FLINN SCIENTIFIC

Name________________________________

Activity A. Diffusion of Gases

Observations and Analysis Questions

1. Describe the initial color and appearance of each solution and any changes that were observed when the Petri dish was covered.

2. What compound was responsible for the color change observed in the phenolphthalein solution? Assuming that none of the liquids were spilled or contacted each other in any other way, how did this compound "travel" to the indicator?

3. What is the role of the phenolphthalein "indicator" in this demonstration? Write an equation for the reaction of ammonia gas with water that explains the indicator color change.

4. What evidence does this demonstration provide that gas molecules are moving continuously about and randomly colliding with nearby walls and surfaces?

5. Describe two observations from daily life that also show us that gas molecules are able to move randomly through a "container."

Activity B. Crush the Can

Observations and Analysis Questions

1. Describe your observations; be specific. What happened when the can was heated? When it was plunged into the water bath?

2. What "force" caused the can to collapse inward on itself?

3. What "drove" the air out of the can as it was heated?

4. Why was there less air pressure inside the can after it was quickly cooled in the water "bath?"

Activity C. Boyle's Law in a Bottle

Data and Results Table

Barometric Pressure				
Gauge Pressure	**Volume of Air in Syringe**	**Total Pressure***	**1/V†**	**P × V**

*See Post-Lab Calculation #2.
†See Post-Lab Calculation #5.

Calculations and Analysis *(Answer on a separate sheet of paper.)*

1. Convert the local barometric pressure to psi units and enter the value to the *nearest psi* in the Data and Results Table.
   1 atm = 760 mm Hg = 29.92 in Hg = 14.7 psi.
2. The tire pressure gauge measures the relative pressure in psi above atmospheric pressure. For each pressure reading in the Data and Results Table, add the local barometric pressure, in psi, to the gauge pressure to determine the total pressure of air inside the pressure bottle. Record the total pressure in the table.
3. *a.* Identify the independent and the dependent variables in this experiment.

   b. Plot a graph of the dependent variable on the *y*-axis versus the independent variable on the *x*-axis. Choose a suitable scale for each axis so that the data points fill the graph as completely as possible. Remember to label each axis (including the units) and to give the graph a title.

   c. Describe the shape of the graph. Draw a best-fit straight line or curve, whichever seems appropriate, to illustrate how the volume of a gas changes as the pressure is varied.
4. The relationship between pressure and volume is called an inverse relationship—the volume of air trapped inside the syringe decreases as the pressure increases. This relationship may be expressed mathematically as $P \propto 1/V$. Calculate the value of 1/V for each volume measurement and enter the results in the table.
5. Plot a graph of pressure on the *y*-axis versus 1/V on the *x*-axis and draw a best-fit straight line through the data points. Choose a suitable scale for each axis. Remember to label each axis and to give the graph a title.
6. Another way of expressing an inverse relationship between two variables ($P \propto 1/V$) is to say that the mathematical product of the two variables is a constant. ($P \times V = \text{constant}$). Multiply the total pressure times the volume for each set of data points. Calculate the average value of the P × V "constant" and the average deviation.

Activity D. Charles's Law — Effect of Temperature on the Volume of a Gas

Data and Results Table

Water Bath	Temperature, °C	Volume of Air in Syringe, mL	Volume / T (mL/°C)	Absolute Temperature, K	Volume / T (mL/K)
Saltwater–Ice					
Ice water					
Room Temperature					
Hot water					

Calculations and Analysis *(Answer on a separate sheet of paper.)*

1. *a.* Identify the independent and the dependent variables in this experiment.

   b. Plot a graph of the dependent variable on the *y*-axis versus the independent variable on the *x*-axis. Choose a suitable scale for each axis so that the data points fill the graph as completely as possible. Remember to label each axis, including the units, and to give the graph a title.
2. Draw a best-fit straight line through the data points on the graph. Describe the mathematical relationship between the temperature and volume of a gas.
3. For each of the four temperatures in this experiment, calculate the value of the volume/temperature (in °C) ratio. How do these ratios compare with one another?
4. *a.* Convert each of the temperature measurements in this experiment to absolute temperature (kelvins, K).

   b. Calculate the value of the volume/temperature (in K) ratio for each of the four temperatures in this experiment. How do these ratios compare with one another?
5. Which volume/temperature ratio (in °C or K) appears to be more constant? Saying that the ratio of two variables is a constant is to say that the two variables are directly proportional to each other. Why is it important to specify absolute temperature (in K) when stating Charles's law?
6. According to the kinetic-molecular theory, the volume of the gas particles is extremely small compared to the volume the gas occupies—most of the volume of gas is "empty space." Based on this theory, does Charles's law depend on the identity of the gas? Would the results in this experiment have been different if different gases had been used in the syringe? On the amount of gas in the syringe? Explain in terms of the KMT and the amount of empty space in gas.