

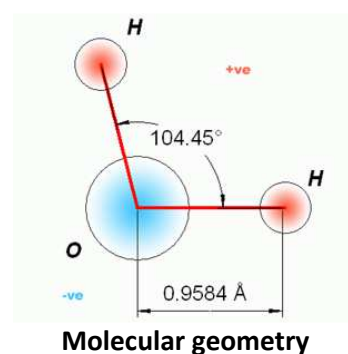
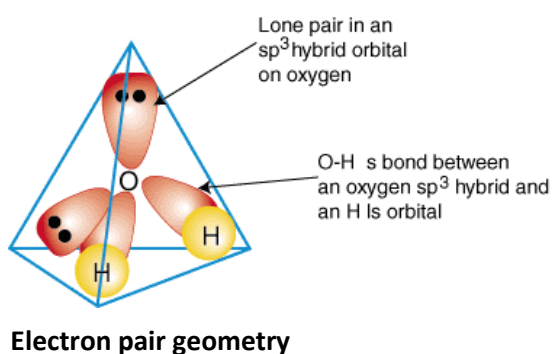
## Answer on Question #42760 - Chemistry - Inorganic Chemistry

### Question:

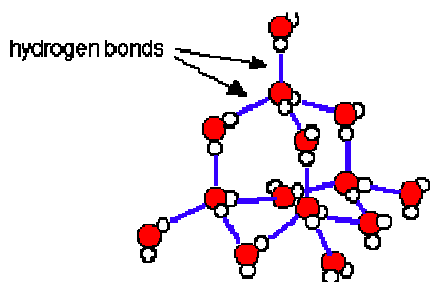
Why bond angle in Ice (109 degree) is more than water (104.5 degree)?

### Answer:

Each O–H covalent bond of a water molecule is formed by the overlap of a 1s orbital of a hydrogen atom with one of the singly occupied  $sp^3$  hybrid orbitals of the oxygen atom. So, two of the six outer-shell electrons of oxygen form covalent bonds with hydrogen atoms, another four forms two lone pairs orbitals. To minimize repulsion between the four orbitals surrounding the oxygen they tend to arrange themselves as far from one another as possible. So, electron pair geometry of water is tetrahedral. The tetrahedron, however, is not regular and somewhat distorted, because repulsion force between the orbitals of lone pairs is stronger than that between the orbitals forming O–H bonds. Consequently, bond angle in water is equal to  $104.5^\circ$ :



The reason why bond angle in ice is more than in liquid water is related to hydrogen bonding. When water turns to ice, water molecules in solid state form regular arrangement due to strong hydrogen bonds between the molecules. In this arrangement every hydrogen atom is involved in hydrogen bond and every oxygen atom is involved in two hydrogen bonds:



The four hydrogen bonds around an oxygen atom form a regular tetrahedron in a fashion found in the diamond (thus, ice and diamond are somewhat topologically related). To form regular tetrahedron the angles must be equal  $109^\circ$ .