Non-covalent Molecular Forces Summed Up!

(INCLUDES HINTS FROM AAP TUTORING!)

First off, there are 7 main types of non-covalent forces.

To make it slightly easier, they are listed in order of the strength of their force:

1. Cation-anion (ionic bonds)
2. Hydrogen Bonding
3. Dipole-Dipole
4. Cation-pi
5. Ion-Dipole
6. Pi/Aromatic Stacking
7. London (dispersion) Forces

These forces are important because they lead to different physical properties (i.e. boiling point, melting point, etc.)

Here’s an overview of each:

1. **Cation-anion (Ionic) Bonds**
   *These are bonds between **electrostatic forces** *(when opposite charges (+/-) attract)*
   *An ionic bond is a highly unequal sharing of electrons
   *Usually atoms on the opposite sides of the Periodic Table have ionic/cation-anion interactions.
   *So, more they are on opposite sides of P.T. = bigger difference in electronegativity = more of a cation-anion interaction.

   **Example:** Typical, NaCl

   Na+ has 1 electron, Cl- has 7 \rightarrow Na gives Cl its one electron to make Cl happy, so Na becomes Na+ (because it LOST an e-) and Cl becomes Cl- (because it GAINED an e-).
2. Hydrogen Bonding

*The one in DNA!

*NEED HYDROGENS TO HYDROGEN BOND!!

*STRONGEST WHEN LINEAR!

*There’s a hydrogen donor and acceptor. The gist:

- **Donor**
  - a large $\delta^+$
  - Be attached to an atom with a high electronegativity; O or N only!! (for 14C at least)

- **Acceptor**
  - must have high $\delta^-$ to attract $\delta^+$
  - MUST HAVE LONE PAIR, can be O or N
  - Anions are acceptors.

**NOTE:** What is a molecule with H’s in it that can’t be Hydrogen Bonded???

**Good answer:** CH4 (any answer in which H is connected to ZERO O’s or N’s will work!)
3. **Dipole-Dipole**
   *oppositely charged ends of 2 bond dipoles attract*
   *Another way to phrase it: ATTRACTIVE FORCES BETWEEN POLAR BONDS*

4. **Cation-pi bonding**
   *Literally, a cation (positively charged atom) attracted to a pi electron cloud*
   EXAMPLE: Na+ being attracted to a benzene ring with pi bonds
5. **Ion-Dipole**
*Bond dipole attracted to an anion (negatively charged atom) OR cation*
*Cation to negative dipole of a molecule*
*Anion to positive dipole of a molecule*
EXAMPLE: like salt in water

![Benzene Diagram](http://proteopedia.org/wiki/images/d/d2/Cation-pi-dougherty.jpg)

![Bond Dipole](http://www.chem.purdue.edu/gchelp/liquids/ions.gif)

6. **Pi/Aromatic Stacking**
*Between aromatic rings*
*important in DNA!*
*The rings line up at different parts of the ring*
7. London (dispersion) forces
*WEAKEST FORCE
*Present in almost all molecules (at the least, it has London forces)
*deals with electrostatic interaction (so since all molecules have electrons, this bond is at least present)
*TEMPORARY
*2 influences
  - **POLARIZABILITY**
    - *How easily an electron cloud is distorted*
    - Is it hard or soft?? (soft=distortion easy, hard=distortion hard)
    - HIGHER ELECTRONEGATIVITY = harder
    - LARGER RADIUS = softer

Larger atomic radius→more polarizable→higher boiling point→more London forces

- **SURFACE AREA**
  - INCREASING s.a. = INCREASING London force

More elongated → higher surface area → higher boiling point!
*This is where Argon (or any other monoatomic gas, etc) comes in → type of Van der Waal’s interaction

London dispersion force (I2 bond)

http://www.dlt.ncssm.edu/tiger/diagrams/bonding/LondonDispersionForce_I2_bond.jpg

These green-boxed, maroon-colored notes are thanks to Jennifer D., one of the Chem 14C tutors in AAP. She is aware of the sharing of these notes.