

Intermolecular Forces & Physical Properties

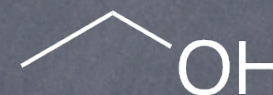
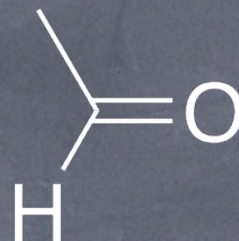
UCI Chem 51A

Dr. Link

Goals

- After this lesson you should be able to:
 - Determine what intermolecular forces are present for a sample of a given molecule
 - Compare physical properties for molecules base on structures

Compare Boiling Points



MM

44

44

44

46

BP (°C)

-42

-24

21

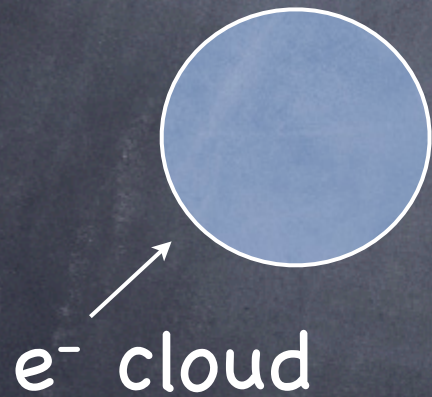
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- Intermolecular forces determine properties!

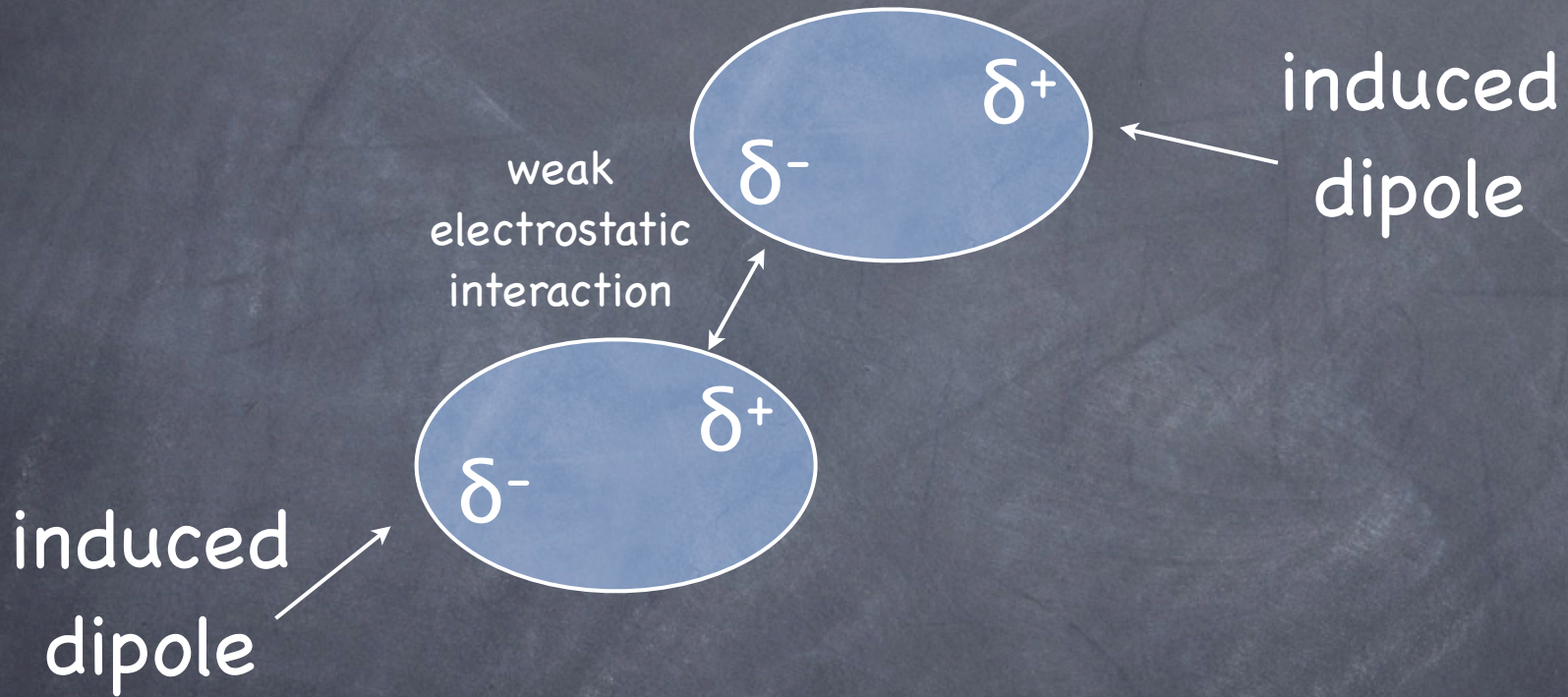
Intermolecular Forces

- INTERACTIONS BETWEEN MOLECULES!
 - van der Waal's forces (AKA London forces, AKA induced dipole interactions)
 - dipole-dipole interactions
 - hydrogen bonding

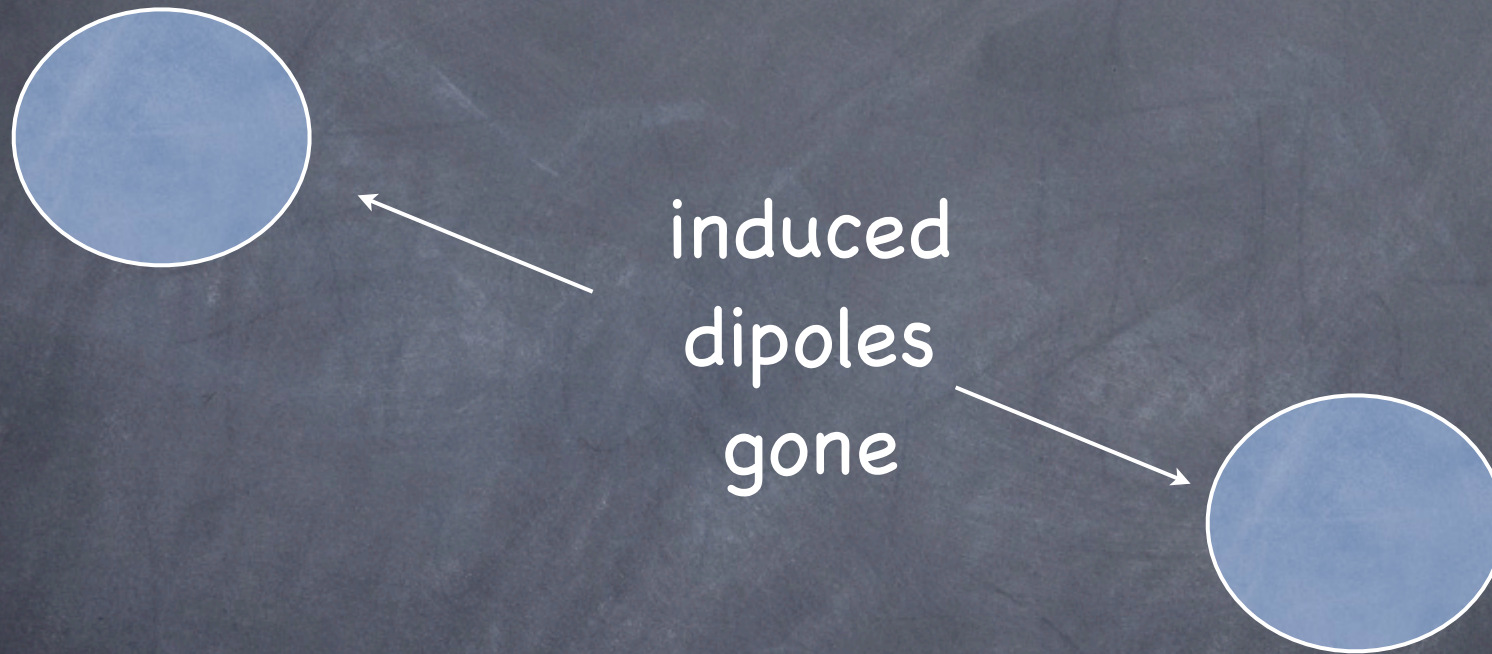
van der Waal's Forces



van der Waal's Forces



van der Waal's Forces



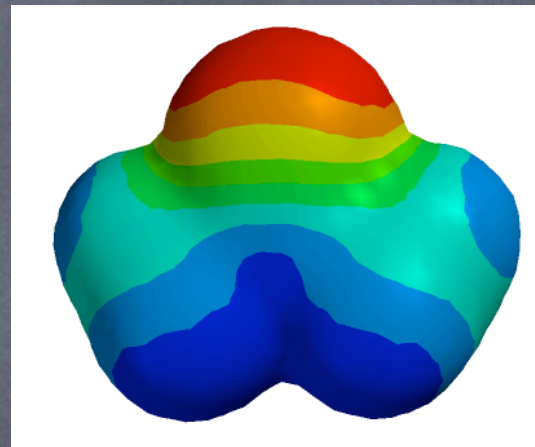
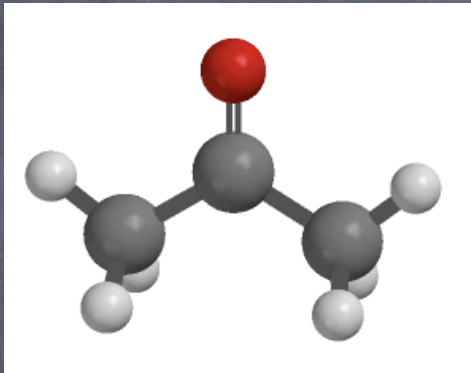
- ALL compounds exhibit van der Waal's forces!

Factors Affecting vdW

- Polarizability: Measure of how the electron cloud around an atom (or molecule) reacts to changes in its electronic environment
- Translation: How "smooshy" is the e^- cloud?
 - Surface area!

****Greater surface area = stronger vdW forces****

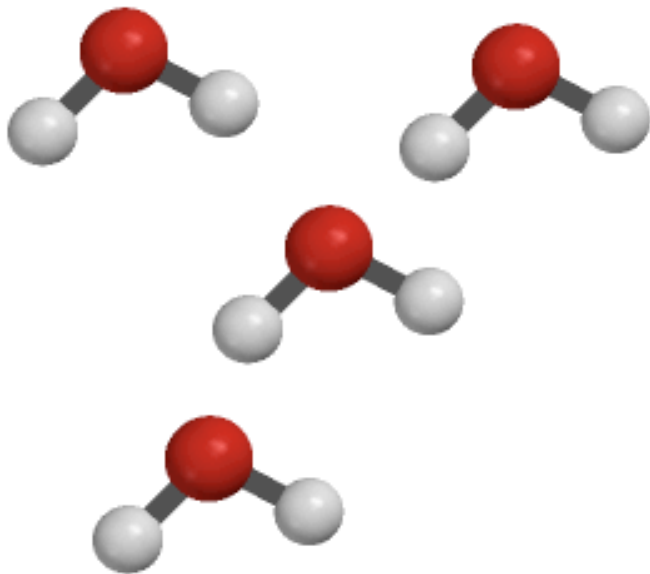
Dipole–Dipole Interaction



- Dipole–dipole interaction: electrostatic interaction between two molecules that have permanent dipoles

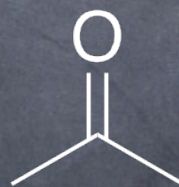
Hydrogen Bonding

- THERE ARE NO REAL "BONDS" IN HYDROGEN BONDING!!!
- REALLY strong dipole interaction



Hydrogen Bonding Details

- Hydrogen bonding: electrostatic attraction between an H-atom bonded to O, N, or F* and a lone pair on O, N, or F* in another molecule
- NOT A BOND!!!



*For F, only H-F

IMF Summary

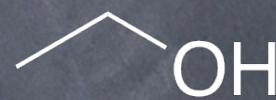
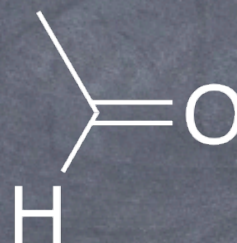
- van der Waal's: temporary (induced) dipole-dipole interaction
- Dipole-dipole interaction: interaction between permanent dipoles
- Hydrogen bonding: interaction between REALLY strong dipoles (O-H, N-H)

IMFs and Physical Properties

- IMFs control physical properties!
- Greater/stronger IMFs = higher BP, MP
- IMFs control solubility!

Phase Transition: Boiling

- Boiling point (simple def.): temperature at which liquid is converted to gas
- What does this have to do with IMFs?



MM

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BP (°C)

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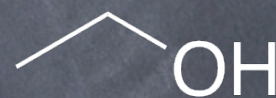
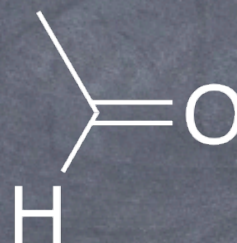
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Phase Transition: Melting

- Melting point (simple def.): temperature at which solid is converted to liquid
- What does this have to do with IMFs?



MM

44

44

44

46

MP (°C)

-188

-142

-123

-115

Solubility

- Like dissolves like. What does that mean?
- How are IMFs involved?

hexane (C_6H_{14})

CH_3OH

C_4H_{10}

water (H_2O)

CH_3OH

C_4H_{10}

Wrapping Up

- Practice identifying which IMFs are present based on structure.
- Practice comparing properties (bp, mp, solubility) based on structure.