PW:N°1

The fundamental laws of the ideal gas: Verification of the Boyle-Mariotte law

I. The theoretical part

Gases are subject to simple laws, based on which the Ideal Gas Law has been derived.

Avogadro's Law	Gay-Lussac's Law	Charles's Law	Boyle–Mariotte's Law
V= kn	P = kT	V = kT	PV = k

Ideal Gas Law

PV = nRT

P (Pressure): The gas pressure is measured in various units, including: **mmHg** ; **bar** ; **pascal**

.We have: **1atm = 760mmHg = 1.013bar =1.013*10^{5}Pas**

V (Volume): The volume of the gas is measured in various units, including: L; dcm

We have: **1cm^3 = 1mL = 10^{-6} m^3.**

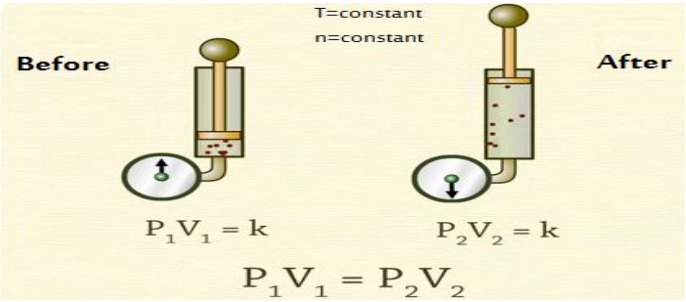
n (number of moles); the quantity of gas is measured in **moles**

R: Ideal gas constant ; **R = 8.341 (J/K.mol) = 2 (cal/K.mol) = 0.820 ((L·atm)/(K·mol))**

T (Temperature): The temperature is measured in various units, including degrees Celsius (°C), absolute temperature (Kelvin, K), or Fahrenheit (F).

We have: **0 °C = 273.15 K = 32 F**.

The Irish physicist and chemist Robert Boyle (1627-1691) and the French physicist Edme Mariotte (1620-1684) explained that there is a relationship between the pressure and volume of a gas. At a constant temperature and with the same number of particles, they observed that the pressure of a gas increases when its volume decreases, and vice versa. This relationship is known as **Boyle's Law**



The relationship is expressed as follows:

"At a constant temperature, when the pressure of a certain amount of gas changes (increases or decreases), the volume of the gas varies inversely with the pressure."

The mathematical representation of Boyle's Law is expressed as follow:

$$P \alpha \frac{1}{V} \quad \Rightarrow \quad P = f\left(\frac{1}{V}\right) \quad \Rightarrow \quad P = k\frac{1}{V} \quad \Rightarrow \quad PV = k$$

Note: Boyle's Law applies to a fixed amount of gas.

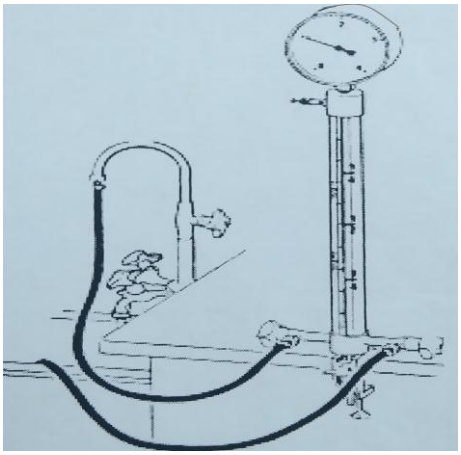
II. Practical Part:

1. **Experimental Principle**: This experiment is based on changing the pressure of a certain quantity of air (considered an ideal gas) either by increase or decrease (pressure-depression), using a gas compression measuring device.
2. **Experiment Objective**: To verify Boyle's Law, i.e., to study the relationship between volume and pressure for a closed volume of air at a constant temperature.
3. **Experimental Tools and Materials**:
   - Boyle-Mariotte apparatus: Manometer, graduated glass tube, quantity of air.

Note: The measured quantity of air is contained inside a closed tube in the upper part. Tap water enters from the lower part of the tube, compressing the trapped air in the tube. The manometer, attached to the device, indicates the corresponding pressure.

Device Explanation:

As shown in the accompanying figure, the glass tube has a volumetric scale with 10 graduations (length l ~ 50 cm, diameter; d ~ 5 cm, i.e., V(tube)~1L. The scale $\frac{3}{4}$ ، $\frac{2}{3}$ ، $\frac{1}{2}$ ، $\frac{1}{3}$ ، $\frac{1}{4}$ includes fractions corresponding to the total volume. The glassThe pressure gauge (measuring from 0 to 4 bar) is connected to a metal tube passing through the glass tube. Communication with this tube is through two openings at the bottom, allowing the intake and outflow of running water. During the experiment, two flexible hoses are connected by rings. One is connected to the tap (for water input), and the other to the basin (for water output). For practical reasons, the running water tap is continuously open during the experiment, and only the tap on the device is used.



Boyle-Marriott device

To pressurize the quantity of air, water is allowed to enter the tube slowly. If the water level reaches the desired mark on the scale, the water supply is stopped. The value of the relative volume and the corresponding pressure are determined. Pressurizing the trapped air in the tube results in smaller and smaller volumes of compressed air. The given pressure value should not be exceeded. The steps can be repeated in the opposite direction.

To verify the results, the product p·Vp·V is calculated. This product should remain constant within the limits of measurement errors

Important note: A safety valve located on the top cover of the tube is opened if the air pressure reaches approximately 4.5 bar tube is surrounded by a transparent cylinder.

Boyle-Mariotte apparatus

1. Steps of the experiment: The experiment is conducted at the laboratory temperature.
   - The first recorded value is the volume of the trapped air inside the container (empty of water), corresponding to the lowest pressure value on the manometer.
   - Water is slowly introduced until the manometer indicates the desired pressure value.
   - The volume corresponding to the previously recorded pressure value is read.
   - We continue to change the pressure value (increasing) according to the given table and record the corresponding volume each time.
   - The results are tabulated.

P (bar) or $*10^5$ (Pascal)	V (L)	P.V	Observation and Conclusion
$P_1 = 1$	$V_1 =$	.....	
$P_2 = 1.3$	$V_2 =$	.....	
$P_3 = 1.5$	$V_3 =$	.....	
$P_4 = 2$	$V_4 =$	.....	