Demonstrations of Gas Laws Lab

***Introduction:***

If the temperature of a gas is held constant as well as the amount, then the pressure and volume of that gas are related by **Boyle’s Law**:

At constant temperature, P1V1 = P2V2

When the volume of a gas is decreased at constant temperature, its pressure increases. When a gas’s volume is increased at constant temperature, its pressure decreases.

If the pressure of a gas is held constant, then the temperature and volume are related by **Charles’s Law**:

At constant pressure, 

When the temperature of a gas is increased at constant pressure, its volume increases. If the temperaure is decreased, the volume decreases also.

If the volume of a gas is held constant, then the pressure and temperature are related by **Gay-Lussac’s Law**:

At constant volume, 

When the temperature of a gas is increased at constant volume, the pressure of the gas increases as well. If the temperature of the gas decreases, so does the pressure.

In today’s experiment you will observe several demonstrations of the gas laws and then attempt to explain them using what you have learned about gases.

***Safety Considerations:***

Exercise extreme caution when using the hot plate. Always wear eye protection.

***Data and Observations***

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| Part One: The Balloon in the Bottle |  |
| Part Two: Happy Birthday |  |
| Part Three: The Invisible Giant |  |
| Part Four: Hot Air Balloon |  |
| Part Five: Egg Over Easy |  |
| Part Six: Marshmallow Fun |  |
| Part Seven: Wet or Dry Paper |  |
| Part Eight: Cartesian Diver |  |

Demonstrations of Gas Laws Lab Conclusions

**Part One: The Balloon in the Bottle**

1. Is the bottle truly empty? Explain.
2. Why was the balloon in the bottle so hard to inflate?
3. What evidence from the bottle/balloon activity shows that air pressure exists?
4. If the air in the bottle contracts, what happens to its volume if it is sealed?
5. Explain why the balloon changes little when you squeeze the bottle. Use terms like **pressure**, **volume**, and **compressible**.

**Part Two: Happy Birthday**

1. What did you see around the mouth of the flask when you first put it into the water. How can you explain this? Use terms like **temperature** and **volume** in your explanation.
2. What effect did the water have on the gas inside the flask? How do you know?
3. Many people mistakenly believe that the water rises into the flask because the candle is removing oxygen from the air. This explanation is not correct because the candle replaces oxygen with carbon dioxide. What is the actual explanation for why the water rose up into the flask? Use terms like **cool**, **volume**, and **pressure** in your explanation.

**Part Three: The Invisible Giant**

1. Why did the can collapse when it was placed mouth down in the ice water?
2. Do you think the can would have collapsed if it had been placed in the water mouth up? Why or why not?
3. If you open a soda bottle then close it and place it in the refrigerator, you’ll often find that the soda bottle partially caves in when you look at it later. How can you account for this phenomenon? How is it related to what you witnessed in this demonstration?

**Part Four: Hot Air Balloon**

1. In terms of **temperature** and **pressure**, how did the balloon get inside the flask?
2. What would have happened had we performed the experiment with a stopper over the flask instead of a balloon? What would the pressure be like inside the bottle (greater than, the same as, or less than the pressure outside the bottle)?
3. Discuss a way to get the balloon out of the flask without peeling it off.
4. Explain what occurred in each situation in terms of the molecules inside the balloon.

**Part Five: Egg Over Easy**

1. What would happen if the egg was not placed immediately over the flask?
2. Describe what is happening to the air temperature inside the flask and the air temperature outside of the flask. Does the air temperature change during the lab?

1. Describe what is happening to the air volume inside the flask and the air volume outside of the flask. Does the air volume change during the lab?
2. Describe what is happening to the air pressure inside the flask and the air pressure outside of the flask. Does the air pressure change during the lab?
3. If you repeated the lab without the egg would the air temperature, volume and pressure do the same thing? Why do you need the egg?

**Part Six: Marshmallow Fun**

1. Why does the air inside the marshmallow fill a larger volume when some of the air outside the marshmallow is removed?
2. What are the air molecules doing that causes them to expand inside the marshmallow?
3. Would a peanut worked just as well for this activity?
4. In terms of **volume** and **pressure**, what happed when the plunger of the syringe was pressed down?
5. In terms of **volume** and **pressure**, what happened when the plunger of the syringe was pulled up?

**Part Seven: Wet or Dry Paper**

1. In your own words, describe what you think air pressure is.
2. When the cup is submerged in the water, why does the paper stay dry?
3. What observations provide evidence that gases exert pressure?
4. In terms of **volume** and **pressure**, what caused the paper to stay in the cup?
5. Provide evidence from the demonstrations to support the claim that gases are compressible.

**Part Eight: Cartesian diver**

1. Describe what happens when you squeeze the water bottle in terms of pressure and volume. **Why does this happen?**
2. What effect would changing the amount of water in your bottle have on the “diver”?
3. How would temperature affect the set up?
4. To be neutrally buoyant, an object must not rise to the surface or sink to the bottom. How can you keep your diver neutrally buoyant?
5. What living creature acts much like a Cartesian diver? What is similar and what is different about the way this creature maintains its neutral buoyancy?
6. Is the density of the “Cartesian Diver” bigger or smaller than the density of water? How do you know that?