

## EXPERIMENT 9

# Cubic and Hexagonal Close Packing of Anions; Structures with Cations in Tetrahedral or Octahedral Holes

*This experiment is assigned on page 465 of the textbook.*

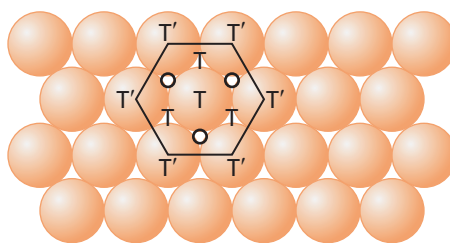
### FOR THE INSTRUCTOR

**REQUIREMENTS FOR THE EXPERIMENT.** Six Student ICE Solid-State Model Kits. This is a group activity. (*Note the textbook error:* The text mistakenly refers to ICE “Polyhedral Model Kits.”)

The Solid-State Model Kits are available from the Institute for Chemical Education, <https://www.ice.chem.wisc.edu>. This kit includes an instruction manual. Before starting, consult the “Getting Started” part of the manual; you may want to have the students try the NaCl practice example. The instruction sheets employed for this lab are entitled “Hexagonal Close Packing” and “Cubic Close Packing”. These instructions are taken from an earlier version of the manual, and may differ in the current version of the manual. The current sheets are found on pages 24 and 25 of the current manual.

## FOR THE STUDENTS

- A. Get in six groups: CCP; CCP-T; CCP-O; HCP; HCP-T; HCP-O.
- B. Before starting, consult the “Getting Started” part of the manual for your group’s Solid-State Model Kit; your instructor may assign you to try the NaCl practice example. Obtain the instruction sheets entitled “Hexagonal Close Packing” and “Cubic Close Packing.”
- C. Everyone fits template L over the green-dot (C6) base and insert metal rods in the holes in the shaded area. Place seven large colorless balls (anions) in the positions in the shaded areas marked in the CCP or in the HCP instruction sheet (so far, both are the same). (See also Figure 8.6a on page 464.)
- D. 1. The CCP-T and HCP-T groups place small pink balls in the *tetrahedral* holes on *top* of the anions in the shaded area. (*Note*: there is another set of tetrahedral holes between triangles of three anions that we are not filling at this time.)
2. The CCP-O and HCP-O groups place medium-sized blue balls in *octahedral holes*, each of which is between a triangle of three anions. There are six triangular-based holes in the gaps, but three of these end up being tetrahedral. The three you want to fill marked below with black circles at the *top left*, *top right*, and *bottom center* positions around the central anion.



- E. All groups build the second layer of anions as shown on your CCP or HCP instruction sheet. (You may consult Figure 8.6b on page 464 of the textbook.) If this has worked correctly, the two groups with pink balls should find that each pink ball touches four colorless balls (anions), while the two groups with blue balls should find that each blue ball touches six anions.
- F. 1. The CCP-T and HCP-T groups place small pink balls in the *tetrahedral* holes on *top* of the second layer of anions in the shaded area.
2. The CCP-O and HCP-O should place medium-sized blue balls in the octahedral holes that are *directly above* the previous layer of blue (octahedral-hole) balls.
- G. 1. All groups build the third layer of anions as shown on the CCP or HCP instruction sheet.
2. The instructions now differ for the two groups: the HCP group puts their anions *directly above* the first set of anions, repeating the anion pattern as ABAB. (See Figure 8.6c on page 464 of the textbook.)
3. The CCP groups puts their third layer in a new pattern not found in either of the first two anion layers, thus generating an ABC ... pattern. (See Figure 8.6d on page 464 of the textbook.)

- H. Examine the structure of your lattice. If the lattice is extended, what is the coordination number of your cation? What is the coordination number of your anion?
- I. Look at the lattice drawings in the textbook in Figure 4.2 on page 168 of the textbook. Which of these lattices, *if any*, have you built? You may also compare your model with the photographs of successfully-built models of cubic close packing and hexagonal close packing in the manual to see which of them you have built, if any.