PRESSURE

Pressure

Pressure is defined as the normal force acting per unit area.

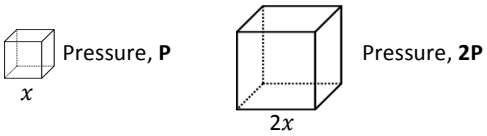
$$P = \frac{F}{A}$$

P : Pressure (Pa or Nm^{-2})
F : Force (N)
A : Area (m^2)

$1\text{Pa} = 1\ \text{Nm}^{-2}$

High pressure is achieved by applying a large force or reducing the contact surface area.

The pressure acting on a cube resting on its side is directly proportional to its length.



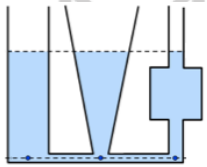
The amount of pressure determines the ability to penetrate another surface.

Everyday Examples of Pressure

High Pressure	Low Pressure
Cutting using a sharp knife is easier due to its smaller contact area.	Tractor using large wheels to prevent sinking into soft ground.
Pushing a thumbtack with its sharp end towards the board to increase pressure.	Eskimo wears snowshoes to distribute his weight over a larger area, allowing him to walk over snow without sinking
Giving a patient an injection using a sharp needle.	Carrying a plastic bag with a thicker handle to reduce pressure on hands.

Liquid Pressure

Pressure in a liquid is proportional to the **density**, **depth** of the liquid and gravitational field strength. It is independent of the volume and cross-sectional area of the liquid.



$$P = h\rho g$$

P : Pressure (Pa)
h : Vertical height (m)
ρ : Density (kgm^{-3})
g : Gravitational field strength (Nkg^{-1})

Barometer

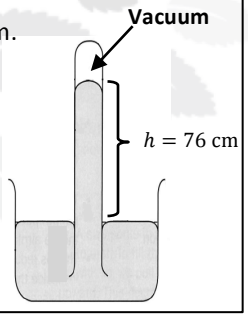
A **barometer** is used to measure atmospheric pressure.

Atmospheric pressure is pressure exerted due to the weight of the air molecules per unit surface area above that point.

1 atmosphere (atm) is equivalent to 1.013×10^5 Pa, or 76 cmHg at sea level.

For a mercury barometer, the unit of measurement is mmHg or cmHg.

10 m of water height is equivalent to 1 atm.

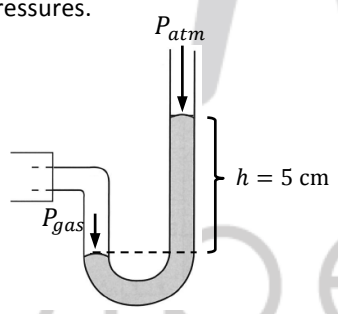


Converting cmHg to Pa

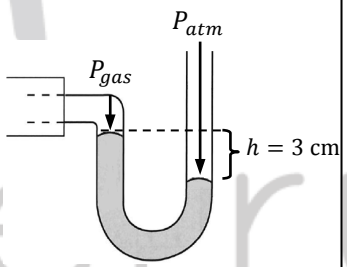
$P = 76\ \text{cmHg}$
$= (0.76\ \text{m})(13600\ \text{kgm}^{-3})(10\ \text{Nkg}^{-1})$
$= 1.03 \times 10^5\ \text{Pa (3sf)}$

Manometer

A **manometer** is used to measure differences in gas or liquid pressures.



$P_{gas} = P_{atm} + 5\ \text{cmHg}$
$= (76 + 5)\ \text{cmHg}$
$= 81\ \text{cmHg}$



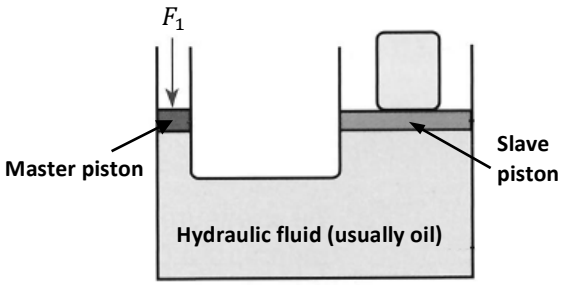
$P_{atm} = P_{gas} + 3\ \text{cmHg}$
$P_{gas} = P_{atm} - 3\ \text{cmHg}$
$= (76 - 3)\ \text{cmHg}$
$= 73\ \text{cmHg}$

Hydraulic Press

In a **hydraulic press,** the liquid pressure is transmitted equally to every part of the liquid. (Pascal's Principle)

$$\frac{F_1}{A_1} = \frac{F_2}{A_2}$$

F : Piston Force (N)
A : Piston Area (m^2)



Gas Pressure

In **Boyle's Law**, the volume of a fixed mass of gas is inversely proportional to the pressure applied to the gas, provided that the temperature and mass of gas remains constant.

$$P_1V_1 = P_2V_2$$

P : Pressure (Pa)
V : Volume (m^3)