Calculate the drift velocity and mean free path of copper when it carries a steady current of 10 amperes and whose radius is 0.08 cm. Assume that the mean thermal velocity = 1.6x10^6m/s and the resistivity of copper = 2x10^-8ohm m

Answer:

The current density is electric current per unit area, J=I/A

$$J = nev_d$$

n=free electron density
v_d = drift velocity

$$n = \frac{(N_A atoms / mole)(\rho \ kg / m^3)}{A(kg / mole)}$$

Avogadro's number Density

Atomic mass

For copper:

$$n = \frac{(6.02x10^{23} atoms / mole)(8.92x10^3 kg / m^3)}{63.5x10^{-3} kg / mole} = 8.46x10^{28} / m^3$$

The mean free path of an electron in copper under these conditions can be calculated from

$$d = \frac{m\, V_t}{n\, \rho\, e^2} = \frac{9{,}11 \cdot 10^{-31} 1.6x10^6}{8{,}46 \cdot 10^{28}\ 2x10^{-8} (1{,}6 \cdot 10^{-19})^2} = 3{,}4 \cdot 10^{-8}\ m$$

The drift velocity

$$V_d = \frac{I}{\pi r^2 ne} = \frac{10}{3{,}14\ (8 \cdot 10^{-4})^2\ 8{,}46 \cdot 10^{28} 1{,}6 \cdot 10^{-19}} = 0{,}0015 \frac{m}{s}$$