CIRCUITS

Current

Resistance

Ohms Law

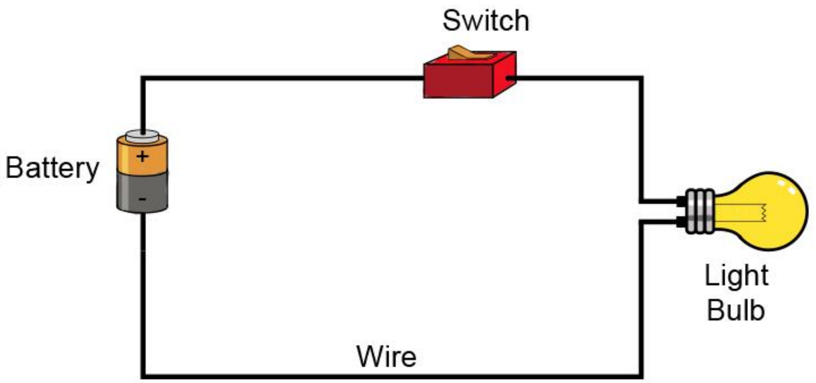
Power

Series Circuits

Parallel Circuits

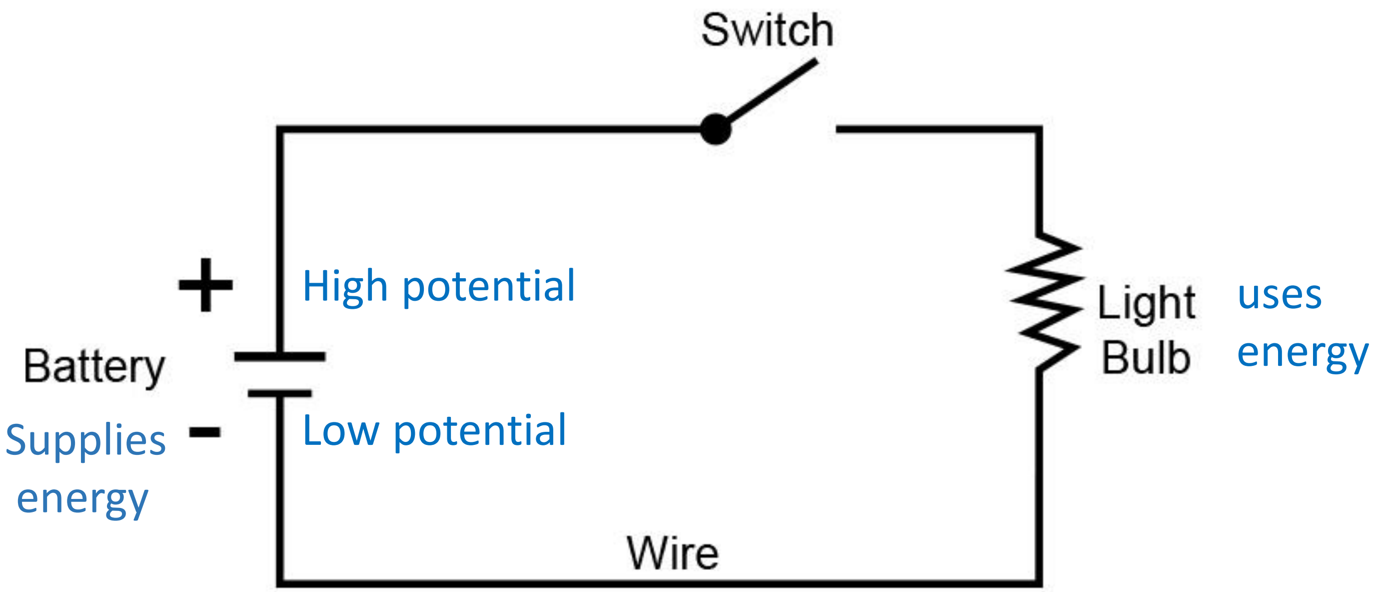
Combination Circuits

CIRCUITS



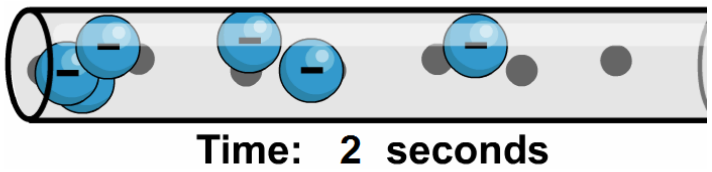
Basic Circuit

Circuit Diagram



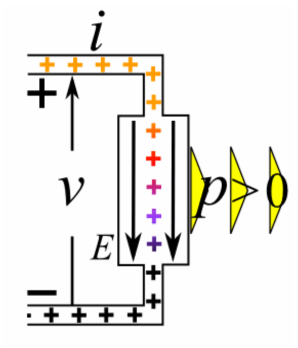
Electric Current

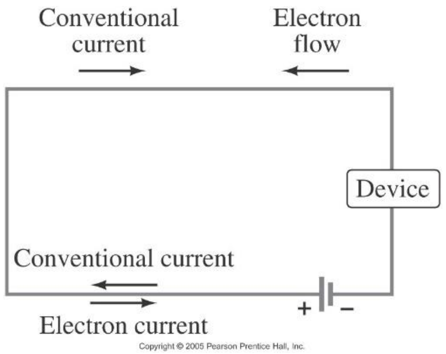
- Rate of Flow of Electric Charge through a conductor.



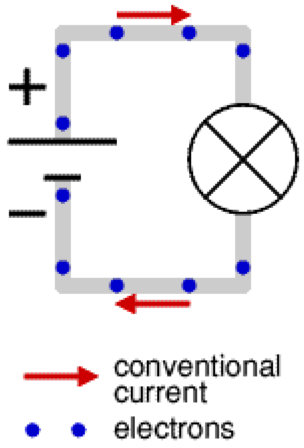
$$I = \frac{\Delta Q}{\Delta t}$$

- Unit of electric current: the ampere, A. 1 A = 1 C/s.





The direction of current in a circuit is described as the direction positive charge move. (+ → −)



But, actually it's the electrons that move through a circuit in the opposite direction of conventional current.

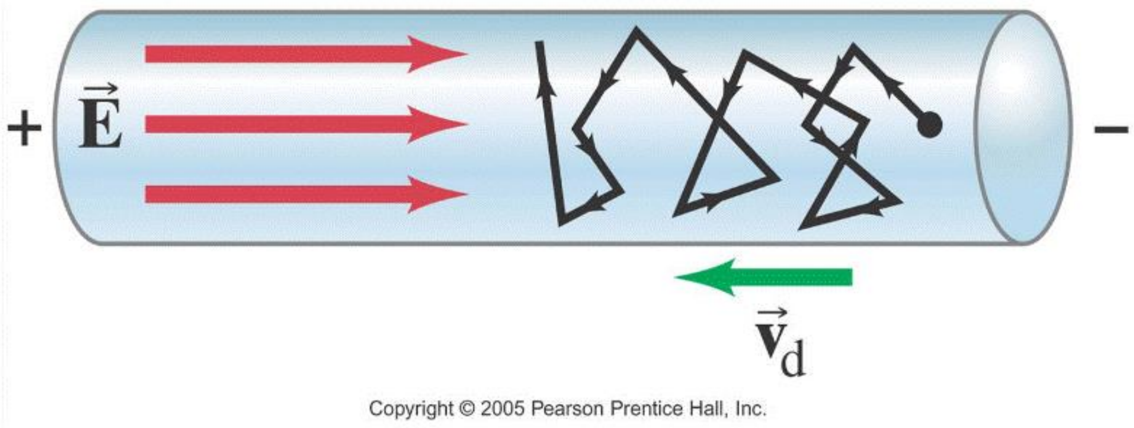
Drift Velocity

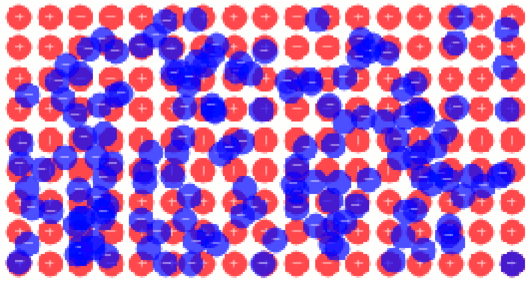
When Electrons move through a wire, they do not move very fast or very straight.

The bounce off and move around each other.

The average speed of the charges is very slow (measured in centimeters per second)

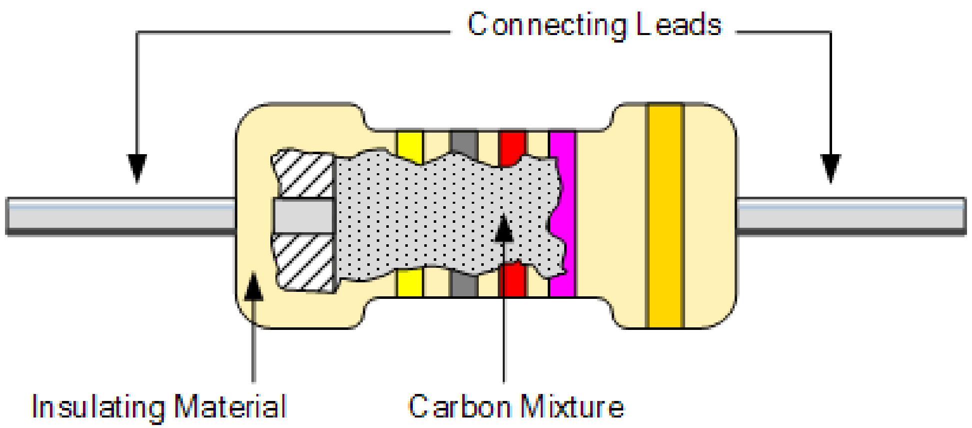
The average speed of the electron is called drift velocity

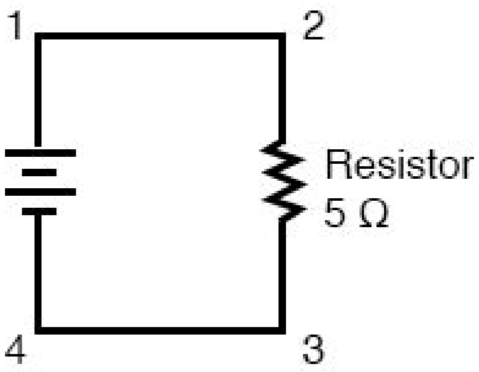




Resistance

- Slows the flow of electric charge
- Uses energy in a circuit
- The ratio of voltage to current is called the resistance: $R = \frac{V}{I}$
- Measure in Ohms. (rhymes with "owns")
- $1\frac{Volt}{Amp}$ = 1 Ω (Ohms)





Resistance

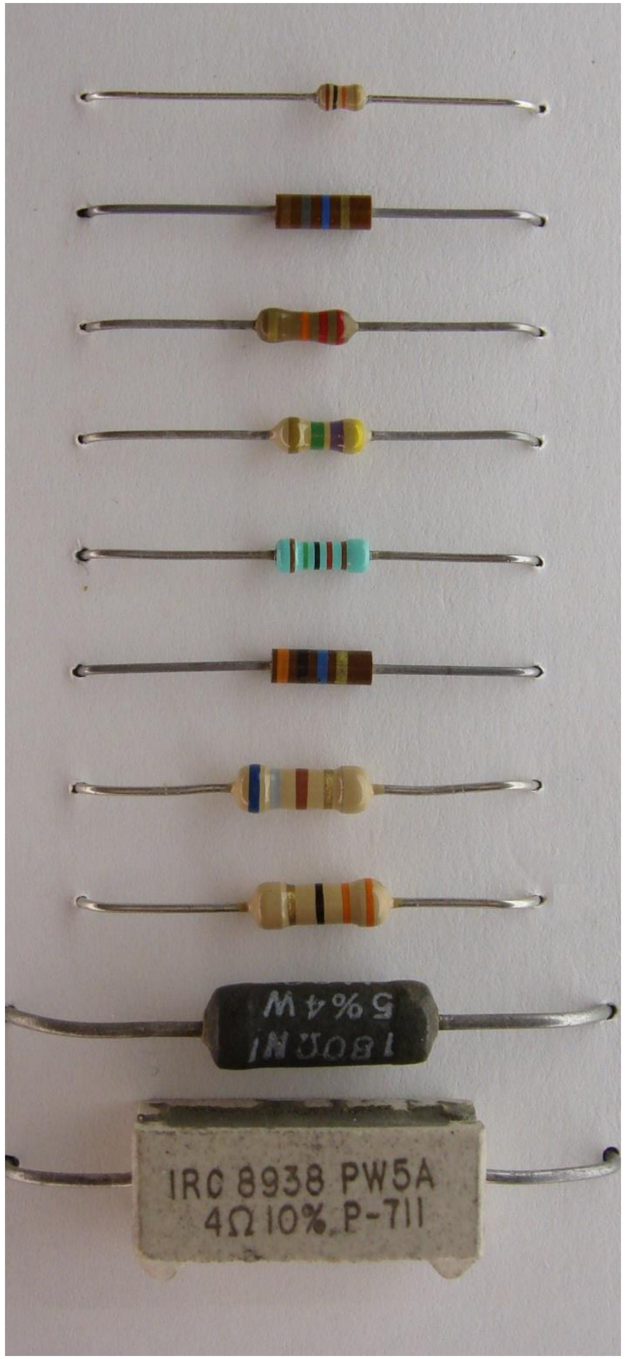
The Resistance of a wire:

- Is Characteristic of the material
  - (Resistivity)

- Is Directly proportional to Length
  - L↑, Ω↑

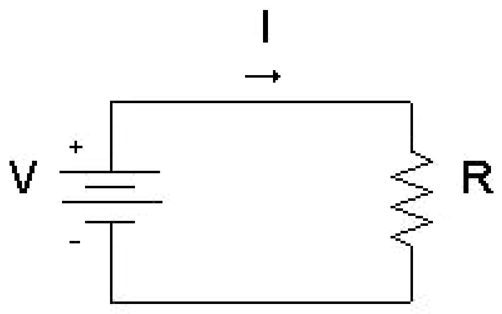
- Is Inversely proportional to Area.
  - A↑ , Ω↓

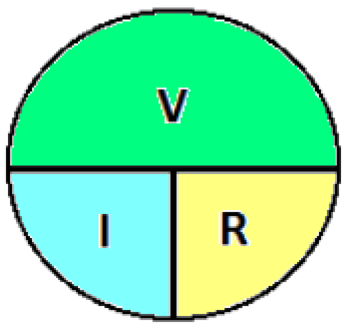
- Increases with temperature
  - T↑, Ω↑



Ohm's Law

$$V = IR$$





Magic Triangle

The Current Electric Potential in any circuit can be found by using Ohms Law (Georg Simon Ohm)

The amount of Electric Potential (Energy per unit charge) (V) used by a resistor depends on the Current through the circuit, and the amount of Resistance $V = IR$

The current depends on the Potential of the Circuit (V (volts)) ,and the Resistance of the Circuit. $I = \frac{V}{R}$

Potential	Current	Resistance
?	0.5A	12Ω
12V	?	4Ω
6V	1.5A	?

Solution
$V = IR = .5 * 12 = 6V$
$I = \frac{V}{R} = \frac{12}{4} = 3A$
$R = \frac{V}{I} = \frac{6}{1.5} = 4\Omega$

Power

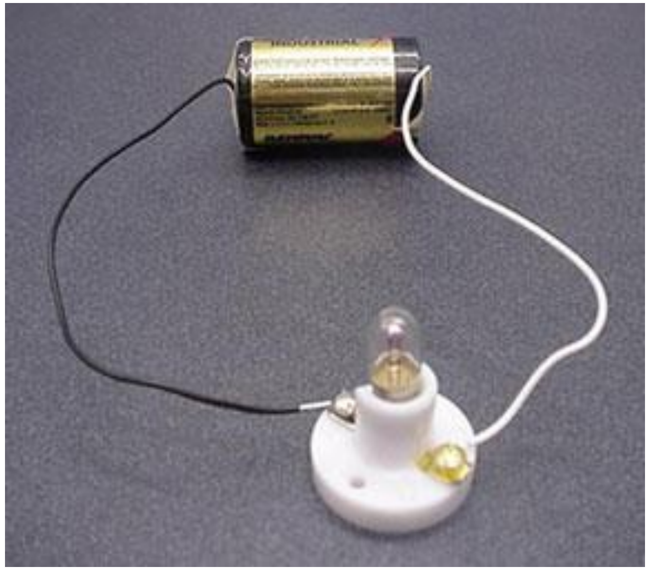
- **Rate at which work is done**

- $P = \frac{Work}{time} \rightarrow V = \frac{Work}{Q} \rightarrow Work = QV \rightarrow (see\ electric\ potential)$

- $P = \frac{Work}{t} = \frac{QV}{t} = \frac{Q}{t}V \rightarrow \left[\frac{Q}{t} = I\right] \rightarrow \quad P = IV$

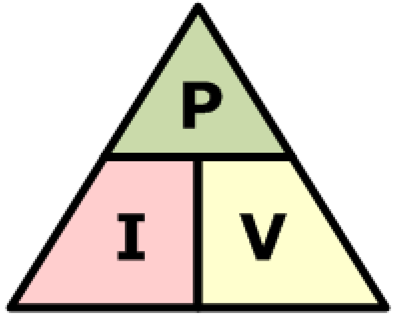
- $P = IV \rightarrow (V = IR) \rightarrow I(IR) = P = I^2R$

- $P = IV \rightarrow I = \frac{V}{R} \rightarrow P = \frac{V}{R}V = P = \frac{V^2}{R}$



3 ways to calculate power.

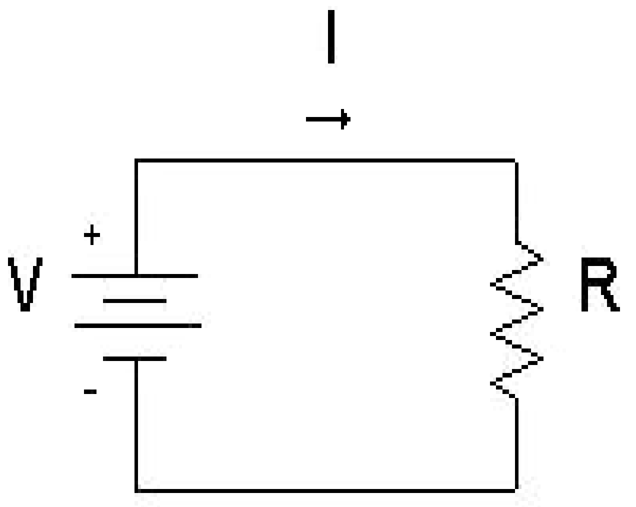
$$P = IV = I^2R\ = \frac{V^2}{R}$$



Magic Circle

Power: Examples

Use Ohms law, and the Power Equations to Complete the following Table.



Potential	Resitance	Current	Power
12V	?	0.5A	?
?	4Ω	0.75A	?
4V	2Ω	?	?

$$P = IV = I^2R = \frac{V^2}{R}$$

$$V = IR$$

Solutions

Potential	Resistance	Current	Power
	$R = \frac{V}{I} = 24\Omega$		$P = IV = 6W$
$V = IR = 3A$			$P = I^2R = 2.25W$
		$I = \frac{V}{R} = 2A$	$P = \frac{V^2}{R} = 8W$

Power

- The electric company measures kilowatt hours → kWh
- kWh = power * time = Work

- Work required to keep your household running.
- 1 kWh= 1000W * 3600s = $3.6*10^6$ J

7 **Electric Details** Electric Choice ID: 0000012345
Residential - Schedule R
Billing Period: May 1, 2014 - Jun 3, 2014 Days Billed: 33

Meter Read on June 3 Meter # 000012345

Current Reading		Previous Reading		kWh Used
13951	-	13386	=	565

8 **BGE Elec Supply**	513.64 kWh x .0966200	49.63
	51.36 kWh x .0885700	4.55
9 **BGE Electric Delivery Service**		
Customer Charge		7.50
EmPower MD Chg	565 kWh x .0041100	2.32
Distribution Chg	565 kWh x .0280100	15.83
RSP Chg/Misc Cr	565 kWh x .0033300	1.88
Dmd Res Chg/Cr	565 kWh x .0002900	.16
ERI Initiative Chg	565 kWh x .0000900	.05
10 **State / Local Taxes & Surcharges**		
MD Universal Svc Prog		.36
Envir Srchg	565 kWh x .0001500	.08
Franchise Tax	565 kWh x .0006200	.35
Total BGE Electric Amount		**$82.71**

The RSP Charge on this bill includes a qualified rate stabilization charge of $0.00611 per kWh approved by the Maryland PSC that BGE is collecting as servicer on behalf of RSB BondCo LLC, which owns the qualified rate stabilization charge.

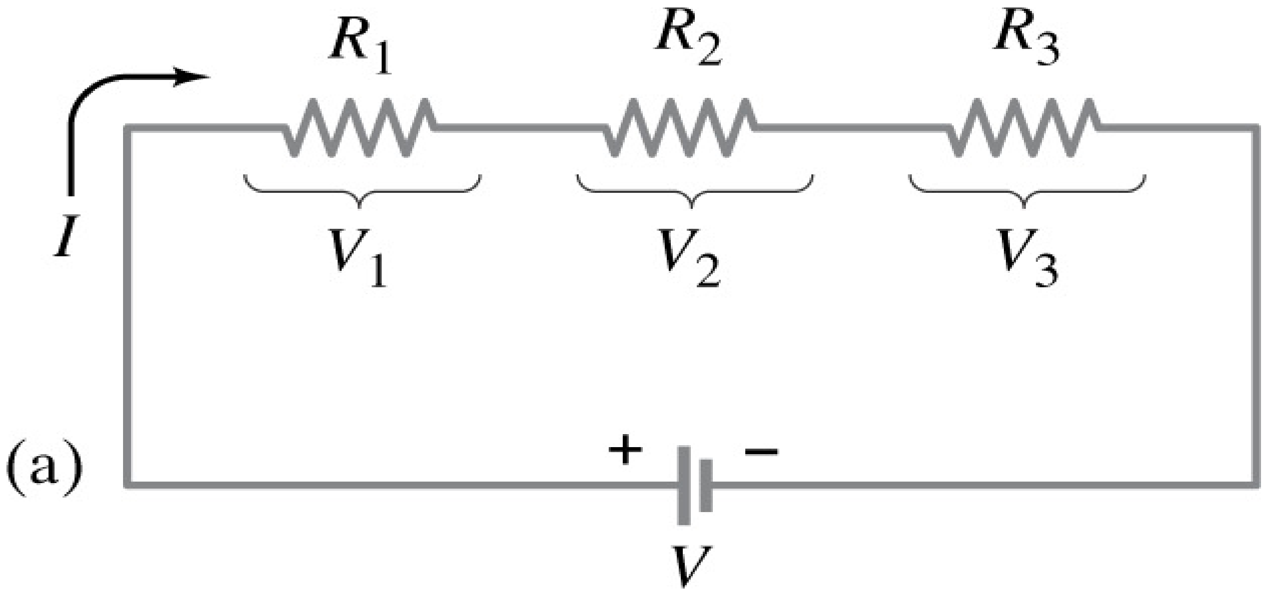
Resistors in Series

A series connection has a single path from the battery, through each circuit element in turn, then back to the battery.

- The sum of the voltage drops across the resistors equals the battery voltage.
- The current through each resistor is the same.
- Voltage across each resistor is different

$$V = V_1 + V_2 + V_3$$

$$V = IR_1 + IR_2 + IR_3$$
$$V = I(R_1 + R_2 + R_3)$$



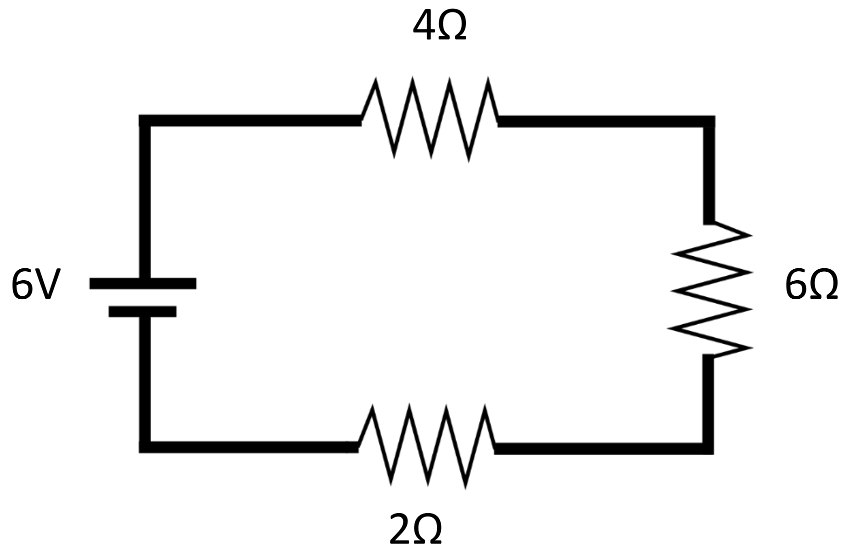
$$V = IR_{eq}$$

$$\boldsymbol{R_{eq} = R_1 + R_2 + R_3}$$

Resistors in Series

Determine the following:

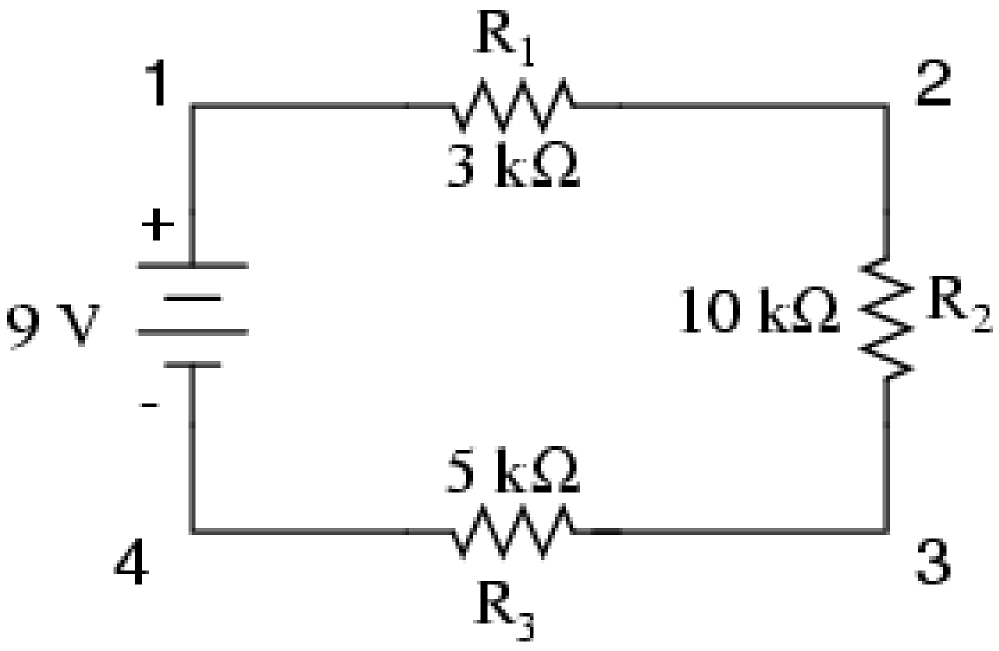
- Equivalent Resistance of the circuit
- Current through the resistors
- Voltage Drop across each resistor
- Power dissipated by each resistor
- Power dissipated by the entire circuit



Resistors in Series

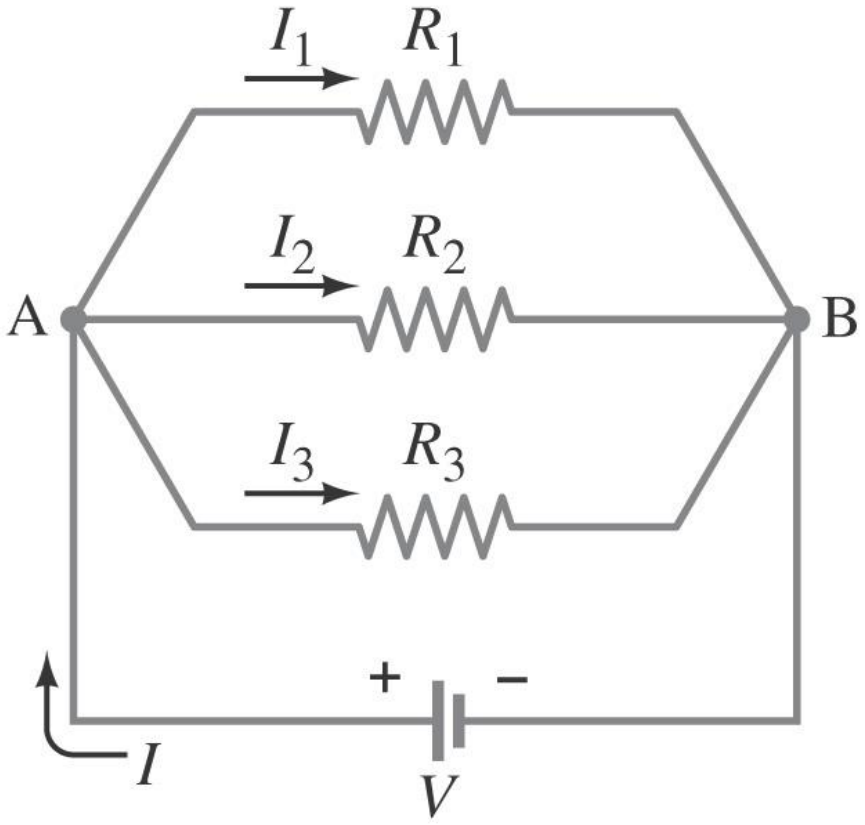
Determine the following:

- Equivalent Resistance of the circuit
- Current through the resistors
- Voltage Drop across each resistor
- Power dissipate by each resistor
- Power dissipate by the entire circuit



Resistors in Parallel

- A parallel connection splits the current
- The voltage across each resistor is the same
- Current across each resistor is different.



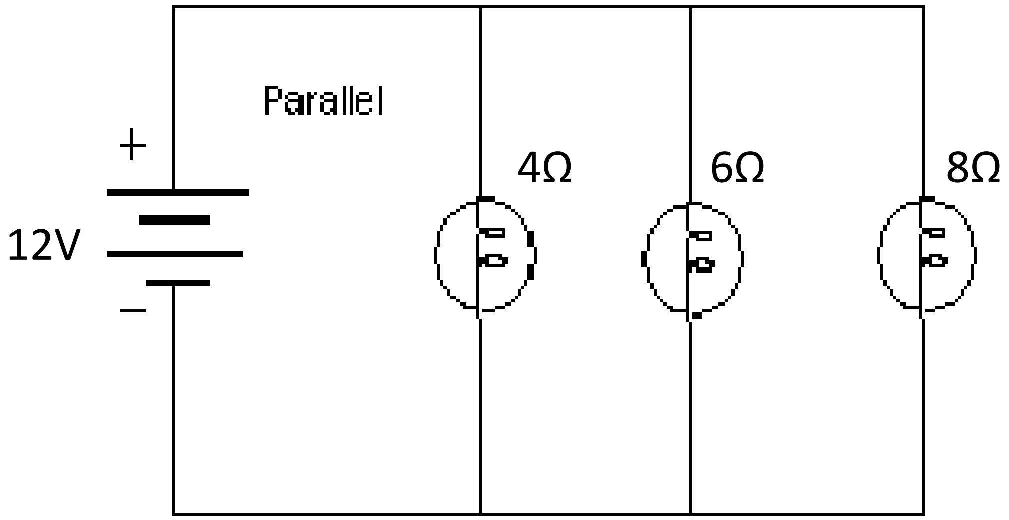
(a)

- $I = I_1 + I_2 + I_3$
- $\frac{V}{R_{eq}} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$
- $\frac{V}{R_{eq}} = V(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3})$
- $\frac{1}{R_{eq}} = (\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3})$

Resistors in Parallel

Determine the following:

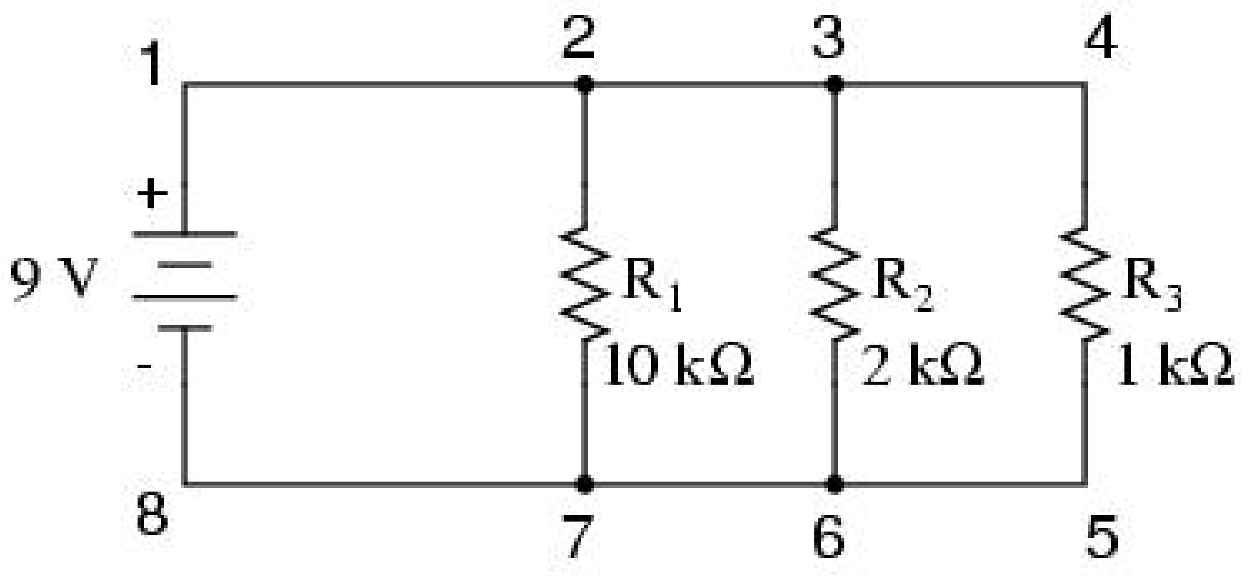
- Equivalent Resistance of the circuit
- Current through the circuit
- Current across each resistor
- Power dissipated by each resistor
- Power dissipated by the entire circuit



Resistors in Parallel

Determine the following:

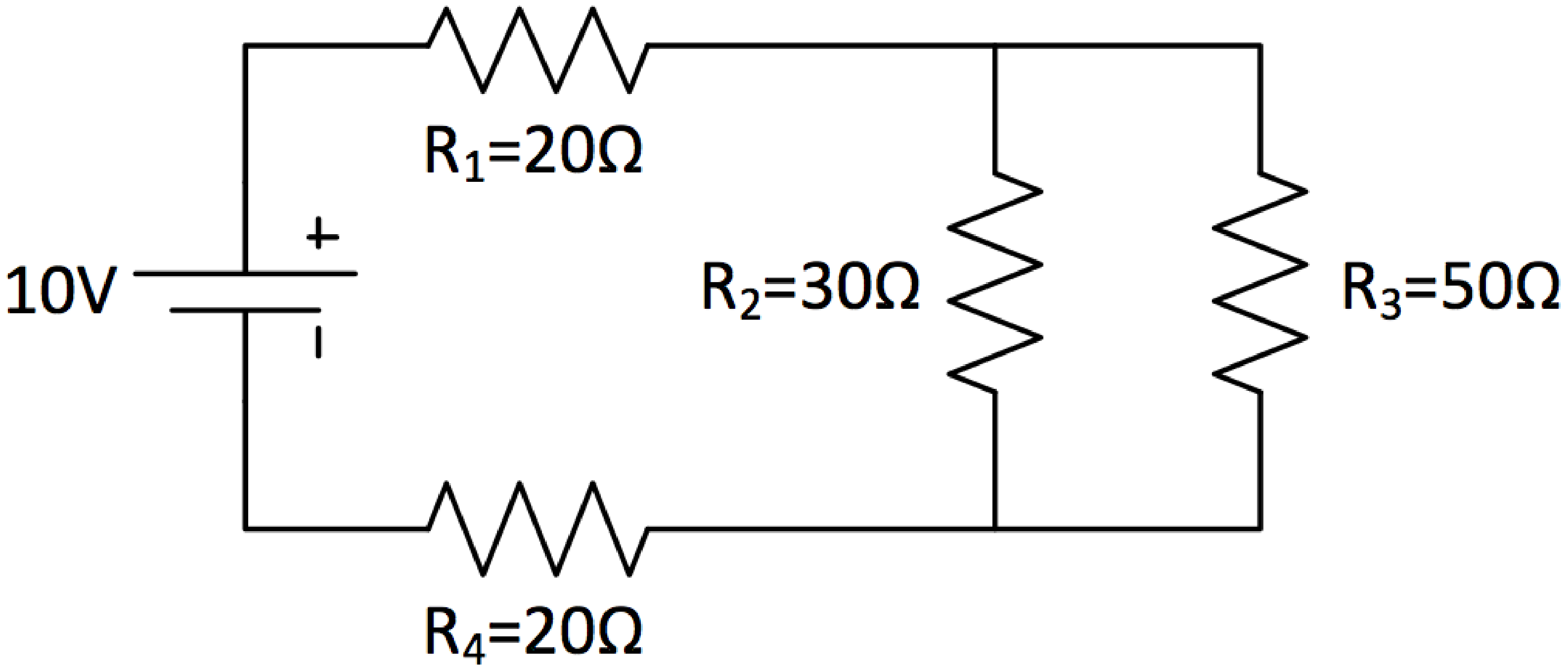
- Equivalent Resistance of the circuit
- Current through the circuit
- Current across each resistor
- Power dissipated by each resistor
- Power dissipated by the entire circuit



Complex Circuits

Determine the following:

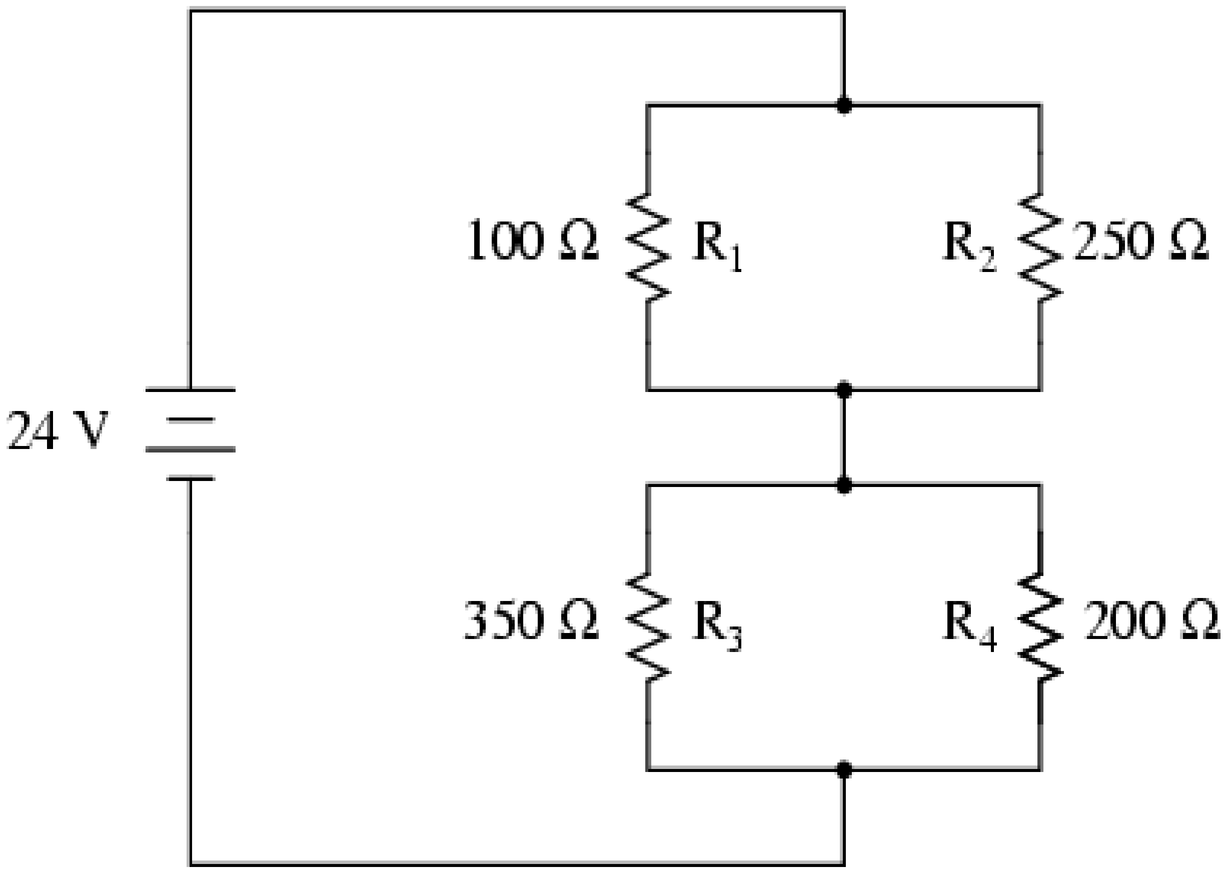
- Equivalent Resistance of the circuit
- Total Current through the circuit
- Current through each resistors
- Voltage Drop across each resistor
- Power dissipate by the entire circuit



Complex Circuits

Determine the following:

- Equivalent Resistance of the circuit
- Total Current through the circuit
- Current through each resistors
- Voltage Drop across each resistor
- Power dissipate by the entire circuit



Complex Circuits

Determine the following:

- Equivalent Resistance of the circuit
- Total Current through the circuit
- Voltage Drop across each resistor
- Power dissipate by the entire circuit