

Intermolecular Forces

Phase Changes

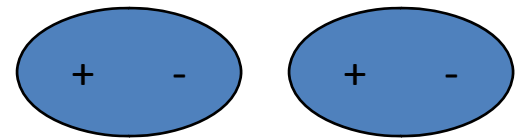
- We know that when a substance changes phase is related to an attraction between the molecules.
- The stronger the attraction, the more likely the substance will be a solid or liquid. The weaker the attraction, the more likely it will be a gas.
- Raising the pressure forces the particles to feel that attraction more since they are forced together.
- Raising the temperature causes the particles to feel the attraction less since they are moving faster.

Types of Attractions

- Dipole-Dipole
 - Strong forces
 - Hydrogen Bond special Dipole-dipole
- Induced Dipole
 - Explains why non-polar molecules can be liquids and solids
- Van der Waal
 - Longer chains interact
 - Polymers are very long chains, solids

Dipole Dipole Interactions

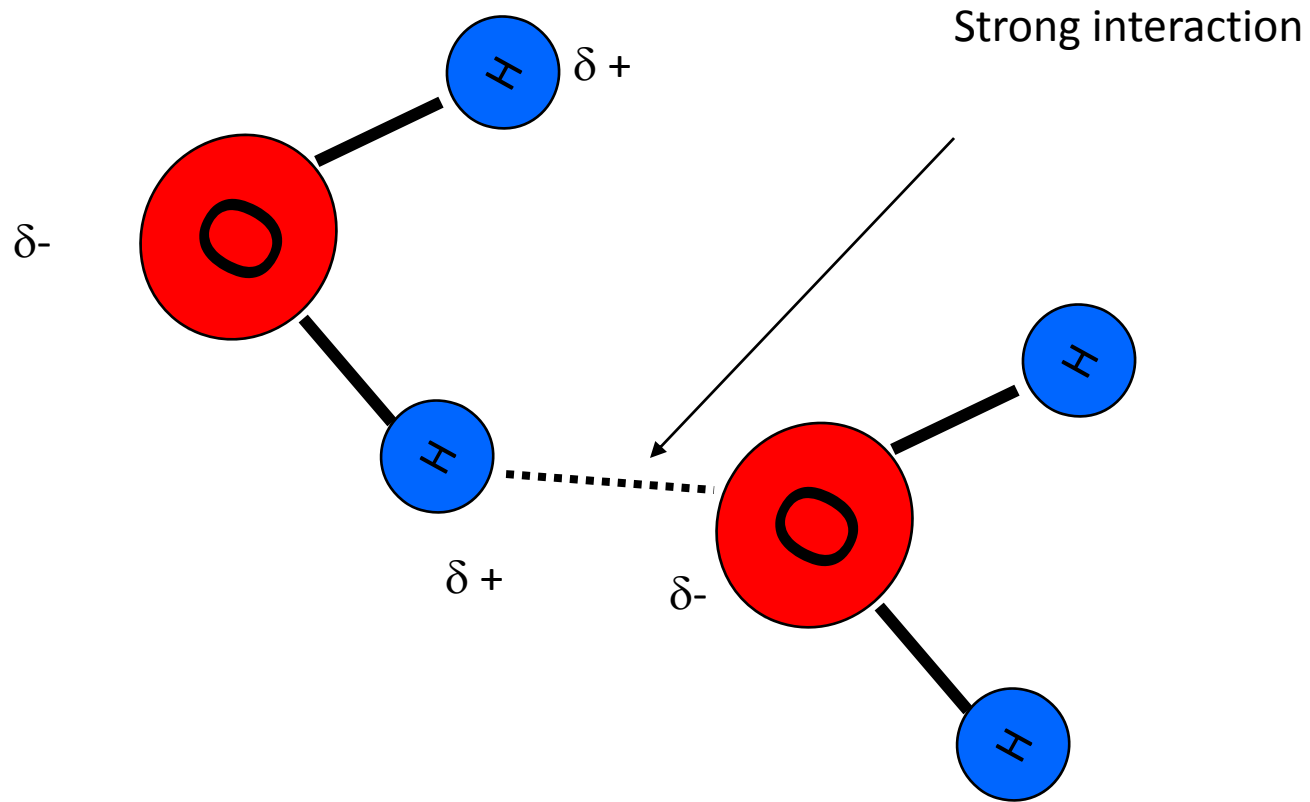
- Dipoles
 - partial negative and partial positive charge on the molecule.
 - This is how polar molecules interact.
- Partial negative and positive attract
 - Dipole - Dipole Forces
 - Strongest dipole-dipole
 - hydrogen bond

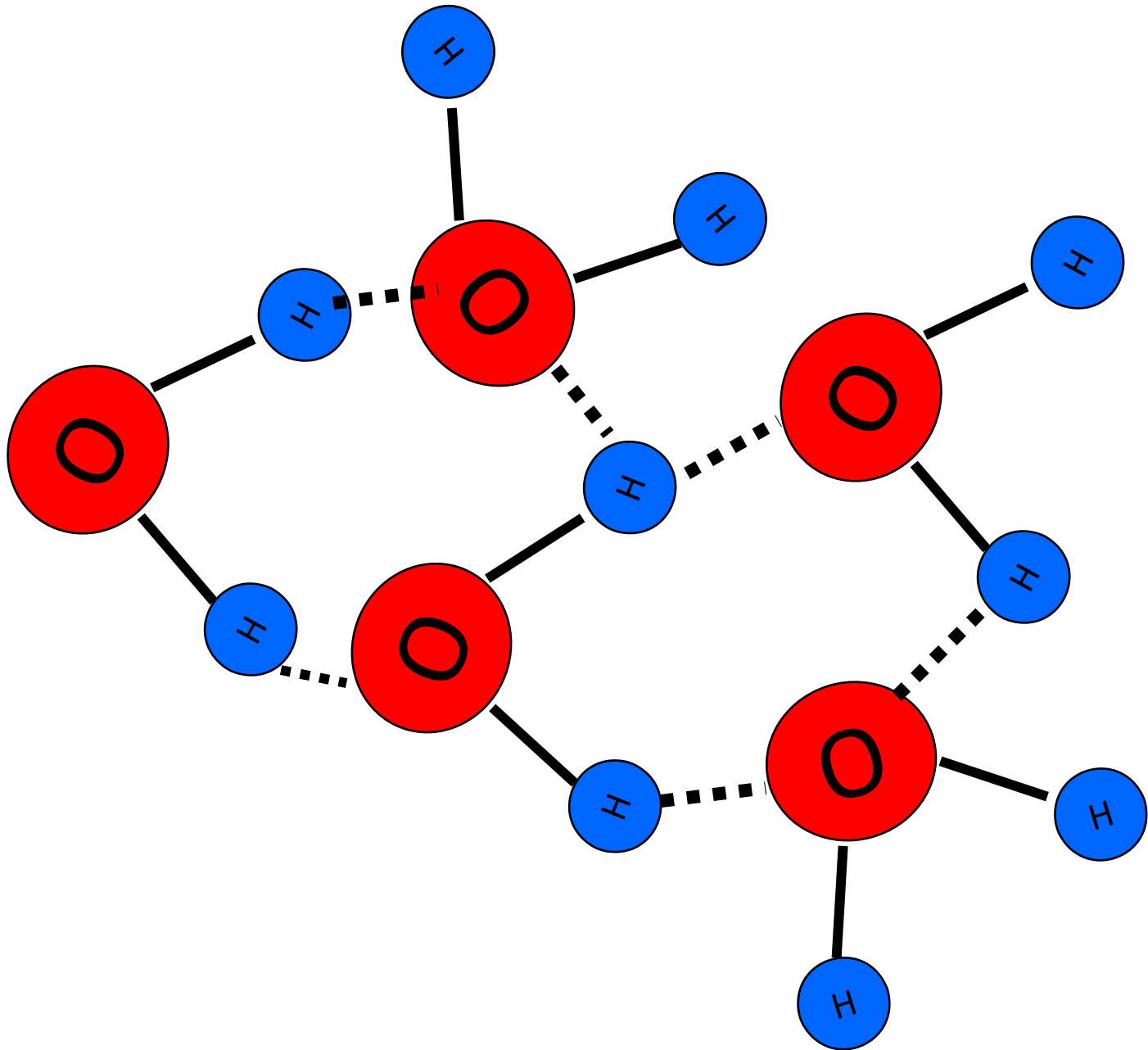


Water

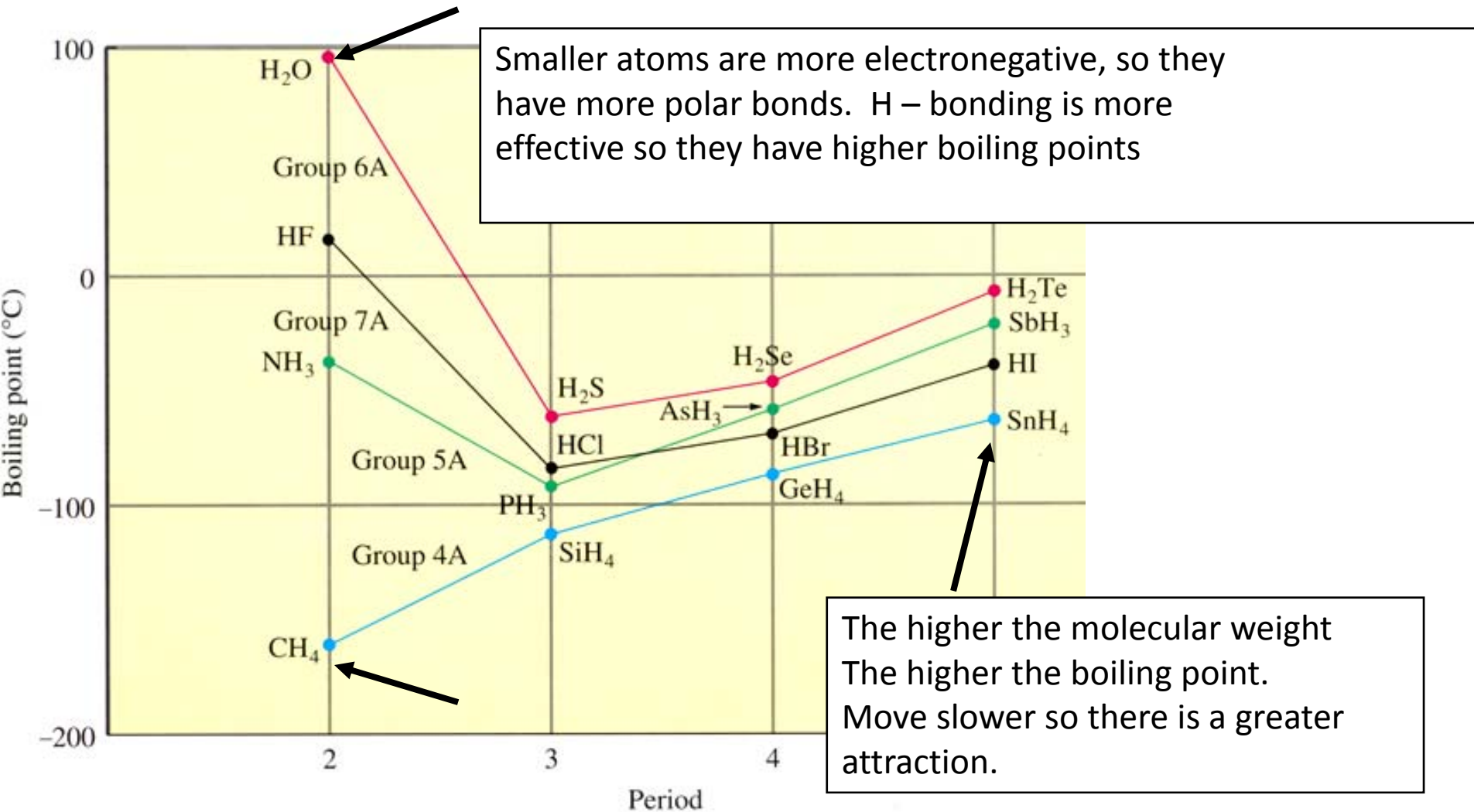
- Water is a polar molecule
- It has a positive end and a negative end
- Oxygen is negative
- Hydrogen is positive
- Any time you have oxygen attract to a hydrogen you get hydrogen bonding.

Hydrogen Bonding



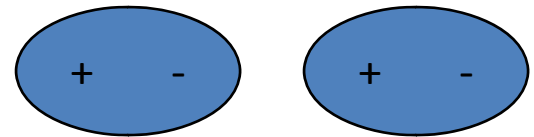
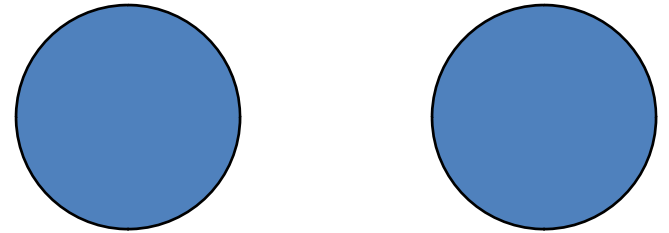


Boiling Points

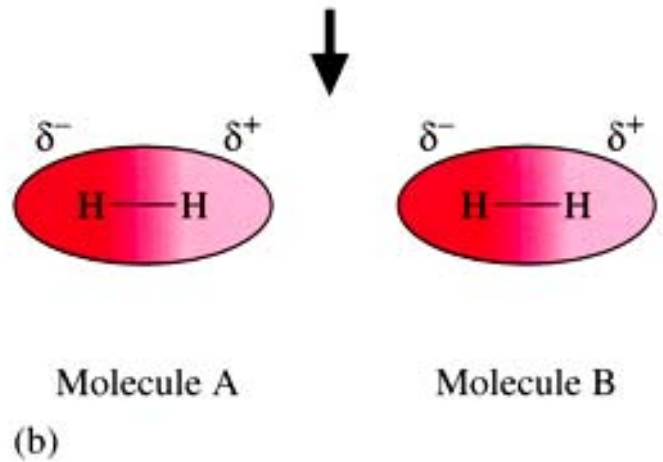
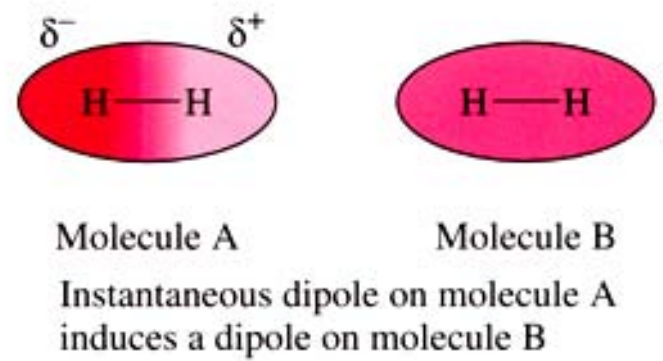
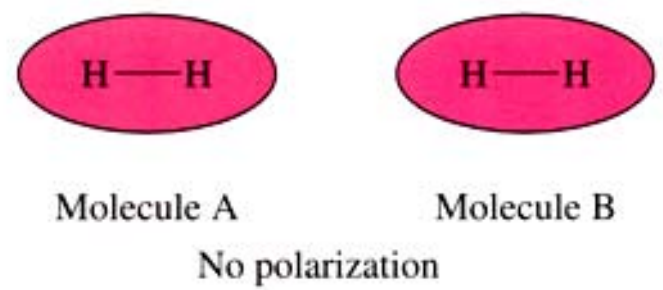
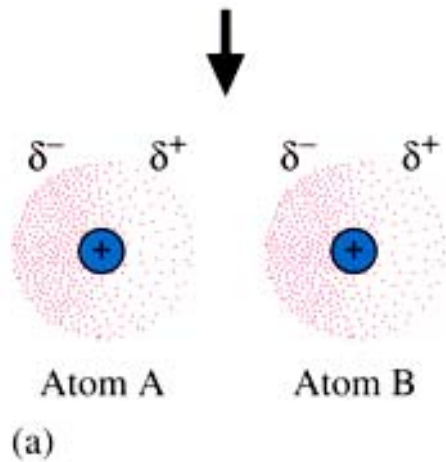
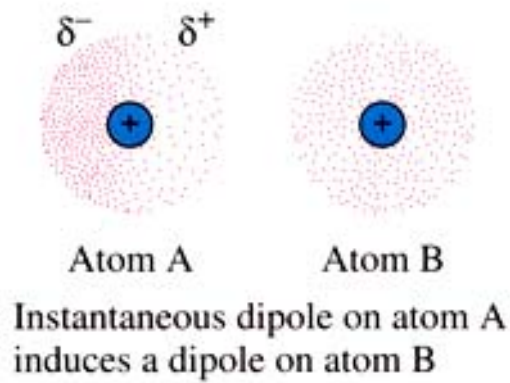
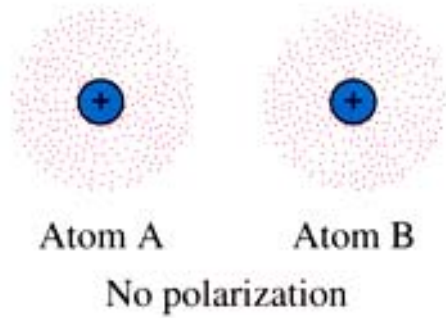


Intermolecular Forces

- Dispersion Forces
- Also called London Forces
- Induced Dipole
 - electron clouds are deformed since the electrons for one molecule repel the electrons on the other molecule creating a temporary dipole.
- Makes gases “real”

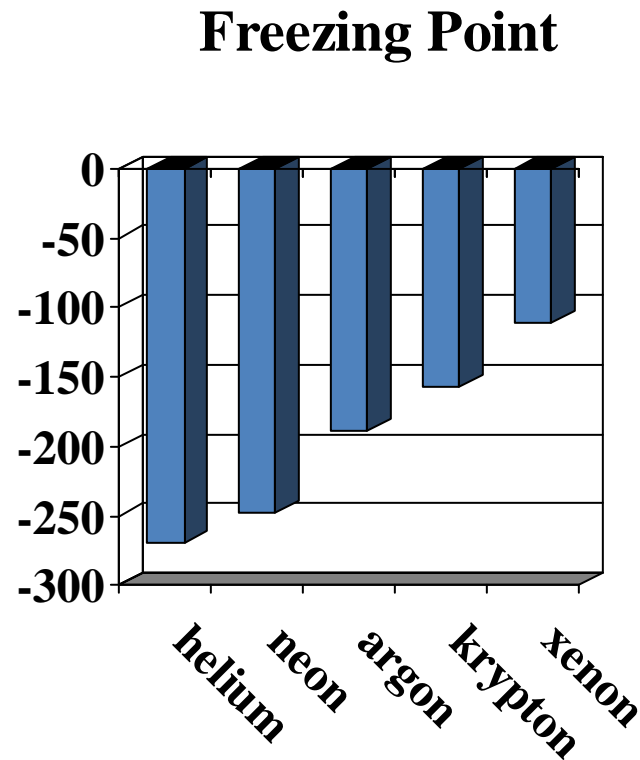


INDUCED DIPOLES



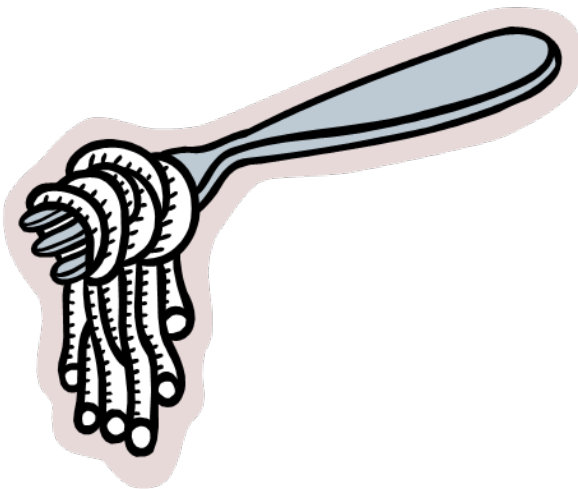
Induced Dipoles

- When non-polar molecules approach
 - Their negative electron clouds repel
 - Inducing a dipole
 - Which allows the molecules to interact
- Helium freezes at 3K
 - Have to move really slowly to induce a dipole



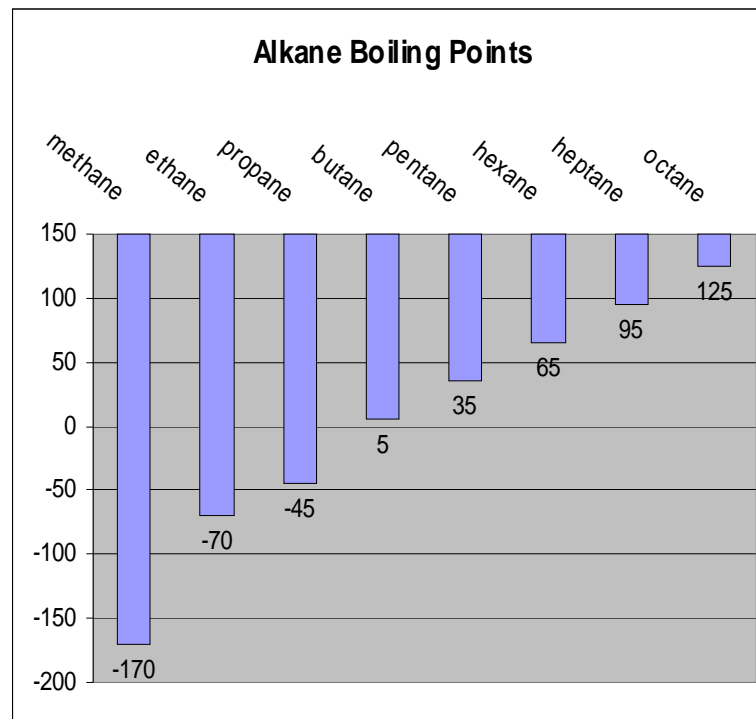
van der Waals Forces

- The longer a molecule, the more interaction with other molecules
- Think of it like spaghetti
 - Long chains get tangled, so it takes more energy to separate them



van der Waals Forces

- The longer the chain, the higher the boiling point
- The chains get tangled like spaghetti and have more induced dipoles.
- Takes more energy to break intermolecular tangles
- It has a higher boiling point



Liquid Properties

- These properties are related to the strength of intermolecular interactions in the liquid phase.
- Viscosity
 - How easily a liquid flows. Higher viscosity flows at a slower rate.
 - Created by the intermolecular forces and can be viewed as an internal friction.
 - Greater the intermolecular forces, the higher the viscosity.
 - Viscosity also lowers with an increase in temperature since the liquids molecules will feel the intermolecular attractions less.
 - Karo syrup vs water
 - Cold oil vs hot oil

Surface Tension

- Beads of water on a newly waxed car and the meniscus in graduated cylinder are examples
- Each water molecule is attracted to its neighbor which is called cohesion.
 - In order to move one water, you have to affect the surrounding molecules.
 - Since there are no other molecules on the top of the water, the net force of cohesion is downward which will hold the molecules in place.
 - The surface doesn't like to be move, hence "tension"
- Adding other particles breaks the cohesion and lowers the surface tension. (soap)

Water is Weird

- Most abundant substance on earth's surface
- You are 60% water
- High heat capacity
- High boiling point
- Lower density solid than liquid
- High surface tension
- High heat of vaporization
- Universal solvent
- Most can be attributed to its strong polarity compared to its small molecular mass.
- These properties are why scientists believe that life has to be water based.