Flipping Physics Lecture Notes:

Resistivity
https://www.flippingphysics.com/resistivity.html

An open circuit does not contain a closed loop for current to flow and therefore current does not flow.
A closed circuit does contain a closed loop for current to flow and therefore current does flow.

We tested various materials and discovered conductors such as aluminum, stainless-steel, and gold do allow current to flow. However, insulators such as plastic rubber and glass, do not allow current to flow. This is because conductors have electrons which are loosely bound to their atoms which allows current to flow. Whereas insulators have electrons which are tightly bound to their atoms which does not allow current to flow.

We have already learned about resistance, R, which is how an object limits current flow. Resistance is a physical property of an object.

$$\Delta V = IR \Rightarrow R = \frac{\Delta V}{I}$$

Today we learn about resistivity, ρ, which is a material property. Resistivity is a fundamental property of the material to limit electric current flow.

Because the difference between Resistance and Resistivity can be difficult for students to remember, I will repeat myself:

- Resistance is the property of an object.
- Resistivity is the property of a material.

Resistance and Resistivity are related by the following equation:

- R = Resistance
- ρ = Resistivity. (I know. I am sorry. It's not density.)
- L = Length
- A = cross sectional area

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

The units for resistivity are: $\Omega \bullet m$

$$R = \frac{\rho L}{A} \Rightarrow \rho = \frac{RA}{L} = \frac{\Omega \bullet m^2}{m} = \Omega \bullet m$$

Resistivities for some common materials at 20°C are:

Material	**ρ @ 20°C (Ω·m)**		**Type**
Silver	1.6×10^{-8}	0.000000016	Conductor
Copper	1.7×10^{-8}	0.000000017	Conductor
Gold	2.4×10^{-8}	0.000000024	Conductor
Aluminum	2.8×10^{-8}	0.000000028	Conductor
Stainless Steel	6.9×10^{-7}	0.00000069	Conductor
Germanium	4.6×10^{-1}	0.46	Semiconductor
Silicon	6.4×10^{2}	620	Semiconductor
Glass	10×10^{10} – 10×10^{14}	100,000,000,000 – 1,000,000,000,000,000	Insulator
Hard Rubber	10×10^{13}	100,000,000,000,000	Insulator
Air	1.3×10^{16} – 3.3×10^{16}	13,000,000,000,000,000 – 33,000,000,000,000,000	Insulator

Resistivities compiled from electronics-notes.com[1] and sciencenotes.org[2].

Resistivity is temperature dependent.

- Conductors: As temperature increases, resistivity increases.
- Semiconductors: As temperature increases, resistivity decreases.

[1] https://www.electronics-notes.com/articles/basic_concepts/resistance/electrical-resistivity-table-materials.php
[2] https://sciencenotes.org/table-of-electrical-resistivity-and-conductivity/