Boyle's Law

1 Objective

- Study the variation of volume and pressure at constant temperature.
- Show that PV is constant.

2 Prelab Questions

1. At room temperature, what does the plot of P with the inverse of V for an ideal gas look like? Explain.
2. Could air be considered an ideal gas? Discuss this briefly.
3. How many moles are there in the air around you in 1cm^3? Find the equivalent number of molecules.
4. Estimate the distance between the air molecules.

3 Principles

- Air trapped in the apparatus behaves like an ideal gas, thus the ideal gas equation governs its behaviour.
- The pressure will be varied and the length of air column recorded.
- Mercury in a flexible tube is used to trap the air. The changes in the level of mercury allow us to calculate the pressure of the trapped air.

4 Apparatus

Boyle's Law Apparatus. The right holder has an open ended tube and the left holder a closed ended tube. The glass tubes are connected with a flexible silicone tube.

5 Precautions

1. Avoid the leakage of trapped air as much as possible.
2. Note that the flexible tube is in a plane parallel to the plane of the stand and that the level of mercury varies in the curved bottom of the tube.
3. Mercury is **very toxic**. Do not touch it, inhale it and do not attempt to dispose of it.

6 Experimental Steps

1. Adjust both sides of the apparatus such that the height of mercury is equal on both sides.
2. Make sure that you are able to move the open ended tube up by 14cm and down by 14cm without any obsticals to the flexible tube.
3. Move the right holder up by 2cm and record the level of mercury on both sides until you reach 14cm above the level you started at.
4. Immediately (not gradually) go back to the level you started at and record the level of mercury, is it the same as when you started (i.e. equal in both sides)?. If they are not equal wait for some time. Going back to the level you started allows you to check if your readings are consistent.
5. Move down 2cm while recording the data until you reach 14cm below the level you started at.
6. Immediately (not gradually) go back to the level you started at and record the level of mercury, repeating step [4].
7. Using a thermometer, record the temperature in the laboratory T_{real}.

7 Evaluation

1. Calculate the difference in the level of mercury Δh. What does that indicate?
2. When moving the open ended tube upwards or downwards, one way produces an increase and the other produces a decrease in pressure of the trapped air. Explain which is which.
3. Plot the pressure of the trapped air P with the length of the air column L. What does L represent? What does the plot represent?
4. Plot the pressure P with the inverse of the length of the trapped air column $\frac{1}{L}$. What does the plot represt?
5. Roughly measure the volume of the trapped air V. Use a vernier tool to estimate the diameter of the tube.
6. Roughly estimate the number of moles in the tube n. Use your prelab questions to help you with this step.
7. Using the data you obtained and calculations you preformed, find the temperature T_{exp} of the lab and compare it with the recorded temperature T_{real}. Invoke the ideal gas law.

8 Postlab Questions

1. If your readings are not consistent, i.e. a difference arises between the initial heights and the final heights of the mercury columns after preforming the experiment, explain why this happened.
2. What happens to the pressure of the enclosed air when the right hand slider slides downwards? Explain and illustrate.
3. Estimate the volume of the trapped air and then find the number of moles in it. Is this consistent compared to Question 3 in the prelab questions?

9 Helpful Sites (clickable links)

- Pressure-dependency of the volume of a gas at a constant temperature (Boyle-Mariottes law).
- Temperature dependency of the pressure of a gas at a constant volume (Amontons' law).