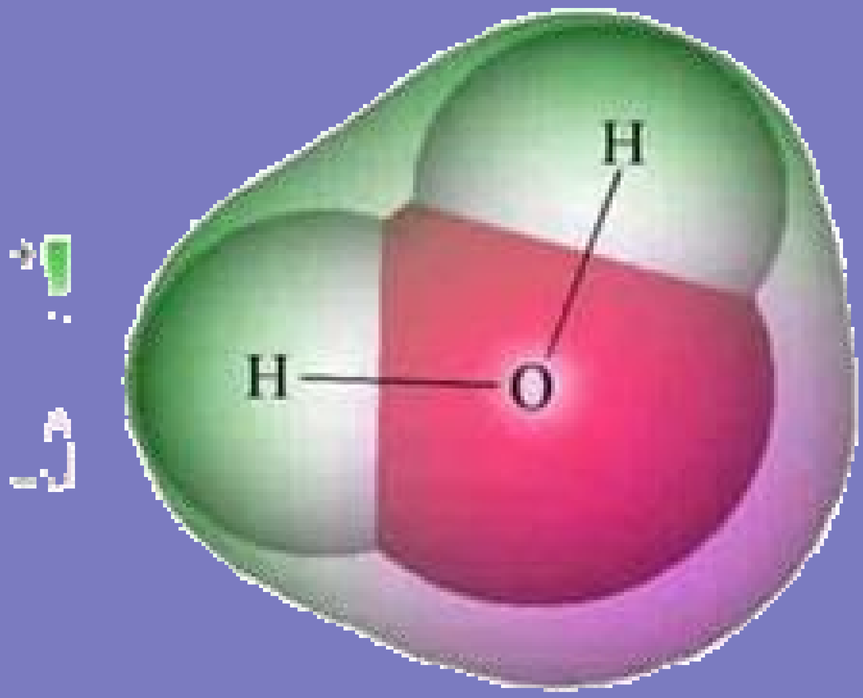
COVALENT BONDING



COVALENT BONDING

Consist of pairs of electrons shared between non metal atoms

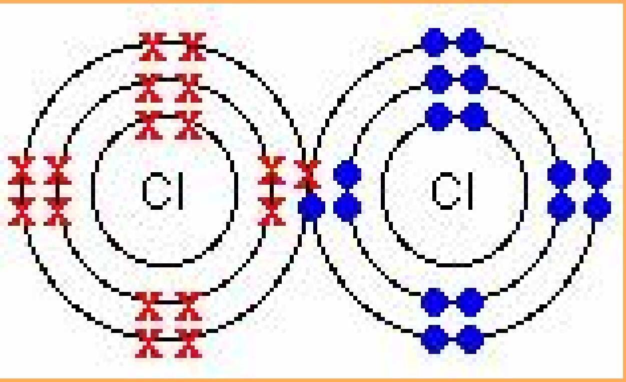
The importance of noble gas structures

As well as achieving noble gas structures by transferring electrons from one atom to another as in ionic bonding, it is also possible for atoms to reach these stable structures by sharing electrons to give covalent bonds.

Some very simple covalent molecules

Chlorine

For example, two chlorine atoms could both achieve stable structures by sharing their single unpaired electron as in the diagram.



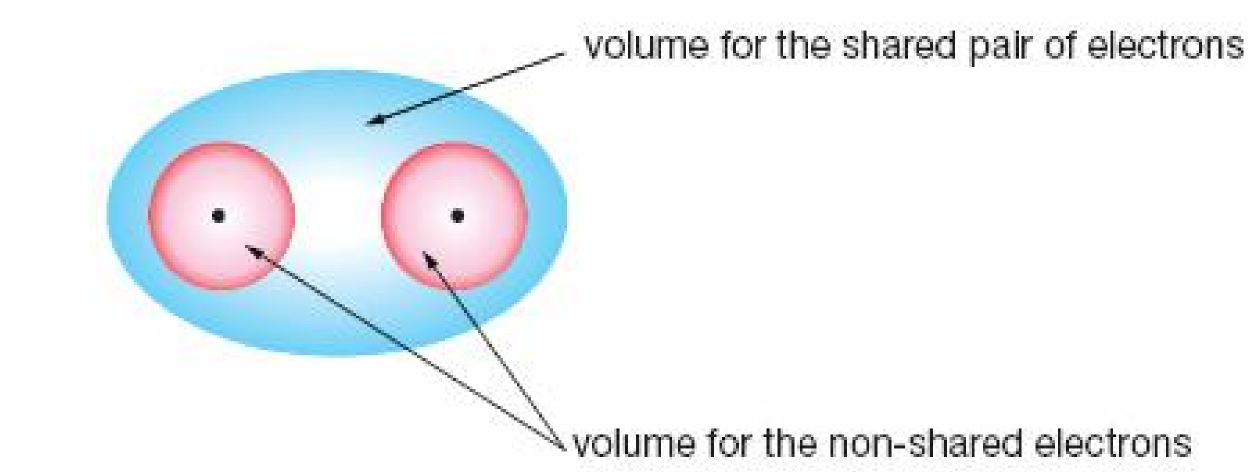
The fact that one chlorine has been drawn with electrons marked as crosses and the other as dots is simply to show where all the electrons come from. In reality there is no difference between them.

The two chlorine atoms are said to be joined by a covalent bond. The reason that the two chlorine atoms stick together is that the shared pair of electrons is attracted to the nucleus of both chlorine atoms.

Two chlorine atoms combine to form a chlorine molecule.
A chlorine atom, with electron confi guration (2, 8, 7) (see Table 1.9 on p. 189), tends to gain one electron to acquire the confi guration of argon (2, 8, 8). Two chlorine atoms can combine to form a chlorine molecule, Cl_2, by sharing a pair of electrons with each atom contributing one electron to the shared pair. Each atom 'considers' that it 'owns' the shared pair and thus counts both members of the pair to determine that it has a noble gas confi guration.

Cl (2, 8, 7) + Cl (2, 8, 7) $\rightarrow$ Cl (2, 8, 6) + shared pair + Cl (2, 8, 6)

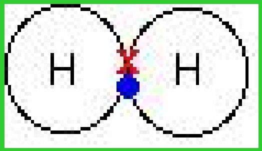
This shared pair of electrons occupies a volume of space that surrounds both atoms. By moving around both nuclei these electrons hold the atoms together and so form a **chemical bond**. This is illustrated in Figure 2.2. The rest of the electrons (that is, the unshared ones) remain in volumes of space that surround one nucleus only.



Each chlorine atom in the chlorine molecule now ‘considers’ that it has the configuration (2, 8, 8) and is therefore ‘satisfied’. This bonding which results from sharing pairs of electrons is called covalent bonding. Each pair of shared electrons is called a covalent bond and is denoted by a dash. Molecular chlorine has the structure:

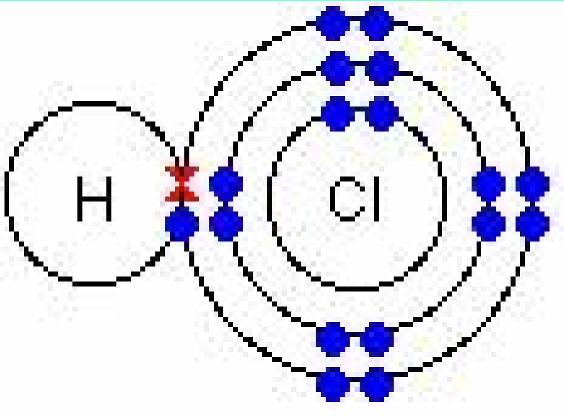
Cl—Cl

Hydrogen

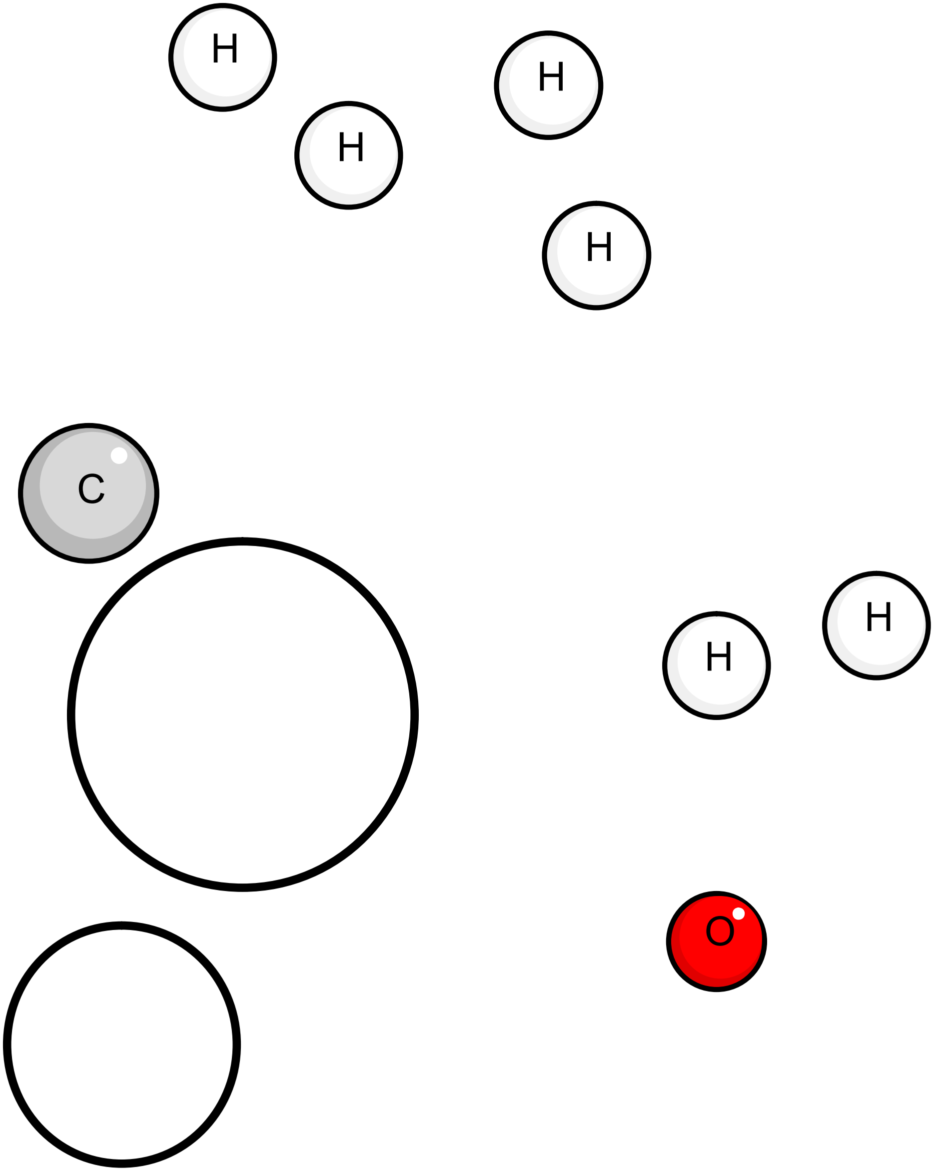


Hydrogen atoms only need two electrons in their outer level to reach the noble gas structure of helium. Once again, the covalent bond holds the two atoms together because the pair of electrons is attracted to both nuclei.

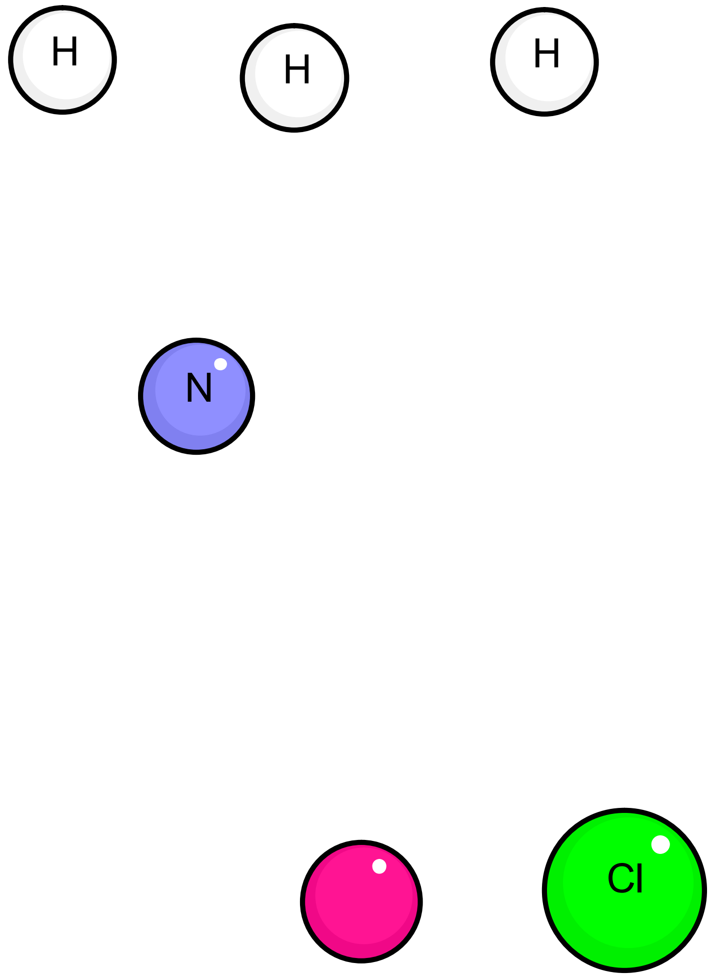
Hydrogen chloride

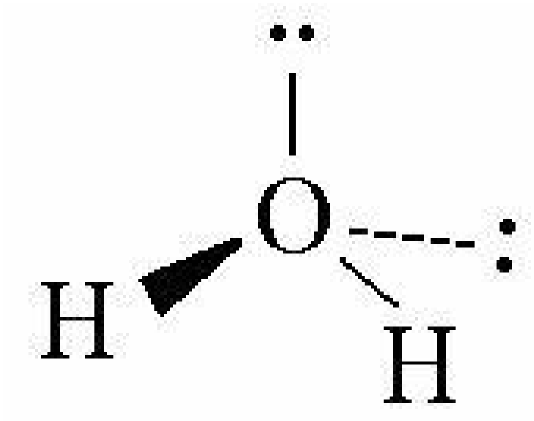


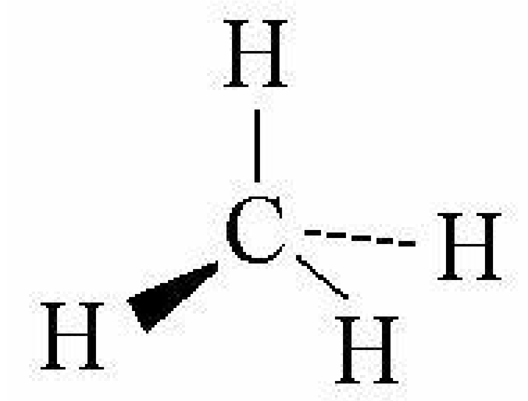
The hydrogen has a helium structure, and the chlorine an argon structure.

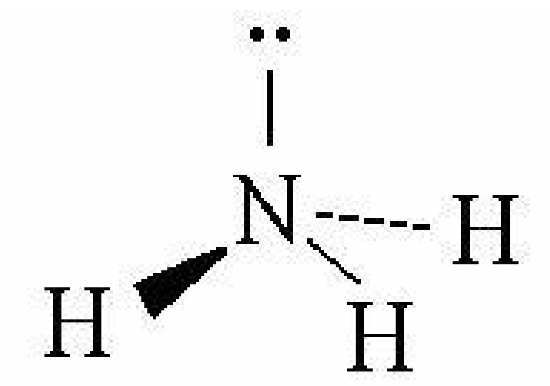


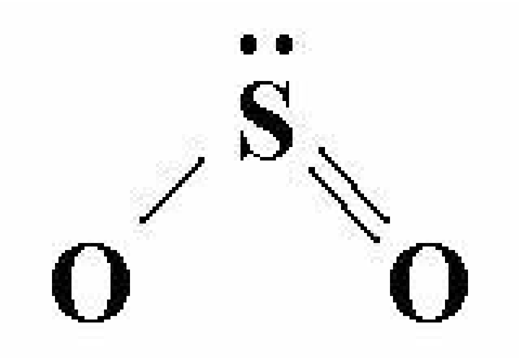
Showing 2D molecules

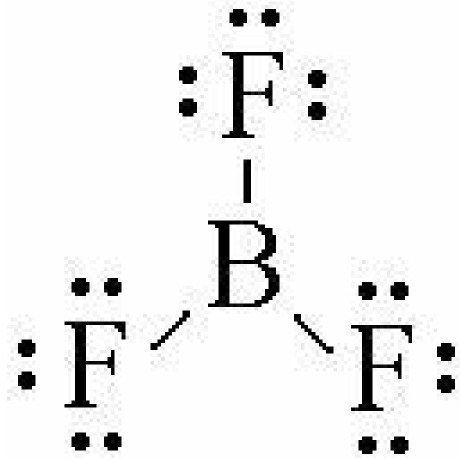

H
H
H
N
Cl

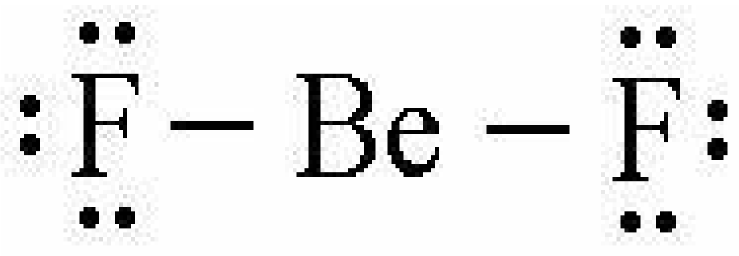

O
H
H

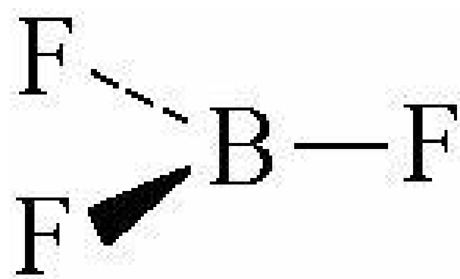

H
C
H
H
H


N
H
H
H


S
O
O


F
B
F
F


F
Be
F


F
B
F
F

Electron Dot Diagrams

VSEPR - A Summary

Valence Shell Electron Pair Repulsion (VSEPR) theory allows the Chemist to predict the 3-dimensional shape of molecules from knowledge of their Lewis Dot structure. In VSEPR theory, the position of bound atoms (ligands) and electron pairs are described relative to a central atom. Once the ligands and lone pair electrons are positioned, the resulting geometrical shape presented by the atoms only (ignoring lone pairs) is used to describe the molecule. Only the bonding pairs determine the final shape. The lone pair(s) will influence this shape
The last slide showing examples of the most common geometries encountered using the VSEPR theory.

Only lone pair electrons on the central atom are shown.

Electron Dot Diagrams

Total Number of **Atoms + Lone pairs** around central atom	Geometry			
No Central Atom	Linear O_2 N_2	With Lone Pairs O_2 N_2		
2	Linear CO_2			
3	Trigonal Planar BF_3	Bent SO_2		
4	Tetrahedral CH_4	Pyramidal NH_3	Bent H_2O	
5	Trigonal Bipyramidal PF_5	See-saw SF_4	T-Shaped ClF_3	Linear XeF_2
6	Octahedral SF_6	Square Pyramidal BrF_5	Square Planar XeF_4	