UNIT 7: *Gases*

Lesson 1 : Properties of Gases and Kinetic Molecular Theory

Essential Question: What is the Kinetic Molecular Theory and how does it help explain the behavior of gases?

Questions/ Vocab, etc.	Notes:
	Properties of Gases 1. Made of atoms or molecules that are very far apart from one another (weak IMF's) 2. High kinetic energy 3. Lowest density of the 3 states 4. Gases take the shape & volume of their container (variable volume & variable shape) 5. Can expand (molecules will move away from each other) 6. Can compress (molecules pushed closer together) Kinetic Molecular Theory (KMT) : based on an ideal gas • A theory that explains ideal gas behavior based upon the motion of molecules • Ideal gases are imaginary gases that follow the assumptions of KMT Assumptions of the KMT (based on an IDEAL GAS) **1.** Gases are made of atoms or molecules that are in constant, rapid, random, straight-line, chaotic motion 2. The "Kelvin" temperature of a gas is ***directly proportiona***l to the average kinetic energy (KE) of the particles. *Temperature change: 100K to 200K, the average kinetic energy doubles* *Temperature change: 25C to 50C, the average kinetic energy increase by a factor of 1.08* 3. Gas particles do not attract or repel one another 4. All gas particle collisions are ELASTIC (no kinetic energy is lost) 5. Gas particles are so SMALL in volume compared to the distances between the particles that the volume of the particle can be assumed to be zero (gases have no volume) **Real Gases** Real gases (like nitrogen), will eventually condense into a liquid when the temperature gets too low or the pressure gets too high BECAUSE: Assumption #3 : Gas particles do have attractive & repulsive forces with one another Assumption #5 : Gas particles do take up space and do have volume Real Gases Behave like Ideal gases (Harris Teeter ***HT has LP*** *low prices)* • At High temperature and Low Pressure • At these conditions, the molecules do not feel the attractive forces that are between them and so they don't draw into one another and condense and solidify Real Gases Deviate from Ideal Gas Behavior • When real gases are at **HIGH** pressure, the gas molecules are compressed making the volume they take up more significant than if they were spread out. • When real gases are at **LOW** temperature, the lower KE causes the molecules to move slower and ATTRACTIVE FORCES that really exist will take effect. • Polar gases (HCl) deviate more than nonpolar gases (He or H_2)

	Other Properties of Gases **Gas Movement:** **Effusion: gas escapes from a tiny hole in the container under pressure** **Diffusion: gas moves across a space from high to low concentration** ● As the mass of particles increases, the particles move SLOWER; the rate of diffusion/effusion is lower. ● As temperature increases, the molecules have greater average kinetic energy and will move faster. The rate of effusion and diffusion is higher. Example **Does Hydrogen gas effuse or diffuse faster than carbon dioxide gas at the same temperature ? Yes or No** Example **You have 2 different gases at the same temperature.** **Do they have the same average kinetic energy? Yes or No** **Do they have the same speed? Yes or No**

Lesson 2 : Gas Variables & Behavior

Essential Question: What are the qualitative relationships between volume, temperature, moles and pressure of a gas?

Questions/ Vocab, etc.	Notes
	Gas Behavior Pressure is defined as: Atmospheric Pressure is measured by a barometer What is the barometric pressure at sea level (1 atm)? ______________________ As altitude increases, the # of gas molecules decreases and so does atmospheric pressure ***Pressure and Moles (# of Molecules)*** *If temperature & volume are held constant:* As the number of moles(molecules) _______________________ there are more molecules to collide with the wall. Collision frequency increases and PRESSURE ____________________. ● What kind of relationship is this? Direct or Inverse ***Pressure and Volume*** *If temperature & moles are held constant:* As volume increases, molecules can travel farther before hitting the wall. Collision frequency decreases and thus PRESSURE _____________________ ● What kind of relationship is this? Direct or Inverse **Temperature** is defined as the AVERAGE KINETIC ENERGY of a substance. As "Kelvin" temperature increases, AVERAGE KINETIC ENERGY increases and MOLECULAR MOTION _____________________ ● What kind of relationship is this? Direct or Inverse

	Pressure and Temperature *If moles & volume are held constant:* As temperature increases, molecular motion increases SO both collision frequency and the force of impact increases and thus PRESSURE ___________________________ • What kind of relationship is this? Direct or Inverse ***Volume and Temperature*** ❑ Volume is the amount of space a gas takes up *If pressure & moles are held constant:* As temperature increases, molecular motion increases SO molecules move farther away from each other and VOLUME ___________________________ • What kind of relationship is this? Direct or Inverse ***Volume and Moles*** *If pressure & temperature are held constant:* As moles increase, there will be more molecules to collide with the wall SO collision frequency increases and VOLUME ___________________________ • What kind of relationship is this? Direct or Inverse ***What happens when atmospheric pressure is greater than the internal pressure of a container?*** • The container will implode

Lesson 3 A : Gas Laws: Boyle's, Charles', Gay Lussac's Gas laws

Essential Question: How can you use Boyle's, Charles' and Gay-Lussac'sGas Law to determine the behavior of a specific gas variable?

Questions/ Vocab, etc.	**Notes**
	Pressure Units Several units are used when describing pressure

Unit	Symbol
Atmospheres	
KiloPascals	
Millimeters of mercury	
Pounds per square inch	

Important Conversion Factors

***1 atm = 101.3 kPa = 760* mm Hg = 760 torr**

1. Convert 654 mm Hg to atm

2. Convert 879 mm Hg to kPa

Temperature

- Temperature must be in KELVIN when dealing with gases
- Represented as K
- To convert Celsius temperature to Kelvin, use °C + 273 = K

Examples

1.Convert 15.6 °C into K

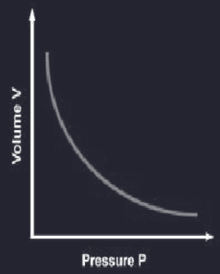
2. Convert 234 K into °C

Standard Temperature & Pressure [STP] - ***These values are on your reference sheet***

- Also known as STP
- 1 atm (101.3 kpa or 760 mmHg) and 0 °C (273 K)

The Gas Laws: Before & After

Boyle's Law



❖ Volume and pressure have an **INVERSELY** proportional relationship when temperature and moles are constant

$$V_1P_1 = V_2P_2$$

Tripling pressure reduces volume by one-third

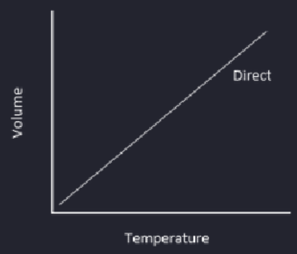
As volume decreases, pressure increases

As volume increases, pressure decreases

Example

A gas sample is 1.05 atm when at 2.5 L. What volume is it if the pressure is changed to 0.980 atm?

Charles Law



❖ Volume and temperature have a **DIRECTLY** proportional relationship when pressure and moles are constant.

Temperature must be in Kelvin units!

$$V_1/T_1 = V_2/T_2$$

Doubling volume doubles the Kelvin temperature of gas

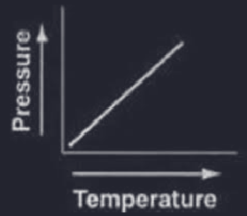
Example:

✔ What is the final volume if a 10.5 L sample of gas is changed from 25.0° C to 50.0° C?

Gay-Lussac Law

❖ Pressure and temperature have a ***DIRECTLY*** proportional relationship when volume and moles are constant.

Temperature must be in Kelvin units!



$$P_1/T_1 = P_2/T_2$$

Halving Kelvin temperature will cut the pressure of the gas in half

Example:

A sample of hydrogen gas at 47.0 °C exerts a pressure of .329 atm. The gas is heated to 77.0° C at constant volume and moles. What will the new pressure be?

Lesson 3 B: Avogadro's and Combined Gas laws

Essential Question: How can you use Avogadro's and Combined Gas Law to determine the behavior of a specific gas variable?

Avogadro's Law

❖ Moles & Volume have a ***DIRECTLY*** proportional relationship when temperature and pressure are constant. $V_1/n_1 = V_2/n_2$

Doubling the moles of gas would double the volume of the gas

Example

A sample with 0.15 moles of gas has a volume of 2.5 L. What is the volume if the sample is increased to 0.55 moles?

Combined Gas Law

→ Expresses the relationship between volume ,pressure, and temperature when moles are held constant. Temperature must be in Kelvin units!

$$\frac{V_1P_1}{n_1T_1} = \frac{V_2P_2}{n_2T_2}$$

Example:

What is the final volume if a 15.5 L sample of gas at 755 mm Hg and 298K is changed to STP?

Lesson 4 : Ideal and Dalton's Law

Essential Question: How can you use Ideal and Dalton's Law to determine the behavior of a specific gas variable?

Questions/ Vocab, etc.	Notes
	Ideal Gas Law (an "AT NOW" equation) • The volume of a gas varies directly with the number of MOLES and its Kelvin temperature • R is the ideal gas law constant whose value is dependent on its units. **P x V = n x R x T** o R can equal to: o THESE ARE ALL FOUND ON YOUR REFERENCE SHEET ▪ .0821 atm L/mol x K ▪ 62.4mmHg L/mol x K ▪ 8.314 L kPa/mol x K **USE THE R VALUE THAT MATCHES TO THE PRESSURE UNIT IN THE PROBLEM!** Example: A sample with 0.55 moles of gas is at 105.7 kPa and 27.0 °C. What volume does it occupy? Example: What is the temperature of 0.52 moles of gas at a pressure of 1.3 atm and a volume of 11.8L? Example: What mass of hydrogen gas in grams is contained in a 10.0 L tank at 27°C and 3.50 atm of pressure? **Dalton's Law** $P_T = P_1 + P_2 + P_3 ....$ Each gas in a mixture exerts its own pressure called partial pressure. It is independent of the other gas molecules P_T = Total Pressure $P_\#$ = partial pressure of each gas

Example:
If a gas mixture is made up of oxygen (2.3 atm) and nitrogen (1.7 atm), what is the total pressure?

The total pressure of the mixture of 3 gases (N2, O2, and He) is 434 torr. N2 gas has a partial pressure of 215 torr and O2 has a partial pressure of 102 torr. What is the partial pressure of He?

Modified Dalton's Law:

When a gas is collected over water, the total pressure of the mixture collected is a combination of water vapor and the gas you are collecting!

$$P_T = P_{gas} + P_{water}$$

Example:
What is the pressure of the water vapor if the total pressure of the flask is 17.5 atm and the pressure of the oxygen gas is 16.1 atm?

Extension Notes for L4

Mole Fraction and Partial Pressure

- Mole Fraction: Ratio of moles of the substance to the total moles.
- symbol is Greek letter chi (X)
- Moles and pressure are proportional to one another

$$\boxed{P_{\text{Gas 1}} = (X_{\text{Gas 1}}) \cdot (P_{\text{Total}})}$$

$$\boxed{X_{\text{Gas 1}} = \frac{\text{moles Gas 1}}{\text{Total moles}}}$$

Example:
In a gas cylinder there are 0.20 moles of O_2,0.80 moles of N_2 and 0.50 moles of Ne. The total pressure is 1.75 atm. Calculate the partial pressure of O_2 , Ne and N_2 gas.