SS 2013

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Exercises "Advanced materials B"
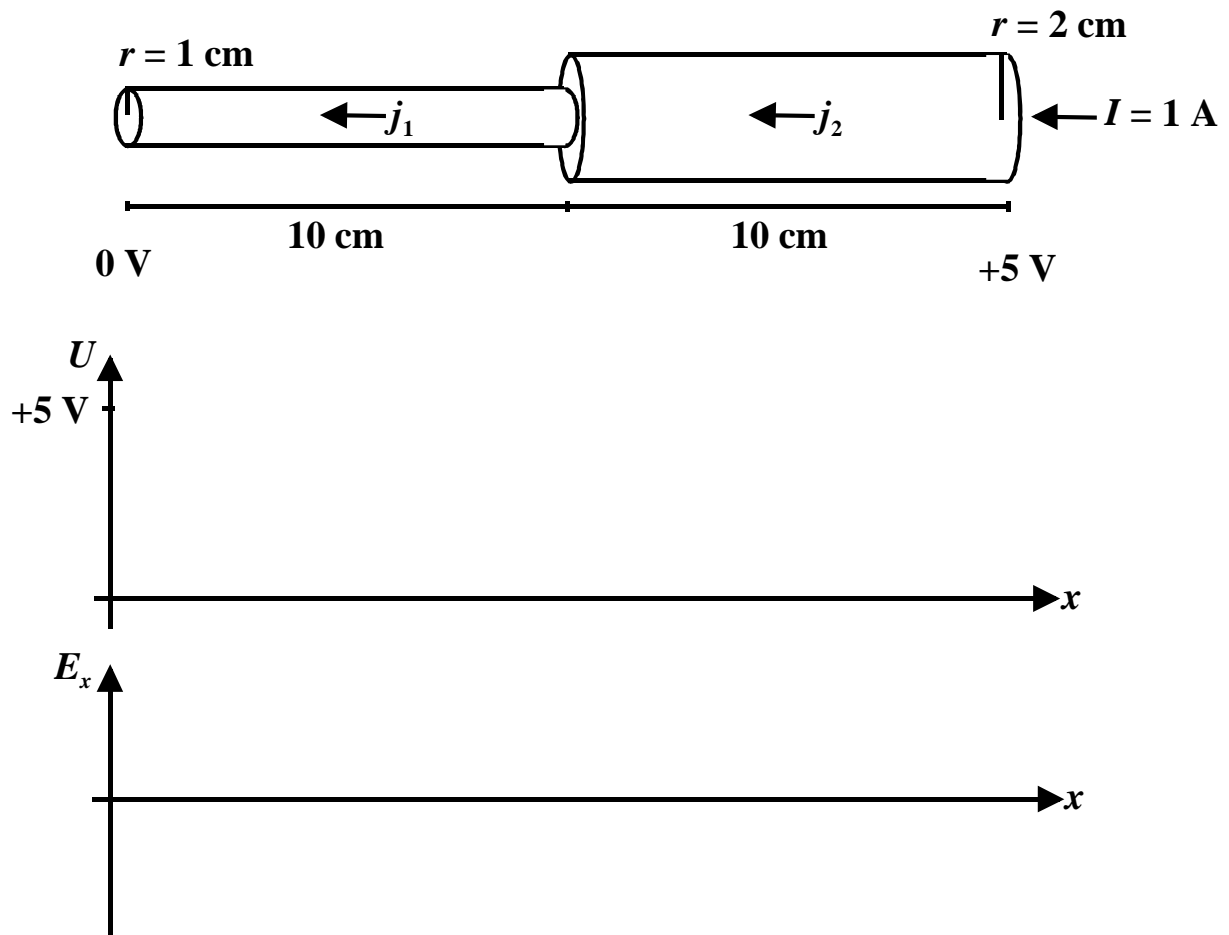
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Exercise 1: Conducting Wire

Fig. 1

Through a cylindrical workpiece of a homogeneous material with a geometry as shown in Fig. 1 a current of 1 A is flowing, if a voltage of 5 V is applied.

a) Define the variables in the following equations: $R = \dfrac{\rho l}{A}$, $\vec{j} = \sigma \vec{E}$ and $\vec{E} = -\vec{\nabla} U$, and discuss these formulas shortly.

b) Prove that the ratio of current densities in the thin and thick conductor part equals

$$\frac{j_1}{j_2} = 4 \; . \tag{1}$$

c) Calculate the electrical field strength in the thin and the thick part of the conductor.

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d) Draw the electrical field and the voltage loss into the coordinate system given above. The x-axis shall correspond to the length scale of the conductor drawn above. The scale for the voltage loss is defined by the dash at 5 V.

e) In which direction are the electrons flowing in the circuit above?

f) Estimate the conductivity of the material regarded here. Is this a good or a bad conductor?

g) Which material parameter determines the conductivity of a solid state material?

h) With increasing temperature the resistance of the workpiece shown above decreases nearly exponentially. What class of material does it belong to?

i) In a Hall measurement the material shows a positive Hall constant. What conclusion can you draw from that?

j) Can the contacting of the workpiece with a metal on the left and right side be a problem? Please explain your answer!