

Bulk Properties of Copper: Density and Resistivity

Answers

1. If you have two identical saucepans, one made of copper and the other of aluminium, how many times heavier will the copper one be?

Just use the ratio of their densities:

$$8940/2700 = 3.31 \text{ times heavier.}$$

2. Compare the resistivities of silver and nichrome alloy. How many times better is silver than nichrome at conducting electricity?

$$\text{The ratio of resistivity is } 1.6 \times 10^{-6} / 1.6 \times 10^{-8} = 100$$

3. Calculate the resistance of a copper cable 50 mm in diameter and 30 km long.

$$R = \rho (L / A)$$

$$= (1.7 \times 10^{-8} \times 30 \times 10^3) / (3.14 \times 25 \times 25 \times 10^{-6})$$

$$= 0.26 \text{ Ohms}$$

4. If you had to replace the cable in question 3 with aluminium, what would the diameter need to be to have the same resistance?

$$R_{\text{Al}} = R_{\text{Cu}}$$
$$(\rho_{\text{Al}} \times L) / (\pi \times r_{\text{Al}}^2) = (\rho_{\text{Cu}} \times L) / (\pi \times r_{\text{Cu}}^2)$$

Cancelling π and L :

$$2.7 \times 10^{-8} / r_{\text{Al}}^2 = 1.7 \times 10^{-8} / r_{\text{Cu}}^2$$
$$r_{\text{Al}}^2 = (2.7 \times 10^{-8}) / (1.7 \times 10^{-8}) \times r_{\text{Cu}}^2$$
$$r_{\text{Al}} = \sqrt{(2.7 \times 10^{-8}) / (1.7 \times 10^{-8})} \times r_{\text{Cu}}$$
$$r_{\text{Al}} = \sqrt{(2.7/1.7)} \times r_{\text{Cu}} = 31.5 \text{ mm}$$

Diameter of the aluminium cable would need to be: $2 \times r_{\text{Al}} = 63 \text{ mm}$

5. The unit of conductivity is the Siemens m^{-1} . Find out who Siemens was and where you will find his name today.

Werner von Siemens. He founded what is now one of the largest multinational engineering companies in the world.

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