

Structure of matter: Homework to exercise 4

Electrical and optical properties of continuous media

Due on November 2nd 2023 at noon

Please indicate your name on the solution sheets and send it to your seminar leader!

1. Multiple-choice test: Please tick the **box(es)** with the correct answer(s)!
(correctly ticked box: +1/2 point; wrongly ticked box: -1/2 point)

The wavenumber $\nu = 5000\text{cm}^{-1}$ corresponds to a wavelength	5000nm	
	2000nm	
	2 μm	
The refractive index of a material is	dimensionless	
	given in s^{-1}	
	given in cm^{-1}	

2. True or wrong? Make your decision!

(2 points): 1 point per correct decision, 0 points per wrong or no decision

Assertion	true	wrong
In linear optics, electromagnetic energy dissipation occurs when the imaginary part of the dielectric function is larger than zero		
All dielectrics have negative refractive indices.		

3. Let a material have the absorption coefficient α . Which path must be travelled by the electromagnetic wave in order to reduce its intensity down to 10%? (2 points)
4. Find an expression for the electric field inside a homogeneously polarized dielectric sphere located in vacuum!
Note: The task is easily solved when regarding the single polarized sphere as a superposition of two homogeneously charged spheres with slightly shifted central points. (6 points)
5. Find an expression for the static polarizability of a spherical particle located in vacuum with radius R , built from a dielectric material with the static dielectric constant ϵ_{stat} . Also, consider the case of a metal sphere, formally replacing ϵ_{stat} by $\epsilon \rightarrow -\infty$. Basing on the expression for the static polarizability of the metal sphere, estimate the polarizability of a fictive atom, assuming the latter as a sphere with a radius equal to 0.05nm. (6 points)

6.

Assume a current $I = 1\text{A}$ flowing through a copper wire with a diameter d of 1.63mm . Estimate the drift velocity of the electrons, assuming that there is approximately 1 free electron per copper atom, a mass density of $\rho = 8.93\text{gcm}^{-3}$, and a mass number of copper of 63.5. Note that the Roman snail in the figure moves with a velocity of approximately 3 meters per hour. Is the drift velocity of the conduction electron higher or smaller than the propagation velocity of the Roman snail?(6 points)

