

Answer on question #58888, Physics / Electric Circuits

Question A 100cm of wire was used in the heating of a 12v 60w heater. The length of wire of the same material having double the cross-sectional area that would be required for a 24v, 60w element is ? cm assuming final temperature is the same

Solution If final temperature is the same, then power of heater is the same, though its resistance is different, as the voltage is different. We

$$I_1 U_1 = I_2 U_2$$

Current of the first heater is $I_1 = P/U_1 = 60/12 = 5$ A. Hence, on the second its gonna be

$$I_2 = I_1 \frac{U_1}{U_2} = 5 \frac{12}{24} = 2.5 \text{ A}$$

Now we can relate resistance of both heaters

$$R_1 = \frac{U_1}{I_1} = 2.4 \Omega \quad R_2 = \frac{U_2}{I_2} = 9.6 \Omega$$

Hence, second heater has 4 times bigger resistance. We assume that the wire and the heater are connected in series and are supplied from source of constant voltage. As the current is twice smaller, the total resistance should be twice smaller. The resistance of the heater is 4 times bigger. Then resistance of the wire should be 8 time smaller. It is connected to cross-section area and length as

$$R = \rho \frac{l}{S}$$

S is 2 time bigger, then if we want R to be 8 times smaller, length l should be 4 times smaller, that is 25 cm.