

10.3: Conductivity of Some Common Materials

The values below are conductivity σ for a few materials that are commonly encountered in electrical engineering applications, and for which conductivity emerges as a consideration.

Note that materials in some applications are described instead in terms of *resistivity*, which is simply the reciprocal of conductivity.

Conductivity may vary significantly as a function of frequency. The values below are representative of frequencies from a few kHz to a few GHz. Conductivity also varies as a function of temperature. In applications where precise values are required, primary references accounting for frequency and temperature should be consulted. The values presented here are gathered from a variety of references, including those indicated in “Additional References” at the end of this section.

Free Space (vacuum): $\sigma \triangleq 0$.

Figure 10.3.1: Commonly encountered elements:

Material	σ (S/m)
Copper	5.8×10^7
Gold	4.4×10^7
Aluminum	3.7×10^7
Iron	1.0×10^7
Platinum	0.9×10^7
Carbon	1.3×10^5
Silicon	4.4×10^{-4}

Water exhibits σ ranging from about $6 \mu\text{S/m}$ for highly distilled water (thus, a very poor conductor) to about 5 S/m for seawater (thus, a relatively good conductor), varying also with temperature and pressure. Tap water is typically in the range $5\text{--}50 \text{ mS/m}$, depending on the level of impurities present.

Soil typically exhibits σ in the range 10^{-4} S/m for dry soil to about 10^{-1} S/m for wet soil, varying also due to chemical composition.

Non-conductors. Most other materials that are not well-described as conductors or semiconductors and are dry exhibit $\sigma < 10^{-12} \text{ S/m}$. Most materials that are considered to be *insulators*, including air and common dielectrics, exhibit $\sigma < 10^{-15} \text{ S/m}$, often by several orders of magnitude.

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