Answer on Question 61341, Physics, Electromagnetism

Question:

9) A coil of wire has a resistance of $25\ \Omega$ at $20°\text{C}$ and a resistance of $25.1\ \Omega$ at $35°\text{C}$. What is its temperature coefficient of resistance?

a) $4.5 \cdot 10^{-4} °\text{C}^{-1}$

b) $3.5 \cdot 10^{-3} °\text{C}^{-1}$

c) $2.6 \cdot 10^{-4} °\text{C}^{-1}$

d) $4.0 \cdot 10^{-5} °\text{C}^{-1}$

Solution:

As we know, the resistance of the wire change linearly with the temperature (if the temperature T does not vary too much):

$$R_1 = R_0[1 + \alpha(T_1 - T_0)],$$

here, α is the temperature coefficient of resistance of wire, T_0 is a fixed reference temperature (in our case $T_0 = 20°\text{C}$), $R_1 = 25.1\ \Omega$ is the resistance at the temperature $T_1 = 35°\text{C}$, $R_0 = 25\ \Omega$ is the resistance at the temperature $T_0 = 20°\text{C}$.

Therefore, from this formula we can find the temperature coefficient of resistance of wire:

$$\alpha = \frac{1}{R_0} \cdot \frac{R_1 - R_0}{T_1 - T_0} = \frac{1}{25\ \Omega} \cdot \frac{25.1\ \Omega - 25\ \Omega}{35°\text{C} - 20°\text{C}} = 2.6 \cdot 10^{-4} °\text{C}^{-1}$$

Answer:

c) $2.6 \cdot 10^{-4} °\text{C}^{-1}$

10) A copper wire has resistance of $2.0\ \Omega$ at $0°\text{C}$ and $2.26\ \Omega$ at $30°\text{C}$. What is its resistance at $50°\text{C}$?

a) $2.43\ \Omega$

b) $3.34\ \Omega$

c) $1.52\ \Omega$

d) 5.31 Ω

Solution:

As we know, the resistance change linearly with temperature (if the temperature T_1 does not vary too much):

$$R_1 = R_0[1 + \alpha(T_1 - T_0)],$$

here, α is the temperature coefficient of resistance for copper, T_0 is a fixed reference temperature (in our case $T_0 = 0°\text{C}$), $R_1 = 2.26\ \Omega$ is the resistance at the temperature $T_1 = 30°\text{C}$, $R_0 = 2.0\ \Omega$ is the resistance at the temperature $T_0 = 0°\text{C}$.

So, from this formula we can find the temperature coefficient of resistance for copper:

$$\alpha = \frac{1}{R_0} \cdot \frac{R_1 - R_0}{T_1 - T_0} = \frac{1}{2.0\ \Omega} \cdot \frac{2.26\ \Omega - 2.0\ \Omega}{30°\text{C} - 0°\text{C}} = 4.3 \cdot 10^{-3} °\text{C}^{-1}.$$

As we know the temperature coefficient of resistance for copper, we can calculate the resistance at the temperature $50°\text{C}$ from the same formula:

$$R_2 = R_0[1 + \alpha(T_2 - T_0)] = 2.0\ \Omega \cdot \left(1 + 4.3 \cdot 10^{-3} °\text{C}^{-1} \cdot (50°\text{C} - 0°\text{C})\right) = 2.43\ \Omega.$$

Answer:

a) 2.43 Ω