Electric Current
Lesson Notes

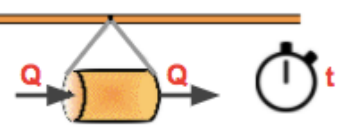
Learning Outcomes
- How do you calculate current?
- How do you describe the direction of current?
- Why do light bulbs light immediately?

What is Current?
When the requirements for a circuit are met and charge is flowing in the wires, we say ***current is present***.

Definition of Current:
Rate at which charge flows past a point on the circuit.

$$\text{Current} = I = \frac{Q}{t}$$

where Q = quantity of charge (coulomb)
t = time (seconds)

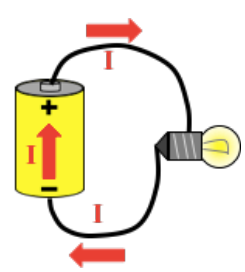


Standard unit: **ampere** (shortened to Amp; abbrev. as A)
1 ampere = 1 coulomb/second 1 A = 1 C/s

Making Meaning of Current
Current is a **rate quantity**. It expresses the amount of something on a per time basis.

Complete the following statements by filling in the blanks.
1. If 5.0 C of charge flow past a point in 2.0 s, then the current is __________ Ampere.
2. If 6.0 C of charge flow past a point in 12.0 s, then the current is __________ Ampere.
3. If __________ C of charge flow past a point in 4 s, then the current is 5 Ampere.
4. If 4.0 C of charge flow past a Point A in 2.0 s, then __________ C flows past Point B in 6.0 s.
5. If 5.0 C of charge flow past a Point A in 10.0 s, then __________ C flows past Point B in 4.0 s.

Conventional Current Directions
- The carriers of charge within the wires of circuits are mobile electrons.
- In street lamps, fluorescent lamps, and semiconductors, the charge carriers can be positive charges, negative charges, or both.
- So how can the direction of current be described.

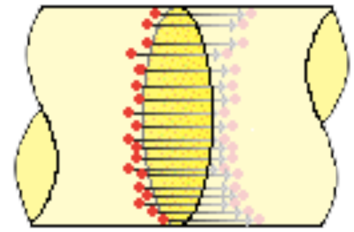


Definition of Conventional Current Direction
The direction of current in an electric circuit is in the direction that + charges move.

Inside the battery: from - to the + Outside the battery: from the + to -.

Current is Not Drift Speed

- Current is not speed. Current describes how many charges *pass across the line* in a second. Speed describes how far they travel in a second.
- Charge carriers drift very, very slowly - maybe 1 meter/hour. Yet with so many drifting, there can be a large current.
- Charges don't have to travel a long distance in a second to have a large current. There just has to be a lot of them crossing over the line.



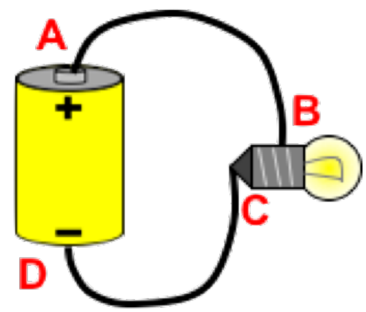
The Turtle Race Analogy:

Imagine a turtle race on an oval track. Turtles don't move fast. But a lot of them could cross the finish line in a second if they were densely packed.

Why Does the Bulb Immediately Light?

When the circuit is closed, the following occurs:

- An electric potential difference (ΔV) is established across the ends of the circuit.
- An electric field signal reaches every electron.
- Electrons in every atom can begin *marching*.
- The light bulb lights.



The electron that causes the bulb to immediately light does NOT originate in the battery; it originates in the filament.

Charge carriers move slowly. But their motion begins immediately. The immediate onset of motion leads to the immediate lighting of the bulb.

Current is "Everywhere the Same"

Charge carriers are like soldiers marching along together, everywhere at the same rate. The marching begins immediately when an electric potential across the two ends of the circuit.

Charge carriers …

- are not consumed,
- are not used up,
- do not disintegrate,
- are never destroyed,
- and do not take an exit-ramp.
-

They enter the battery at the same rate they exit the battery.