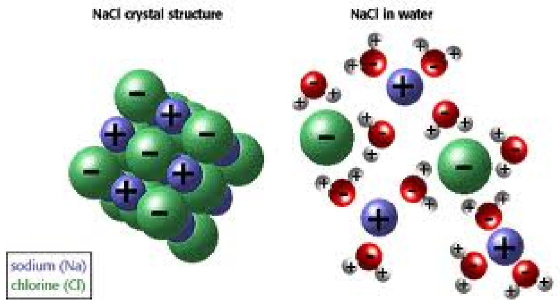
8.1 - 8.4 - Types of Chemical Bonds



Intro to Chemical Bonds

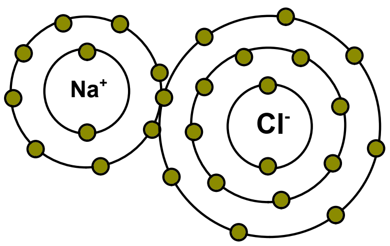
The vast array of different chemical compounds requires joining atoms at the electronic level during bonding.

The chemical bonds can be classified broadly into three types, depending on the degree of electron transfer:
A. Ionic Bond: total transfer of electron from one atom to another.
B. Covalent Bond: sharing of electrons between bonded atoms.
C. Polar Covalent Bond: partial sharing of electrons in a bond results in lopsided charge distribution.

Other attractive forces exist that we will meet later.

Ionic Bond

Electrostatic force that holds oppositely charged particles together.
Ionic Compounds: Electrically neutral substance bound by ionic bonds. No net charge.
As single representative particle of an ionic compound is a formula unit.



Common Binary Ionic Compounds

Def: ionic compounds made of only two elements.

Table salt: sodium chloride (NaCl)

Fluorite (mineral): calcium fluoride (CaF_2) - used in toothpaste.

Lime (cement): calcium oxide (CaO)

Covalent Bonds

Covalent Bonds form in non-ionic compounds where pairs of electrons are shared, not lost or gained.

Whatever type of bond is observed, atoms tend to gain stability (won't react) by following the octet rule - having eight valence electrons.

Molecule: A group of covalently-bonded elements.
(Ionic compounds = formula unit)

1. Example: How many electrons gained in:

O?	Cl?	P?
2	1	3

Bond Character

Chemical bonds are not totally ionic or covalent: it depends on how atoms attract electrons.

Absolute difference in electronegativity (atom's ability to attract electrons in a bond) defines bond type.

Note: in formulas, typically the least electronegative element is written first, followed by the most electronegative. Ex: HCl

Table of Bonds

A general numeric guide to bond character is provided.

It's reliant on finding the difference between the electronegativity values of two bound atoms.

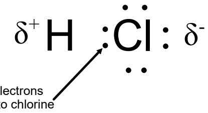
Electronegativity Difference	Bond Character
> 1.9	Mostly Ionic
0.4 - 1.9	Polar Covalent
≤ 0.4	Mostly Covalent
0.0	Nonpolar Covalent

Polar Covalent Bonds

When two atoms share electrons unequally, the result is a dipole moment: a molecule with charged ends.

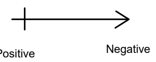
Partial charges are present on a molecule due to lopsided electron distribution.

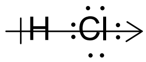
The charged ends of the molecule are labeled with δ^+ if it's positive or δ^- if it's negative (delta).



A dipole is denoted with an arrow pointing towards the negatively charged end.

2. Draw HCl, showing positive and negative ends.

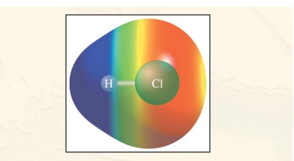
Symbol: 



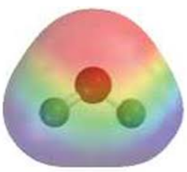
Electrostatic Potential Maps

Molecules with a permanent dipole moment (rather than a transient one) can be mapped out, with electron-rich (negative) regions indicated in red, and electron-poor (positive) regions indicated in blue.

Here, HCl and water are shown. If your picture is not in color, chlorine and oxygen are negative.



HCl

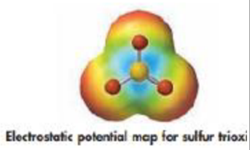


Water

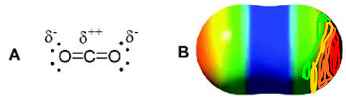
Electrostatic Potential Maps

Molecular shape contribute to dipole moments. Symmetric molecules distribute charge evenly, so even if they have polar bonds, they will not have a permanent dipole moment (think: tug-of-war).

Example: SO_3. This forms a planar molecule (we will explore shapes later on in this chapter), with equal bond angles. The map:



Carbon dioxide is linear, oxygen atoms pull on carbon from both directions equally.



Properties of Covalent Compounds

A. Polar compounds dissolve in polar solvents (acetone, water, ammonia - etc).

B. Non-polar compounds dissolve in non-polar solvents. (vegetable oil, gasoline, turpentine, mineral oil, etc.)

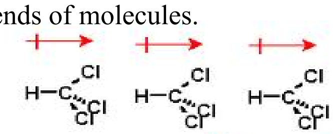
C. Dissimilar compounds tend not to dissolve in each other (oil and water, lava lamp).

Properties of Covalent Compounds

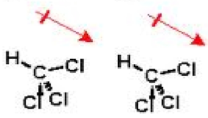
D. Covalent compounds have lower melting and boiling temperatures than ionic compounds.

E. Exhibit different intermolecular forces:

I. Dipole–dipole: attraction between positive and negative ends of molecules.

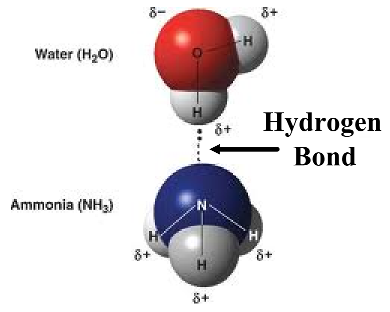


Dipole-Dipole Attraction



Properties of Covalent Compounds

II. Hydrogen bond. A dipole-dipole force where the positive end is a hydrogen atom; the negative end is either fluorine, oxygen, or nitrogen.



Homework

Preview 8.5 - 8.12

8.1 - 8.4 Problems in your Booklet
Due: Next Class