

Exercises "Electronic Materials"

#4

Exercise 4: 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 density N from the molar volume for the three elements.
- e) Calculate the equilibrium distance d_E for hydrogen for $E = 1 \text{ kV/cm}$, 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?