Answer on Question #43910-Physics-Electrodynamics

What is the ratio of drift velocity and rms velocity of an electron in room temperature?

Solution

RMS velocity of an electron at room temperature is

$$v_{RMS} = \sqrt{\frac{3kT}{m_e}},$$

where $T = 300\ K$, k is the Boltzmann constant, m_e is the mass of an electron.

Drift velocity of an electron is

$$v_{drift} = \frac{eE\tau}{2m_e},$$

where e is a charge of an electron, τ is mean free time between collisions (at room temperature $\tau = 3 \cdot 10^{-14}\ s$), E is an electric field.

The ratio of drift velocity and rms velocity of an electron in room temperature is

$$\frac{v_{drift}}{v_{RMS}} = \frac{\frac{eE\tau}{2m_e}}{\sqrt{\frac{3kT}{m_e}}}.$$

For example in an electric field of $100\frac{V}{m}$ this ratio is equal

$$\frac{v_{drift}}{v_{RMS}} = \frac{\frac{1.60 \cdot 10^{-19}\ C \cdot 100\frac{V}{m} \cdot 3 \cdot 10^{-14}\ s}{2 \cdot 9.11 \cdot 10^{-31}\ kg}}{\sqrt{\frac{3 \cdot 1.38 \cdot 10^{-23}\frac{J}{K} \cdot 300K}{9.11 \cdot 10^{-31}\ kg}}} = \frac{0.26}{1.2 \cdot 10^{5}} = 2.1 \cdot 10^{-6}.$$