Electrical Training

Week 2: Common Circuit Elements, Series vs. Parallel, KVL & KCL, Circuits on Breadboards

Agenda

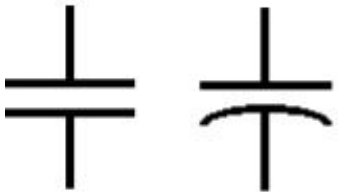
- Resistors, Capacitors, Inductors, Diodes/LEDs, FETs
- Circuit Analysis
  - Nodes & Junctions
  - Series vs. Parallel
  - KVL & KCL
- Measurements
- Circuits & Breadboards

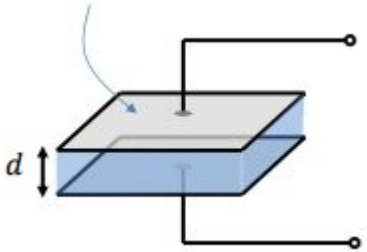
Resistors

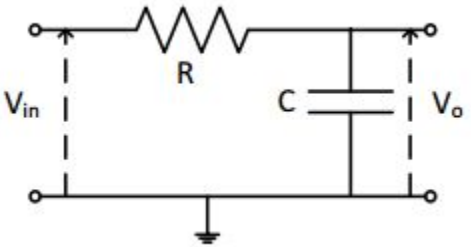
- Element that inhibits the flow of electrons
- Changes flow of current

Capacitors

- Element that temporarily stores electrical energy
  - polarized
  - non-polarized

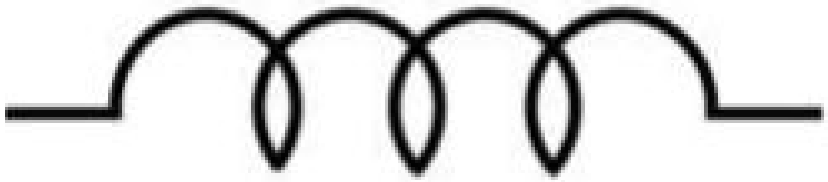






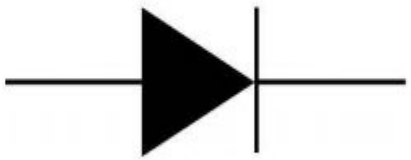
What is an Inductor?

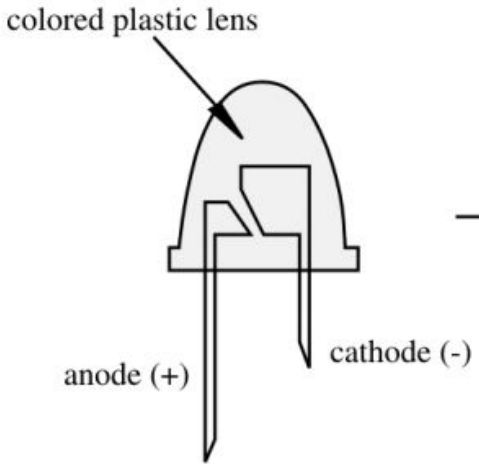
- Element that temporarily stores energy in the form of a magnetic field among its coils

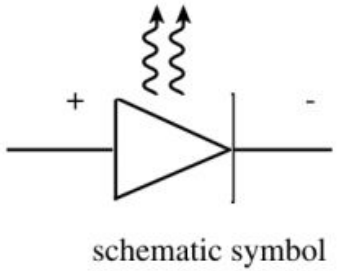


Diodes and LEDs

- Element that limits the flow of electrons to one direction
- Forward Bias: V+ > V-
- Reverse Bias: V- > V+
- Unbiased: V+ == V-
-

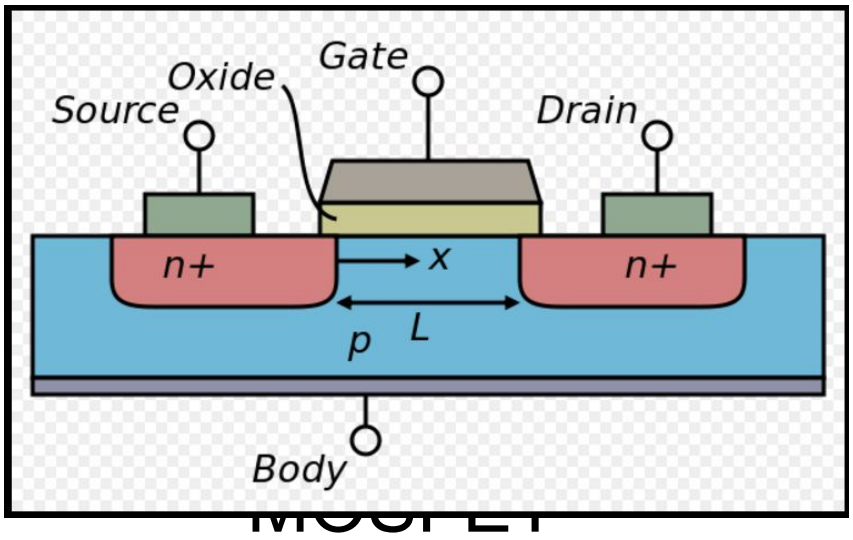


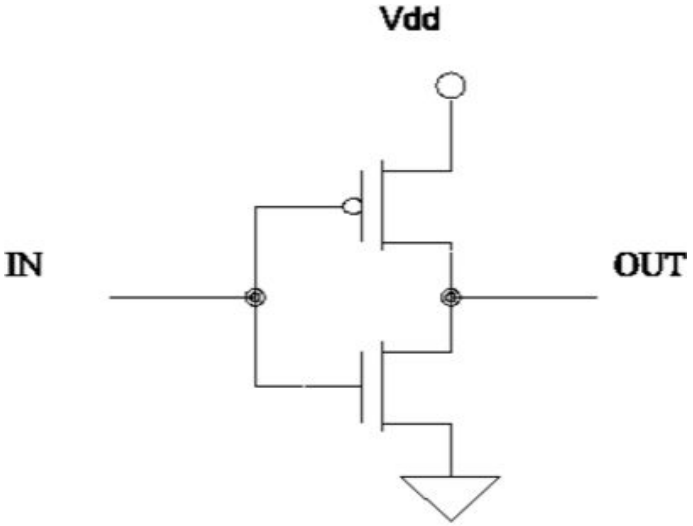




Field Effect Transistors (FET)

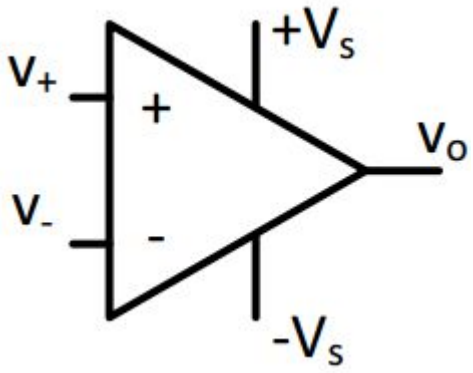
- Field Effect Transistors - Controls electric conductivity of a channel

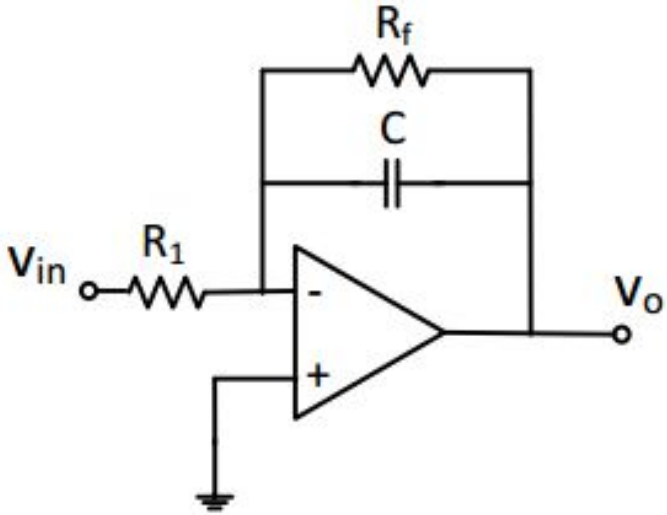




Operational Amplifiers (OP Amps)

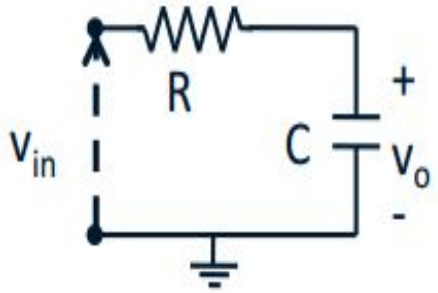
- Op amps are active devices that can be used to filter or amplify signals.
- Boosts power without changing waveform.



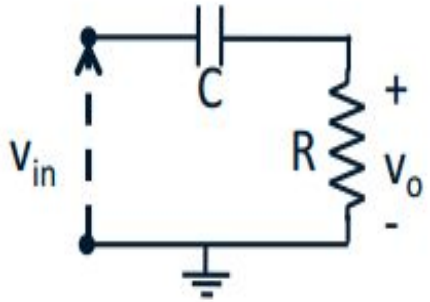


Summary of RC and RLC (Passive) Filters

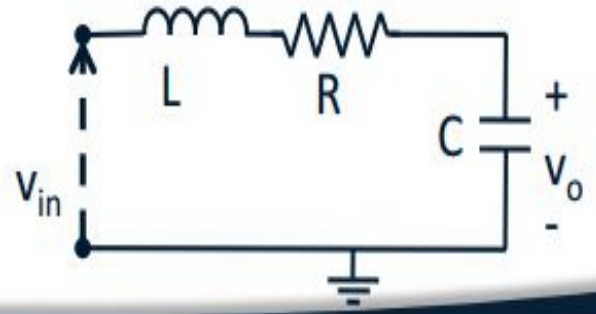
RC Lowpass:



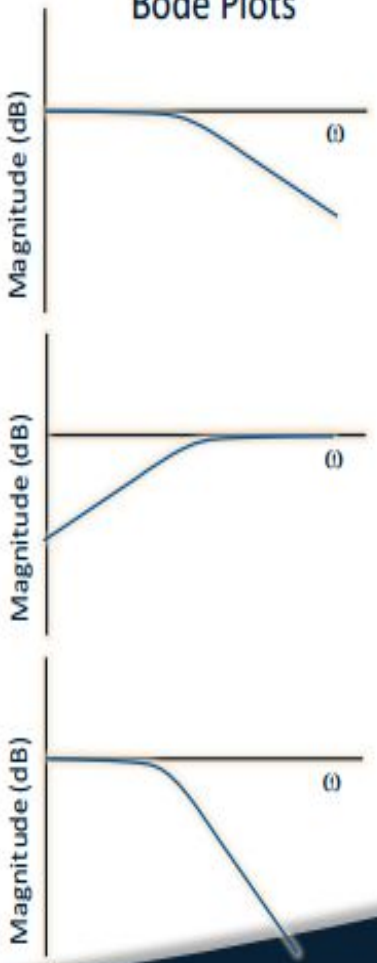
RC Highpass:



RLC Lowpass:



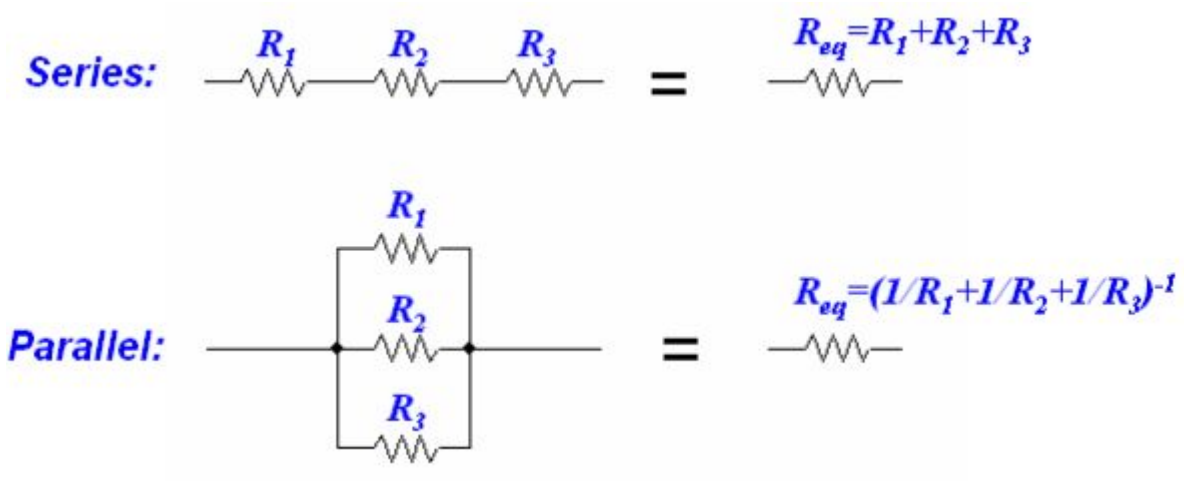
Bode Plots



Circuit Analysis

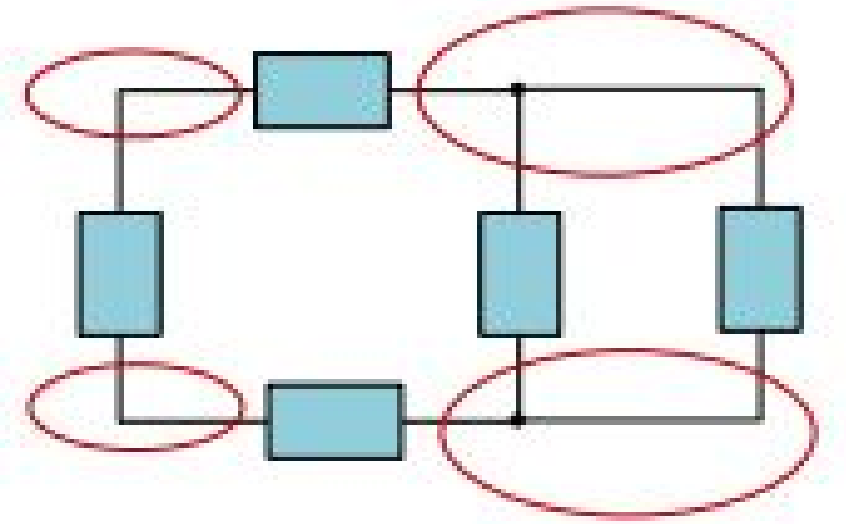
Series vs. Parallel

- Series → Same Current (I)
- Parallel → Same Voltage (V)



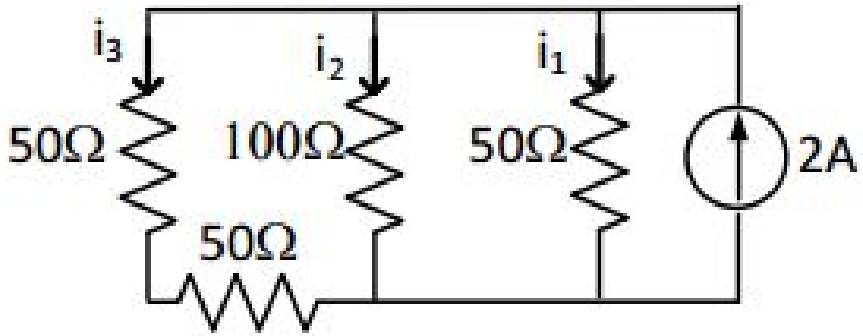
Node

- Any place on a circuit where two or more circuit ELEMENTS meet.



Junction

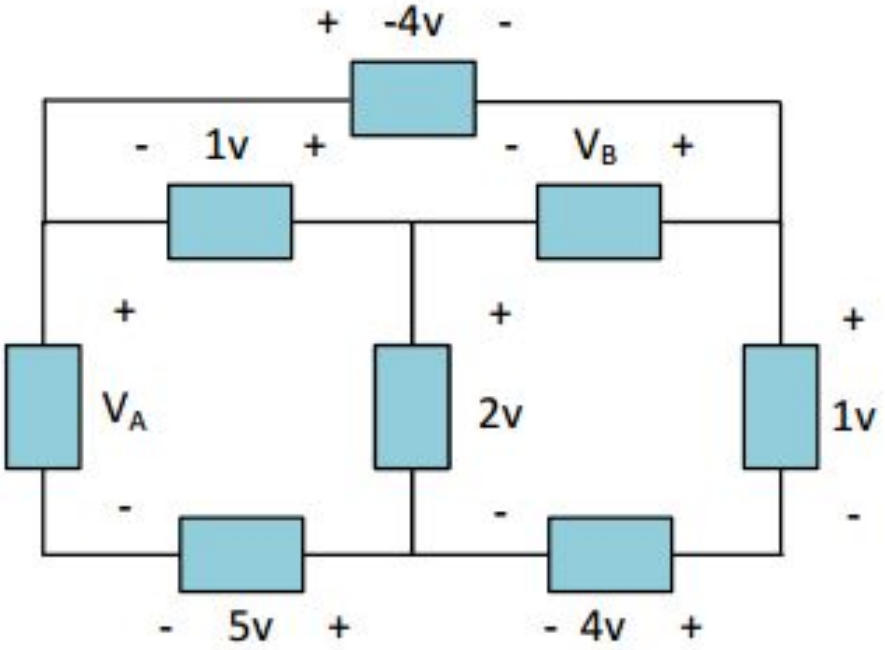
- Any place on a circuit where two or more WIRES meet.



Kirchoff's Voltage Law (KVL)

Sum of the voltages around any loop = zero

$$\sum V_{loop} = 0$$

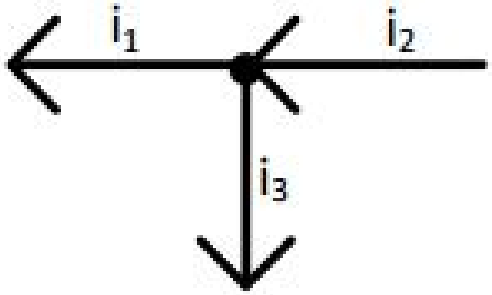


Kirchoff's Current Law (KCL)

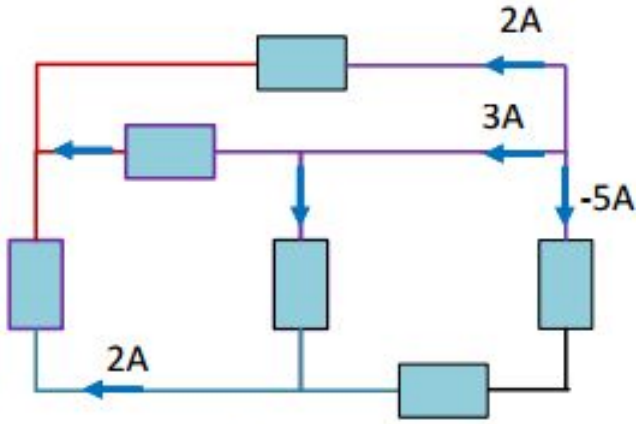
Sum of the currents leaving a node = sum of current entering the node

$$\sum i_{leaving} = \sum i_{entering}$$

(1)



(2)

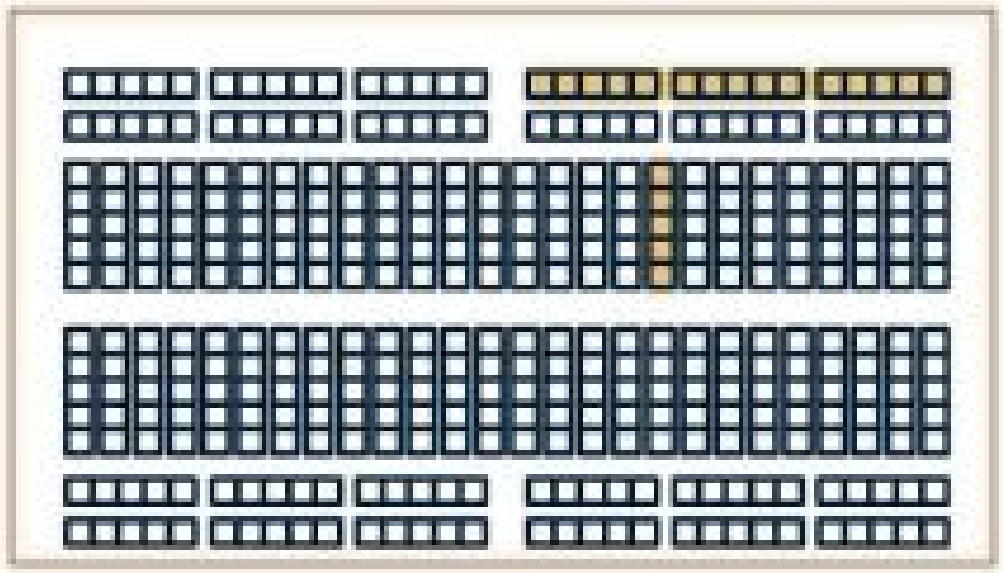


$$\sum i_{leaving} = 0$$

$$\sum i_{entering} = 0$$

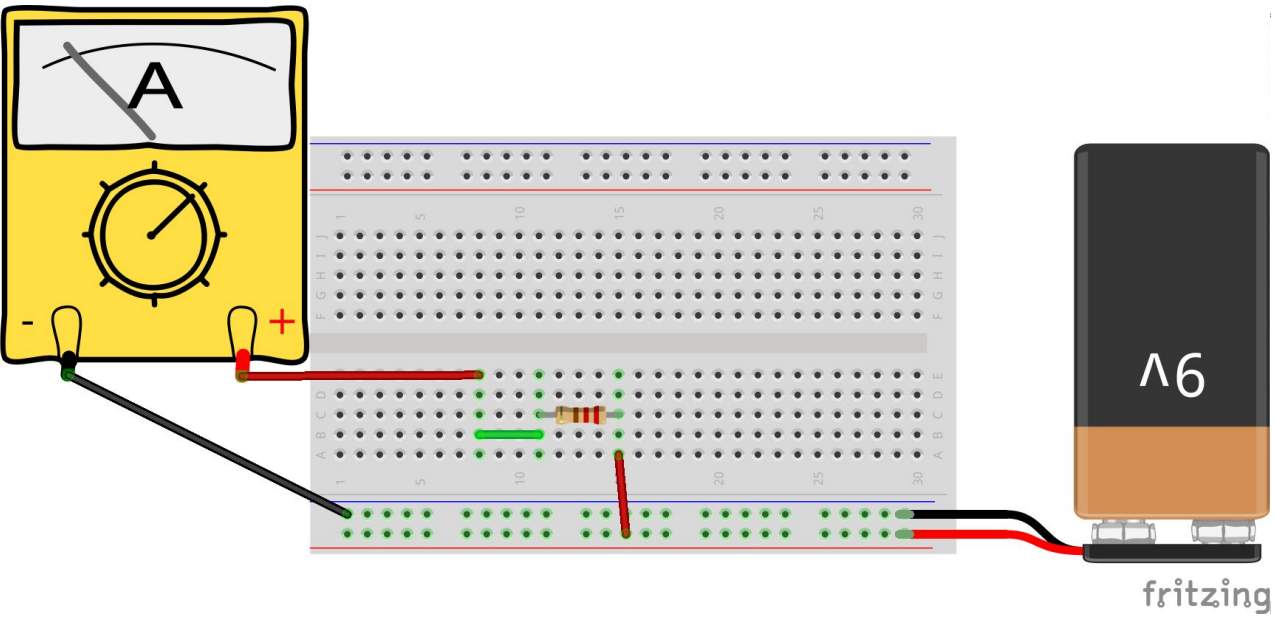
$$\sum i_{leaving} = \sum i_{entering}$$

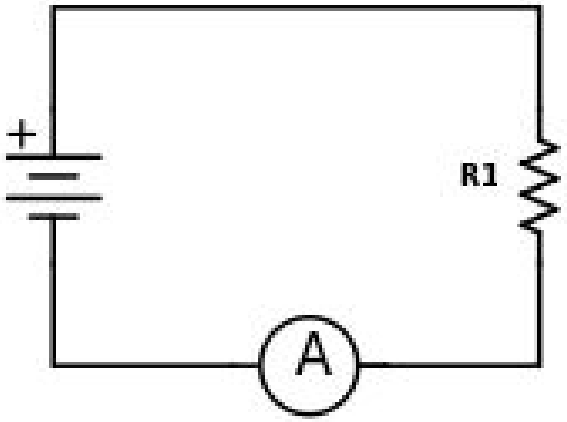
Breadboard



Circuit - Measure Current

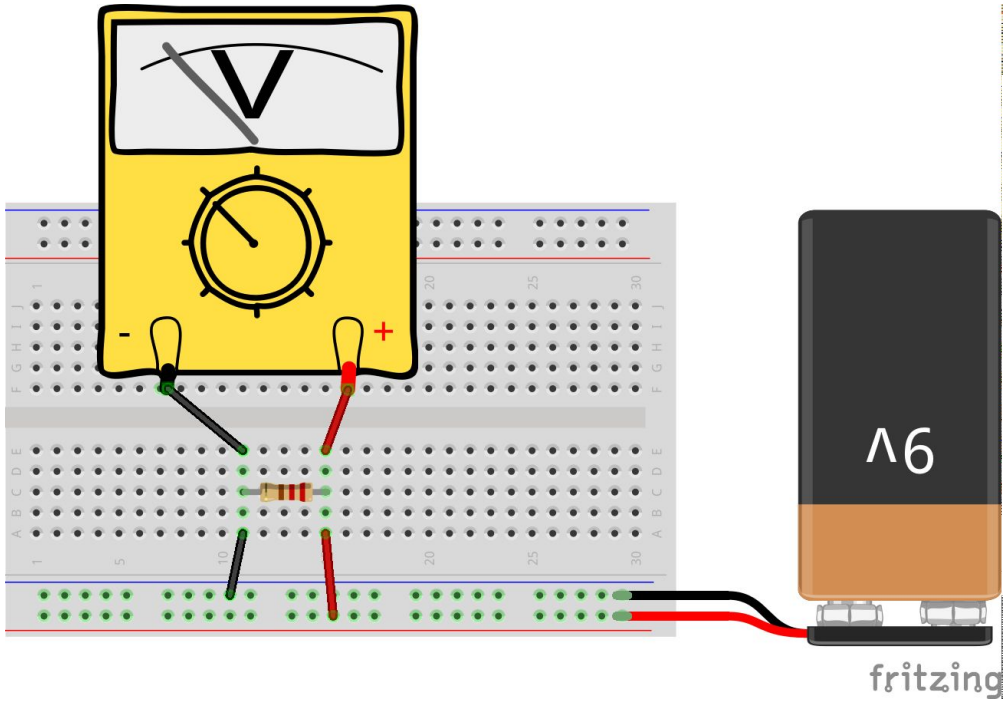
Ammeter connected in *series* with circuit

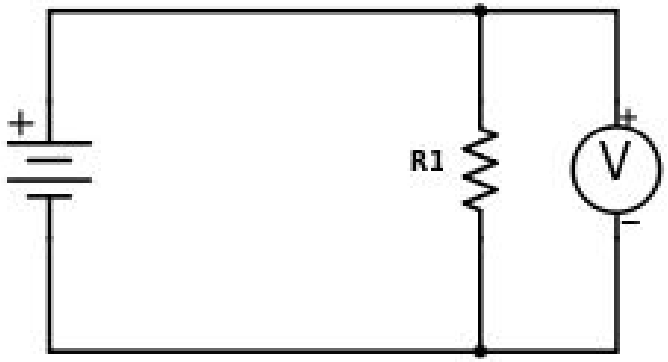




Circuit - Measure Voltage

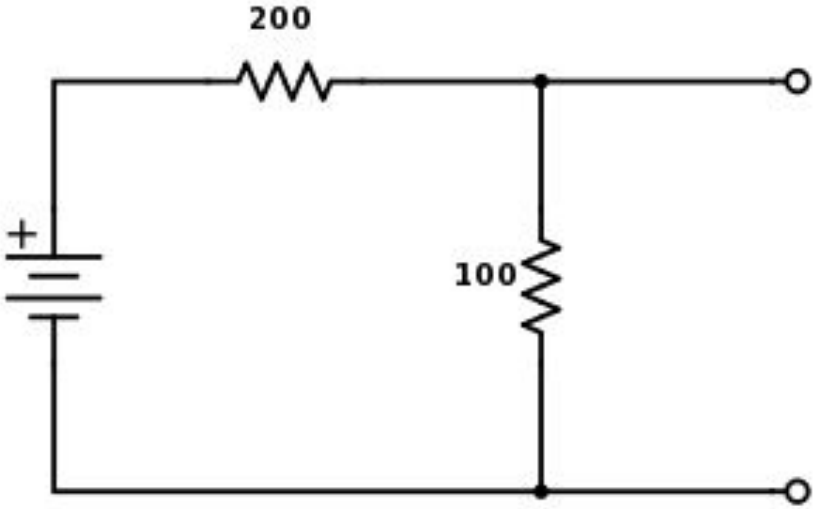
Voltmeter connected in *parallel* with circuit

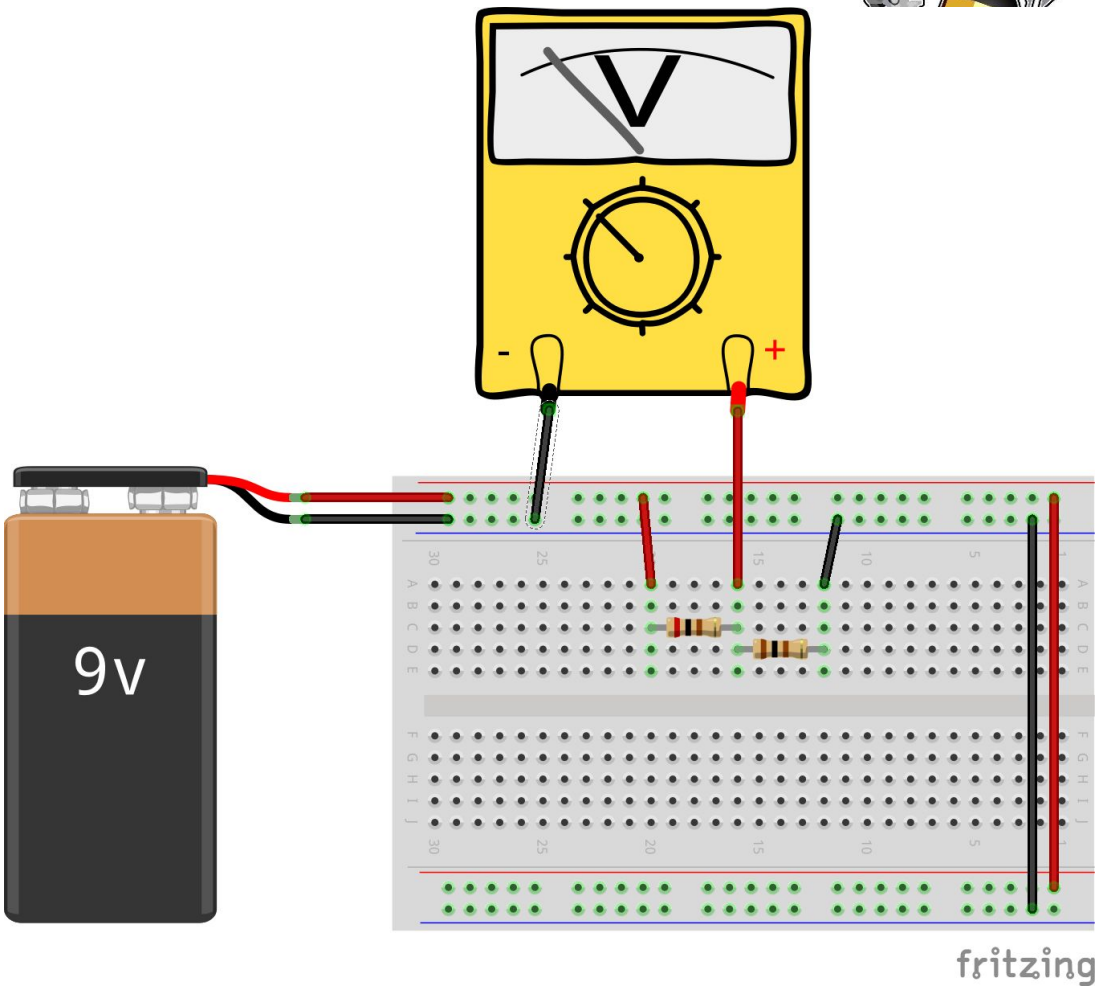




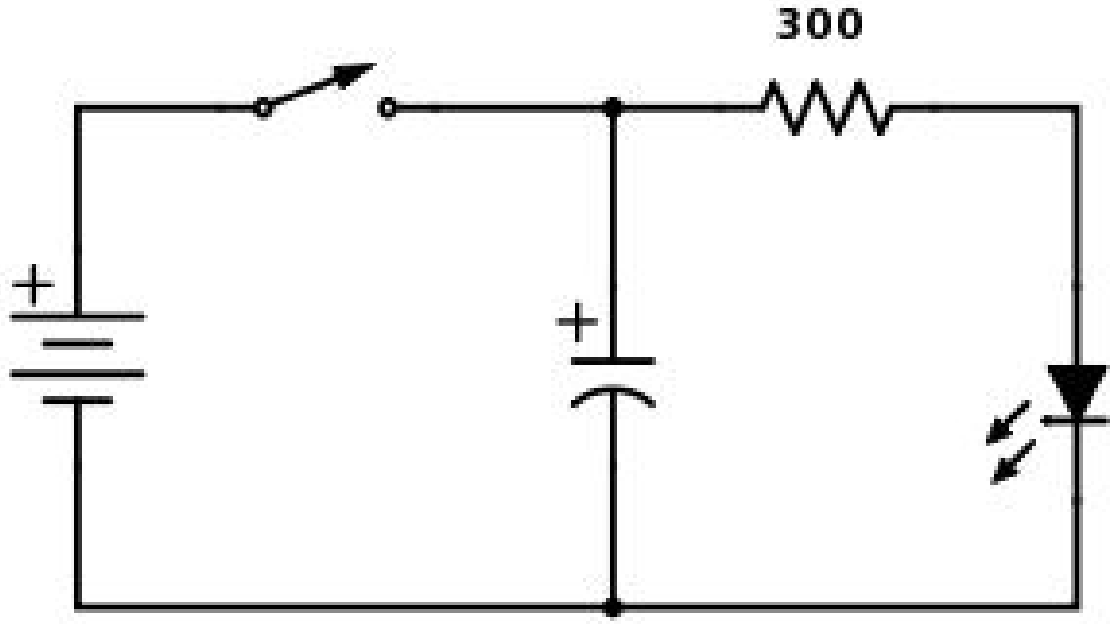
Voltage Divider

$$V_{out} = \frac{R_2}{(R_1 + R_2)} V_{in}$$

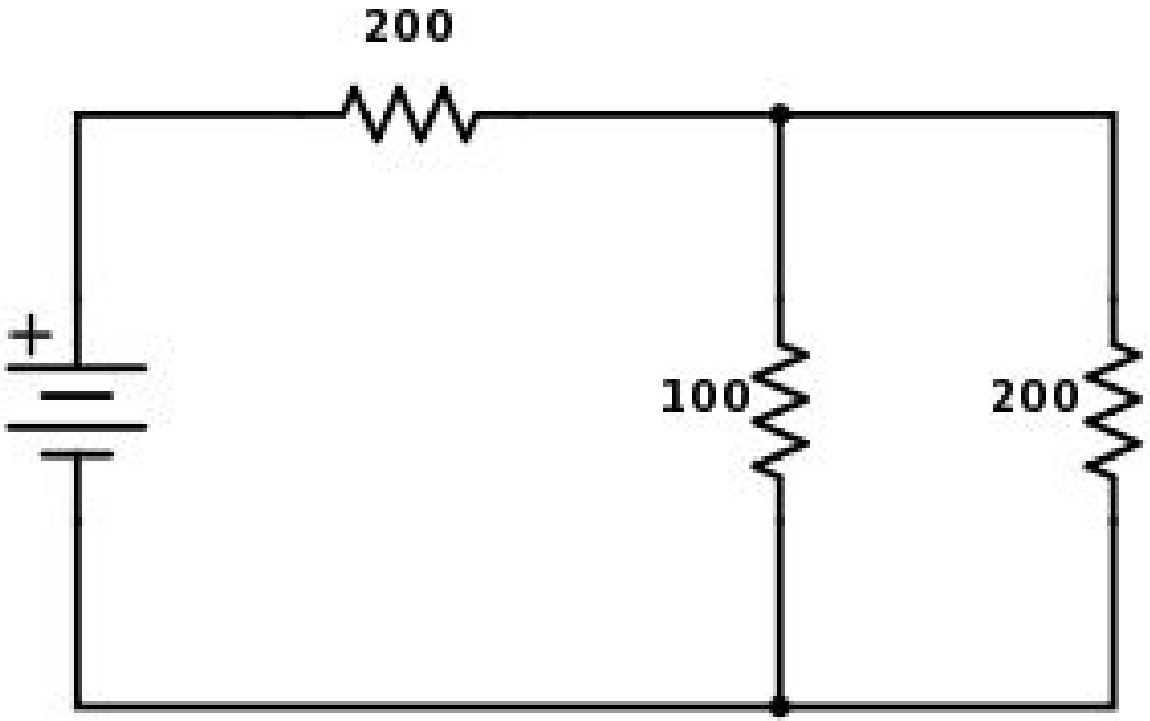




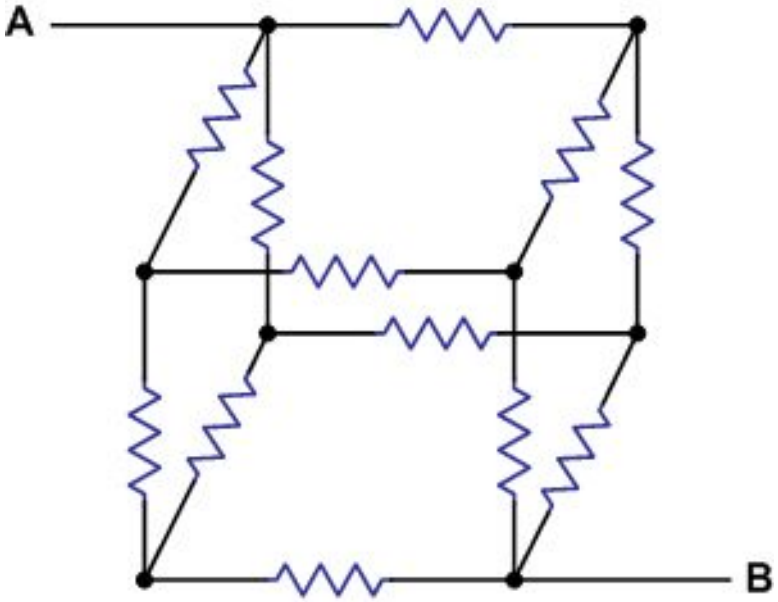
RC Circuit



Build Circuit and Measure Current Through R_{eq}



Challenge: Find R_{eq} of resistor cube



Assume all resistors are 100 ohm.

What if all resistors are 220 ohm?

END