Charles' Law

PA State Standards:

3.7.10.B Apply appropriate instruments and apparatus to examine a variety of objects and processes.
3.4.10.A Describe concepts about the structure and properties of matter.
2.5.11.B Use symbols, mathematical terminology, standard notation, mathematical rules, graphing and other types of mathematical representations to communicate observations, predictions, concepts, procedures, generalizations, ideas and results.
1.2.11.A Read and understand the central content of informational texts and documents in all academic areas.

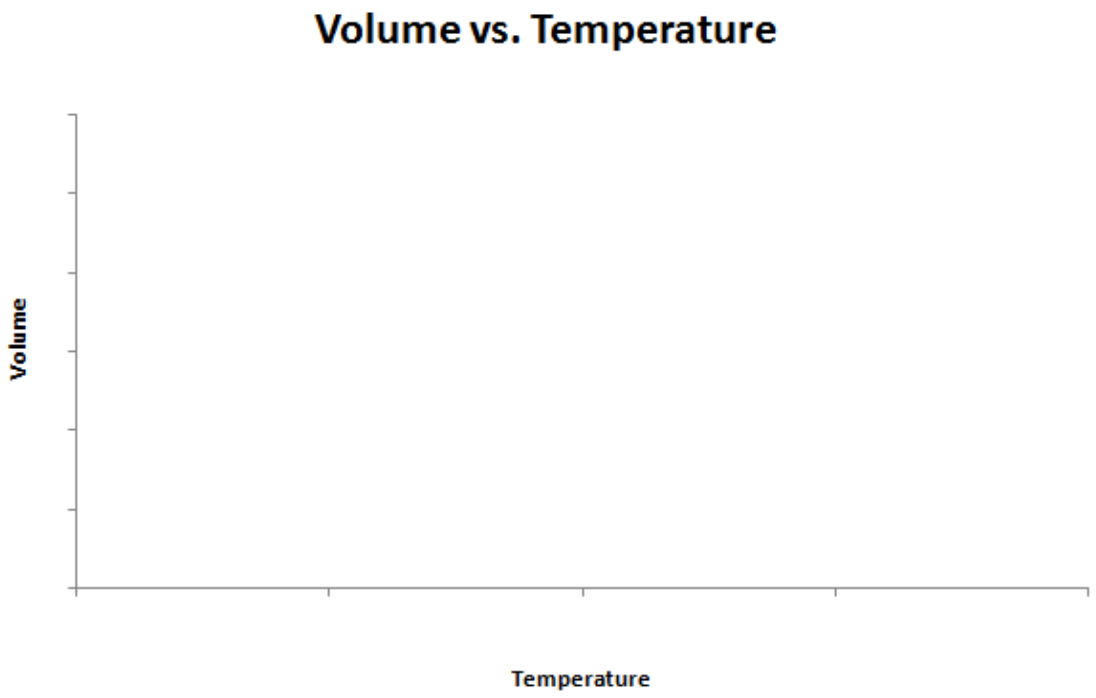
Introduction:

There are four important variables to be measured when dealing with a gas: pressure, volume, mass, and temperature. Relationships among the variables can be determined by holding one or two of the variables constant. Charles' Law deals with the relationship between temperature and volume. In this experiment, you will measure the volume of gas by changing its temperature while holding the mass and pressure constant in order to determine the relationship between temperature and volume.

Guiding Question:

Please answer the following question before beginning the lab.

What will a graph of volume vs. temperature look like? Draw a graph below.



Equipment/Materials:

2 - 250 mL beakers
hot plate
thermometer
thin-stemmed pipet
water

Safety:

- Always wear safety goggles and an apron in the laboratory.

Procedure:

1. Pour water into a 250 mL beaker, and allow the water to reach room temperature. Record the temperature of the water in the data section.

2. Heat another 250 mL beaker with water to approximately 10 ˚C above the room temperature water.

3. To determine the volume of the pipet at room temperature, completely fill a thin-stemmed pipet with room temperature water. Hold it vertically and count the number of drops of water it contained as the water is dispensed. Record this volume in the data section.

4. Remove the beaker from the hot plate once it has reached the appropriate temperature.

5. Insert the bulb of the empty pipet into the beaker of warm water, and hold it in the water for 2 minutes. Record the temperature of the warm water when you remove the pipet.

6. After 2 minutes, immediately flip the pipet, without squeezing, and insert the stem into the beaker containing the room temperature water. Water will be drawn into the pipet.

7. After no more water is drawn into the pipet, carefully remove the pipet from the water and count the number of drops of water it contained. Remember to hold the pipet vertically when dispensing.

8. The volume of air inside the pipet decreases during the cooling process, drawing water into the pipet. The amount of water drawn into the pipet represents the change in the volume of the pipet during the cooling process. This change in volume should be added to the volume of the room temperature pipet. Record this total volume as the volume at the temperature obtained in step five.

9. Repeat steps 4-8 increasing the temperature in intervals of about 10 degrees. Record the temperature and total volume of the gas. Do not heat above 70 ˚C.

Data:

Temperature (K)	Volume (# of drops)

Calculation:

Plot the data on a volume vs. temperature graph and insert a line of best fit.

Questions:

1. What is the relationship between temperature and volume?

2. Explain in terms of the molecular theory the relationship between temperature and volume.

3. Why was the temperature recorded when the pipet was removed from the water?

4. Why is the volume of water drawn into the pipet added to the initial volume of the pipet to obtain the total volume at the warmer temperature?

5. What would the temperature be if the volume of the gas in the pipet were reduced to zero?