactly opposite:
$+1.6\times10^{-19}C$

Overall, the hydrogen atom is neutral

In conductors, like copper and aluminum, electrons move very easily from one atom to the next.

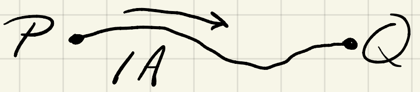
Electric current is measured in $\frac{\text{Coulombs}}{\text{second}}$. This combination is so common, it has a name:

$$1\ \text{Amp} = 1\text{A} \equiv 1\,\frac{\text{C}}{\text{s}}$$

Passing negative charge is like <u>paying</u> someone by <u>accepting</u> some of their debt.

Question for you:

If 1 amp is flowing through a wire from points P to Q, describe what is happening in terms of electrons?



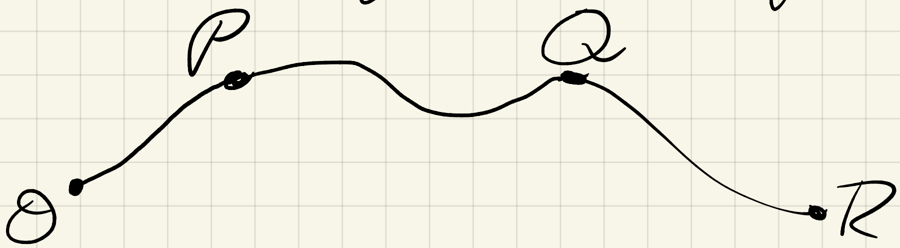
How many electrons per second?

What direction?

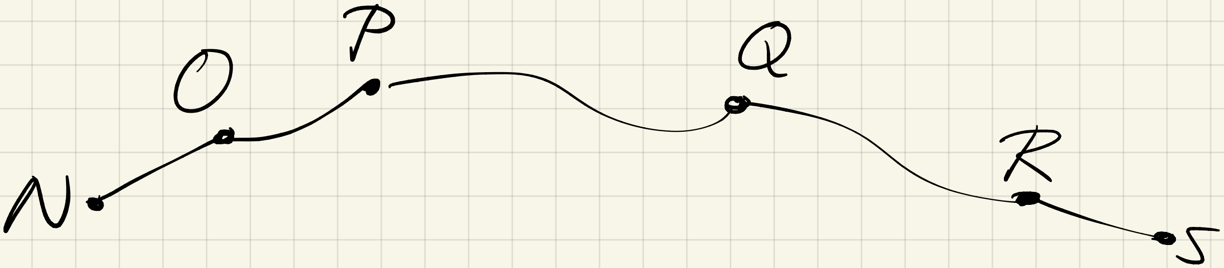
Again, Charge can never pile up. That means that everything almost we deal with in circuits is <u>neutral</u> — even batteries and capacitors.

(So "charging" a battery is a little misleading. As many electrons are pushed into the positive terminal as are drawn out of the negative terminal.)

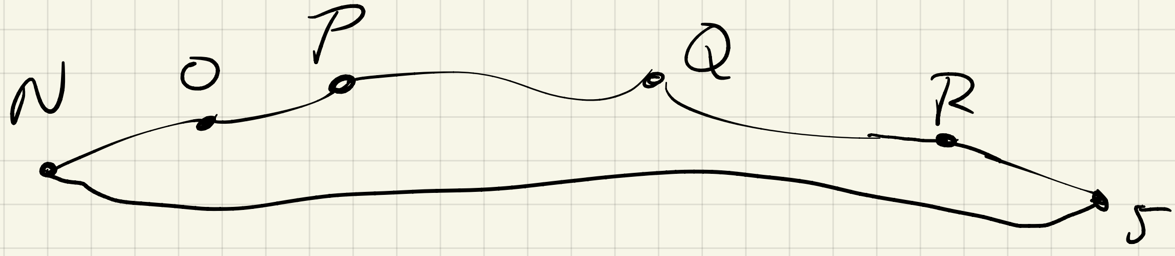
That means that there must be something to supply the current at P and carry it away from Q.



of course that is also true of Q and R.

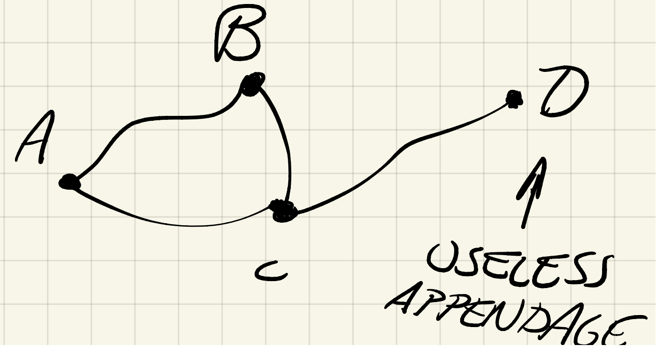


If charge can never pile up the only way to make a circuit that does anything is to close the loop



That's why circuits are called *circuits*.

No useful piece of a circuit ever dangles by itself



Water falls and releases gravitational energy due to gravitational force.

Charge "falls" (not necessarily down) and releases energy due to electrical force. You can't feel electrical force (unless it is so strong you get zapped).

We have equipment to measure it. Just like height we need a reference point. Alternatively, we measure the difference in two heights (the first height is acting as a reference point).

Instead of gravitational potential, measured in $\frac{J}{kg}$ we have electrical potential, measured in $\frac{J}{C}$.

$\frac{J}{C}$ is such a common unit, it has a name:

$$1\ \text{Volt} = 1V \equiv \frac{1J}{C}$$

Instead of saying electrical potential we either shorten that to just potential, or more commonly we say "voltage". Voltage is measured in Volts.

Question for you: that's a rate (of charge movement)

If 10 A drops through 100V, how much power is being released?

← that's a rate too (of energy)