# **Electric Current**

Until now, we thought that there was no electric field in a conductor. However, electrons move freely around, so *on average*, there is no electric field/charge in a conductor.

* Conductors act like **pumps**, pushing electrons through (with an potential difference).
* We’ll ignore the thermal motion of the electrons.
* Current:
  + depends on the resistance of the wire
  + The **technical current direction** is the opposite of the direction the electrons actually flow: from *positive to negative* (electrons move against the current)
  + charge and current is conserved across the length of a wire!
  + Current is conserved: it always adds up!
* Current does not care about direction of the wire: it flows where there is a voltage difference
* Electrons collide with protons when they have a constant acceleration. Acts like a terminal velocity: **drift velocity** ()
  + depends on:
    - voltage
    - material (copper has a very high drift velocity)
  + where is the “mobility” (material constant)
* Current is the same regardless of the width of the wire, but **current density**is not
  + - (where is the volume)
  + calculate area charge moves through (circle?)
  + ( is number of electrons *per cubic meter!*, is the charge of the electron, and is the volume)
    - So this depends very much (and only) on the material and
    - Ohm’s Law:
    - (not too relevant...)

## **Ohm’s Law**

* + where the **conductivity** is
  + this is a material constant
  + measured in
* Current is homogeneous in a wire (because the electric field is homogeneous)
  + So , , and
  + Makes...
    - If is the **resistance** (constant that depends on the material), then:
    - (Ohm’s Law)
* Voltage decreases across a resistor (linearly)
* Resistance in Series:
  + Split the current: effectively doubling the length of the resistance
  + Current stays the same: (same current across entire circut)
  + Voltage is added:
  + (like putting capacitors in parallel)
* Resistance in Parallel:
  + (current is added: splits among wires)
  + (Voltage is the same on both ends: same source!)
  + (like capacitors in series: less resistance!)
  + Sanity Check: total resistance is less than any other resistance
    - Good exam questions: big circuits!
* Resistance:
  + This resistance *only* depends on the conductor itself.
  + is the resistivity constant, while is the length of the conductor and is the cross-sectional area
* Assume wires are perfect conductors, so no voltage change until meets resistor.
* Kirchkoff’s Rules:
  + Junction Rule: sum of all currents at a junction is 0
  + Loop Rule: sum of all voltages in a loop is 0