

Lesson 0: Voltage

Recall: Like charges repel
Unlike charges attract

You have probably heard of “volts” or “voltage”. Voltage is a defined unit. It is defined as the amount of energy per coulomb of charge at a location.

Since energy is measured in joules and charge is measured in coulombs the units for voltage are:

$$\text{Voltage} = \frac{\text{Joules}}{\text{Coulomb}}$$

Voltage is a scalar. It has a symbol capital V and the abbreviation for the unit “volts” is also a capital V.

Have I mentioned lately that we are running out of letters?

Before spring break we brought out the Van de Graaff generator, and some students chose to receive an electric shock. I mentioned that the sparks being generated were several hundred thousand volts.



How was this possible? The voltage that comes out of a standard plug outlet is 120 V (in North America), and that is enough to cause serious injury.

The answer is in the definition of voltage. When students were getting shocked by the Van De Graaff generator, each coulomb of charge had lots of energy but there the amount of charge in coulombs was very small.

Compare that with a plug outlet. Although each coulomb of charge has only 1 J of energy, there is basically an unlimited supply of charge.

Key idea: Voltage measures the amount of energy per coulomb of charge at a location.

I find it helpful to have a “real world” analogy for voltage.
Consider gravitational potential energy:

$$PE = mgh$$

If I pick a mass up from the floor and slowly begin lift it higher and higher, I am increasing the total potential energy.

Another way to think about this: I am increasing the average energy per kilogram.

When I have charges at a higher voltage, that increases the energy per coulomb.

Voltage is sort of like height. Charges at a higher voltage have more energy per coulomb kind of like masses at a higher height have more energy per kilogram.

We will use “height” as an analogy for voltage when we begin to solve circuits next lesson.

Because of this, another word that is often used in place of voltage is “potential”. Don’t confuse potential (in volts) with potential energy (in joules).

Summary:

Voltage is defined as the amount of energy per charge at a location.

Symbol: V Scalar or Vector? Units: Volts

Voltage is sort of like height. Higher height means more energy per kilogram. Higher voltage potential means more energy per coulomb.

Another word for “voltage” is “potential”.

Homework:

Do a google search for “phet html5 dc circuit construction kit” or go to the following link:

<https://phet.colorado.edu/en/simulation/circuit-construction-kit-dc>

Click on the link, and then run the sim by pressing the play button:

Circuit Construction Kit: DC



- Series Circuit
- Parallel Circuit
- Ohm's Law



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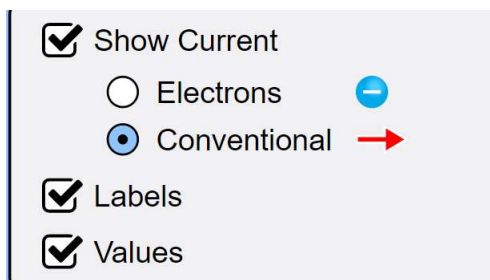
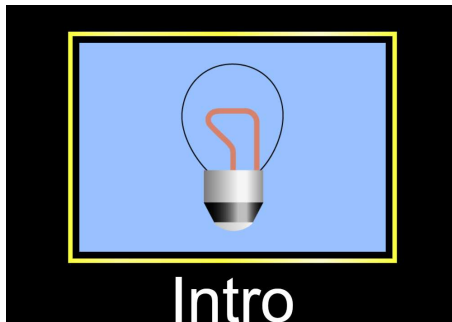
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If you have a mobile device, it should still work. I hope.

Once you are in, choose “Intro”.



Toggle “Conventional” and toggle “Values”.

Your homework is to build a circuit with 1 battery, 1 switch, and 2 lightbulbs that are lit up. Once you have built the circuit, take a picture of it on your phone (or take a screenshot) and email it to me. In your email, answer the following questions:

1. Use the voltmeter to measure the voltage in each light bulb. What is the voltage in each lightbulb? (ans: 4.5 V)

2. Use the ammeter to measure the current in the wire. What is the current in the wire? (ans: 0.45 A)

Note: the answers that I gave for the homework assume you are using the default values of the sim.