Answer on Question#51721 - Physics - Electromagnetism

1. 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?
   (A) v/4
   (B) v/2
   (C) 2v
   (D) 4v

2. 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:

1. The current is proportional to the velocity of free electrons and inversely proportional to the cross-section area of the wire. If the new wire has circular cross-section with the twice larger radius, the cross-section area is 4 times larger, since the area of the circle is proportional to radius squared. Thus, for the current to remain the same the drift velocity of electrons should be 4 times larger : 4v.
2. The resistance of the wire can be written in the following way
$$R = \rho \frac{l}{A},$$
where l – is the length of the wire, A – is its cross-section area, and ρ – is the resistivity. Since the volume of the wire remain unchanged, we can write the following
$$A_i l_i = A_f l_f,$$
where A_i, A_f – are the initial and final cross-section areas, and l_i, l_f – are the initial and finak length of the wire. Since it is given that $l_f = 3l_i$, we obtain
$$A_f = A_i \frac{l_i}{l_f} = A_i \frac{l_i}{3l_i} = \frac{A_i}{3}$$
The new resistance is
$$R_f = \rho \frac{l_f}{A_f} = \rho \frac{3l_i}{A_i/3} = 9\rho \frac{l_i}{A_i} = 9R_i = 9 \cdot 8\Omega = 72\Omega,$$
where $R_i = \rho \frac{l_i}{A_i}$ – is the initial resistance of the wire.

Answer:

1. (D)
2. (a)