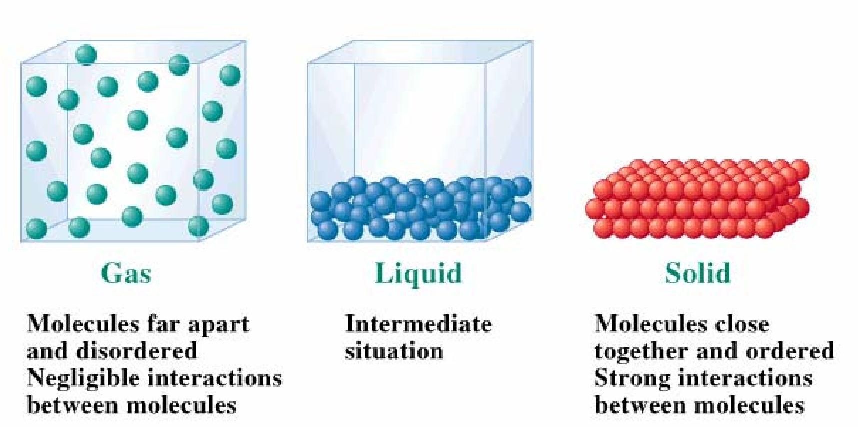
Gases
Day 12

Phases of Matter



Kinetic Molecular Theory ("Ideal Gases")

1) The molecules of a gas are in continual, and random, motion of varying speeds.
2) The average kinetic energy of the gas molecules is directly proportional to the temperature of the gas.
3) The gas molecules collide with each other and with the walls of their container, but kinetic energy is conserved.
4) The separation between gas molecules is much larger than the molecules themselves (KMT assumes the molecules have no volume).
5) The molecules do not stick together after collisions because there is no attractive energy between them.
6) The collisions between the molecules and the walls of the container give rise to the pressure.

Same thing again

1.Gas molecules moving in straight lines
2.Temperature related to KE($1/2\ mv^2$)
3.Molecules act like billiard balls, collisions are elastic.
4.Volume of molecules small compared to volume of the gas. An ideal gas molecule has no volume.
5.Gas molecules do not stick to each other. Ideal gases have no attraction.
6.Pressure is related to collisions with the side wall of the container.

Properties of Gases

•Volume, V: measured in liters (L)
•Amount, n: measured in moles
•Temperature, T: measures in kelvin (K)

- K = C+273.15

•Pressure, P: measured in atmospheres (atm)

- 760 torr= 760 mm Hg = 1 atm
- 14.70 lb/in^2 = 1 atm

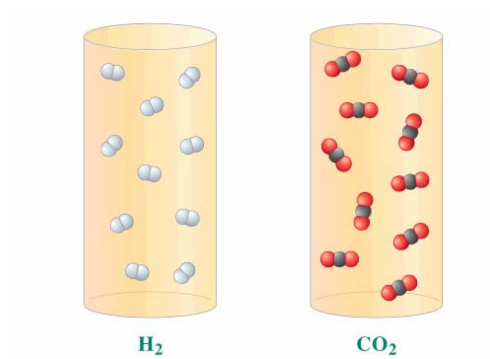
Pressure in a closed system

•P=force/area
•in a closed system, the force is the molecules hitting the sidewall of the container.
•The area is the area of the walls of the container

http://mc2.cchem.berkeley.edu/Java/molecules/index.html

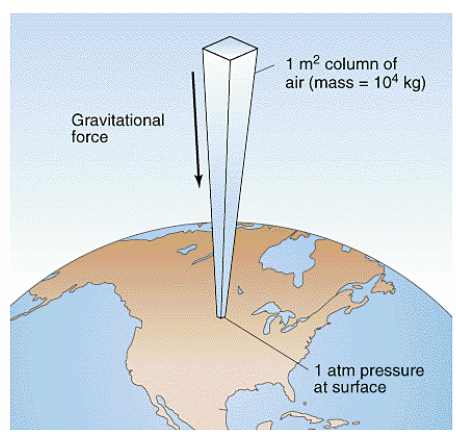
2 tanks, equal T, V, P and n

All gases tend to act the same. There are no attractive forces to differentiate a H_2 and a CO_2.

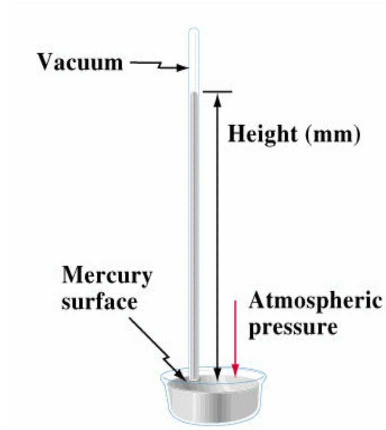


Pressure in an open system

What is the pressure of the atmosphere on your book sitting on your desk?
•Pressure=force/area.
•The area is the areas of the top of the book.
•Imagine a column of gas extending from your book to the top of the stratosphere. The force comes from the weight of that gas pushing down. (F=mg where g= 9.8m/s2).



Barometer



- measuring P
- Hg in tub feels weight of 1 atm
- Hg in bottom of tube feels weight of 760 mm Hg
- Which is denser air or Hg?

Describing Gases (Ideal Gas Law)

- Since all gases act mostly like ideal gases, they follow the same behavior, described by

$$PV=nRT$$

R= 0.08206 L atm/mole K.

What is the volume of one mole of air at STP, 1.00 atm and 0 º C?

Combined Gas Law

$$\frac{PV}{nT} = R \text{ so } \frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}$$

Generally we worked with closed or sealed systems so $n_1 = n_2$ number of moles stays the same.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

A sample of 23.0 L of NH_3 gas at 10 ºC is heated at a constant pressure until it fills a volume of 50.0 L. What is the new temperature in ºC? Problem 5.18

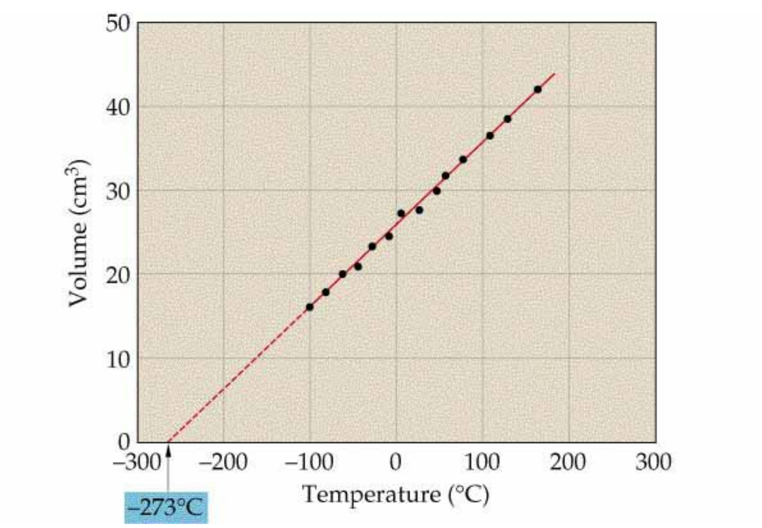
Note that constant pressure means that $P_1 = P_2$

How do I know which equation to use?

•If you see "changing", "moved", "compressed", use the combined gas law equation. $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

•If you are asked about a single situation, use the ideal gas equation. $PV = nRT$

Determining absolute zero



Dalton's Law of Partial Pressure

♦In a gas, molecules are so far apart that they have little or no effect on each other.

♦In a mixture of gases, each molecule acts independently of all the others.

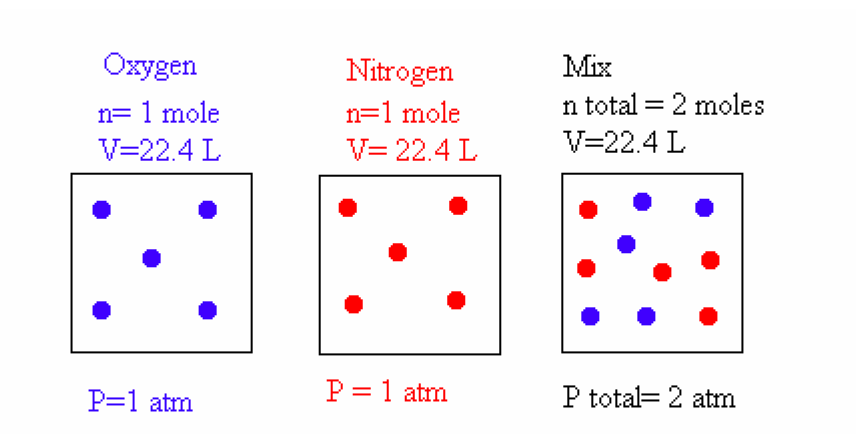
♦Dalton saw that the collisions of each molecule against the walls of its container contributed to the total pressure in the container.

♦Dalton's Law of Partial Pressure states that the total pressure of a mixture of gases is the sum of the individual partial pressures. It is written:

PT = P1 + P2 + P3 + . . .

Partial Pressure Defined

- **The partial pressure of a single gas in a mixture is defined as the pressure the gas would exert if it were alone in the container.**
- **PV=nRT holds for each individual gas in a mixture, as well as for the total mixture.**



An example

Partial Pressures and Mole Fractions

Let n_i be the number of moles of gas i exerting a partial pressure P_i, then

$$P_i = C_i P_t,$$

where C_i is the mole fraction (n_i/n_t).

n_t is the number of moles total.

Air is 78% nitrogen, 21% oxygen and 1% other stuff.
What is the partial pressure of oxygen in this room?