

task_70jig4yzznocarsq_with_calculation

Student Group

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temperature dependent resistance, power, heat, exam ee1 WS2022

**Exercise E2 Temperature-dependent Resistance
(written test, approx. 6 % of a 60-minute written test, WS2022)**

A refrigerator exhibits a temperature coefficient of resistance of 10^{-6} K^{-2} and a temperature coefficient of resistance of 0.01 K^{-1} . The refrigerator has a resistance of $10 \text{ k}\Omega$ at 25°C . Its temperature coefficients are: $\alpha = 0.01 \text{ K}^{-1}$ and $\beta = 71 \cdot 10^{-6} \text{ K}^{-2}$.

Result
The temperature inside the refrigeration system can reach down to -40°C .

Calculate the resistance of the thermostat at -40°C .

$$R = 6.5 \text{ k}\Omega$$

The power transfer resistor R is part of the circuit and generates heat. Therefore, a solution is to use a heat sink to cool the resistor.

Therefore, with constant U and increasing R the power decreases. Ten times more resistance decreases the heat flow to one-tenth.

$$R = R_0 \cdot (1 + \alpha \cdot \Delta T + \beta \cdot \Delta T^2)$$

with $\Delta T = T_{\text{end}} - T_{\text{start}}$

$$R = 10 \text{ k}\Omega \cdot (1 + 0.01 \text{ K}^{-1} \cdot (-40^\circ\text{C} - 25^\circ\text{C}) + 71 \cdot 10^{-6} \text{ K}^{-2} \cdot (-40^\circ\text{C} - 25^\circ\text{C})^2)$$

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