

Experiment-1

Study the variations of pressure and volume of air

Description:

The pressure and volume of an ideal gas at a given temperature is related through the Boyle's law $PV = \text{constant}$. In this experiment, you will trap some air in a tube between water masses and vary the pressure to study this P-V relation. This may help you decide if air at room temperature and close to 1 atm pressure can be treated as an ideal gas.

Making the manometer:

Manometer is a device used for measuring pressure of liquids and gases. In this experiment you will make your own manometer and do the measurements with its help.

You have to procure a transparent and flexible plastic pipe, preferably around 2 metre length and external diameter about 7-8 mm. Such pipes will be easily available in any hardware shop near your house. Apart from this, you need two 30 cm plastic scales, and some material from your home.

Make an arrangement as shown in Figure-1. Part of the transparent pipe is stuck on a vertical board. The board can be any hard plane sheet available in your home. One 30 cm scale is fixed on the board and the other is stuck on the hanging end of the pipe.

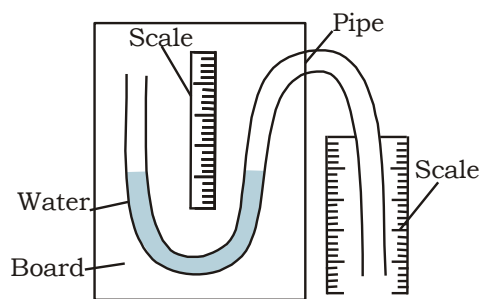


Figure-1

Making measurements with your manometer:

Take water in a transparent container and dip the hanging end of the pipe in it. Ensure that the pipe goes vertically in water and most of the plastic scale can be dipped in it. As the pressure at the hanging end increases due to depth of water in the container, the levels in the U-tube section will change. Also some water will rise in the pipe at the hanging end. Measure the different lengths shown in Figure-2. Repeat the experiment by dipping the tube in the container at different depths. Tabulate your data.

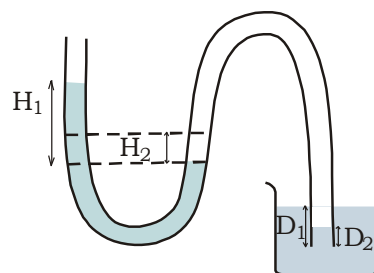


Figure-2

Plot the variation of

- i) D_1 vs H_1
- ii) D_2 vs H_2
- iii) D_1 vs D_2

where

D_1 = Depth to which the pipe is dipped in the container

D_2 = Height to which water rises in the pipe dipped in container

H_1 = Difference in the water level in the two arms of the manometer

H_2 = Height by which water dips in the right arm from its equilibrium position in the manometer

Draw your inference from the plots.

Pressure of the trapped air can be calculated from the water surface in the container or from the water surface in the left arm of the manometer.

Checking for validity of Boyle's law

Calculate the pressure and volume of the trapped air in the pipe. Write the expression of pressure of the trapped air in terms of atmospheric pressure, different lengths and the density of water. The volume of air will be the length of the trapped air multiplied by the cross-sectional area of the pipe. Find how the pressure and volume of the air trapped in the pipe change with depth D_1 . Tabulate your data. Plot the variation of pressure with the volume of the trapped air.

Does your data follow Boyle's law i.e. $PV = \text{constant}$.

Finding the number of moles

Use one set of P and V to find the number of moles trapped. Use newspaper report of average temperature at your place and use it for calculation.

Extra exploration:

Extra exploration is to think of extension of the experiment that you are asked to do in this write up. If you think of doing such new things and do it, there is a separate credit for it in the evaluation scheme. One such extra exploration can be to change the length of the pipe and see if there is a change in your conclusions.

Expectations:

1. A photograph of the complete experimental setup.
2. Less than one-minute videos as you take the readings each of the
 - height of water level risen inside the end of pipe dipped in water (using the scale attached to the pipe)
 - height of water level risen in the arm of pipe open to air (using the scale attached to the vertical board)
3. Neatly tabulated observations, graphs and calculations.
4. Error analysis of the data and the results obtained.
5. A report describing your entire experiment, observations, graphs and inferences in a pdf format.