March 15, 2013 Physics 132 Prof. W. Losert

Outline

- Circuits
- Nernst Potential

Office hours Thursday after spring break 4-5.30

Units

■ Current (*I*)	**Ampere** = Coulomb/sec
■ Voltage (*V*)	**Volt** = Joule/Coulomb
■ E-Field (*E*)	Newton/Coulomb = Volt/meter
■ Resistance (*R*)	**Ohm** = Volt/Ampere
■ Capacitance (*C*)	**Farad** = Volt/Coulomb
■ Power (*P*)	**Watt** = Joule/sec

Resistivity and Conductance

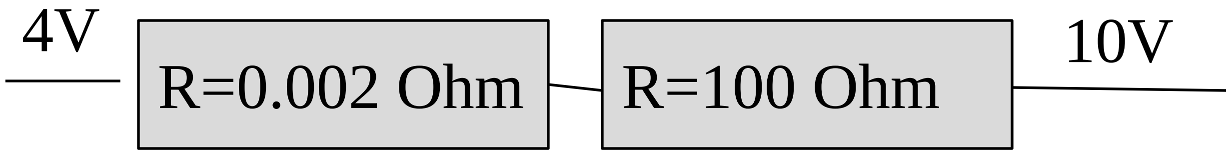
- The resistance factor in Ohm's Law separates into a geometrical part (*L/A*) times a part independent of the size and shape but dependent on the material. This coefficient is called the *resistivity* of the material (*ρ*).
- Its reciprocal (*g*) is called *conductivity*. *(The reciprocal of the resistance is called the conductance (G).)*

$$R = \rho \frac{L}{A} = \frac{1}{g}\frac{L}{A} = \frac{1}{G}$$

Analogy: Water flow

- Water flow is a useful analogy to electric currents because water
  - can divide
  - is conserved and cannot be compressed.

Sketch a water analogue for the following circuit



Q: What about the water analogy for capacitors?

Very useful heuristic

- Wires have very small resistance (e.g. 1 foot of 13 gauge wire has a resistance of 0.002 Ohm) This R is generally negligibly small compared to other resistances in the circuit through which current flows, so we can approximate it as zero resistance.

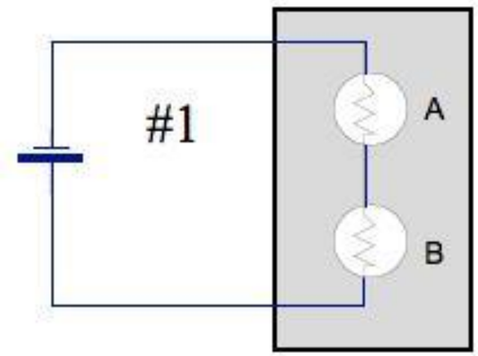
- The Constant Potential Corollary (CPC)
  - Along any part of a circuit with 0 resistance, then $\Delta V = 0$, i.e., the voltage is constant

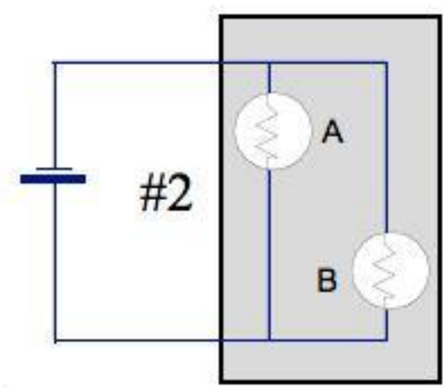
Foothold ideas: Kirchhoff's principles

1. ***Flow rule***: The total amount of current flowing into any volume in an electrical network equals the amount flowing out.
2. ***Ohm's law***: in a resistor, $\mathrm{D}V = IR$
3. ***Loop rule***: Following around any loop in an electrical network the potential has to come back to the same value (sum of drops = sum of rises).

In the two cases shown here a battery is connected up to a box containing some identical bulbs.
The battery maintains a constant potential difference $\mathcal{V}_0$. across its terminals.
Which bulbs will be brighter?

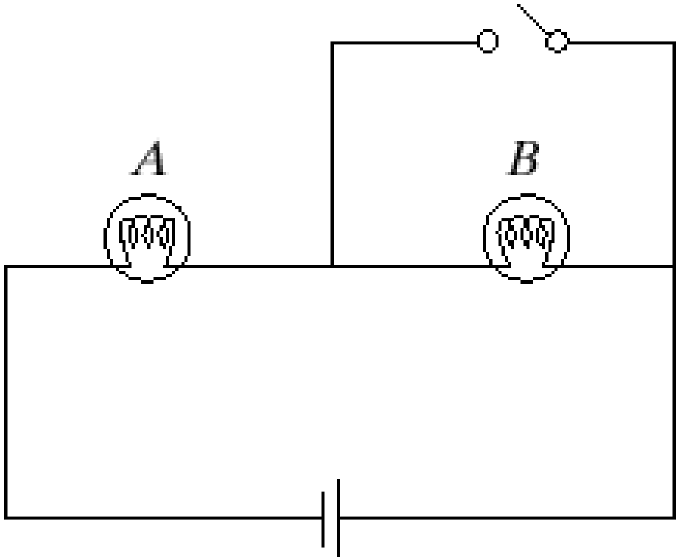
1. A in #1
2. B in #1
3. A and B in #1 (equal)
4. A in #2
5. B in #2
6. A and B in #2 (equal)
7. All 4 equal
8. Other





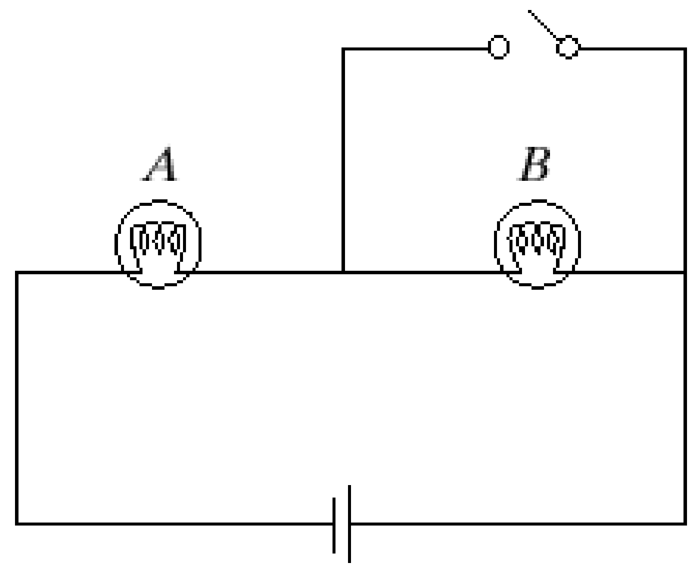
This circuit has two identical light bulbs burning with equal brightness and a single 12 V battery. When the switch is closed, the brightness of bulb A

1. increases
2. decreases
3. decreases to 0
4. remains the same



This circuit has two identical light bulbs burning with equal brightness and a single 12 V battery. When the switch is closed, the brightness of bulb B

1. increases
2. decreases
3. decreases to 0
4. remains the same

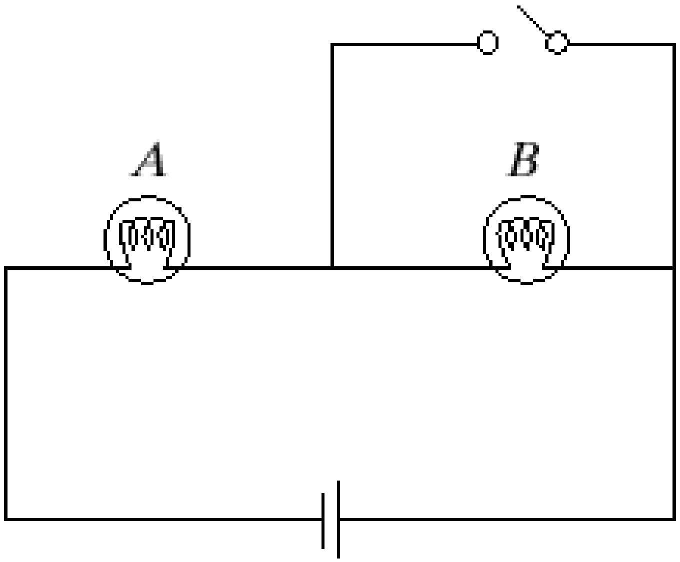


Electric Power

- The rate at which electric energy is depleted from a battery or dissipated (into heat or light) in a resistor is

$$Power = I\mathrm{D}V$$

This circuit has two identical light bulbs burning with equal brightness and a single 12 V battery. When the switch is closed, the **power dissipated by the elements in the circuit**



1. increases
2. decreases
3. decreases to 0
4. remains the same