Answer on question #61339, Physics / Electromagnetism

7) 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.

a) 72Ω
b) 60Ω
c) 80Ω
d) 45Ω

Solution:

The electrical resistivity ρ is defined as:

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

Thus, the resistance is

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

The volume of wire is

$$V = Al = const$$

$$A_1 l_1 = A_2 l_2$$

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

By the condition of the task

$$l_2 = 3l_1$$

The ratio of resistances is

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

So,

$$\frac{R_1}{R_2} = \frac{l_1}{3l_1} \cdot \frac{l_1}{3l_1}$$

$$\frac{R_1}{R_2} = \frac{1}{3} \cdot \frac{1}{3}$$

$$\frac{R_1}{R_2} = \frac{1}{9}$$

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

Answer: a) 72Ω

8) A cirrent 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?

a) v/4
b) v/2
c) 2v
d) 4v

Solution:

$$j = nev$$

$$j = \frac{I}{A}$$

Where,

$$A = \pi r^2$$

$$j = \frac{I}{\pi r^2}$$

$$\frac{I}{\pi r^2} = nev$$

For wire twice the radius,

$$\frac{I}{\pi {r_1}^2} = nev_1$$

By the condition of the task,

$$r_1 = 2r$$

$$\frac{I}{\pi (2r)^2} = nev_1$$

$$\frac{I}{4\pi r^2} = nev_1$$

$$\frac{nev}{4} = nev_1$$

The new mean drift velocity is

$$v_1 = \frac{v}{4}$$

Answer: a) v/4