THE OHIO STATE UNIVERSITY

COLLEGE OF ENGINEERING

Current and Voltage

Today…

- Learning Objectives:
  - What current is.
  - Understand the difference between voltage at a point and voltage at across a component.

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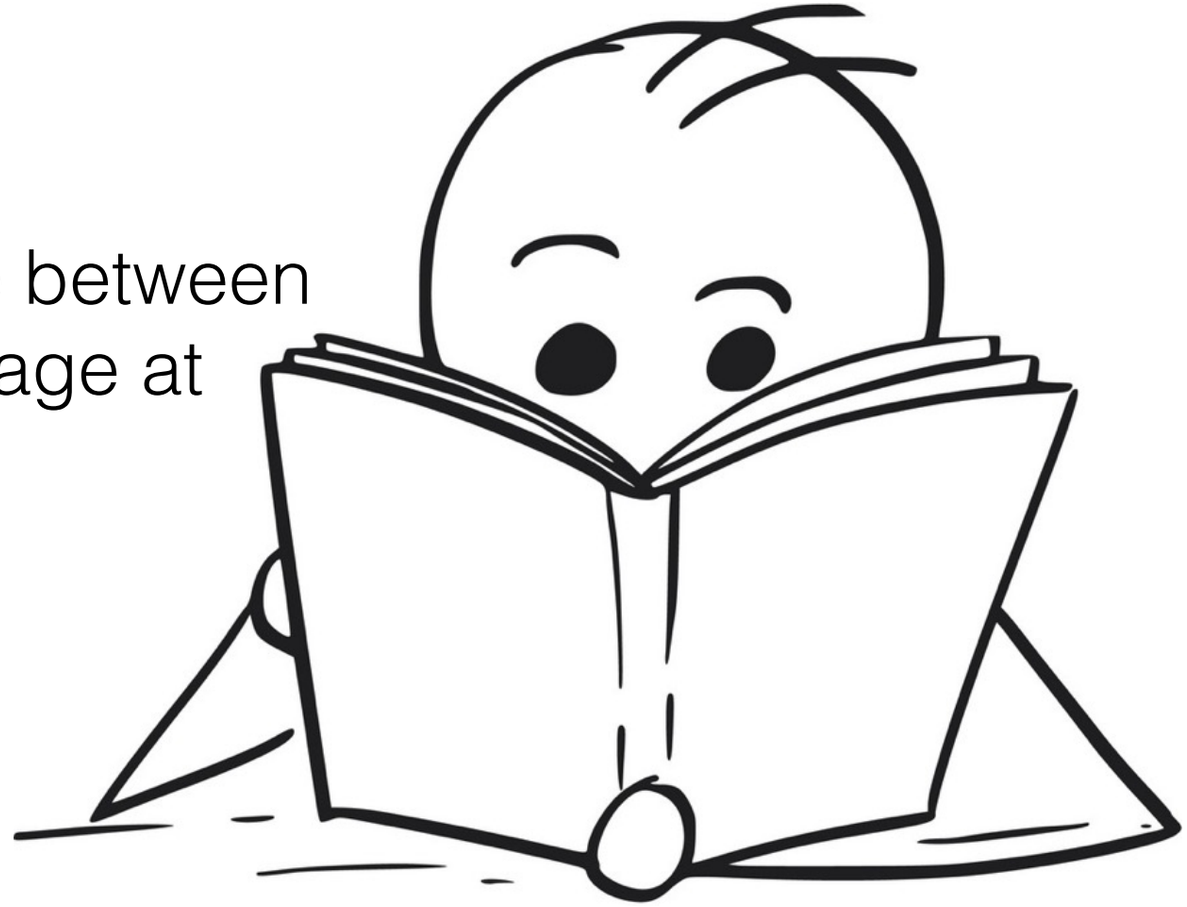


Electronic Devices

- Electronic devices are components that control the flow of electrical currents for the purpose of information processing and system control.

- Electronic devices are usually small and can be grouped together into packages called integrated circuits.

- **Circuit analysis** is **important** in order to be able to design, synthesize and evaluate the performance of electric **circuits.**

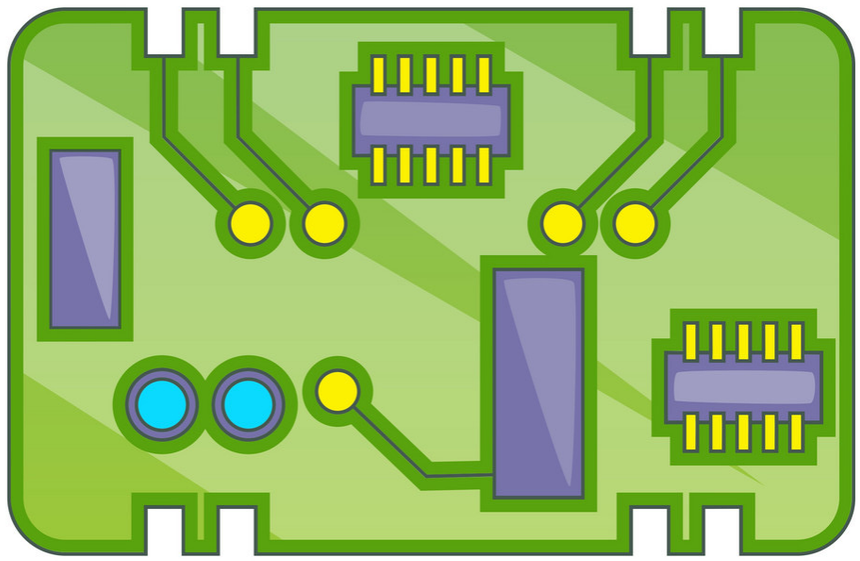
Circuit Analysis

- **What it is:** Circuit analysis, or solving a circuit, means figuring out voltages and currents in each element.

- **The general strategy:** Create a set of equations based on the given circuit, solve for independent voltage and current variables (usually using linear algebra), solve for the rest of the system.

- **The tools:** Ohm's Law, Kirchhoff's Law, Node Voltage Method, Mesh Current Method.

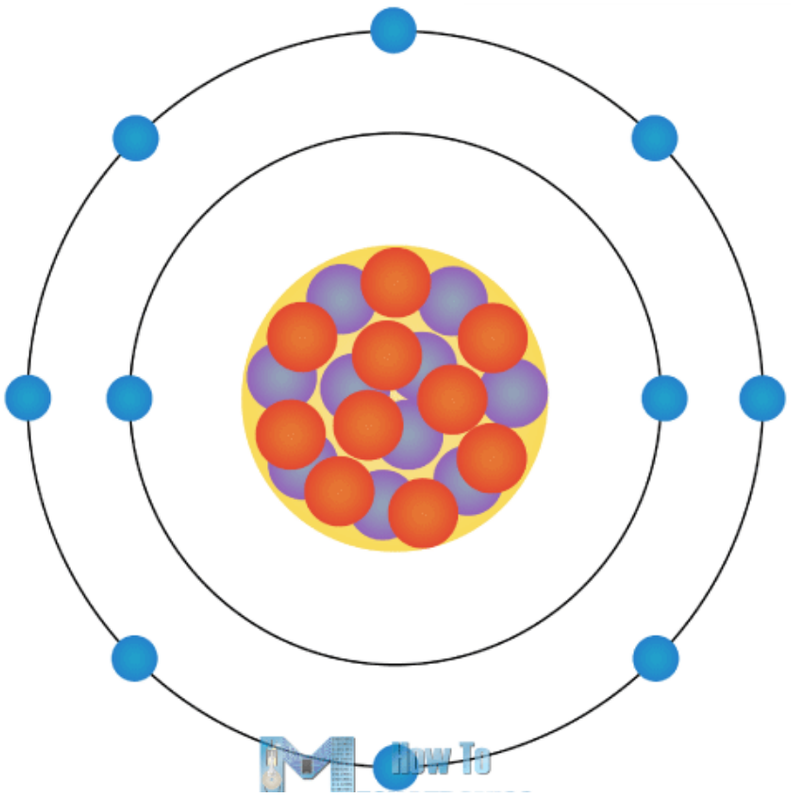
- **The engineering skill:** Learn how to break down complicated problems into simpler pieces.



Electric Charge

Review:

- Atom is made up of electrons and nucleus.
- Nucleus contains the protons and the neutrons.
- Electrons are outside the nucleus like a cloud surrounding the nucleus.



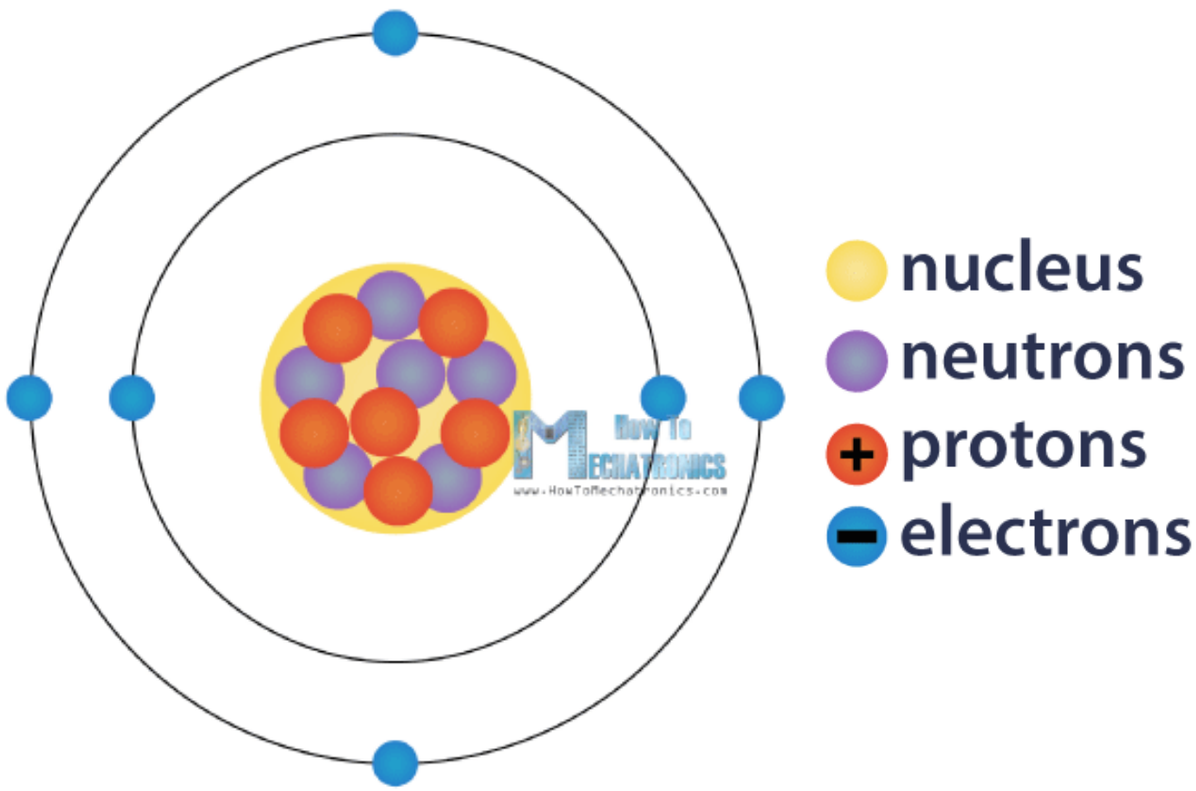
Electric Charge

Review:

- Generally, the atoms have neutral charge.

electrons = # protons

- We can change the atom's charge, by causing it to gain or lose electrons.

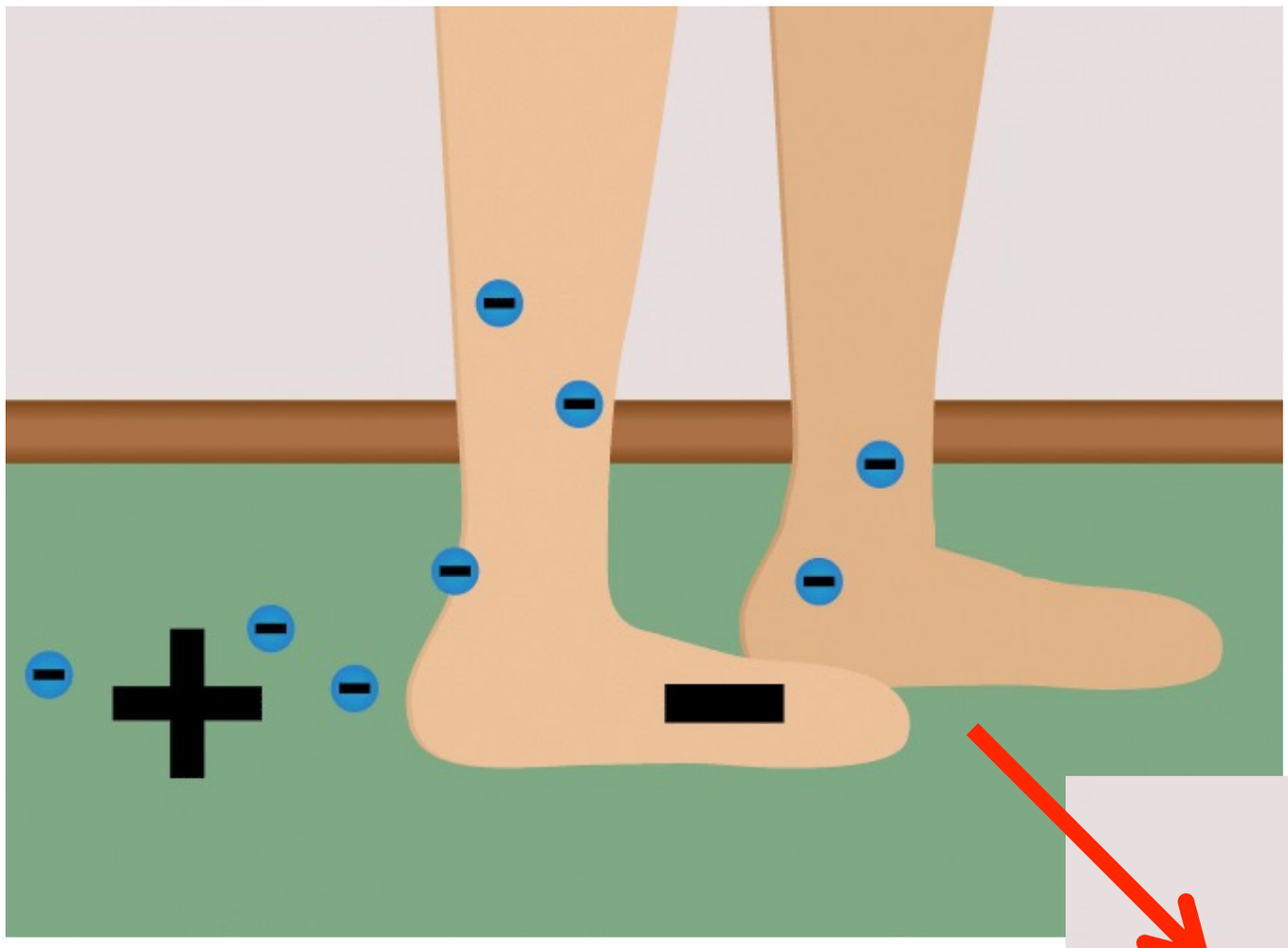


- If an atom gains electrons, it becomes negatively charged

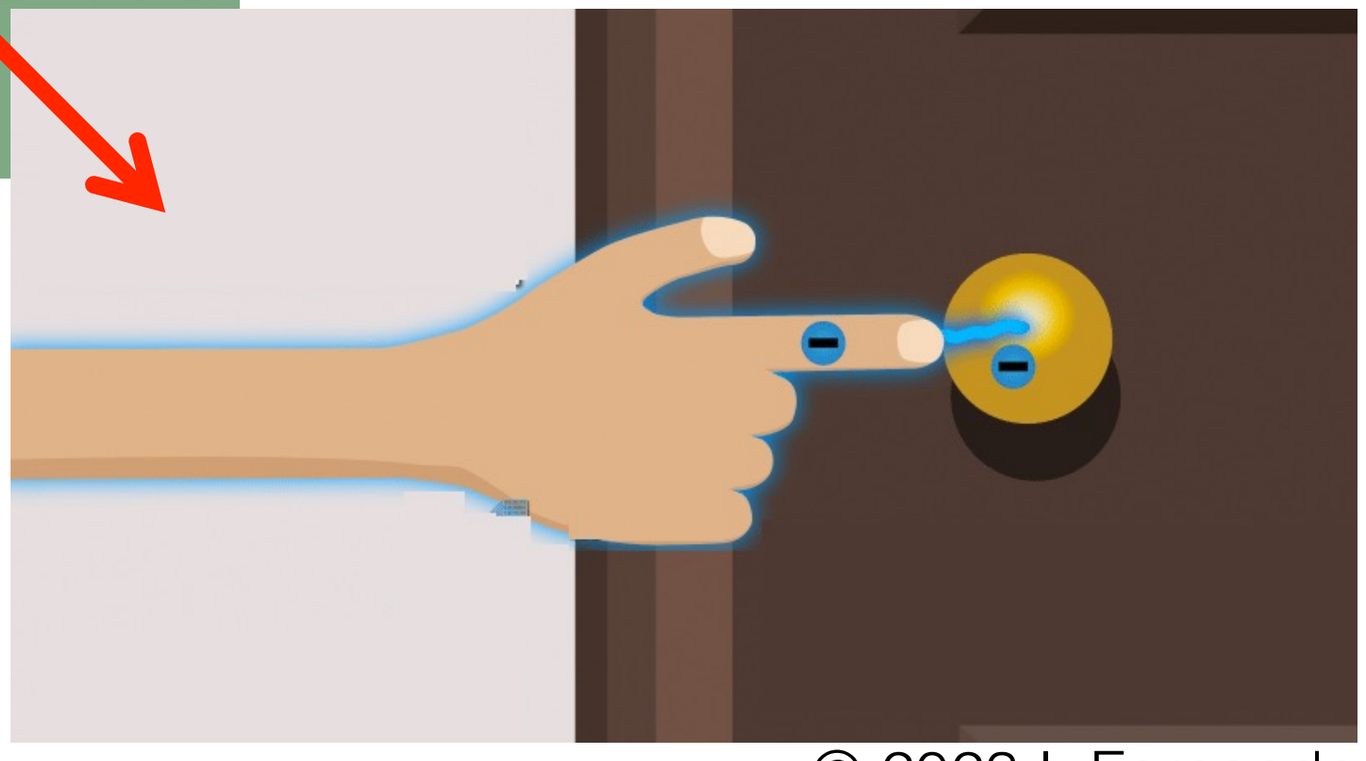
- If an atom loses electrons, it becomes positively charged.

STATIC ELECTRICITY

Example

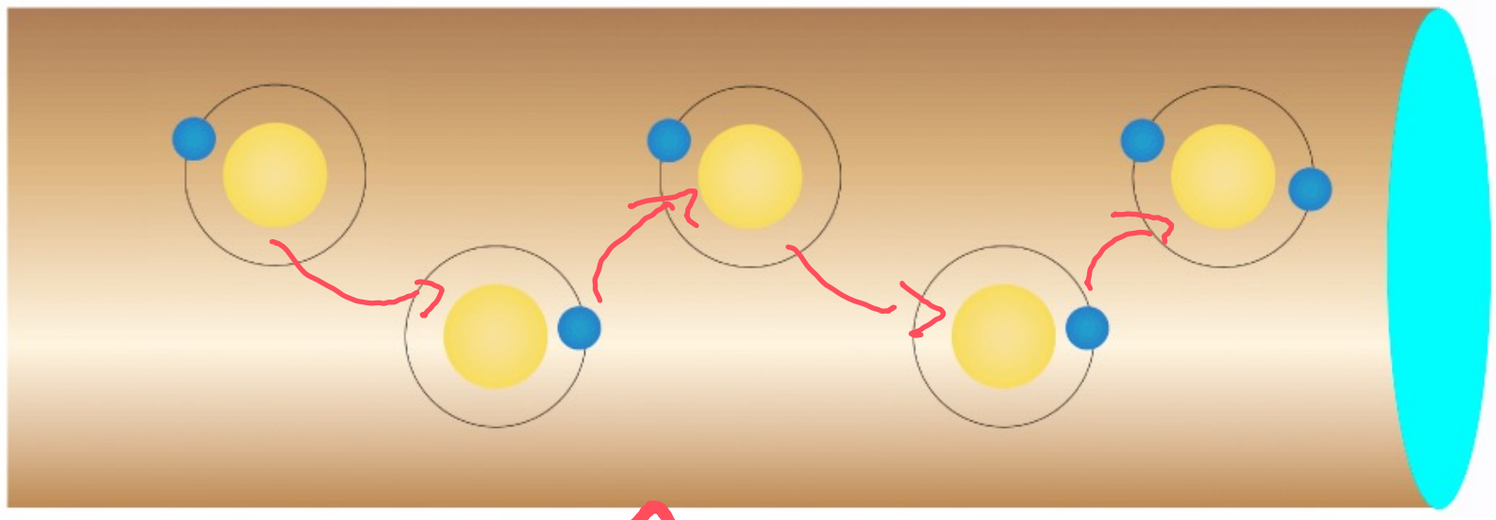


Law of conservation of electric charge: Charge can't be created, it can only be moved from one place to another.



Current

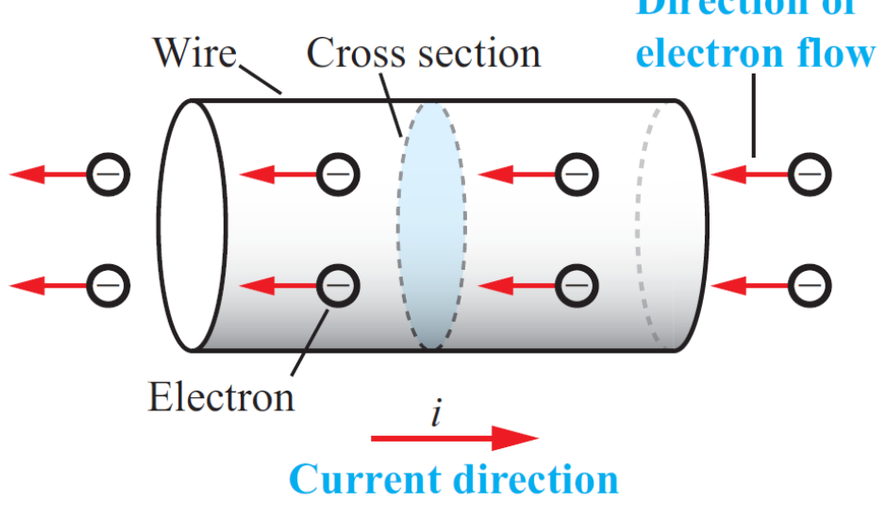
- Copper wire
  - One electron in the outer shell
  - Little energy needed to move an electron



Current

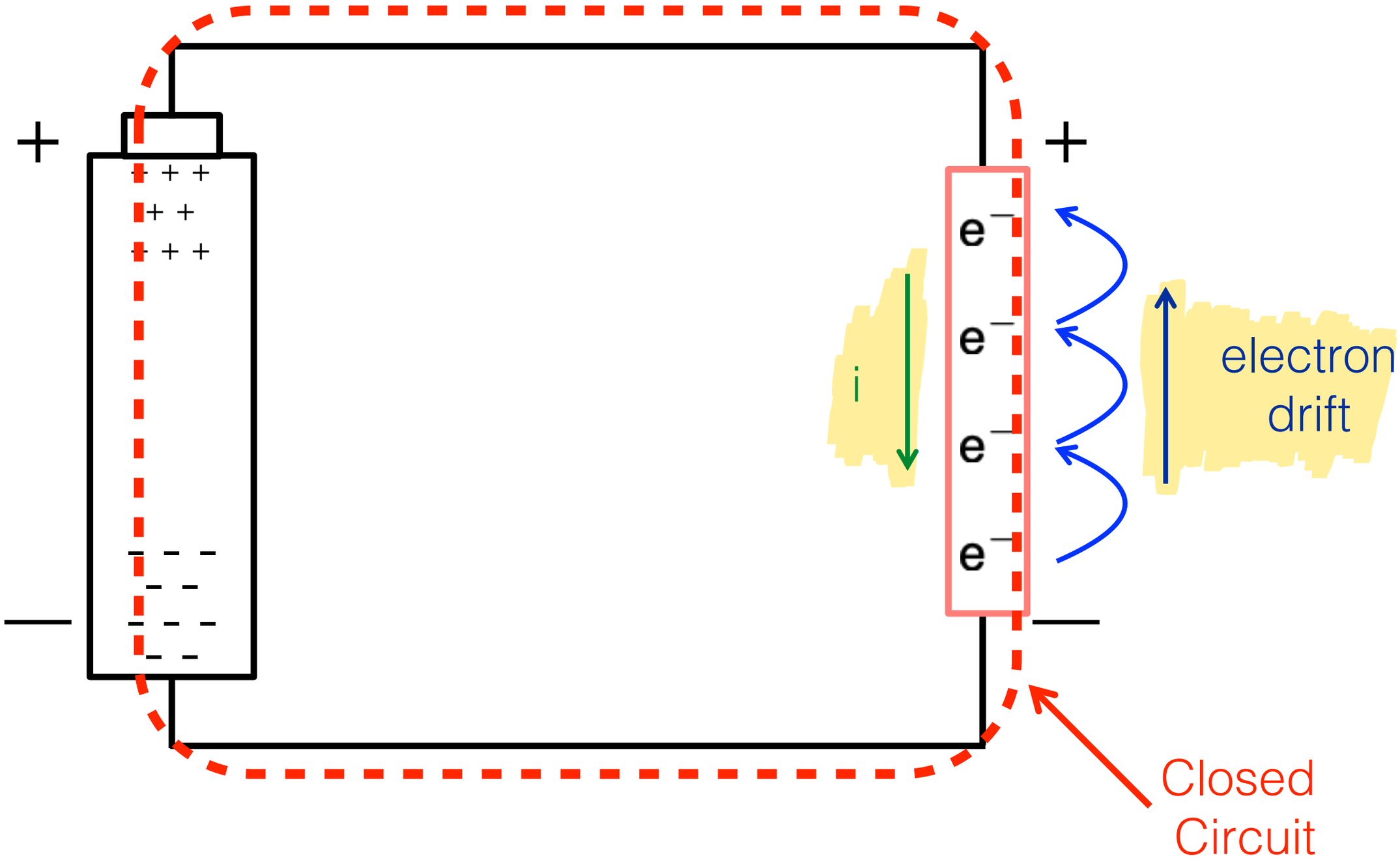
- Electric current: is the movement of electric charge in a wire over a period of time.

$$i = \frac{dq}{dt}$$

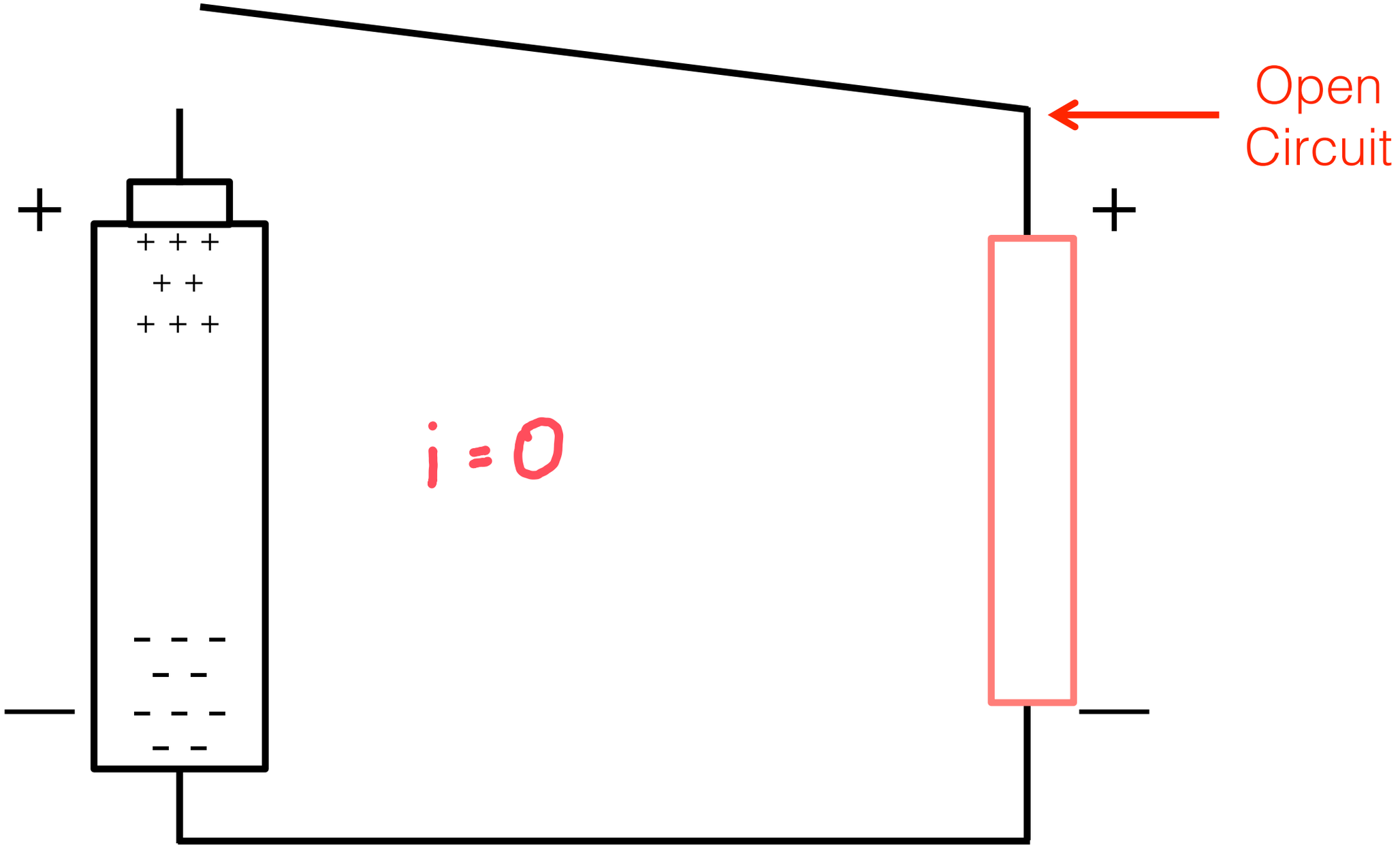


$$\frac{1C}{1s} = 1[Ampere] = 1[amp] = 1[A]$$

- Conventionally, we assume current moves opposite to electron flow.



Remark: Current cannot flow without a complete loop.

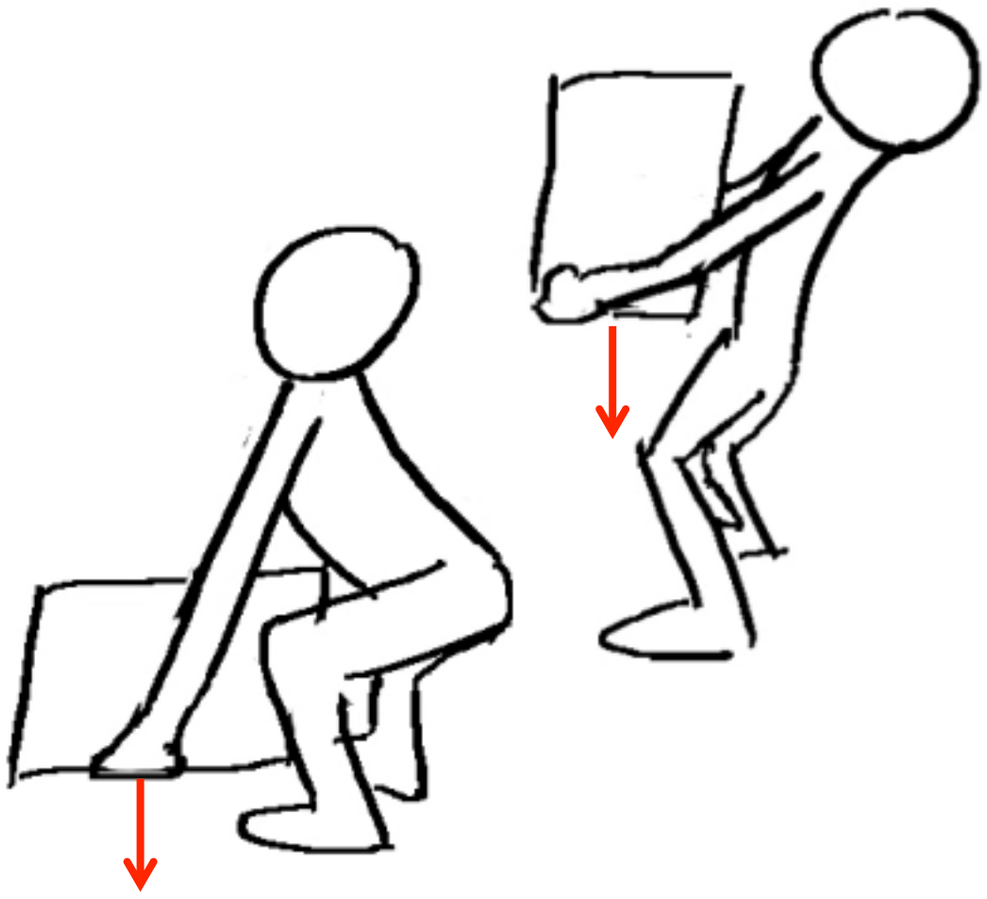


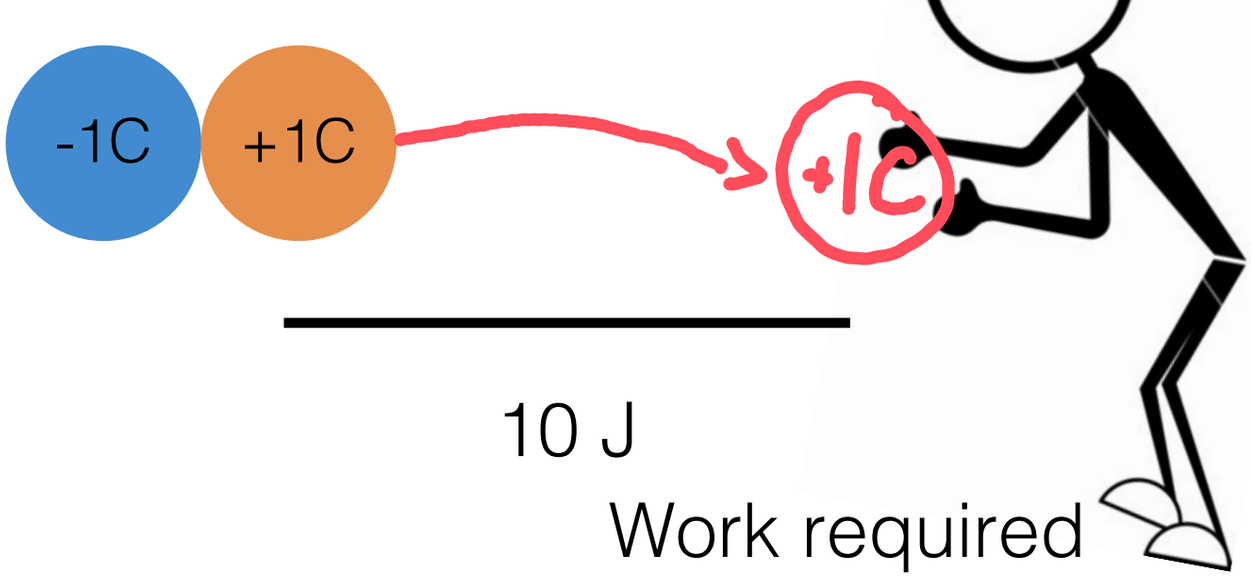
Remark: Current cannot flow without a complete loop.

Voltage

- Lifting a box against gravity requires work

$$\frac{10\ J}{1C} = 10\ V$$





Voltage: Energy per unit charge required to move that charge between two points.

Voltage

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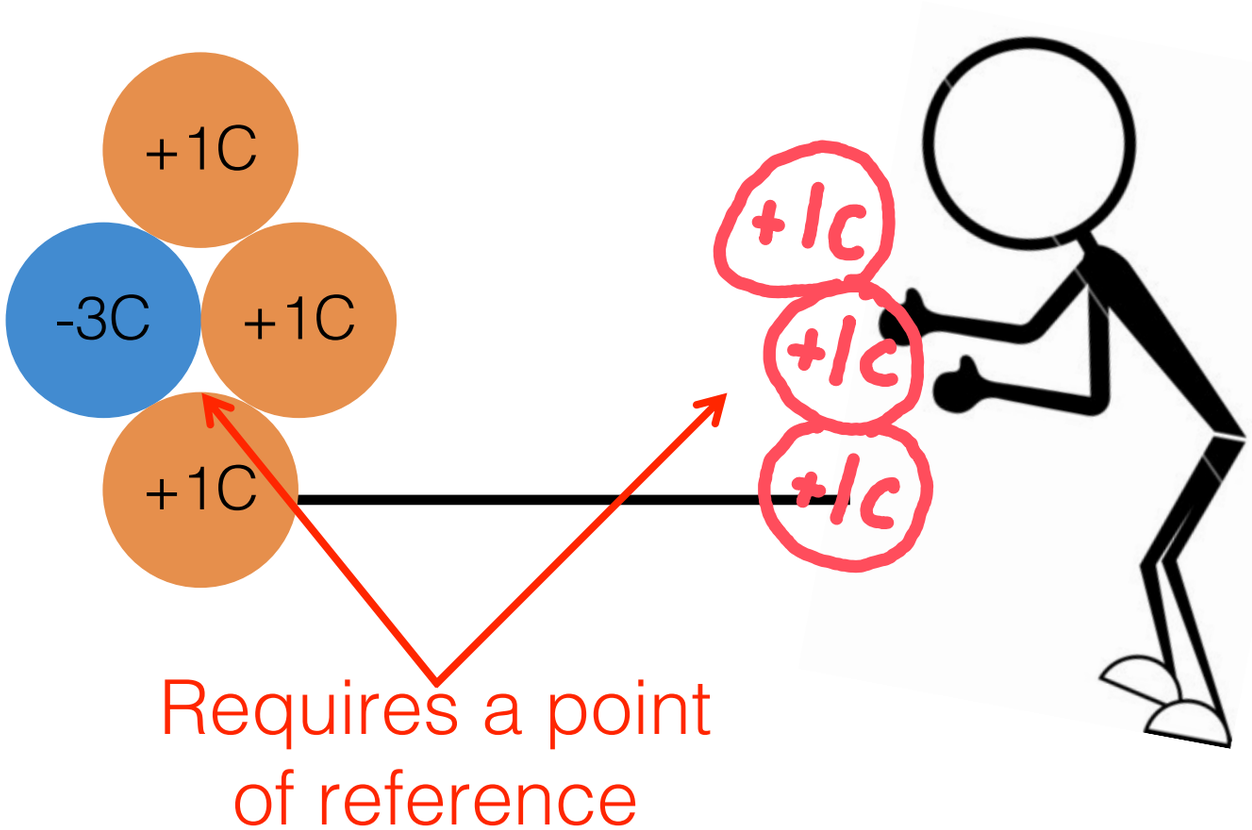
$$v = \frac{dW}{dq}$$

$$\frac{1J}{1C} = 1[Volt] = 1[V]$$

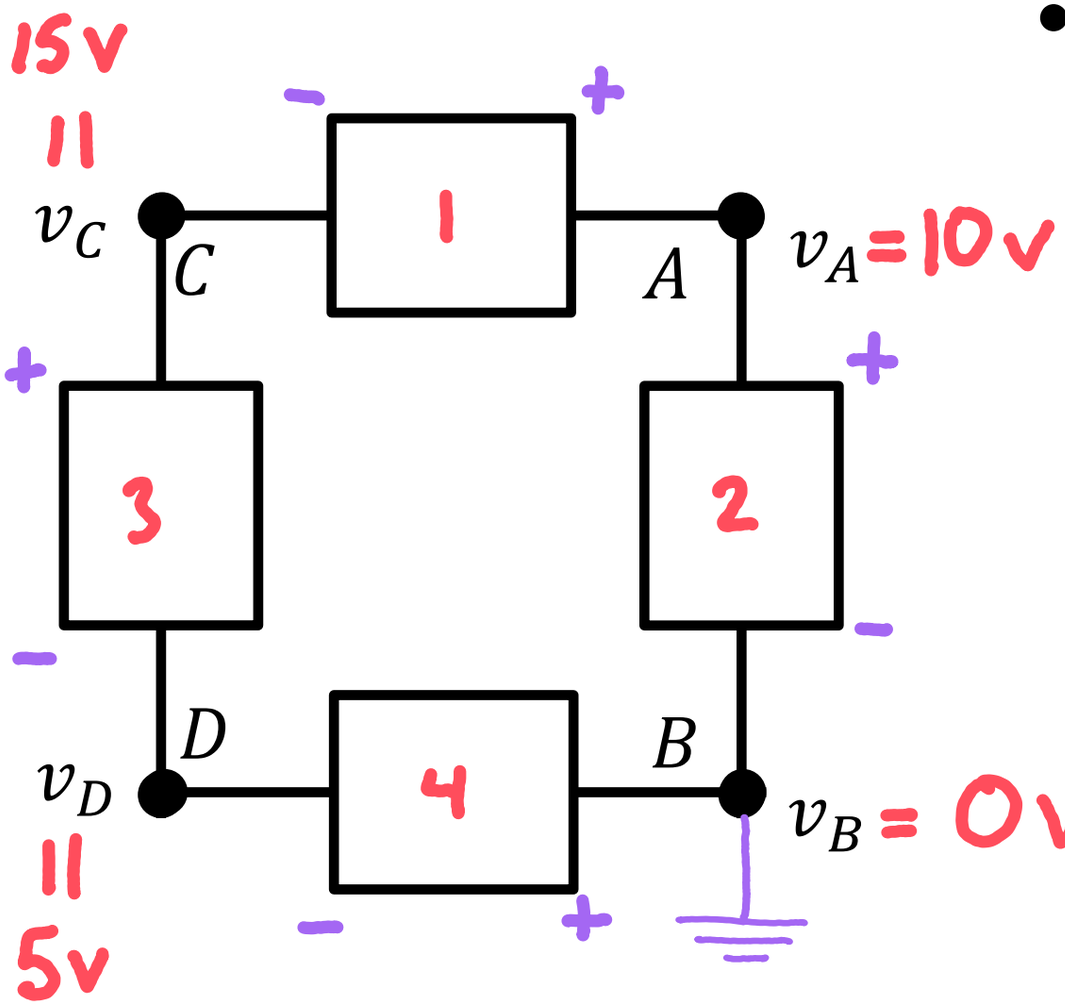
$\frac{20J}{2C} = 10V$ $\frac{30J}{3C} = 10V$



Voltage at a Point

node

- Recall that: Voltage is the energy per unit charge required to move that charge between two points. **Requires a reference point.**



- Assume B is reference point: Ground

Note: Voltage at reference is always zero.

$V_1 = V_A - V_C = -5V$

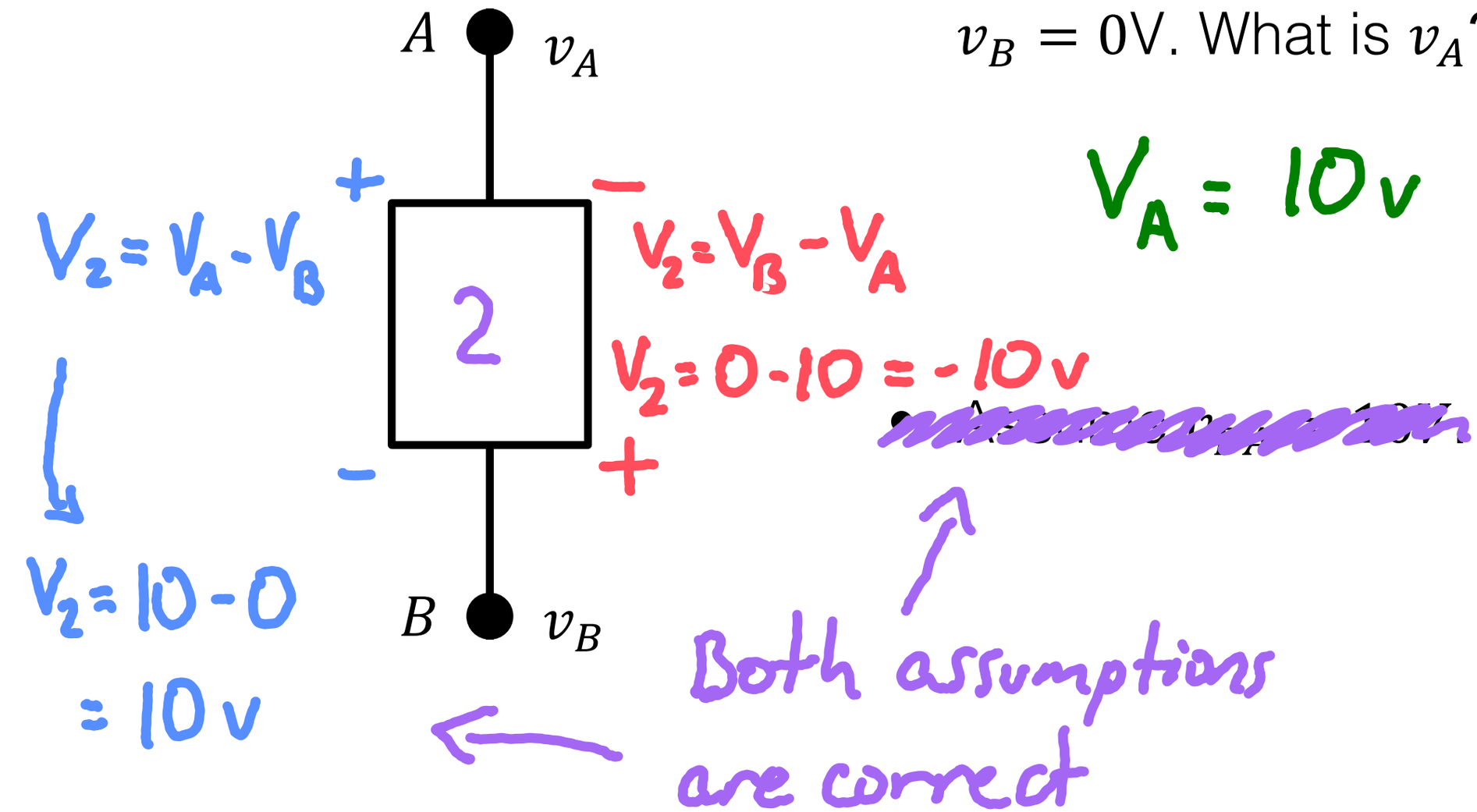
$V_2 = V_A - V_B = 10V$

$V_3 = V_C - V_D = 10V$

$V_4 = V_B - V_D = -5V$

Voltage Across a Component

- Voltage across a component is the voltage difference between the voltage at each of the points that the component is connected to.



- Assume $v_{AB} = 10V$ and $v_B = 0$V. What is v_A?

$V_A = 10v$