States of Matter/Gas Laws
Eight Stations...No Pressure! Lab

Objectives:

- observe evidence of changes in pressure, volume, and temperature in multiple systems
- be able to explain the mechanisms and relations between those three variable for each system
- calculate theoretical values for pressure, volume, or temperature given the other two

Equipment:

Note: This is an incomplete list. Make sure you take note of all the equipment used in this lab in order to include a proper list in the "Materials" section for the writeup of this lab in your notebook.

- fire piston
- cotton
- hand boiler
- candle
- 12 oz. aluminum can
- ice water
- dry ice
- marshmallows

Procedure(s):

Fire Piston

1. Place a small wisp of cotton either on the center of the fire piston stand or in the end of the clear plastic tube.
2. Assemble the fire piston: slide the clear plastic tube onto the wooden stand, and place the metal piston in the top of the clear plastic tube.
3. ***Quickly*** depress the piston within the tube. Record your results.
4. If the cotton fails to ignite, remove the piston to allow fresh air into the tube, try a smaller piece of cotton, and repeat the procedure.
5. Repeat the procedure with a tiny piece of Kleenex, tissue paper, or paper. Record your results.

Imploding Can

1. Record the height, radius or diameter, and circumference of your can.
2. Put a "sploosh" of water in the bottom of a 12 oz. can. (around 25-30 mL)
3. Place the can on a screen on a ringstand over the bunsen burner and heat the water until it boils (steam comes out the top of the can)
4. Once the water is boiling, use a pair of tongs to quickly turn the can upside down and place it in a large dish filled with ice water.

Bottle to bottle fountain

1. Place bottles on table with all water in the bottom bottle on a paper towel (this system may leak just a little).
2. Invert the bottles and observe.

Cartesian divers

1. Gently squeeze the two liter bottle and observe what happens to the object floating inside.
2. It may be helpful to observe carefully the eyedroppers in the bottles without the little squid costumes on. Pay particular attention to the air inside the eye dropper as you squeeze.

Hand boiler/"Love meter"

1. ***Carefully*** (the glass meter is very fragile) pick up the meter and hold one hand completely around the bottom of the meter. Observe.
2. When you are finished, please tip the meter sideways and wrap your hand around the other end of the meter to get the fluid to all go down into the bottom bulb again.

Candle Power!

1. Place the candle in the middle of a class dish using clay to hold it into place.
2. Put a couple of centimeters of water in the bottom of the dish.
3. Put a beaker upside down over the candle. Place the edges of the beaker on four pennies so that there is a gap between the top of the beaker (it's upside down, remember!) and the bottom of the dish.
4. Remove the beaker without disturbing the placement of the pennies. Light the candle. Place the beaker back in position.
5. Observe the level of water in the beaker as the candle goes out. Measure the height of the water in the beaker in millimeters.

Marshmallow injection

1. Place a marshmallow inside the syringe with the tip blocked and compress the plunger. Observe what happens to the marshmallow.
2. Repeat the process above with the tip open so that the plunger may be pushed in without creating any pressure. Now, block the tip, and slowly withdraw the plunger to increase the volume inside the syringe. What happens to the marshmallow this time?
3. Try the procedure with both full sized and mini-marshmallows.

Dry ice tubes

1. Using a scoopula, place a small amount of dry ice inside an uninflated two liter bottle tube.
2. Observe.

Analysis/Results:

1. For each station, produce a detailed diagram, and a paragraph of explanation outlining exactly what occurs at that station and how. Be sure to be very detailed in your explanation of how the various phenomena are occurring. Some stations may also include a few additional questions listed below.

Fire Piston

2. Using the Combined Gas Law with the following quantities, calculate the minimum pressure created in the fire piston. $P_i = 1$ atm, $V_i = 9$ mL, $T_i = 25\ ^\circ C$; $V_f = 0.5$ mL, $T_f = 230\ ^\circ C$
3. Some people tried to put large amounts of cotton in to get a bigger flame, and they got no flame. Propose why this might happen.
4. Did paper, Kleenex, or tissue paper work? What do you think determines when the fire piston can create a fire and when it can't.

Imploding Can

2. Describe which gases were present and at which partial pressures inside the can before you started heating the water, after the water was heated but before dunking in ice water, and after dunking in ice water. Describe the total pressures inside and outside the can for each of those times as well.
3. If you created a perfect vacuum within the can (0 atm), then what would be the force (in pounds) exerted on the outside of the can? (Hint: 1 atm = 14.7 psi, use the height, radius, and circumference of your can to find the surface area)

Candle Power!

2. Convert the height in mm H_2O into atmospheres of pressure. Your teacher will give you the conversion units.
3. Use the difference in pressure to calculate the change in moles of gas. How does this compare to the theoretical change in moles of gas? (Your teacher will provide a chemical equation for the combustion of paraffin).

Dry Ice Tubes

2. In your question #1, be sure to list ***all*** the chemicals found in the tube (and their states) when the dry ice is first added to the tube, as the dry ice starts to disappear, and then when all the dry ice is gone. (Example: liquid water would be "$H_2O(l)$", steam would be "$H_2O(g)$", etc.)

Conclusion:

Looking at our examples, what practical use could they have in the real world? Look up "fire piston" online to find out how this can be used. For the imploding can example, discuss whether or not that sort of implosion could happen in other cases in real life. Propose a couple examples, and what could be done to avoid those situations.