

# Intermolecular Forces & Physical Properties

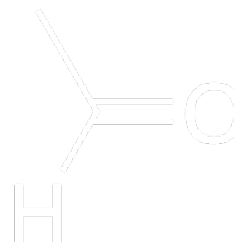
UCI Chem 51A

Dr. Link

# Goals

- ① After this lesson you should be able to:
  - ① Determine what intermolecular forces are present for a sample of a given molecule
  - ① Compare physical properties for molecules base on structures

# Compare Boiling Points



MM

44

44

44

46

BP (°C)

-42

-24

21

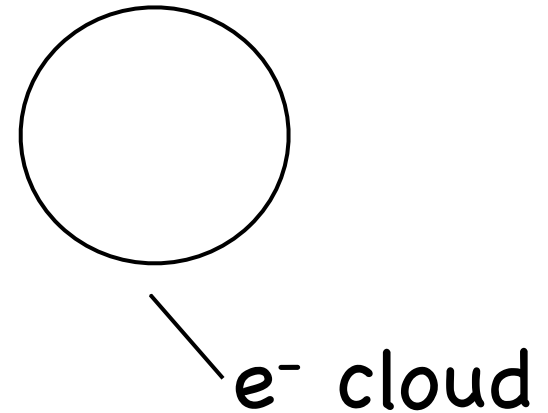
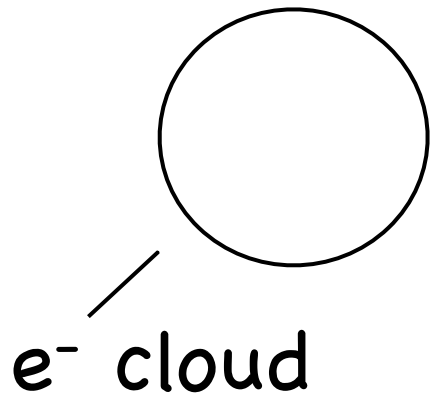
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④ Intermolecular forces determine properties!

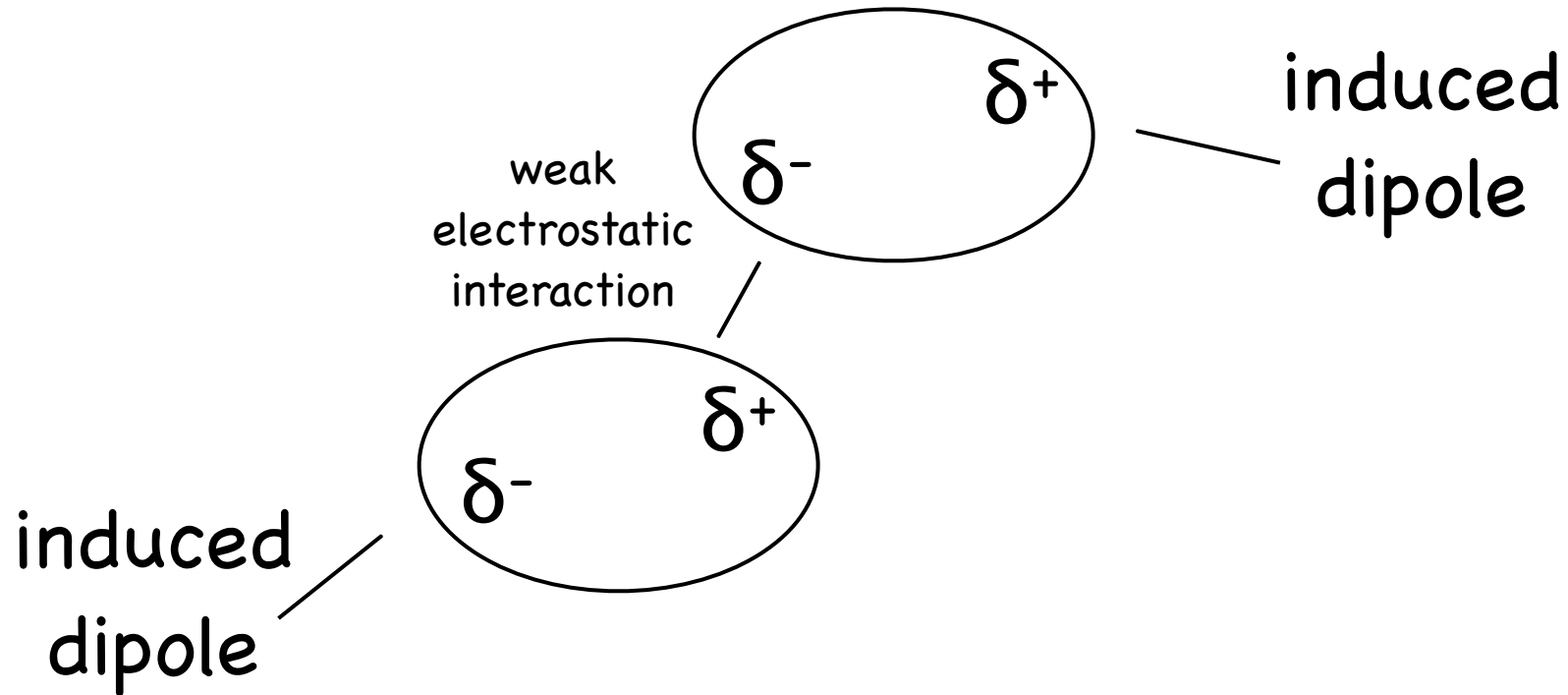
# Intermolecular Forces

- ④ INTERACTIONS BETWEEN MOLECULES!
  - ④ van der Waal's forces (AKA London forces, AKA induced dipole interactions)
  - ④ dipole-dipole interactions
  - ④ hydrogen bonding

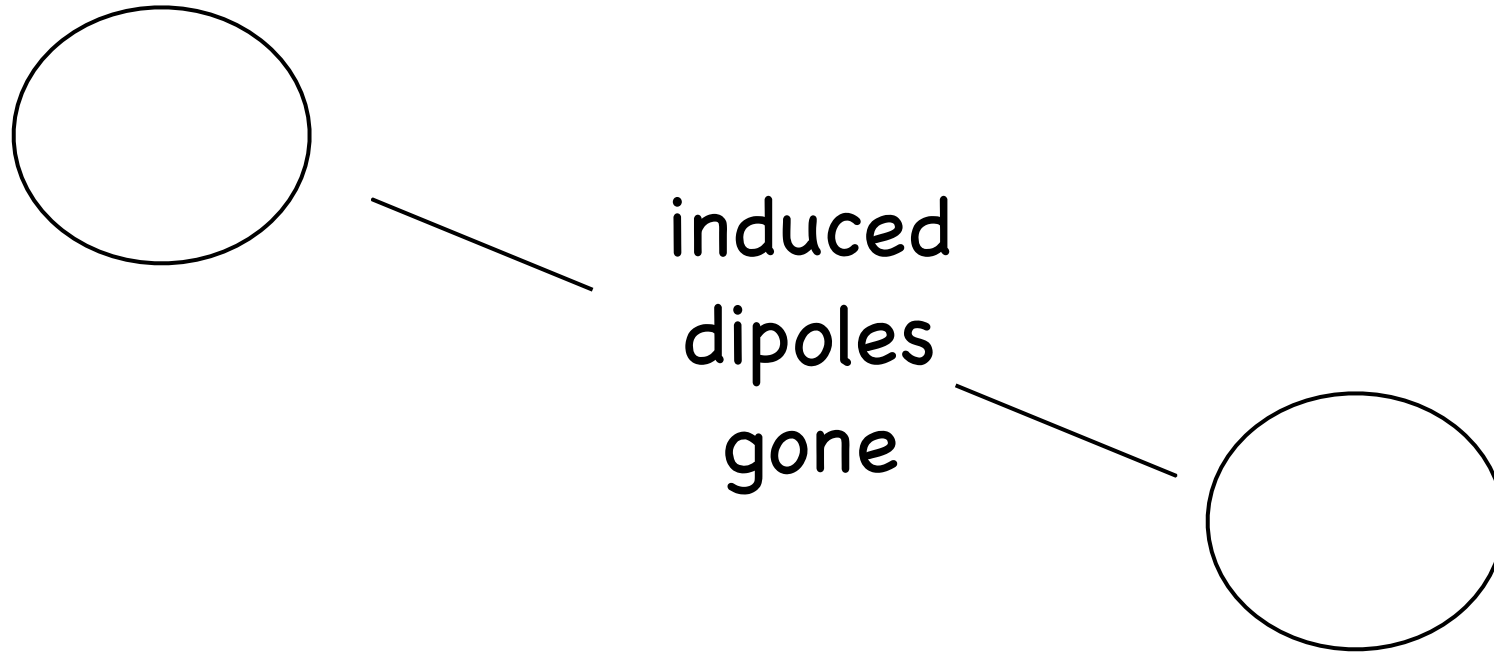
# van der Waal's Forces



# van der Waal's Forces



# van der Waal's Forces



- ⦿ ALL compounds exhibit van der Waal's forces!

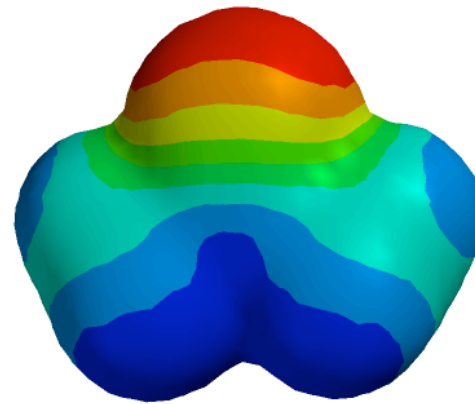
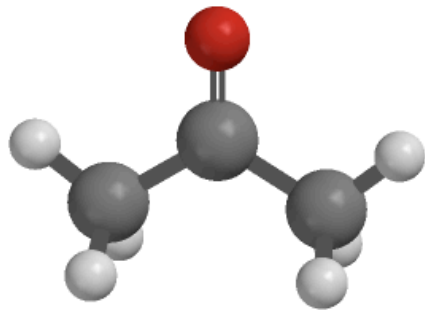
# Factors Affecting vdW

- 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\*\***



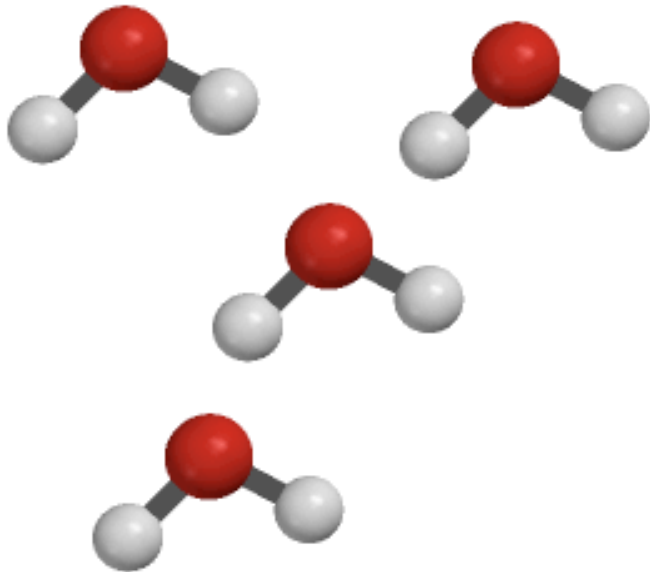
# Dipole-Dipole Interaction



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

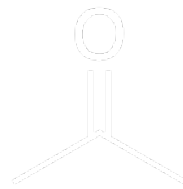
# Hydrogen Bonding

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



# Hydrogen Bonding Details

- ④ 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
- ④ NOT A BOND!!!



\*For F, only H-F

# IMF Summary

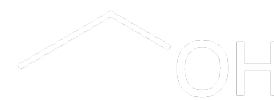
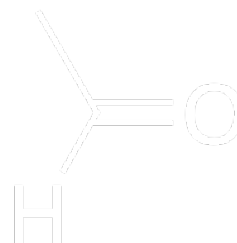
- ① van der Waal's: temporary (induced) dipole-dipole interaction
- ② Dipole-dipole interaction: interaction between permanent dipoles
- ③ Hydrogen bonding: interaction between REALLY strong dipoles (O-H, N-H)

# IMFs and Physical Properties

- ③ IMFs control physical properties!
- ③ Greater/stronger IMFs = higher BP, MP
- ③ IMFs control solubility!

# Phase Transition: Boiling

- ③ Boiling point (simple def.): temperature at which liquid is converted to gas
- ③ What does this have to do with IMFs?



MM

44

44

44

46

BP (°C)

-42

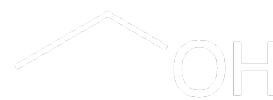
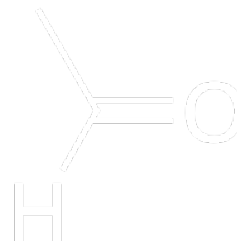
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# Phase Transition: Melting

- 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

- ④ Like dissolves like. What does that mean?
- ④ How are IMFs involved?

hexane ( $C_6H_{14}$ )

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$CH_3OH$

$C_4H_{10}$

water ( $H_2O$ )

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$CH_3OH$

$C_4H_{10}$



# Wrapping Up

- ④ Practice identifying which IMFs are present based on structure.
- ④ Practice comparing properties (bp, mp, solubility) based on structure.