Lab 3 – 3 Dimensional Symmetry.

In addition to the graded exercise, there are several example boxes to get you used to looking at block models of the crystal classes. Before you begin the lab exercises, make sure to go through these examples.

Example box 1. This box contains models that fall into the hexagonal system. The hexagonal system is divided into the hexagonal and rhombohedral divisions. One model is from the hexagonal division; one is from the rhombohedral division. The rhombohedral model will have 1 3-fold axis of rotation and can sometimes have 3 mirror planes parallel to the rotation axis. There is no mirror plane perpendicular to the rotation axis. The hexagonal model has 1 6-fold axis of rotation, up to 6 mirror planes parallel to the 6-fold axis and 1 mirror plane perpendicular to the 6-fold axis. There can be up to 6 2-fold axis perpendicular to the 6-fold axis.

Example box 2. The models in this box are all isometric. These have the highest symmetry of all the classes. Use your first finger and thumb to act as the axis of rotation and turn these models every which way but loose. Many have 3 4-fold axes, up to 4 3-fold axes, and several 2-fold axes. Mirror planes are everywhere – up to 9 in some cases.

Example box 3. Tetragonal system – these models will have one 4-fold axis, 2 2-fold axis and up to 5 mirror planes, one of which is perpendicular to the 4-fold axis, the rest parallel to it. The 2-fold axes will also be perpendicular to the 4-fold axis.

Example box 4. Only 1 box of orthorhombic models. All the models will have 3 2-fold axes of rotation, all perpendicular to each other, with a mirror plane perpendicular to each axis of rotation.

Example box 5. Triclinic system, the lowest symmetry class. I challenge you to find a symmetry element in these models. (I could have slipped up and put in the wrong models – it's up to you to prove me wrong).

12.108 Lab#3: 3-Dimensional Symmetry

Definitions
centric = possessing a center of symmetry (inversion)
crystal form = a set of symmetrically equivalent faces, defined by the orientation of their poles (face normals) relative to symmetry elements
crystal system = a coordinate system defined by three noncoplanar unit translations and the angles between them, which generate a lattice of a given symmetry, compatible with translation of a subset of the 32 space point groups (see Putnis pg 12-13)

1. Cubes and related crystal forms. a) The figure below shows that a cube can "grow" from an octahedron. Many crystals with cubic symmetry display the intermediate forms which contain both cubic and octahedral faces. What does this suggest about the symmetry of these forms? Examine blocks #1, 2, 9, and 10, and sketch one each of the rotational axes on the cube and octahedron in the figure.

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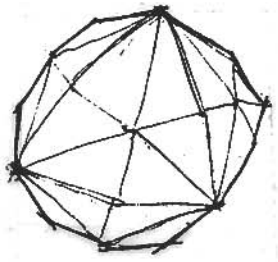
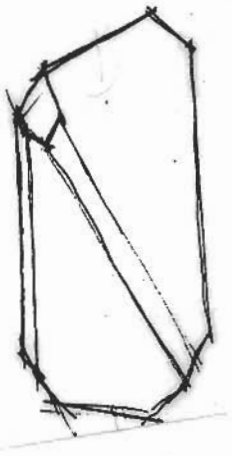
FIG. 2.25*(a)*. Schematic cross section of a crystal that grew from stage (1), a nucleus (with only *o* faces), via stages (2) and (3) to the final form of (4), with only *a* faces. The arrows are growth vectors representing the direction of fastest crystal growth. Note that the faces perpendicular to these growth vectors (*o* faces) are finally eliminated in stage (4).

(b) Illustration of the complete crystals (at the various stages 1 to 4), for which *(a)* provides the schematic cross section. The form consisting of *o* faces only is an octahedron; the one with *a* faces only is a cube; and the two intermediate forms are combinations of the octahedron and the cube in different stages of development.

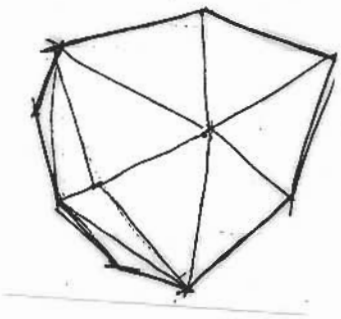
b) Examine block #7. It displays general forms of the same crystal system as the cube. Sketch the block, list all symmetry operations which produce the forms present, and identify the crystal system to which it belongs.



c) Large block #29 contains one symmetry element which also occurs in the tetrahedron. Sketch the block and identify the symmetry element, (which for this block is the only symmetry element present) showing its location.



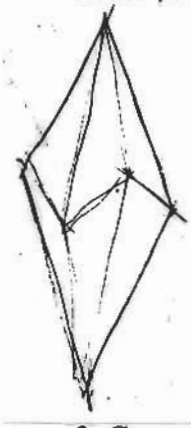
d) Block #19 is a tetrahedron, and blocks #20 and 22 display additional forms of the same crystal system. Sketch block #22 , list all symmetry operations which produce the forms present, and identify the crystal system to which it belongs.



e) Blocks #7 and 22 display general forms of the same crystal system, but are not the same. Why are they different?

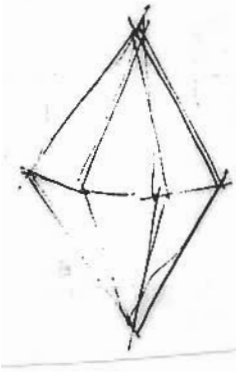
2. Calcite forms. a) Blocks #38, 39 and 41 all represent forms in which calcite crystals may grow. What are the similarities and differences between block #39 (rhombohedron) and a cube?

b) Examine block #41. Sketch the block, list all symmetry operations which produce the forms present, and identify the crystal system to which it belongs..



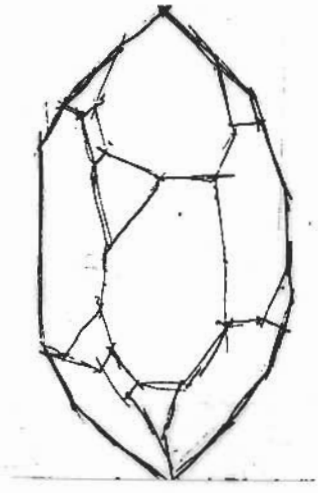
3. Corundum forms. a) Blocks #50 and 51 represent forms common to corundum. What are the similarities and differences between blocks #51 and 41 (from the calcite box)?

b) Examine block #51. Sketch the block, list all symmetry operations which produce the forms present, and identify the crystal system to which it belongs.

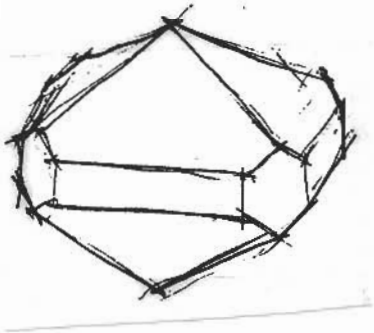


4. Quartz forms. a) Large blocks #15 and 16 display general forms of quartz. What is the difference between the two blocks?

b) Sketch one of the blocks, list all symmetry operations which produce the forms present, and identify the crystal system and space point group to which it belongs..

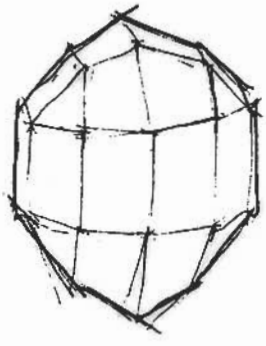


5. Zircon forms. a) Block #34 is almost identical in form to the sample zircon crystal. Sketch the block, list all symmetry operations which produce the forms present, and identify the crystal system to which it belongs.

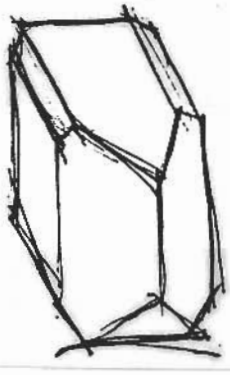


6. Symmetry groups with low equipoint numbers.

a) Block #69 displays some of the forms common to olivine. Sketch the block, list all symmetry operations which produce the forms present, and identify the crystal system to which it belongs.



b) Block #77 displays some of the forms common to feldspars. Sketch the block, list all symmetry operations which produce the forms present, and identify the crystal system to which it belongs.



c) Examine block #84. Sketch the block, list all symmetry operations which produce the forms present, and identify the crystal system to which it belongs.