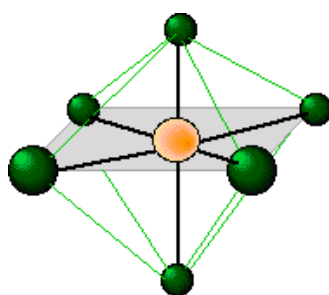


OCTAHEDRAL COORDINATION

Just as four electron pairs experience the minimum repulsion when they are directed toward the corners of a tetrahedron, six electron pairs will try to point toward the corners of an **octahedron**. An octahedron is not as complex a shape as its name might imply; it is simply two square-based pyramids joined base to base. You should be able to sketch this shape as well as that of the tetrahedron.



The shaded plane shown in this octahedrally-coordinated molecule is only one of three equivalent planes defined by a four-fold symmetry axis. All the ligands are geometrically equivalent; there are no separate axial and equatorial positions in an AX₆ molecule.

At first, you might think that a coordination number of six is highly unusual; it certainly violates the octet rule, and there are only a few molecules (SF₆ is one) where the central atom is hexavalent. It turns out, however, that this is one of the most commonly encountered coordination numbers in inorganic chemistry. There are two main reasons for this:

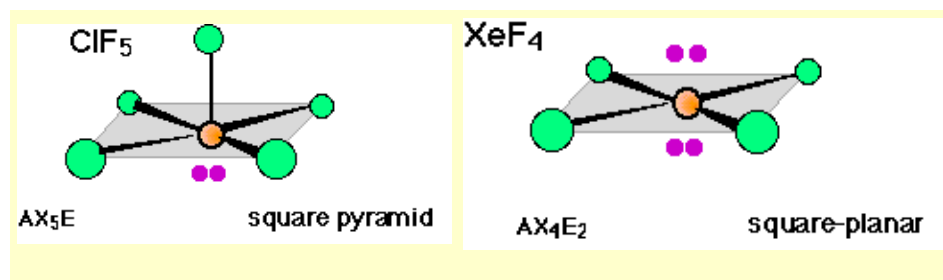
- Many transition metal ions form coordinate covalent bonds with lone-pair electron donor atoms such as N (in NH₃) and O (in H₂O). Since transition

elements can have an outer configuration of d^10s^2 , up to six electron pairs can be accommodated around the central atom. A coordination number of 6 is therefore quite common in transition metal hydrates, such as $\text{Fe}(\text{H}_2\text{O})_6^{3+}$.

- Although the central atom of most molecules is bonded to fewer than six other atoms, there is often a sufficient number of lone pair electrons to bring the total number of electron pairs to six.

Octahedral coordination with lone pairs

There are well known examples of 6-coordinate central atoms with 1, 2, and 3 lone pairs. Thus all three of the molecules whose shapes are depicted below possess octahedral coordination around the central atom. Note also that the orientation of the shaded planes shown in the two rightmost images are arbitrary; since all six vertices of an octahedron are identical, the planes could just as well be drawn in any of the three possible vertical orientations.



Source: <http://www.chem1.com/acad/webtext/chembond/cb05.html>