# N28 – Intermolecular Forces

An Introduction

# Intermolecular Attractions

- **State of matter (s, l, g) determined by the strength of the attractions between the particles.**

- **At room temperature, moderate to strong attractive forces result in materials being solids or liquids.**

- **The stronger the attractive forces are, the higher the boiling point of the liquid and melting point of the solid.**
  - **Other factors also influence the melting point.**

# Why are molecules attracted to each other?

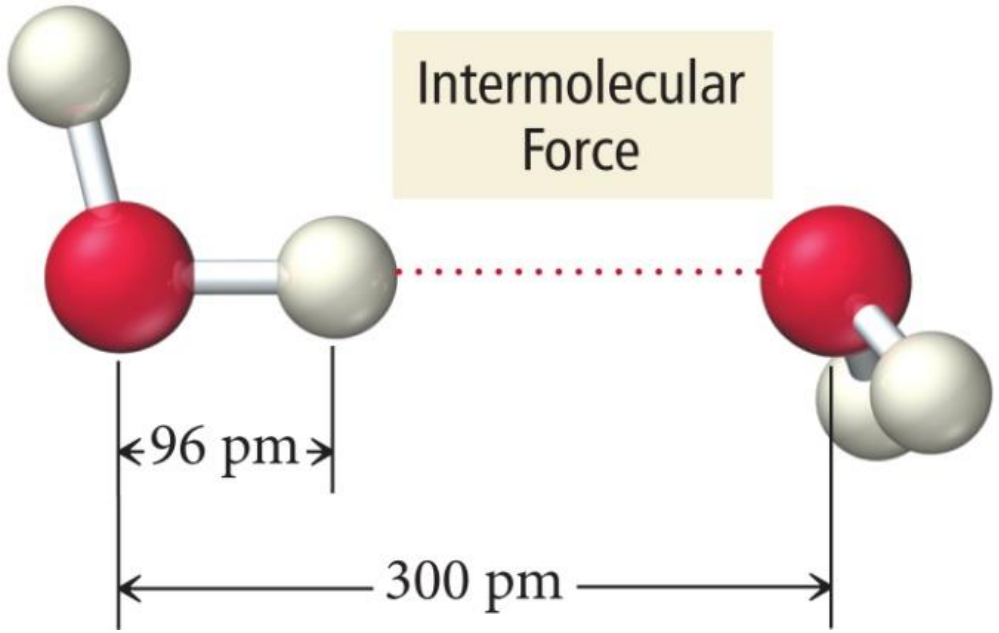
**Intermolecular attractions are due to attractive forces between opposite charges.**

+ ion to − ion

+ end of polar molecule to − end of polar molecule

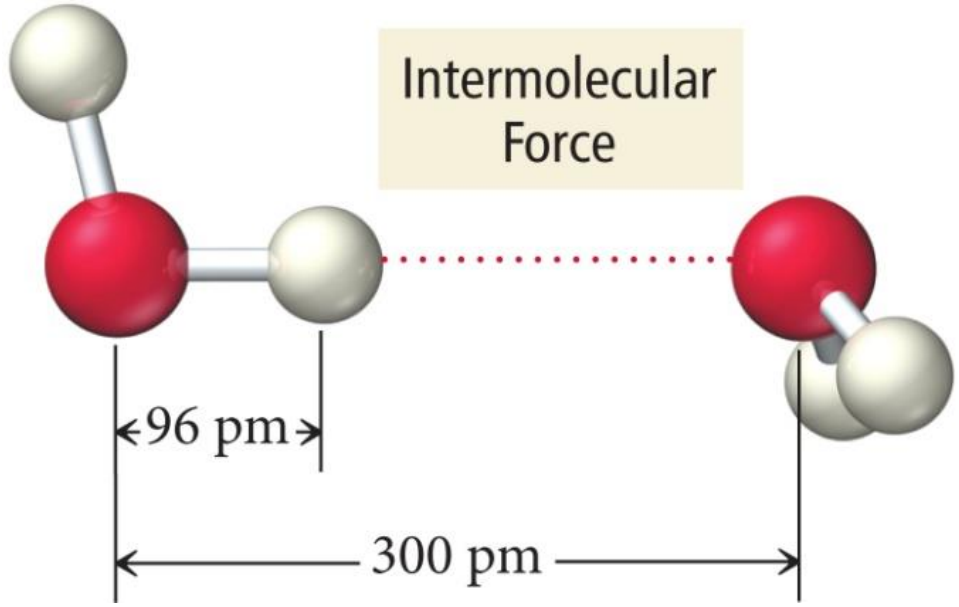
H-bonding especially strong

**Even nonpolar molecules will have temporary charges**



# Why are molecules attracted to each other?

- **Larger charge = stronger attraction**
- **Longer distance = weaker attraction**
- However, these attractive forces are small relative to the bonding forces between atoms.
  - Generally smaller charges
  - Generally over much larger distances



# Trends in the Strength of Intermolecular Attractions

The stronger the attractions between the atoms or molecules, the more energy it will take to separate them.

# Trends in the Strength of Intermolecular Attractions

Boiling a liquid requires that we add enough energy to overcome all the attractions between the particles.

- However, not breaking the covalent bonds

# Trends in the Strength of Intermolecular Attractions

- The higher the normal boiling point of the liquid, the stronger the intermolecular attractive forces.

- Normal BP happens when vapor pressure = atmospheric pressure

# Kinds of Attraction

## London Dispersion Forces

Temporary polarity in the molecules due to unequal electron distribution leads to attractions

# Kinds of Attraction

## Dipole-Dipole Attractions

Permanent polarity in the molecules due to their structure leads to attractive forces

# Kinds of Attraction

## Hydrogen Bonds

An especially strong dipole–dipole attraction results when H is attached to an extremely electronegative atom [N,O,F].

# Relative Magnitude of Forces

**The types of bonding forces vary in their strength as measured by average bond energy.**

**Strongest** **Network Covalent bonds** **400 kcal/mol**

**Hydrogen bonding** **12-16 kcal/mol)**

**Dipole-dipole interactions** **2-0.5 kcal/mol**

**Weakest** **London forces** **less than 1 kcal/mol**

# Practice

**What type of IMF is in $H_2O$?**

**Hydrogen Bonding**

# Practice

**What type of IMF is in Ammonia?**

**Hydrogen Bonding**

# Practice

**What type of IMF is in HCl?**

**Dipole-Dipole**

# Practice

**What type of IMF is in $CO_2$?**

**London Dispersion**

# Practice

**What type of IMF is in $CH_4$?**

**London Dispersion**

# Practice

**What type of IMF is in Hydrogen Sulfide?**

**Dipole-Dipole**