Question #31268, Physics, Other

A wire with resistance of 80Ω 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.

Solution.

If the density of the material is unaffected by the drawing process, then wire volume V is unaffected too.

$$V = S \cdot l;$$

where $\boldsymbol{l}$ - is wire length, m;

S - is the cross-sectional area, m^2;

If final wire length l_2 is three times its original length l_1 ($l_2 = 3l_1$), then final cross-sectional area S_2 is:

$$S_2 = \frac{V}{l_2} = \frac{V}{3l_1} = \frac{1}{3}S_1$$

The wire resistance is:

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

where ρ is the resistivity, Ω/m;

The final wire resistance is:

$$R_2 = \rho \frac{l_2}{S_2} = \rho \frac{3l_1}{\frac{1}{3}S_1} = 9\rho \frac{l_1}{S_1} = 9R_1 = 9 \cdot 80 = 720\ \Omega.$$

Answer: the resistance of the longer wire is $\boldsymbol{720\ \Omega}$.