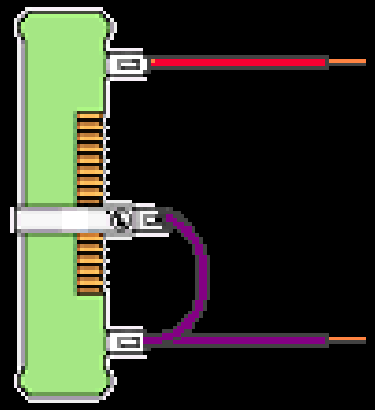

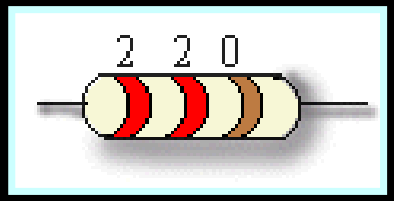
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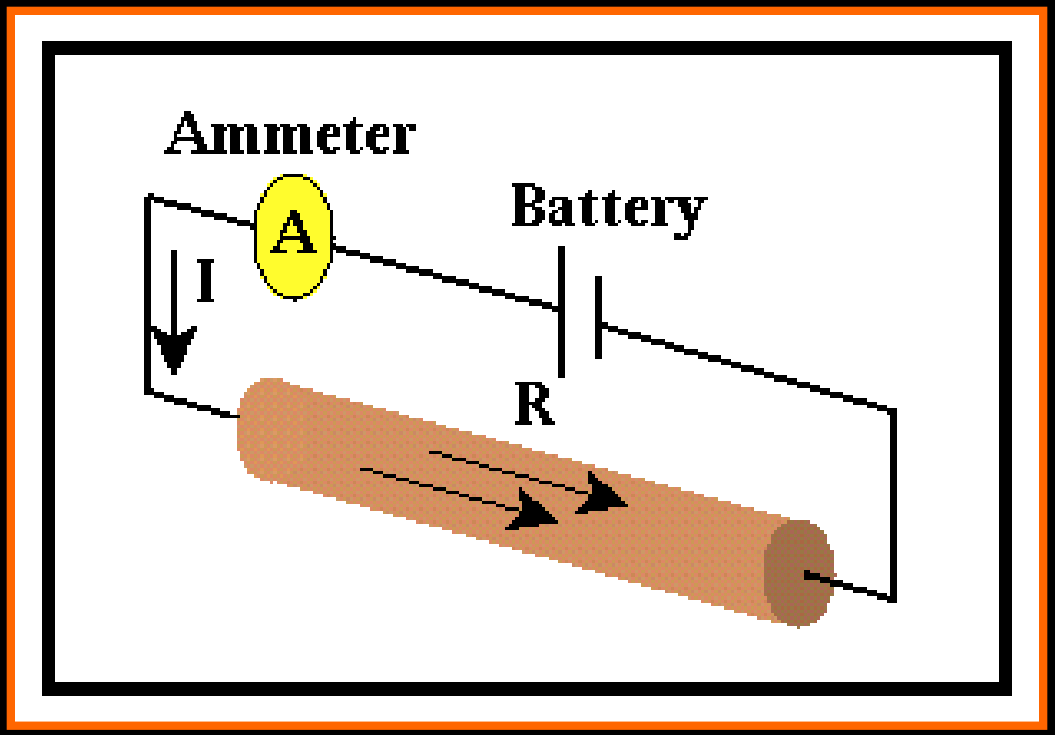
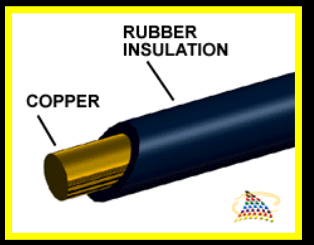
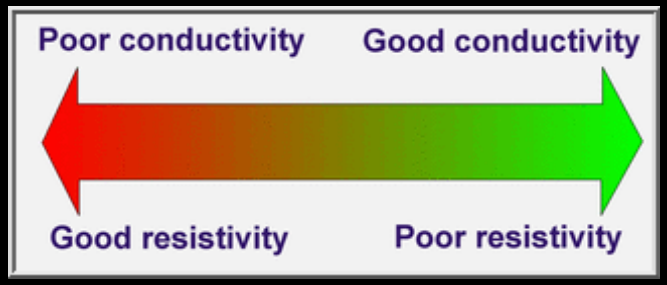

Ammeter
A
Battery
I
R

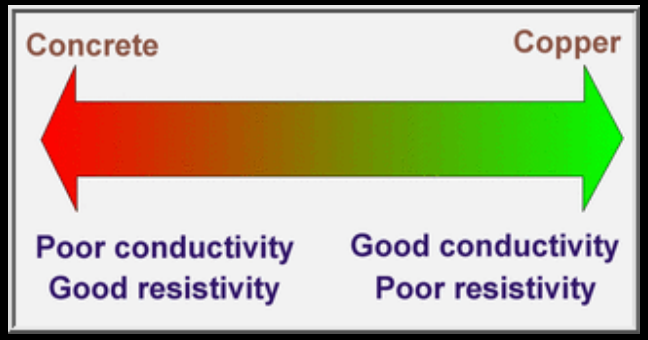


Resistivity, what is it?

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.





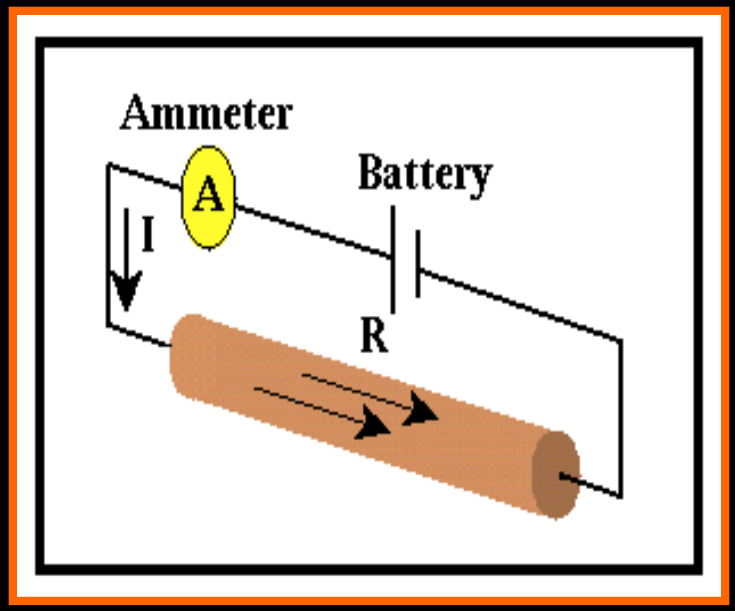
- A conductor's **Resistance** is defined as the ratio of the **Applied Voltage** to the **Current produced.**

$$R = V/I$$

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

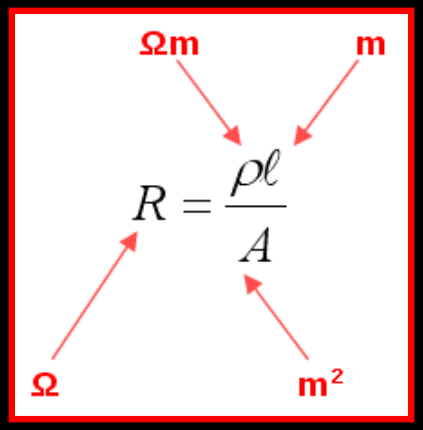
- Resistance can be calculated for any object.
  - Good conductor – low resistance
  - Poor conductor –high resistance
- All circuit elements have some resistance.

The resistance of connecting wire leads is considered negligible.



Resistance

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



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

Length ← L

Area ← A

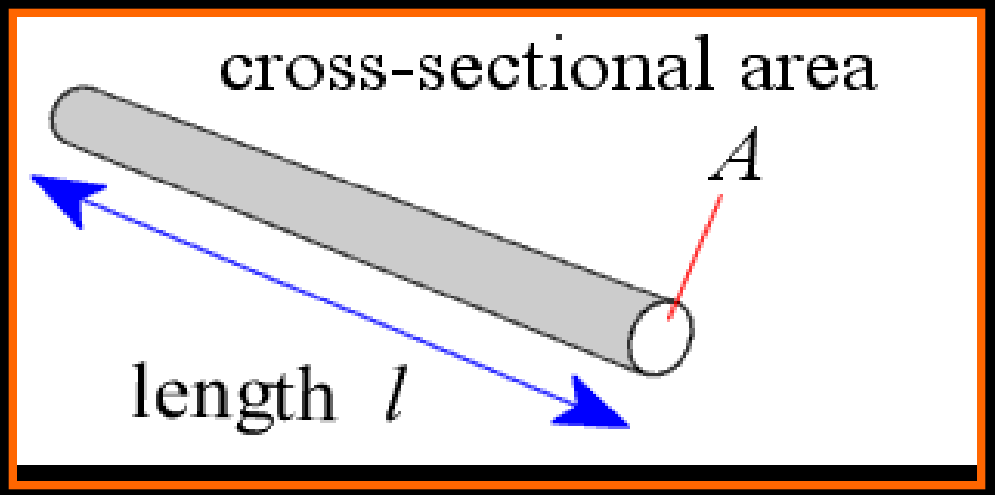
Resistivity: (units Ω·m)

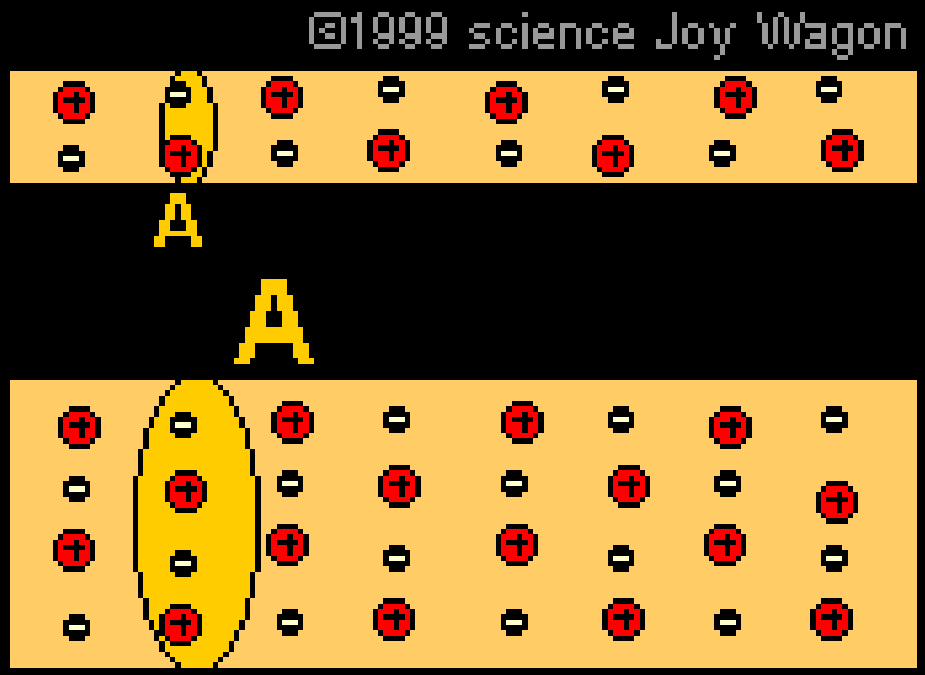
- ***Increase the Length, flow of electrons impeded***
- ***Increase the cross-sectional Area, flow enhanced***

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

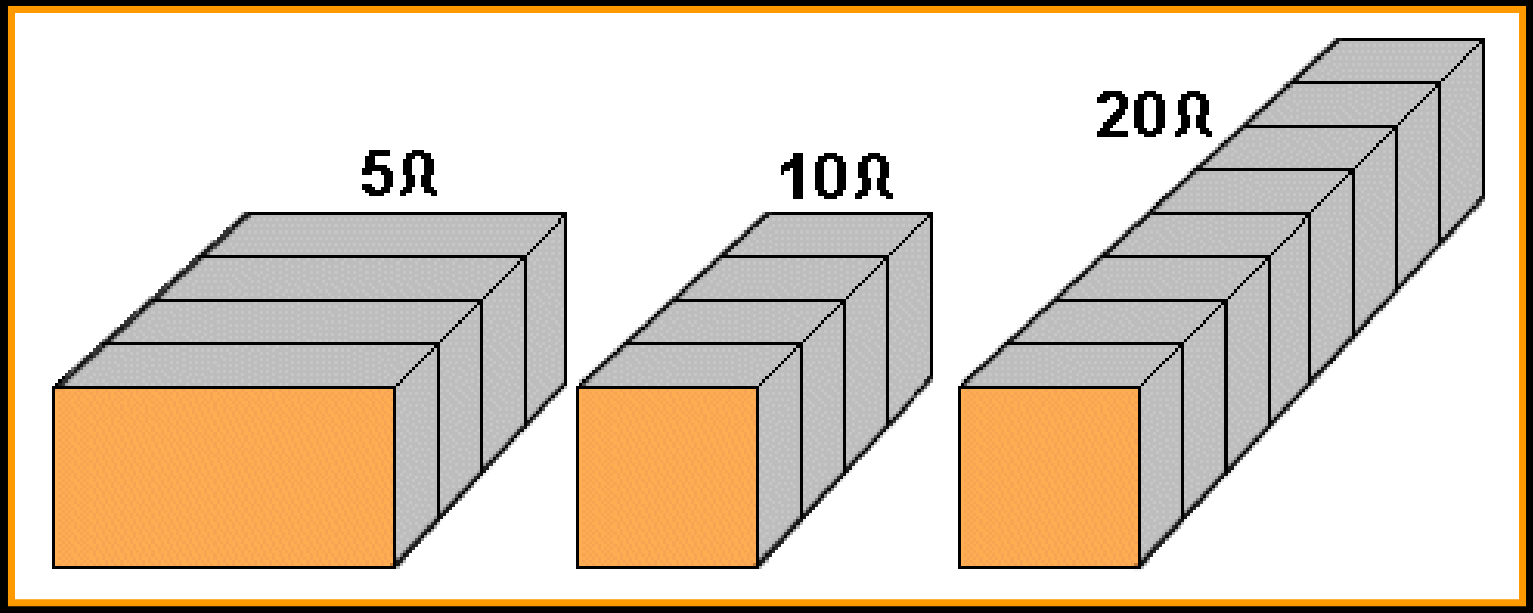
- ***Is proportional to l***
- ***And inversely proportional to A***
- ***The constant ρ (rho)***
- ***Is known as the resistivity.***

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

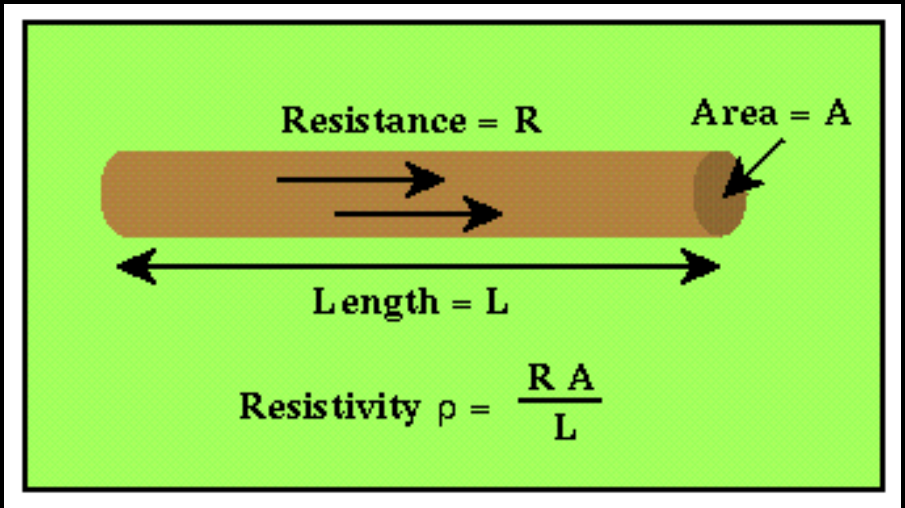




Increasing the cross-sectional area
increases the number of available electrons.

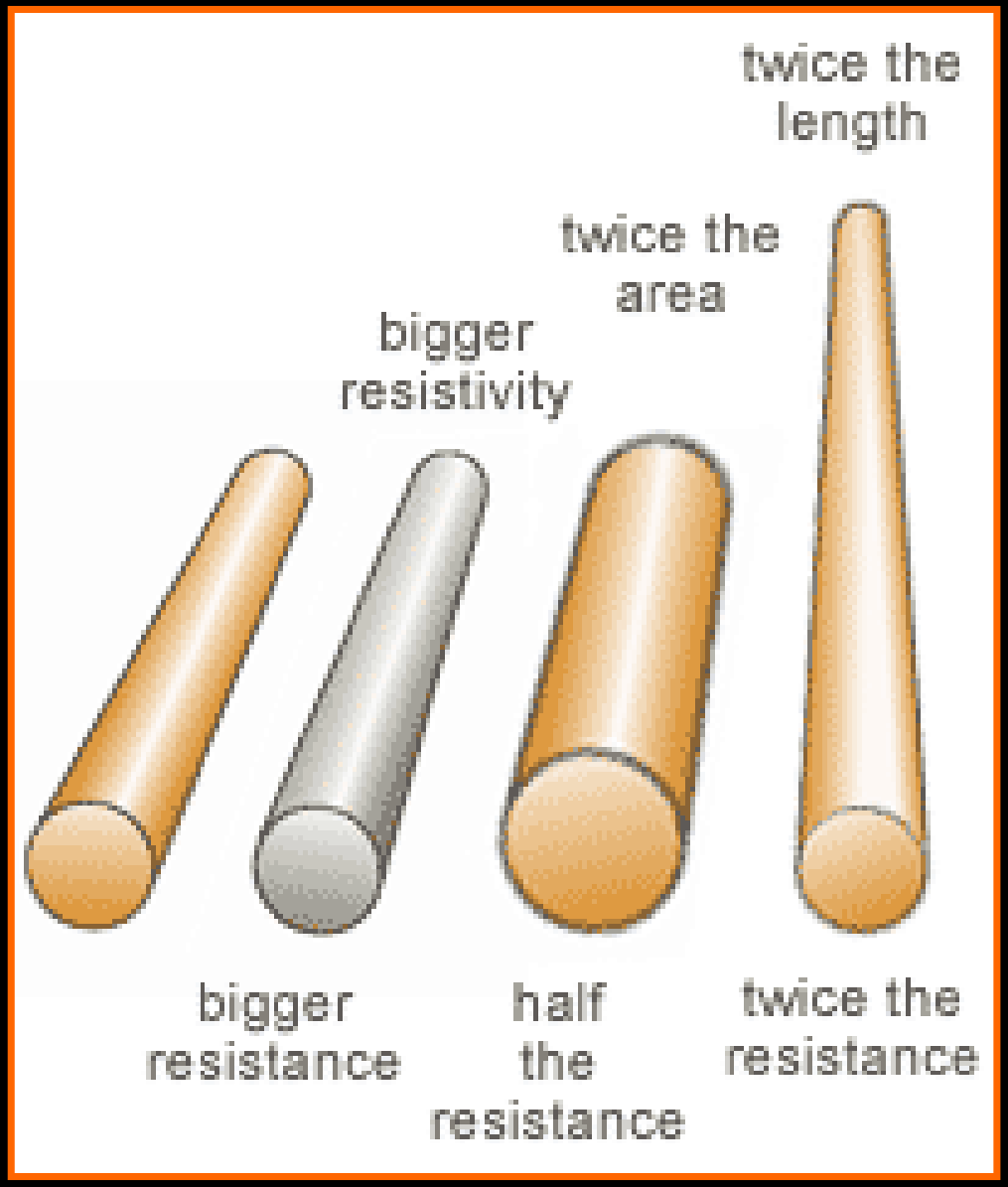

5Ω
10Ω
20Ω

Resistivity



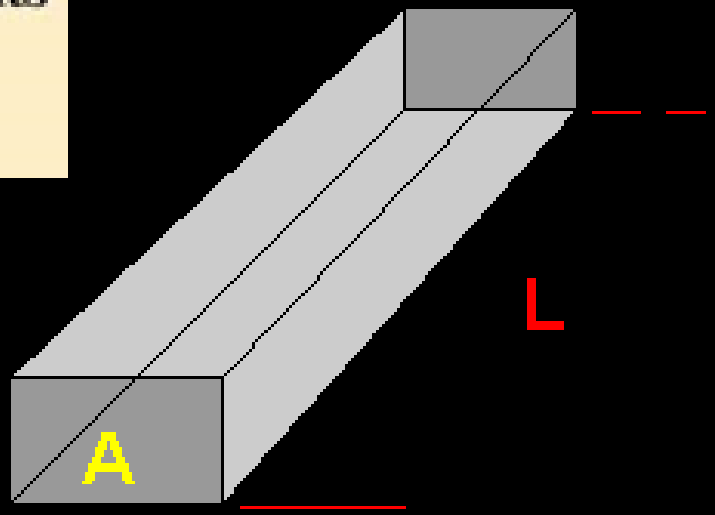
$$R = \rho \frac{l}{A}$$

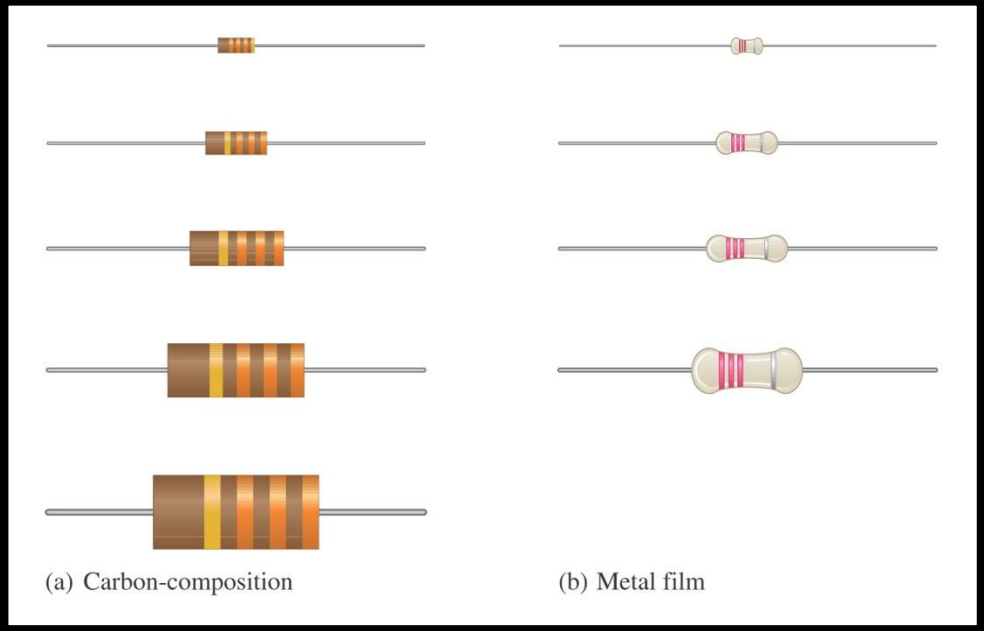
Resistivity has units of Ohm · metres ($\Omega \cdot m$)


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}

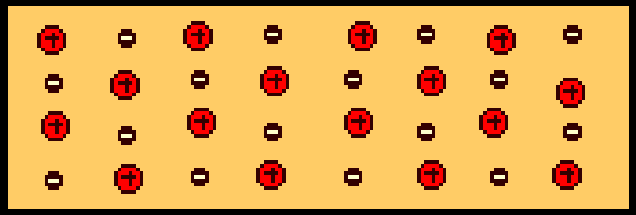


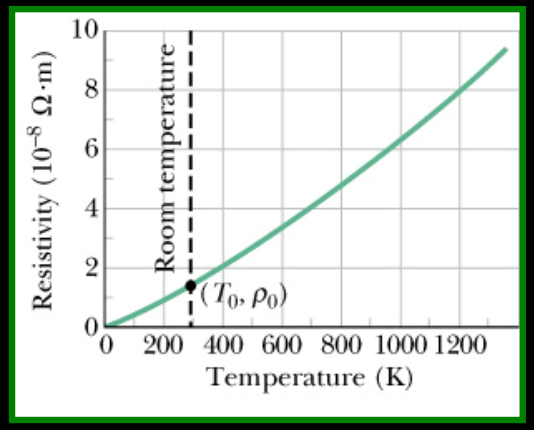


Resistivity and temperature.

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

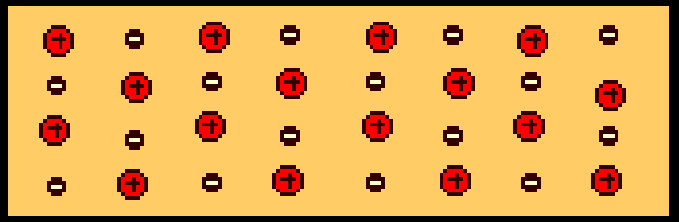
Warm wire





©1999 Science Joy Wagon

Cold wire



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.

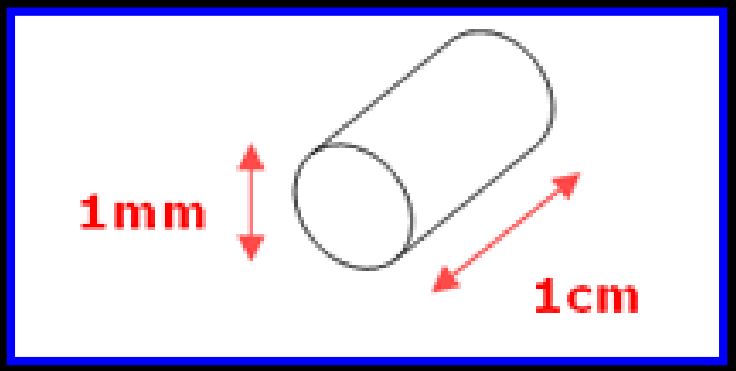
Superconductivity

- 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.

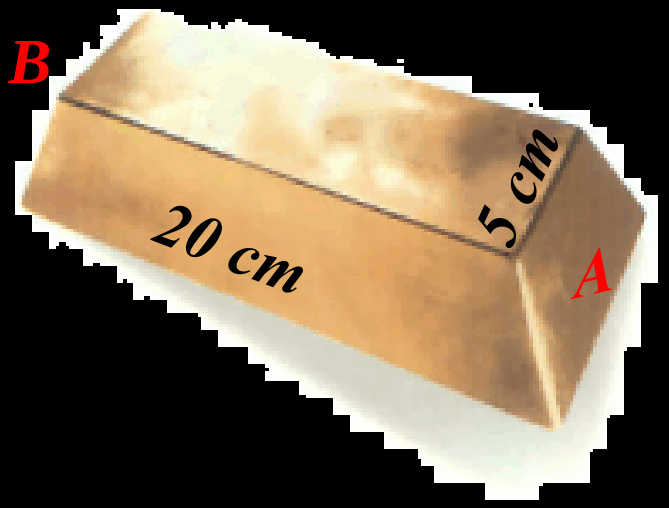
Find the resistance of a piece of copper with a diameter of 1 mm and a length of 1 cm



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

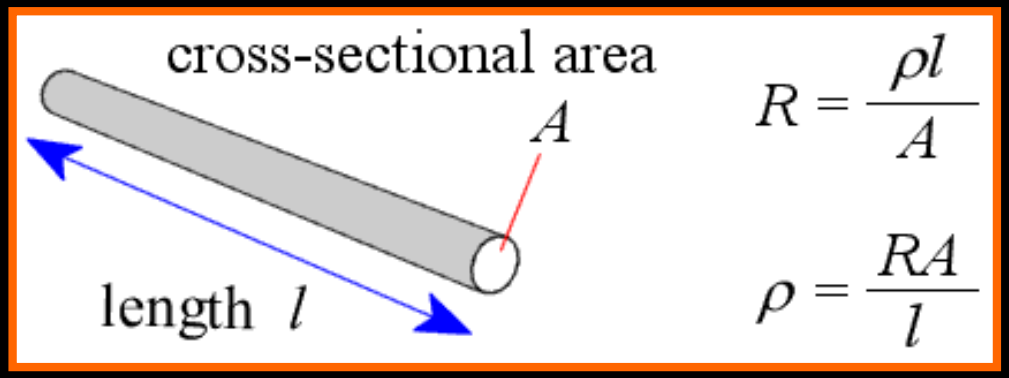
Nick the gold broker from Mandurah has just received a gold bullion bar for his birthday from his friend Dodgey Jack. The face of the bar is 5 cm on both sides, and the length is 20 cm. The resistance between faces A and B is measured to be 0.8 micro-ohms. Nick the broker assumes that the bullion is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

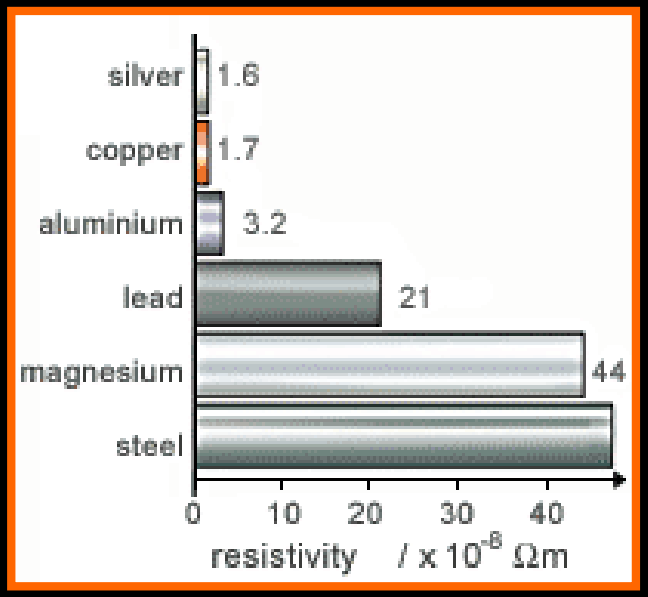
$$R = \rho L / A$$
$$= (2.4x10^{-8}\,\Omega \cdot m)(.2m) / .05^2\,m^2)$$
$$= 1.92x10^{-6}\,\Omega$$

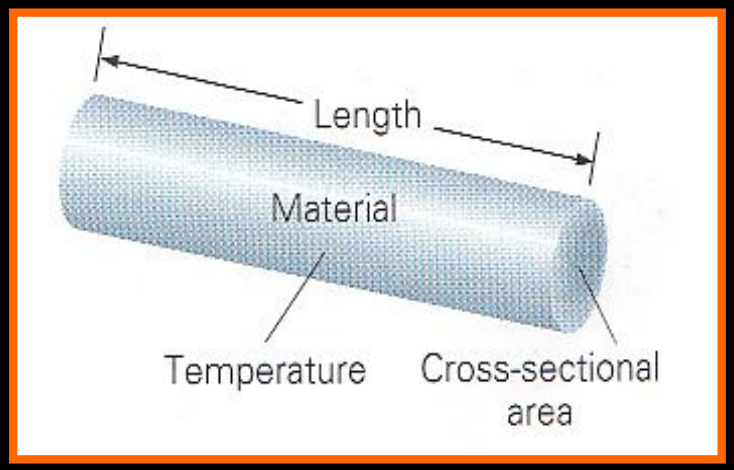


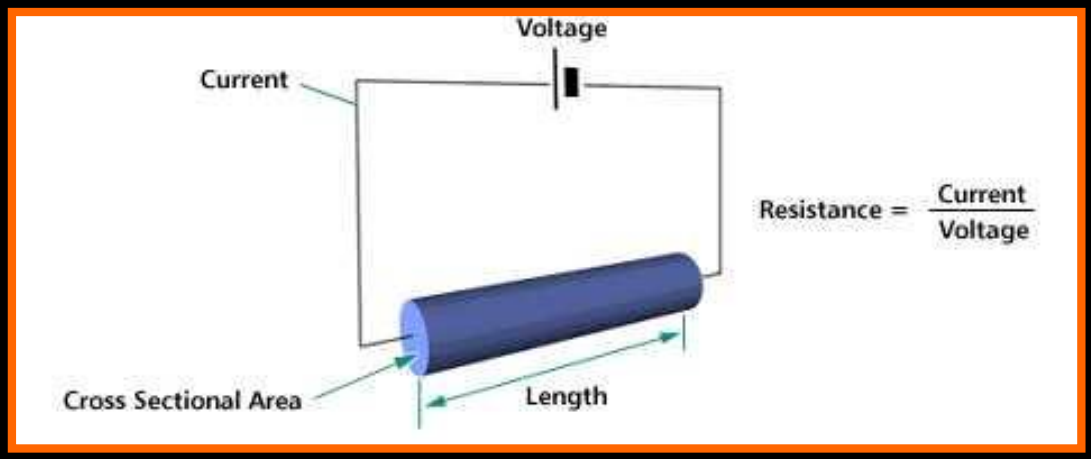
=1.92 uΩ don't try to cash it in!

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