

# task\_rj0r6j4apumukrj6\_with\_calculation

## Student Group

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## Table of Contents

Exercise E1 Resistance of a Wire by Resistivity (written test, approx. 6 % of a 60-minute written test, WS2022) ..... 2

resistivity, power, exam ee1 WS2022

### Exercise E1 Resistance of a Wire by Resistivity (written test, approx. 6 % of a 60-minute written test, WS2022)

A heating element made of nichrome wire with a temperature coefficient of resistance of  $\alpha = 0.00180 \text{ } ^\circ\text{C}^{-1}$  is used. Electric power dissipation (= heat flow) of  $P = 40 \text{ W}$  is necessary. Determine the current  $I$  and the operating voltage  $U$  for heating elements. The nichrome wire has a resistivity of  $\rho = 1.10 \cdot 10^{-6} \text{ } \Omega \cdot \text{m}$ . The heating element is  $l = 3 \text{ m}$  long and has a diameter of  $d = 3.57 \text{ mm}$ .  
 Solution:  $R = 10^{-3} \text{ } \Omega$   
 ∴ Calculate the resistance  $R$  of the heating element.

Solution

$$\begin{aligned} P &= U \cdot I = R \cdot I^2 \quad \rightarrow \quad I = \sqrt{\frac{P}{R}} \\ &= \sqrt{\frac{40 \text{ W}}{10^{-3} \text{ } \Omega}} \end{aligned}$$

$$\begin{aligned} R &= \rho \cdot \frac{l}{A} \quad | \quad \text{with } A = r^2 \cdot \pi = \frac{1}{4} d^2 \cdot \pi \\ R &= \rho \cdot \frac{l}{\frac{1}{4} d^2 \cdot \pi} \quad | \quad R = \frac{4 \cdot \rho \cdot l}{d^2 \cdot \pi} \\ &= \frac{4 \cdot 1.10 \cdot 10^{-6} \text{ } \Omega \cdot \text{m} \cdot 3 \text{ m}}{(3.57 \cdot 10^{-3} \text{ m})^2 \cdot \pi} \end{aligned}$$

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