Gas Laws Extra Credit

For extra credit this quarter, you have the opportunity to explore some interesting applications of Charles's and Boyle's Laws. You may earn up to 7 points of extra credit for each activity that you complete and report upon, up to a maximum of 20 points. Each report will be submitted as a separate write up. You may work with a partner, but not groups larger than 2.

Each typed report should include:

- Narrative description of what you experienced during the activity
- 3-4 photos, embedded in your report, depicting the important aspects of your activity as you carry it out (pictures you take, not from the internet)
- An explanation of what you experienced based on your understanding of Charles's and Boyle's Laws

Option 1: Can Crusher

Materials

- Large mixing bowl
- Ice
- Empty soda can
- Sauce pan
- Stove

Procedure

Create a large bowl of ice water. Fill the bottom of an empty soda can with about ¼ inch of water. Place ½ inch of water in a sauce pan. Stand the can in the water in the sauce pan. Boil the the water in the pan until you notice vapor steaming from the opening of the soda can. Using tongs, grab the can and quickly place it upside down in a bowl of ice water.

Option 2: Balloon & Syringe

Materials

- A Large (≅ 60 mL) syringe
  Available at Lindon Nursery (531 State St. Lindon) for about $1
- Small balloon

Procedure

Blow up a balloon to a small size that will fit into the syringe. Tie the balloon. Remove the plunger from the syringe and drop the balloon into it. Replace the plunger. Position the plunger at the top of the syringe. Place your finger over the small opening at the bottom of the syringe and push the plunger downwards. Make note of how the size of the balloon changes. Remove your finger to equalize the pressure in the syringe back to normal. Position the plunger at the bottom of the syringe, almost touching the balloon. Replace your finger over the small opening at the bottom of the syringe and pull the plunger upwards. Make note of how the size of the balloon changes. Remove your finger to equalize the pressure in the syringe back to normal.

Option 3: Egg in a Bottle

Materials

- Saucepan
- 2 Eggs
- Stove
- Paper towel
- Vegetable oil
- Glass bottle with a mouth slightly smaller than a hardboiled egg
- Matches
- Paper

Procedure

Place the eggs in a saucepan and add enough water so that the eggs are covered by about an inch. Let the water boil for 5 minutes, then remove the pan from the heat and cover it. Let it sit for 25 minutes, then remove the eggs and dip them in cold water. Use a paper towel to coat the inside edge of the bottle mouth with a little bit of vegetable oil for lubrication. Peel one of the eggs, then dip it in water and set it with the small end down in the mouth of the glass bottle. It should be slightly larger than the mouth of the bottle, so it doesn't fit inside. Use a match to light the end of a strip of paper on fire. Lift the egg off the bottle, drop the paper inside with the flame down, and quickly replace the egg.

Option 4: Balloon in Freezer

Materials

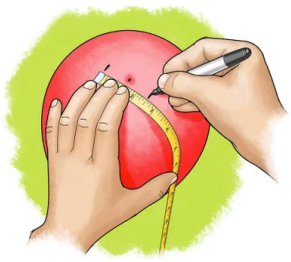
- Freezer with some empty space
- Two latex balloons that will inflate to approximately nine to 12 inches
- Piece of string, at least 20 inches long
- Permanent marker
- Cloth tape measure. (A regular tape measure or ruler can also work, but a cloth tape measure is preferable.)
- Scrap piece of paper and a pen or pencil
- Clock or timer

Preparation

- Make sure your freezer has enough space to easily fit an inflated balloon inside. The balloon should not be smushed or squeezed at all. If you need to move food to make space, be sure to get permission from anybody who stores food in the freezer. Also make sure to avoid any pointy objects or parts of the freezer.
- Blow up a balloon until it is mostly—but not completely—full. Then carefully tie it off with a knot. Measure and record the circumference of the widest part of the balloon using a cloth tape measure or a piece of string (and then measure the string against a tape measure).
- Inflate another balloon so it looks about the same size as the first balloon, but don't tie it off yet. Pinch the opening closed between your thumb and finger so the air cannot escape. Measure the circumference of the balloon, then adjust the amount of air inside until it is within about half an inch or less (plus or minus) of the first balloon's circumference. Tie off the second balloon.

Procedure - use the questions in the procedure to guide your thinking; don't directly answer them

- Turn one of the balloons so you can look at the top of it. At the very top it should have a slightly darker spot. Using the permanent marker, carefully make a small spot in the center of the darker spot.
- Take a cloth tape measure (or use a piece of string and a ruler or regular tape measure) and line the small spot (from the previous step) up with the 1¼ inch mark on the ruler. Then make a line at the 0 inch mark and the 2.5 inch mark. Your lines should then be 2.5 inches apart with the small spot in the center.
- Repeat this with the other balloon so that it also has lines that are 2.5 inches apart on its top.
- Somewhere on one balloon write the number "1" and on the other balloon write the number "2."



- Because it can be difficult to draw exact lines on a balloon with a thick permanent marker, now measure the exact distance between the two lines you drew on each balloon, measuring from the outside of both lines. (For example, the distance might be two and three eighths inches or two and five eighths inches.) Write this down for each balloon (with the balloon's number) on a scrap piece of paper. Why do you think it's important to be so exact when measuring the distances?
- Put balloon number 1 in the freezer in the area you cleared out for it. Leave it in the freezer for 45 minutes. Do not disturb it or open the freezer during this time. How do you think the size of the balloon will change from being in the freezer?
- During this time, leave balloon number 2 somewhere out at room temperature (not in direct sunlight or near a hot lamp).
- After balloon number 1 has been in the freezer for 45 minutes, bring your cloth tape measure (or piece of string and regular tape measure) to the freezer and, with the balloon still in the freezer (but with the freezer door open to let you access the balloon), quickly measure the distance between the two lines as you did before. Did the distance between the two lines change? If so, how did it change? What does this tell you about whether the size of the balloon changed? Why do you think this is?
- Then measure the distance between the two lines on balloon number 2, which stayed at room temperature. Did the distance between the two lines change? If so, how did it change? How did the balloon's size change? Why do you think this is?
- Overall, how did the balloon change size when placed in the freezer? What do your results tell you about how gases expand and contract as temperature changes?
- After taking balloon number 1 out of the freezer leave it at room temperature for at least 45 minutes to let it warm up. Then remeasure the distance between the lines. How has the balloon changed size after warming up, if it changed at all?

Sources:

- https://sciencing.com/easy-experiments-using-gas-laws-5506609.html
- https://www.scientificamerican.com/article/size-changing-science-how-gases-contract-and-expand/
- http://www.thesciguys.ca/Boyles-Law-Experiment