Overview of Chapter 13

- Intermolecular Forces
- Liquids and their Properties
- Solids and Their Properties
- Phase diagrams

Today's Topics

- Intermolecular interactions
- Hydrogen bonding: DNA
- Solids and liquids
- Properties of liquids

Questions to consider:

- What type of intermolecular interactions are the strongest?
- What holds the DNA double helix together?
- Why does salt melt at 800°C but dissolves easily in water?
- What happens to the molecules of a liquid when they are heated?

Forces Involving Induced Dipoles

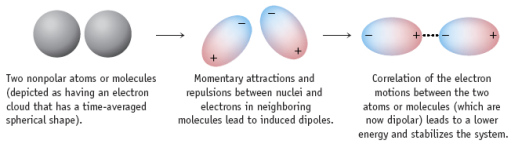
Solubility increases with mass of the gas

Table 13.2 The Solubility of Some Gases in Water*

Gas	Molar Mass (g/mol)	Solubility at 20 °C (g gas/100 g water)†
H_2	2.01	0.000160
N_2	28.0	0.00190
O_2	32.0	0.00434

Forces Involving Induced Dipoles

Formation of a dipole in two nonpolar I_2 molecules.



Induced dipole-induced dipole

Induced Dipole-Induced Dipole

- Works with all molecule types
- Works better with larger atoms and molecule (those are more polarizable)
- These forces are weak, but they add up

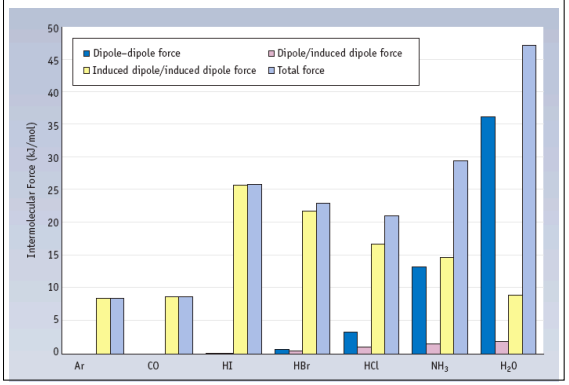
Forces Involving Induced Dipoles

The magnitude of the induced dipole depends on the size of the electron cloud in the molecule.

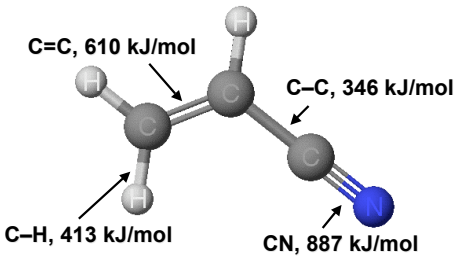
Higher molecular weight means more electrons and larger induced dipoles.

Molecule	**Boiling Point (°C)**
CH_4 (methane)	-161.5
C_2H_6 (ethane)	-88.6
C_3H_8 (propane)	-42.1
C_4H_{10} (butane)	-0.5

Strength of Intermolecular Forces



Covalent Bonding Forces (for comparison)



Solids: Ion-Ion Forces

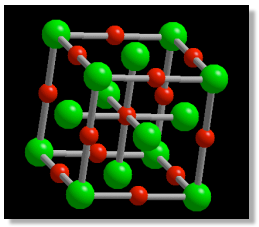
Na^+ and Cl^- in salt

These are the strongest forces.

Lead to solids with high melting temperatures.

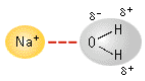
NaCl, mp = 800 °C

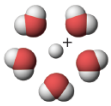
MgO, mp = 2800 °C



Attraction Between Ions and Permanent Dipoles

Water is highly polar and can interact with positive ions to give hydrated ions in water.

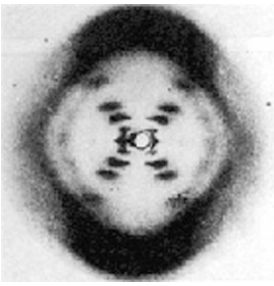




Water surrounding a cation

Water surrounding an anion

What is this?



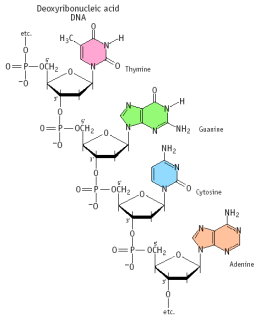
Discovering the Double Helix

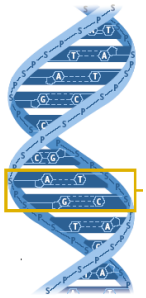
James Watson and Francis Crick, 1953

Rosalind Franklin
1920-1958

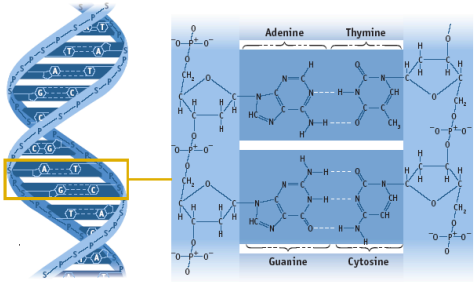
Maurice Wilkins
1916 - 2004

Hydrogen bonding in biology: DNA

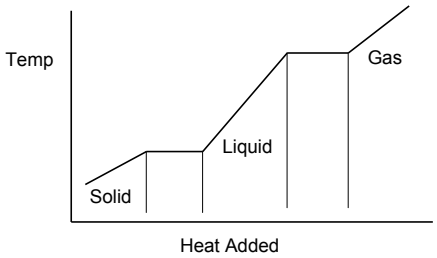




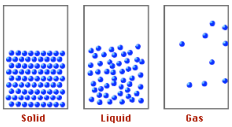
DNA Base pairing through H-Bonds



Phase changes



Solids, liquids, and gases



Solids have little molecular motion

Liquids have some molecular motion

Gases have extensive molecular motion