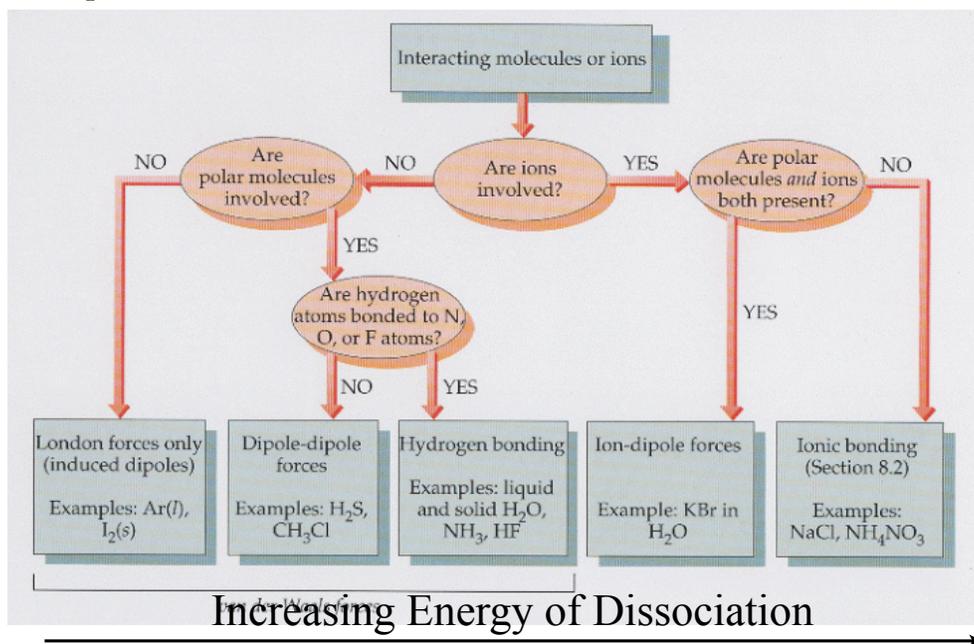


Intermolecular Forces

Intermolecular Forces

Summary

- Dispersion forces are found in all substances



Intermolecular Forces

The Basics

- Two types of electrostatic forces
- Intramolecular forces
 - Forces that exist within ionic and molecular particles
 - Ionic bonds
 - Covalent
 - High energies of dissociation
 - Strong

Intermolecular Forces

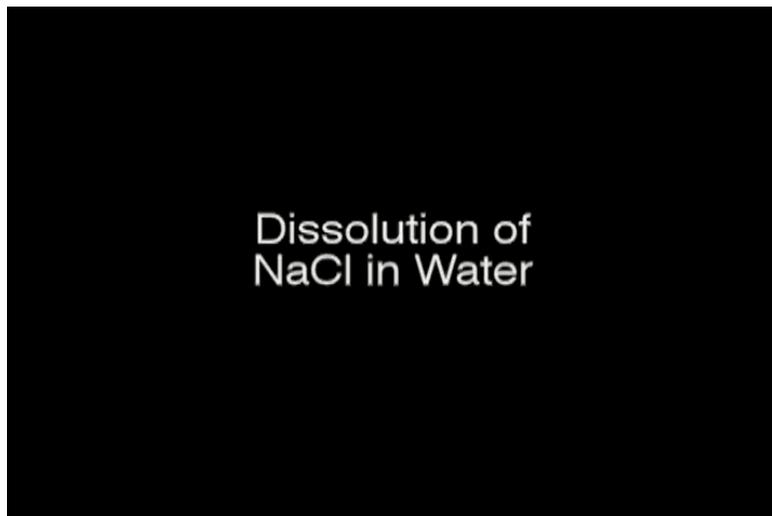
The Basics

- Two types of electrostatic forces
- Intermolecular forces
 - All involve attractions between positive and negative dipoles
 - Low energies of dissociation
 - About 15% as strong as ionic or covalent bonds
 - 1 type involves an ionic component
 - Ion-Dipole Forces
 - 3 types exist between neutral molecules - Van der Waals forces
 - Dipole-Dipole Forces
 - Induced Dipoles (London Dispersion Forces)
 - Hydrogen Forces (Hydrogen Bonding)

Intermolecular Forces

Ion-Dipole Forces

- Exists between an ion and the partial charge on the end of a polar molecule
- Especially important for solutions of ionic solutes in polar liquids
 - Ionic salts in water



Intermolecular Forces

Dipole-Dipole Forces

- Exists between neutral polar molecules
- Occurs when the positive dipole of one molecule attracts the negative dipole of another
- Molecules must be extremely close
- Molecules with higher polar characteristics have larger dipole- dipole forces

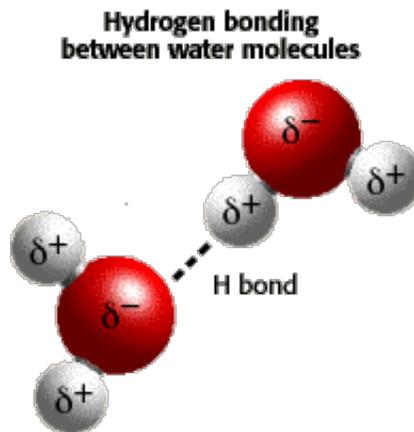
Intermolecular Forces

Hydrogen Forces

- A special type of intermolecular force that exists between a H atom (when bonded to F, O, N) and an unshared electron pair on a nearby, small, electronegative ion or atom (usually a F, O, or N) in another molecule
- Strongest of the intermolecular forces
- These are a special example of a dipole-dipole attraction that occurs with F, N, or O because they are so highly electronegative
- Because H has no inner shell electrons, when it bonds to a highly electronegative atom its electrons are shifted away, exposing an **unshielded** proton.
- This **naked proton** is then attracted to the unbonded electrons of another atom
- Because H is so small, it can approach closely to the other atom, increasing the strength of the interaction

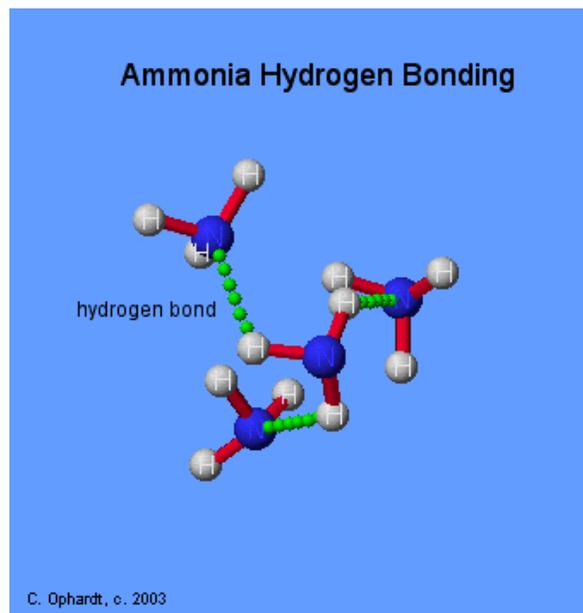
Intermolecular Forces

Hydrogen Forces



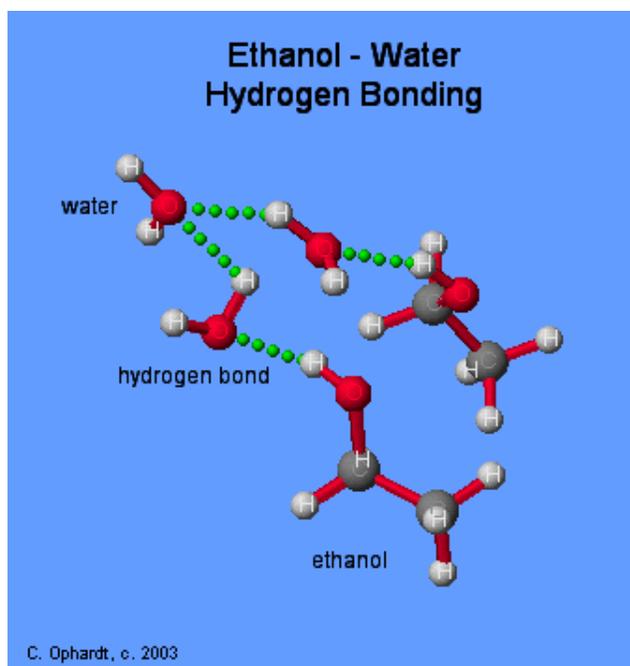
Intermolecular Forces

Hydrogen Forces



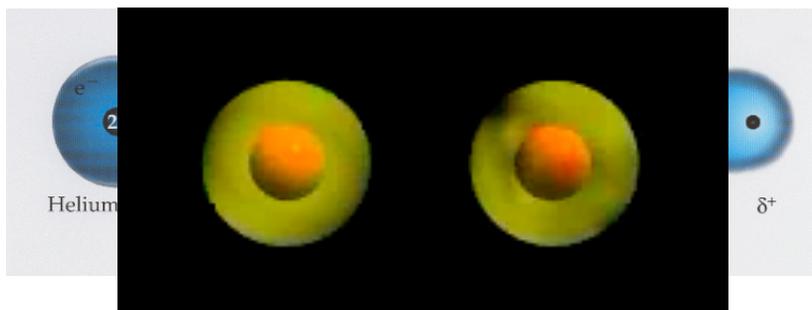
Intermolecular Forces

Hydrogen Forces



Intermolecular Forces

Induced Dipoles (London Dispersion Forces)

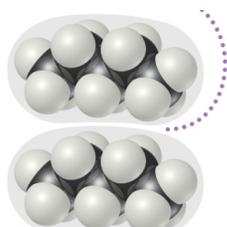


- Exists between non-polar atoms or non-polar molecules
- Involves the formation of an instantaneous dipole
 - The average electron distribution in a non-polar particle is symmetrical
 - However, the instantaneous electron distribution can be polar
- This slight polar character can cause (induce) dipoles in neighboring particles
 - This distortion, resulting from external electric fields, causes an intermolecular force

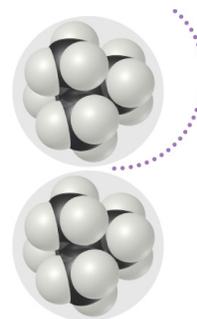
Intermolecular Forces

Induced Dipoles (London Dispersion Forces)

- Polarizability
 - The ease with which an external electric field can distort the electron distribution of an atom or molecule
 - “Sloshiness”
 - The larger (more massive) a particle, the greater its polarizability
 - The more “elongated” a particle, the greater its polarizability



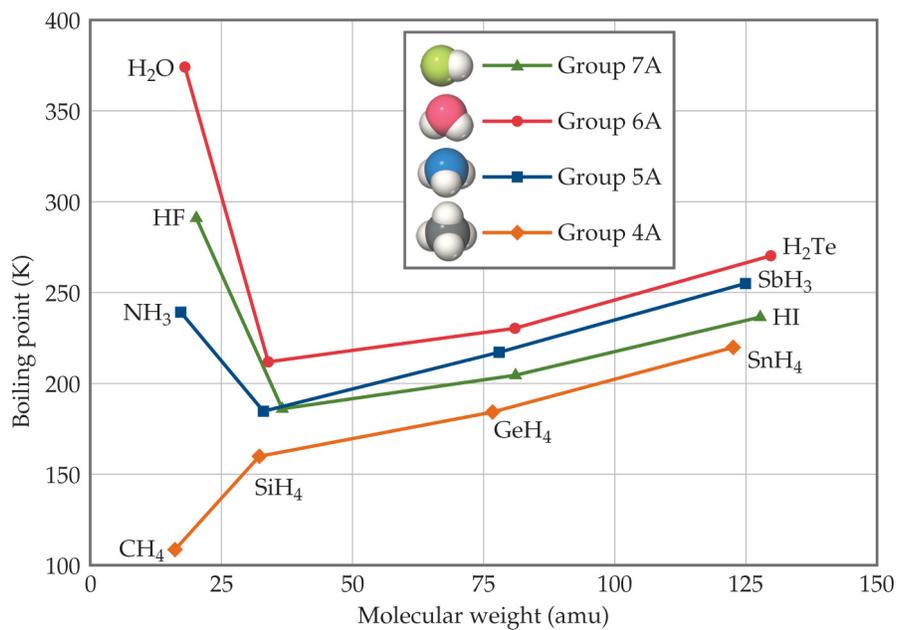
n-Pentane (C₅H₁₂)
bp = 309.4 K



Neopentane (C₅H₁₂)
bp = 282.7 K

Intermolecular Forces

Application



Intermolecular Forces

Homework

- 11.2 / 11.3 / 11.17 / 11.19 / 11.20 / 11.22 / 11.23 / 11.26 / 11.27 / 11.33