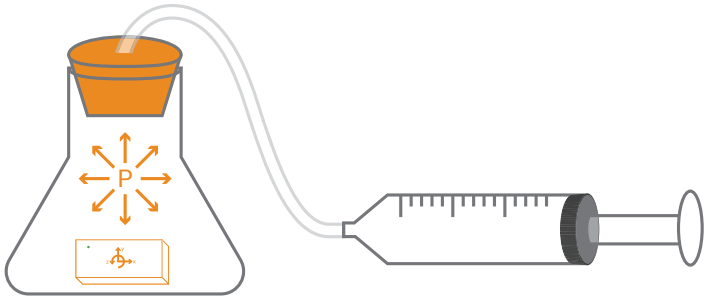
Pressure and Volume with a Syringe and Flask

Exploration

Explore air pressure, temperature, and volume and how they work together. In a syringe sealed to an Erlenmeyer flask , when the syringe's plunger moves back and forth, the volume of air in the syringe and flask changes. Will the pressure also change if the temperature of the air sealed in the syringe and flask changes? A PocketLab can be placed inside the Erlenmeyer flask to measure the change in pressure as the the volume and temperature change.

Materials

- Syringe
- Erlenmeyer flask
- Tubing connected to flask stopper
- PocketLab



Objective

In this experiment, students will:

1. Develop a model that describes the relationship between air pressure, volume, and temperature.
2. Describe what is happening to the air particles when there is a greater or less air pressure.
3. Describe what is happening to the air particles when there are changes in temperature and how that relates to the measurement of temperature itself.

Predictions

- When the syringe and flask are sealed, as the volume decreases, what will happen to the air pressure? Explain your reasoning.

- If the temperature of the air inside the syringe and flask increases, what will happend to the air pressure? Explain your reasoning.

Part 1

1. Connect one end of the tubing to the syringe and the other end to the rubber stopper as shown in the diagram.
2. Connect the PocketLab to the PocketLab app and place the PocketLab inside the flask. Pull the plunger on the syringe all the way back and seal the flask with the rubber stopper.
3. Turn the graph to Pressure and note the mBar reading when the plunger is pulled all the way back.
4. Take a few moments to play around with the syringe, moving the plunger back and forth while watching the pressure change. Push the plunger into the syringe until the rubber stopper “pops” off. Answer Data Analysis and Observations Question 1 and 2 before moving on to step 5.
5. Place the plunger back in the syringe. Move the plunger to the syringe’s first volume increment (140 mL). Begin recording data in the PocketLab app.
6. Push the plunger to the next major increment on the syringe (130 mL). Continue recording while observing the pressure change..
7. Continue pushing in the syringe to smaller and smaller volumes and recording the pressure. Be sure to always decrease the volume by the same amount (140 mL, 130 mL, 120 mL, 110 mL). Do so until the rubber stopper pops off.
8. Complete the data table below.

Data Analysis and Observations

1. What do you notice when you move the syringe back and forth? Describe what is happening to the volume and air pressure inside the syringe and flask.
2. What did you notice when the stopper “popped” off? Explain how this may relate to the volume and air pressure inside the syringe and flask.
3. As the volume of the syringe decreases, how is pressure affected? Use the data collected to support your answer.

Conclusions

- What is air pressure a measurement of?
- Explain the relationship between the volume of the syringe when sealed and the air pressure inside the syringe. Describe why the pressure changes the way it does. Be sure to talk about the molecules in the air and what is happening to them when the volume changes.
- As you pushed the plunger farther into the syringe, why did it get more and more difficult? Why did the rubber stopper evetnually pop off?

Part 2

1. Remove the plunger, then place it back in the syringe and move it to 140 mL.
2. With your group, come up with a way to increase the air temperature inside the syringe and flask. Use what you have at your desk or whatever materials your teacher may provide.
3. Once your group has come up with an idea to increase the temperature, begin recording pressure data. Observe the pressure data before your group increases the temperature.
4. Increase the temperature in the syringe and flask with whatever method your group came up with. Observe whether the pressure graph changes. Do not record with the temperature graph.

Data Analysis and Observations

1. How do you know whether your group actually increased the temperature in the syringe and flask? Explain.
2. How did increasing the temperature in the syringe and flask affect the air pressure inside? Explain how you know.

Conclusions

- If you were to light a candle and hold it underneath the flask, what do you think the pressure graph would do? Explain your answer in terms of what you think the air particles would do when the temperature increases.
- Explain the relationship between the pressure and temperature of a gas.
- Using your observations, what property of the gas particles do you think temperature is actually measuring? Explain your answer.

Optional Extensions

- Use the data collected to find the rate of change between the volume of your syringe and the air pressure in the syringe. Write a linear equation that shows the relationship between volume and air pressure for your specific syringe.
- Pick an increment on your syringe that was too difficult to push the plunger to when the syringe was sealed. Use your equation to predict what the pressure would be if you could get the plunger to that point.
- If you were to push the plunger all the way into the syringe, then seal the syringe with your finger and pull the plunger back out, what do you think would happen to the air pressure? Why? Try it.
- The atmospheric pressure is approximately 1,013 mBar at sea level and 440 mBar at the top of Mount McKinley (the tallest mountain in the United States). Why do you think the air pressure changes at different elevations?
- An altimeter measures your altitude. Describe how you think an altimeter works.
- What is the altitude at sea level? What is the altitude at the top of Mount McKinley? Use your syringe and the two-graph function to observe the “Pressure” and “Pressure Altitude” graphs at the same time to find the answers.
- Look up the altitudes of other famous places and use the two-graph function, along with the syringe to find the air pressure at those different places. Record your findings.