

# *Teacher Guide*

## HOT AIR

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Task/Assessment Name (if applicable): Investigation Of Temperature And Volume Of A Gas

Unit or Course: Properties of Matter

Developers: Paul Giambatista and Kay Sanders

Purpose: To explore the possible effect of temperature on the volume of a gas

Vermont Framework Standards: 7.12

Vermont Grade Expectations or Local Learning Goals: S7-8:2,5,12,13,14

**S7-8:5 Students demonstrate their ability to REPRESENT DATA by...** Representing independent variable on the “X” axis and dependent variable on the “Y” axis **AND** Determining a scale for a diagram that is appropriate to the task **AND** Using technology to enhance a representation **AND** Using color, texture, symbols and other graphic strategies to clarify trends/patterns within a representation.

**S7-8:2**

**Students demonstrate their understanding of PREDICTING AND HYPOTHESIZING by...** Predicting results (evidence) that support the hypothesis **AND** Proposing a hypothesis based upon a scientific concept or principle, observation, or experience that identifies the relationship between variables.

**S7-8:12**

**Students demonstrate their understanding of the States of Matter by...** Modeling (plays, models, diagrams) molecular motion of the three states of matter and explaining how that motion defines each state.

**S7-8:13 Students demonstrate their understanding of the Properties**

**of a Gas by...** Using real world examples (tires, balloons, soda) predict and explain the effect that a change in one variable

**S7-8:14**

**Students demonstrate their understanding of Physical Change by...** Constructing their own models representing the states of matter at the molecular level and explaining the effect of increased and decreased heat energy on the motion and arrangement of molecules **AND** Observing the physical processes of evaporation and condensation, and accounting for the disappearance and appearance of liquid water in terms of molecular motion and conservation of mass.

Materials and Administration Notes:

**Safety glasses**

**3 round balloons per group (Please be cautious of latex allergies and check with school nurse before using this assessment.) Also test your balloons by doing this investigation, previous to administering assessment.**

**3 containers large enough to submerge a balloon**

**3 lengths of string, each long enough to measure balloon circumference**

**ruler**

**clock with a second hand**

**hot water**

**ice**

**water**

**waterproof marker**

**something with a flat bottom to submerge the balloons**

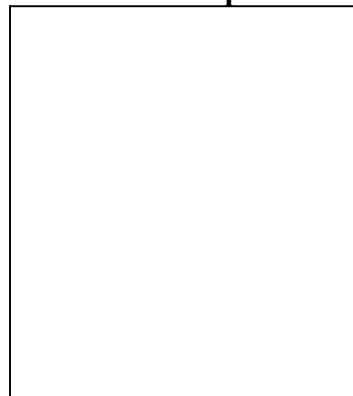
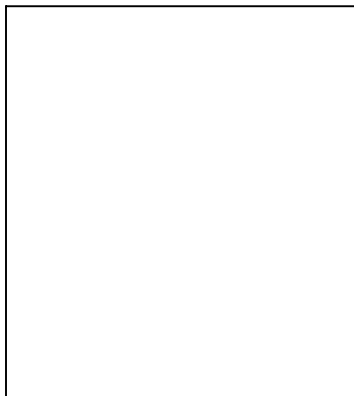
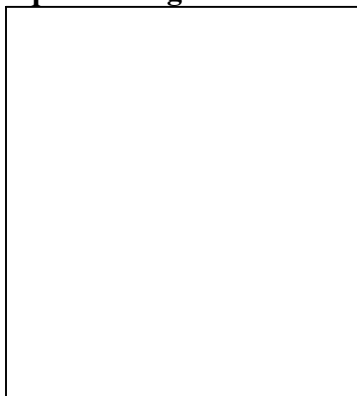
**Extreme hot water may cause balloon to burst. Do not exceed 125°F (52°C).**

Scenario:

You work for the Celebrate With Balloons Company in Vermont which delivers balloons. You have received an order for the Rose Bowl parade for 10,000 balloons. A typical truck can hold 5,000 inflated balloons. Someone on your team suggests that temperature might affect the volume of the balloons. After checking weather reports you find the temperature in Vermont is ten below zero (-10° F) and the temperature in California is 83° F. **Use your knowledge of the effect of temperature on the volume of gases to determine if you need to send one, two or three delivery trucks the parade.**

**Question/Task #1:**

**In the boxes below make diagrams that compare the position and motion of molecules in solids, liquids and gases. Use dots to show molecules. Label each diagram in the blank space below it.**



\_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_

1. Depth of Knowledge (circle):     **Web Level 1**     Web Level 2     Web Level 3

2. Part of the Grade Expectation(s) **most strongly elicited** by the question.  
S7-8:12 & S7-8:14 Properties of Matter

3. Pre-requisite skills and knowledge students need to be successful:

Students need to understand molecular properties of solids, liquids and gases.

4. Expected (correct) student response:

The sequence from solid to liquid to gas should show molecules moving farther apart relative to each other and include a description of relative kinetic energy (speed).

5. Score Guide:

Key elements:

1. Distance between molecules grows going from solid to liquid to gas. (maximum total = 1 point)

**Question/Task #2:**

**Based on your understanding of the motion of molecules predict how the surrounding temperature of a balloon will affect the volume of the balloon. Explain your thinking.**

1. Depth of Knowledge (circle):      Web Level 1      Web Level 2      Web Level 3

2. Part of the Grade Expectation(s) **most strongly elicited** by the question.

S7-8:2 Predicting and Hypothesizing

S7-8:13

3. Pre-requisite skills and knowledge students need to be successful:

Knowledge of the scientific method, in particular, experience making predictions. There exists a predictable relationship among the volume, temperature, and the amount of a gas.

4. Expected (correct) student response:

Key elements:

1. Hypothesis includes cause and effect.
2. Hypothesis states a rationale based on scenario or prior knowledge.

5. Score Guide:

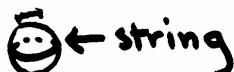
1 point for each key element (maximum total = 2 points).

**In the following experiment you will use a water bath to represent the air surrounding the balloon. You will explore the affect of varying the temperature of this water bath on the volume of the balloon. The volume of a sphere is given by the formula  $V = 4/3 \pi r^3$  . Remember the radius is**

the diameter divided by two or  $r = d/2$  and Circumference is  $\pi d$ . You may use 3.14 as an approximation for  $\pi$ . Record your measurements in the data table.

### Procedure

1. Obtain 3 containers and label one cold, another tap, and a third hot.
2. Add tap water to the tap container until it is about two thirds full.
3. Add ice water to the cold container until it is also two thirds full. This water should come from the container in the cooler labeled cold stock.
4. Fill the third container with hot tap water or heat water until it is about 125°F (52°C).
5. Blow up 3 balloons so that they have nearly the same circumference. Use the string to determine this distance. Mark the string to indicate the initial circumference for each balloon.



6. Calculate the volume of the balloons. Record this data in the box in Task # 3.
7. Briefly submerge each balloon one at a time in the tap water until half of the balloon is below the surface. Make three marks around the balloon at the waterline. Remove them one at a time. Immediately use the string to determine the circumference of each balloon at the three marks.

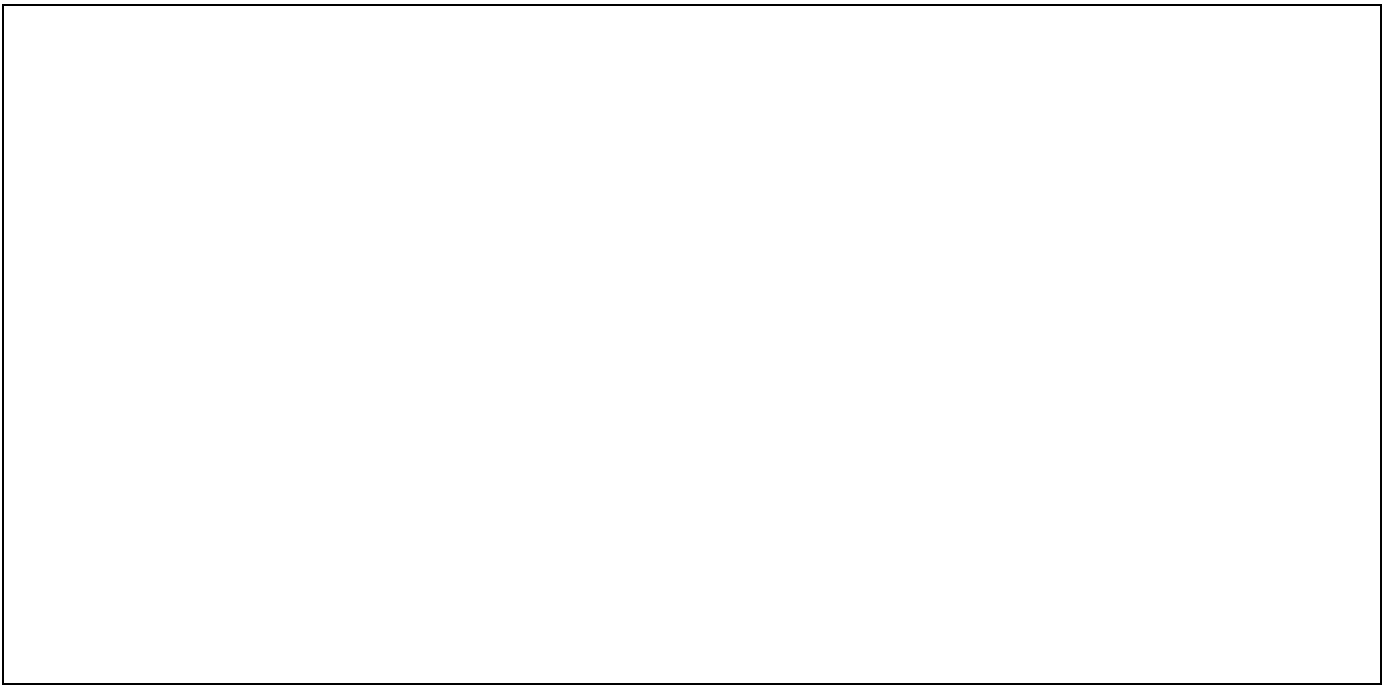


8. Lay the string on the ruler to measure the actual circumference. Record this in a data table.
9. Leave one balloon in the tap water and totally submerge another balloon in the cold water and the third balloon should be submerged in the hot water. Remember to use an object with a flat bottom to hold balloons in position.



Allow the balloons to sit for 3 minutes. Then, let them rise in the water up to the marks you previously made on each balloon. Find the circumference of each as you did in 7. Record the results for the circumference. Calculate the volume of the each balloon for each temperature of water.

In the space below record the data you just collected and make your calculations.



**Question/Task #3:**

**In the space below, use your data table to construct a line graph that will show patterns of change. Use the x-axis for temperature (relative) and the y-axis for volume (cm<sup>3</sup>).**

**Volume of a Gas vs. Temperature**



1. Depth of Knowledge (circle):      Web Level 1      Web Level 2      Web Level 3

2. Part of the Grade Expectation(s) **most strongly elicited** by the question.  
S7-8:5 Representing Data and Analysis.

3. Pre-requisite skills and knowledge students need to be successful:  
Knowledge of graphing skills.

4. Expected (correct) student response:  
Key elements:

1. **Correct identification of x and y-axes.**
2. **Scale is appropriate to the task.**
3. **Data is correctly graphed.**

**5. Score Guide:**

**One point for each key element (maximum total = 3 points)**

**Question/Task #4:**

**What do your data indicate about the relationship between temperature and volume of a gas?  
How does the data you collected support your prediction in Task #2?**

1. Depth of Knowledge (circle):      Web Level 1      Web Level 2      Web Level 3

2. Part of the Grade Expectation(s) **most strongly elicited** by the question.  
S7-8:7 Students demonstrate their ability to explain data.

3. Pre-requisite skills and knowledge students need to be successful:  
Ability to recognize patterns in scientific data.

4. Expected (correct) student response:

Key elements:

1. Response clearly cites evidence from the experiment as supporting or refuting the hypothesis.

5. Score Guide:

One point for each key element (maximum total = 1 point).

**Question/Task #5:**

**Read the paragraph at the bottom of page 1 again.**

**Based on what you have learned in this experiment how should you deliver 10,000 balloons to the Rose Bowl parade? (Consider the number of trucks, amount of gas and temperature changes balloons undergo while traveling across the country.) Be sure to use your evidence from this experiment to support your reasoning.**

1. Depth of Knowledge (circle):      Web Level 1      Web Level 2      Web Level 3

2. Part of the Grade Expectation(s) **most strongly elicited** by the question.

S7-8:8 Applying Results

S7-8:13 Using real world examples to demonstrate knowledge of the properties of a gas.

3. Pre-requisite skills and knowledge students need to be successful:

Reading comprehension and calculation skills.

Ability to recognize patterns.

4. Expected (correct) student response:

Key elements:

1. Student demonstrates awareness that a change in temperature changes the volume of a gas.  
Student demonstrates understanding that the volume of the balloons will increase Student quantifies need for third truck by calculating volume of balloons using their data to support their work.

5. Score Guide:

One point for each key element (maximum total = 3 points).

