Lab: Gas Pressure

FOR THE TEACHER

Summary
In this lab, students will better understand what causes pressure in a container and the variables that affect pressure (volume, temperature, number of moles) by mimicking molecular motion of gases.

Grade Level
Middle School, High School

NGSS Alignment
This lab will help prepare your students to meet the performance expectations in the following standards:

- **MS-PS1-4:** Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed
- **HS-PS3-2:** Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative positions of particles (objects).
- **Scientific and Engineering Practices:**
  - Developing and Using Models
  - Analyzing and Interpreting Data

Objectives
By the end of this lab, students will

- Understand the relationship between a gas’s pressure and volume.
- Understand the relationship between a gas’s pressure and temperature.
- Understand the relationship between a gas’s pressure and moles.

Chemistry Topics
This lab supports students’ understanding of

- Pressure
- Gas laws

Time
**Teacher Preparation:** 5 minutes
**Lesson:** 30 minutes

Materials

- Large rope (between 32 and 40 ft long, creating a square between 8’x8’ and 10’x10’)
  - 4 students to hold the rope in a square shape, 5-10 students to be “gas molecules”
- Large area of clear space
- Timer

Safety
Students will come into contact with each other during this activity.
Teacher Notes

- Students learn better by doing. This activity allows students to experience "pressure" by taking on the role of a gas particle. Students have fun and learn some important facts about gas pressure.
- You may want to adjust the length of rope/number of “gas molecule” volunteers depending on the space you have available. When you change the “container size,” you can use the same rope, just leave some of it as an extra tail that does not actually form part of the square boundary.
- Be sure students don’t become too enthusiastic about their collisions!
- Be sure students are all counting collisions the same way in each trial – assigning a student to count the collisions on one side of the rope, for instance, or assigning one student outside of the rope box to count all the collisions of one of the “gas particle” students. The second option might be more consistent as it eliminates the problem of losing count if multiple students are colliding with a particular side of the rope at the same time. It might be best to have the same students holding the rope/counting collisions to ensure consistency between trials, but you could switch out the “gas molecule” volunteers to give more students a chance to participate.
- If you wanted to make connections to math, you could add another trial or two and have them graph the data for each of the different scenarios. They should see a direct relationship (diagram A, below) between pressure vs. temperature and pressure vs. number of particles, and an inverse relationship (diagram B, below) for pressure vs. volume. (You would need at least 3 trials for each scenario because 2 points will always make a straight line, but the pressure vs. volume graph should show the inverse relationship, which is not linear.)

FOR THE STUDENT

Lesson

Gas Pressure

Background
Pressure is caused by the number of collisions between molecules and the force of these collisions. When there are more collisions, or if the molecules collide with greater force, the pressure is higher. There are three things that can affect the number of collisions:

1) Size of the container
2) Temperature
3) Number of molecules

You will look at how these three factors affect the number of collisions and therefore affect the pressure of a gas.

Procedure
For each of the following parts, you will need a long rope and four students to hold the rope in a square shape. Each student holding the rope will count how many times “gas molecules” (about 5 student volunteers) collide with their wall of the container during a time period of one minute for each trial.

Gas molecules should remember the following:
1) Gas molecules travel in straight path until acted upon by the wall of the container or another gas molecule. They do not turn to avoid or cause a collision.

2) Gas molecules move at constant random motion. So you should not change your speed or stop during the duration of a trial.

3) Gas molecules are not attracted to or repelled by each other. So you should not change directions to hit or avoid your classmates.

**Results**

**PART A**

Container size and pressure: Gas molecules should move at room temperature.

<table>
<thead>
<tr>
<th>Container Size</th>
<th>Number of collisions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
</tr>
<tr>
<td>Small container</td>
<td></td>
</tr>
<tr>
<td>Large container</td>
<td></td>
</tr>
</tbody>
</table>

**PART B**

Temperature and pressure: Gas molecules should speed walk for high temperature and walk slowly for low temperature.

<table>
<thead>
<tr>
<th>Temperature</th>
<th>Number of collisions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
</tr>
<tr>
<td>High Temp</td>
<td></td>
</tr>
<tr>
<td>Low Temp</td>
<td></td>
</tr>
</tbody>
</table>

**PART C**

Number of molecules and pressure

<table>
<thead>
<tr>
<th>Number of Molecules</th>
<th>Number of collisions</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Trial 1</td>
</tr>
<tr>
<td>5 molecules</td>
<td></td>
</tr>
<tr>
<td>10 molecules</td>
<td></td>
</tr>
</tbody>
</table>

**Analysis**

1) What two things cause pressure in gases?

2) Out of the three factors that affect the number of collisions, which do you think would affect the pressure the most? Why?

3) As you *increase* the size of a container, what happens to pressure?

4) As you *decrease* the number of gas particles, what happens to pressure?

5) As you *increase* the temperature, what happens to pressure?

6) As temperature *decreases*, what do you think would happen to the volume of the container if the volume were able to change?