Mathematics 308
Assignment 6
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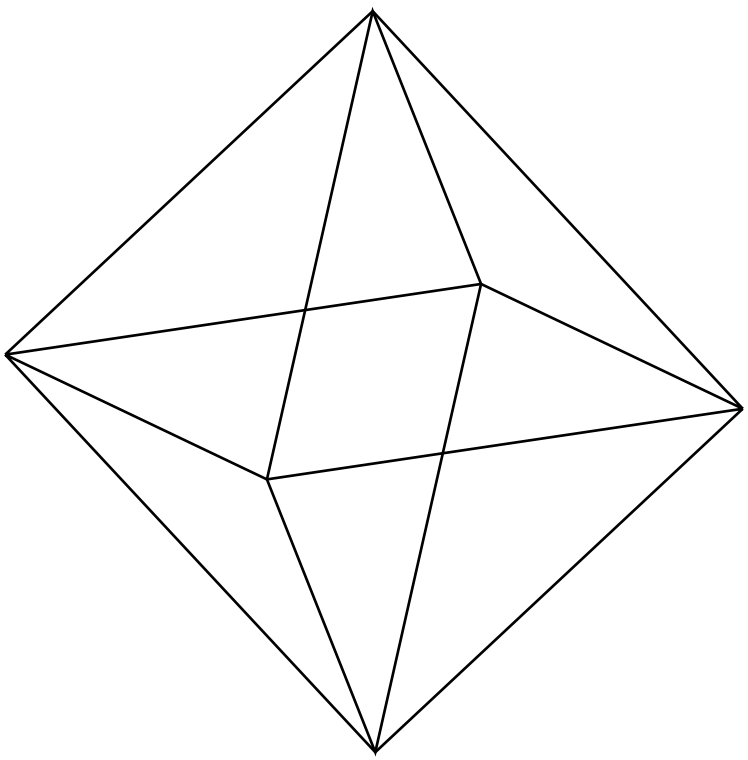
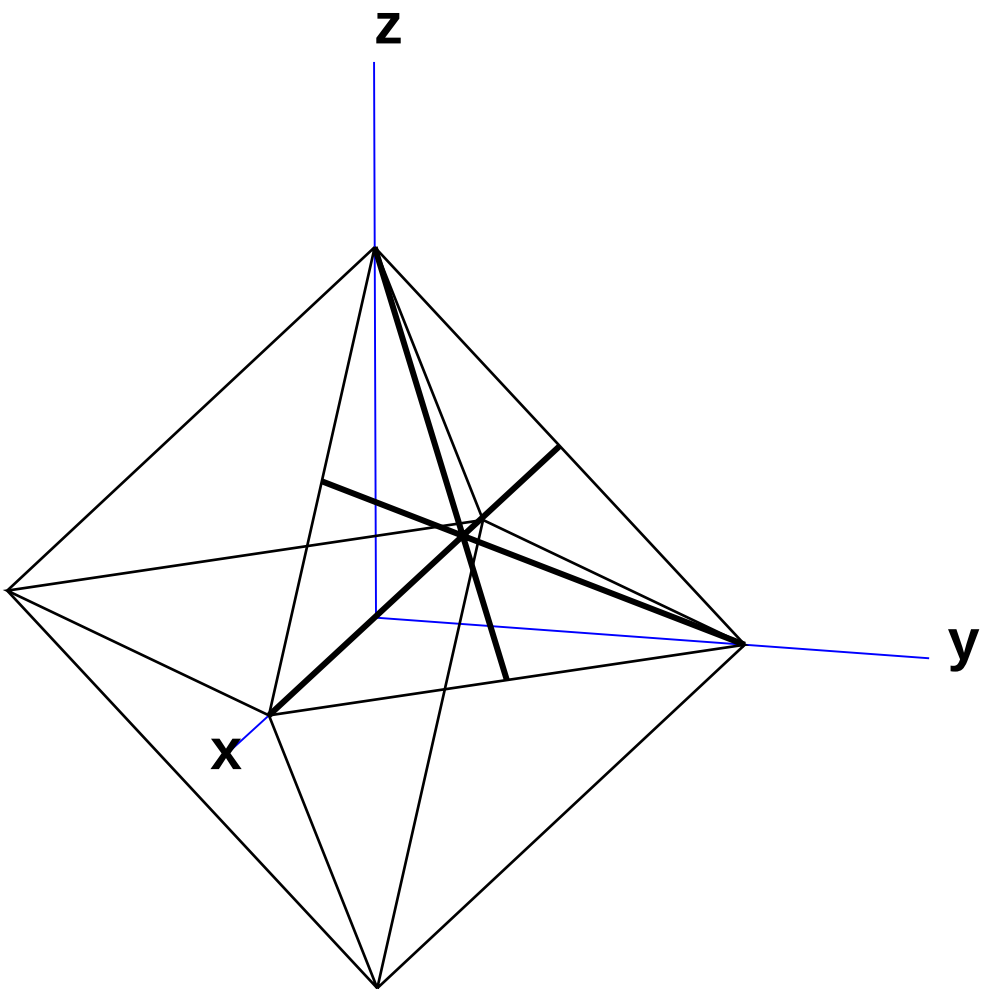
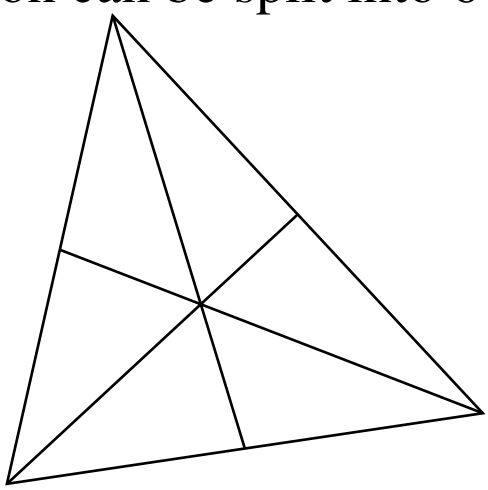




Notice that each face of the octahedron can be split into 6 triangles which are actually identical to each other. Thus each face produces 6 symmetries. So in total, an octahedron has 6 x 8 faces = 48 symmetries.



Thus there are 48 symmetries. In the next pages I will illustrate examples of these symmetries. Infact, the octahedron contains 48 symmetries which can be classified into 10 different groups.

They are:

E = the identity symmetry element. As its name implies it is the molecule or geometric structure itself.

C2 = a rotation axis that rotates 360/2 = 180 degrees. Thus 2 rotations will produce an identical image.

C2' = is an axis perpendicular to the principal axis, the largest Cn axis, which in the octahedron's case is the C4.

C3 = also a rotation axis which rotates 360/3 = 120 degrees. So 3 rotations will produce an identical image.

C4 = a rotation axis which rotates 360/4 = 90 degrees. This is the principle axis for the octahedron.

i = the center of symmetry. This causes inversion of all points through the center of symmetry, for the octahedron, it's the center atom.

sigma-h = the reflection plane perpendicular to the principal axis.

sigma-d = a reflection plane which bisects the C2 axis perpendicular to the principal axis and contains the principal axis.

S4 = contains a rotation by 360/4 = 90 degrees and then reflection in a plane that is perpendicular to the rotation axis.

S6 = similar to the S4 but rotation by 360/6 = 60 degrees and then followed by a reflection through a plane perpendicular to the rotation axis.

For simplicity, I have constructed each octahedron by web model so that it would be easier to visualize the movement of the vertices. Note that in Chemistry, this technique of symmetry elements is used to determine symmetry on molecules. Hence each vertex represents an atom labelled A, B, C, D, E, F, G. Since this is a regular octahedron, each atom is assumed to be the same, in order to belong to the octahedron point group Oh. In a molecule, the entire set of symmetry operations is known as a Point Group. This is important in chemistry where the symmetry is used to determine molecular structure by spectroscopic methods such as infrared and UV spectra.