Report Form for Solid State Structures

Note: Many of these questions will not make sense if you are not reading the accompanying lab handout.

Station 1. Simple Cubic Lattice

1. How many unit cells share an atom that is located on a corner of the unit cell?

2. Based on your answer to the previous question, what fraction of a corner atom belongs to each individual unit cell?

3. How many nearest neighbors does each atom have in a unit cell (we call this the atom's coordination number)?

4. How many total atoms make up one unit cell if we consider only the fraction of each atom that is contributed to the unit cell?

5. What kind of hole is at the center of the simple cubic lattice?

6. How many of these hole are in a unit cell?

7. Express the length of the unit cell, ***a***, in terms of the radius of an atom, ***r***. Give your answer in the form of an equation, such as $\boldsymbol{a} = 1.5 \times \boldsymbol{r}$. You may assume that the atoms in the unit cell touch each other. Show your work!

Station 2. Face-Centered Cubic Lattice

1. How many total atoms make up one unit cell if we consider only the fraction of each atom that is contributed to the unit cell?

2. How many complete (totally within the unit cell) octahedral holes are in this unit cell?

3. How many complete tetrahedral holes are in this unit cell? If you are having trouble seeing the tetrahedral holes, take a look at the unit cell for fluorite on the computer (Station 8) which has cations in these holes.

4. How many octahedral holes are partially contained (that is, shared with other unit cells) in this unit cell?

5. Express the length of the unit cell, ***a***, in terms of the radius of an atom, ***r***. Give your answer in the form of an equation, such as $a = 1.5 \times r$. Show your work!

6. Consider the simple cubic unit cell and the fcc unit cell. Assuming that the anions in each are of the same size, which unit cell's holes will best accommodate a larger cation?

Station 3. Body-Centered Cubic

1. What is the coordination number of each sphere in the unit cell?

2. Express the length of the unit cell, ***a***, in terms of the radius of an atom, ***r***. Give your answer in the form of an equation, such as $a = 1.5 \times r$.? Show your work!

3. What is the ratio of corner spheres to center spheres in the unit cell? Be sure to consider only the fraction of each atom in the unit cell.

4. What kind(s) of holes are in this unit cell, including partial holes shared with other unit cells, and how many complete holes are there?

Station 4. Closest Packed

1. Using the available pennies and box, arrange a single layer of pennies using the simple cubic unit cell. How many pennies did you fit in the box?

2. Using the available pennies and box, arrange a single layer of pennies using the fcc unit cell. How many pennies did you fit in the box?

3. Using the diagram from the lab handout, what is the area of the two-dimensional cross-section through the simple cubic unit cell? What percentage of this area is empty? Show your work!

4. Using the diagram from the lab handout, what is the area of the two-dimensional cross-section through the closest packed unit cell? What percentage of this area is empty? Show your work!

5. What is the packing pattern for hexagonal closest packing?

6. What is the packing pattern for cubic closest packing?

7. Are any of the structures from the first three stations examples of closest packing? If so, which one(s)?

Station 5. NaCl

1. What type of lattice do the Cl^- ions form?

2. What is the coordination number for the Na^+ ions?

3. What is the coordination number for the Cl^- ions?

4. In what types of holes do you find the Na^+ ions?

5. What percentage of these holes are occupied by Na^+ ions?

6. Verify by counting atoms and partial atoms that the number of Na^+ ions is the same as the number of Cl^- ions. Show your work!

Station 6. CsCl

1. What type of lattice do the Cl^- ions form?

2. In what kind of holes are the Cs^+ ions located?

4. What is the coordination number for Cs^+?

5. What is the coordination number for Cl^-?

6. Verify by counting atoms and partial atoms that the number of Cs^+ ions is the same as the number of Cl^- ions. Show your work!

Station 7. Zinc Blende Structure

1. What type of lattice do the S^{2-} ions form?

2. In what type of holes are the Zn^{2+} ions located? It may help to examine the computer model for zinc blend that shows only two layers of Zn^{2+} and S^{2-} ions.

3. What percentage of these holes contain a Zn^{2+} ion?

4. Verify by counting atoms and partial atoms that the number of Zn^{2+} ions is the same as the number of S^{2-} ions. Show your work!

Station 8. Fluorite Structure

1. What type of lattice do the Ca^{2+} ions form?

2. In what type of holes are the F^- ions found?

3. What percentage of these holes are occupied by a F^- ion?

4. How many total Ca^{2+} ions and F^- ions are in the unit cell? Does your answer make sense. Show you work and explain your reasoning!

Station 9. Wurtzite Structure

1. What type of lattice do the S^{2-} ions form?

2. In what type of holes are the S^{2-} ions located?

Station 10. Rutile Structure

1. How many titanium atoms and how many oxygen atoms are in the unit cell. What does this suggest about the simplest chemical formula for rutile? Show your work and explain your reasoning.

2. Given your answer to the previous question , what is the oxidation state for titanium?

3. What is titanium's coordination number?

4. What is oxygen's coordination number?

Station 11. Diamond

1. The computer model of diamond's unit structure suggests that some carbon atoms make up the lattice and some carbon atoms occupy holes within the lattice. What type of lattice makes up the unit cell?

2. In what type of holes are the other carbon atoms located?

3. What percent of these holes are occupied?