Voltage

Voltage is defined as the difference of potential energy per unit of charge between two points.

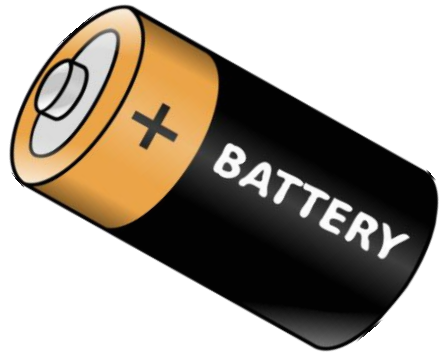
$$V = \frac{\Delta U}{Q}$$

Intuitively, voltage tells us how much energy a charge would get if it was placed in such voltage. This has some analogies with the gravitational potential that we saw before. However, this is a generalization that works for both positive and negative charges.

A voltage is measured in "Volts", we use the letter V to represent it.

$$1\ \text{Volt} = \frac{1\ \text{Joule}}{1\ \text{Coulomb}}$$

An example of a voltage source:



Current

An electric current is any type of flow of charged particles. We measure it by counting the number of charged particles flowing through a defined section per unit of time

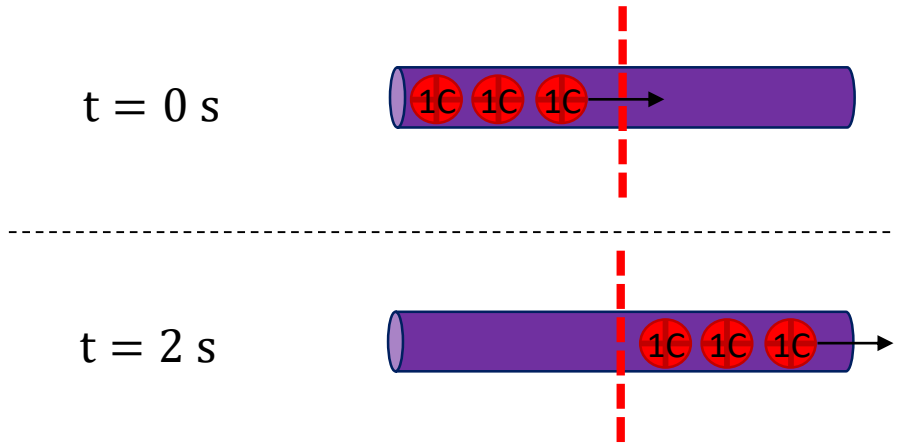
$$I = \frac{\Delta Q}{\Delta t}$$

By convention, a current follows the direction of **positive** charges. Therefore, a current always flows from the positive side of a voltage source to the negative.

If the charges flowing are negative, we say that the currents flows in the opposite direction.

Current is measured in "Amperes", and it is represented by the letter I.

$$1\ \text{Ampere} = \frac{1\ \text{Coulomb}}{1\ \text{Second}}$$



$$I = \frac{3\ \text{Coulomb}}{2\ \text{seconds}} = 1.5\ \text{A}$$

Resistance

Resistance is the property of the objects that tells us how much this object opposes the flow of electrical current. An element of an electric circuit that opposes the flow of current is called a “resistor”.

In a simple electric circuit, we will have a voltage source and a resistor. The voltage source induces an electric current that flows across the resistor. The voltage, resistance, and current in such a circuit are related by the following formula:

$$V = R \times I$$ → Ohm’s law

Resistance is measured in “Ohms”, but we use the Greek letter Ω instead. Resistance is represented by R.

$$1\ \text{Ohm} = 1\Omega = \frac{1\ \text{Volt}}{1\ \text{Ampere}}$$

An example of a resistor:

Homework

Problem 1. Suppose that you have a battery of 1.5V that has pumped a total of 3 Coulomb of electric charge through it. What is the maximum amount of work that can be done by this circuit?

Hint: Recall that $W = \Delta U$.

Problem 2. The brightest phase of a lightning bolt lasts approximately 1 millisecond (1ms, “milli” stands for 1/1000). During that time, a charge of approximately 10 C moves between the cloud and the ground. Estimate the typical electric current during this event.

Homework

Bonus exercise. Go to https://www.brainpop.com/games/circuitconstructionkitdc/ and click “Play game” and then select the “Intro” option.

- Use your knowledge of electrical circuits to build a circuit in which you can get an electric current and turn on a light bulb.
- Vary the voltage in your voltage source. What happens to the current?
- Vary the resistance of the light bulb. What happens to the current?
- What happens if you create a “Short circuit”?
- Can you create a circuit that has “more than one paths”?
- Explore as much as you want with the different options available.