Name: _____

Gas Laws

Background

In this investigation you will examine three gas laws including Boyle's Law, Charles' Law and Gay-Lussac's Law. You will explore how manipulating the variables of volume (L), pressure (atm) and temperature (K) can affect a sample of gas. The formula for each of the gas laws are:

Boyle's Law:	Charles' Law:	Gay-Lussac's Law:
$P_1V_1 = P_2V_2$	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Prelab Questions

1. Solve for "*x*" in the following algebraic equations and report your final answer with the correct number of significant digits:

   a. $(1.34)(5.46) = (1.76)(x)$

   b. $\frac{4.38}{332} = \frac{x}{267}$

   c. $\frac{2.25}{295} = \frac{4.85}{x}$

2. Briefly describe, in your own words the meaning of each of the following variables, and common units of measurement associated with each:

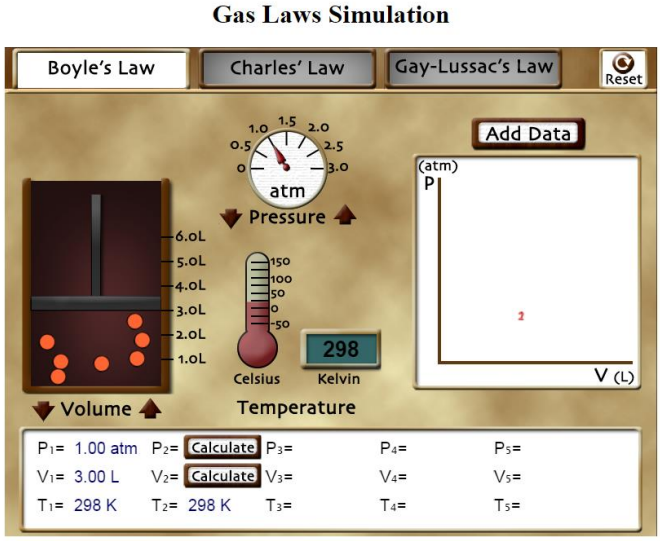
   a. Volume

   b. Pressure

   c. Temperature

Procedure

Visit http://www.teachchemistry.org/gaslaws. Make sure that you select the "Boyle's Law" tab to begin; it will be shown in white. You should see the picture below on your screen.



Boyle's Law

1. Which one of the three variables: Pressure, Volume or Temperature cannot be changed in Boyle's Law? This variable is considered a constant.

2. Using the volume control arrows, reduce the volume of the gas to 1.70L.
   a. In the space below record your observations regarding the behavior of the particles in the gas sample as the volume is reduced. Make certain to discuss *collisions* in your comments.
   a. Calculate the new pressure value for the gas, showing all of your work.
   b. Check your final answer for part b by clicking the *calculate* button next to P_2.

a. Observations when Volume is *reduced*:	b. Calculation
	$P_1V_1 = P_2V_2$

3. Press the *reset* button at the top right of the screen.
   Using the pressure control arrows, reduce the pressure of the gas to 0.700atm.
   a. In the space below record your observations regarding the behavior of the particles in the gas sample as the pressure is reduced.
   b. In the space below calculate the new volume value for the gas.
   c. Check your final answer for part b by clicking the *calculate* button next to V_2.

a. Observations when Pressure is *reduced*:	b. Calculation
	$P_1V_1 = P_2V_2$

4. Press the *reset* button at the top right of the screen.
    a. Using the pressure control arrows, increase the pressure value to 1.50 atm, and fill in the corresponding V_2 value in the data table below.
    b. Press the *Add Data* button. Using the pressure control arrows, increase the pressure to 2.00atm and fill in the corresponding V_3 value in the data table below.
    c. Repeat step b for pressure values of 2.50atm and 2.90atm.

P_1 = 1.00atm	P_2 = 1.50atm	P_3 = 2.00atm	P_4 = 2.50atm	P_5 = 2.90atm
V_1 =	V_2 =	V_3 =	V_4 =	V_5 =

    d. Based on the data collected in the table above, what trend can be observed for volume of a gas when the pressure of the gas is increased?

Important Terms

Direct relationship: A relationship between two variables, where a change in one variable results in the same change in the other variable. For example, if one variable is increased, then the other variable will also increase.

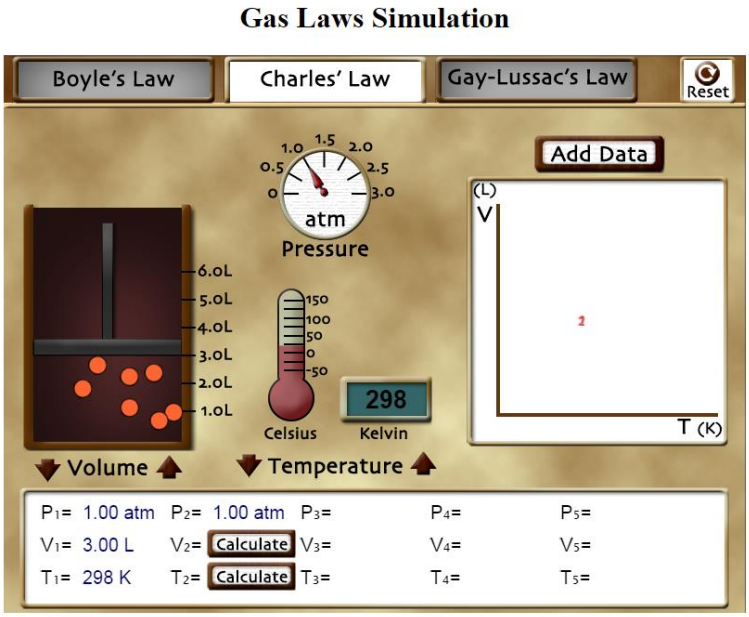
Indirect relationship: A relationship between two variables, where a change in one variable results in the opposite change in the other variable. For example, if one variable is increased, then the other variable will decrease.

    e. Considering the terms described above, do the variables of pressure and volume have a *direct* or an *indirect* relationship in Boyle's Law? Justify your answer with data.

    f. Considering what you now know about Boyle's law, make a prediction based on the following situation: What would happen to the pressure of a gas inside a sealed bottle, if the bottle was squeezed tightly, reducing the volume of the gas by half? Explain your thoughts.

Charles' Law

Change the simulation to "Charles' Law" by clicking the tab at the top of the screen it will be shown in white. You should see the picture below on your screen.



1. Which one of the three variables: Pressure, Volume or Temperature cannot be changed in Charles' Law? This variable is considered a constant.

2. a. Using the Temperature controls, increase the temperature of the gas. What changes do you observe in the behavior of the particles of the gas while the temperature is increased?

   b. Continue to increase the temperature value until T_2 = 443K. Using the equation for Charles' law, calculate the volume of the gas at this increased temperature. Check your final answer for part b by clicking the *calculate* button next to V_2:

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

   c. Based on the final value calculated in part b) is Charles' law considered a direct or an indirect relationship between the variables? Explain your choice with reasoning.

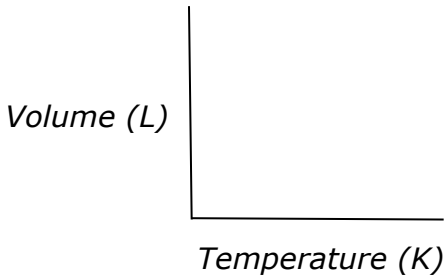
3. Press the *reset* button at the top right of the screen.
   Using the volume control arrows, reduce the volume of the gas to 1.86L.
   a. In the space below record your observations regarding the behavior of the particles in the gas sample as the volume is reduced.
   b. In the space below calculate the new temperature value for the gas.
   c. Check your final answer for part b by clicking the *calculate* button next to T_2.

a. Observations when Volume is *reduced*:	b. Calculation
	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$

   d. Convert the final value for T_2 into Celsius units.

4. Press the *reset* button at the top right of the screen.
   - Using the pressure control arrows, increase the temperature value to a measurement of your choosing. Then press *Add Data*. This will fix a data point on the graph for T_2.
   - Increase the temperature three additional times; select *Add Data* for each data point: T_3, T_4, and T_5.

   a. Plot these points on the graph below, estimating the five data points created:

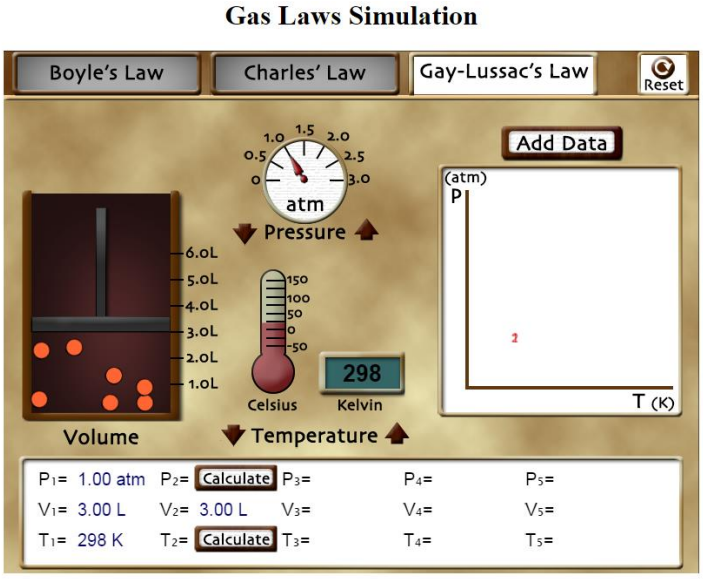


   b. Based on the data points collected on the graph, make a statement about the trend that can be observed between the volume and temperature of a gas.

5. Considering what you now know about Charles' law, make a prediction based on the following situation: What would happen to the volume of a gas inside a sealed bottle, if the bottle was heated to double its original temperature? Explain your thoughts.

Gay-Lussac's Law

Change the simulation to "Gay-Lussac's Law" by clicking the tab at the top of the screen it will be shown in white. You should see the picture below on your screen.



1. a. The equation for Gay-Lussac's law is $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ does it look most similar to the equation for Boyle's Law or the equation for Charles' law?

   b. What variable is held constant in Gay Lussac's law?

   c. Based on your answer to part a) what prediction can you make about the relationship between the variables of Pressure and Temperature of a gas?

2. a. Using the pressure control arrows, increase the pressure value to 1.50atm, and fill in the corresponding T_2 value in the data table below.
   b. Press the *Add Data* button. Using the pressure control arrows, increase the pressure to 2.00atm and fill in the corresponding T_3 value in the data table below.
   c. Repeat step b for pressure values of 2.50atm and 2.90atm.

P_1 = 1.00atm	P_2 = 1.50atm	P_3 = 2.00atm	P_4 = 2.50atm	P_5 = 2.90atm
T_1 =	T_2 =	T_3 =	T_4 =	T_5 =

   d. Based on the data collected in the table above, what trend can be observed for temperature of a gas when the pressure of the gas is increased? Is this considered a direct or an indirect relationship between the variables?

3. Press the *reset* button at the top right of the screen.
   Using the temperature control arrows, reduce the temperature of the gas to 158K.
   a. In the space below record your observations regarding the behavior of the particles in the gas sample as the temperature is reduced. Make certain to discuss *collisions* in your comments.
   b. In the space below calculate the new pressure value for the gas.
   c. Check your final answer for part b by clicking the *calculate* button next to P_2.

a. Observations when Temperature is *reduced*:	b. Calculation
	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$

4. Considering what you now know about Gay-Lussac's law, make a prediction based on the following situation: What would happen to the pressure of a gas inside a sealed bottle, if the bottle was cooled to half of its original temperature? Explain your thoughts.

Checking Comprehension
Please create a list of the variable given in each problem and show all your work required to complete the calculation.

1. Calculate the temperature of a gas when it is expanded to 5.25L. The gas originally occupies 3.45L of space at 282K.

2. The temperature of a gas is increased from 125ºC to 182ºC inside of a rigid container. The original pressure of the gas was 1.22atm, what will the pressure of the gas be after the temperature change?

3. The volume of gas in a container was originally 3.24L, while at standard pressure, 1.00atm. What will the volume be if the pressure is increased to 1.20atm?