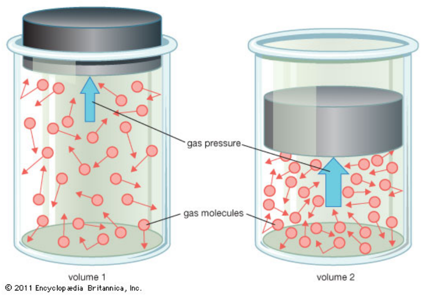
Chem Unit 11.2 Notes - The Ideal Gas Law

11.2 - The Ideal Gas Law



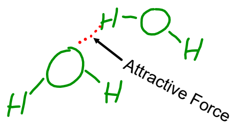
Ideal Gases

Different gases have different expansion properties, depending on how they interact.

At low densities, however, all gases exhibit identical expansion behavior.

Non-interactive gases are called Ideal Gases (a theoretical condition), and are considered to have:

1. no mass,
2. no electrostatic interactions,
3. no volume,
4. no collisions.



Molar Volume and STP

Avogadro's Principle: equal volume of gases at the same temperature and pressure contain equal numbers of particles.

At **S**tandard **T**emperature and **P**ressure (STP) (0 degrees Celsius (273 K), and 1.0 atm pressure), one mole of any gas has the same molar volume, equal to 22.4 liters.

For conversions, use: $\frac{22.4L}{1mol}$ or $\frac{1mol}{22.4L}$

1. Molar Volume Example

What volume will 2.16 g of krypton gas occupy at STP?

Convert mass to moles:

$$2.16\,g \bullet \frac{1\,mol\,Kr}{83.80\,g\,Kr} = 0.0258\,mol\,Kr$$

$$0.0258\,mol\,Kr \bullet \frac{22.4\,L}{1\,mol} = 0.577\,L$$

Ideal Gas Law

The Ideal Gas Law relates the number of moles to pressure, temperature, and volume.

PV = nRT	P = pressure (atm) V = volume (L) n = number of moles of gas (mol) R = Universal Gas Constant: $0.0821\frac{L \bullet atm}{K \bullet mol}$ T = temperature (Kelvins)

The Universal Gas Constant (R) is a factor that ties the four variables together at ANY condition.

2. Ideal Gas Example

If the pressure exerted by a gas at 298 K in a volume of 0.044 L is 3.81 atm, how many moles of gas are present?

Ideal Gas Law:

$$PV = nRT$$

$$n = \frac{PV}{RT} = \frac{3.81\,atm \bullet 0.044\,L}{0.0821\frac{L \cdot atm}{K \cdot mol} \bullet 298\,K} = 0.00685\,moles$$

The Ideal Gas Law and Density

Remember that density equals mass over volume:

$\rho\,(or\,D) = \frac{m}{V}$	m = mass (g) V = volume (L)

Using molar mass, the equation of gas density is:

$\rho = \frac{MP}{RT}$	M = molar mass (g/mol) P = pressure (atm) R = 0.0821 L atm/K mol T = temperature (K)

Why do we care about density of gases?

Fire Extinguishers! Demo.

3. Density Example

Determine the density of chlorine gas at 22.0 ºC and 1.00 atm.

List known values:

M = 70.90 g/mol
P = 1.00 atm
T = 22.0 ºC = 295 K

$$\rho = \frac{MP}{RT} = \frac{70.90\frac{g}{mol} \bullet 1.00\,atm}{0.0821\frac{L \bullet atm}{K \bullet mol} \bullet 295\,K} = \boxed{2.93\frac{g}{L}\,Cl_2}$$

Homework:

11.2 Booklet Problems
Due: Next Class