Answer on Question #45850, Physics, Electric Circuits

A wire with resistance of 8.0Ω is drawn out through a die so that its new length is three times its original length. Find the resistance of the longer wire assuming that the resistivity and density of the material are unaffected by the drawing process.

72Ω

60Ω

80Ω

45Ω

Solution:

The electrical resistivity ρ is defined as:

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

where

R is the electrical resistance of a uniform specimen of the material (measured in ohms, Ω)

l is the length of the piece of material (measured in metres, m)

A is the cross-sectional area of the specimen (measured in square metres, m^2).

Thus, the resistance is

$$R = \frac{l}{A}$$

The ratio of resistances is

$$\frac{R_1}{R_2} = \frac{l_1 A_2}{l_2 A_1}$$

The volume of wire is

$$V = Al = constant$$

Thus,

$$A_1 l_1 = A_2 l_2$$

From given,

$$l_2 = 3l_1$$

Thus,

$$\frac{A_2}{A_1} = \frac{l_1}{l_2} = \frac{1}{3}$$

So,

$$\frac{R_1}{R_2} = \frac{l_1}{3l_1}\frac{A_2}{A_1} = \frac{1}{3}\cdot\frac{1}{3} = \frac{1}{9}$$

Then,

$$R_2 = 9R_1 = 9 \cdot 8.0\ \Omega = 72\ \Omega$$

Answer: 72Ω