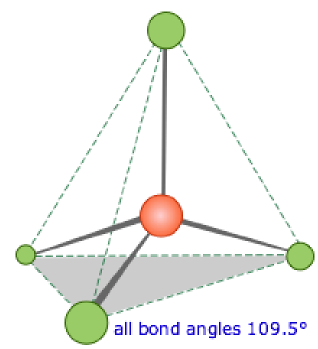
TETRAHEDRAL COORDINATION

Methane, CH_4, contains a carbon atom bonded to four hydrogens. What bond angle would lead to the greatest possible separation between the electron clouds associated with these bonds? In analogy with the preceding two cases, where the bond angles were 360°/2=180° and 360°/3=120°, you might guess 360°/4=90°; if so, you would be wrong. The latter calculation would be correct if all the atoms were constrained to be in the same plane (we will see cases where this happens later), but here there is no such restriction. Consequently, the four equivalent bonds will point in four **geometrically equivalent directions** in three dimensions corresponding to the four corners of a **tetrahedron** centered on the carbon atom. The angle between any two bonds will be 109.5°.

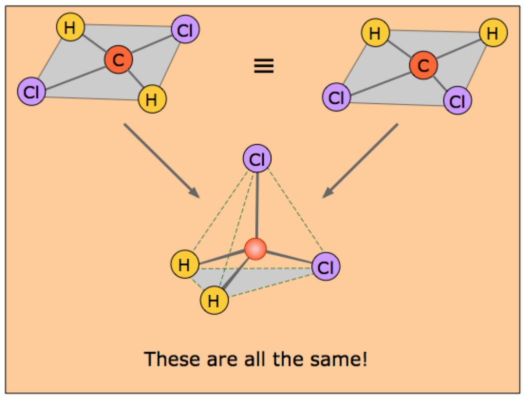


This is called **tetrahedral coordination.**

This is the most important coordination geometry in Chemistry: it is imperative that you be able to sketch at least a crude perspective view of a tetrahedral molecule.

It is interesting to note that the tetrahedral coordination of carbon in most of its organic compounds was worked out in the nineteenth century on purely geometrical grounds and chemical evidence, long before direct methods of determining molecular shapes were developed.

For example, it was noted that there is only one dichloromethane, CH_2Cl_2.



If the coordination around the carbon were square, then there would have to be two isomers of CH_2Cl_2, as shown in the pair of structures here. The distances between the two chlorine atoms would be different, giving rise to differences in physical properties would allow the two isomers to be distinguished and separated.

The existence of only one kind of CH_2Cl_2 molecule means that all four positions surrounding the carbon atom are geometrically equivalent, which requires a tetrahedral coordination geometry. If you study the tetrahedral figure closely, you may be able to convince yourself that it represents the connectivity shown on both of the "square" structures at the top. A three-dimensional ball-and-stick mechanical model would illustrate this very clearly.

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