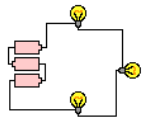
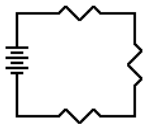
Lesson 8
Simple/Combination Circuits

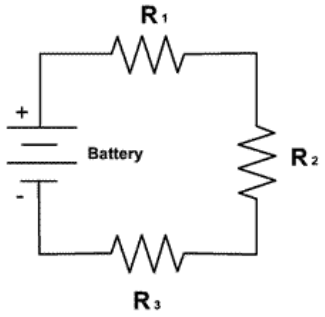
Series Circuit:
Recall that in a series circuit, energy from the source is given to everything in its path.

Drawing of Circuit



Schematic Diagram of Circuit





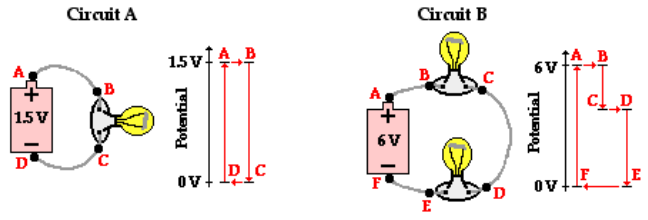
(see p. 593 for circuit symbols)

Set up this circuit and measure the current and voltage at the points indicated.

What do you notice about the currents measured?
What do you notice about the voltages measured?

Conclusions:
In a series circuit,

- Current is the same everywhere
- Total voltage rises equal total voltage drops (as electrons move through an electric circuit, they gain energy in the source and lose energy in the loads, but the total energy gained in one trip is equal to the total energy lost.



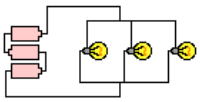
These results form part of Kirchoff's laws (Gustav Kirchoff).

Example:
If the source voltage in a series circuit is 3.0 V and the two bulbs have the same resistance, what is the voltage drop across each bulb?

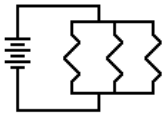
Example:
What is V_2 in the circuit shown?

Parallel Circuit:

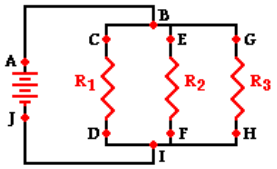
Drawing of Circuit

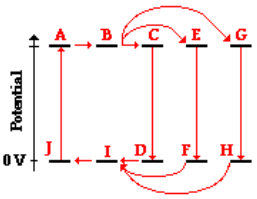


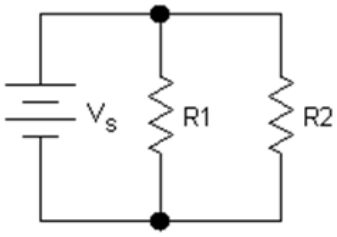
Schematic Diagram of Circuit



In a parallel circuit, electrons do not have to travel through every element in the circuit. Loads are connected side by side rather than along a single path. The diagram below shows that the potential drop is through one resistor only for a charge.







Set up this circuit and measure the current and voltage at the points indicated.

What do you notice about the currents measured?
What do you notice about the voltages measured?

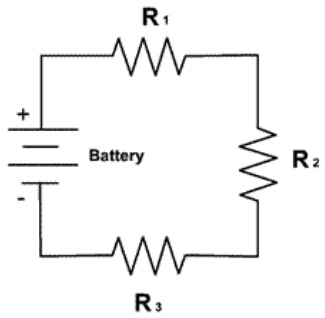
Conclusions:
In a parallel circuit,

- voltage is the same everywhere
- all current entering a junction (node) will equal all current leaving a junction. (charge cannot pile up)

Example:
What is the current I_2 if I_1=2.6 A and I_3=2.1 A?

Total Resistance:
Before we can begin to analyse circuits, we need to know how to find total resistance in a circuit.

Consider the series circuit shown:



What is the total resistance for this circuit?

Remember that in a series circuit, voltage adds up and current is constant.

$$V_T = V_1 + V_2 + V_3$$

using Ohm's law,

$$I_T R_T = I_1 R_1 + I_2 R_2 + I_3 R_3$$

and since I is constant,

$$R_T = R_1 + R_2 + R_3$$

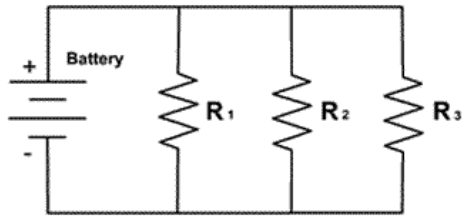
The total resistance in a series circuit is the sum of the individual resistances.

Example:
If the total resistance for a series circuit is 60 Ω, what is R_2 if R_1=25Ω and R_3=15Ω?

Example:
In the diagram shown, what is R_2?

Example:
In the circuit shown, determine R_1, V_1, I_1, I_2, R_3, and I_3.

Consider the parallel circuit shown:



What is the total resistance for this circuit?
Remember that in a parallel circuit, current adds up and voltage is constant.

$$I_T = I_1 + I_2 + I_3$$

using Ohm's law,

$$\frac{V_T}{R_T} = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3}$$

and since V is constant,

$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

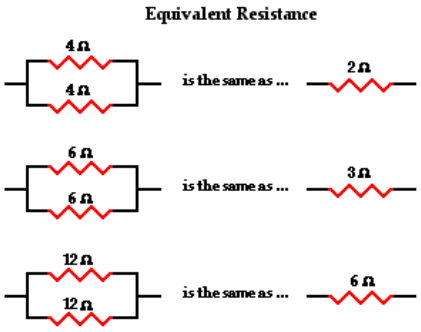
*Note: In a series circuit if one resistor is removed the circuit is broken. If more resistors are added, the total resistance increases (and current decreases). Light bulbs in series would become dimmer as more were added.

In a parallel circuit, if one resistor is removed, the other branches will be unaffected. If more resistors are added, the bulbs maintain a constant brightness. The total resistance decreases (more current is produced to maintain the brightness).

Example:
What is the total resistance in the circuit shown?

When resistors in parallel are identical, the total resistance can be found by dividing the value of one resistor by how many there are:

$$R_{total} = \frac{R_{individual}}{N}$$



Example:
What is the total resistance of ten resistors of 36 Ω each connected in parallel?

Example:
A technician requires a 3.0 Ω resistor for an electronics project. However, all that are available in the supply room are 12.0 Ω resistors. Are these of any use to the technician? Explain.

Example:
What is the total resistance of a 25 Ω, a 5.0 Ω and a 50.0 Ω resistor connected in parallel?

Example:
The total resistance of four resistors connected in parallel is 2.0 Ω. The values of the other resistors are 24 Ω, 4.0 Ω and 12 Ω. What is the value of the fourth resistor?

Combination Circuits:
These consist of both series and parallel portions.

Recall:

	Series Circuit	Parallel Circuit
Current	**Constant**	**Adds up**
Voltage	**Adds up**	**Constant**

Example:
In the circuit shown below, find I_T, I_1, I_2, I_3, I_4, I_5, V_1, V_2, V_3, V_4, and V_5.

Example:
In the circuit shown below, find I_1, I_2, I_3, V_1, V_2, V_3.

Example:
What is V_1 in the circuit shown?

Example:
A 6.0 V battery is set up in a circuit. All of the current passes through a 6.0 Ω resistor and then splits between two branches, one of which has a 2.0 Ω resistor and the other a 4.0 Ω resistor. Determine the total resistance and the current and voltage in each resistor.

Example:
In the circuit shown calculate:

a) the voltage across the 6.0 Ω resistor.
b) The current through the 5.0 Ω resistor.
c) The power dissipated in the 2.0 Ω resistor.
d) Will a 5.0 A fuse placed after the 6.0 Ω resistor blow?