11.7: Geometry in Transition Metal Complexes

If you have studied Lewis structures, then you know that the number of lone pairs and atoms around a specific atoms tells you the geometry at that specific atom. Something very similar is true in coordination complexes, but it's slightly simpler. In transition metal complexes, the lone pairs on the metal do not contribute to the metal complex's overall geometry. All that matters is the number of ligands attached to the metal.

- In coordination complexes, the number of ligands determines the geometry.

As a result, there is a pretty straightforward correlation between coordination number (the number of ligands) and geometry.

# ligands	**geometry**
2	linear
3	trigonal planar
4	tetrahedral; sometimes square planar
5	trigonal bipyramidal; sometimes square pyramidal
6	octahedral

There are two exceptions to that straightforward rule. Coordination number four and coordination number five both have two possible geometries. How do we know which will happen?

For coordination number five, we really can't make an easy prediction. In terms of the angles between ligands, these two possible geometries are really pretty close to each other, so the distinction is subtle. If you call everything that's five-coordinate a trigonal bipyramidal geometry, you will be in the right ballpark.

Coordination number four is a different story; we do have some predictive ability here. However, there are two different factors that come into play, so there are still some subtle cases.

The first factor is sterics or crowding. In a tetrahedron, the four ligands are 109 degrees away from each other. In square planar geometry, the four ligands are only 90 degrees away from each other. Since a tetrahedral geometry is less crowded, sterics makes this geometry more favorable and common.

To form a square planar geometry, there has to be some factor that offsets the steric preference for tetrahedral geometry. Electronic destabilization can occur in tetrahedral geometry. The same goes for square planar geometry; however, destabilization occurs to a lesser extent when there are eight electrons on the metal in this geometry. As a result, square planar geometry is most common when the metal has eight electrons.

See a more in-depth discussion of coordination complexes in a later course.