# Forming Compounds

- Atoms bond to form **stable octets** -- filled p&s orbitals in the highest energy level
- When a bond is formed, energy is released (heat, light).
- To undo a bond, you must put in energy -- called the **bond energy** and is measured in kJ/mol

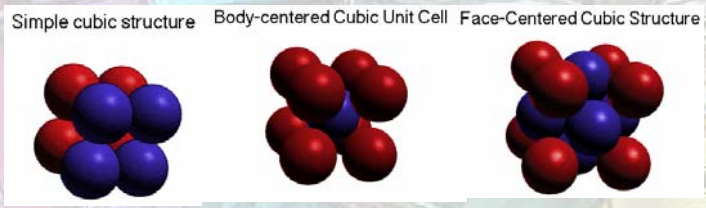
# Forming Compounds

<u>Ionic Bonds</u>

- An ionic bond in NaCl:
  - Na gives up one electron (becomes $2s^2 2p^6$)
  - Cl gains one electron (becomes $3s^2 3p^6$)
  - Both get a stable octet
- Ionic bonds happen between oppositely charged ions
- Ionic compounds are electrically neutral
- **Salts** are ionic compounds containing ions other than $H^+$, $OH^{-1}$, $O^{-2}$

# Forming Compounds

- Salts form crystal forms -- **lattices**.
- **Unit cell** is the smallest part of the crystal lattice that still shows shape of the overall lattice
- Some examples: (images from http://www.okstate.edu/jgelder/solstate.html




Ex.: most metals (atoms must be same size for sc to form)

Ex.: CsCl

Ex.: NaCl

# Forming Compounds

- Salts have high melting points and boiling points because they have very strong bonds (needs a lot of energy to break the bonds)
- Salts are hard and brittle -- strong bonds in crystal structure do not allow movement

# Forming Compounds

Covalent Bonds

- Covalent compounds are formed by elements sharing electron pairs so that each element has eight electrons surrounding it.
- We will see more of how this works when we talk about Lewis Diagrams…

# Other Bond-Like Forces

**Van der Waals Forces** – weak intermolecular forces. See types below…

- **Dipole-dipole forces** attract polar molecules to one another (we'll talk about polarity soon).

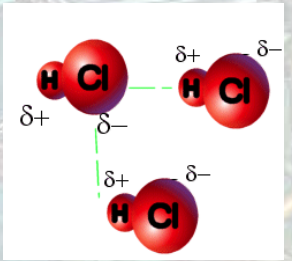
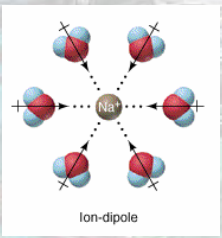



Image from http://www.teachmetuition.co.uk/Chemistry/Intermolecular/dipole.htm

# Other Bond-Like Forces

- **Ion-Dipole forces** attract an ion (+ or -) to a polar molecule. Example: $Na^+$ and $Cl^-$ ions aligning themselves with dipoles of water molecule.

Image from http://www.science.uwaterloo.ca/~cchieh/cact/c123/intermol.html




- See animation at http://www.chem.iastate.edu/group/Greenbowe/sections/projectfolder/flashfiles/thermochem/solutionSalt.html

# Other Bond-Like Forces

- **London Dispersion forces** attract nonpolar molecules or atoms by temporary induced dipoles

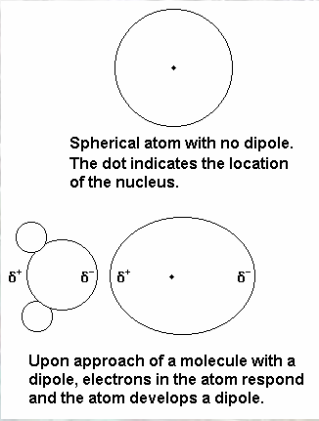
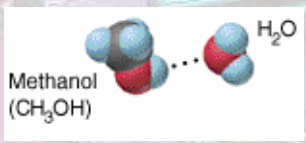



Image from:
http://www.chem.purdue.edu/gchelp/liquids/inddip.html

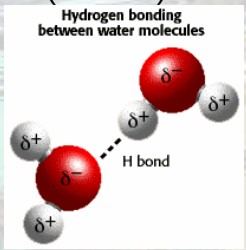
## Other Bond-Like Forces

**Hydrogen Bonds** – a special type of dipole-dipole interaction between a hydrogen in a polar bond and an O, N, or F atom (note that they are very electronegative).

- H-bonds can affect boiling point (raises it)




Left image from:
http://www.science.uwaterloo.ca/~cchieh/cact/c123/intermol.html
Right image from:
http://www.biology.arizona.edu/biochemistry/tutorials/chemistry/page3.html




## Other Bond-Like Forces

**A nice summary of intermolecular forces:**

http://www.wisc-online.com/objects/index_tj.asp?objID=GCH6804

## Polarity

- How can you tell if a bond or molecule is ionic or covalent? You can use electronegativity.
- Here are the rules:
- If the difference in electronegativities of the two elements is greater than 1.7, then the bond is ionic.
  - The compound will have a crystal lattice
  - Soluble in polar solvents, insoluble in nonpolar solvents

## Bond Polarity

- If the difference in electronegativities of the two elements is between 0.4 and 1.7, then the bond is polar covalent. You can then slice up that category into 3 sections and have weakly polar, polar, and strongly polar covalent categories.

## Polarity

If the difference in electronegativities of the two elements is less than 0.4, then the bond is nonpolar covalent.

➢The substance will be soluble in nonpolar solvents and insoluble in polar solvents.

| Nonpolar Covalent | Polar Covalent | Ionic |
|---|---|---|
| <0.4 | 0.4-1.7 | >1.7 |

## Polarity

➢If the effective poles are not in the same position, then the molecule will be a dipole with effective charges, like $H_2O$. It will then, in effect behave like an ionic compound in regard to solubility.


## Polarity

➢If the effective poles are in the same position, then the molecule has no molecular dipole and no effective charge and behaves as if it were nonpolar. Example is $CCl_4$ (draw)

## Polarity

Keep in mind that the definition of polar/nonpolar is a spectrum – it ranges from zero polarity to more and more polar. Chemists set the boundaries and definitions. For example, a bond with an electroneg. difference of 1.65 is defined as polar covalent, but is it that different than a bond with electronegativity difference of 1.75? No. They would actually have very similar properties even though one would be defined as covalent and the other defined as ionic.