Chapter 4

Lecture 7

Gases I

General Chemistry

- **OUTLINES**
- 1-1 Introduction
- 1-2 Gas Pressure
- 1-3 Gas Laws
- a. Boyle's Law
- b. Charles Law
- c. Gay-Lusac's Law

(a, b, c) → Combined gas Law

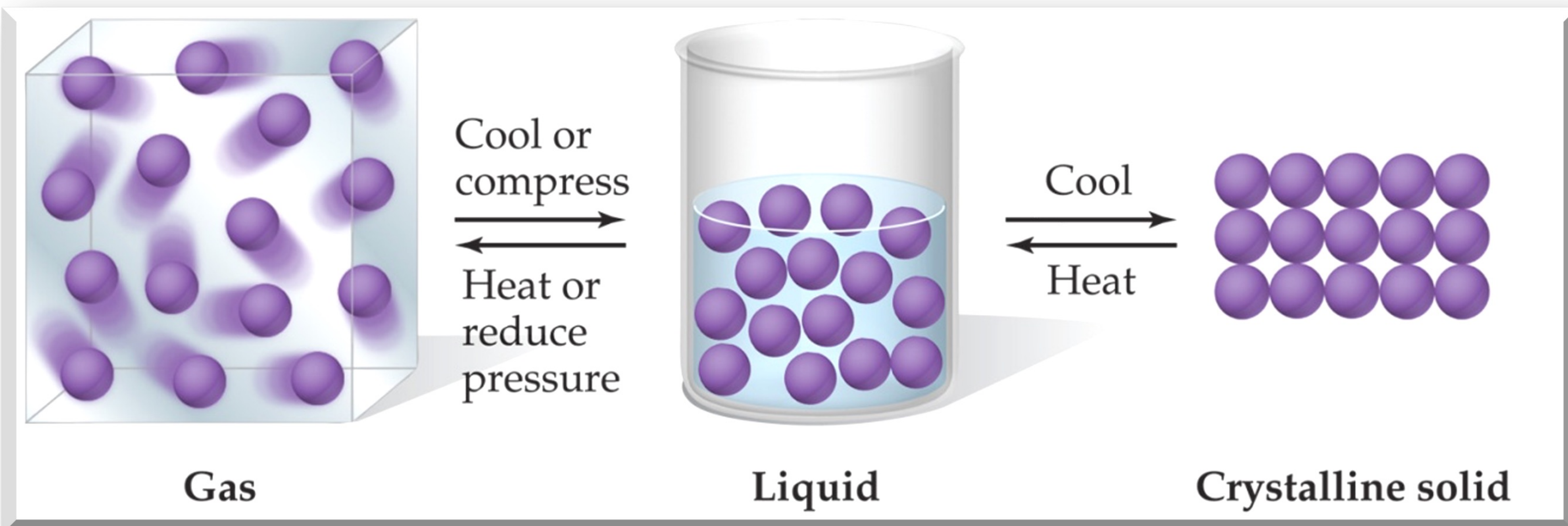
5.1 Introduction

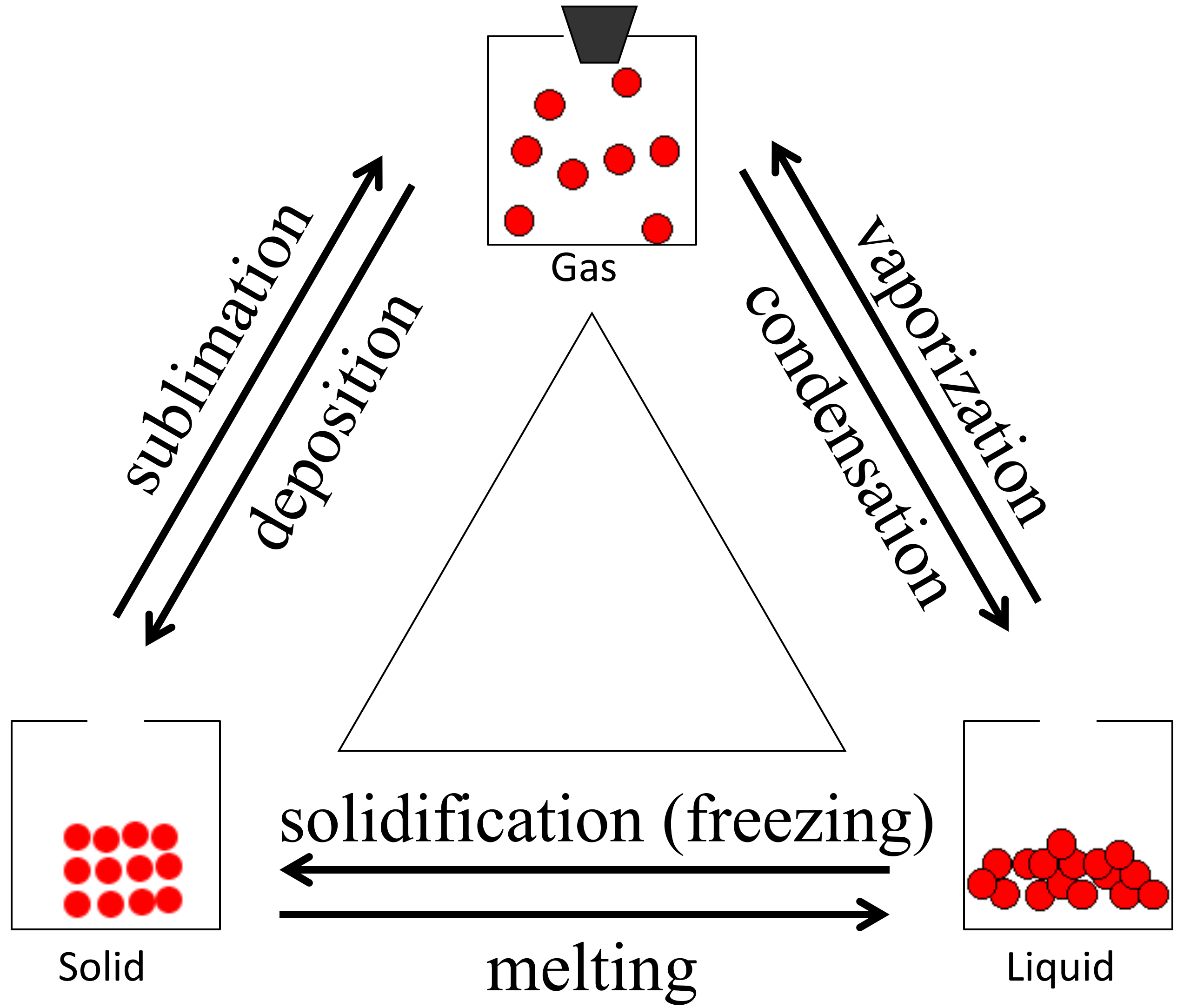
The major differences between solids, liquids, and gases are due to the relationships among particles. These relationships include:

1- The average distance of separation of particles in each state.

2- The kinds of interactions between the particles

3- The degree of organization of particles.





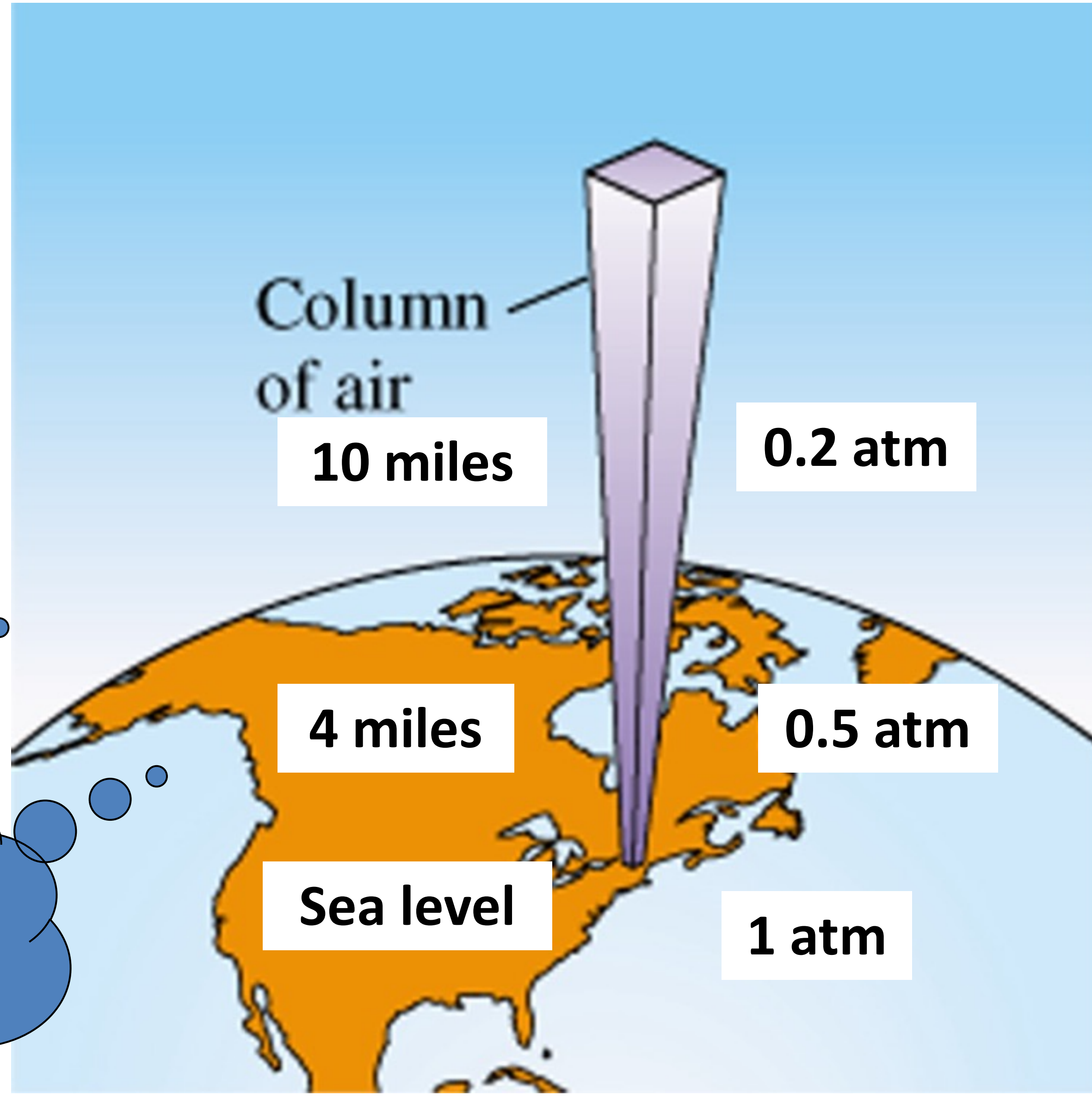
Gas
sublimation
deposition
vaporization
condensation
Solid
Liquid
solidification (freezing)
melting

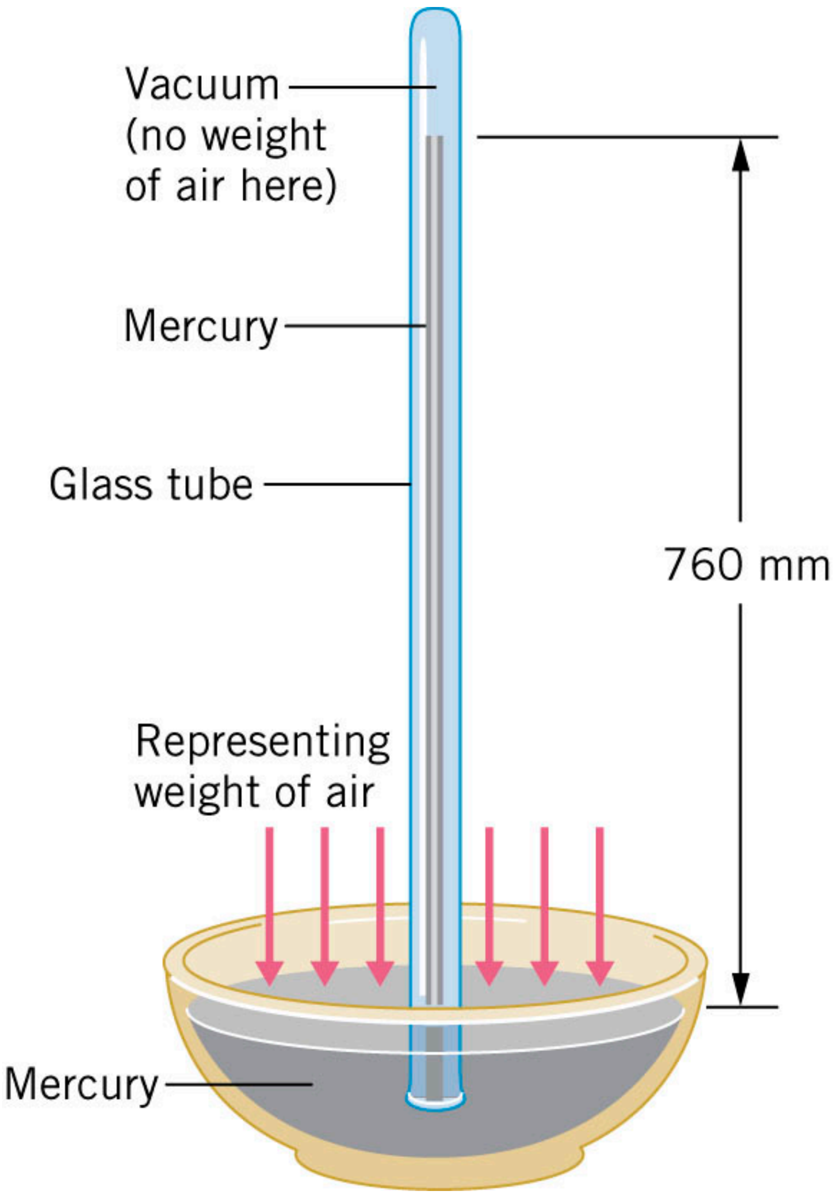
Character	Solid	Liquid	gas
Particle arrangement	Packed close together In a regular arrangement	Closely Packed together in an irregular arrangement	Arranged totally irregular
Shape	Have fixed shape and volume	Have no fixed shape but fixed volume	Have no fixed shape and no fixed volume
Motion of particles	No freely motion but vibrate in its position	Move around past each other	Move randomly
Ability to compress	No compression	Little	Easy

5.2 Gas pressure

Atmospheric pressure varies with the altitude and weather

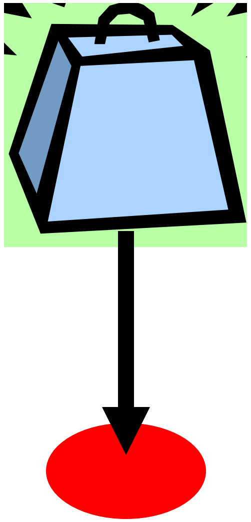
The pressure decreases as we move further from the sea level





Atmospheric pressure is measured with a **barometer**. A *Torricelli barometer* consists of a glass tube sealed at one end, about 80 cm in length. The tube is filled with mercury, capped, inverted, and the capped end immersed in a pool of mercury. When the cap is removed the atmosphere supports a the column of mercury about 760 mm high.

Pressure = $\frac{\text{Force}}{\text{Area}}$



(force = mass x acceleration)

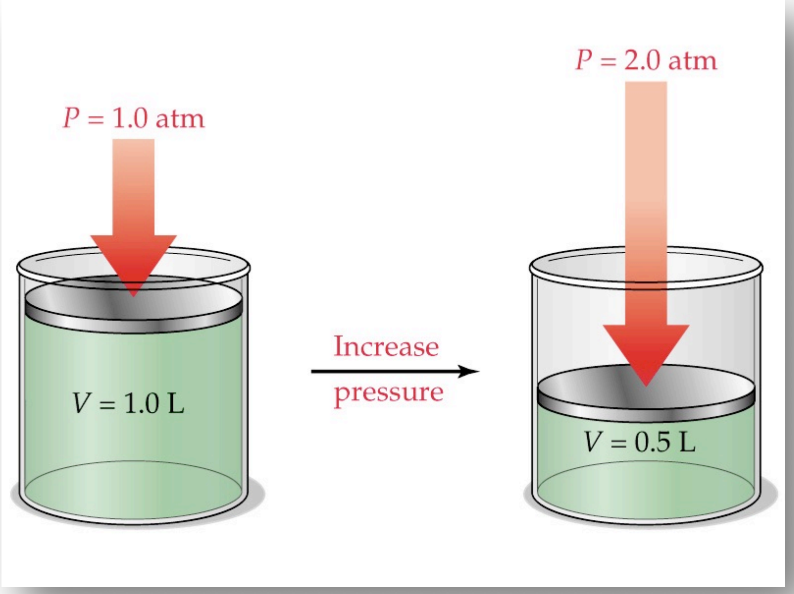
Units of Pressure

1 pascal (Pa) = 1 N/m^2

1 atm = 760 mm Hg = 760 torr = 101.325 KPa

5.3 Gas Laws

- The gases laws are a set of laws that describe the relationship between Temperature (T), Pressure (P), Volume (V), and Moles (n) of gas.
- **A-Boyles's law** **THE VOLUME–PRESSURE RELATIONSHIP**
- "At a given temperature, the product of pressure and volume of a definite mass of gas is constant".
- $PV = k$ (constant n, T



$$P_1V_1 = P_2V_2$$

Moves for uh\animation of gas law.exe

Problem 1:

A gas occupies 3.00 L at 2.00 atm pressure. Calculate its volume when we increase the pressure to 10.15 atm at the same temperature.

solution

$$P_1V_1 = P_2V_2$$

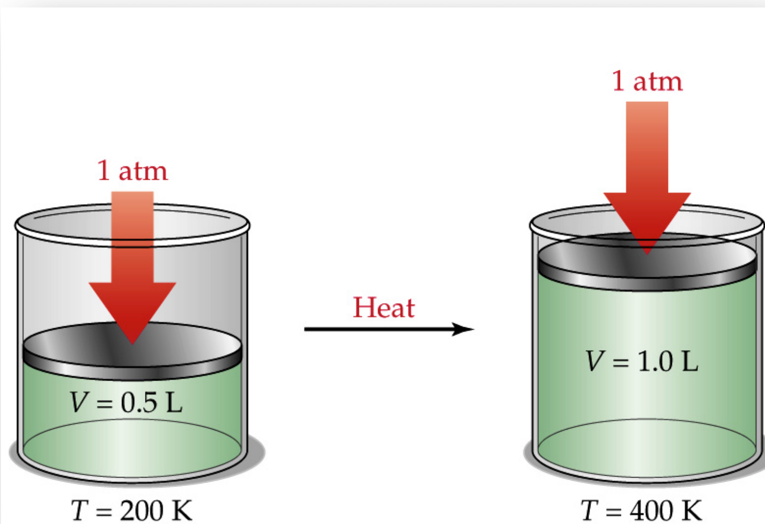
$$V_2 = \frac{P_1V_1}{P_2}$$

$$V_2 = \frac{(2.00\ \text{atm})(3.00\ \text{L})}{10.15\ \text{atm}} = 0.591\ \text{L}$$

II- CHARLES'S LAW:

THE VOLUME–TEMPERATURE RELATIONSHIP

- "At constant pressure, the volume occupied by a definite mass of a gas is directly proportional to its absolute temperature."



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

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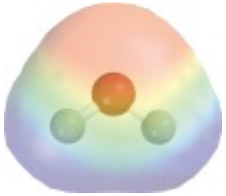


Gay Lussac's Law
Temperature- Pressure Relationship

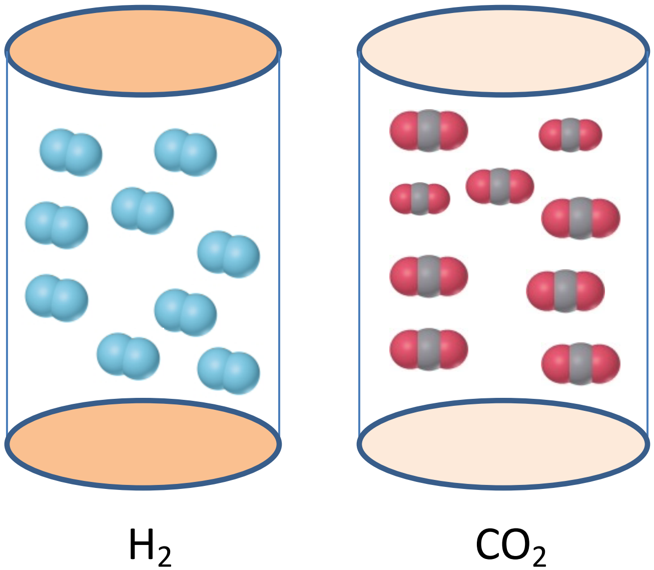
- Gay Lussac's law states that "At constant volume, the pressure is directly proportional to the Kelvin temperature

$$\frac{\textit{Pressure}}{\textit{temperature}} = \textit{constant} \quad \text{or} \quad \frac{P_1}{T_1} = \frac{P_2}{T_2}$$

animation of gas law.exe

Avogadro's law.

Two equal tanks of gas of equal volume at the same temperature and pressure contain the same number of molecules. **$V \infty n$, $V = Cn$ C = constant**



$V \infty n$, $V = Cn$ C = constant

- Example:
- In an autoclave, steam is generated at 1.00 atm. After the autoclave is closed, the steam is heated at constant volume until the pressure gauge indicates 1.13 atm. What is the final temperature in the autoclave?
- Solution:

$$T^{\circ} = 100 + 273 = 373\,^{\circ}K$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

$$T_2 = \frac{P_2 T_1}{P_1} = \frac{(1.13\,atm)(373\,K)}{1\,atm} = 421\,K$$

$$The\ final\ temperature\ is\ 421\,K,\ or\ 421 - 273 = 148\,^{\circ}C$$

Combined Gas Law

Name	Expression	Constant
Boyle's law	$P_1V_1 = P_2V_2$	T
Charles's law	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$	P
Gay-Lussac's law	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$	V

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$