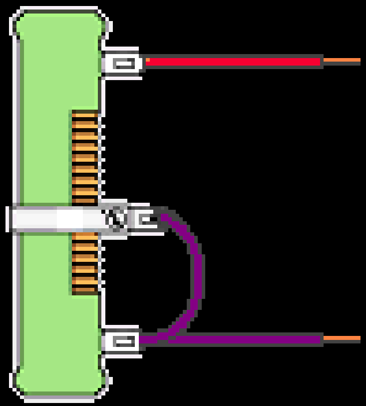
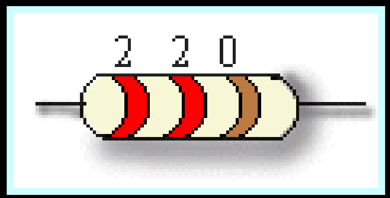
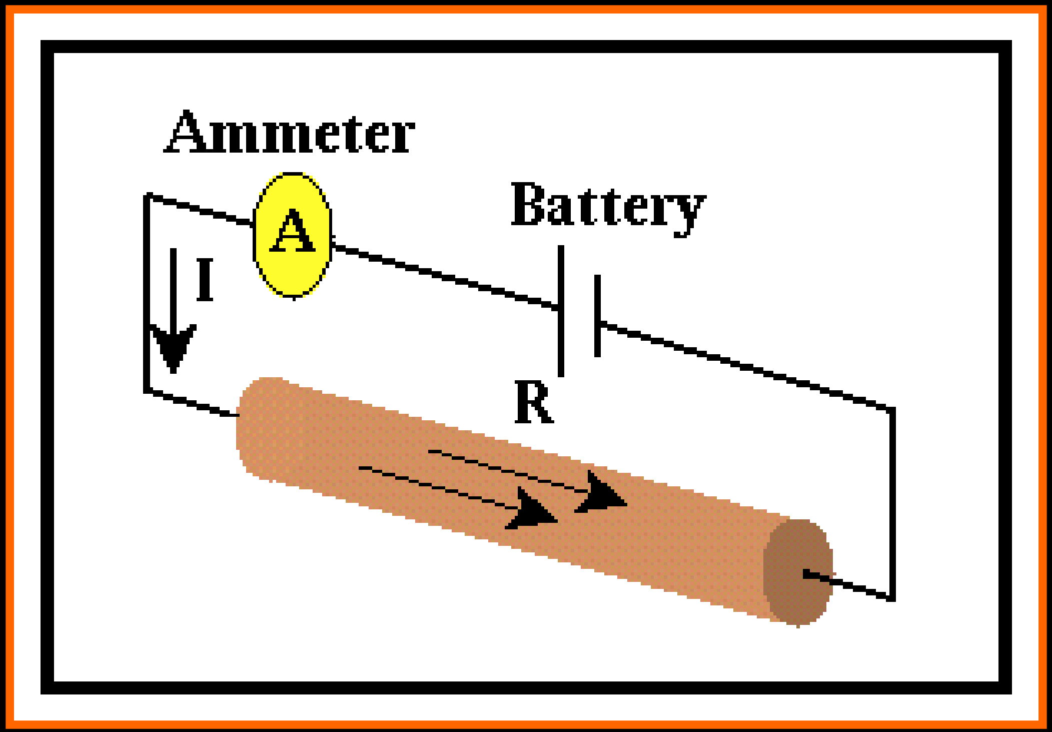
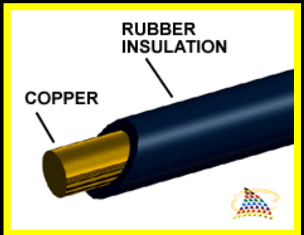



2 2 0

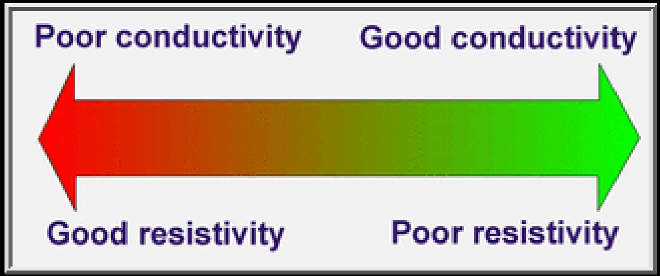

Ammeter
A
Battery
I
R

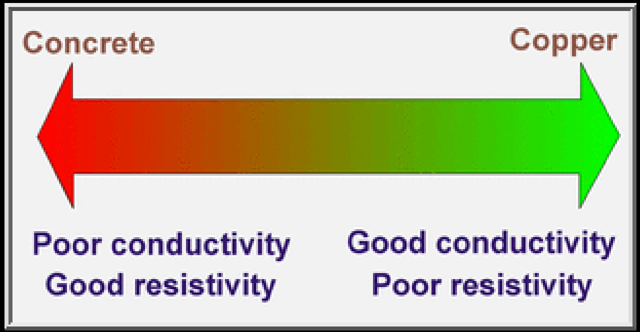


Resistivity, what is it?

Resistivity is the opposite of conductivity, it's a measure of how effectively a material slows down the flow of electricity.

Insulators have a high resistivity rating. Materials such as metals and other conductors have a low resistivity rating.



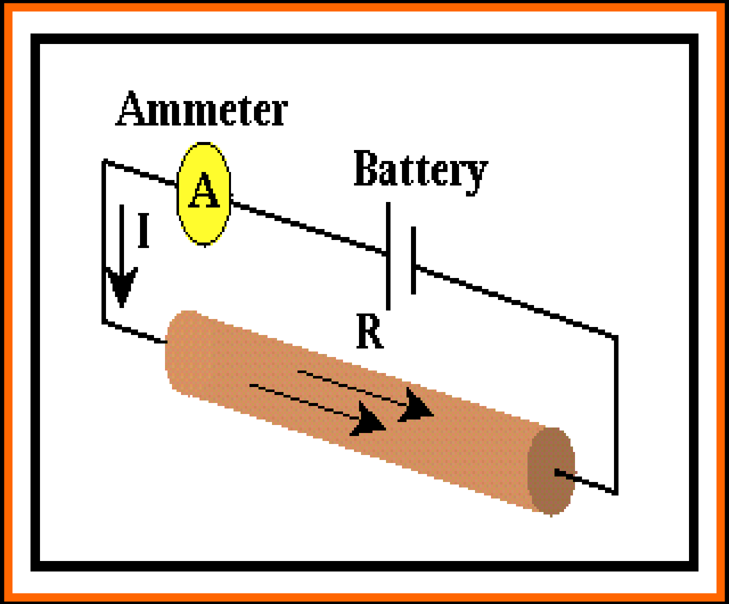


- A conductor's **Resistance** is defined as the ratio of the **Applied Voltage** to the **Current produced.**

$$R = V/I$$

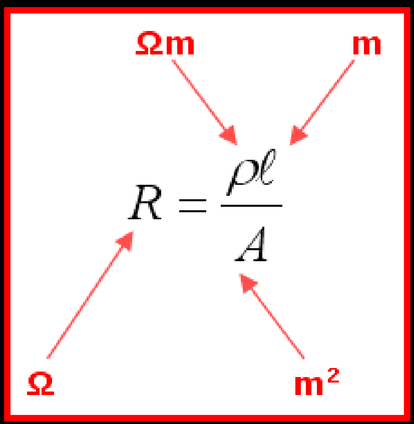
- **Scalar**
- **Units: Ohm** $[\Omega] = [V/A]$

- Resistance can be calculated for any object.
  - Good conductor – low resistance
  - Poor conductor –high resistance
- All circuit elements have some resistance. The resistance of connecting wire leads is considered negligible.



Resistance

- ***The geometry of the resistor matters***



$$R = \rho \frac{L}{A}$$

Length

Area

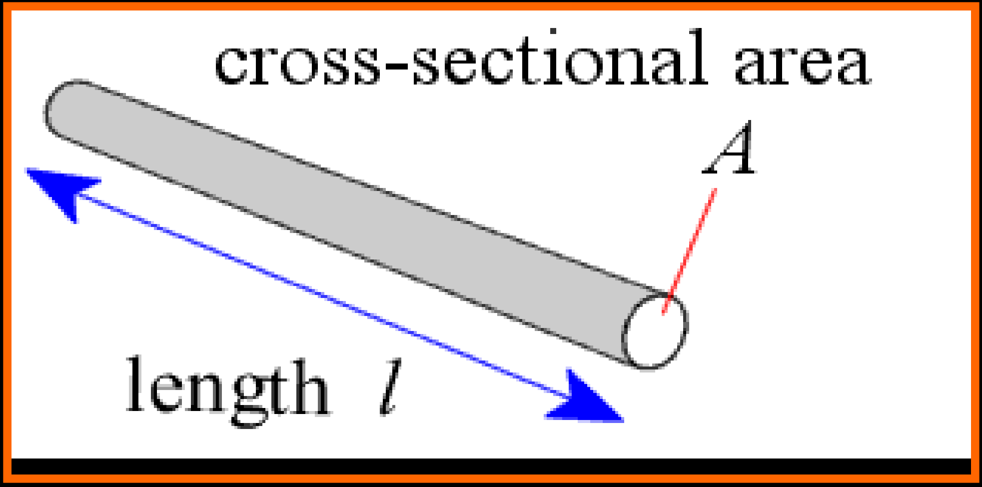
Resistivity: (units Ω·m)

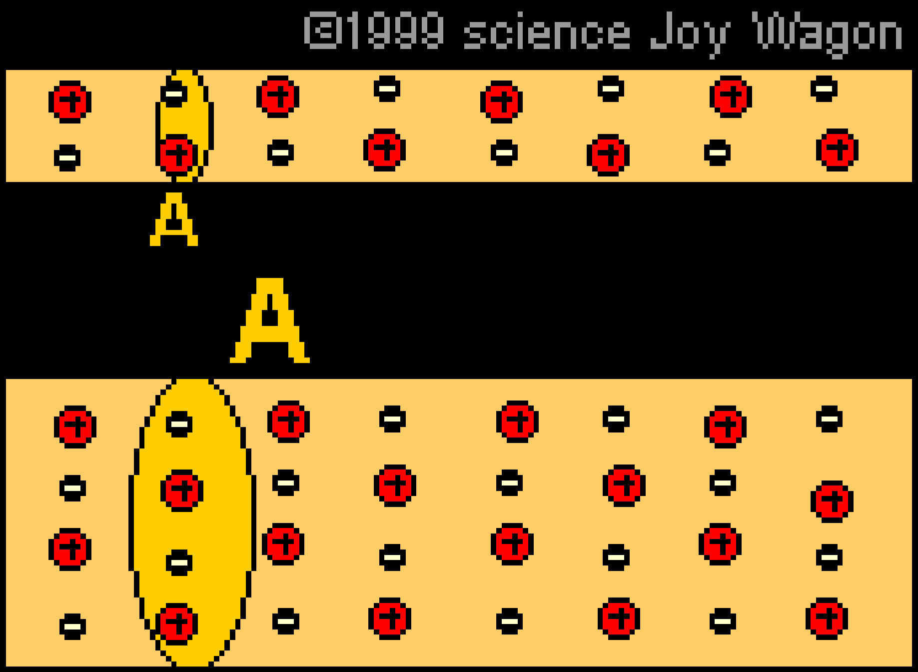
- ***Increase the Length, flow of electrons impeded***
- ***Increase the cross-sectional Area, flow enhanced***

For a wire of length l and cross-sectional area A the resistance R:

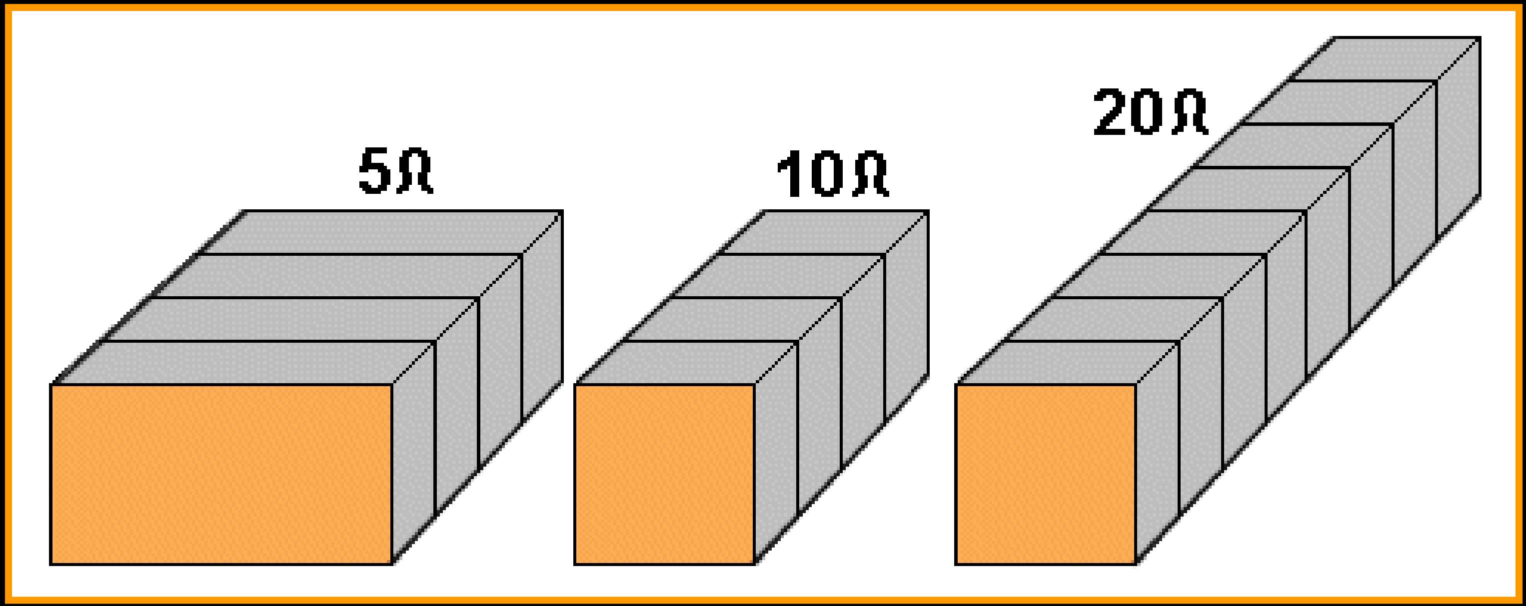
- ***Is proportional to l***
- ***And inversely proportional to A***
- ***The constant ρ (rho)***
- ***Is known as the resistivity.***

$$R = \rho \frac{l}{A}$$

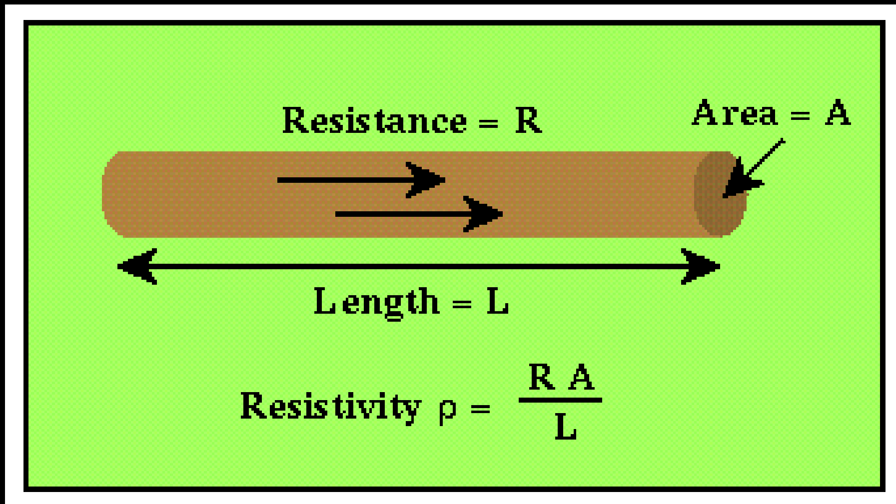




Increasing the cross-sectional area increases the number of available electrons.

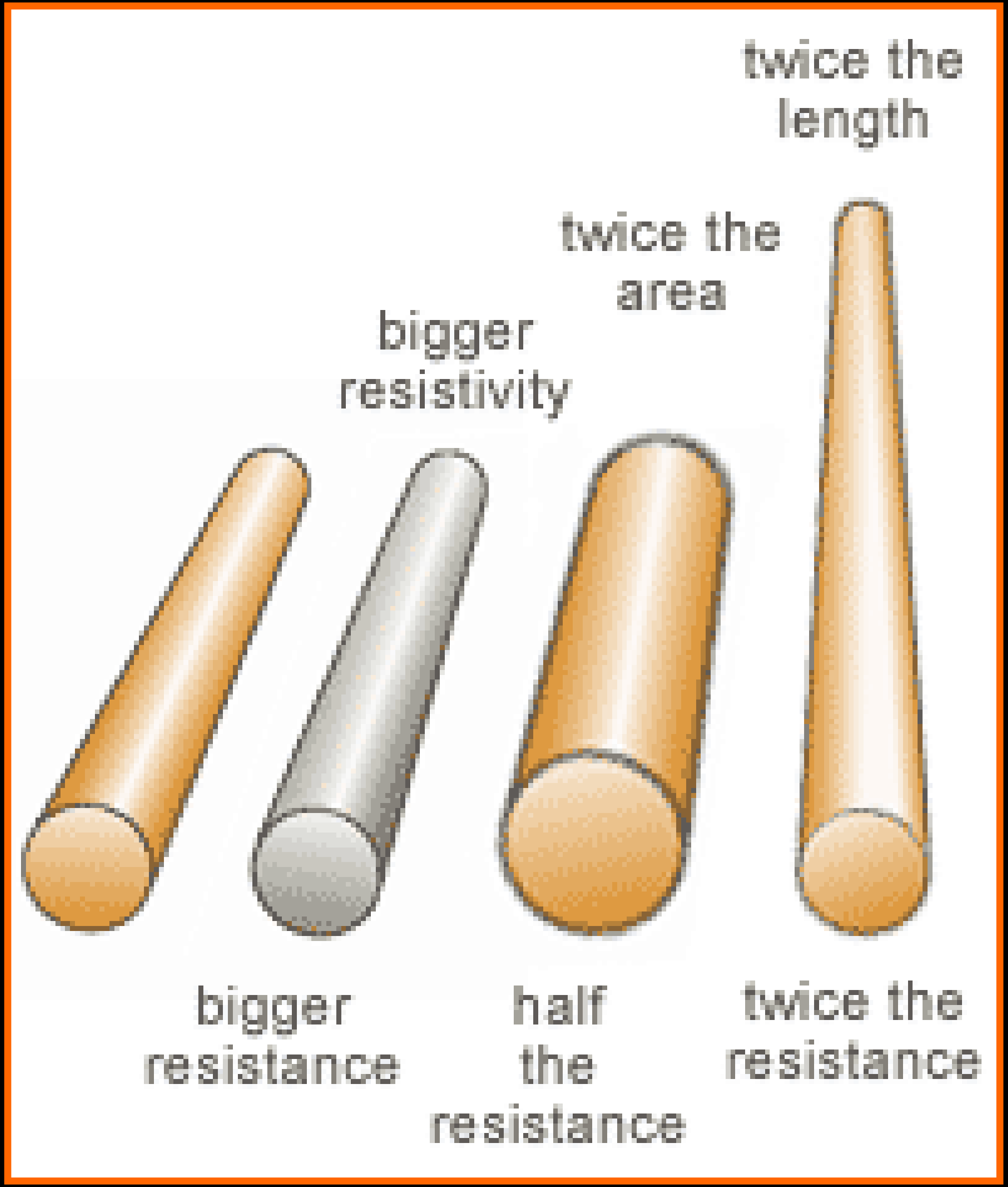

5Ω
10Ω
20Ω

Resistivity



$$R = \rho \frac{l}{A}$$

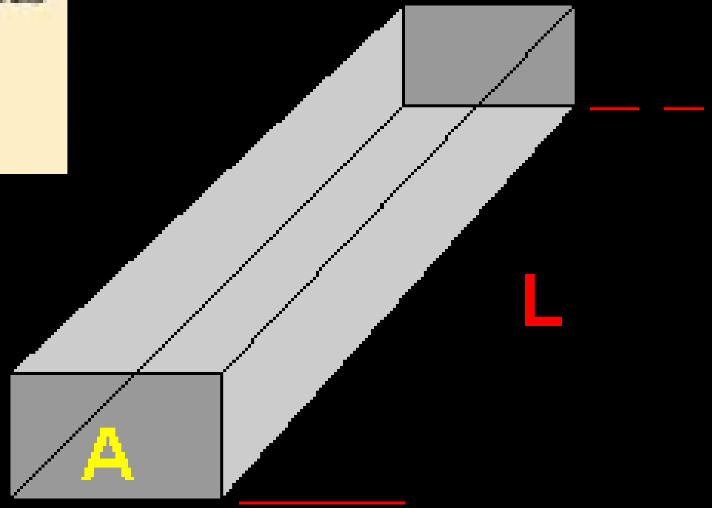
Resistivity has units of Ohm· metres (Ω· m)

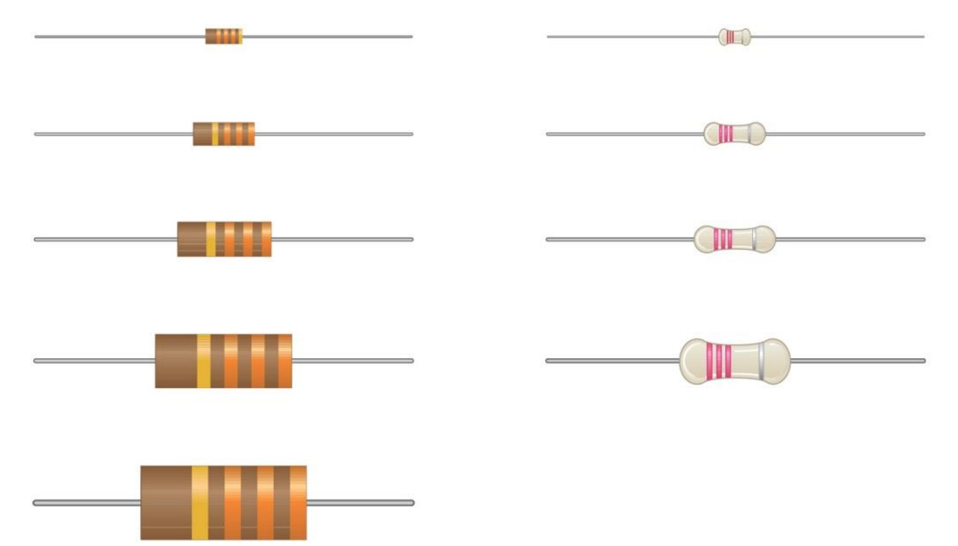


twice the length
twice the area
bigger resistivity
bigger resistance
half the resistance
twice the resistance

Resistivities and Temperature Coefficients of Resistivity for Various Materials (at 20°C)

Material	Resistivity ($\Omega \cdot m$)
Silver	1.59×10^{-8}
Copper	1.7×10^{-8}
Gold	2.44×10^{-8}
Aluminum	2.82×10^{-8}
Tungsten	5.6×10^{-8}
Iron	10.0×10^{-8}
Platinum	11×10^{-8}
Lead	22×10^{-8}
Nichrome*	150×10^{-8}
Carbon	3.5×10^{5}
Germanium	0.46
Silicon	640
Glass	$10^{10}-10^{14}$
Hard rubber	$\approx 10^{13}$
Sulfur	10^{15}
Quartz (fused)	75×10^{16}



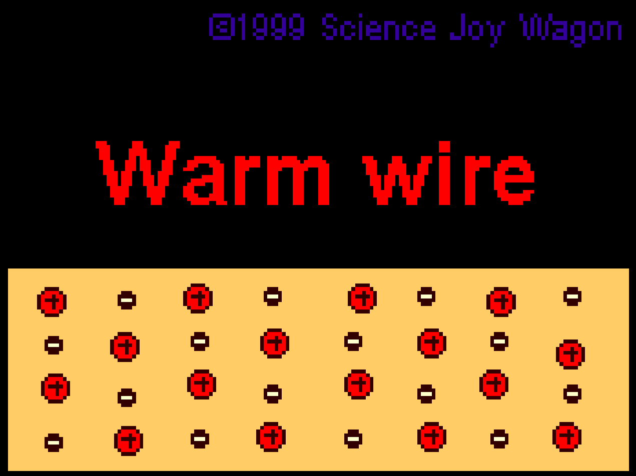


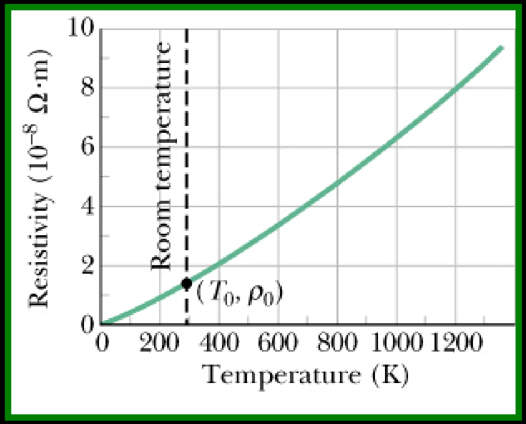
(a) Carbon-composition

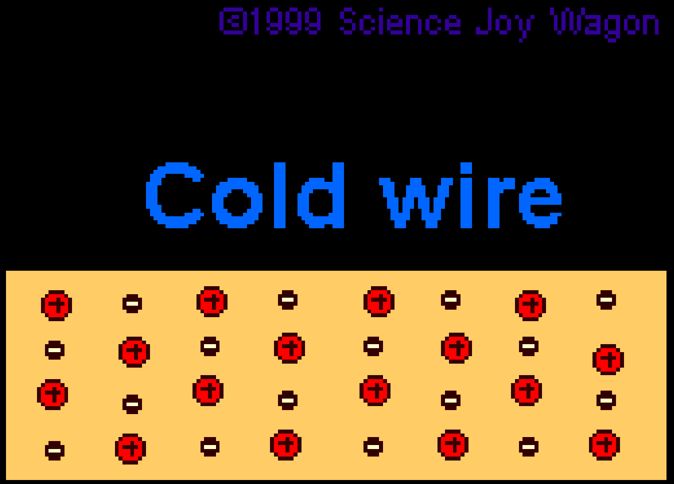
(b) Metal film

Resistivity and temperature.

The resistance and resistivity changes with temperature, therefore resistivity at quoted at a specific temperature







The resistance is proportional to the length l and inversely proportional to the cross-sectional area A, the material the conductor is made from, and the temperature.

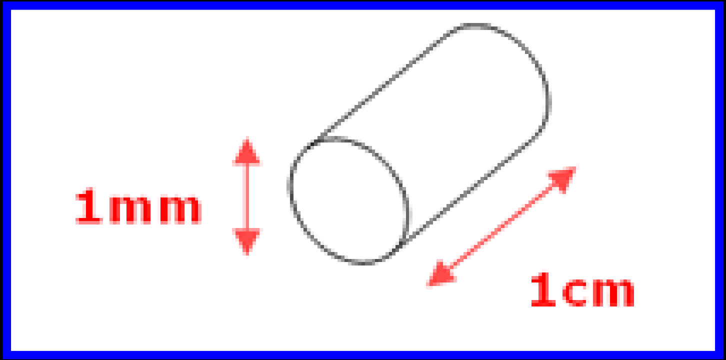
Superconductivity

- Below a certain critical temperature,

Resistance becomes ZERO, allowing current to exist without energy wasted.

Superconductivity, although predicted and discovered a century ago has only become useful recently due to the development of rare-earth conductive ceramics. Superconductive wires are used in the electromagnets of MRI machines.

Find the resistance of a piece of copper with a diameter of 1 mm and a length of 1 cm



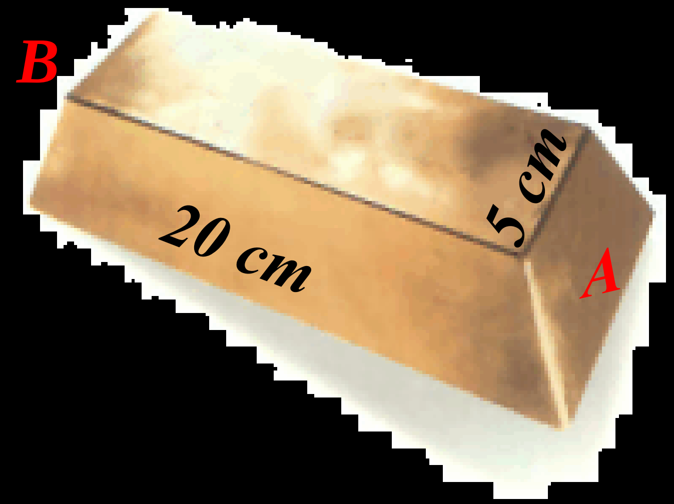
$$R = \rho \frac{l}{A} = \frac{(3 \text{ x } 10^{-8})(1 \text{ x } 10^{-2})}{(\pi \cdot (.5 \text{ x } 10^{-3})^2} = \frac{12}{\pi} \text{ x } 10^{-4} \Omega$$

Bolbo the gold broker from Baghdad has just received a gold bullion bar for his birthday from his brother Bob. The face of the bar is 5 cm on both sides, and the length is 20 cm. The resistance between faces A and B is measured to be 0.8 micro-ohms. Bolbo the broker assumes that the bullion is gold if the measured resistance is within +/- 10% of the theoretical value. Is the material gold or is it bogus?

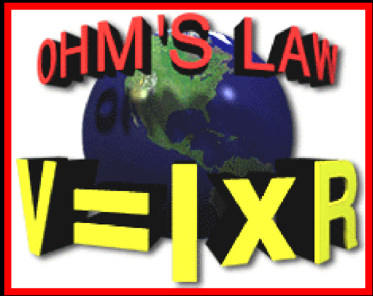
$$R = \rho L / A$$

$$= (2.4x10^{-8}\,\Omega \cdot m)(.2m) / .05^2\, m^2)$$

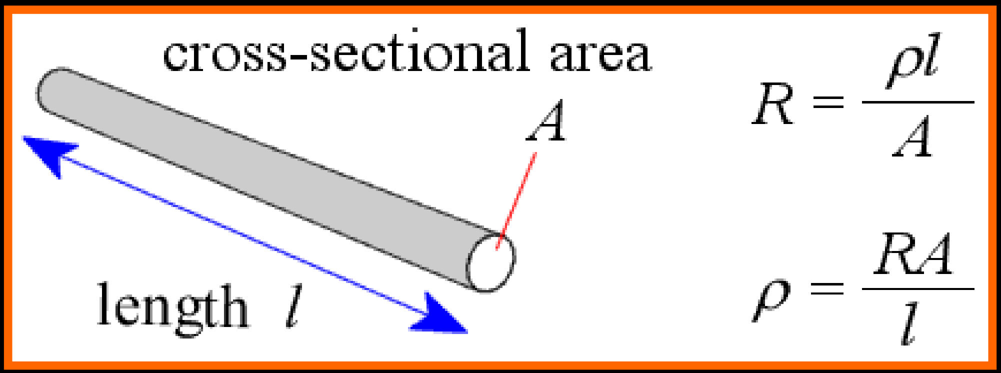
$$= 1.92x10^{-6}\,\Omega$$

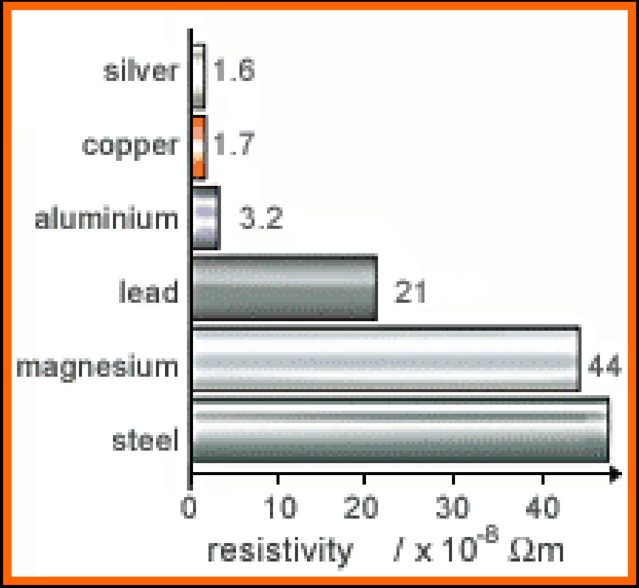


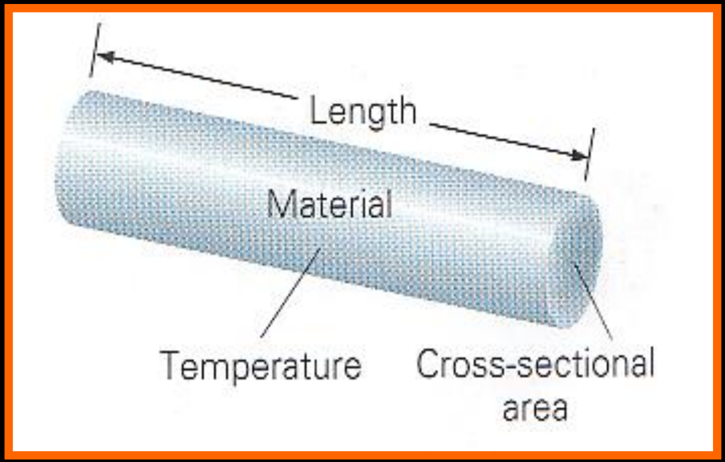
=1.92 uΩ don't try to cash it in!

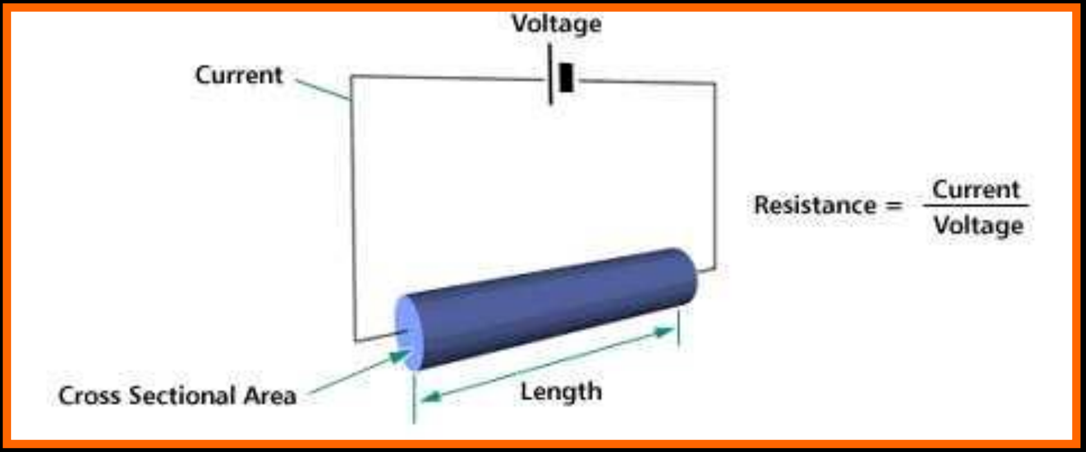

OHM'S LAW
V=IXR

Summary


cross-sectional area
A
length l
$R = \frac{\rho l}{A}$
$\rho = \frac{RA}{l}$


silver
1.6
copper
1.7
aluminium
3.2
lead
21
magnesium
44
steel
0
10
20
30
40
resistivity / x 10^{-8} Ωm


Length
Material
Temperature
Cross-sectional area


Voltage
Current
Resistance = Current / Voltage
Cross Sectional Area
Length