Gas Laws and KMT

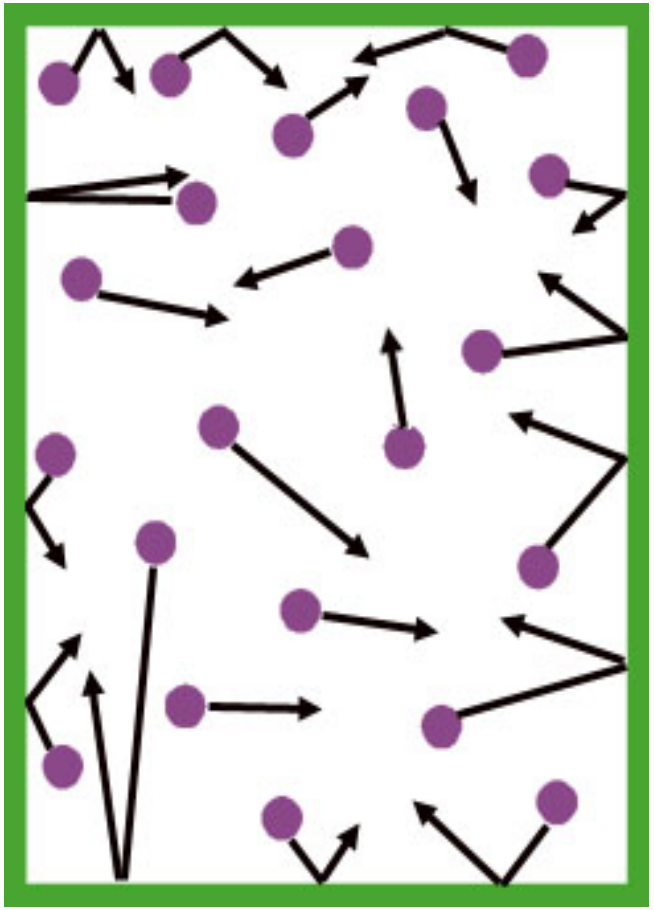
Unit 7, Module 1

Kinetic Molecular Theory

- The Kinetic Molecular Theory (KMT) is a theory that can be used to describe the general behavior and physical properties of gases, liquids, and solids. In this unit, we will focus specifically on how it is used to describe gases.
- KMT is based on five assumptions:

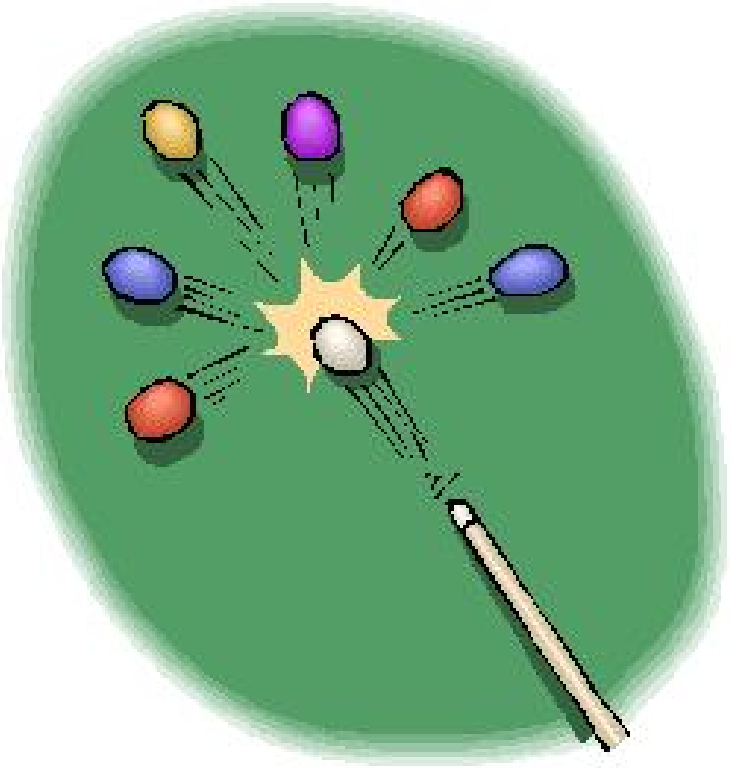
KMT

i. Gases consist of large numbers of tiny particles that are spread far apart relative to their size. Most of the volume occupied by gases is *empty space*. In other words, the volume of the individual gas particles relative to the volume occupied by the gas itself is considered to be negligible (zero).



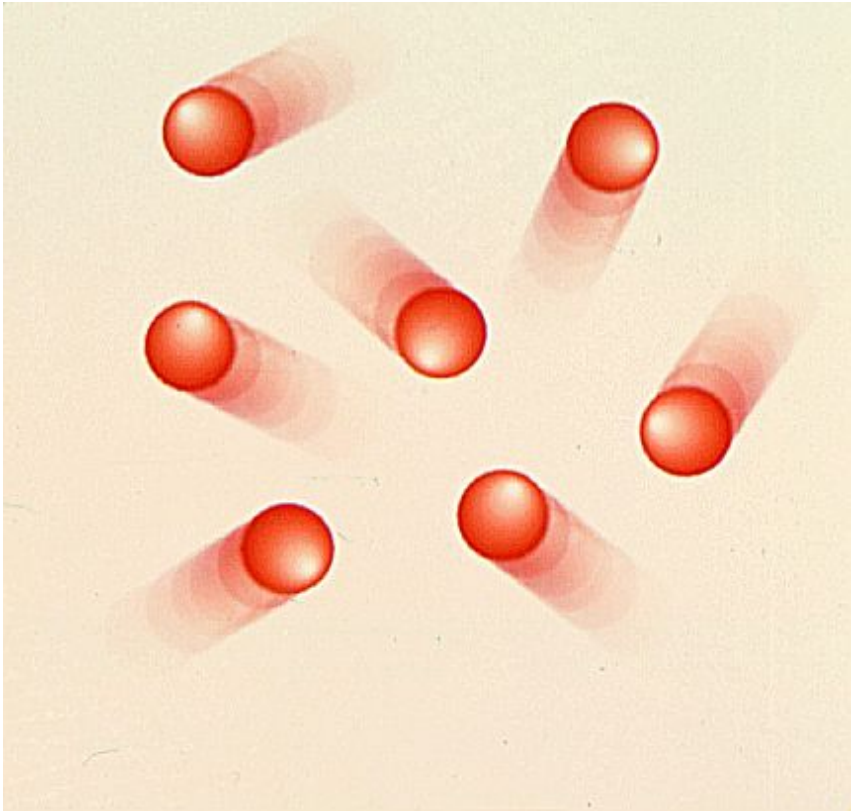
KMT

ii. Gas collisions are considered to be perfectly elastic; in other words, kinetic energy is conserved in collisions involving gas molecules.



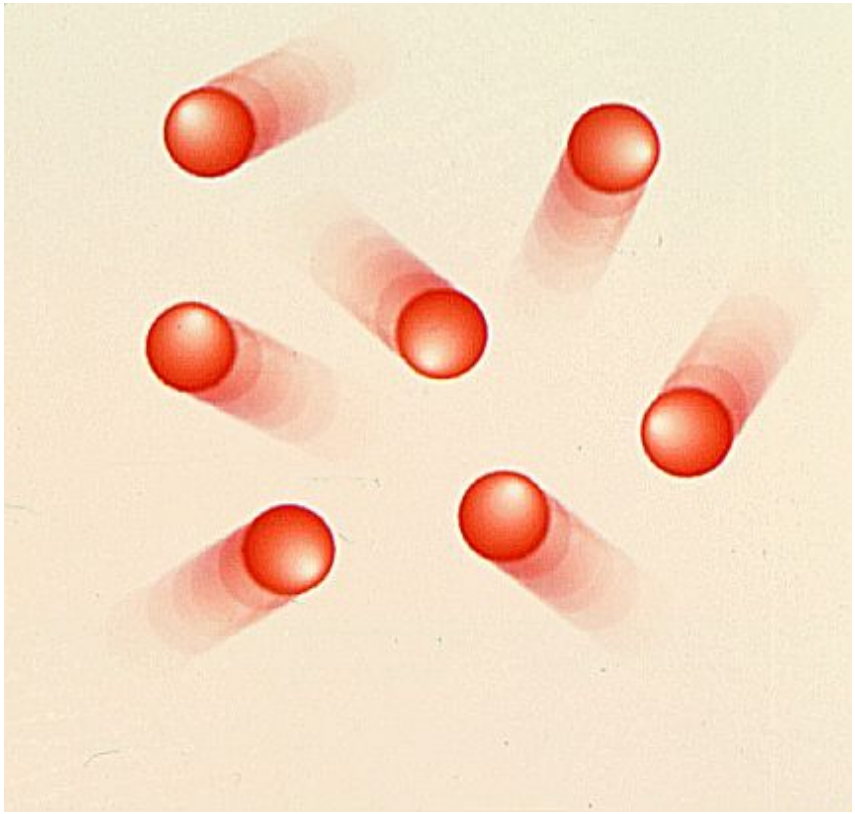
KMT

iii. Gas particles are in constant rapid random motion. Their kinetic energy is high with respect to the other states of matter.



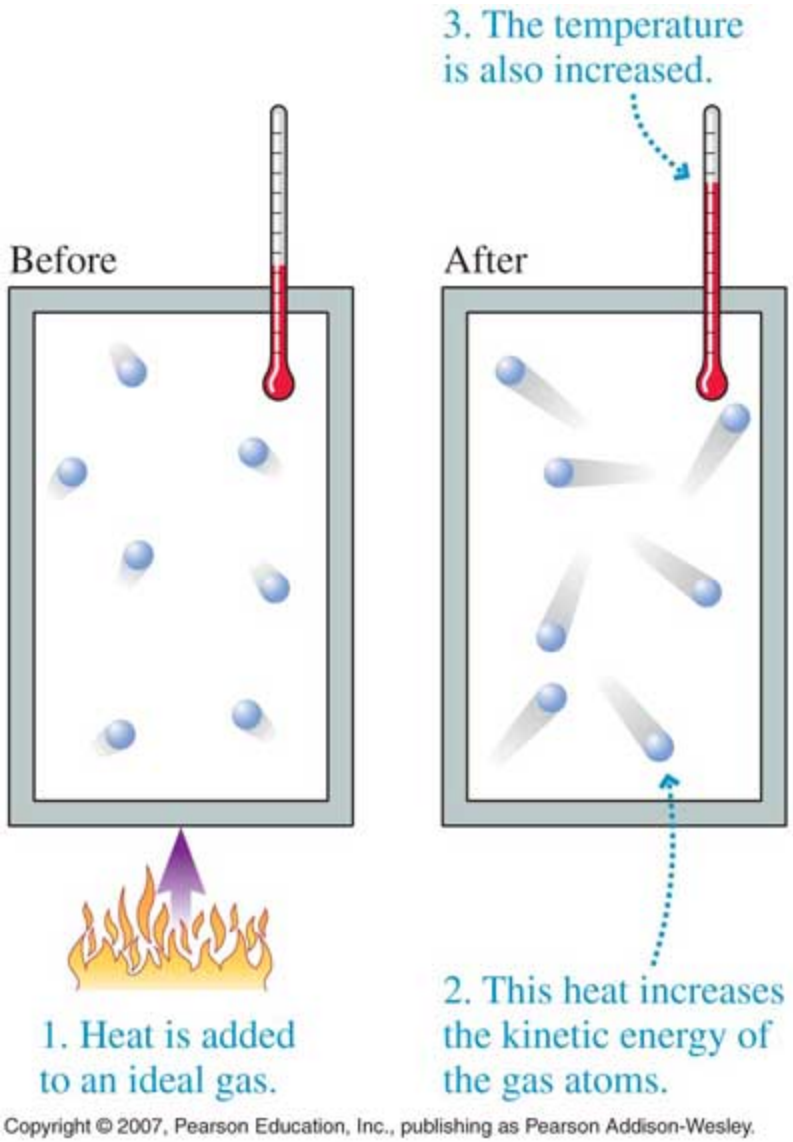
KMT

iv. There are no attractive or repulsive forces between gas particles.



KMT

v. The average kinetic energy of gas particles is directly proportional to the Kelvin temperature of the gas. In other words, the higher the Kelvin temperature the higher the kinetic energy of the particles.



Properties of Gases

1. ***Expandability*** – a gas will expand to take the shape of whatever container it is in. This agrees with kinetic molecular theory because gas particles move rapidly in all directions (iii) and there are no attractive or repulsive forces between particles (iv).

Properties of Gases

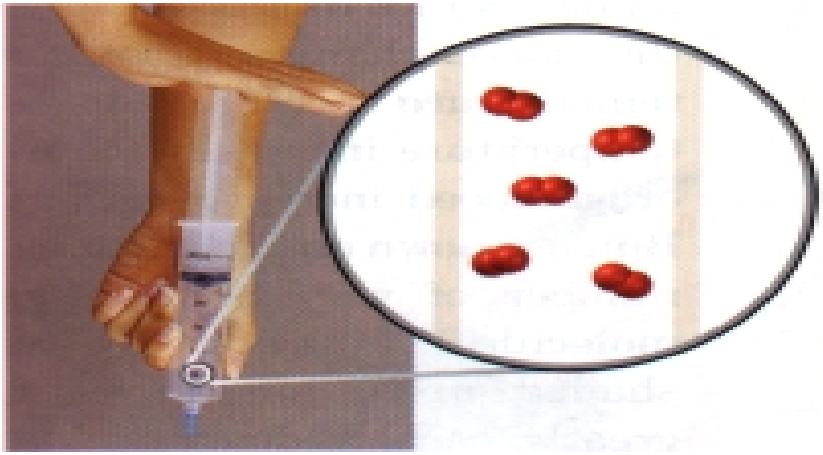
2. ***Fluidity*** – a gas has the ability to flow. This agrees with kinetic molecular theory because there are no attractive or repulsive forces between gas particles which might prohibit their ability to flow (iv) and because gas particles are in constant, rapid, random motion (iii).

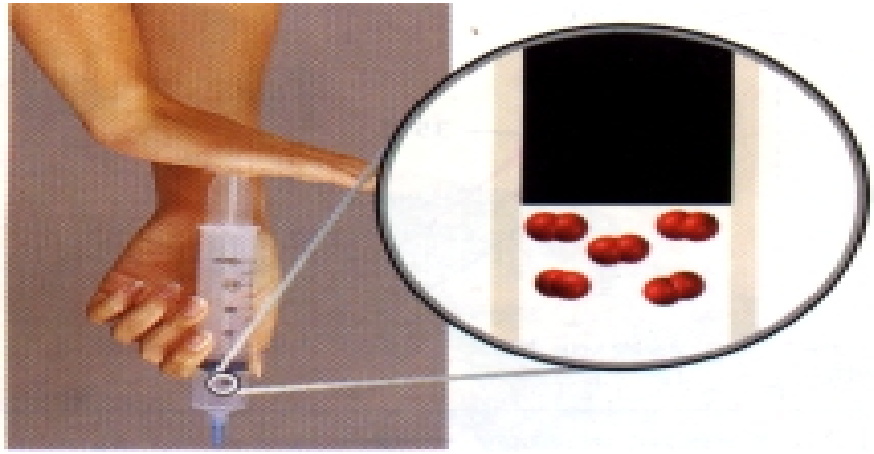
Properties of Gases

3. ***Low Density*** – the density of a gas is about 1/1000 the density of the same substance in the liquid state. This agrees with kinetic molecular theory because the particles are so much farther apart in the gaseous state (i).

Properties of Gases

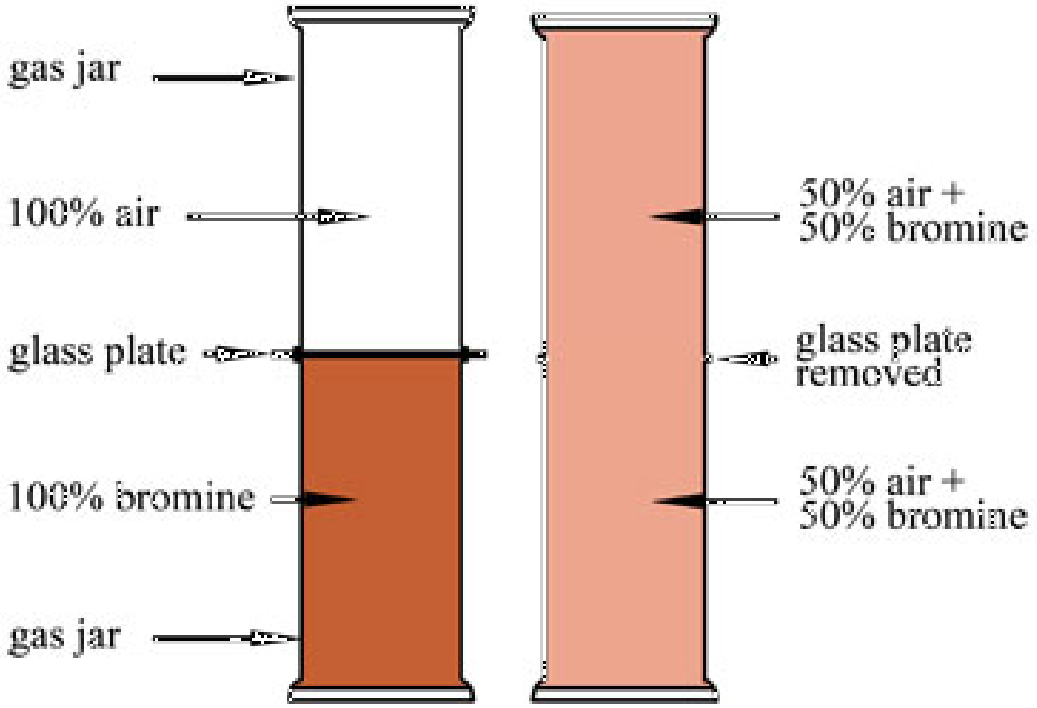
4. ***Compressibility*** – the volume of a given sample of gas can be greatly decreased. This agrees with kinetic molecular theory because there is a lot of room between particles (i) and so they can be pushed closer together.





Properties of Gases

5. ***Diffusion*** – gases spread out and mix with one another, even without being stirred. This agrees with kinetic molecular theory because of the random and continuous motion of gas particles (iii).

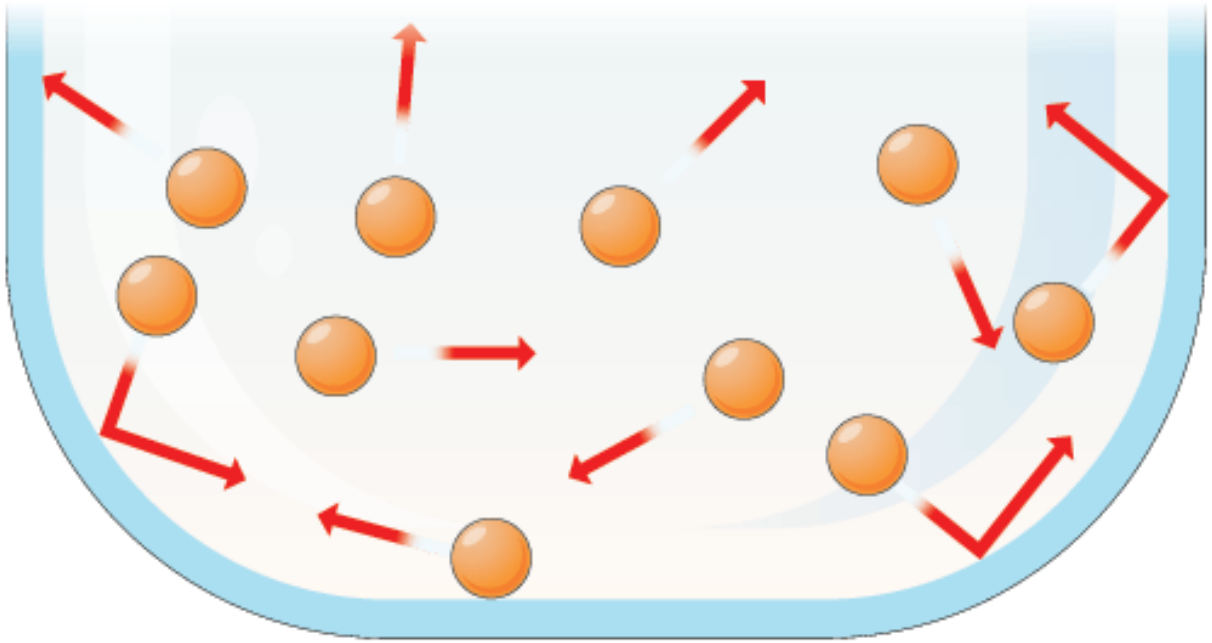


Variables that Define a Gas

a. ***Pressure (P)*** – results from collisions of gas particles with the walls of its container. Pressure is defined as force per unit area. It can be measured with a barometer or manometer. Units for pressure include:

- Atmospheres (atm) 1 atm = 760 mmHg = 101.325 kPa
- Pascals (Pa)
- Torr
- Millimeters of mercury (mmHg)
- Kilopascals (kPa)
- Pounds per Square Inch (psi)

Collisions Cause Pressure



Variables that Define a Gas

b. ***Volume (V)*** - may be expressed in liters (L), milliliters (mL), cm^3 (cc), dm^3. Gases expand, diffuse, spread out, to occupy the entire volume of the container to which they are confined.

Variables that Define a Gas

c. ***Temperature (T)*** – Always expressed in Kelvin!!!!

$$\text{Kelvin} = {}^{\circ}\text{C} + 273.15$$

This temperature reflects the kinetic energy of the gas particles.

Variables that Define a Gas

d. ***Number of Moles (n)*** - in other words, how many particles are present in the sample of gas