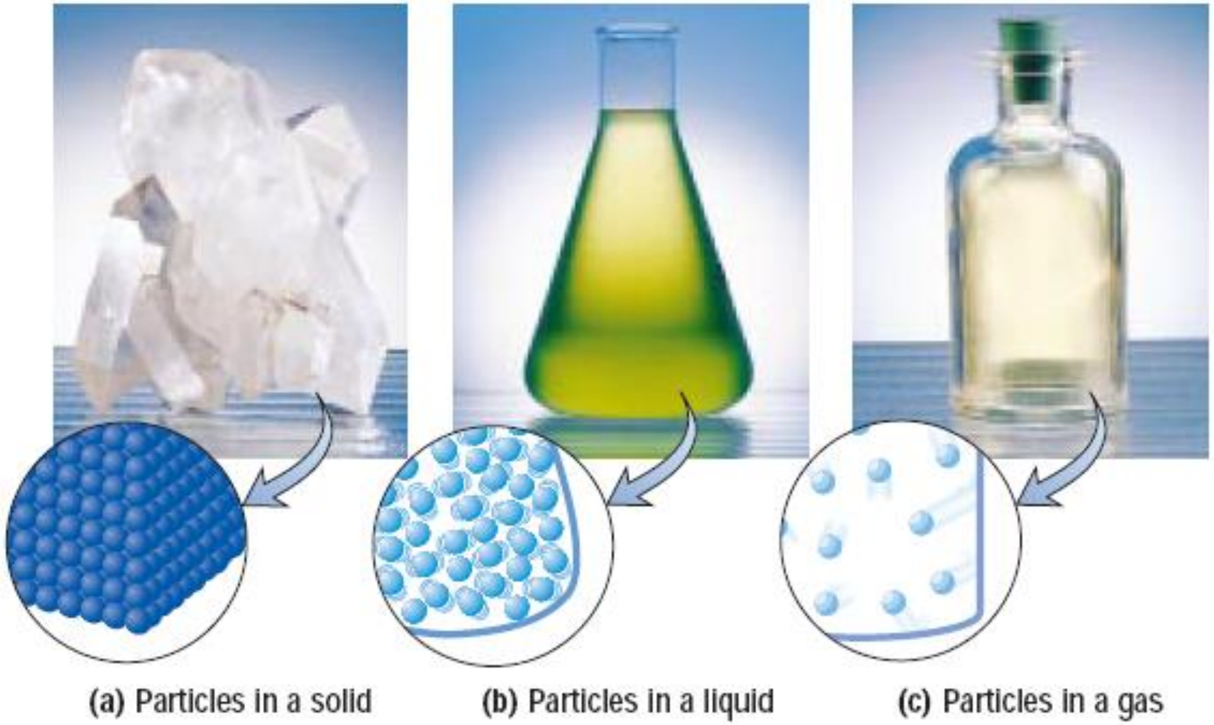
Ch. 13.1 States of Matter

The Kinetic Theory

- The ***kinetic theory*** is a way to describe the <u>motion</u> of particles.
- It states that particles in all forms of matter, (*s*, *l*, *g*), are in constant motion, (either "<u>vibrating</u>", "<u>sliding</u>", or "<u>flying</u>".)



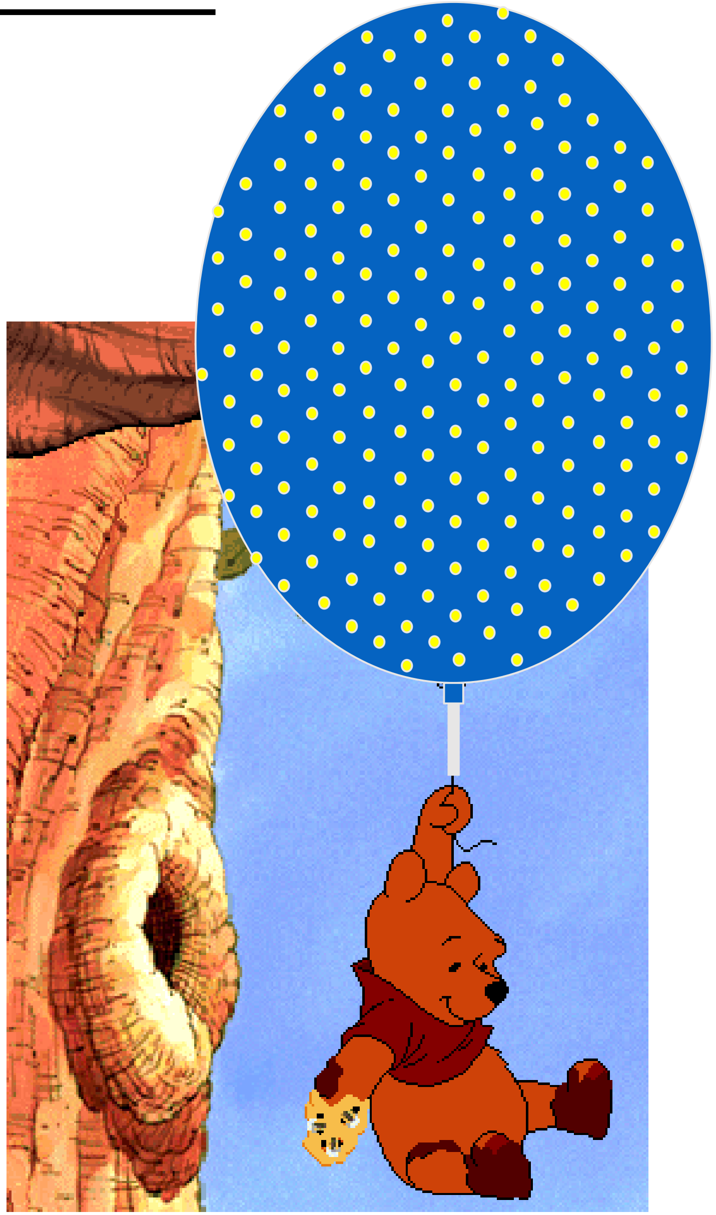
Ch. 13.1 Gases

Physical Characteristics of Gases

- Take volume and shape of their container.
- Easily compressed (can be squeezed together)
  - *Ex: air tanks*
  - Gases can compress because of the space between each particle
- Mix evenly and completely.
- Very low densities.

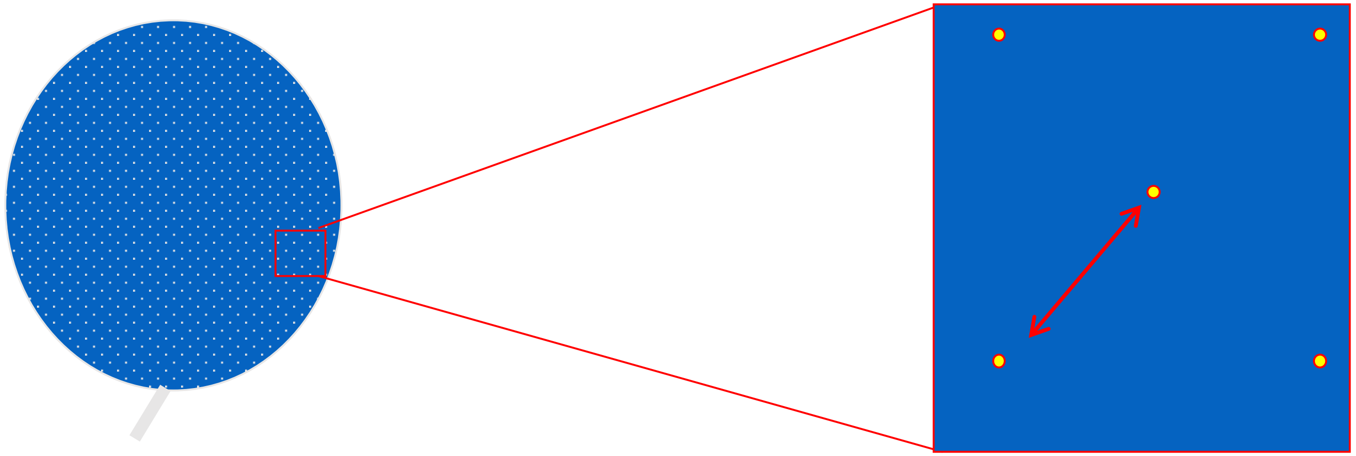
6 Basic Principles of KMT

1. Gases consist of tiny particles.



2. Gas particles are very far apart

99.9% empty space!

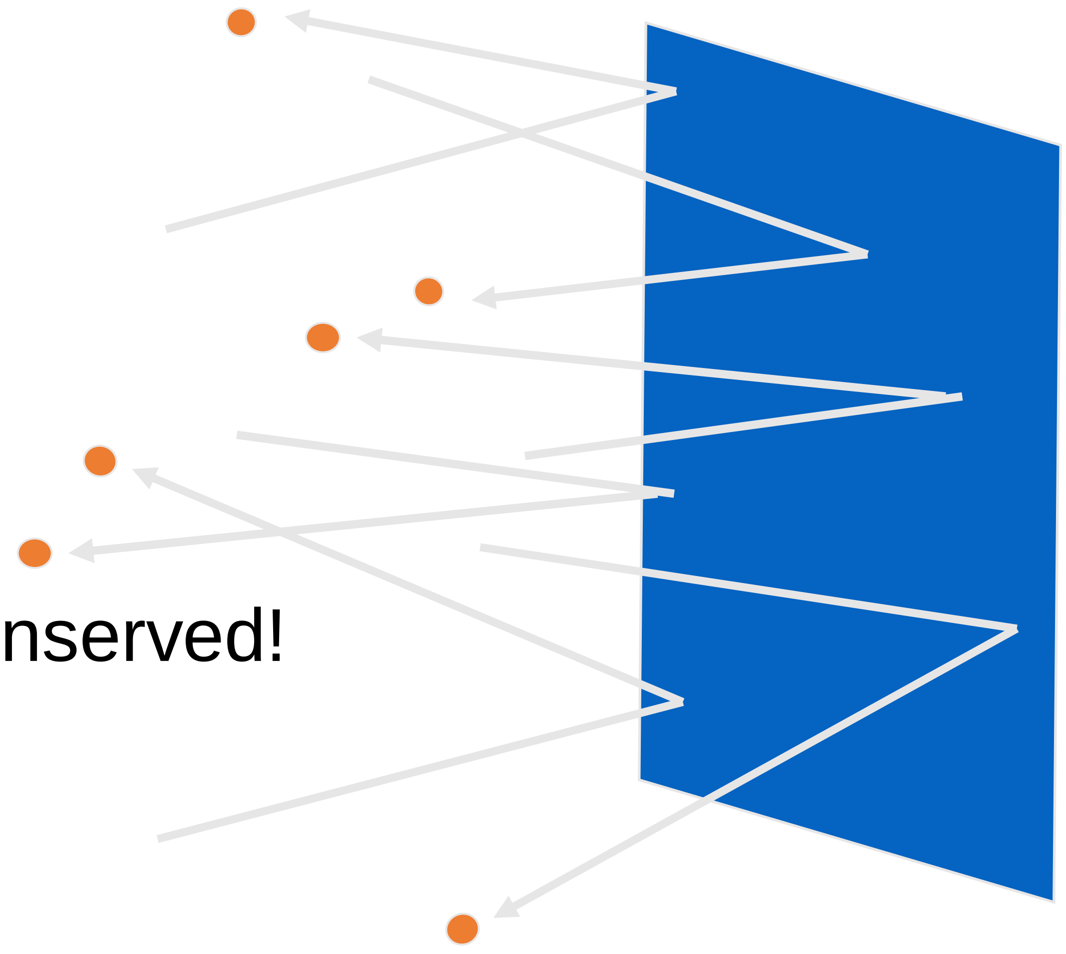


3. Gas particles do not attract nor repel

"no intermolecular forces"

4. Gas particles collide without losing energy.

“perfectly elastic collisions”



Energy is conserved!

5. Gas particles move in random straight lines.

* Gas molecules travel at very high speeds, about 6000 km/hr (~2700 mi/hr).

6. At a given temperature all gases have the same average kinetic energy

-Temp is a measure of average Kinetic Energy

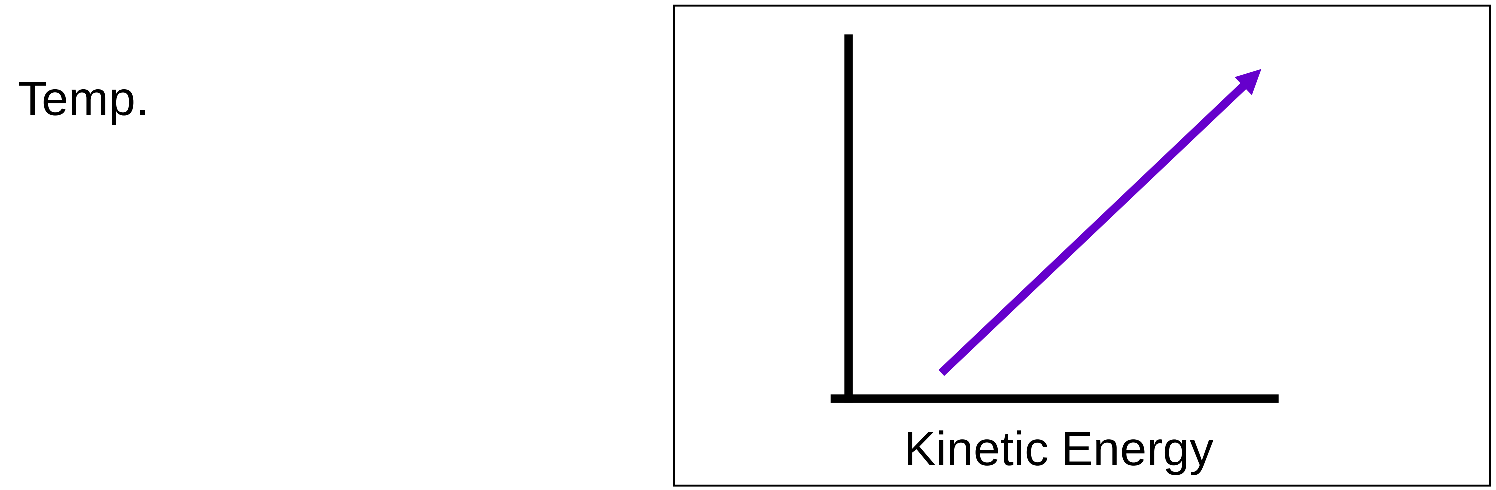
- ***Higher temp=higher kinetic energy***

- **Absolute temperature:** based on average particle speed; measured in Kelvin (K)
- **Absolute zero (0 K):** particles are not moving; there is no temp below 0 K.

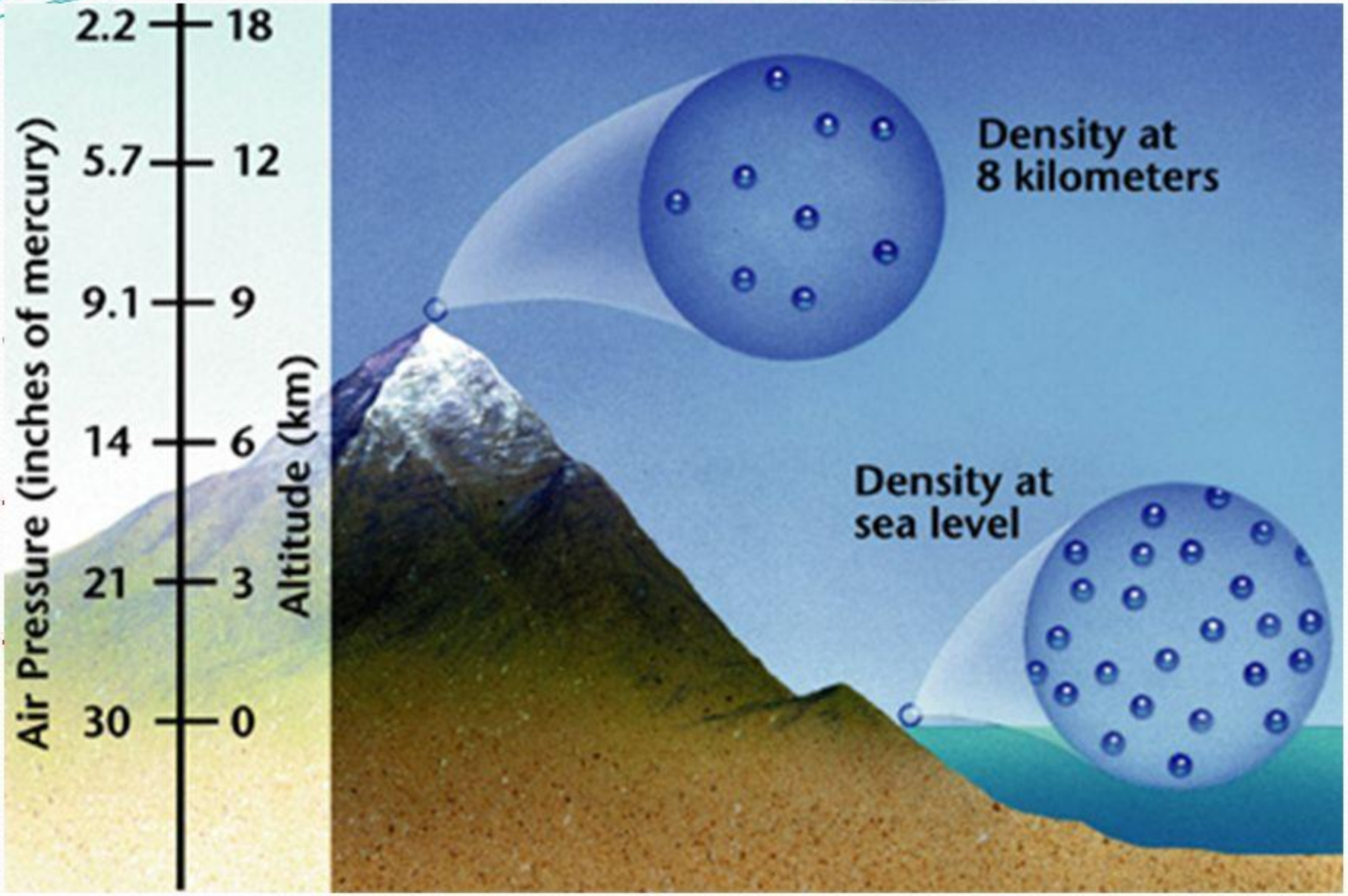
$$K = °C + 273$$

Ch13.1 continued: Temperature & Kinetic Energy

- ___higher___ the temp = ___faster___ particles = ___more___ K.E.



- ___Direct___ **Relationship**: As T increases, K.E. increases.
- At 0 K, (___absolute___ ___zero___), KE = ___zero___.
- Doubling T in Kelvins ___doubles___ the K.E.



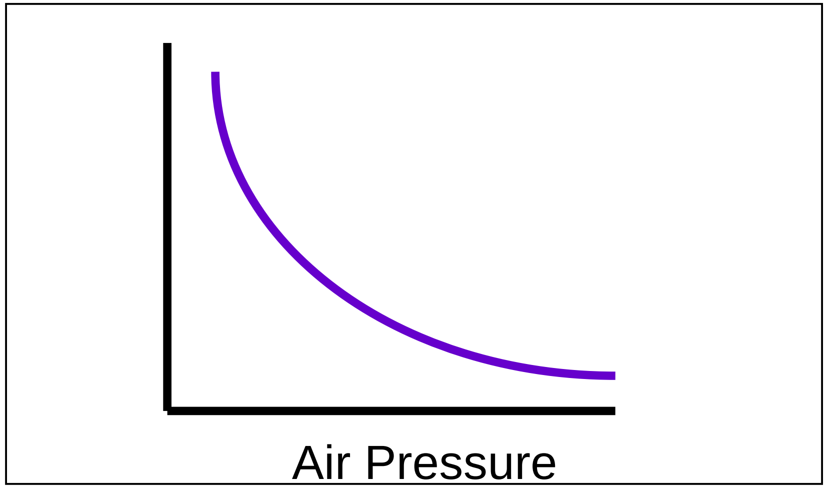
Air pressure is caused by the effect of gravity on the particles. Gravity is what gives things weight. The closer the particles are to the surface of the earth, the stronger the effect of gravity.

High altitude= lower pressure

Low altitudes=high pressure

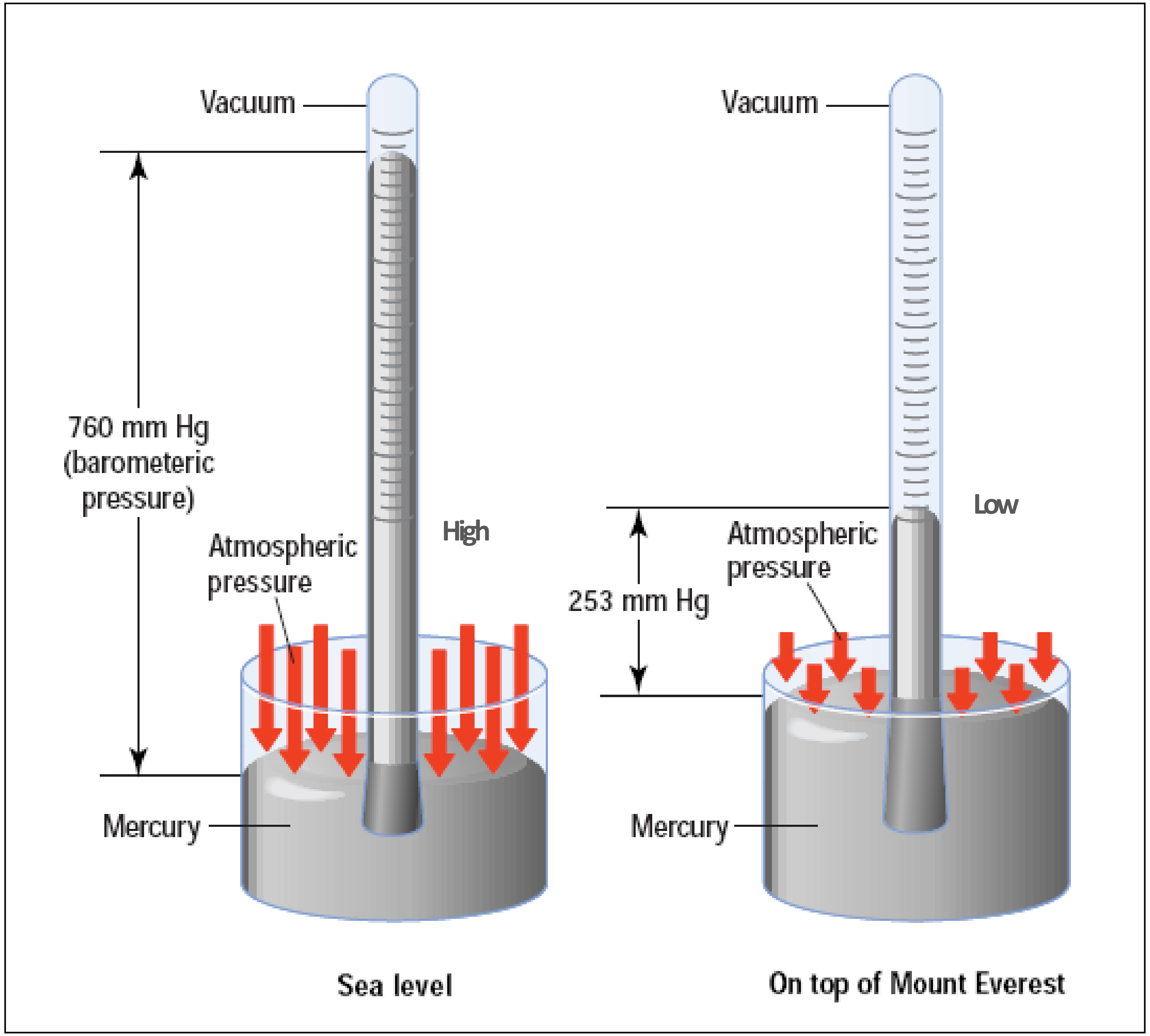
Altitude & Air Pressure

- Higher up = less air molecules = fewer collisions = less pressure



- **Inverse Relationship**: As altitude increases, pressure decreases

Barometer



A barometer is a tool used to measure air pressure.

The units used to measure pressure are:

- mm Hg
- Atm (atmosphere)
- KPa (kilopascal)
- torr

Gas Pressure Units: Conversion Factors

"Standard Pressure" is the pressure at sea level:

1 atm = 760 mm Hg = 760 torr = 101.3 kPa

Practice Problem: The pressure on top of Mt. Everest is 253 mm Hg. What is this pressure in units of kPa, and atm?

$$253\ \text{mm Hg} \times \frac{101.3\ \text{kPa}}{760\ \text{mm Hg}} = 33.7\ \text{kPa}$$

$$253\ \text{mm Hg} \times \frac{1.00\ \text{atm}}{760\ \text{mm Hg}} = 0.333\ \text{atm}$$

Gas Pressure Units: Conversion Factors

Practice Problem: The pressure in death valley is 776 mm Hg. What is this pressure in units of kPa, and atm?

$$776 \text{ mm Hg} \times \frac{101.3 \text{ kPa}}{760 \text{ mm Hg}} = 103.5 \text{ kPa}$$

$$776 \text{ mm Hg} \times \frac{1.00 \text{ atm}}{760 \text{ mm Hg}} = 1.02 \text{ atm}$$

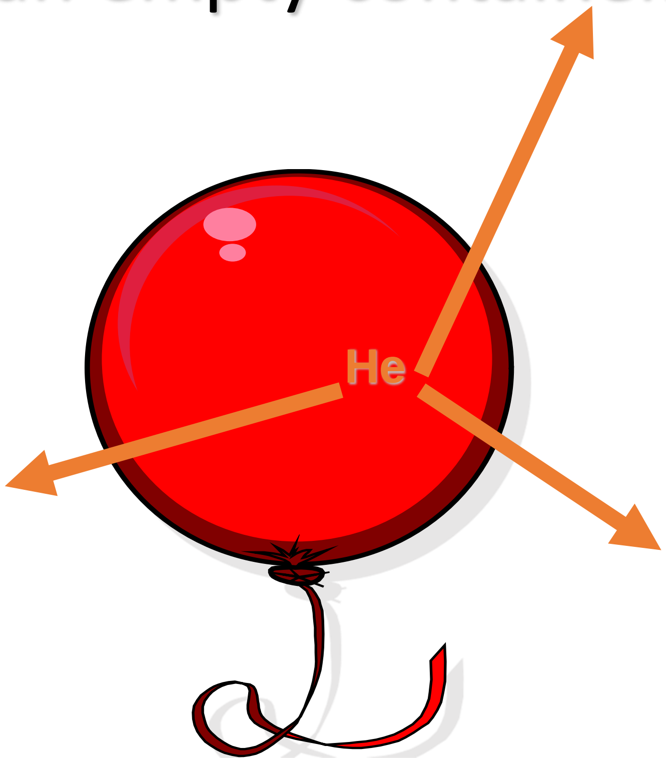
GAS DIFFUSION AND EFFUSION

Diffusion:

Mixing of gases. From an area of high concentration to low concentration

Effusion:

movement of molecules through a small hole into an empty container.



Graham's Law of EFFUSION

Molecules effuse based on the **size** of the gas molecule.

Does He or O_2 effuses faster?

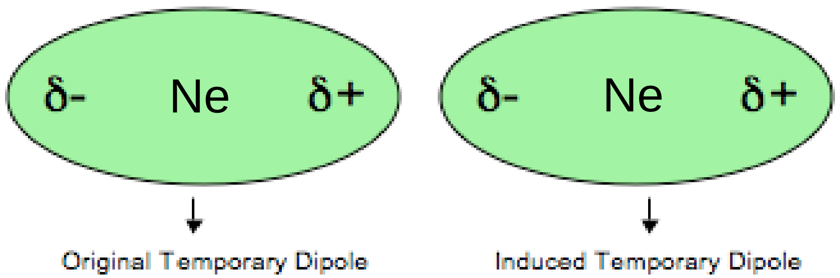
Thomas Graham, 1805-1869. Professor in Glasgow and London.

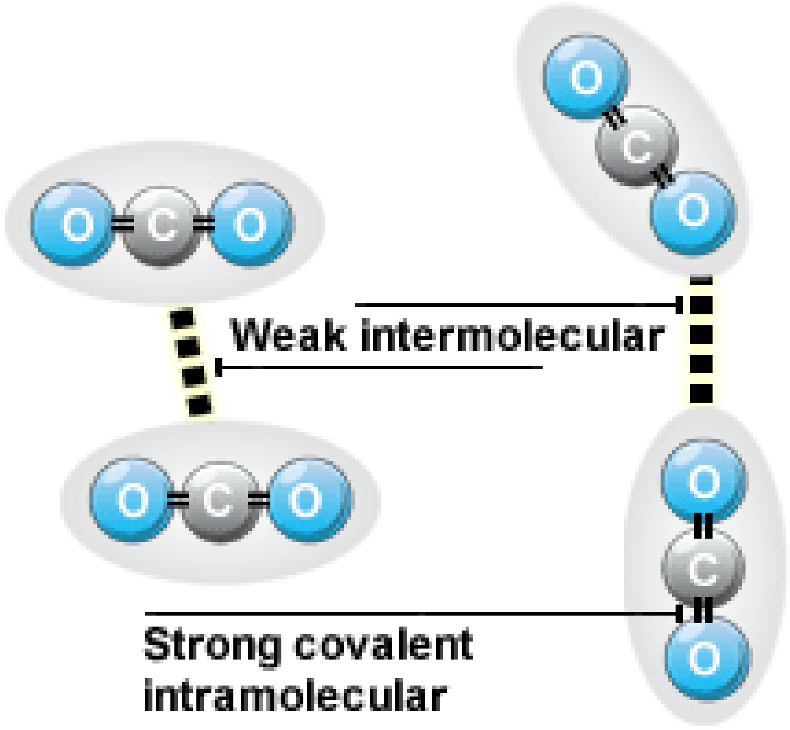
Ch 13.2 Intermolecular Forces

- ***Intermolecular forces*** occur **between** molecules.

London dispersion forces:

Occur between ALL molecules
…but are **TEMPORARY!**

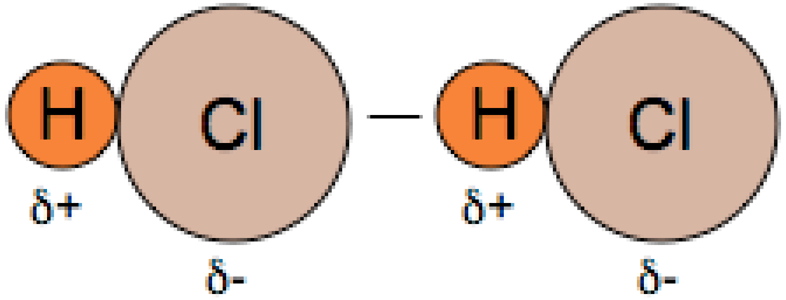




Caused by ***normal movement of electrons***

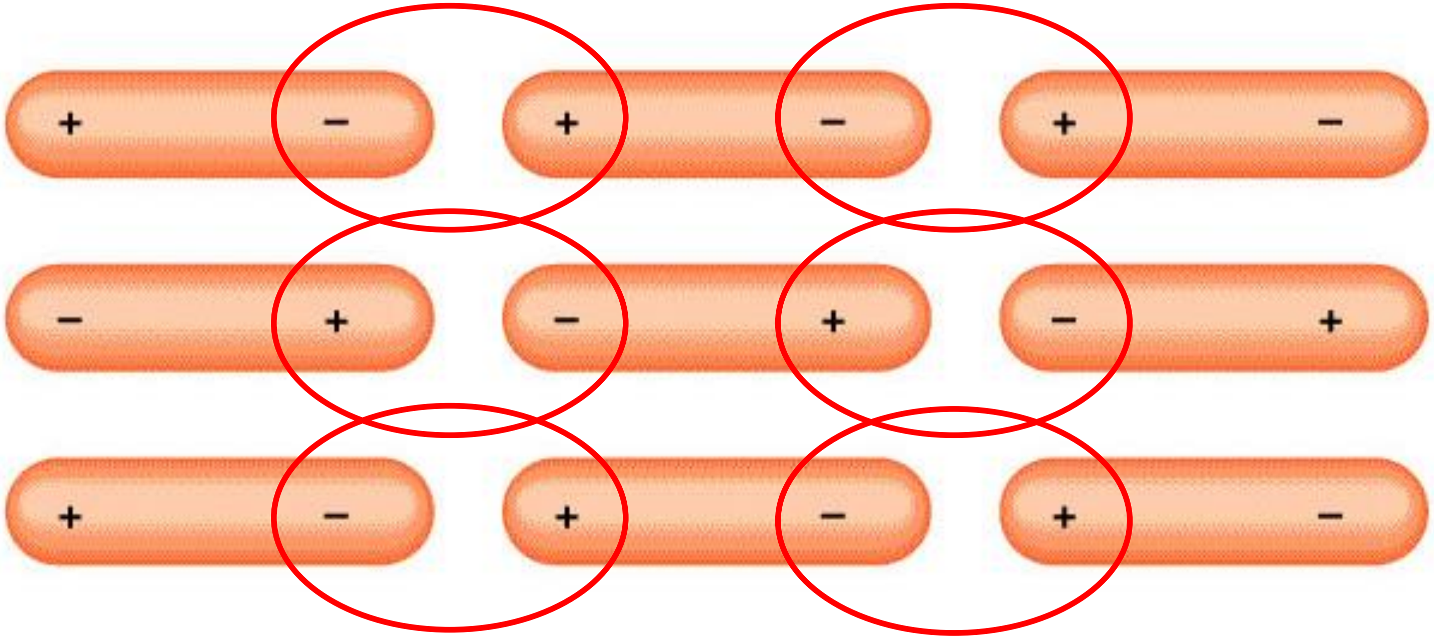
→ more electrons = greater dispersion forces

Dipole-Dipole Forces



Occur between **polar molecules** **only**

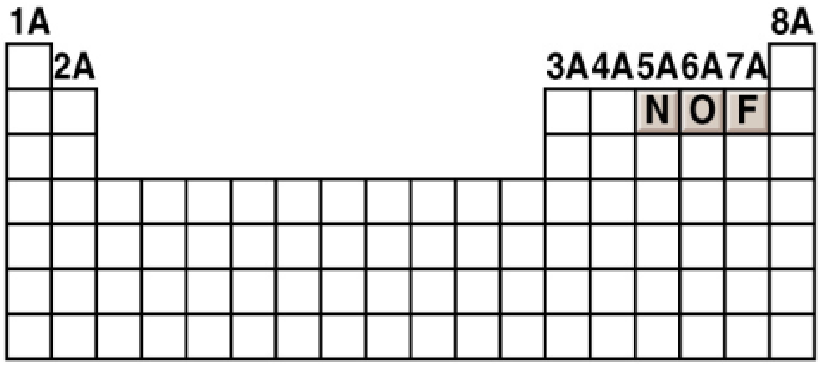
stronger than dispersion forces

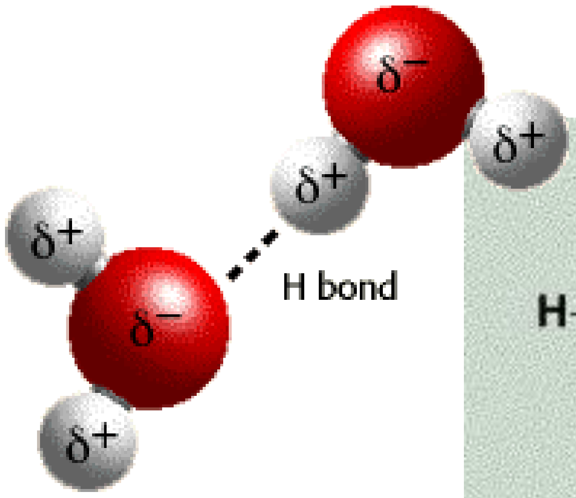


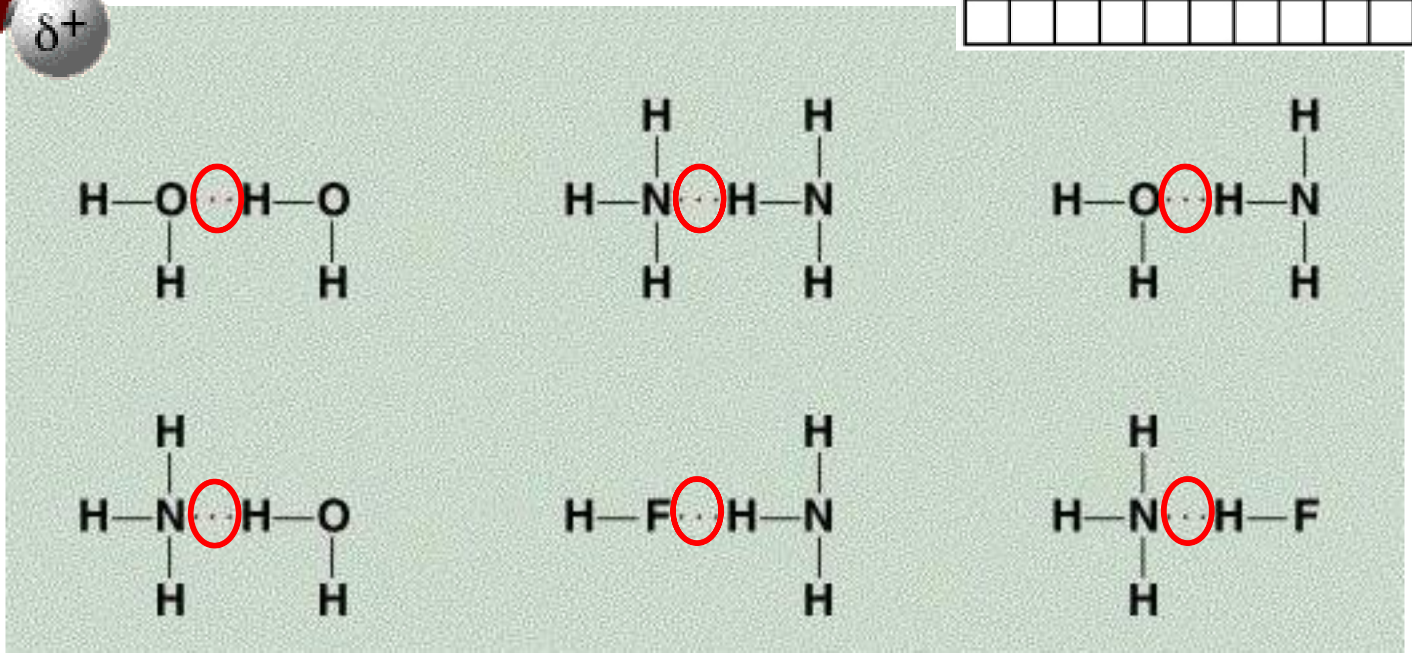
Hydrogen Bonding

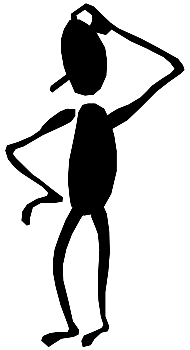
Strongest IM forces

A dipole-dipole interaction between the H *in a polar N-H, O-H, or F-H bond* and an electronegative ***O, N, or F*** atom.









What type(s) of intermolecular forces exist between each of the following molecules?

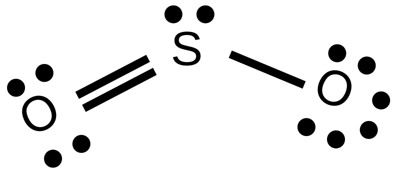
HBr

HBr is a polar molecule: **dipole-dipole** forces. There are also **dispersion** forces between HBr molecules.

CH_4

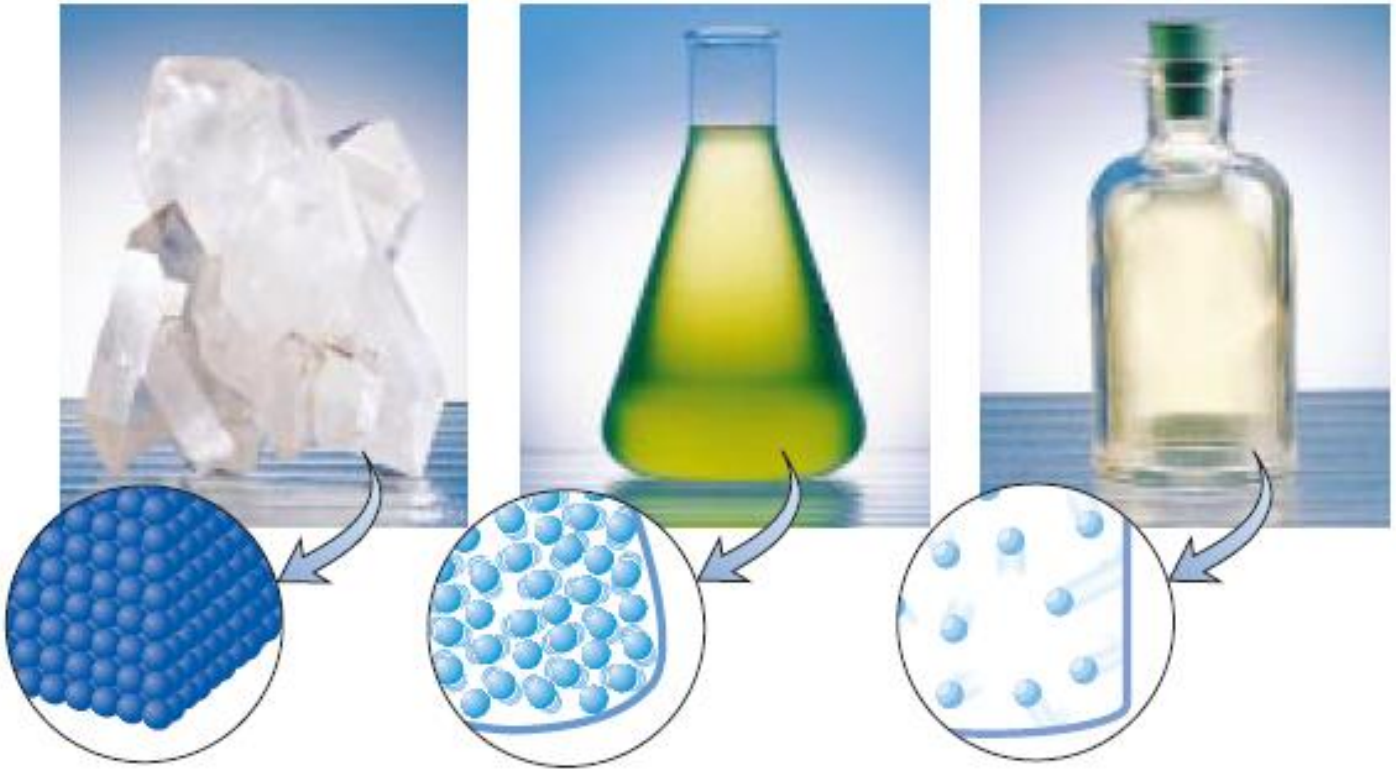
CH_4 is nonpolar: **dispersion** forces.

SO_2



SO_2 is a polar molecule: **dipole-dipole** forces. There are also **dispersion** forces between SO_2 molecules.

Ch. 13.3 Liquids and Solids

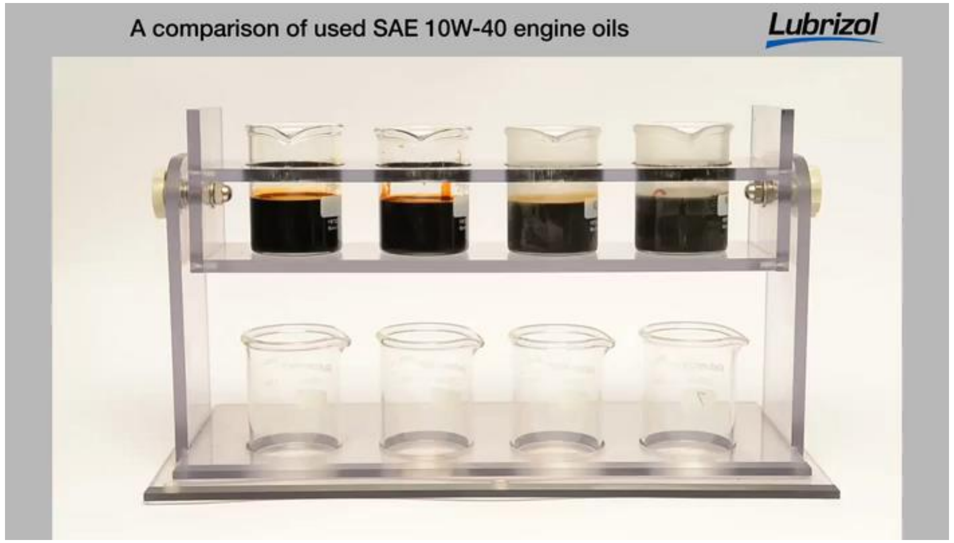


(a) Particles in a solid
(b) Particles in a liquid
(c) Particles in a gas

Ch. 13.3 Liquids

Viscosity

- **Viscosity is the resistance of a liquid to flow.**
- *Stronger intermolecular forces = higher viscosity.*

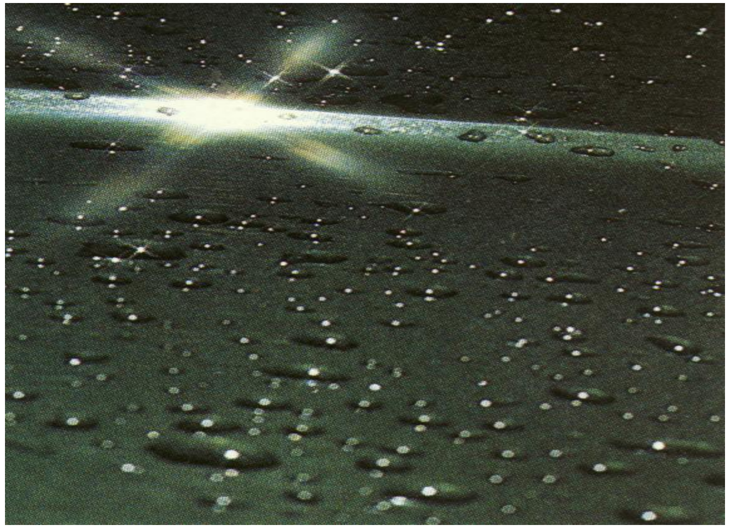
- **Affected by temperature**
  - *Example: Oil in a frying pan*

Ch 13.3 Liquids

Surface Tension

- **is energy required to increase the surface area.**

- **Surface molecules attracted inwards.**
  - Therefore, surface molecules are packed more closely.



- **Surfactants lower the surface tension**
  - Soaps and detergents

Ch 13.3 Liquids

- **Cohesive forces exist between molecules of a liquid.**
- **Adhesive forces exist between the liquid and its container.**

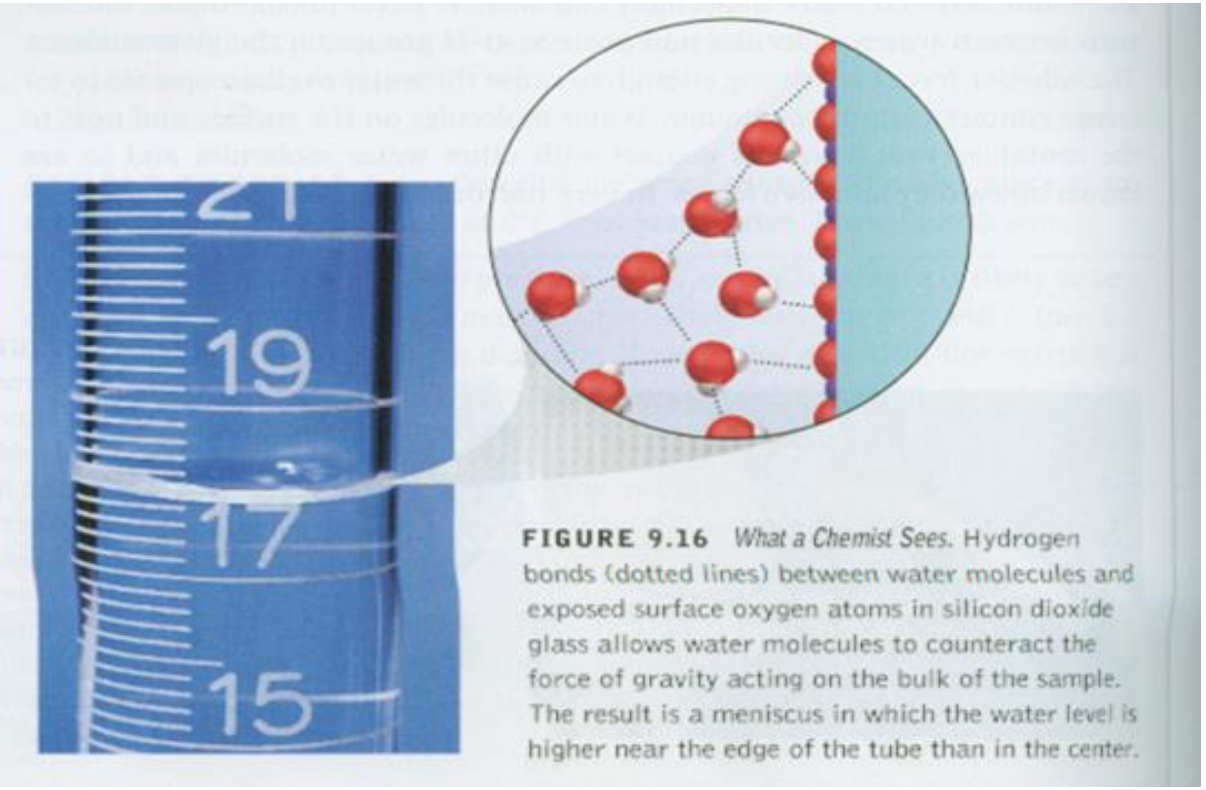


FIGURE 9.16 *What a Chemist Sees.* Hydrogen bonds (dotted lines) between water molecules and exposed surface oxygen atoms in silicon dioxide glass allows water molecules to counteract the force of gravity acting on the bulk of the sample. The result is a meniscus in which the water level is higher near the edge of the tube than in the center.

Capillary Action –

Spontaneous rising of a liquid in a narrow tube.

Ch 13.3 The Nature of Solids

- There are 2 general classifications of solids:

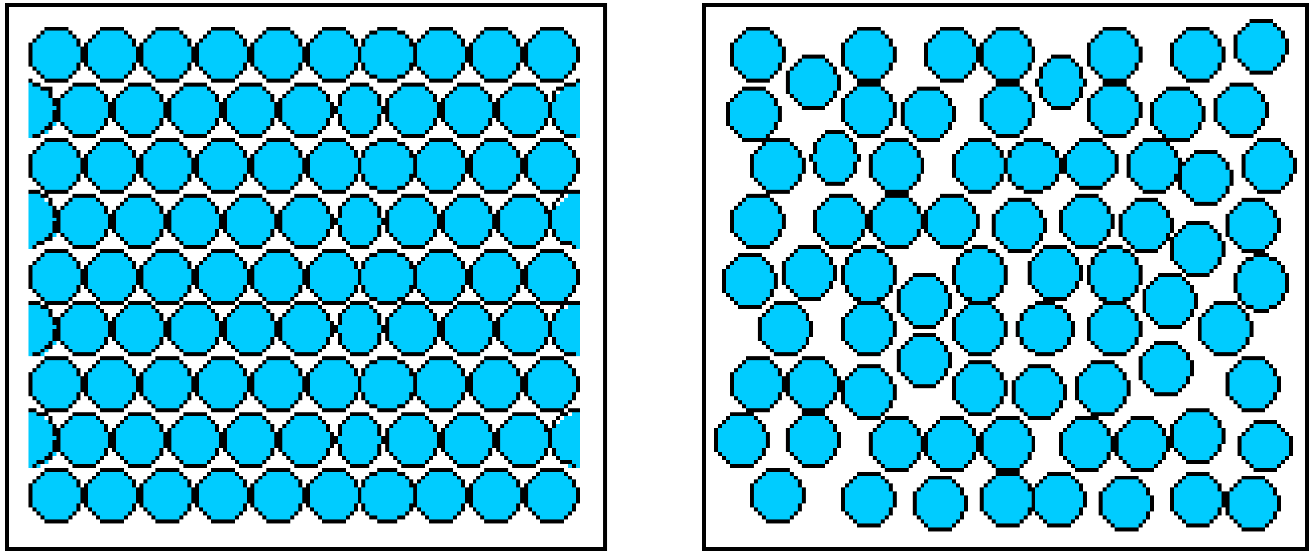
(1)__***Amorphous***__ : No __pattern__ to the arrangement of particles. Their melting point is over a __wide__ __range__ of temperatures. They just get __softer__ and __softer__ when heated.

*Examples:*__wax__, _glass_, butter, gum, Jell-O, _plastic_.

The Nature of Solids *(continued)*

(2) ___***Crystalline***___: Well-ordered, ___definite___ arrangement of atoms. Crystals have a ___repeating___ structure and a melting point at a very narrow range of temperatures.

Examples: ___sugar___, ___salt___, quartz, ___diamonds___, ___rubies___, ___water (ice)___, ___gold___



crystal solid amorphous solid

Allotropes

More than one crystalline arrangement of the atoms.

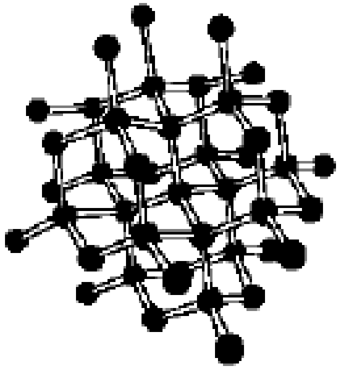
**Example:* Carbon has 3 allotropes:

(1) Graphite = “flat layers” of atoms

(2) Diamond = ”cubic blocks” of interlocking atoms

(3) “Buckyball”= a “soccer ball-shaped sphere” of 60 atoms

buckminsterfullerene



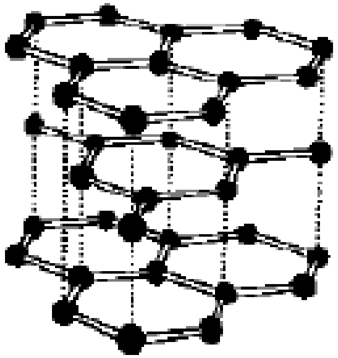
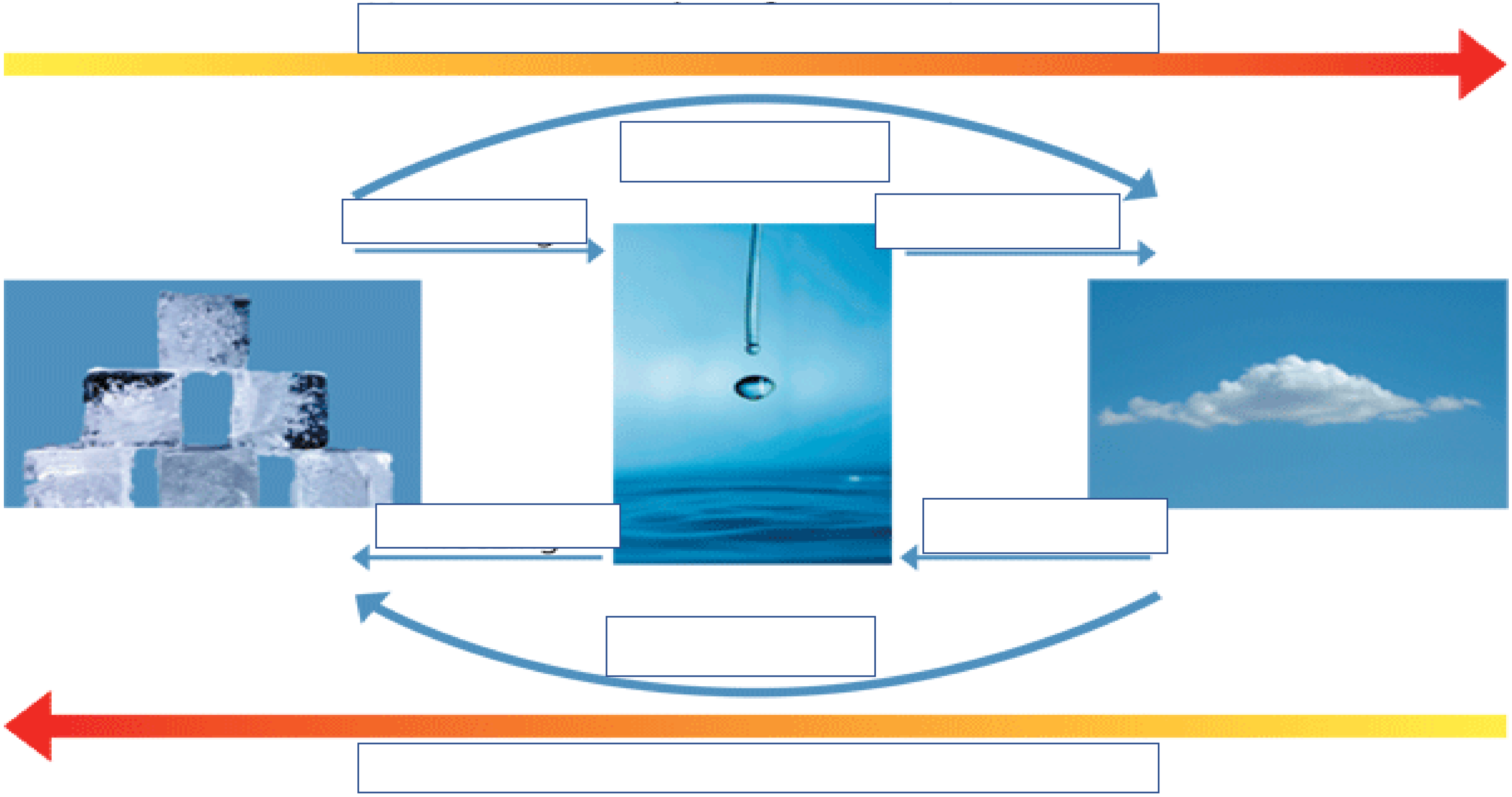


Figure 7

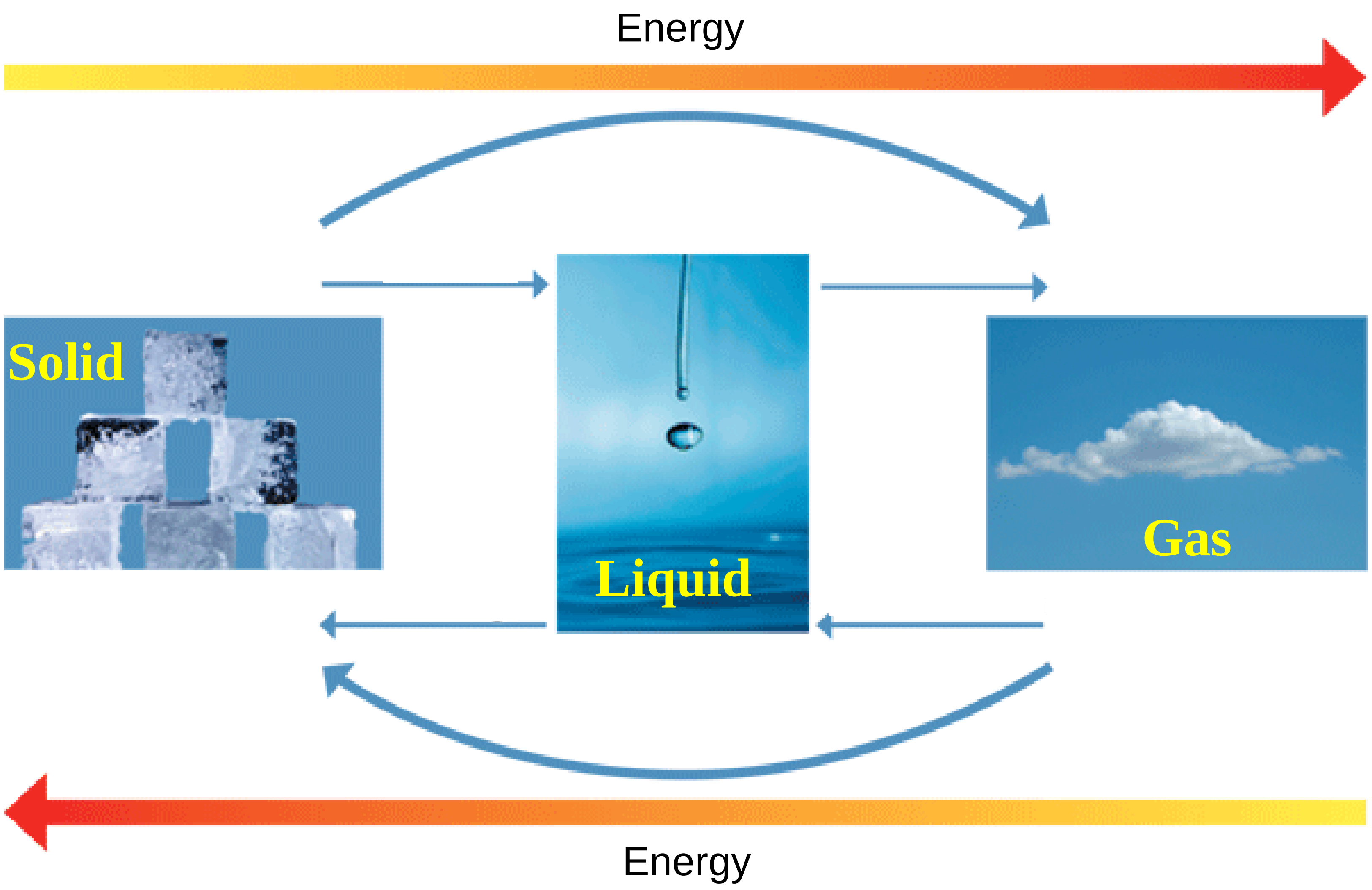
13.4 Phase Changes *(and Energy)*



Vocabulary

Vaporization: The process by which a liquid changes to a gas or a vapor
Condensation: The process by which a gas or a vapor becomes a liquid
Sublimation: The process by which a solid changes directly to a gas without first becoming a liquid
Melting: the process by which the particles in a crystalline structure begin to flow to form a liquid
Freezing: The process by which the molecules in a liquid arrange themselves in a crystalline structure
Deposition: The process by which the substance changes from a gas or a vapor into a solid without first becoming a liquid
add text

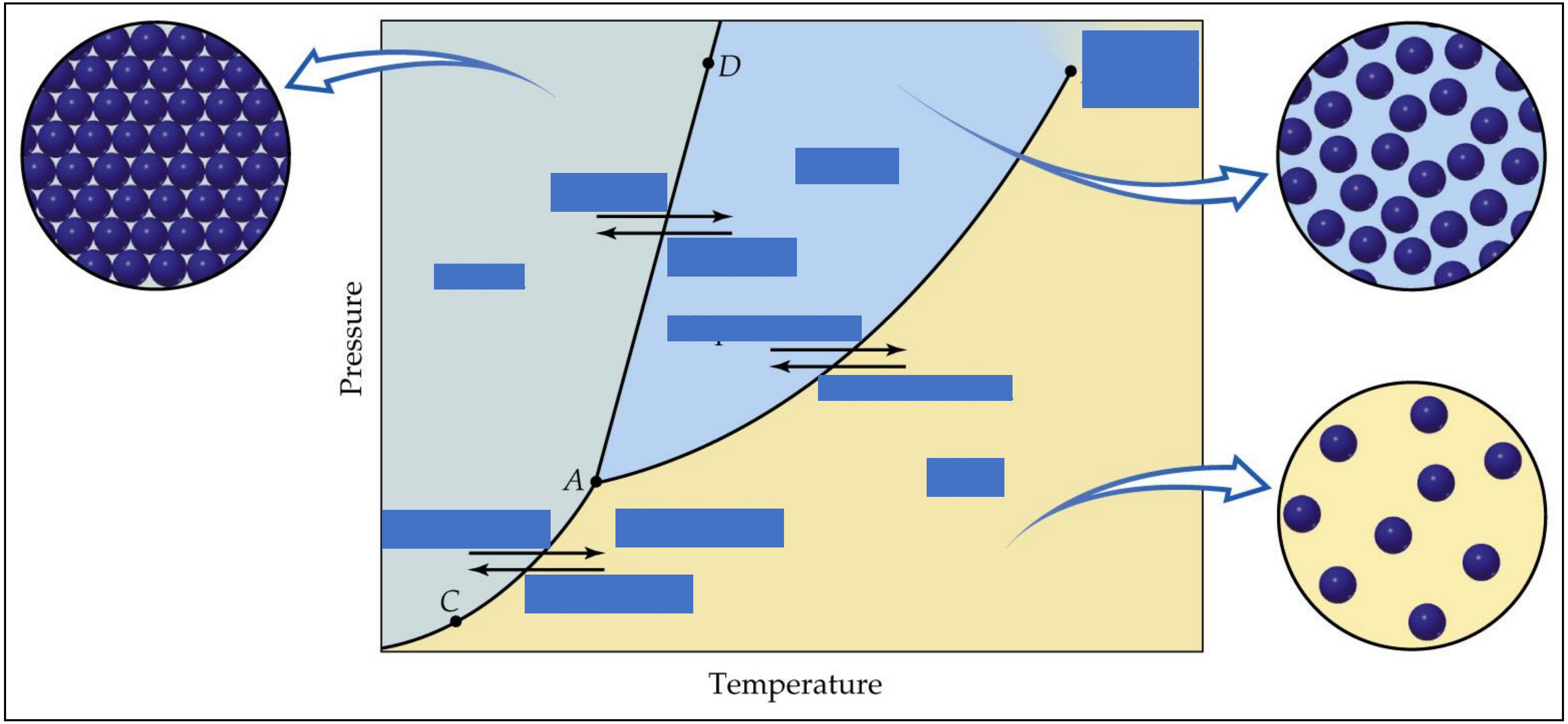
13.4 Phase Changes *(and Energy)*



Phase Diagram

Phases of matter at various temperatures and pressures

for a particular substance



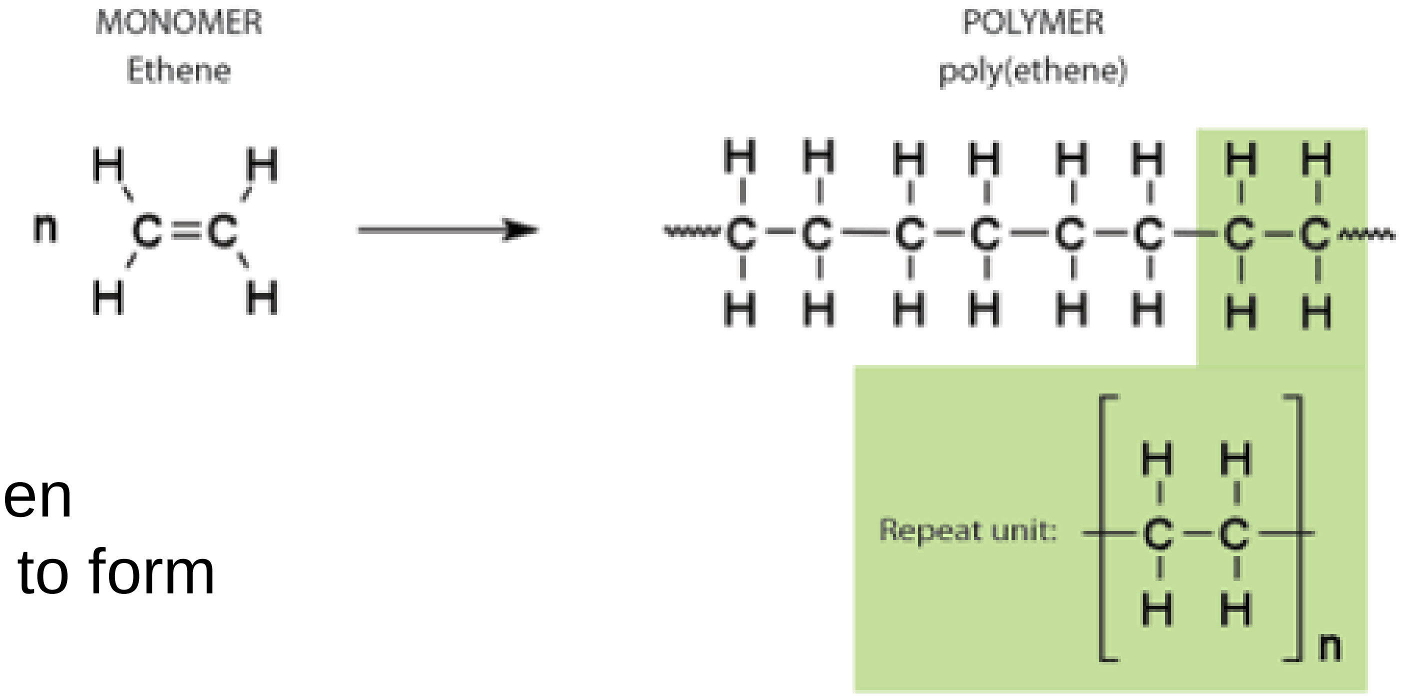
Triple Point: All 3 phases of matter at __equilibrium_____.

Critical Point: The highest temp. at which the liquid phase can exist.

Ch 23.5 Polymers

Ch 23.5 Polymers

A **polymer** is a large molecule made up of many repeating structural units called a **monomer**

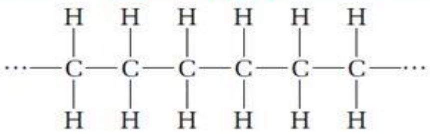
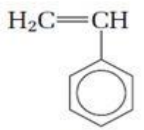
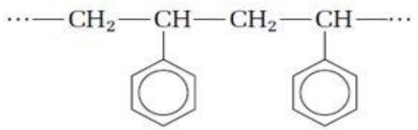
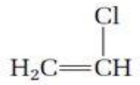
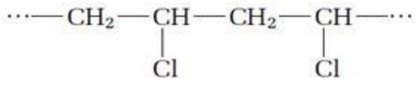
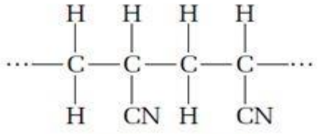


Polymerization reaction: when monomer units bond together to form polymers

Polymerization Reactions

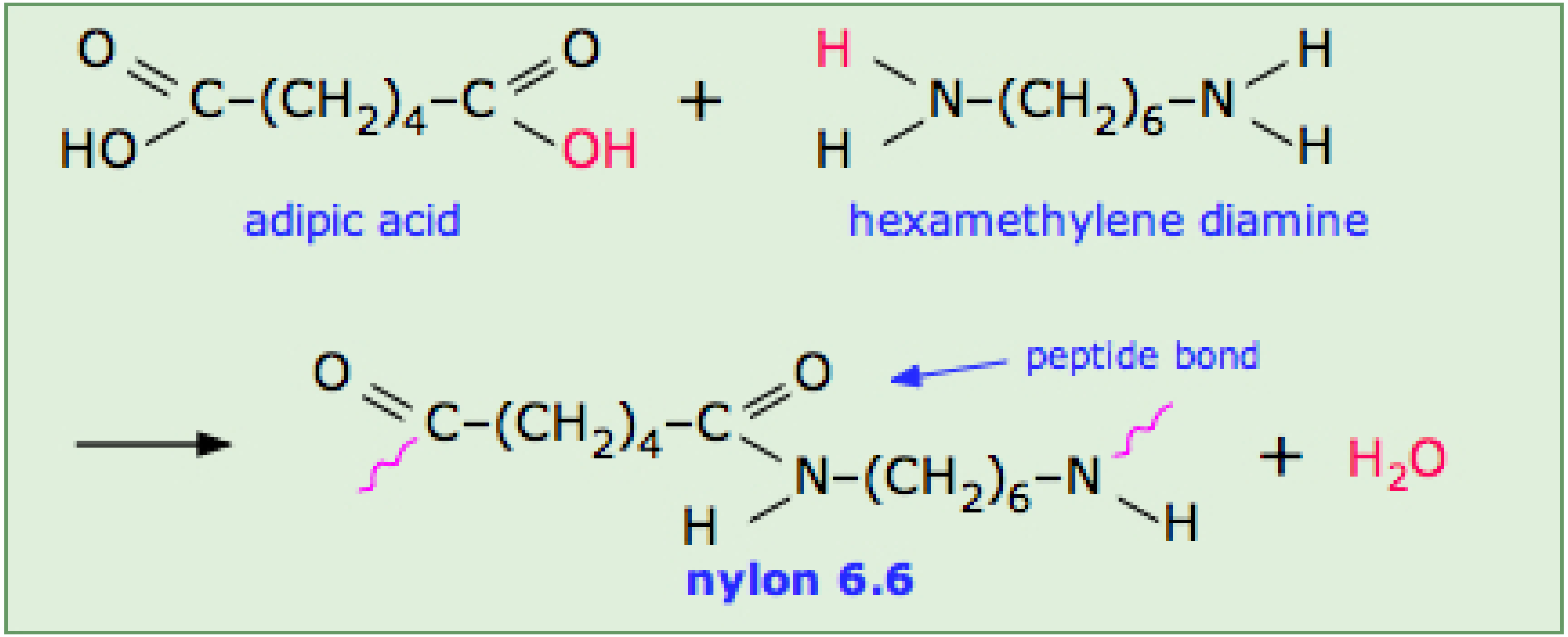
Addition polymerization: A reaction in which all monomers are retatined in the polymer product. (there's only one product)

Examples of Addition Polymers

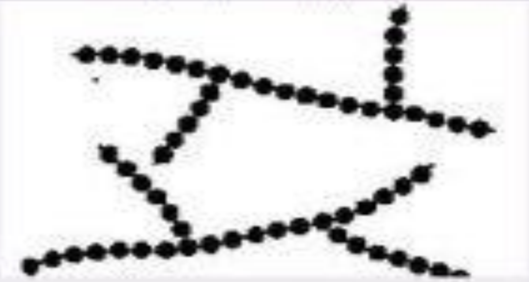
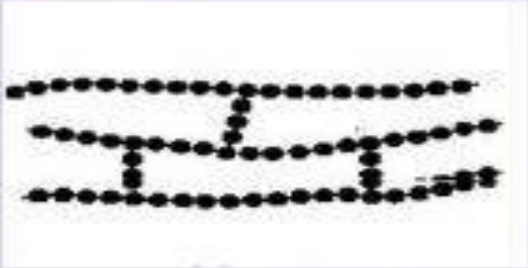
Name	Structure of monomer	Structure of polymer	Uses
polyethene	$H_2C{=}CH_2$ ethene	 polyethene	• plastic bags • plastic milk, juice, and water bottles • toys
polystyrene	 styrene	 polystyrene	• styrene and Styrofoam™ cups • insulation • packaging
polyvinylchloride (PVC, vinyl)	 vinyl chloride	 polyvinylchloride (PVC)	• building and construction materials • sewage pipes • medical equipment
polyacrylonitrile	$H_2C{=}CH{-}CN$ acrylonitrile	 polyacrylonitrile	• paints • yarns, knit fabrics, carpets, and wigs

Polymerization reactions

Condensation Polymerization: when two different monomer units bond together to produce a polymer and a small amount of waste product(usually water)



Properties of polymers

Polymer	Properties
 e.g: poly(ethene)	- Low melting point - Flexible
 e.g: poly(propene)	- Relatively low melting point - More rigid
 e.g: Kevlar	- Very high melting point - Very rigid (usually)