Exercises " Advanced materials B"

#5

Exercise 5: Electronic polarization

a) Explain the basic idea of the calculation of electronic polarization.

b) What is the origin of the two opposing forces F_1 and F_2 (cf. lecture script)?

c) Look up the following values
- atomic radius R,
- molar volume V_M,
- atomic number z,
for hydrogen, silicon, and lead.

d) Calculate the atomic densitiy N from the molar volume for the three elements.

e) Calculate the equilibrium distance d_E for hydrogen for $E = 1$ kV/cm, 100 kV/cm, and 10 MV/cm.

f) Calculate the "spring constant" k of the electrostatic binding force between nucleus and electron shell for hydrogen.

g) Calculate the frequency f belonging to k for hydrogen and calculate the wavelength λ of an electromagnetic wave that can be emitted by the resonator (if it acts as an antenna).

h) Determine the dielectric susceptibility χ_H for hydrogen caused by the electronic polarization.

i) Calculate e)-h) for a silicon atom. In this case *CRC – Handbook of Chemistry and Physics* gives $\chi \approx 11$. What could be the reason why the calculated value is smaller?

j) Calculate e)-h) for a lead atom. Why is the assumed model problematic to draw conclusions for the response of a piece of lead to an applied electrical field?