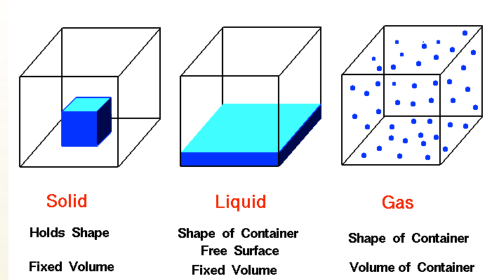
Chem 130
Unit 3

Gases
Electromagnetic Energy,
Atomic Structure & Bonding

States of Matter



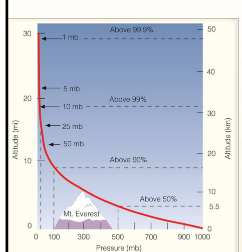
Gases

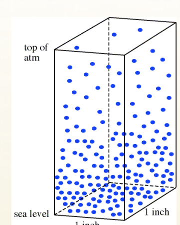
- Quantities important to characterizing gases:

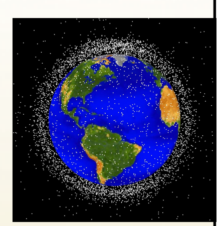
		Units
Pressure	force/area	Atm, mm Hg, torr, pascal
Volume	Space occupied	Liter, cm^3
Temperature	Kinetic energy and velocity of gas particles	° C or K
Amount	# of particles	moles

Pressure

Pressure = force/area







Pressure

Atmospheric Pressure: 760 mm Hg

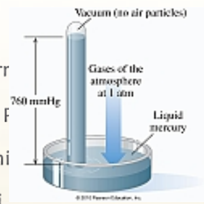
1 atm

760 torr

101325 P

101.3 mi

14.7 psi

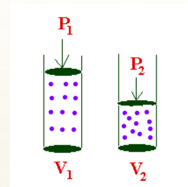


Boyle's Law

- Boyle's Law $p_1V_1 = p_2V_2$

If Pressure increases

volume decreases



Boyle's Law

If a 10.0 L helium balloon has a pressure of

655 mm Hg, what is the pressure if the balloon's

Volume decreases to 2.5 L?

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$p_1V_1 = p_2V_2$

655 mm Hg (10 L) = p_2 (2.5 L)

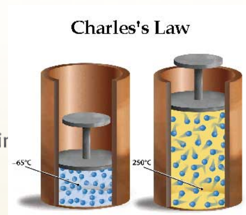
- p_2 = 2620 mm Hg

Charles' Law

- Charles' Law:

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

Volume increases as temperature ir



Charles' Law

If that 10.0 L balloon at 25° C is released

at Kaufman Stadium in Kansas City (– 4°C)

What Is the new volume?

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

Charles' Law

If that 10.0 L balloon at 25° C is released

at Kaufman Stadium in Kansas City (– 4°C)

What Is the new volume?

$$\frac{10.0L}{298K} = \frac{V_2}{269K}$$

V_2 = 9.02 L

Gay-Lussac's Law

- Gay-Lussac's Law:

$$\frac{p_1}{T_1} = \frac{p_2}{T_2}$$

As temperature increases,

Pressure increases

Combined Gas Law

$p_1V_1 = p_2V_2$ Boyle's Law

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ Charles' Law

$\frac{p_1}{T_1} = \frac{p_2}{T_2}$ Gay-Lussac's Law

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Combined Gas Law

STP = Standard Temperature and Pressure

A hot air balloon has a Volume of 400 L when the temperature is 20°C and the pressure is 360 mm Hg

What is its volume at STP?

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What is its volume at STP?

$\frac{p_1V_1}{T_1} = \frac{p_2V_2}{T_2}$ $\frac{(300 \text{ mm Hg})(400 L)}{293 K} = \frac{760 \text{ m...}}{273 K}$

= 147 L

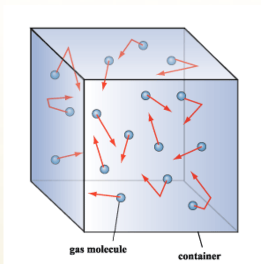
Ideal Gases

Non-interacting

Point particles

Random motion with

Elastic collisions
(no energy lost)



Avogadro's Law

Equal volumes of gas contain the same

Number of particles at the same

Temperature and pressure

n = number of moles

$$\frac{p_1V_1}{nT_1} = \text{constant}$$

Avogadro's Law

At STP

$$\frac{p_1V_1}{nT_1} = \frac{(1\ \text{atm})(22.4\ \text{L})}{(1\ \text{mole})(273\text{K})} = \frac{0.082}{\text{mole}}$$

= Universal G

= R

Ideal Gas Law

How many moles of Helium are present

in a 65 L balloon at 20°C and 705 torr?

$pV = nRT$

Ideal Gas Law

How many moles of Helium are present in a 65 L balloon at 20°C and 705 torr?

$pV = nRT \qquad n = pV/RT$

$= \dfrac{(705/760)\text{atm} \ (65\ \text{L})}{(0.082\ \text{L atm/mole K})(293}$

= 2.5 moles He

Ideal Gas Law

What is the pressure inside of a barbeque gas cylinder of propane with a volume of 45 L at 25°C if the cylinder contains 5 kg of propane?

$pV = nRT$

Ideal Gas Law

What is the pressure inside of a barbeque gas cylinder of propane with a volume of 45 L at 25°C if the cylinder contains 5 kg of propane?

5 kg = 5000 g x 1 mole/44 g = 113.6 moles

$p = \dfrac{nRT}{V} = \dfrac{(113.6\ \text{moles})(0.082)(298\ \text{K})}{45\ \text{L}}$

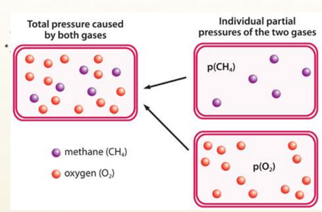
= 61.7 atm

Partial Pressure

Each gas atom/molecule acts independently so

Gas mixtures behave the same as pure gases.

$P_{total} = \Sigma(p_1 + p_2 + p_3 \ldots.$



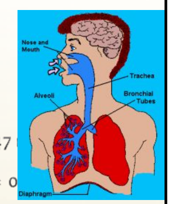
Partial Pressure

Air: example of a gas mixture

P_{total} = 760 mm Hg

= p_{N_2} + p_{O_2} + p_{CO_2} + P_{H_2O}

= 573 mm Hg + 100 mm Hg + 40 mm Hg + 47



p_n 100 mm Hg = 0

Partial pressure = p_{total} p_{O_2} = 760 mm Hg