Linear Circuits

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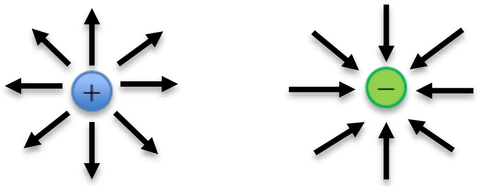
Voltage

Objective: By the end of this lesson, you should describe and quantify voltage.

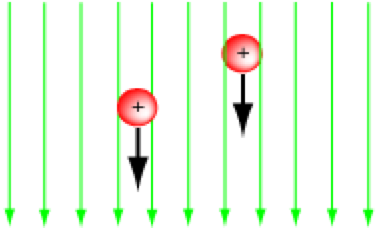
Builds Upon

- This lesson builds upon charge flow.
- Charged particles exert a force on other charged particles.
- This force per unit charge is called an electric field.



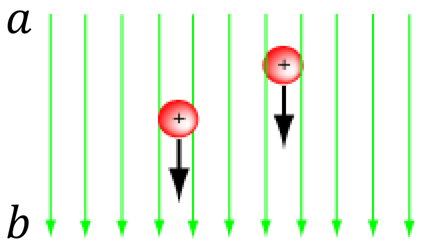
- Charges flow because their electric fields exert forces that push each other.

What is Voltage?



- When moving through an electric field, a charge either gains energy or loses energy.
- Charge loses energy when moving in the same direction of the electric field lines.
- Charge gains energy when moving in the opposite direction of electric field lines.
- Voltage is the energy either gained or lost per coulomb of charge.

How do you calculate voltage?



- Voltage (V) is the change in energy (w) per coulomb of charge (C).

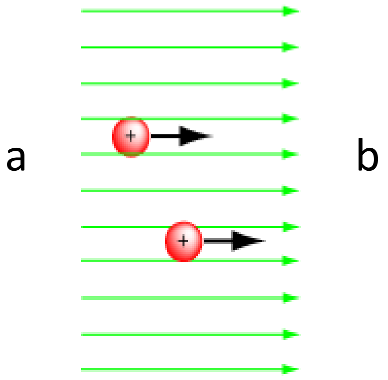
$$V = \frac{dw}{dq}$$

- Or voltage can be expressed as energy in joules (J) over charge in coulombs (C).

$$V = \frac{energy}{charge}$$

- Variable: V
- Units: $\frac{J}{C}, volts$

Calculate voltage.



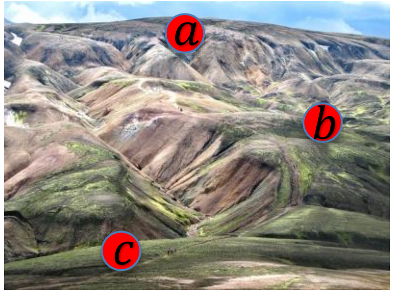
- v_{ab} is the energy lost per unit charge as charge moves from a to b.
- v_{ba} is the energy gained per unit charge as charge moves from b to a.

- Quiz: $4C$ of charge lose $20J$ of energy when moving from a to b. What is the voltage v_{ab}?
- Quiz: $21J$ of energy are required to move $3C$ from charge from b to a. What is the voltage v_{ba}?

Voltage is always measured from a reference point.

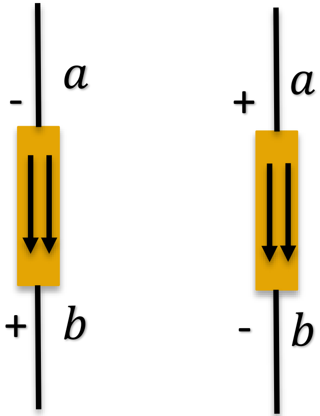
- Voltage measurements are relative.

- As an analogy, consider a mountain. In order to measure the height of point a on the mountain, we must define a reference point.

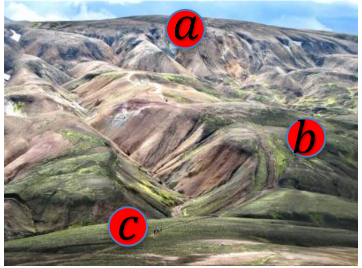


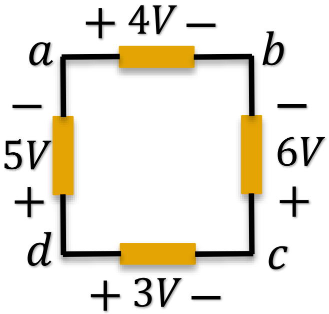
- Similarly, in order to measure the voltage at point a in the circuit, we must define a reference point.

- This reference point only affects our measurements, not the actual direction of the electric field that causes the voltage drop/increase.



Voltage potentials add from point to point.

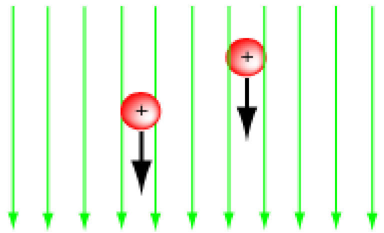




- Consider the mountain above once more. If we travel from point a to b to c and then back to a, our height has not changed.

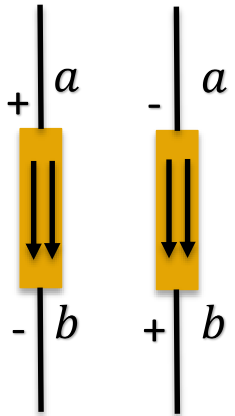
- Similarly, in a circuit, if we travel from points a to b, c, d and then back to a, our voltage has not changed.

Key Concepts



- Voltage is the energy either gained or lost per coulomb of charge.

$$V = \frac{dw}{dq}$$



- Voltage measurements are relative.

- Voltage potentials add from point to point.