PhET Gas Law Simulation Name: _____

http://phet.colorado.edu/new/simulations/sims.php?sim=Gas_Properties

If the direct link does not work, use Google, and use the search terms "Phet Gas properties". You can download the program on your home computer if you have Java, or you can run it online.

Part 1: *Play*

Purpose: Play! See how everything works before we try to find any relationships.

Procedure:

1. Pump the handle once. Watch the temperature and pressure gauge. See how long it takes for the values to stabilize. Record the values in **Table 1 on the next page**.

2. Using the little person pushing on the wall, decrease the volume of the box in about half. Describe what happens to:

Temperature:
Pressure:

3. Using the little person pushing on the wall, make the volume as small as possible and watch for at least 60 seconds. Thoroughly describe what happens over the course of the full minute. Be sure to address the following in your answer:

   a. What happens to the container and the little man pushing on the container?
   b. What happens to temperature and pressure?
   c. Describe the particle speeds of both the heavy and light species.

4. Hit the "Reset" button. Give the pump a push with the heavy species. Wait for the values to stabilize and record the results in table 1 **on the next page**.

   Are these values the exact same as the first time you did it? _____ Why or why not?

5. There is a box in the lower right corner entitled "Gas in Pump". Select the "light species". You will notice that the pump turns red. Give the pump a press. Wait for the values to stabilize and record the results in table 1 **on the next page**.

6. In the box entitled "Heat Control", grab the arrow and move it to add. What happens?

7. Using the "Heat Control", grab the arrow and move it to "remove." What happens?

8. Feel free to play with the simulator. Try the "Pause" and "Step" buttons at the bottom. Try sliding the top of the container. Take about 3-5 minutes to play with the different options.

Table 1: Playing with the simulation program

	After pumping the "heavy" handle once (1st time)	After pumping the "heavy" handle once	After cutting the volume in about half	**Reset**: Constant volume 1 pump of heavy species	Added 1 pump of light species
Temperature (K)					
Pressure (atm)					
Number of Heavy Species					
Number of Light Species					

Part Two: Boyle's Law

Purpose: To see how pressure and volume are related to each other (keeping everything else constant).

Procedure:
1. Hit the reset button.
2. In the upper left corner under "Constant Parameters", select "Temperature". This will make sure that temperature will not change significantly.
3. We will need a way to measure the volume. Hit the button "Measurement Tools". Select the "Ruler" box. A ruler should appear at the top of the screen. The ruler can be moved so you can measure the size of the box. This will make a good way of measuring the volume.

4. To see how the relationship between pressure and volume works, temperature and number of moles must be constant. The temperature can be held constant by selecting it in the corner.

5. Take 8 separate measurements over a large range of numbers without exploding the container.

Table 2: Volume and Pressure of a gas with temperature constant at_____ and Particles constant at _____

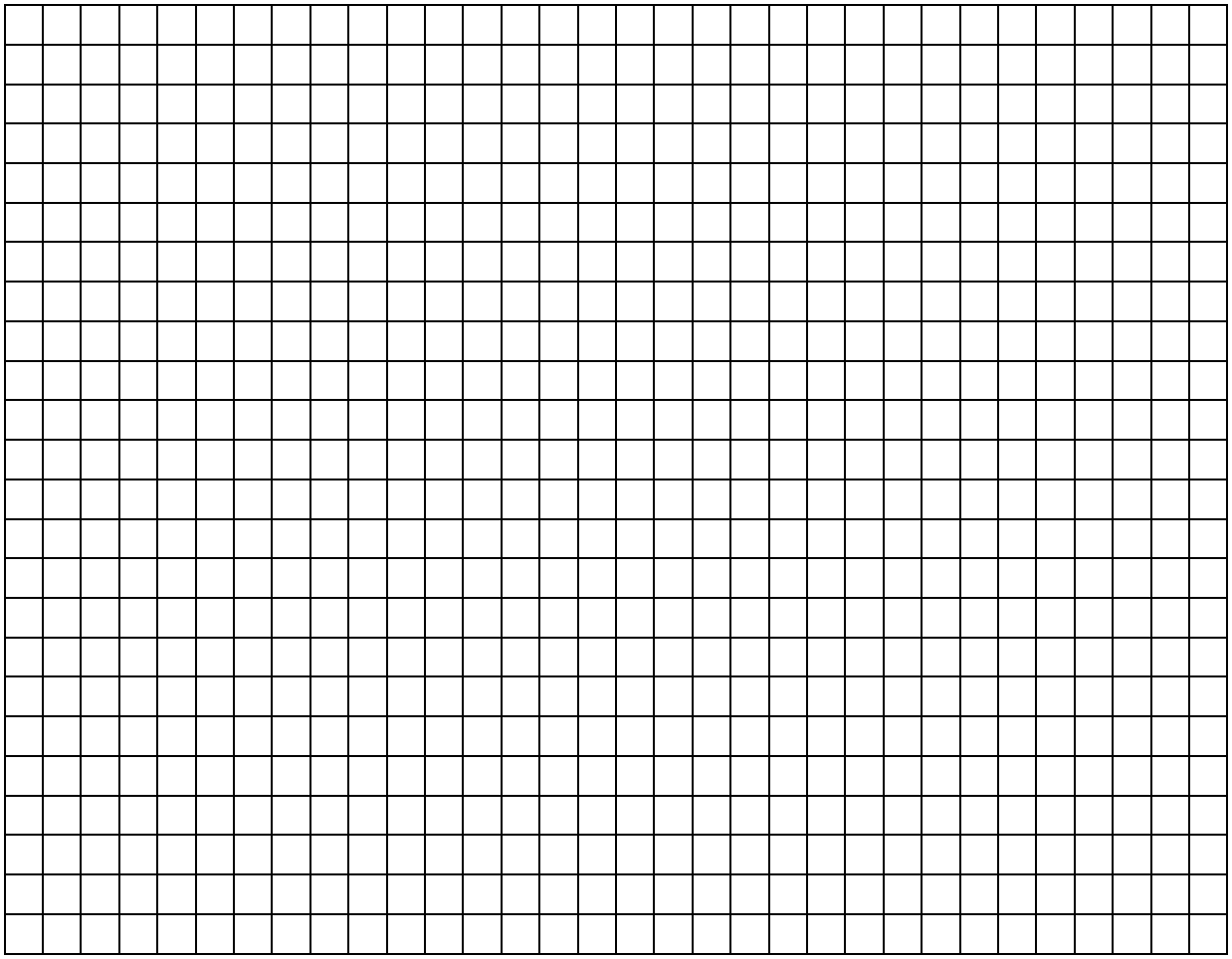
Volume (nm)								
Pressure (atm)								

Questions:
1. What is the independent variable?

2. What is the dependent variable?

3. What 2 factors are being held constant?

6. Make a graph of the relationship. Be sure your graph has all of the proper components.



7. Describe the relationship of your graph. Be sure to include the variables and constants in your answer. (you answer should contain the words temperature, volume, pressure and moles)

Part 3. Charles' Law

Purpose: to determine the relationship between volume and temperature (with everything else constant).

Procedure: You get to design how to test the purpose. Write down the settings you put the simulator to.

Please note: if you want to hold pressure constant, the container must have something in it first. Add particles, then hold pressure constant. If you hold pressure constant before adding particles in the container (P = 0 atm), the program will attempt the impossible, by trying to hold the pressure at 0 atm.

1. What is the independent variable?

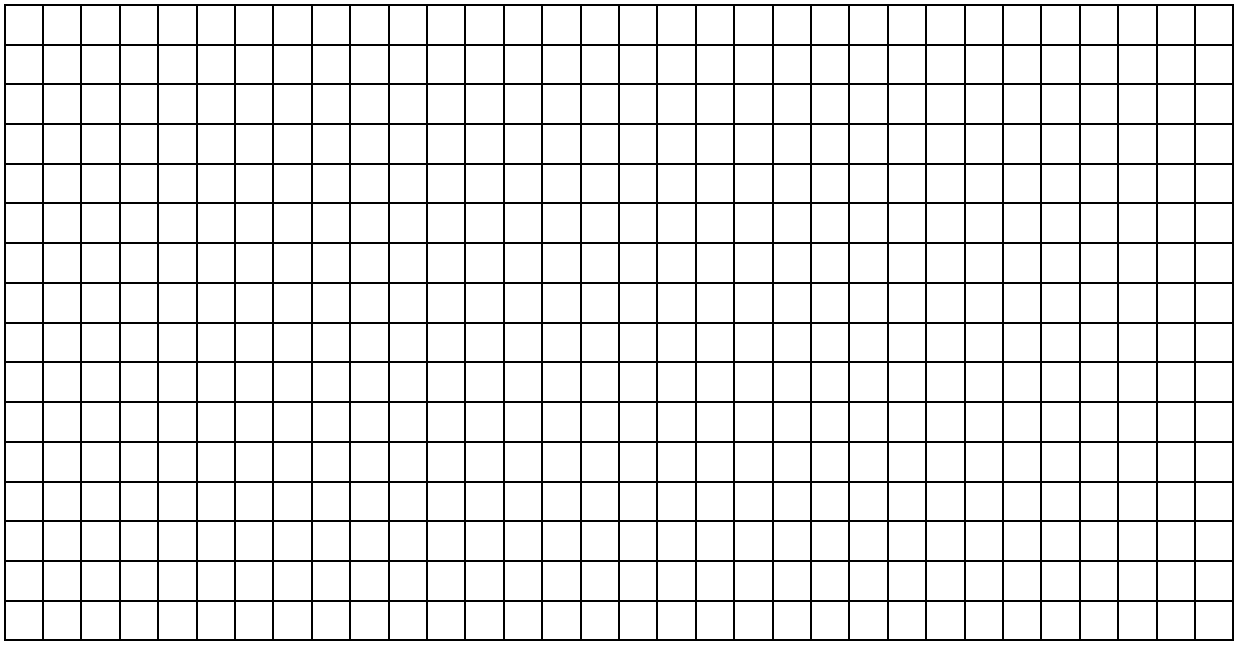
2. What is the dependent variable?

3. What 2 factors are being held constant?

Make a data table to collect at least 8 pieces of data over a large range. Be sure the data table has the proper components (title, units, gridlines, etc).

Table 3: _____

Make a graph of the Charles' Law relationship. Be sure your graph has all of the proper components.



7. Describe the relationship of Charles' Law. Be sure to include the variables and constants in your answer.

Part 4. Gay-Lussac's Law

Purpose: to determine the relationship between pressure and temperature (with everything else constant).

Procedure: You get to design how to test the purpose. Write down the settings you put the simulator to.

1. What is the independent variable?

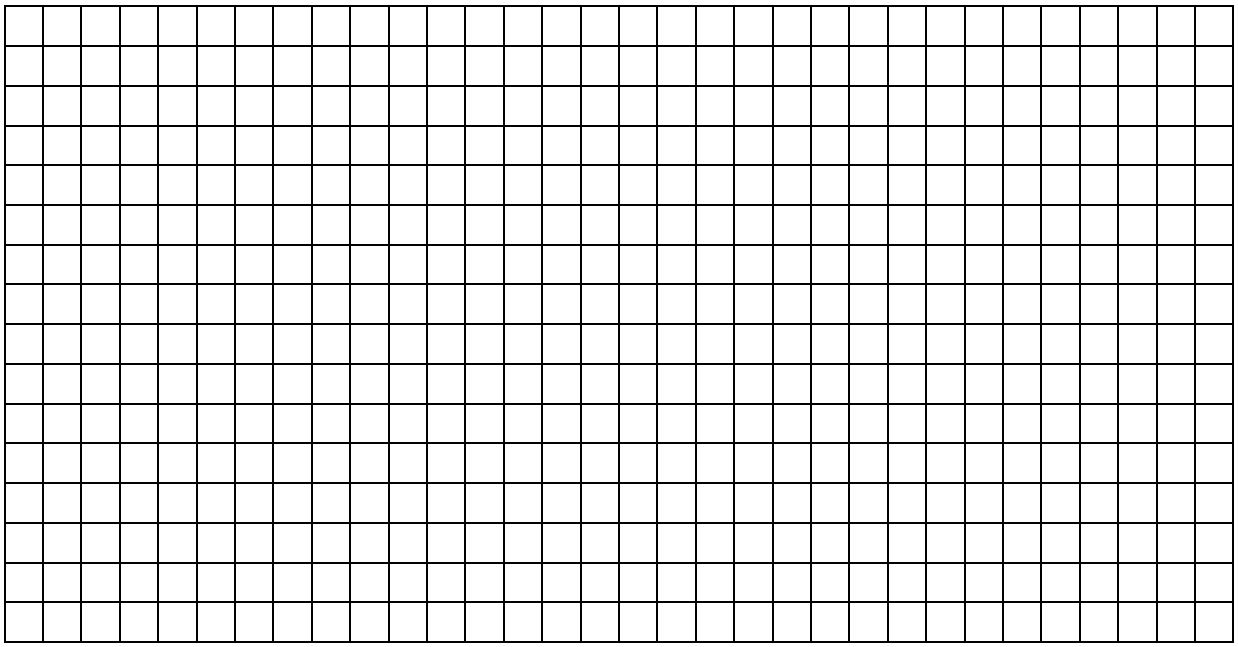
2. What is the dependent variable?

3. What 2 factors are being held constant?

Make a data table to collect at least 8 pieces of data over a large range. Be sure the data table has the proper components (title, units, gridlines, etc).

Table 4: _____

6. Make a graph of the relationship of Gay-Lussac's Law. Be sure your graph has all of the proper components.



7. Describe the relationship of Gay-Lussac's Law. Be sure to include the variables and constants in your answer.

Part 5. Relationship between particles and pressure

Purpose: to determine the relationship between particles and pressure (with everything else constant).

Procedure: You get to design how to test the purpose. Hint: In the "Advanced Options", you should select the "Temperature of new particles" and pick a temperature. This should hold it constant.
Write down the settings you put the simulator to.

1. What is the independent variable?

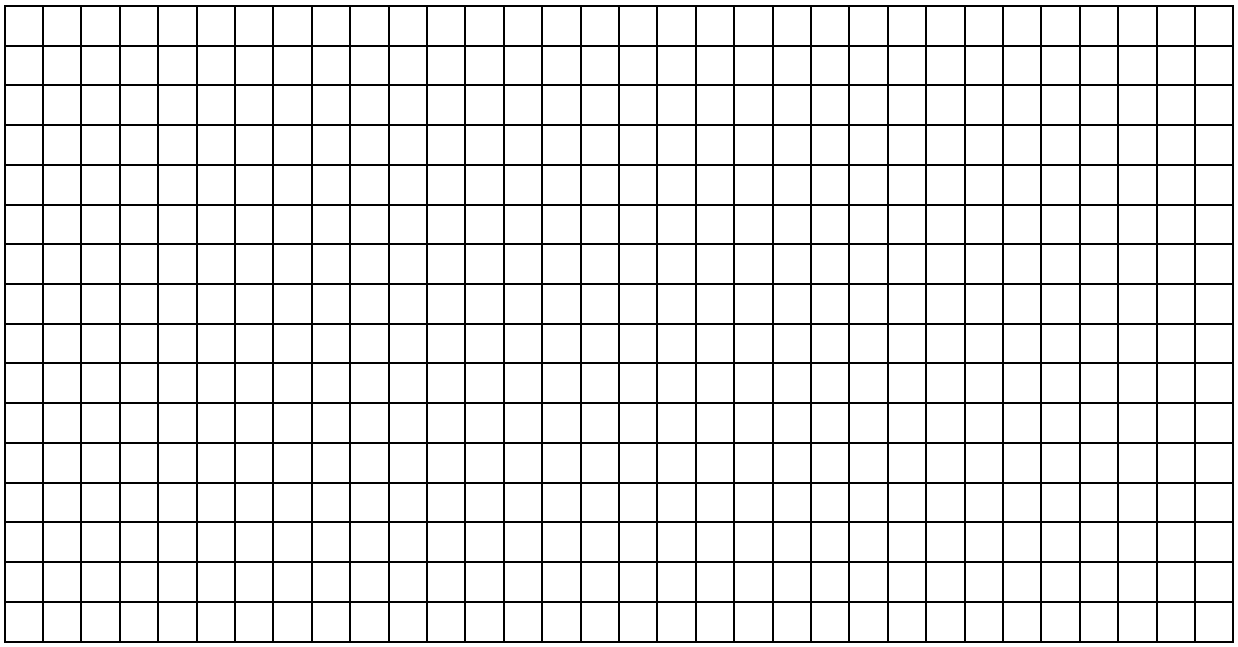
2. What is the dependent variable?

3. What 2 factors are being held constant?

Make a data table to collect at least 8 pieces of data over a large range. Be sure the data table has the proper components (title, units, gridlines, etc).

Table 5: _____

6. Make a graph of the relationship of Pressure and number of particles. Be sure your graph has all of the proper components.



7. Describe the relationship. Be sure to include the variables and constants in your answer.

Part 6: Comparing the effect of particle size.

Purpose: **Your goal is to see if there is a difference between using heavy or light particles.**

Procedure:

1. Hit the Reset button.
2. Under the "Measurement Tools" section, be sure to have the "Center of Mass Markers" checked.
3. Under the "Advanced Options" tab, be sure that the temperature is check with a value of 300 K.
4. Set the "Constant Parameter" to be volume.
5. Type in the appropriate number of particles in the boxes on the far right of the screen.
6. Fill in the data table below.
7. When finished with one trial, repeat from step 1 (be sure to reset, just to be safe).
8. For the last rows of the table, chose a combination of heavy and light particles to a total of 500.

Table 6: Measurement of Pressure, Temperature, and moles.

		Trial 1	Trial 2	Trial 3	Average
100 Heavy Particles	Pressure (atm)				
	Temperature (K)				
	Number of Particles				
100 Light Particles	Pressure (atm)				
	Temperature (K)				
	Number of Particles				
50 of each Type	Pressure (atm)				
	Temperature (K)				
	Number of Particles				
___ heavy	Pressure (atm)				
	Temperature (K)				
___ light	Number of Particles				

Questions:

1. Is there a *significant* difference between the averages of the 100 light particles and the 100 heavy?

   b. How does the particle ***size and mass*** change the pressure or temperature?

2. Describe how the lighter particles move compared to the heavy particles.

   b. Considering that all the particles in the container are at the same temperature, why do the particles move at different speeds?

Summary of Activity

Table 7: _____

held constant	Relationship of remaining variables.
particles and pressure	
particles and volume	
particles and temperature	
volume and temperature	

Does the size of the particle matter when looking at the properties of gases? _____

When at the same temperature, why do large particles move slower than small particles?