

Exercises for Advanced Inorganic Chemistry, Part Solid State Chemistry

1. Discuss and explain the different types of atomic radii that can be used to describe crystal structures.
2. Assume the lattice constants of the following rock salt type structures to be 545 pm (MgSe), 591 pm (CaSe), 623 pm (SrSe) and 662 pm (BaSe). Calculate the cation radii. To determine the Se^{2-} radius, assume that the Se^{2-} ions are in direct contact in MgSe.
3. Assume WC to crystallize in the rock salt structure. Describe the mutual coordination of W and C.
4. Give the CN and coordination polyhedra of Mg and Cu in their structures.
5. What type of elements crystallize in the Mg and Cu structure, respectively.
6. How many neighbours (Cl^- and/or Na^+ !) has a Na^+ ion in NaCl in its (a) first (Cl^-), (b) second (Na^+) and (c) third (Cl^-) coordination sphere?
7. The element Ta is bcc and has an atomic radius of 0.143 nm at 20 °C. Calculate a value for its lattice constants in Å.
8. The element W crystallizes in the bcc structure with lattice constants 3.16 Å. Calculate a value for its atomic radius in nm.
9. Calculate a value for the density of ccp (fcc) Nickel from its lattice constant $a = 0.352$ nm and its atomic mass of 58.71 g/mol.
10. Calculate the space filling for a bcc and a primitive packing of spheres.
11. Calculate the ideal radius ratio for CN = 3, 4 and 8.
12. Make suggestions for possible structure types of a crystalline solid with the general chemical composition AB and give their structural features.
13. Make suggestions for possible structure types of a crystalline solid with the general chemical composition AB_2 and give their structural features.
14. Sketch the principle properties of the structures of sphalerite and fluorite.
15. KCl crystallizes in the rocksalt structure with $a = 6.29$ Å. Calculate the interatomic distances for the first, second and third coordination sphere.

16. Sketch the unit cells of the crystal structures of zincblende, nickelarsenide, and cadmiumiodide.
17. Describe the structural relation between ReO_3 and SrTiO_3 .
18. Calculate the lattice enthalpy for CsCl ($a = 411 \text{ pm}$). Calculate first r_0 and assume the Born exponent n to be 8.
19. Describe the chemical transport reaction and the Czochralski process and their main use.
20. Which material is produced by „hydrothermal synthesis“ and how does it operate?
21. Describe the „Sputtering“- and the CVD-procedure.
22. What are „Zintl phases“ and to which group of solids do they belong?
23. Give an example for a Zintl phase and describe the electron counting.
24. Zeolithes are a special group of solids. Which characteristic structural and chemical/physical properties do they have ?
25. What defects or imperfections do exist in real structure of crystals?
26. Explain the terms „Schottky“- and „Frenkel“-defect
27. Explain the most important differences between a semiconductor and a metal.