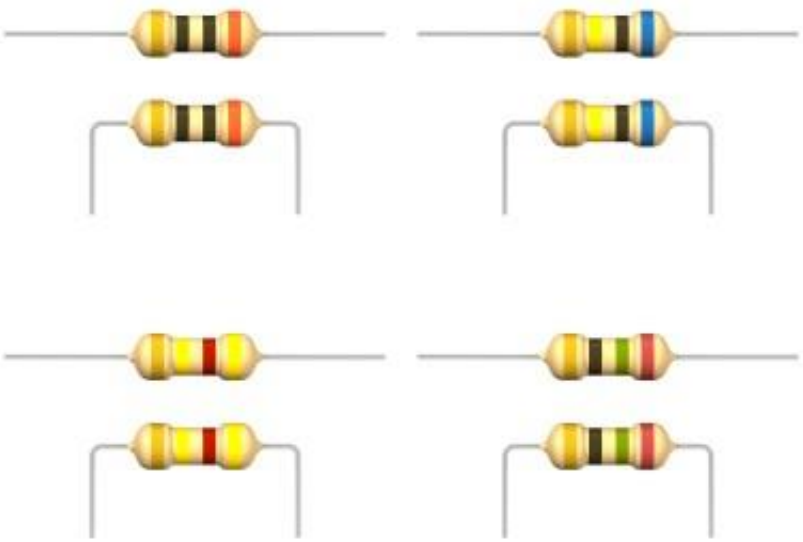
16.2
Electrical Resistance



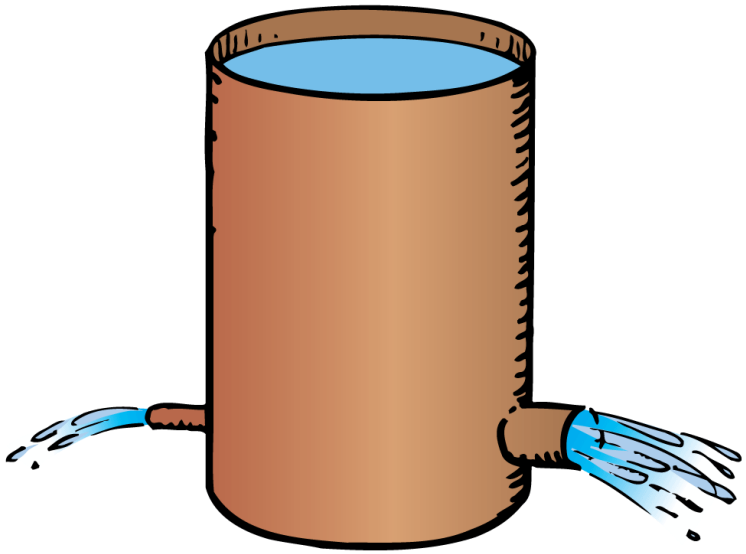
Electrical Resistance

- The amount of charge that flows in a circuit depends on the voltage provided by the voltage source.
- The current also depends on the resistance that the conductor offers to the flow of charge—the electric resistance.
- This is similar to the rate of water flow in a pipe, which depends on the pressure difference and on the resistance of the pipe.

Electrical Resistance

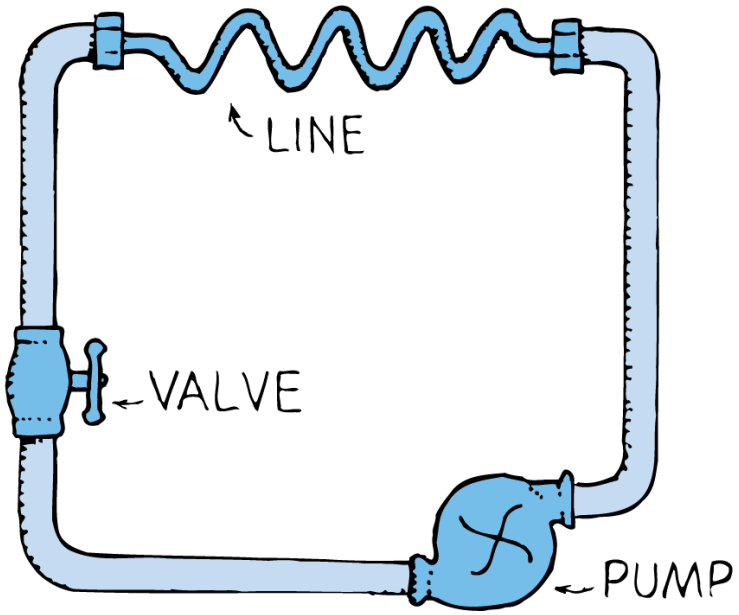
For a given pressure, more water passes through a large pipe than a small one.

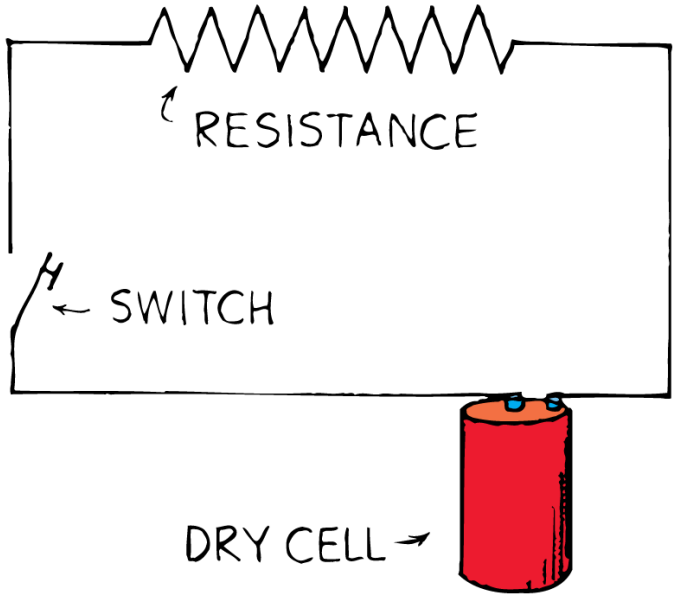
Similarly, for a given voltage, more electric current passes through a large-diameter wire than a small-diameter one.



Electrical Resistance

A simple hydraulic circuit is analogous to an electric circuit.





Electrical Resistance

The resistance of a wire depends on the conductivity of the material in the wire and on the thickness and length of the wire.

- Thick wires have less resistance than thin wires.
- Longer wires have more resistance than short wires.
- Electric resistance also depends on temperature. For most conductors, increased temperature means increased resistance.

Electrical Resistivity

Materials ability to resist the flow of electric charge is known as resistivity (ρ).

- **Units: Ω·m (Ohm's · meter)**

Resistivities at 20°C	
Material	**Resistivity (Ω•m)**
Aluminum	2.82×10^{-8}
Copper	1.72×10^{-8}
Gold	2.44×10^{-8}
Nichrome	$150. \times 10^{-8}$
Silver	1.59×10^{-8}
Tungsten	5.60×10^{-8}

Electrical Resistance

An objects ability to resist the flow of charge depends on both its shape and resistivity.

Formula: $R = \rho \cdot L/A$

Units for resistance: Ω (Ohm's)

R = Resistance (Ω)
L = length (m)
A = area (m^2)

Resistance Assessment Questions

Example #1

A 3.5 meter length of wire with a cross-sectional area of 3.14 x 10^{-6} m^2 at 20° C has a resistance of 0.0625 Ω. Determine the resistivity of the wire.

Resistance Assessment Questions

Example #2

The electrical resistance of a metallic conductor is inversely proportional to its:

a. Temperature
b. Length
c. Cross-sectional area
d. Resistivity

Resistance Assessment Questions

Example #3

A copper wire is 20 m long and has a 0.254 m diameter. Compute its resistance.

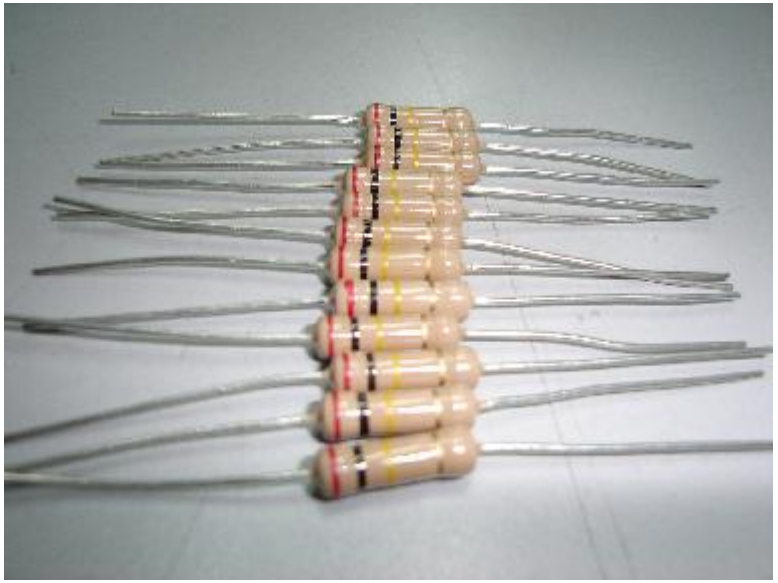
Resistance Assessment Questions

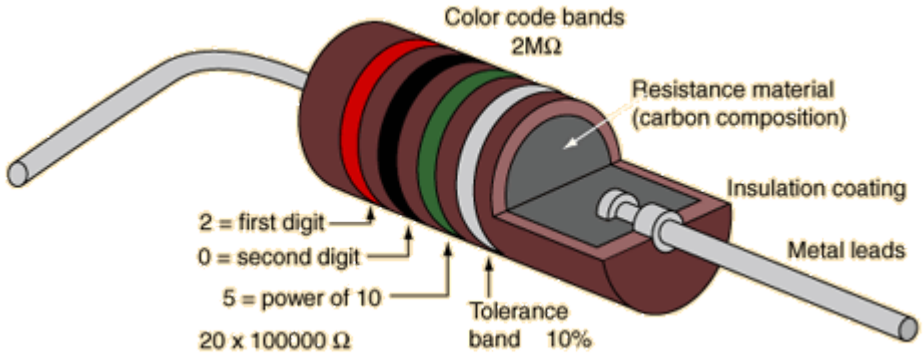
Example #4

A 5 Ω resistor is made from Nichrome wire 1 mm in diameter. What length of wire is required?

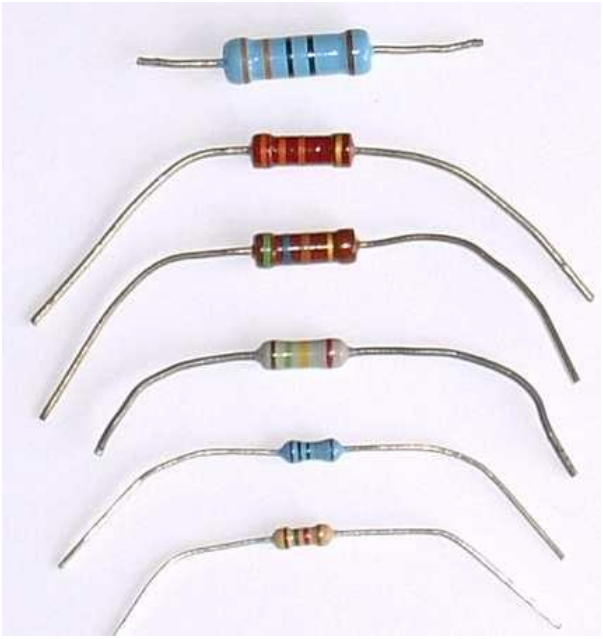
Resistor Color Codes

Color coding is a system of marking the resistance of a resistor. It consists of different colored bands that are used to figure out the resistance in ohms.

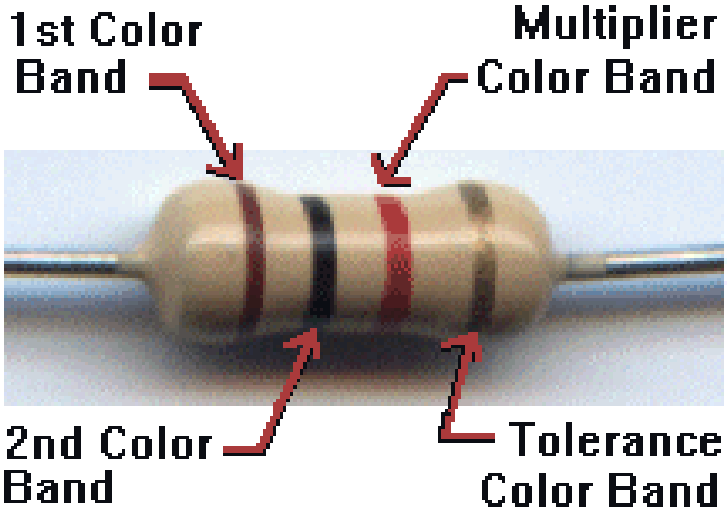




Resistor Color Codes



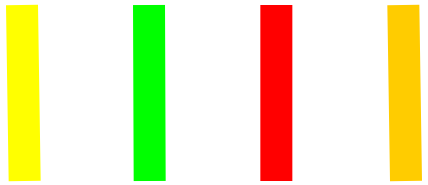
Resistor Color Codes



- The first two or three bands correspond to a two or three-digit number. Each color corresponds to a particular digit that corresponds to a color chart.
- The third or fourth band is called the multiplier band. This is the power of ten to be multiplied by your two-digit number.
- The last band is called the tolerance band. It gives you an error range for the labeled resistance.

Resistor Color Example

A resistor color code has these color bands:
Calculate its resistance and tolerance:



(yellow, green, red, gold)

1. Look up the corresponding numbers for the first three colors:

Yellow = 4, Green = 5, Red = 2

2. Combine the first two digits and use the multiplier:

$45 \times 10^2 = 4500$

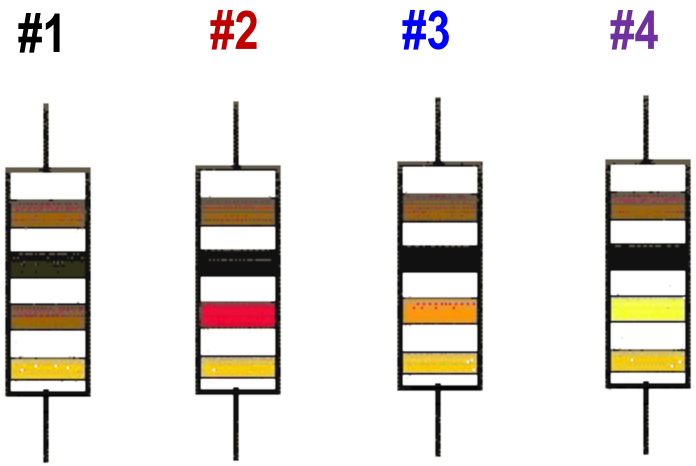
3. Find the tolerance corresponding to gold and calculate the maximum error:

Gold = 5% and 0.05 (4500) = 225

So, the resistance is 4500 Ω ± 225 Ω

Resistor Color Example

Calculate only the resistance of each resister:



#1: 100 Ω

#2: 1,000 Ω or 1K Ω

#3: 10,000 Ω or 10K Ω

#4: 100,000 Ω or 100K Ω

Resistor Color Example

Calculate the following for resistance and tolerance:

(red, brown, green, gold)

2,100,000 Ω +/- 105,000 Ω

(brown, black, blue, gold)

10,000,000 Ω +/- 500,000 Ω