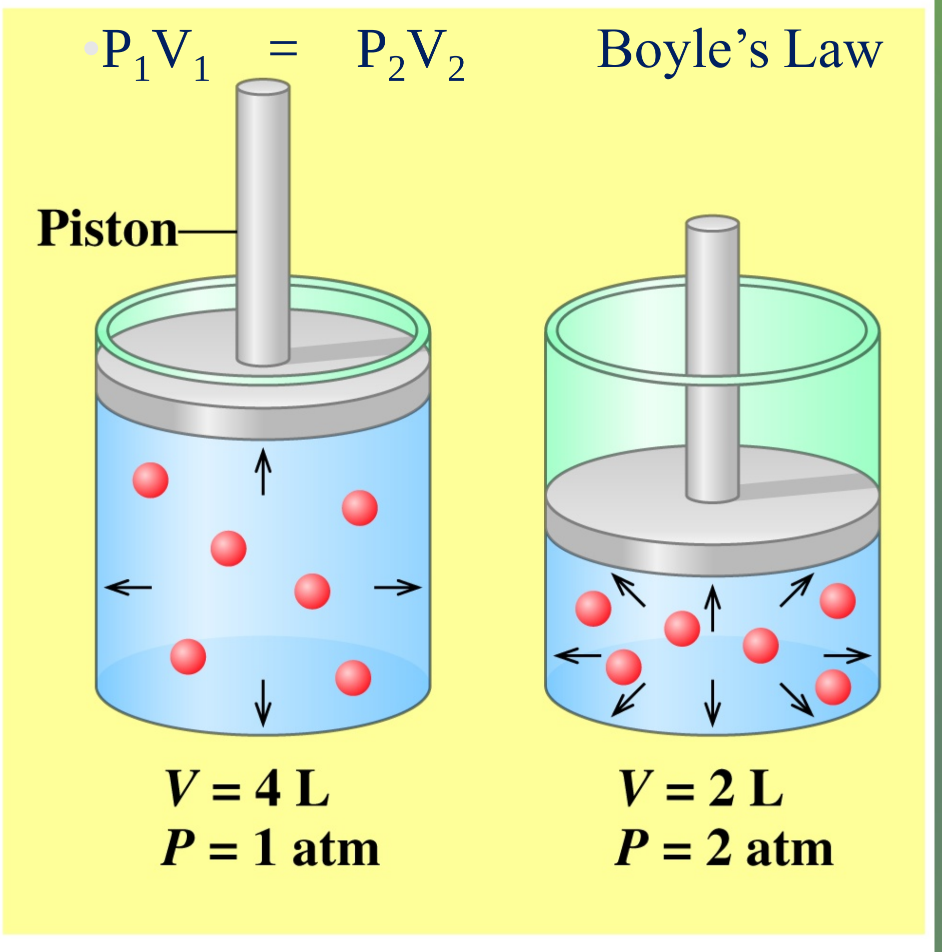
# Pressure and Volume (Boyle's Law)

# Boyle's Law

**Boyle's Law** states that

- the pressure of a gas is inversely related to its volume when T and n are constant.
- if volume decreases, the pressure increases.
- The law states that **pressure is inversely proportional to the volume**

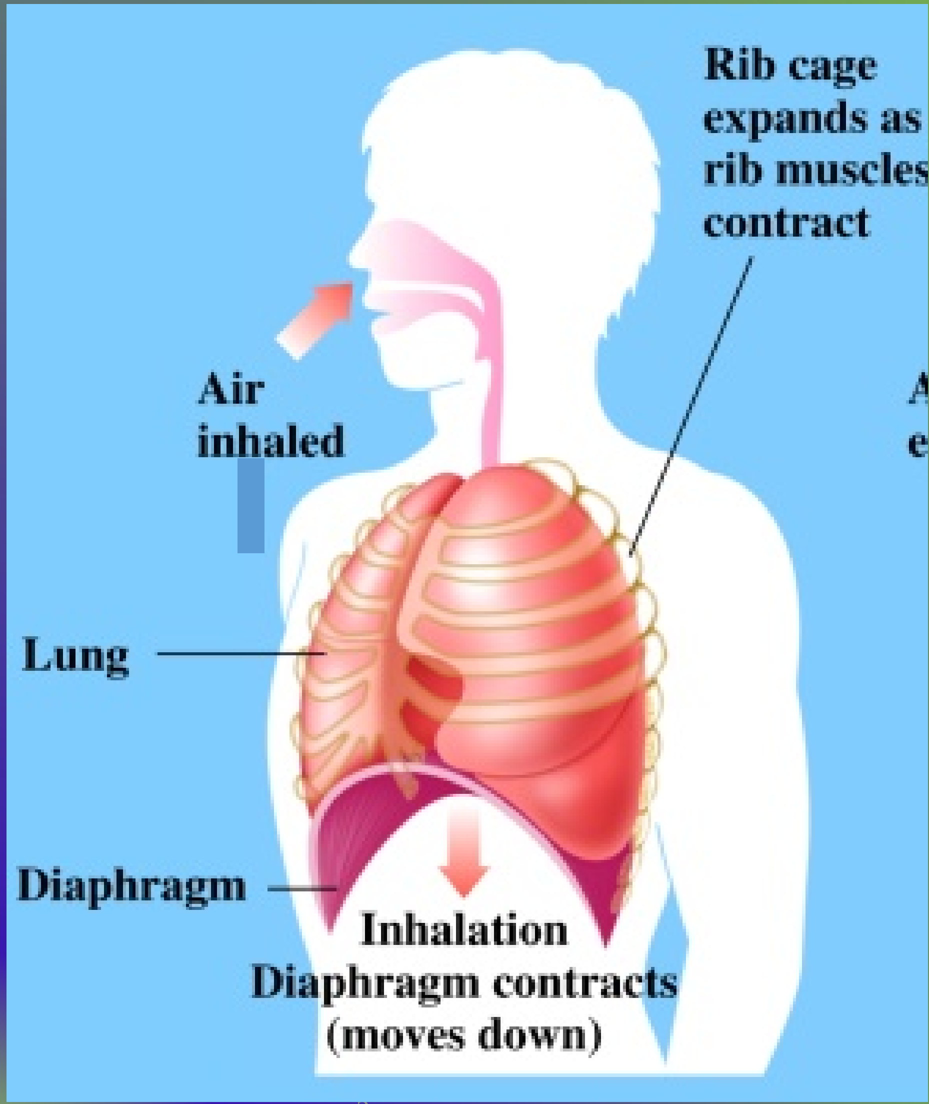
$$PV = nRT$$



# Boyles' Law and Breathing

During an inhalation,

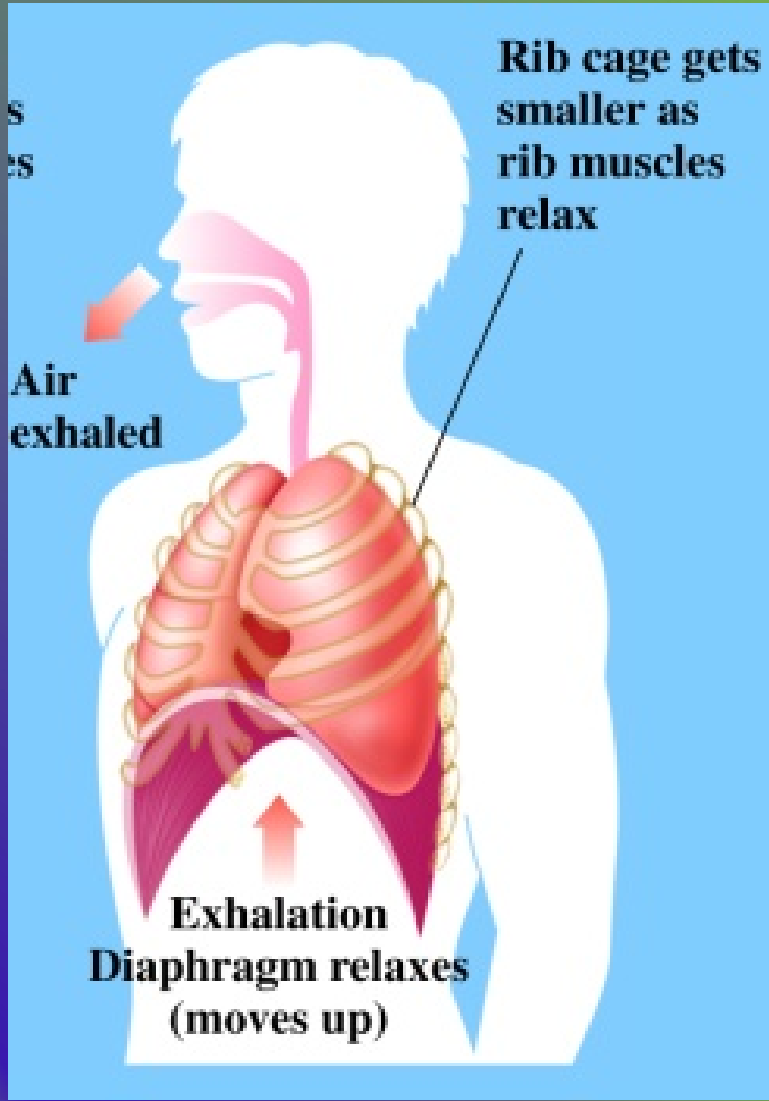
- the lungs expand.
- the pressure in the lungs decreases.
- air flows towards the lower pressure in the lungs.



## Boyles' Law and Breathing

During an exhalation,

- lung volume decreases.
- pressure within the lungs increases.
- air flows from the higher pressure in the lungs to the outside.



# How can we investigate Boyle’s Law?

**Method 1:**

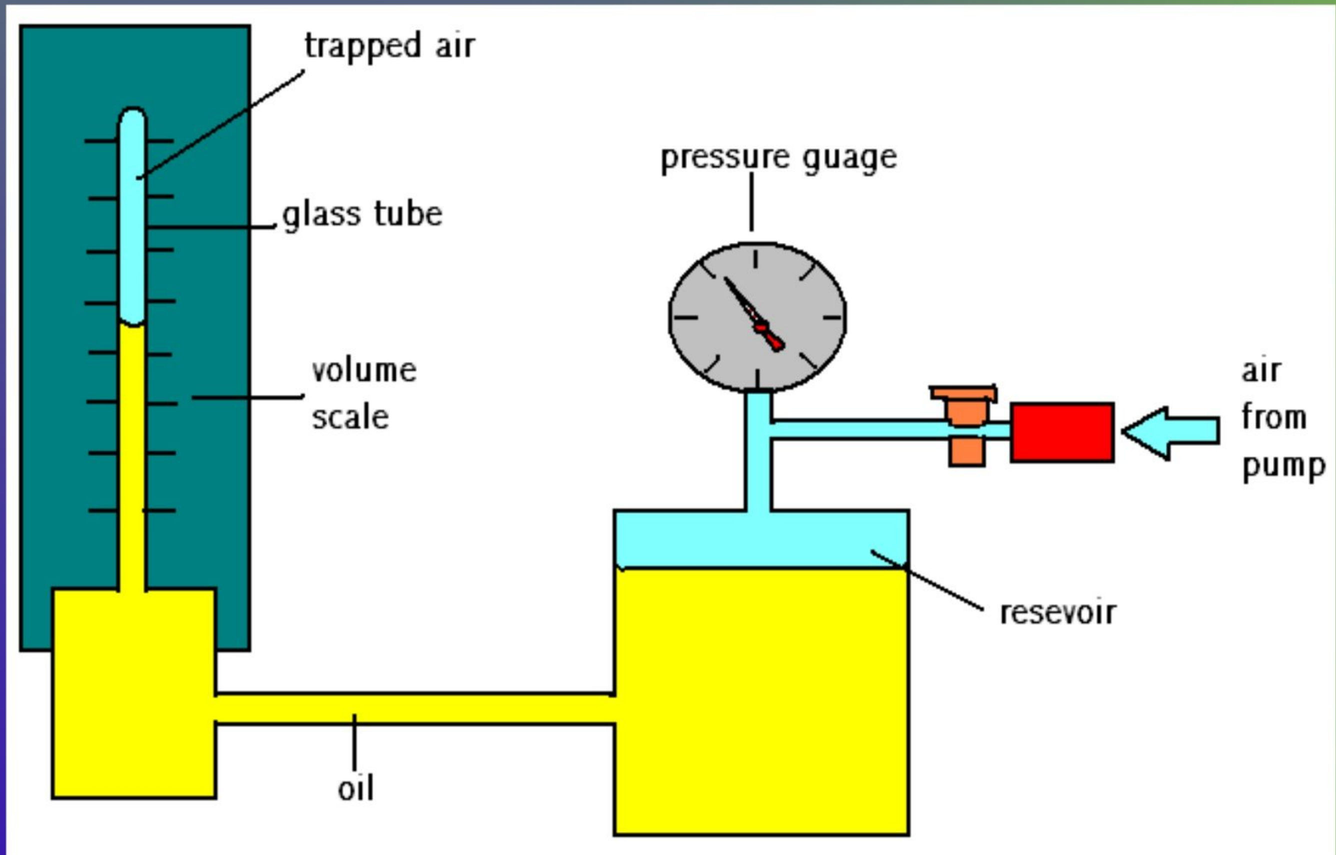
using of pump for creation of pressure difference

**Method 2:**

pressure difference due to height difference  (U type tube)

# Method 1

- Gas volume = constant (sealed into a cylinder)
- Temperature = constant
- Apply increasing pressure to the gas through Pascal law
- We can calculate the pressure by dividing the force applied by the area of the top of the cylinder
- The volume will be shown on the scale on the cylinder



# Below are some results of an experiment

| Pressure p | Volume V | P x V |
|---|---|---|
| 1.1 | 40 | 44 |
| 1.7 | 26 | 44 |
| 2.2 | 20 | 44 |
| 2.6 | 17 | 44 |

- Calculate **P.V** (pressure x volume) for each set of results. What do you notice?

- For a fixed mass of gas, at constant temperature, **P.V = constant** or

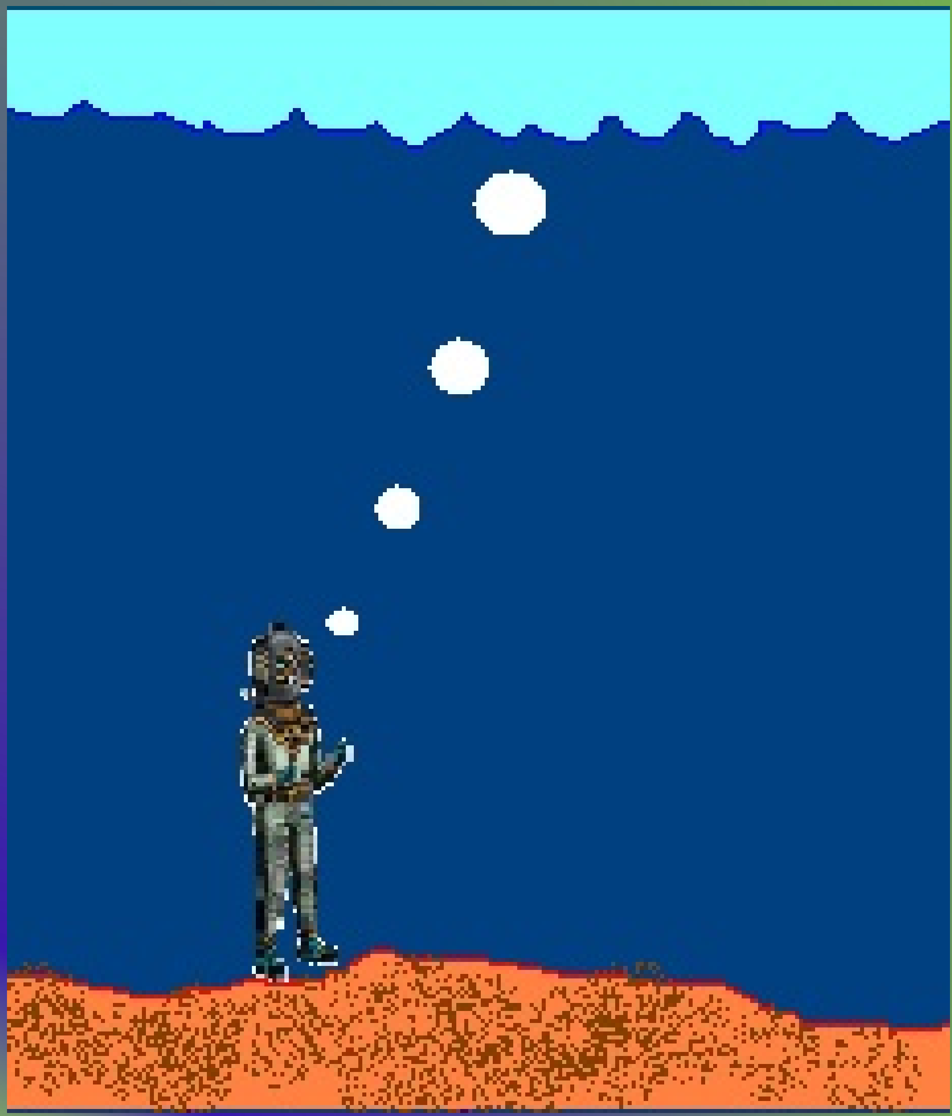
$$P_1 . V_1 = P_2 . V_2$$

# diver

- A deep sea diver is working at a depth where the pressure is 3.0 atmospheres. He is breathing out air bubbles. The volume of each air bubble is 2 $cm^2$. At the surface the pressure is 1 atmosphere. What is the volume of each bubble when it reaches the surface?

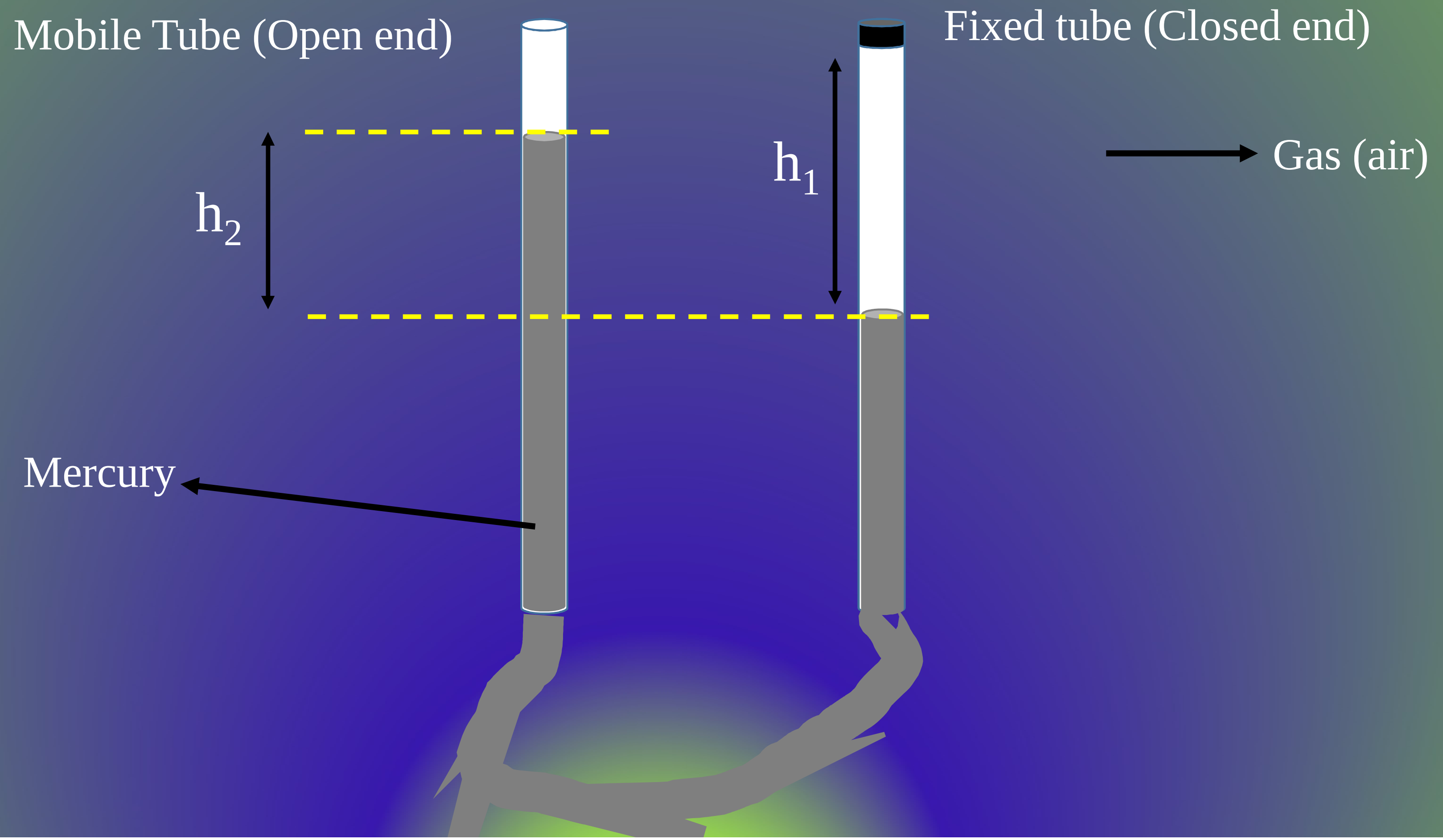
volume of bubbles = 6 $cm^3$

Note that $P_1$ and $P_2$ have the same unit, as will $V_1$



# Method 2

U-shape tube



$$A = Constant$$

$$V_{gas} = A.h_1 \quad , P_{gas} = P_0 + \rho_{Hg} g h_2$$

$$Boil's\ law: \quad P_{gas}.V_{gas} = Constant$$

$$\rightarrow A.h_1.(P_0 + \rho_{Hg} g h_2) = Constant$$

$$h_1.(P_0 + \rho_{Hg} g h_2) = Constant$$

$$if \quad P = P(mmHg) \Rightarrow h_1.(P_0 + h_2) = Constant$$

| **No. experiment** | **$h_1$ (mm)** | **$h_2$ (mm)** | **$h_1.(P_0+h_2)$** |
|---|---|---|---|
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