

Exercise 1.3-2

Derive numbers for v_0 , v_D , τ , and l

Show that the claims made in the backbone text are actually true (for room temperature = **300 K**). Use the following equations taken from the backbone

- For the [average velocity \$v_0\$](#) of a particle zooming around in the crystal:

$$v_0 = \left(\frac{3kT}{m} \right)^{1/2}$$

- For the [mean time \$\tau\$ between scattering](#):

$$\tau = \frac{\sigma \cdot m}{n \cdot e^2}$$

- For the [drift velocity \$v_D\$](#)

$$v_D = - \frac{E \cdot e \cdot \tau}{m}$$

- For the minimal [mean free path length \$l_{\min}\$](#) obtained for $v_D = 0$:

$$l_{\min} = 2 \cdot v_0 \cdot \tau$$

Of course, you need numbers for the concentration n of the free carriers and for the specific conductivity σ

- Since we are essentially considering metals, you assume for a start that you have **1** free electron per atom if you want to find a number for n . Here are a few data needed for the calculation:

Atom	Density [kg · m ⁻³]	Atomic weight × 1,66 · 10 ⁻²⁷ kg	Conductivity σ × 10 ⁵ [$\Omega^{-1} \cdot \text{m}^{-1}$]	Concentration Atoms n [m ⁻³] ???
Na	970	23	2.4	
Cu	8.920	64	5.9	
Au	19.300	197	4.5	

You may run into some trouble with the dimensions. Just look at conversions from, e.g. [eV] to [J], from Ω to V and A , and at the relations between Volt, Ampere, Watts and Joule.



Solution