Answer on Question#55905 - Physics - Electromagnetism

10. A current flows in a wire of circular cross-section with the free electrons travelling with a mean drift velocity v. If an equal current flows in a wire of the same material but of twice the radius, what is the new mean drift velocity?
    $v/4$
    $v/2$
    $2v$
    $4v$
11. A wire with resistance of $R_0 = 8.0\Omega$ 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:

10. Since the radius doubled, the cross-sectional area quadrupled. The current is proportional to the drift velocity and inversely proportional to the cross-sectional area, therefore for the current to remain the same the new drift velocity must be 4 times smaller than the previous one: $v/4$.
11. The resistance is given by
$$R = \rho\frac{l}{A},$$
where ρ—is the resistivity of the material, l—length of the wire, A—is the cross-sectional area. Let the initial length of the wire be l_0 and the initial cross-sectional area be A_0. Since the volume of the wire didn't change after drawing and the final length is $L = 3l_0$, we obtain
$$l_0 \cdot A_0 = L \cdot A,$$
where A—is the final cross-sectional area. Therefore
$$A = \frac{l_0 \cdot A_0}{L} = \frac{l_0 \cdot A_0}{3l_0} = \frac{A_0}{3}$$
Since the resistivity of the material didn't change, we obtain the following equation for the final resistance of the wire R
$$\frac{R}{R_0} = \frac{\rho\frac{L}{A}}{\rho\frac{l_0}{A_0}} = \frac{L \cdot A_0}{A \cdot l_0} = \frac{3l_0 \cdot A_0}{\frac{A_0}{3} \cdot l_0} = 9$$
Therefore
$$R = 9R_0 = 9 \cdot 8\Omega = 72\Omega$$

Answer:

10. $v/4$
11. 72Ω