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Exercises and Complements for the Introduction to Physics II

for Students

of Biology, Pharmacy and Geoscience

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Exercise 13.

A current is transported via a high-voltage wire made of Copper (density $\rho_M = 9.0 \cdot 10^3$ kg·m^{-3}, atomic mass $M_A = 63.3 \cdot 10^{-3}$ kg·mol^{-1}) and of length 10 km (diameter $d = 2$ cm).

(a) Determine the resistance of the wire ($\varrho_{Cu} = 1.7 \times 10^{-8}$ Ωm).

(b) A current $I = 100$ A flows through the wire, and at the beginning of the line a voltage of 220 V is given. What is the voltage at the end of the wire, and therefore the voltage drop?

(c) How long does an electron need on average to travel from the beginning to the end of the wire?

Hint: Assume that only one electron per Cu-atom contributes to the conductivity.
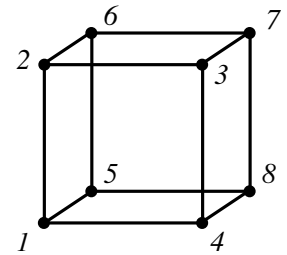
Exercise 14.

The salt content in human blood is 9 g per Liter. In order to investigate the electrical conductivity of blood, consider a saline solution containing 9 g NaCl disolved in in 1000 g H_2O.

(a) What is the conductivity of this solution? The mobilities b of the ions are $4.6 \cdot 10^{-8}$ m^2/Vs (Na) and $6.85 \cdot 10^{-8}$ m^2/Vs (Cl).

(b) Estimate the resistance of the human body between the two hands. The distance between hands is ≈ 1.5 m, and the cross-section of a hand is ≈ 10 cm^2.

(c) If 100 mA current flows through the chest cavity, it is lethal. Which voltages are therefore dangerous?

Exercise 15.

Imagine a cube with twelve edges, consisting of twelve identical resistors R (see figure on the right). Determine the total resistance of the whole cube, if an electric voltage is applied between the points 1 and 7.

Exercise 16.

Consider the cube from exercise 15 and define an electrical network spanned by the path(s) between points i) 1 and 3, ii) 1 and 2. Determine the total resistance of both networks.

Answers.

Exercise 13. (a) 0.54 Ω   (b) 54 V, respectively 166 V   (c) $4.3 \cdot 10^8$ s

Exercise 14. (a) $1.7 \ \Omega^{-1} \mathrm{m}^{-1}$ (b) 882 Ω   (c) 88 V

Exercise 15. $5R/6$

Exercise 16. $7R/12$ und $3R/4$