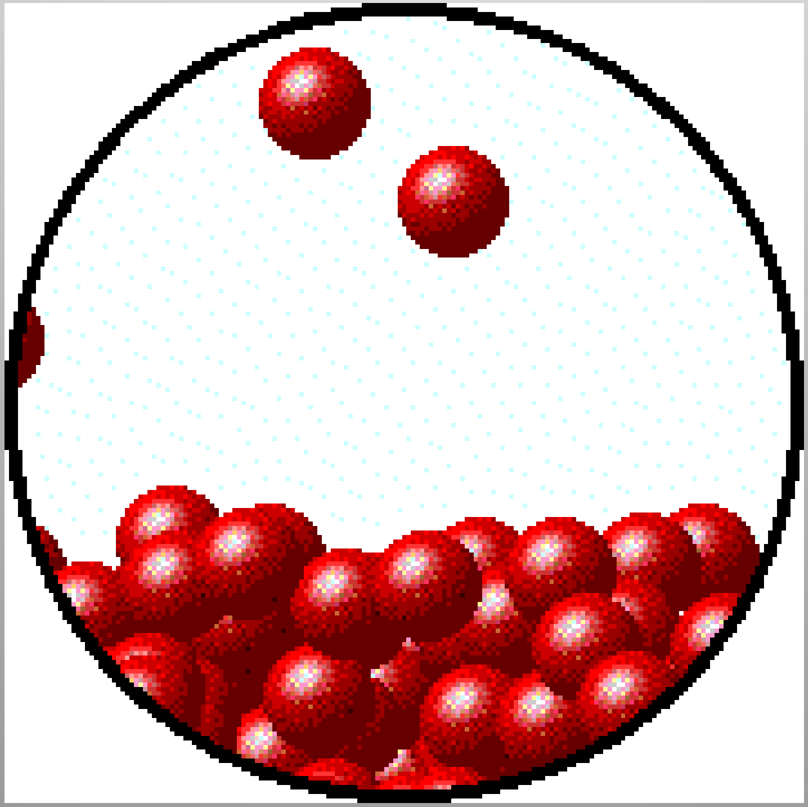
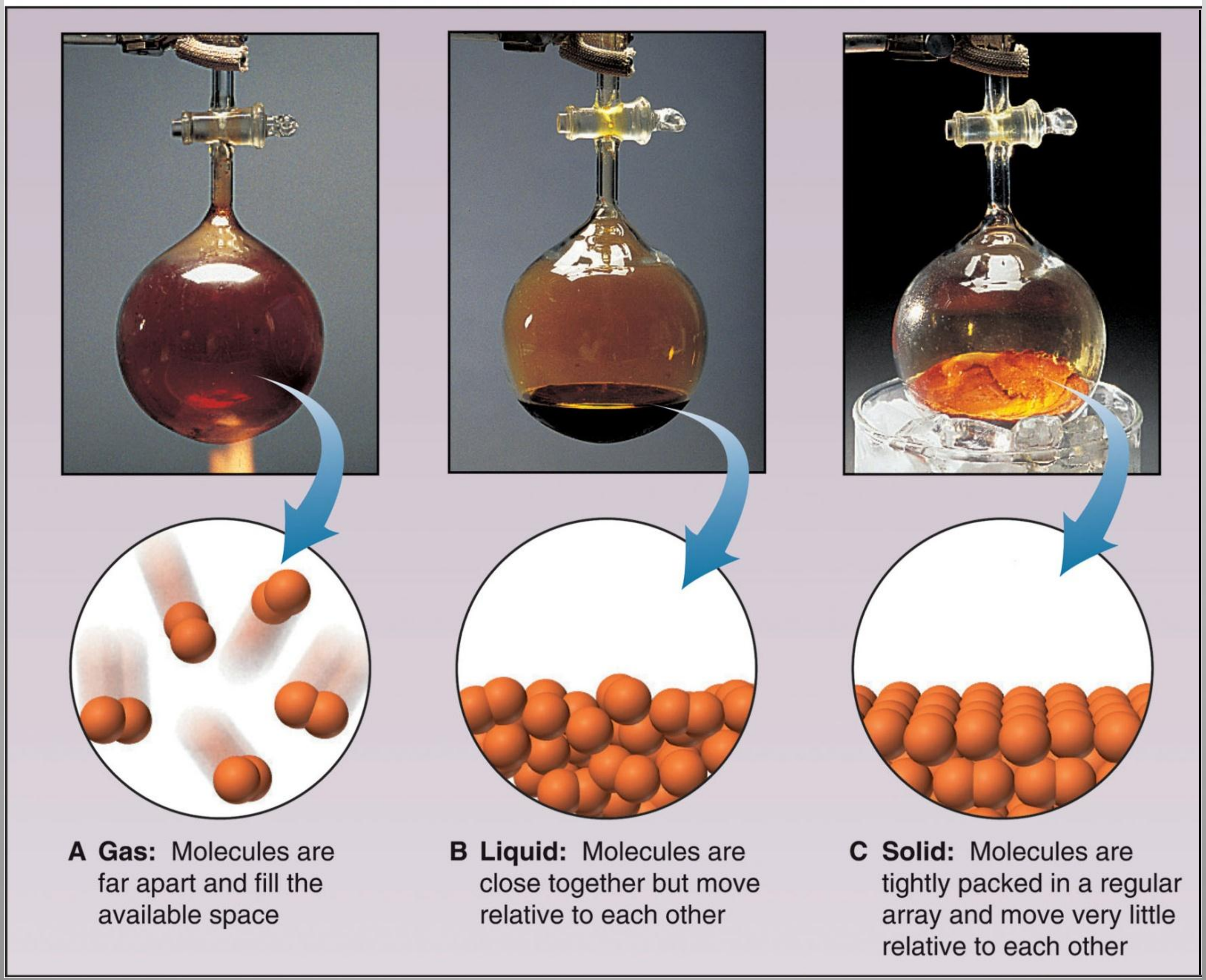
Solid, Liquids, and Gases

Their properties and changes



The three states of matter.



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Gases

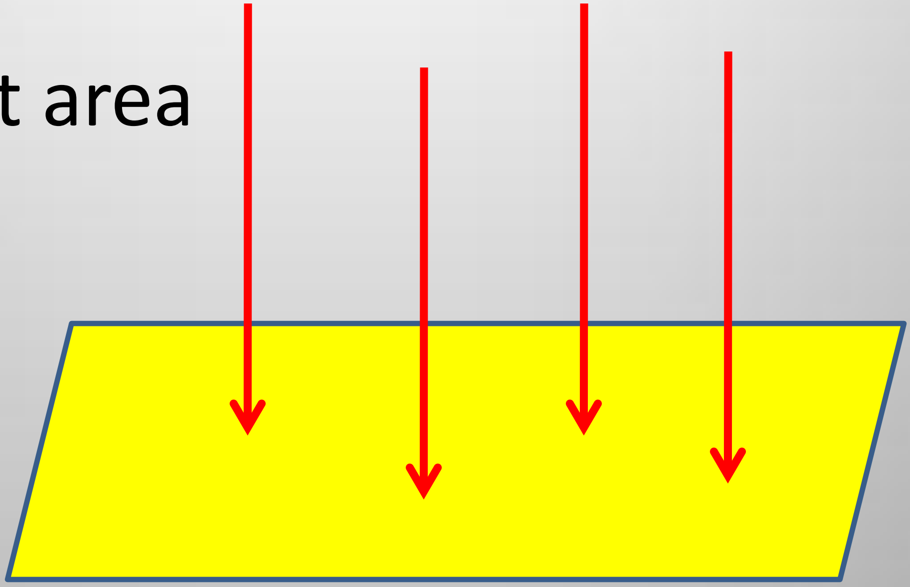
- Because gases have so much space between the particles they have properties that are dependent on one another.

Gas Variables

- **Volume (V)** - mL, L, kL…
- **Temperature (T)** – ^{o}C measured in lab but K (kelvin) for calculations
- **Number of particles (n)** – moles
- **Pressure (P)** – mmHg, psi…(more to come)

Pressure

- Force per unit area



A mercury barometer

Figure 5.3

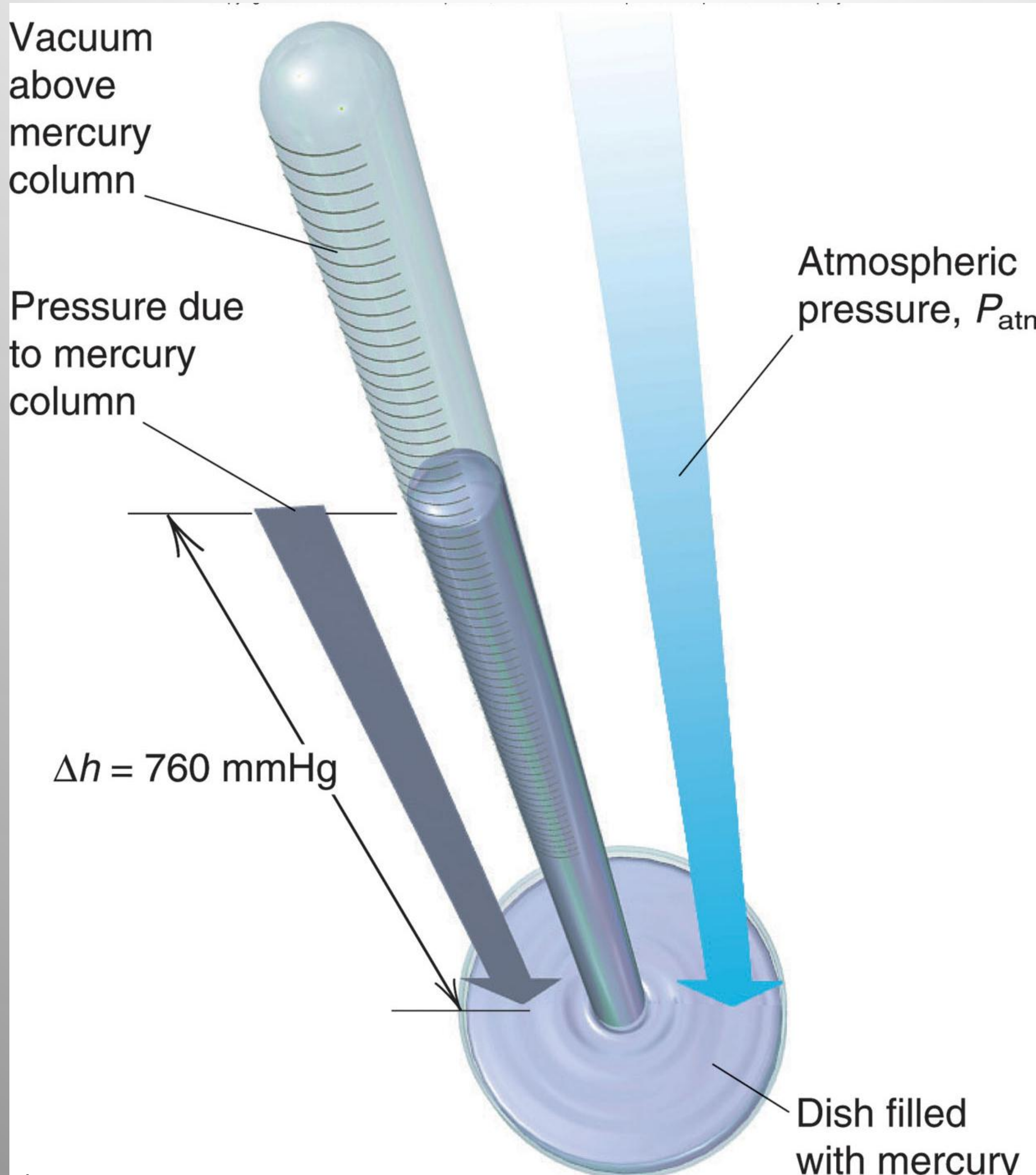


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Table 5.1 Common Units of Pressure

Unit	Atmospheric Pressure	Scientific Field
pascal(Pa); kilopascal(kPa)	1.01325×10^5 Pa; 101.325 kPa	SI unit; physics, chemistry
atmosphere(atm)	1 atm*	chemistry
millimeters of mercury(Hg)	760 mm Hg*	chemistry, medicine, biology
torr	760 torr*	chemistry
pounds per square inch (psi or lb/in^2)	$14.7 lb/in^2$	engineering
bar	1.01325 bar	meteorology, chemistry, physics

**This is an exact quantity; in calculations, we use as many significant figures as necessary.*

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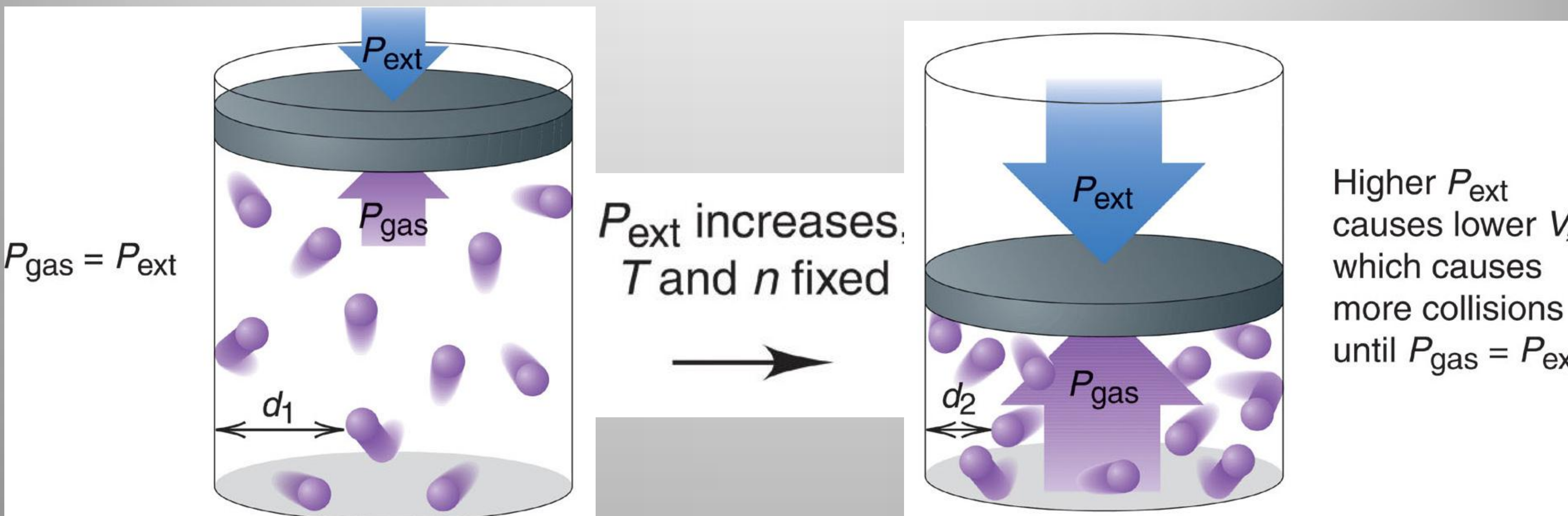
Gas Variable Relationships

- To investigate the relationship between 2 gas variables we need to hold the other 2 constant.
- Constant P - same # of collisions/unit area
- Constant V - rigid container
- Constant T – thermostat control
- Constant n – keep container sealed

The Relationship Between Pressure and Volume



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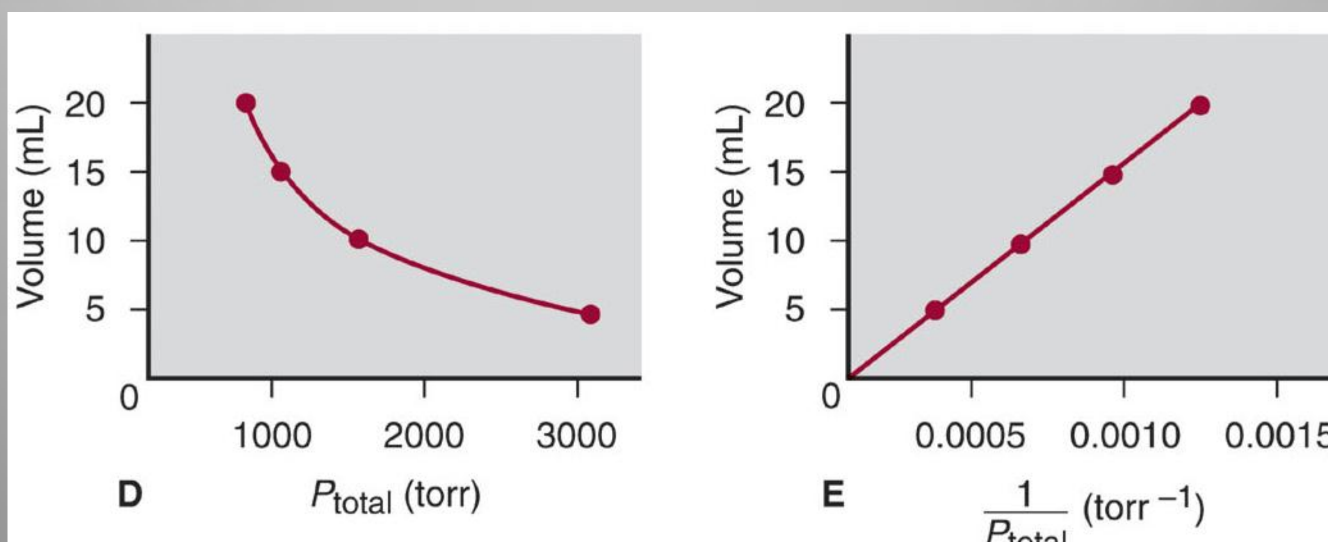
The relationship between the volume and pressure of a gas.

C

V (mL)	P (torr)			$\frac{1}{P_{total}}$	PV (torr • mL)
	Δh +	P_{atm} =	P_{total}		
20.0	20.0	760	780	0.00128	1.56×10^4
15.0	278	760	1038	0.000963	1.56×10^4
10.0	800	760	1560	0.000641	1.56×10^4
5.0	2352	760	3112	0.000321	1.56×10^4

$$P_1V_1 = P_2V_2$$

Boyle's Law



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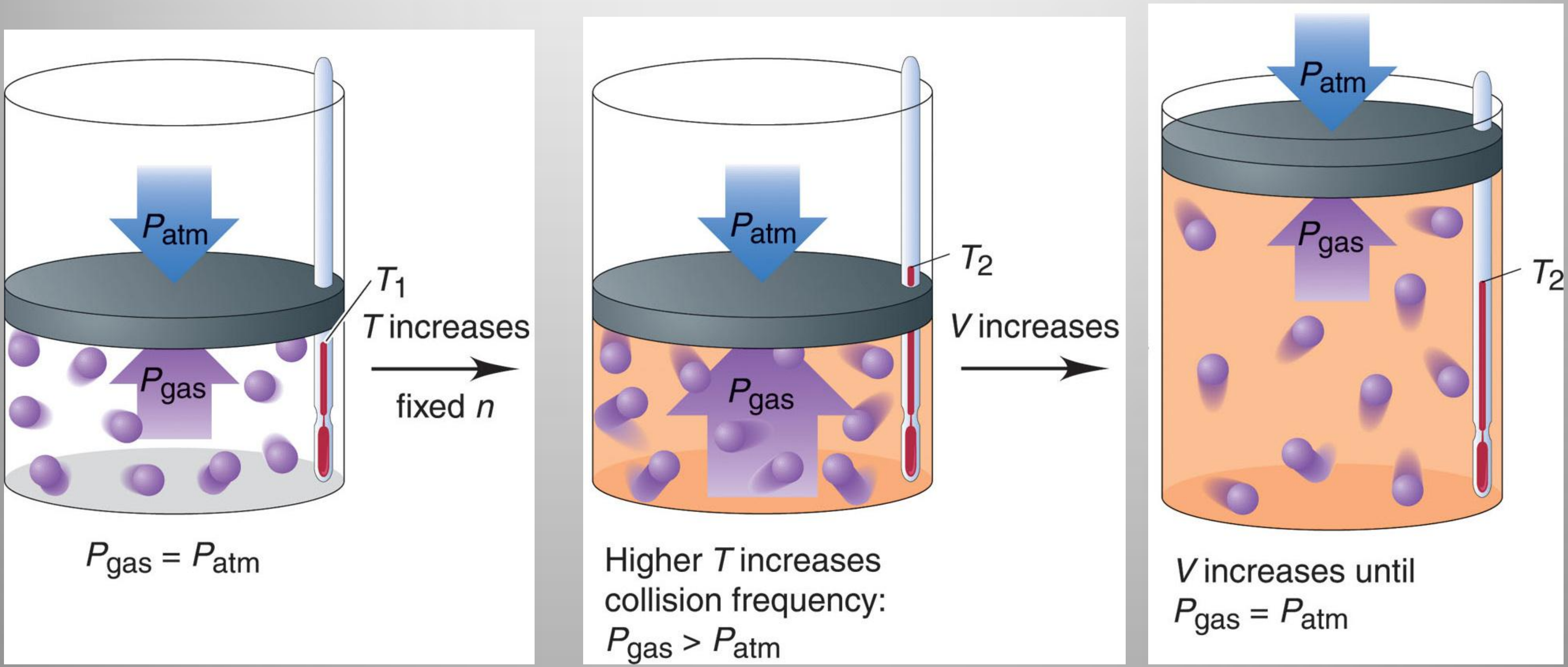
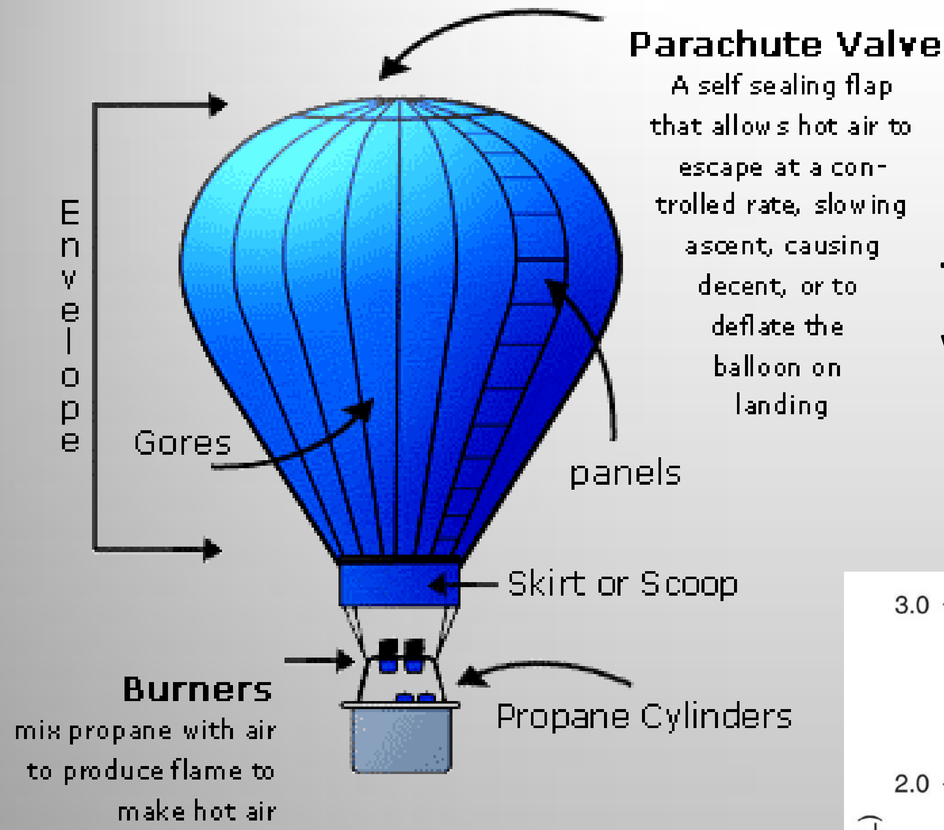
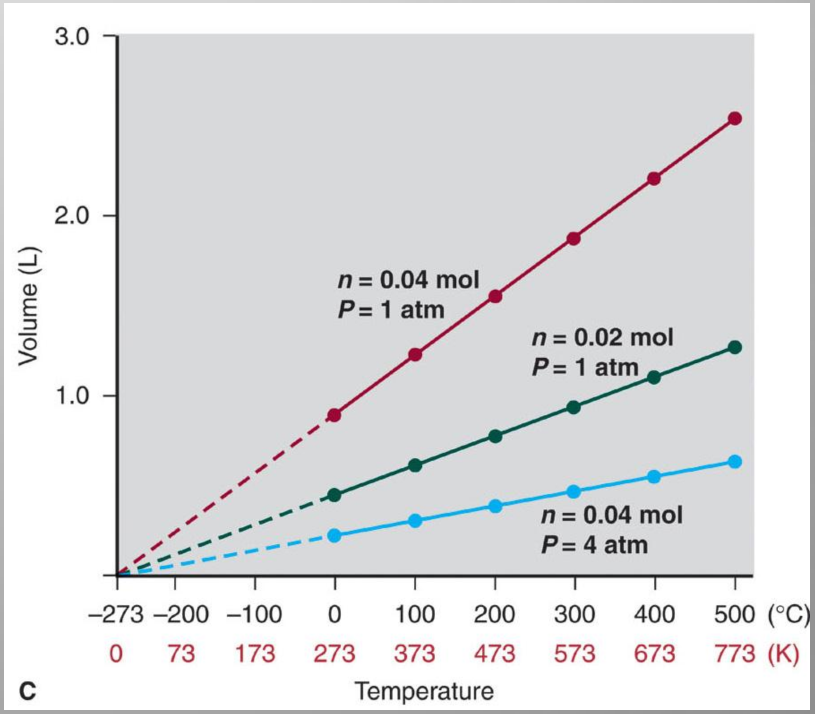
A molecular description the relationship between temperature and volume.





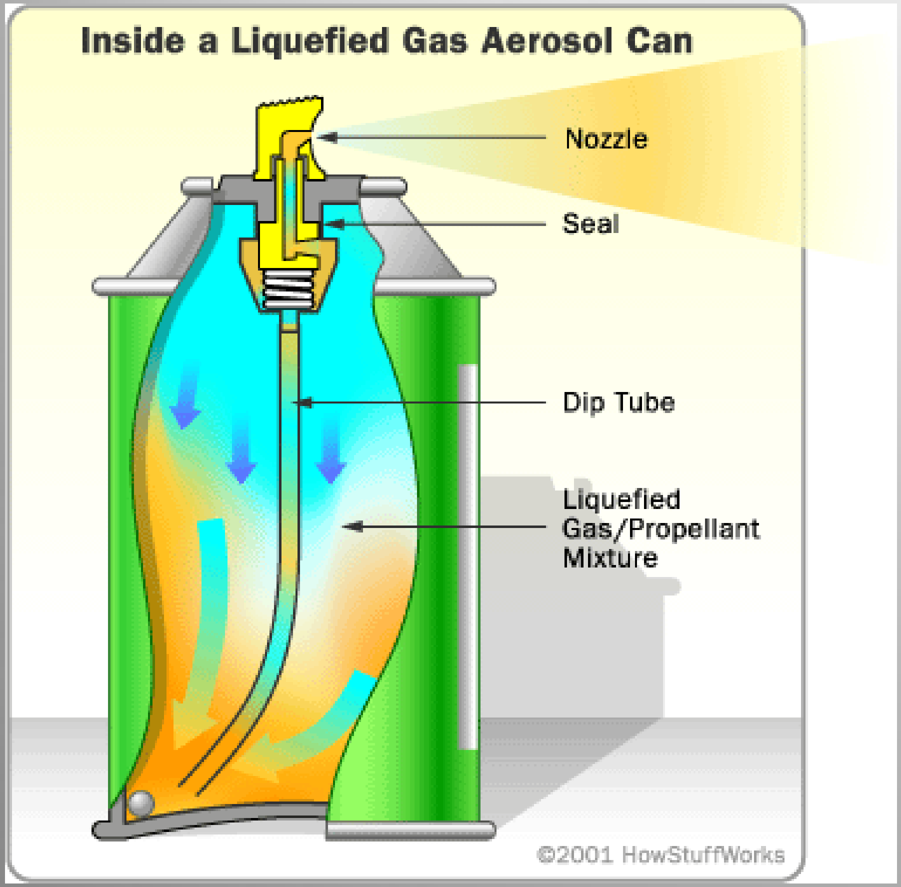
The relationship between the volume and temperature of a gas.



Charles's Law

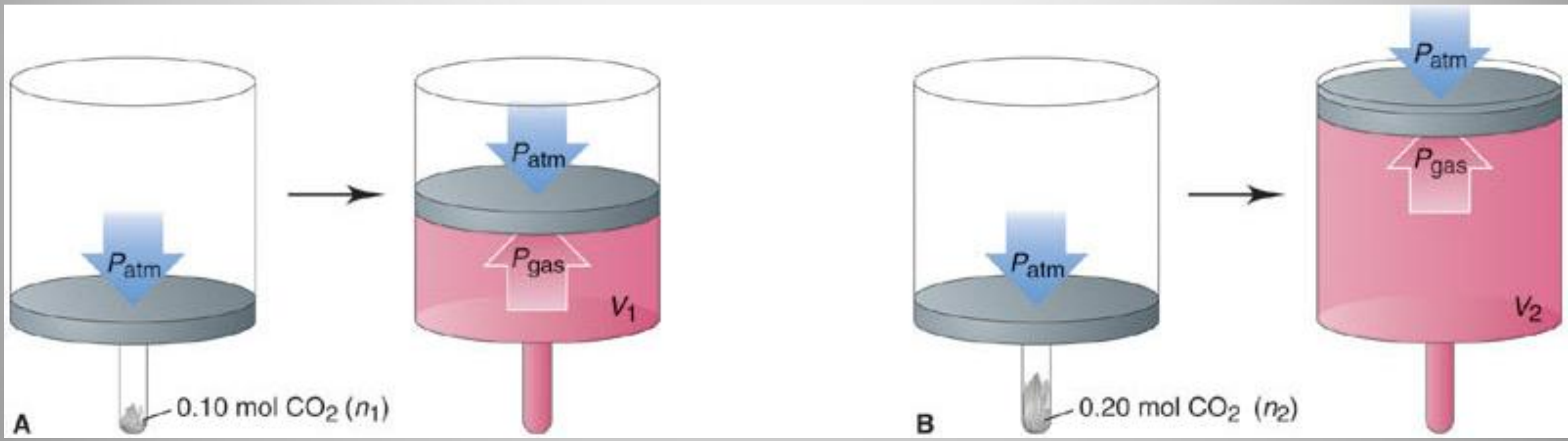
$$\frac{V_2}{V_1} = \frac{T_2}{T_1}$$

The relationship between pressure and temperature



- As temperature increases, gas particles move faster and make more collisions. As a result the pressure in the container increases.
- For an aerosol can the pressure may be so great that the seam on the can may give way in an explosion.

An experiment to study the relationship between the volume and amount of a gas.



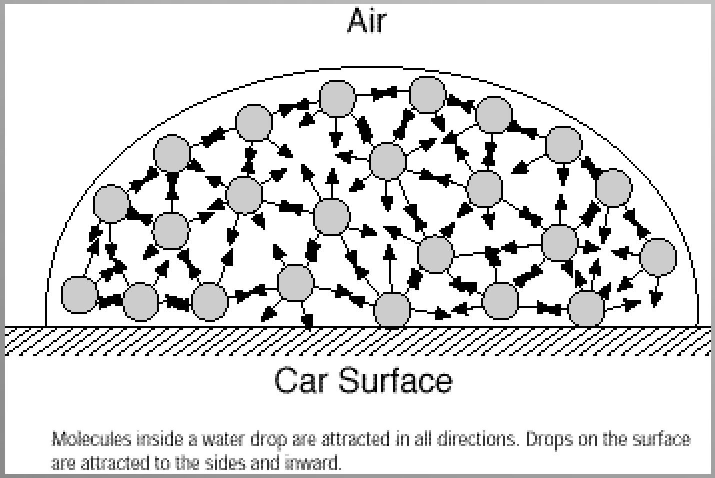
$$V \alpha n \quad \text{or} \quad V = \text{constant} \times n$$

The more gas particles you have the more collisions occur. To keep the pressure the same, the volume has to increase so there is more room for the particles. This is why balloons expand when you blow air into them.

Solids and Liquids

- Because the particles are so much closer in liquids and solids, there are chances for particles to attract (or repel). This and the mass of the particles are main factors in determining the properties of solids and liquids.
- Some properties are boiling and melting points, surface tension, vapor pressure, and crystalline structure.

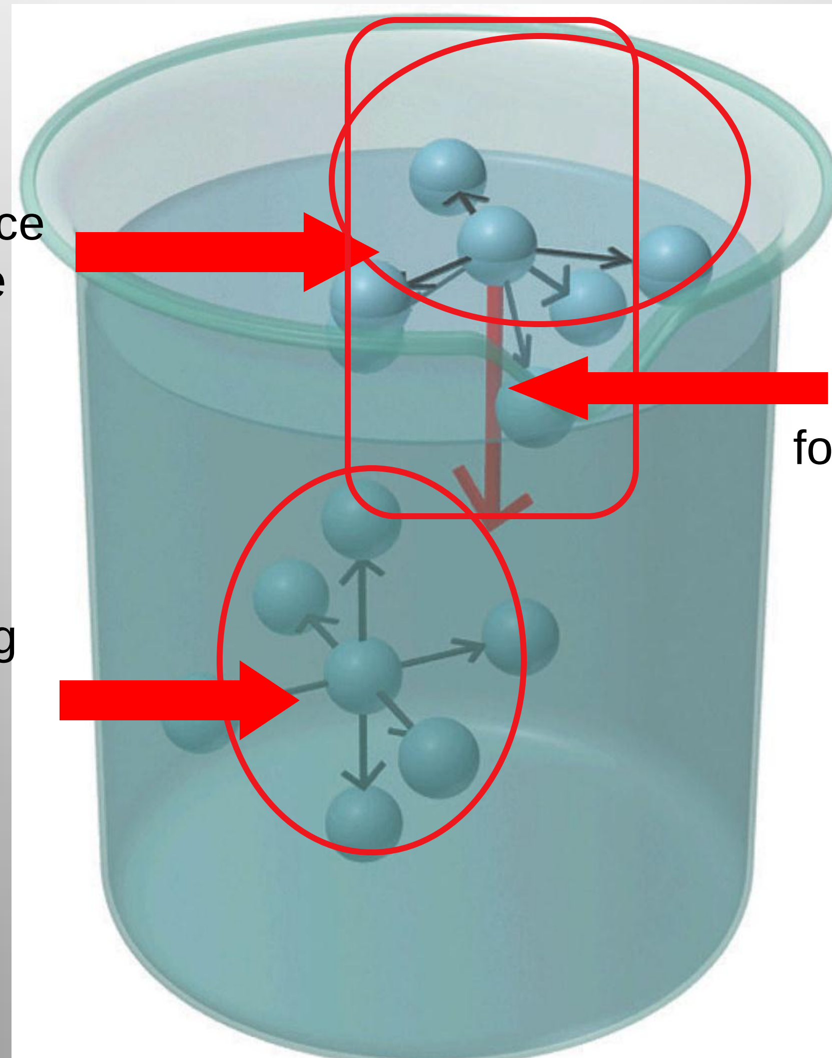
Surface Tension



- Surface tension is the tendency for liquid surface to contract.
- Depends on attractive forces
- Compounds that interfere with the forces and reduce surface tension are called surfactants.

The molecular basis of surface tension.

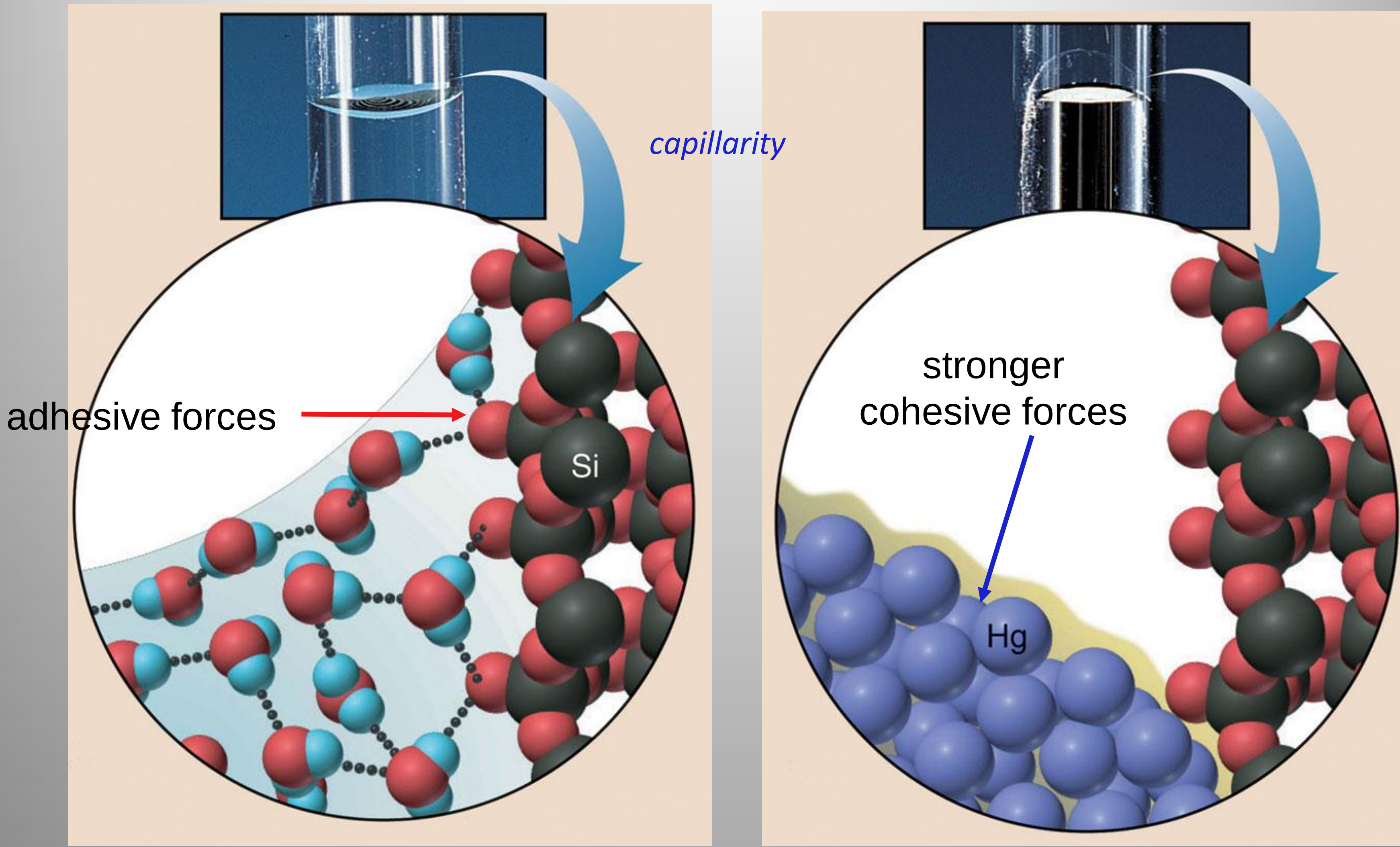
hydrogen bonding occurs across the surface and below the surface



the net vector for attractive forces is downward

hydrogen bonding occurs in three dimensions

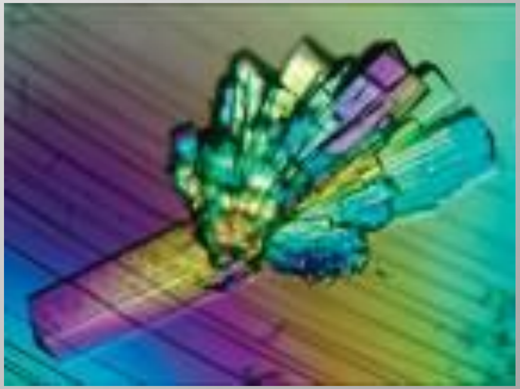
Shape of water or mercury meniscus in glass.



H_2O Hg

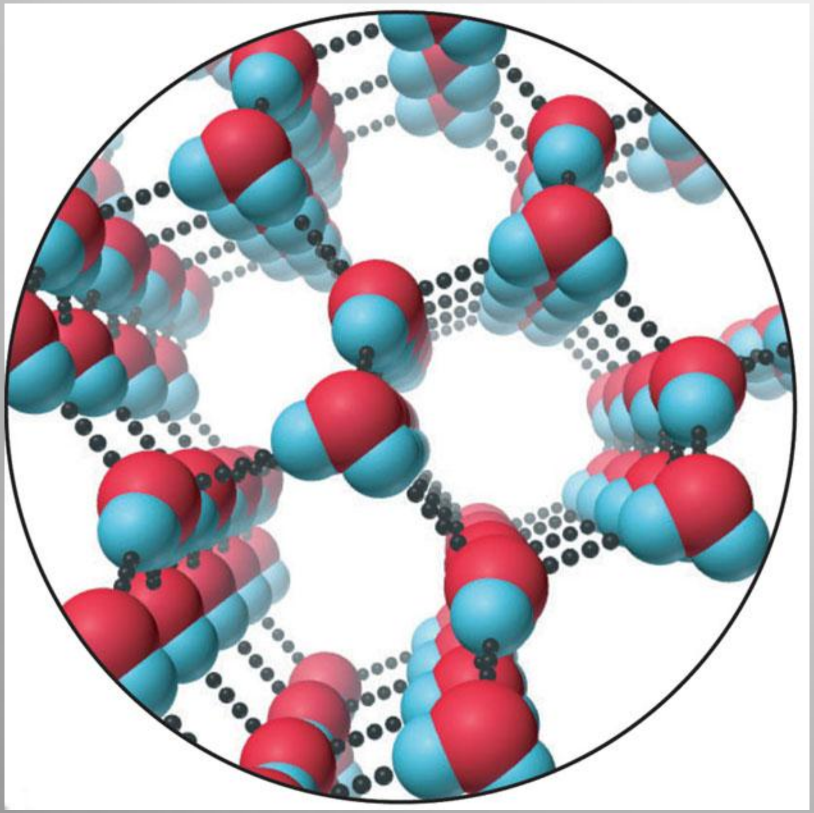
Solids

- Solids may have a definite structure and are called crystalline.

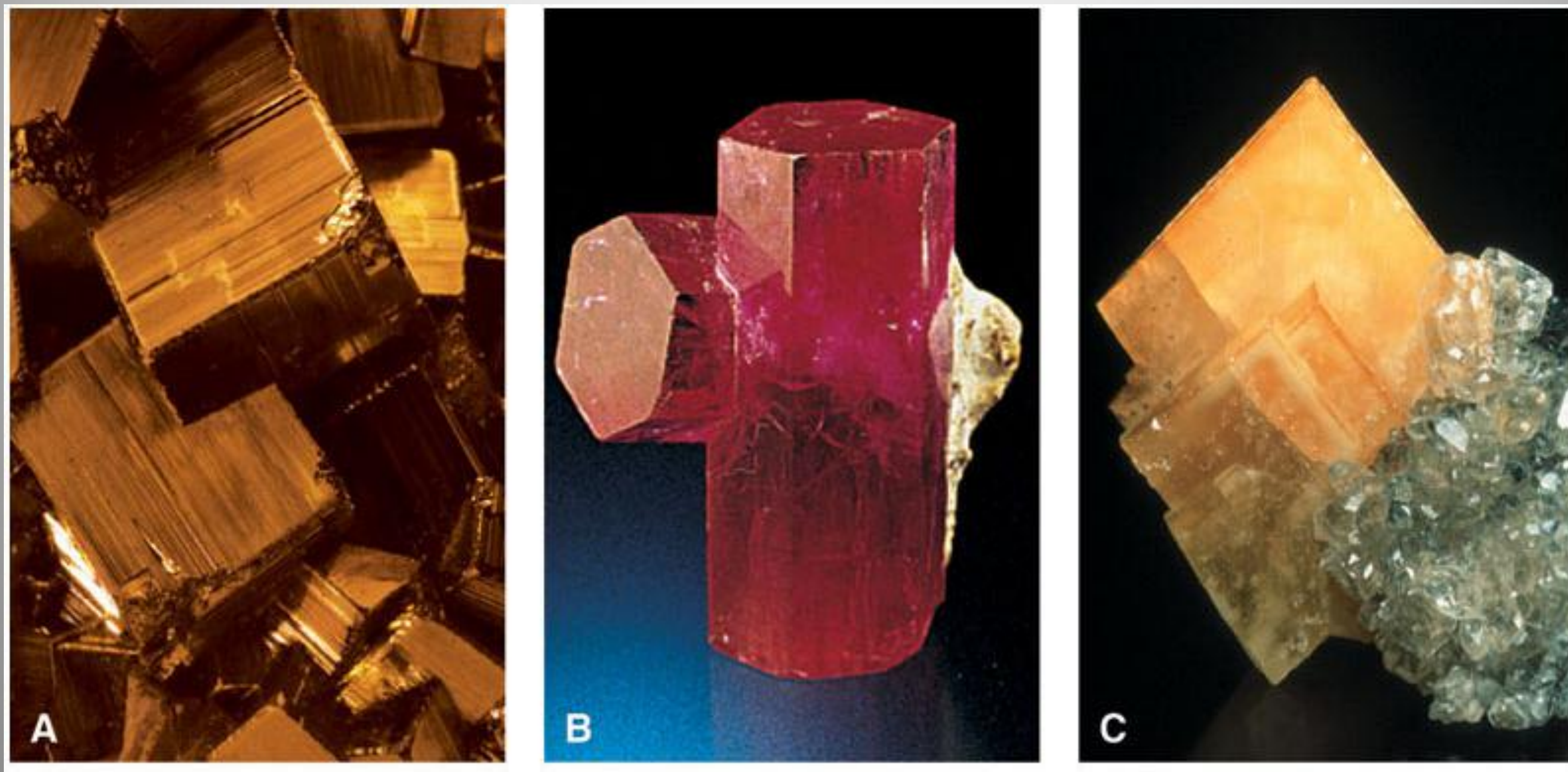


- Solids that have no regular shape are called amorphous.

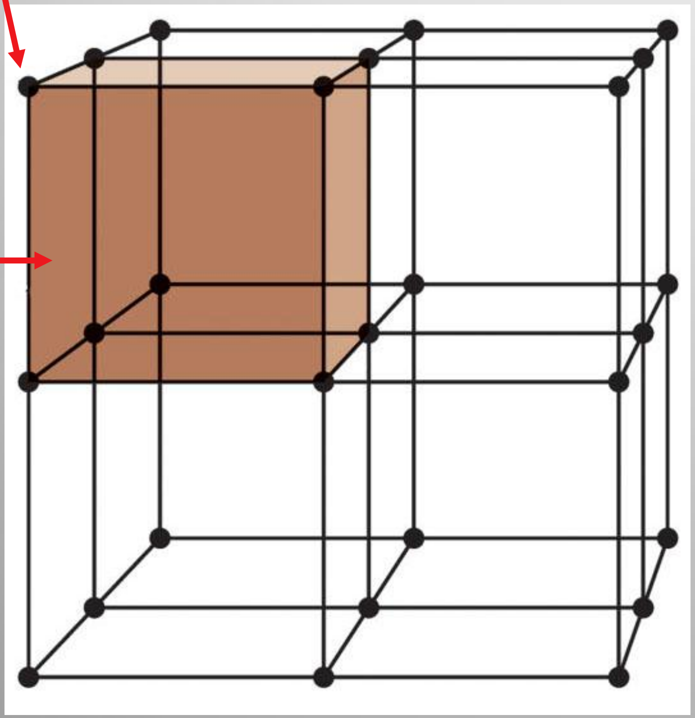
The hexagonal structure of ice.



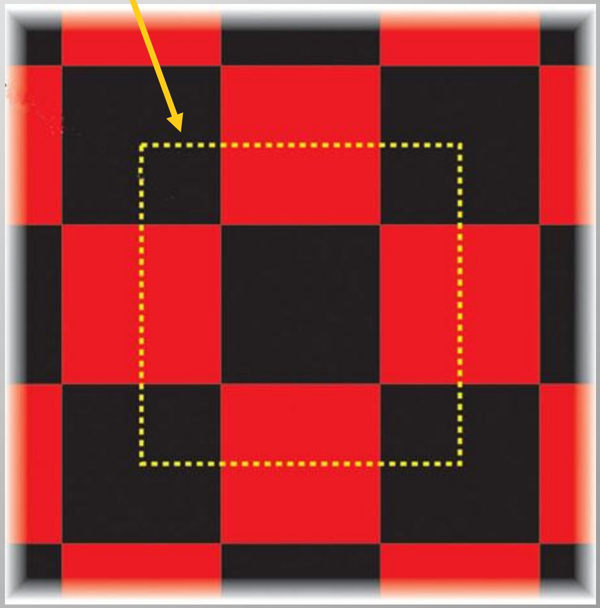
The striking beauty of crystalline solids.



The crystal lattice and the unit cell.



portion of a 3-D lattice



portion of a 2-D lattice

Phase Changes

Phase Changes