Gases - Properties

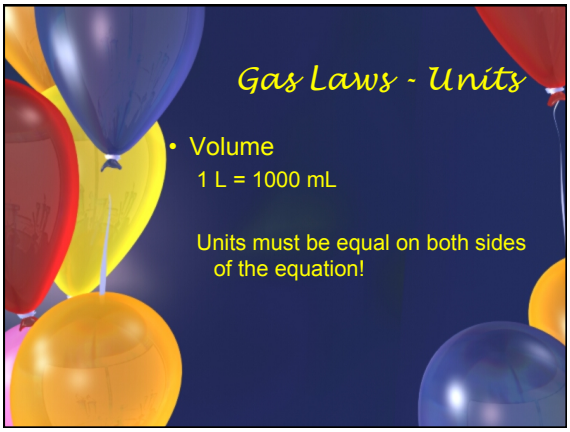
- No Definite Shape
- No Definite Volume

Gas Laws - Units

- Pressure
  Force per unit area on a surface

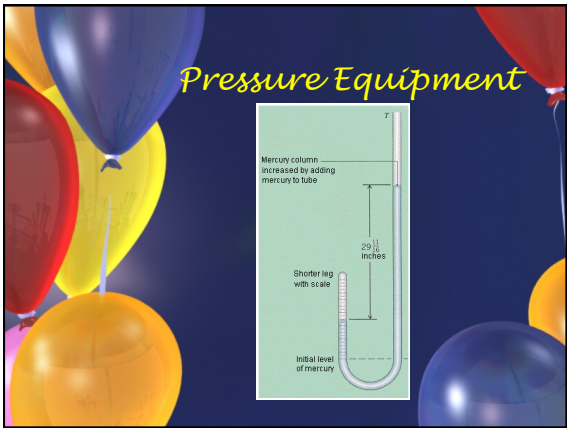
1 torr = 1 mm Hg
1 atm = 760 torr or mm Hg
1 atm = 14.69 psi


Pressure - Unit Conversions
1. Convert 800. torr to atm.
2. Convert 0.45 atm to mm Hg.
3. Convert 650 mm Hg to atm.


Gas Laws - Units
• Volume
1 L = 1000 mL
Units must be equal on both sides of the equation!


Gas Laws - Units
• Temperature
K = 273 + C
Units must be in Kelvin!


Pressure
• Barometer
Evangelista Torricelli - 1643


Pressure Equipment
Mercury column increased by adding mercury to tube
29 1/2 inches
Shorter leg with scale
Initial level of mercury


Pressure Equipment

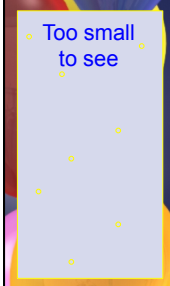
Standard Temp. & Pressure

"STP"

0 Degrees Celsius [273 K] & 1 Atmosphere

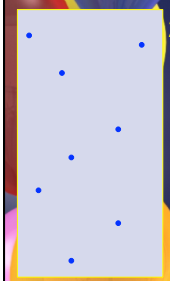
At STP, 1 mole of any gas occupies 22.4 liters.

The Kinetic Theory of Matter



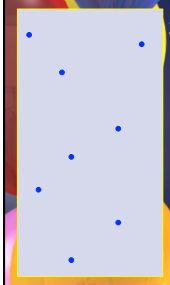
1. Gases consist of tiny particles (atoms or molecules)

The Kinetic Theory of Matter



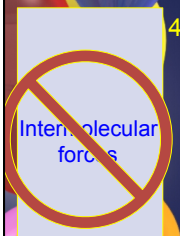
2. These particles are so small, compared with distances between them, that the volume (size) of the individual particles can be assumed to be negligble (zero).

The Kinetic Theory of Matter



3. The particles are in constant random motion, colliding with the walls of the container. These collisions with the walls cause the pressure exerted by the gas.

The Kinetic Theory of Matter

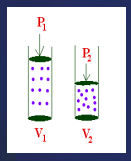


4. The particles are assumed NOT to attract or repel each other.

The Kinetic Theory of Matter

5. The average kinetic energy ($KE = \frac{1}{2} mv^2$) of the gas particles is directly proportional to the Kelvin temperature of the gas.

Boyle's Law



- Pressure and Volume have an inverse relationship.

$$P_1V_1 = P_2V_2$$

Units must be equal on both sides!

Charles' Law

- Temperature and Volume have a direct relationship

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

Units must be equal on both sides! (T in Kelvin.)

Gay-Lussac / Amonton

- Temperature and Pressure have a direct relationship

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

Units must be equal on both sides! (T in Kelvin.)

#1 How do pressure, volume, and temperature affect gases?
#3 How do solve problems with Boyle's, Charles', and Gay-Lussac, (Amontons') Laws?

Agenda

- Gas Laws WS #2: 8-10
- BBEC Review
- "JPMMM vs. Vacuum Pump"
- Exploring Pressure Lab
- EC Independent Research: Popcorn Kernels
- CW/HW: Finish Gas Law WS #2: Page 1
- 3-2-1

#1 How do pressure, volume, and temperature affect gases?
#3 How do solve problems with Boyle's, Charles', and Gay-Lussac, (Amontons') Laws?

BBEC Review

Be careful of LAB equipment!

Topics:

- Pressure Box
- Volume Box
- Temperature Box
- Gas Laws (BL; CL; GLAL)

Memorize Kinetic Molecular Theory for tomorrow!

#1 How do pressure, volume, and temperature affect gases?
#3 How do solve problems with Boyle's, Charles', and Gay-Lussac, (Amontons') Laws?

Demo

"Jet-Puffed Marshmallow Man vs. the Vacuum Pump"

What will happen to JPMMM as the pressure drops?

Which Law helps to explain this?

How strong is 1 atmosphere of pressure?

#1 How do pressure, volume, and temperature affect gases?
#3 How do solve problems with Boyle's, Charles', and Gay-Lussac, (Amontons') Laws?

Candle Lab

- Why does the water level rise?
- Helpful Hints:
  - What percentage of the atmosphere is oxygen?
  - $C_{25}H_{52} + O_2$ ➔
  - How much of your candle was used?
  - Gas Pressure
  - Gas Temperature
  - Gas Volume

#1 How do pressure, volume, and temperature affect gases?
#3 How do solve problems with Boyle's, Charles', and Gay-Lussac, (Amontons') Laws?

Exploring Pressure Lab

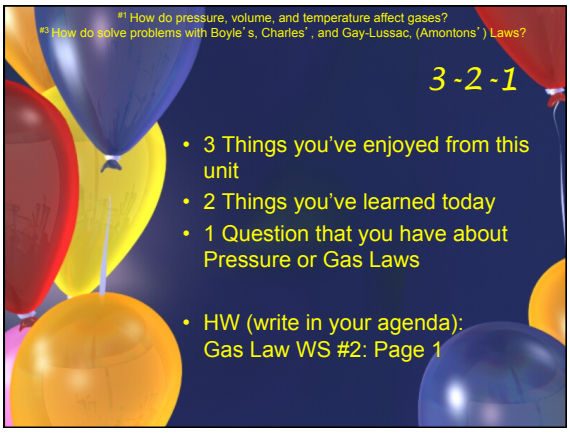
- Working in pairs
- Group 1: Hall-Side
  - Part A: Online Research (~10min)
  - Part B: Cartesian Diver (~5 min)
- Group 2: Window-Side
  - Part C: Popcorn (~15 min)
- Switch in ~15 minutes
- Submit Lab Sheet when finished
- Extra Time: Gas Law WS #2: Pg 1

#1 How do pressure, volume, and temperature affect gases?
#3 How do solve problems with Boyle's, Charles', and Gay-Lussac, (Amontons') Laws?

Independent Research

"Generic vs. Name Brand Popcorn"

- Extra Credit Criteria:
  - Compare and Contrast "Popping Effectiveness" (Ratio of Popped-to-Unpopped Kernels) and Cost
  - 2 Generic Brands and 2 Name Brands
  - Written Report
  - Due in by the end of next week


#1 How do pressure, volume, and temperature affect gases?
#3 How do solve problems with Boyle's, Charles', and Gay-Lussac, (Amontons') Laws?
3-2-1
• 3 Things you've enjoyed from this unit
• 2 Things you've learned today
• 1 Question that you have about Pressure or Gas Laws
• HW (write in your agenda): Gas Law WS #2: Page 1


#1 How do pressure, volume, and temperature affect gases?
#3 How do solve problems with Boyle's, Charles', and Gay-Lussac, (Amontons') Laws?
Agenda
• Gas Laws WS #2: Page 1
• Packet Pg. 6
• Exploring Pressure Lab
• 3-2-1


#1 How do pressure, volume, and temperature affect gases?
#3 How do solve problems with Boyle's, Charles', and Gay-Lussac, (Amontons') Laws?
Agenda
• Review Packet Pg. 6
• Review Kinetic Molecular Theory
• BBEC Review (KMT)
• Combined Gas Law
• Gas Laws WS #2: Page 2 #10; 1-5

#1 How do pressure, volume, and temperature affect gases?
#3 How do solve problems with Boyle's, Charles', and Gay-Lussac, (Amontons') Laws?

Agenda

- Review Gas Laws WS #2: Page 2 #10; 1-5
- BBEC Review (KMT)
- Avogadro's Law
- Dalton's Law
- Gas Laws Packet: Finish Page 8

Avogadro's Law

- Volume is directly proportional to the number of moles.

$$V = k\,n$$

k is a constant
n is the amount of gas

Units must be equal on both sides!

Avogadro's Law

- A more useful representation of Avogadro's Law could be derived as follows:

$V = k\,n \rightarrow V/n = k$

If $\frac{V_1}{n_1} = k$ and $\frac{V_2}{n_2} = k$

Then $\frac{V_1}{n_1} = \frac{V_2}{n_2}$

Dalton's Law of Partial Pressures

- The total pressure is equal to the sum of the partial pressure of each gas.
- $P_{total} = P_1 + P_2 + P_3 + \ldots + P_n$
- 1 atm = $P_{nitrogen} + P_{oxygen} + P_{others}$
- Collection of a gas over water:
  - $P_{total} = P_{water} + P_{gas}$
  - (Page 859) Table A-8 Water-Vapor Pressure

Ideal Gas Law

- Relates pressure, volume, temperature, and the number of moles
- PV=nRT
- Ideal Gas Law Constant, R
  - R : 0.0821 L·atm/mol·K

Ideal Gas Law

- Two other useful ways to use the Ideal Gas Law:
  - n: # of moles (in mol)
  - m: mass (in grams)
  - M: Molar Mass in (g/mol)
- M = m/n ➔ n = m/M
- PV=(m/M)RT ➔

MVP = mRT

Ideal Gas Law

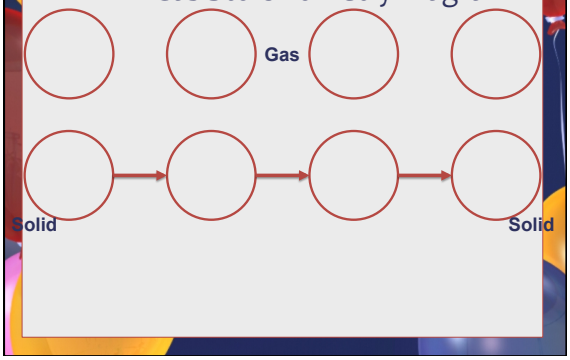
- Two other useful ways to use the Ideal Gas Law:
  - m: mass (in grams)
  - V: volume (in L)
  - D: Density (in g/L)
- MVP=mRT ➔ MP = mRT/V
- MP=(m/V)RT ➔

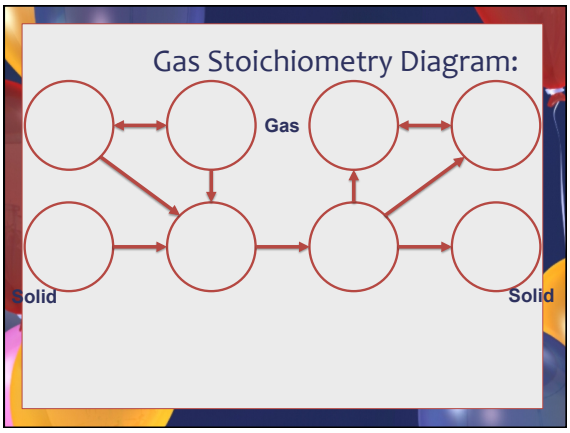
MP = DRT

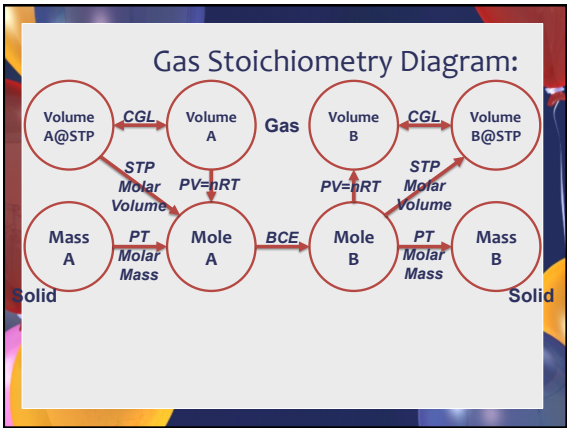
Gas Laws & Stoichiometry

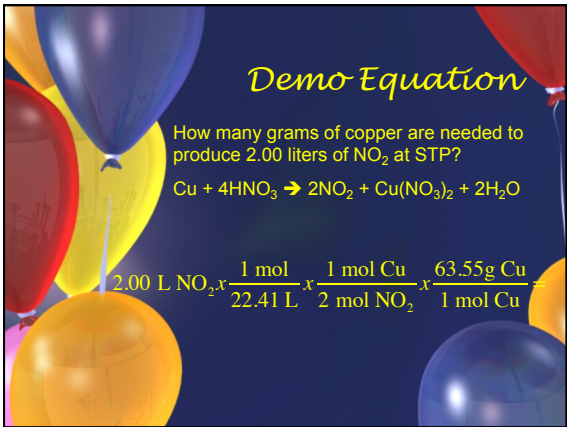
- Tools for using Gas Laws & Stoichiometry:
  - Balanced Chemical Equation
    - Elements (Lucky 7, P_4, S_8)
    - Formulas (Charges Balanced)
  - 1 Mole Gas = 22.41 L at STP
  - Mole – Mole Ratio
  - PV=nRT
  - MVP = mRT

Gas Stoichiometry Diagram:




Gas Stoichiometry Diagram:
Gas
Solid
Solid


Gas Stoichiometry Diagram:
Volume A@STP
CGL
Volume A
Gas
Volume B
CGL
Volume B@STP
STP Molar Volume
PV=nRT
PV=nRT
STP Molar Volume
Mass A
PT Molar Mass
Mole A
BCE
Mole B
PT Molar Mass
Mass B
Solid
Solid


Demo Equation
How many grams of copper are needed to produce 2.00 liters of NO_2 at STP?
$Cu + 4HNO_3 \rightarrow 2NO_2 + Cu(NO_3)_2 + 2H_2O$
$2.00\ L\ NO_2 x \frac{1\ mol}{22.41\ L} x \frac{1\ mol\ Cu}{2\ mol\ NO_2} x \frac{63.55g\ Cu}{1\ mol\ Cu} =$