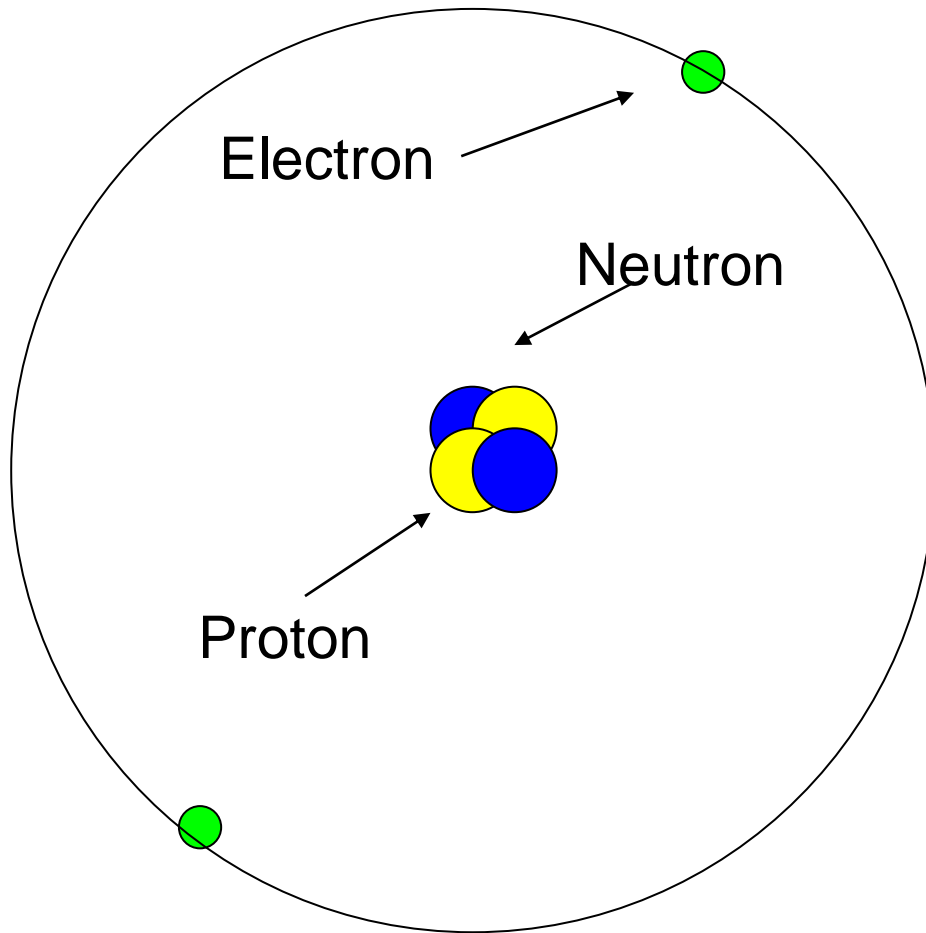


Electrical Circuits

- Identify the different symbols on a circuit diagram.
- Calculate the resistance, current, and voltage in a simple parallel or series circuit.
- Identify Kirchhoff's and Ohm's Laws.



Atomic Structure



- Proton – element
- Neutron – isotope
- Electron – charge

Charge

- Proton: Positive charge
- Neutron: No charge
- Electron: Negative Charge
- Symbol: Q
- Unit: Coulomb (C)
 - 1C = the charge of 6.242×10^{18} electrons



Free Electrons

- Electrons not specifically bound to a single atom
- Molecule – 3D lattice of atoms
- Copper wire – short length of wire has 10^{24} free electrons, but no net charge



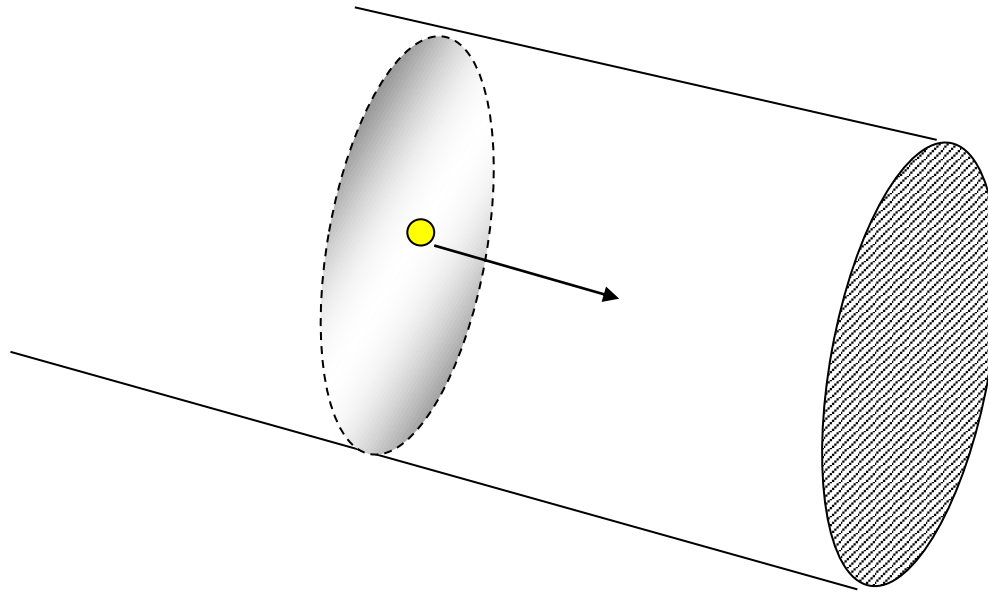
Conduction

- Electron Flow – Current
 - Requires “Free-Electrons”
 - Symbol: I or i
 - Unit: Amperes or amps (A)
 - Arrow points in direction of (+) charge flow



Current

- Charge of 1 coulomb passing a point in a second
Or, 6.242×10^{18} electrons per second
- Analogous to gpm in hydraulics



Resistance

- Opposition to current flow, just like friction loss in hydraulics.
- Symbol: R
- Units: ohms (Ω)
- Analogous to friction loss in hydraulics



Electro-Motive Force

- Potential energy
 - The ability to do work
 - Battery: like a water tower
 - Generator: like a pump
- Symbol: E or V
- Units: Volts (V)
- Analogous to psi in hydraulics
- Relative measure
 - Car Battery: Positive terminal is +12 V as referenced to negative terminal
 - Alarm Systems: 24 V typical
 - Arrowhead at the higher potential



EMF

- Sources
 - Chemical – battery
 - Magnetic – generator
 - Heat – thermocouple
 - Light – photoelectric cell
 - Pressure - piezoelectric cell
 - Friction – static electricity



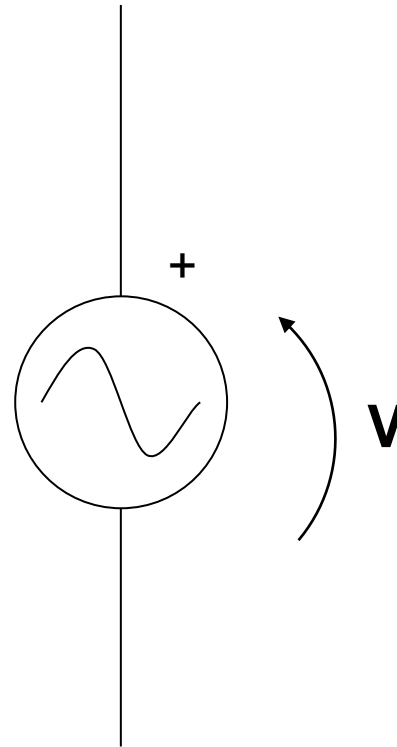
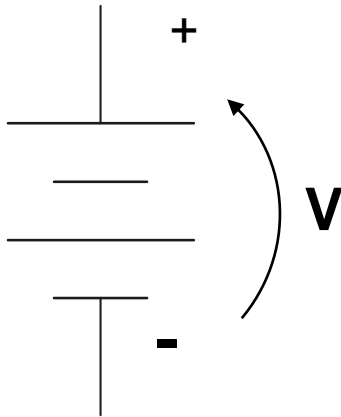
Symbology

- Voltage: $V = J/C$
- Charge: $Q = C$
- Current: $I = C/s$
- Resistance: $R = V/I$
- Energy: $E = J = VQ = (J/C)(C)$
- Power: $P = VI = (J/C)(C/s) = J/s = \text{Watts (W)}$



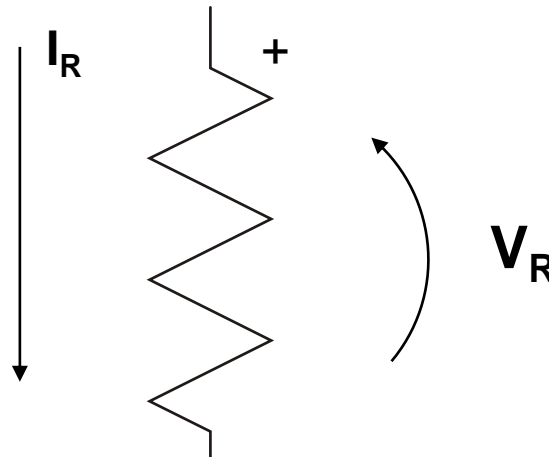
Sources

- Batteries
- Generators



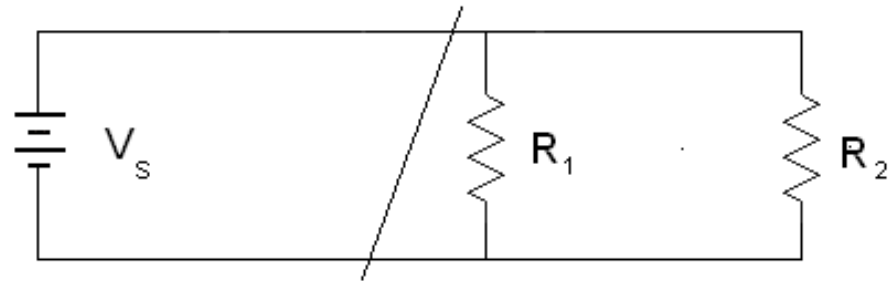
Ohm's Law

$$V = IR$$

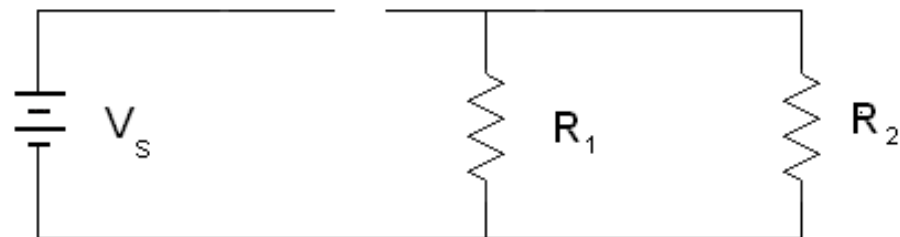


Faults

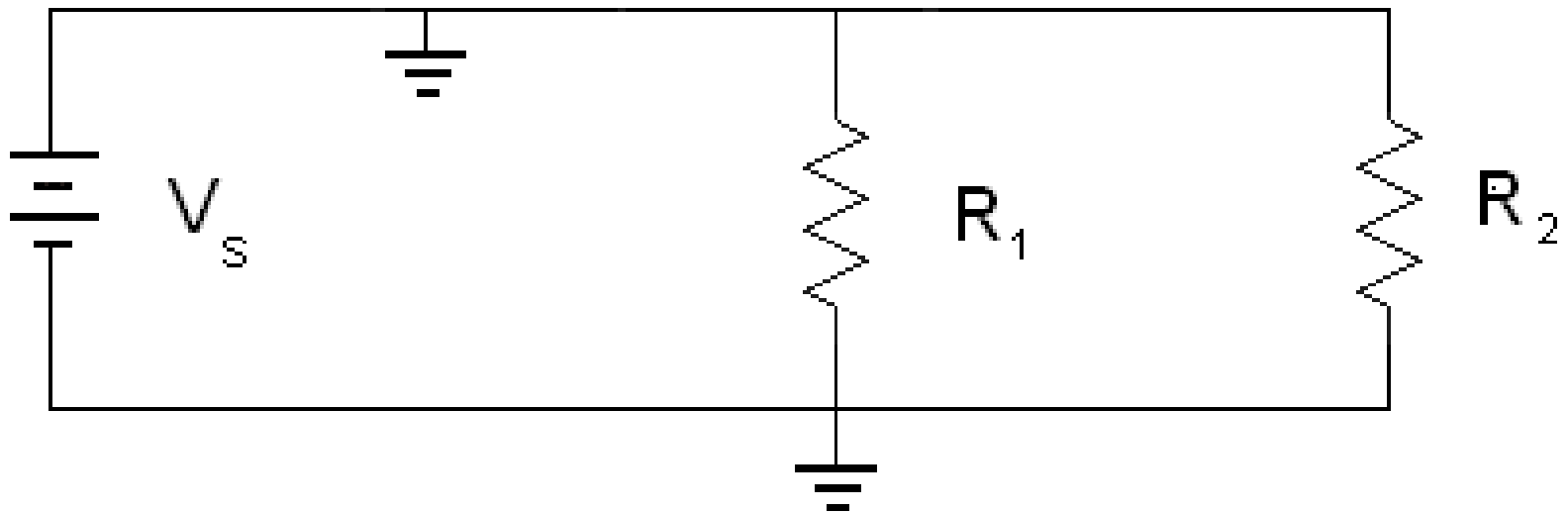
- Short Circuits



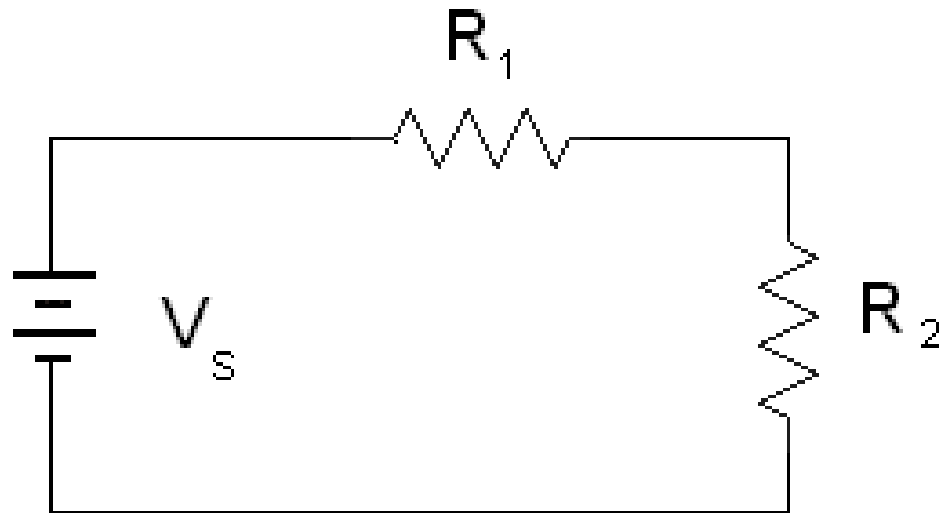
- Open Circuits



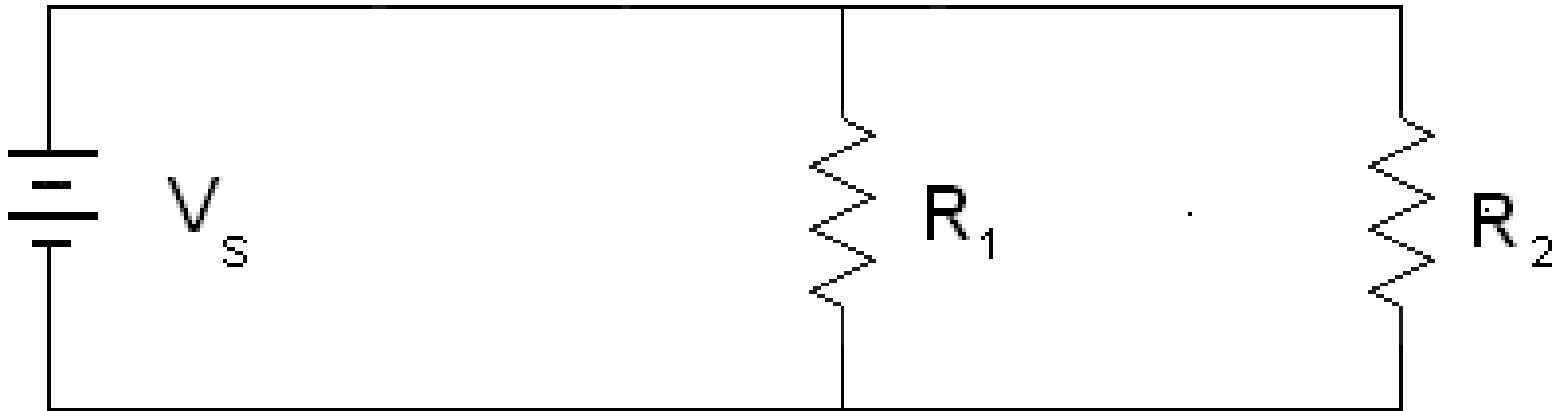
Grounds



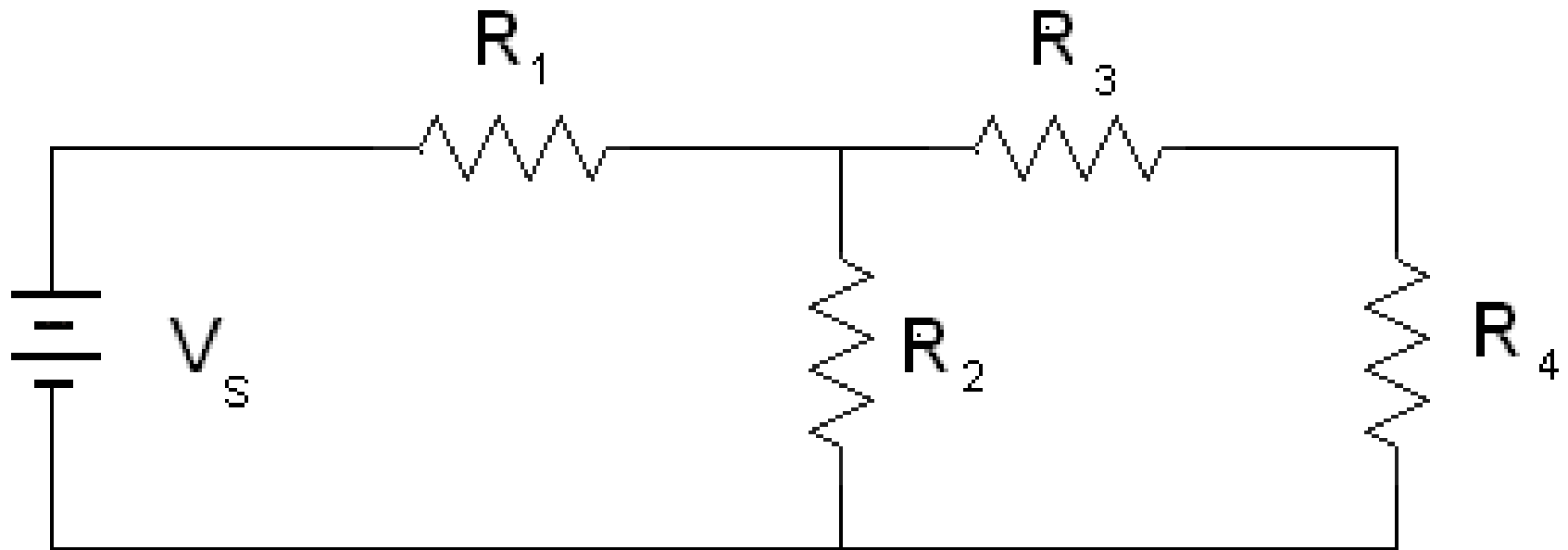
Series Circuits



Parallel Circuits



Series-Parallel Circuits



Kirchoff's Laws

- KCL: $\sum I_{\text{in}} = \sum I_{\text{out}}$
- KVL: $\sum V_{\text{rise}} = \sum V_{\text{drop}}$

