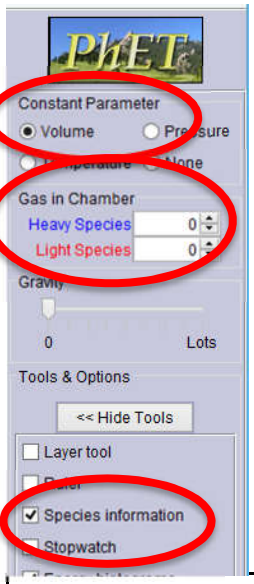
Dalton & Graham's Law Simulation Activity **Name** _____

Go to: http://phet.colorado.edu/en/simulation/gas-properties

Run the java application. Set up the simulation according to the instructions and answer the questions.

Graham's Law: Kinetic Energy and Speed: Compare the kinetic energy and average speed at two different temperatures and record your results in the table below.



Directions:

1. Set **volume as a constant parameter**
2. Enter **100 heavy species** of the gas into the chamber
3. Wait for the gas particles and numerical values to equalize and record the temperature ($\mathbf{T_1}$)
4. Check "**species information**" and record the average speed of the heavy particles
5. Change the number of **heavy species to 0 and enter 100 light species** of gas into the chamber. Record the average speed for the light species at this same temperature **($\mathbf{T_1}$)**.
6. Use the **heat control** to add or remove heat and change the temperature of the system. Record this as your $\mathbf{T_2}$ and repeat steps 2-6.
7. Enter **100 heavy and 100 light** species into the chamber at the T_2 temperature to examine a mixture of particles.

	Avg. Speed of "Heavy" Particles Only	Avg. Speed of "Light" Particles Only	Avg. Speed of Heavy + Light Mix.
Average Speed for T_1 T_1 = _____K			
Average Speed for T_2 T_2 = _____K			

1. Compare the average speed for the heavy vs. light particles at the same temperature. Are these the same or different? What does this tell you about how mass affects the kinetic energy of the particles?

2. Compare the average speed for the heavy and light particles at different temperatures. Are these the same or different? What does this tell you about the relationship between temperature and kinetic energy?

3. Compare the average speed of the particles in the mixture to those of the heavy-only and light-only gases at the same temperature. Do the heavy & light particles retain their speed even when mixed?

Dalton's Law: Pressure and Mixtures of Gases

The atmosphere is composed of many gases in different ratios, and all of them contribute to the total atmospheric pressure. Use the simulation to explore this relationship by testing combinations of heavy and light gases.

For each Test #, record your measurement and answer the questions if there are any. You can hit "reset" in between each one. Make sure the temperature is the same for each measurement (default should be 300 K).

Test #	Pressure Measurement	Questions
1	100 Light particles =	
2	100 Heavy particles =	
3	200 Heavy particles =	How does this compare to the pressure you measured in #2?
4	100 Heavy + 100 Light particles =	How does this compare if you were to add the pressures you measured in #1 and #2?
5	200 Heavy + 100 Light particles =	How does this compare if you were to add the pressures you measured in #1 and #3?
6	100 Heavy + 50 Light particles =	

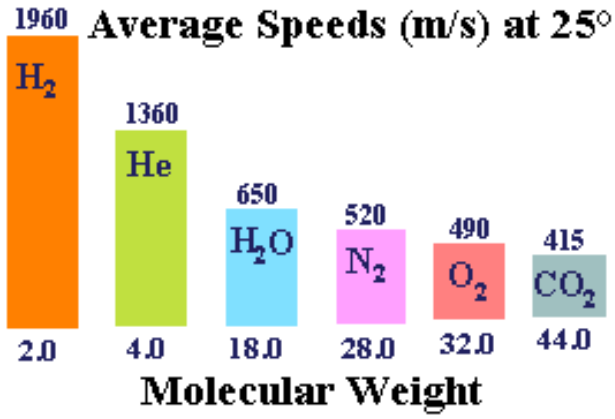
1. For Test 6 (100 Heavy + 50 Light particles), what is the pressure contribution from the heavy particles (P_{heavy})? How did you figure this out?

2. What is the pressure contribution from the light particles (P_{light})? How did you figure this out?

Graham's Law of Diffusion-

Under ideal conditions, the rates at which different gases diffuse (spread out) are _____ proportional to their molar masses.

In other words, _____ gas molecules will move _____than smaller gas molecules.



Examples:

1. Compare the rates of diffusion of H_2 and O_2 gases at the same temperature and pressure.

2. Rank the following gases from slowest to fastest rate of diffusion: H_2, CO_2, Ne, H_2S.

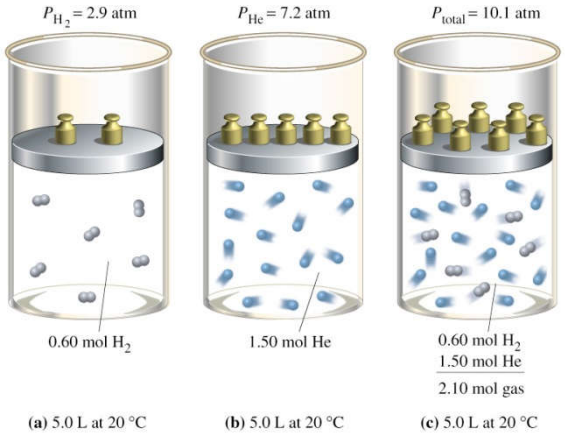
3. Compare the rates of effusion of nitrogen (N_2) and helium at the same temperature and pressure.

4. Compare the rate of effusion of carbon dioxide (CO_2) with hydrochloric acid (HCl) at the same temperature and pressure.

Dalton's Law-

-
-

P_{total}=



Examples:

1. Two gases such as oxygen and nitrogen are present in a flask at the following pressures. When combined, what is the pressure of the flask?

$P_{Nitrogen}$ =250. mm Hg

P_{Oxygen}=300. mm Hg

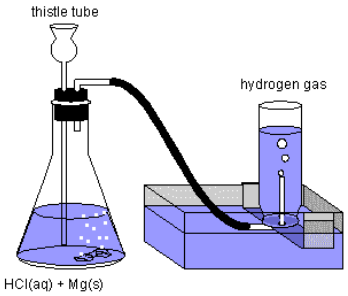
List all variables	Write the formula of the appropriate Gas Law	Plug & Chug	Final Answer is… (check your work!)
Known:			
Unknown:			

2. Neon gas has a pressure of 1.49atm in its container. When added to a container holding helium gas the total pressure is 2.34atm. What is the pressure of the helium gas?

List all variables	Write the formula of the appropriate Gas Law	Plug & Chug	Final Answer is… (check your work!)
Known:			
Unknown:			

Dalton's Law Continued: Water displacement of gas:

- Gases given off from the rxn travel through the tube and into the adjacent container for collection
- Gas is *impure* and contains some water vapor



P_{atm}=

Examples:

1. Oxygen gas from the decomposition of potassium chlorate was collected by water displacement. The barometric pressure and the temperature during the experiment were 731.0torr and 20.0˚C respectively. What was the partial pressure of the oxygen collected? The vapor pressure of water at 20°C is 17.5 torr

List all variables.	**Write the formula of the appropriate Gas Law**	**Plug & Chug**	**Final Answer is… (check your work!)**
Known:			
Unknown:			

2. Some hydrogen gas was collected over water at 20.0 ˚C. The partial pressure of hydrogen is 742.5 torr. What is the barometric pressure of the gas? The vapor pressure of water at 20°C is 17.5 torr

List all variables.	**Write the formula of the appropriate Gas Law**	**Plug & Chug**	**Final Answer is… (check your work!)**
Known:			
Unknown:			

Dalton and Graham's Law Practice:

1. A mixture of H_2, NH_3, CO_2 and N_2 has a total pressure of 800. Torr. The partial pressures of 3 gases are given. What is the partial pressure of N_2?
   PH_2=114 torr
   PNH_3=171 torr
   PCO_2=229 torr

2. A 250. mL sample of oxygen is collected over water at 25°C and 760.0 torr pressure. What is the pressure of the dry gas alone? (vapor pressure of water at 25°C=23.8 torr)

3. A 54.0 mL sample of oxygen is collected over water at 23°C and 770.0 torr pressure. What is the volume of the dry gas at STP (Vapor pressure of water at 23°C=21.1 torr)

4. What is the relative rate of diffusion of NH_3 compared to He (does it diffuse faster or slower)?

5. An unknown gas diffuses 0.25 times as fast as He. Is the molar mass of the unknown gas greater and less than that of He?