How do we calculate R?

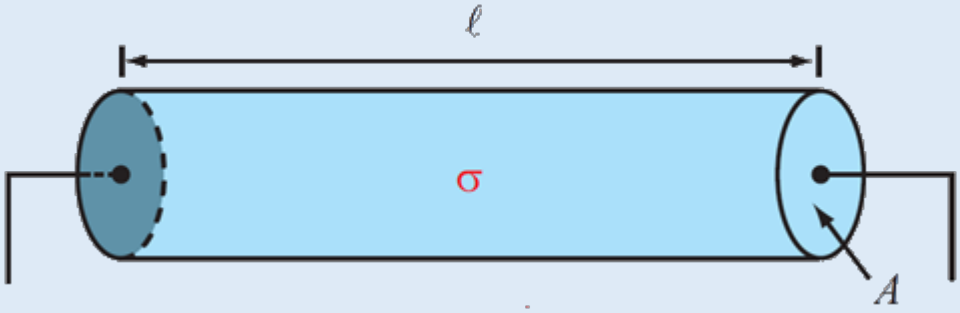
Ohm's Law tells us that in a conductor, the voltage and current are proportional to each other (within some useful range). That is,

$$v = i \cdot R \quad (\Omega)$$

where the proportionality constant, R, is called **resistance** and has the units of Ohms (Ω).

In general, resistance is a function of *material properties* and *geometry of the conductor*.

A long, cylindrical wire provides a good example and other geometries have similar (although sometimes much more complex) equations.



The wire in this example has a material property called **conductivity**, σ, which is a measure of how much obstruction the material's atoms present to moving electrons. The units of σ is Siemens / m. A Siemen (S) is just the reciprocal of the ohm (Ω). Amusingly, before being standardized, the Siemen was often called the *mho*.

The resistance, R, can be calculated from:

$$R = \frac{\ell}{\sigma A} \quad (\Omega)$$

Note:

- the higher the conductivity, the lower the resistance
- the larger the cross sectional area, the lower the resistance
- the longer the wire, the higher the resistance

The reciprocal of conductivity provides the same information and is often cited instead. This is called the resistivity, ρ, and has units of Ωm.

$$\rho = \frac{1}{\sigma} \quad (\Omega \cdot m)$$