

task_rj0r6j4apumukrj6_with_calculation

Student Group

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Exercise E1.1 Resistance of a Wire by Resistivity (written test, approx. 6 % of a 60-minute written test, WS2022)

2. Heating elements are used to heat wire with a temperature of 180°C . Electric power dissipation (= heat flow) of $P=40\text{ W}$ is necessary. Calculate the current I needed to operate it.

The Nichrome wire has a resistivity of $1.10 \cdot 10^{-6}\ \Omega\text{m}$.

The heating element is 3 m long and has a diameter of 3.57 mm .

Solution $\begin{aligned} R &= \rho \cdot \frac{l}{A} \end{aligned}$

1. Calculate the resistance R of the heating element.

Solution $\begin{aligned} P &= U \cdot I = R \cdot I^2 \quad \rightarrow \quad I = \sqrt{\frac{P}{R}} = \sqrt{\frac{40\text{ W}}{0.33\ \Omega}} \end{aligned}$

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

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