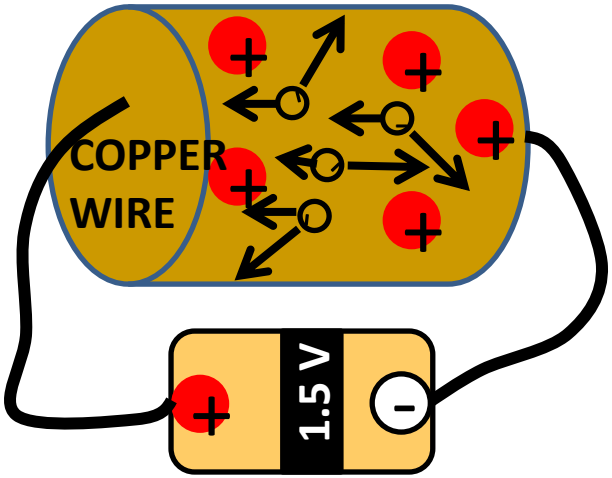
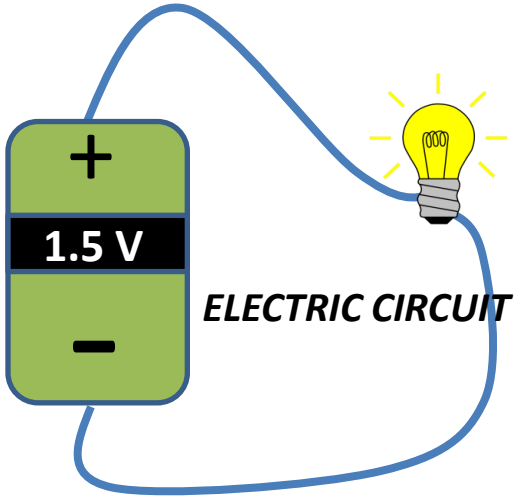
CHAPTER 35

Electric Circuits

Sections 35.1-7

ELECTRIC CIRCUIT:

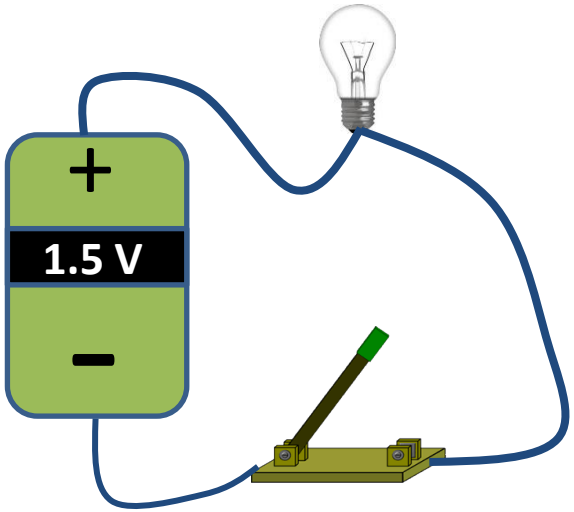




- A path that electrons flow through.
- Remember that electrons in wires are already moving randomly.
- When connected to a circuit, the electrons now have “drift velocity” along with their random motion.
- This movement creates an electric current through the circuit when the circuit is closed.

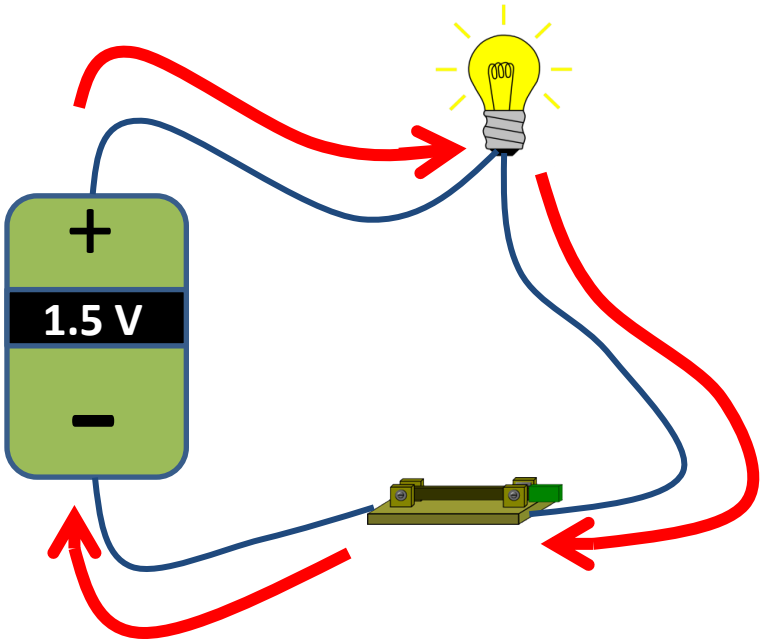
OPEN CIRCUIT

- _____
- _____
- Flipping a light switch **OFF**, **“opens”** the circuit making it incomplete



CLOSED CIRCUIT

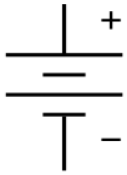
- _____
- _____
- Flipping a light switch **ON**, **“closes”** the circuit making it complete.



ILLUSTRATING A CIRCUIT:

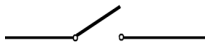
WIRE:

BATTERY:



BULB:

OPEN SWITCH:



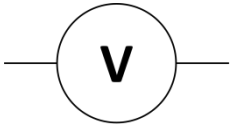
CLOSED SWITCH:

AMMETER:

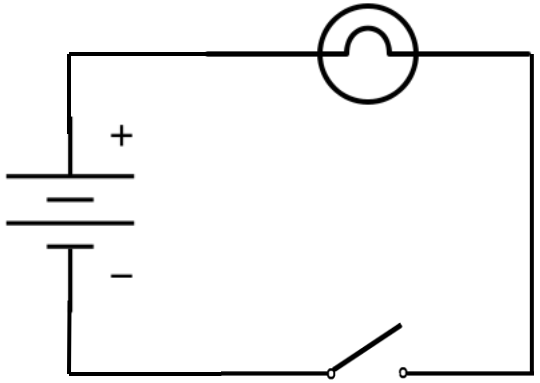
RESISTOR:

FUSE:

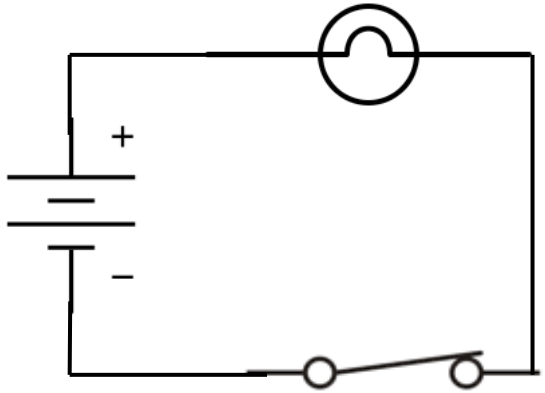
VOLTMETER:



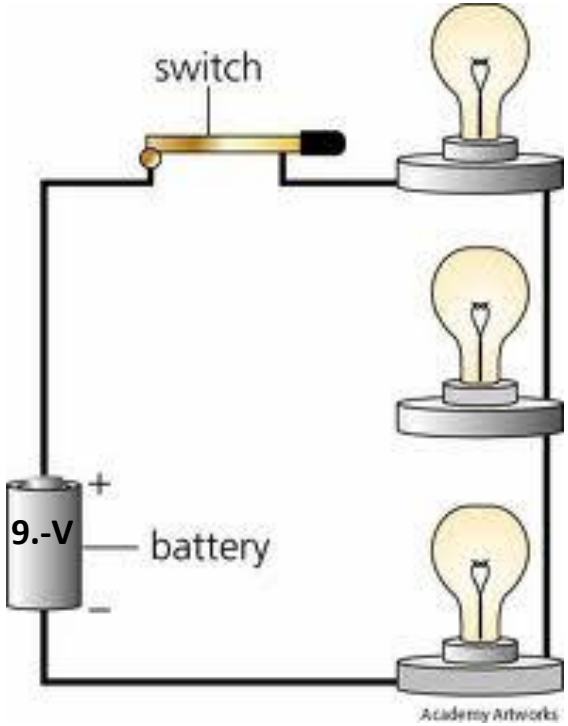
OPEN CIRCUIT



CLOSED CIRCUIT



SERIES CIRCUIT:



- _____
  _____
  _____
  _____.
- The electrons flow first through the battery, then to the 1st lamp, then to the 2nd lamp, through the 3rd lamp and through the battery again.
- Each lamp provides resistance.
- _____
  _____.
- Total Resistance = R1 + R2 + R3
- The current is equal to 1 amp
- I = V/R1 + R2 + R3….

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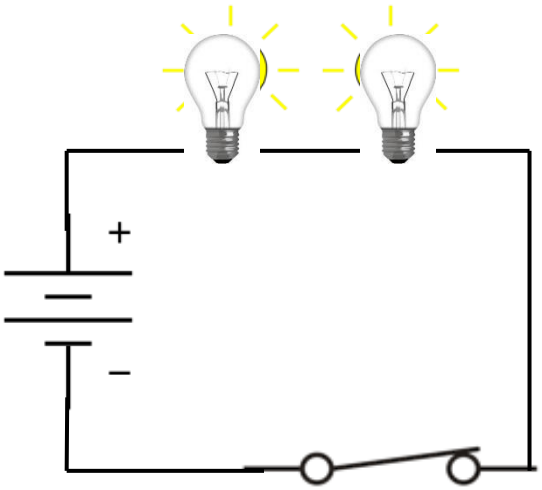
Series Fundamentals:



- _____
- _____
  _____
- Current = voltage / total resistance
- **Each voltage drop** depends on the **resistance of each device** in the circuit.
- A failure of one device **(X)** in the circuit stops all current in the circuit.
- Conservation of energy –
  - power used in the circuit equals power supplied to the circuit.

- Calculating voltage drop: A circuit has a 9.-Volt battery connected to a 1-ohm bulb and a 2-ohm bulb. Find total resistance, current and then voltage drop.

$$I = \frac{V}{R}$$

$$\text{Total } R = R_1 + R_2 + R_3 \ldots$$

$R_{total} = 3\Omega$

$V = 9.$

$I = \frac{9.-V}{3\Omega} = 3A$

Voltage drop $= IR$

$V = 3A \times 1\Omega = 3V$

$V = 3A \times 2\Omega = 6V$

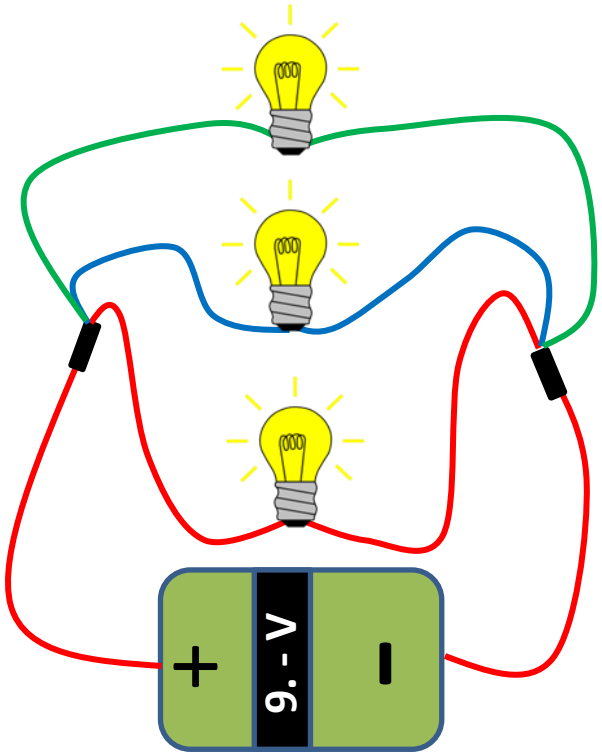
Battery Voltage = Voltage drop

- Calculating voltage drop: A circuit now has a 12.-Volt battery connected to a 1-ohm bulb and a 2-ohm bulb. Find total resistance, current and then voltage drop.

Voltage drop = I R

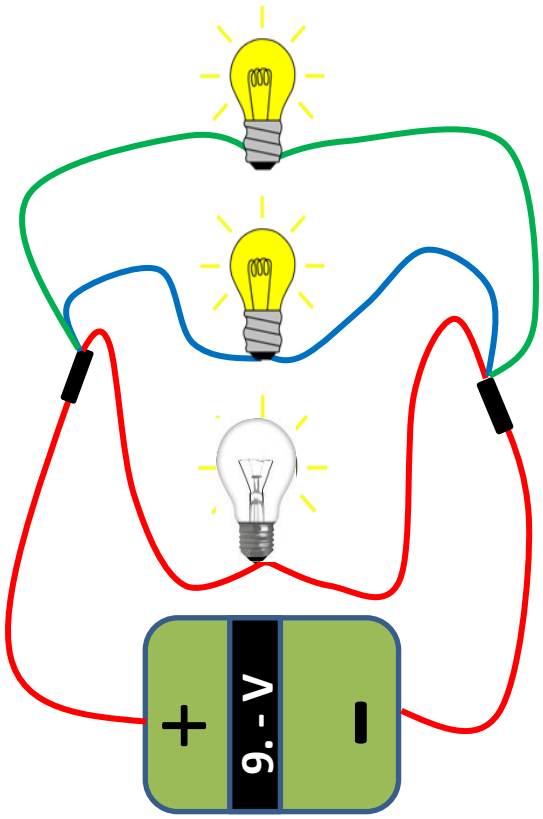
- Calculating voltage drop: A 12-Volt battery is connected in series to a 1-ohm and a 5-ohm bulb. What is the voltage across each bulb?

PARALLEL CIRCUIT:



- Each electrical device is connected to the same two points in the circuit.
- _____
  _____
- _____
  _____(the voltage drop for each device is equal to the full battery charge)
- _____
  _____
- _____
  _____.
- Why?
  - _____
    _____

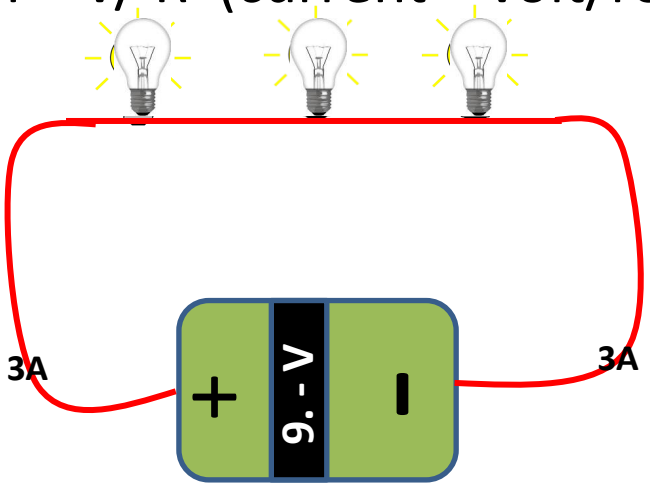
Parallel Fundamentals:

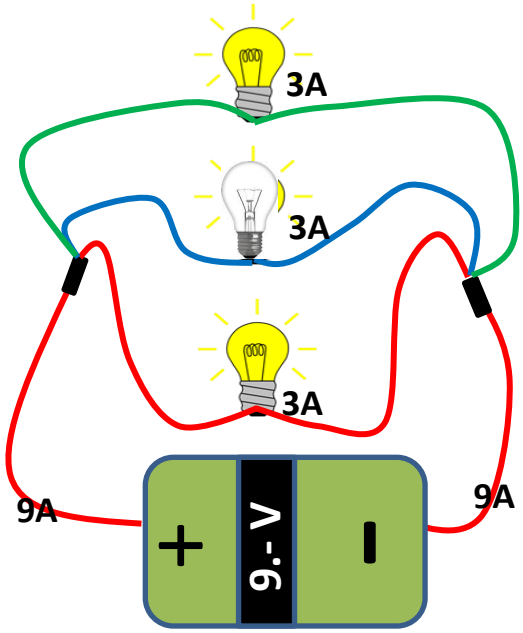


- _____ _____.
- Total current through the circuit divides among the parallel branches.
- Adding the parallel currents = total circuit current.
- _____ _____.
- From this battery's perspective, the overall resistance of the circuit is decreased by 1/3 for each branch.
- _____ _____
- **R TOTAL** = PRODUCT / SUM
- ***R1 X R2 divided by R1 + R2***
- This battery is putting out 3 x more energy and will last a shorter period of time.

A MATHEMATICAL LOOK AT SERIES VS. PARALLEL and the DIFFERENC IN RESISTANCE:

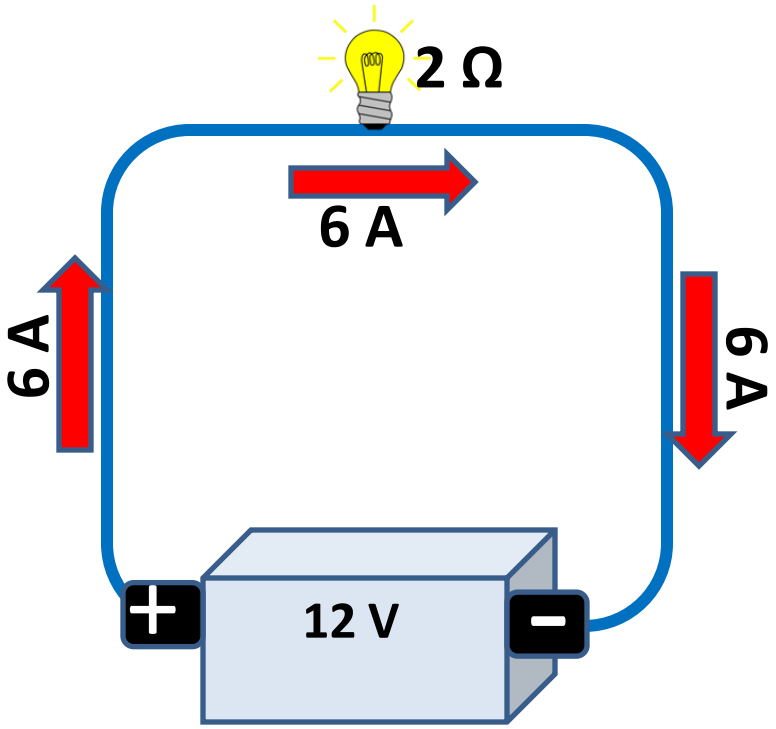
I = V/ R (current = volt/resistance)





I= V/R
I = 9V/3Ω = 3 amps total across the 1 wire.
Series Resistance = Volt / total amps
Series Resistance = 9V / 3 amps = **3 ohms**
Greater resistance across the wire, less current
Battery uses 1/3 less energy; lasts longer
Bulbs become progressively dimmer
1 bulb goes out; they all go out

I= V/R
I = 9V/3Ω = 3 amps across each of the 3 wires.
Parallel Resistance = Volt / total amps
Parallel Resistance = 9V / 9 amps = **1 ohm**
Less resistance across the wires, more current
Battery uses 3 x more energy; shorter lasting
All bulbs have the same brightness
1 bulb goes out, the rest stay on



SERIES:

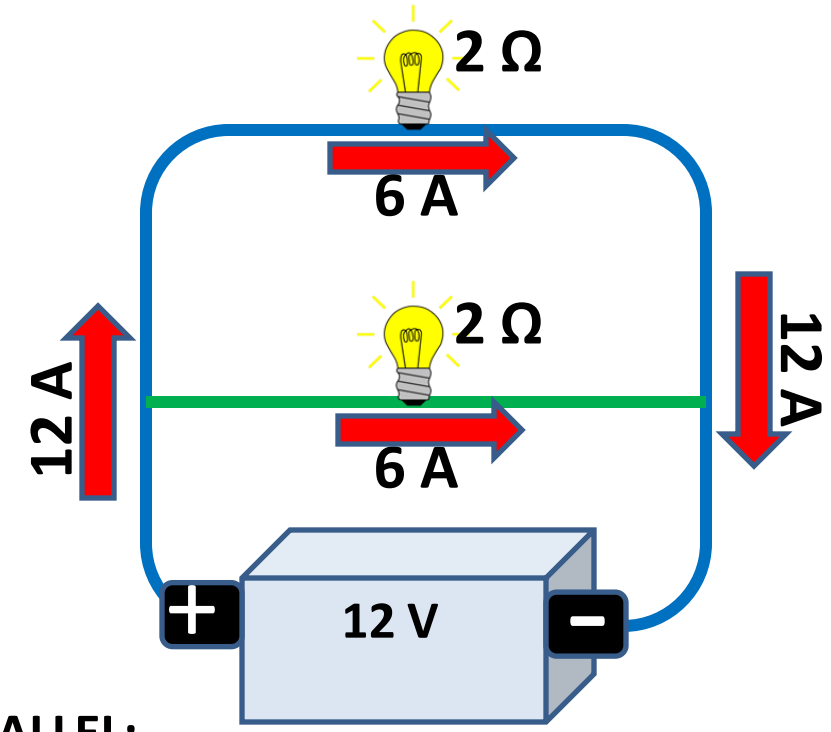
R = 2 ohms

V = 12

I = V/R

I = 12 V / 2 ohms = 6A

GREATER RESISTANCE, LESS CURRENT



PARALLEL:

R = 2 ohms at each bulb

R total =**R1 x R2 divided by R1 + R2 = ?**

V = 12

I = V/R total

I = 12 V / 1 ohm = 12A

OR…LOOK AT EACH BRANCH SEPARATELY

I = 12 V / 2 ohms

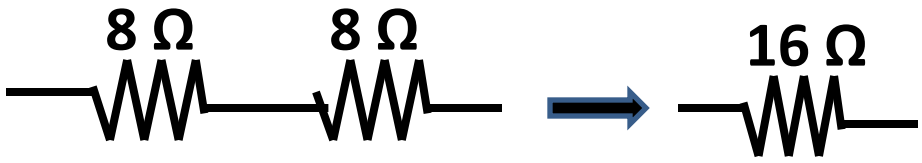
I = 6A (for each branch)

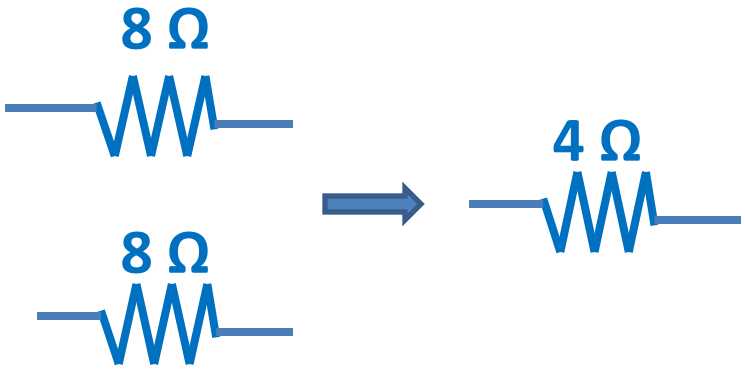
I total = $I_1 + I_2$ = 12A

LESS RESISTANCE, GREATER CURRENT

- The equivalent resistance of resistors connected in series is the sum of their values.

- The equivalent resistance of a **pair** of equal resistors connected in parallel is half the value of either resistor.





$$R_{total} = R_1 + R_2 \ldots$$

$$R_{total} = \frac{R_1 \times R_2}{R_1 + R_2}$$

- All the electrical outlets are on one parallel circuit. The circuit can run 15 amps of current. Can the following all be plugged in at once: A 240 Ω light, a 150 Ω stereo, and a 10 Ω air conditioner?

Find the current for each device $I = \frac{V}{R}$

$V = 120$ for each device

What is the total current in a parallel circuit containing a 12-Volt battery, a 2 Ω resistor, and a 4 Ω resistor?

Battery = 12V

Battery = 12V

Parallel Circuits and Overloading:

- Electric current is brought into a house through lead wires (or lines).
- The lines are connected to wall outlets and have very low resistance
- 110-120 volts are placed on the lines
- The voltage is applied to appliances
- The appliances are connected in parallel by plugs to the lines.
- _____ _____.
- _____
- _____

FUSES

- Connected in a series along the supply line of current
- Made up of a “wire ribbon” that heats up and melts at a certain current.
- A 20 amp fuse will not allow more than 20 amps of current to flow.
- The fuse will be “blown” over 20 amps.

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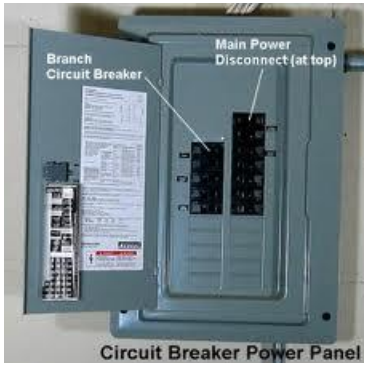
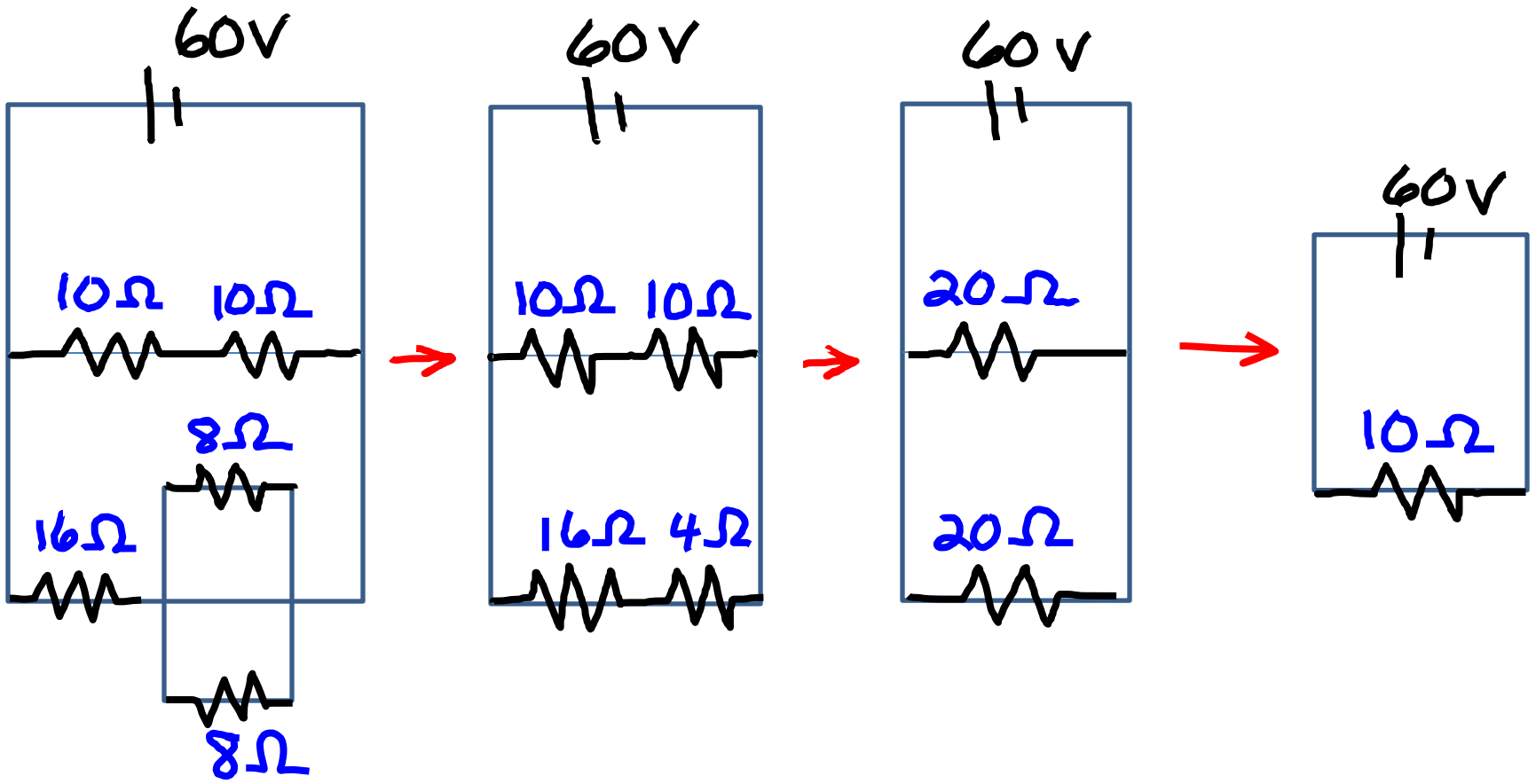
Al7uyYPmY9nY8XVu_Ki7MrI_K7G5oceovBAP_hd6

CIRCUIT BREAKERS

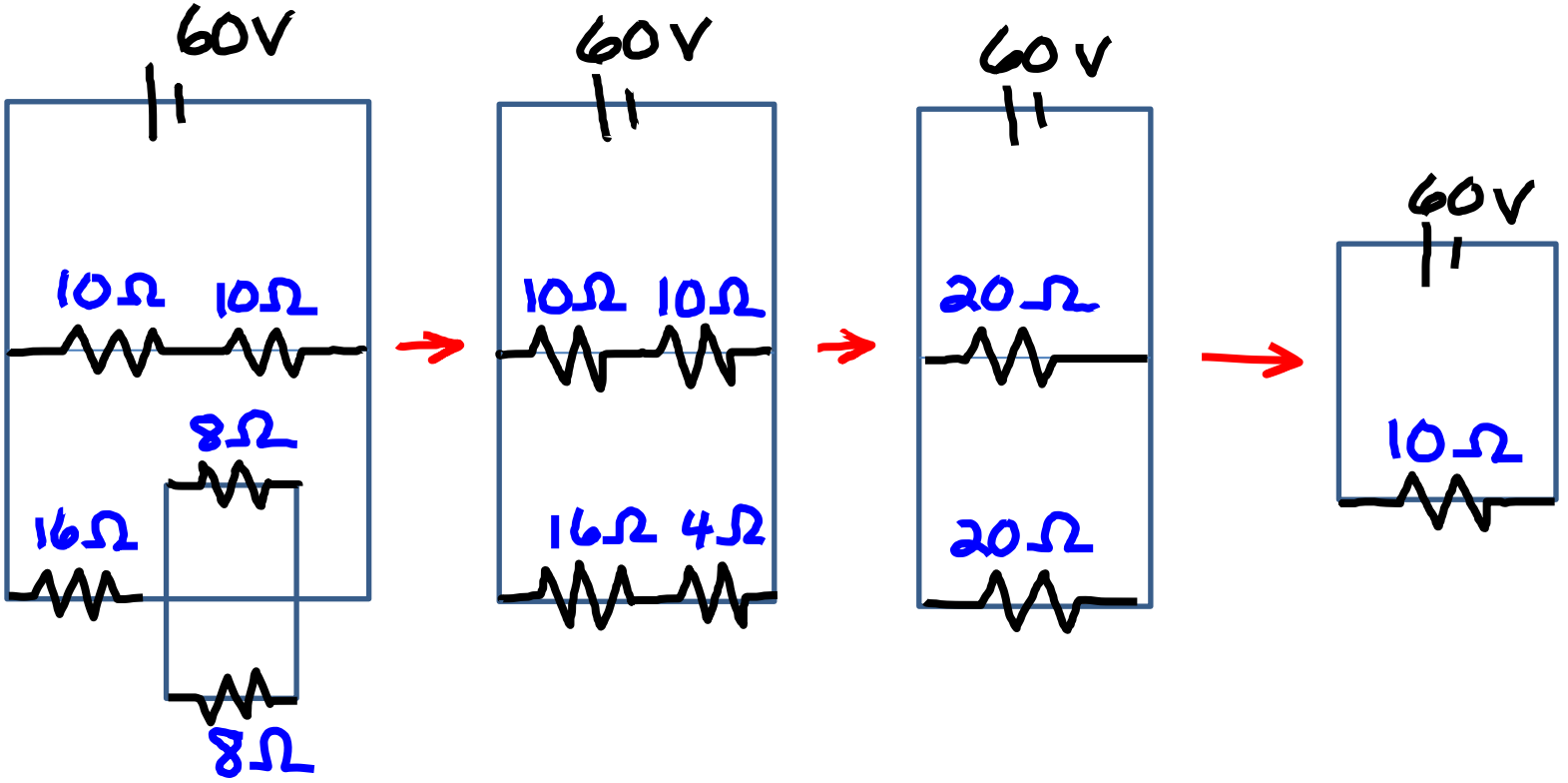
- Connected in a series along the supply line of current.
- Bimetallic strip or magnet used to open a switch.
- Stops the flow of current if there is an overload on the wire.
- The breaker can be reset once the overload is corrected.

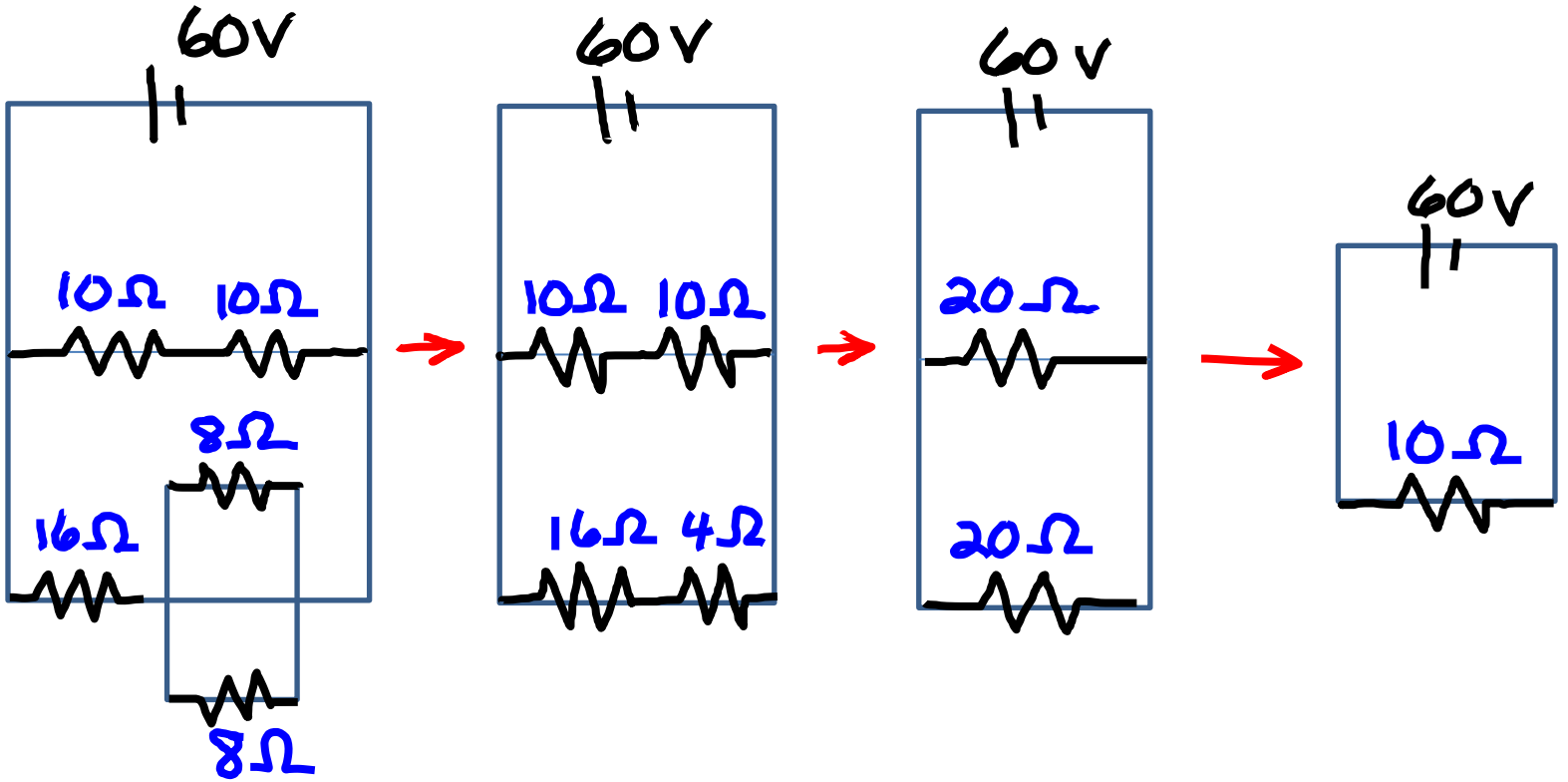


COMBINING RESISTORS IN A “COMPOUND CIRCUIT”…
Series & Parallel



1. What is the current in amps through the battery?
2. What is the current in amps through the pair of 10 ohm resistors?
3. What would it be through the 8 ohm resistors?
4. What is the power supplied by the battery?




60V
10Ω
10Ω
8Ω
16Ω
8Ω
60V
10Ω
10Ω
16Ω
4Ω
60V
20Ω
20Ω
60V
10Ω