Answer on Question #74045 Physics / Electric Circuits

The mass density of copper is $\rho = 8.95 \times 10^3$ kg m^{-3}. If one charge carrier is contributed by each copper atom, calculate the number density of charge carriers in copper. If $I = 5$ A current is flowing in a copper wire of cross-sectional area $A = 4 \times 10^{-6}$ m^2, calculate the drift velocity of electrons.

Solution:

The number density of charge carriers

$$n = \frac{\rho}{m_0}$$

where $m_0 = \frac{\mu}{N_A} = \frac{0.063}{6.02 \times 10^{23}} = 1.05 \times 10^{-25}$ kg is the mass of copper atom.

So

$$n = \frac{8.95 \times 10^3}{1.05 \times 10^{-25}} = 8.55 \times 10^{28}\ 1/\text{m}^3$$

The electrical current

$$I = envA$$

So, the drift velocity of electrons

$$v = \frac{I}{enA} = \frac{5}{1.6 \times 10^{-19} \times 8.55 \times 10^{28} \times 4 \times 10^{-6}} = 9.14 \times 10^{-5}\ \text{m/s}$$

Answers:

$n = 8.55 \times 10^{28}\ 1/\text{m}^3$

$v = 9.14 \times 10^{-5}$ m/s