

## MODELING CRYSTAL SHAPES

Minerals are defined as “naturally-occurring, crystalline solids with definite chemical compositions.” When they are able to form unimpeded, minerals can create beautiful crystal structures. Some familiar examples are six-sided quartz, rhombohedral calcite, and twelve-sided garnets. Museums and ‘rock hounds’ enjoy displaying the varieties of mineral crystals.

Crystal shape results from the arrangement of the atoms, ions, or molecules that make up the mineral. Differences in chemical bonding and other factors create the basic “unit cell,” and connected cells in the three dimensions produce the “crystal lattice” that may be seen in hand specimens.

Mineralogists have studied crystal structures intensely for almost two hundred years. Modern technologies, such as x-rays, are routinely used in advanced research. But for introducing students to mineral crystals, you may want to use simple models to show them the 7 lattice systems. You can make models out of many materials. For today, we will use raisins and toothpicks.

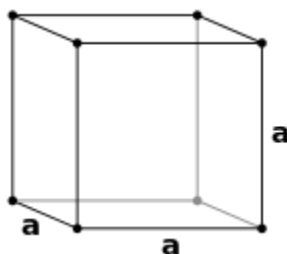
### Activity 1 The Basic Crystal Lattice Systems

Each group should start with about 20 toothpicks, 30 – 40 raisins, scissors, and a paper towel. Examine the diagrams below and try to use your materials to make models of one or two of the unit cells. You can choose any of these. When you have created your models, compare them with available mineral samples.

1) “Cubic” (“Isometric”)

All sides are equal in length and at perpendicular ( $90^\circ$ ) angles.

Examples: pyrite, galena, halite

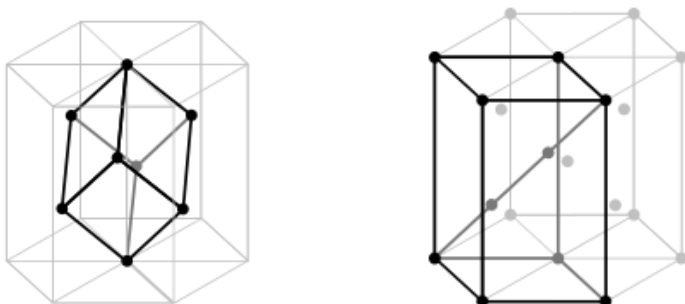


2)

“Trigonal” (“Rhombohedral”)

Similar to the cubic, but stretched in one direction.

Examples: quartz, calcite, dolomite

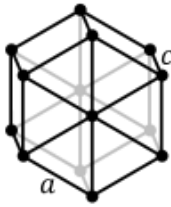




3) "Hexagonal" (6-sided)

At least one side shows a 6-sided structure.

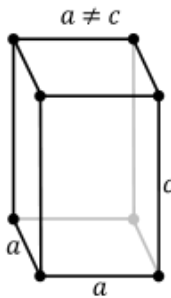
Examples: beryl, apatite



4) "Tetragonal"

Rectangular prism with a square base

Examples: rutile, zircon, wulfenite

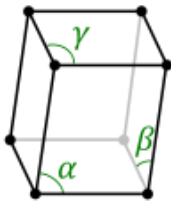


5) "Monoclinic"

Rectangular prism with a parallelogram as its base

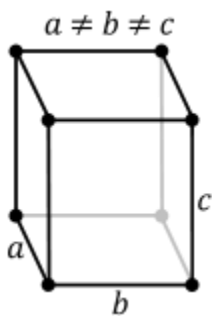
Examples: orthoclase, gypsum, sulfur

$$\beta \neq 90^\circ$$
$$\alpha, \gamma = 90^\circ$$



6) "Orthorhombic"

Rectangular prism with a rectangular base.



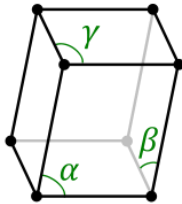


7) "Triclinic

No sides are the same length and no right angles

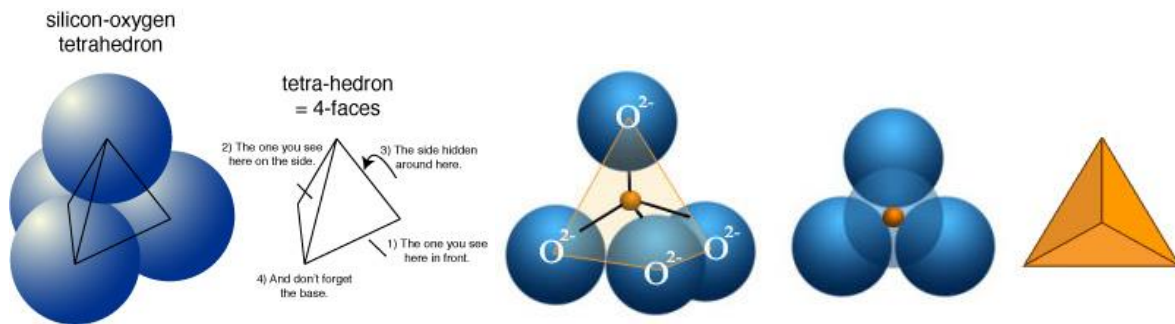
Example: microcline

$$\alpha, \beta, \gamma \neq 90^\circ$$



## Activity 2 The Silicon-Oxygen tetrahedron and other Basic Molecular Structures

Silicate minerals are the most common minerals in the crust. The basic structure in all silicates is the silicon-oxygen tetrahedron: one silicon atom surrounded by four oxygen molecules. Some ways to represent it are:



(source: <http://www.geojeff.org/course-materials/physical-geology-lab/lab-2-minerals-i/silicate-structure/si-o-tet-whole-view.jpg/image>;  
<http://www.visionlearning.com/img/library/modules/mid140/Image/VLObject-3539-060516120522.jpg>

Use your raisins and toothpicks to try to create a tetrahedron model. Draw an image of your result:



One important factor in why there are different silicate minerals is the way in which the tetrahedral attach.

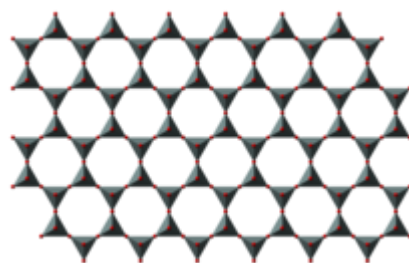
Pyroxene is an example of a single-chain silicate, in which the tetrahedral share two atoms.



Double-chain silicates form when tetrahedral share two or three atoms each. Amphiboles are one such mineral.



Sheet silicates share three oxygen atoms each and also link to form two-dimensional sheets. This creates minerals, such as muscovite and biotite micas, that easily cleave into thin [ieces.



Framework silicates share all four oxygen atoms and so create 3-D structures. Quartz and feldspars are examples of such mineral structures.

Join with others near you to try to make models of some of these structures.

What are some benefits from learning with models? What are some limitations?

How could you adapt these or other materials to represent similarities and differences in closely related minerals, such as calcite ( $\text{CaCO}_3$ ) and dolomite [ $\text{CaMg}(\text{CO}_3)_2$ ]?

What are some other common materials you could use to make molecular structures?