# Atmospheric Pressure

## Atmosphere and atmospheric pressure

(a) Atmosphere. The gaseous envelope surrounding the earth from all around, is called atmosphere. It extends approximately up to 400 km. It contains air which is 72% nitrogen and 21% oxygen in addition to small percentage of carbon dioxide, hydrogen etc.

(b) Atmospheric pressure. Air possesses weight and hence it exerts pressure like liquids. The atmospheric pressure at a point is defined as the force acting normally on a unit area round that point, due to the total height of the air column of the atmosphere above it.
Its value is maximum at sea level and decreases as we go to higher altitudes.
Its symbol is $P_a$ and S.I. unit is newton per square metre (N $m^{-2}$) or pascal ($P_a$).
$P_a = 1.013 \times 10^5$ $Nm^{-2}$.

## Measurement of atmospheric pressure

The atmospheric pressure was measured by Torriceilli through an experiment in terms of height of mercury column in a mercury barometer.
Atmospheric pressure = 1 atmosphere
$= 0.76$ mm Hg $= 0.76 \times 13.6 \times 10^3 \times 9.8$
$= 1.01 \times 10^5$ N $m^{-2} = 10^5$ $P_a$.

## Fortin's barometer

A barometer is an instrument which is used for measuring the atmospheric pressure. The barometer most commonly used in laboratories is Fortin's Barometer, described ahead : **(a) Construction.** It consists of a glass tube of narrow bore and about 1 metre long. It is closed at upper end and drawn into a jet and bent at the lower end (Fig). The upper 1/3 part, nearer the closed end is of wider bore to avoid the effect of surface tension.
It is completely filled with pure, dry, air-free mercury and inverted vertically in a small reservoir containing pure, dry, air free mercury.
The vertical sides of the reservoir are made of glass and its bottom is in shape of a chamois leather bag, which can be raised or lowered by means of a screw. As the screw is moved up, the bottom of leather bag is raised and the mercury level in the reservoir is raised. As the screw is moved down, the bottom of leather bag is lowered and the mercury level in the reservoir is lowered. An ivory pin 'P' is fixed to the bottom of the cover of the reservoir and the mercury level in reservoir is adjusted with the screw, so as to touch the tip of the ivory pin P (Fig).

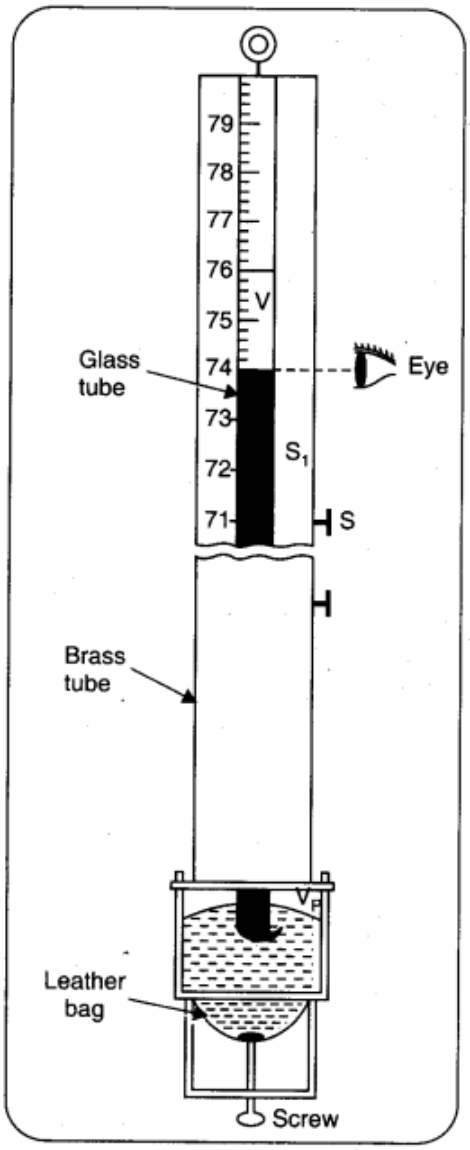


**Fig.** Fortin's Barometer.

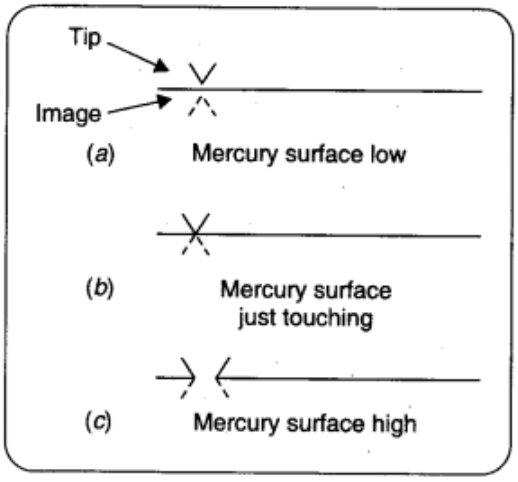


**Fig.** Zero adjustment.

A brass tube encloses the glass tube. There are two vertical slits, cut diametrically opposite to each other, in upper one-third part of the brass tube. Through the slits, the level of mercury in the glass tube can be seen. Main scale $S_1$ is engraved on the brass tube on the one side of the front slit and zero of this scale coincides with the tip of the ivory pin P. A brass vernier 'scale V can be moved up and down in the front slit by the rack and pinion screw S.

**(b) Adjustment.** 1. The barometer is hung vertically from a peg inside a wooden case having a glass cover.
2. Screw is moved till the tip of P just touches tip of its image in mercury, without causing any depression in mercury surface [Fig].
3. The rack and pinion screw S is adjusted till the lower edge of the vernier scale V

appears to just touch the mercury surface in the barometer tube. In this position, a small portion of the white background is visible at the sides of the barometer tube due to the convexity of the mercury surface.
4. Read the position of the zero of V scale on scale and also the vernier division coinciding with the main scale division and find the height of mercury in the barometer tube.
The white background is very helpful in making the adjustment with screw S.
5. Note the temperature as recorded by the thermometer attached on the brass tube, {not shown in diagram)

## Gaslaws

**(a) Boyle's Law.** It states that the pressure (P) of an enclosed gas (i.e., for a given mass of gas) is inversely proportional to its volume (V), provided temperature of the gas remains constant.
i. e., For an enclosed gas, at constant temperature (T),

$$P \propto \frac{1}{V}$$

or

$$PV = \text{Constant.}$$

**(b) Charles' Law.** It states that for an enclosed gas (i.e., for a given mass of gas) at a constant pressure (P), the volume (V) of the gas is directly proportional to its absolute temperature (T).
i. e., For an enclosed gas at constant pressure (P).

$$V \propto T$$

or

$$\frac{V}{T} = \text{Constant.}$$

**(c) Gay Lussac's Law or Pressure Law.** It states that for an enclosed gas (i.e., for a given mass of gas) at a constant volume (V), the pressure (P) of the gas is directly proportional to its absolute temperature (T).
i. e., For an enclosed gas, at constant volume (V),

$$P \propto T$$

or

$$\frac{P}{T} = \text{Constant.}$$

## Gas equation

The gas equation for an ideal gas is

$$PV = \mu RT$$

$R$ is gas constant for 1 mole gas. It has same value for all gases. Hence it is called **Universal Gas Constant.** Its value is

$$R = \frac{P_0 V_0}{T_0} = \frac{(76 \times 13.6 \times 980) \times (22400)}{273}$$

$$= 8.31 \times 10^7 \text{ erg mol}^{-1} \text{ K}^{-1} = 8.31 \text{ J mol}^{-1} \text{ K}^{-1}.$$