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"What one man calls God, another calls the laws of physics."

-Nikola Tesla

TOPIC 6: PRESSURE

THE ABOUT

CHAPTER ANALYSIS

MASTERY

- Be clear about the different applications of pressure
- Mercury barometer, hydraulic system, U-tube manometer

EXAM

- Tested in MCQ and Section A or B

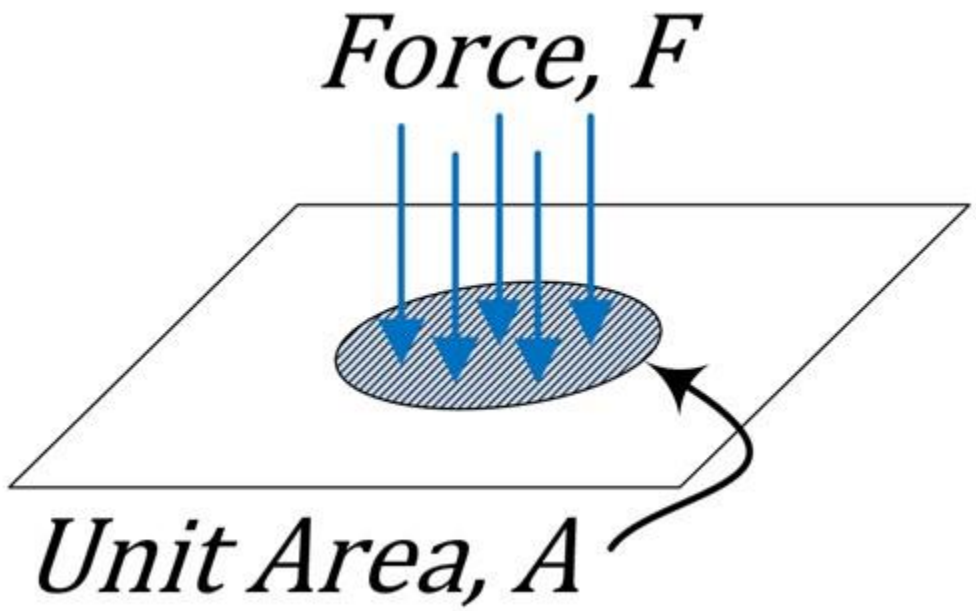
WEIGHTAGE

- Light-medium overall weightage
- Constitute to around **4%** of marks for past 5 year papers

KEY CONCEPT

PRESSURE
PRESSURE IN FLUIDS
ATMOSPHERIC PRESSURE

PRESSURE



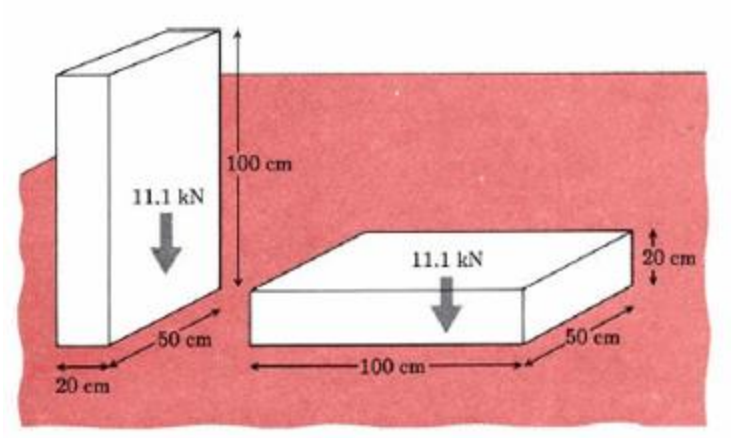
PRESSURE

Pressure is defined as the force acting per unit area.

Unit: Pascal (Pa) or Nm^{-2}

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}}$$

PRESSURE



*For a block with unique dimensions, the **smallest base area** gives the **greatest pressure**.*

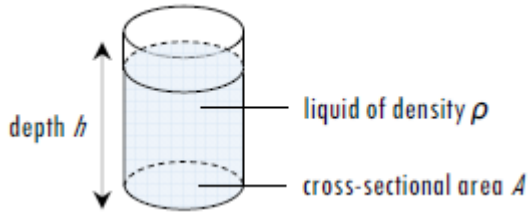
*Meanwhile, **the largest base area** gives **the least pressure.***

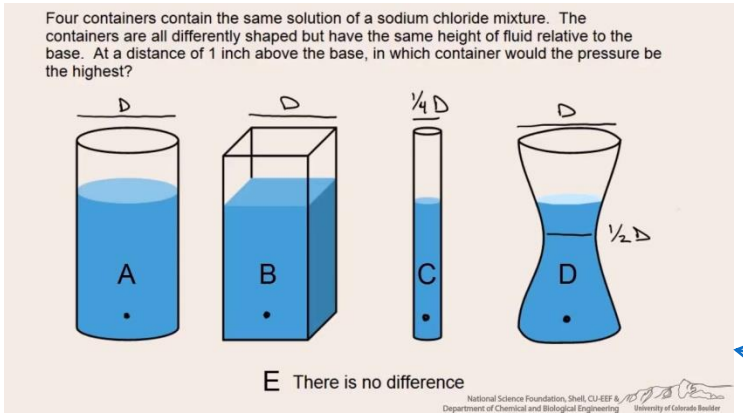
PRESSURE

When calculating pressure, take note of the units whether it is in cm or m.

Also, mass is in kg while weight is a force, with units Newton (N).

PRESSURE IN FLUIDS





MES: FEEL THE PRESSURE

PRESSURE IN FLUIDS

Pressure exerted by a fluid is proportional to the depth at which the body is submerged.

Formula:

P = ρgh

The formula ***P = ρgh*** is a derivative of P = F / A.

P = F / A
P = Weight / A
P = mg / A

Since mass = density x volume,

P = (density x volume x g) / A

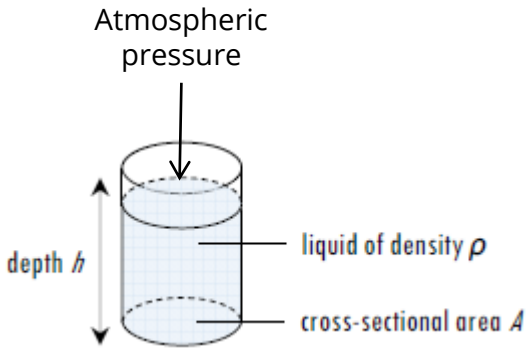
Since Volume / A = height,

P = ρgh

Hence for any liquid, the height of the liquid in any container or orientation will give us the pressure.

This is regardless of the shape or dimension/base area of the container.

PRESSURE IN FLUIDS



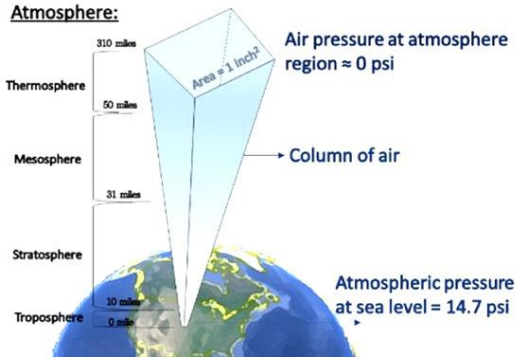
ATMOSPHERIC PRESSURE

Atmospheric pressure is defined as the weight of air in the atmosphere per unit area of any surface.

Air that is around us exerts pressure on all bodies on Earth.

Hence, a more accurate formula for fluid pressure that is exposed to air is,

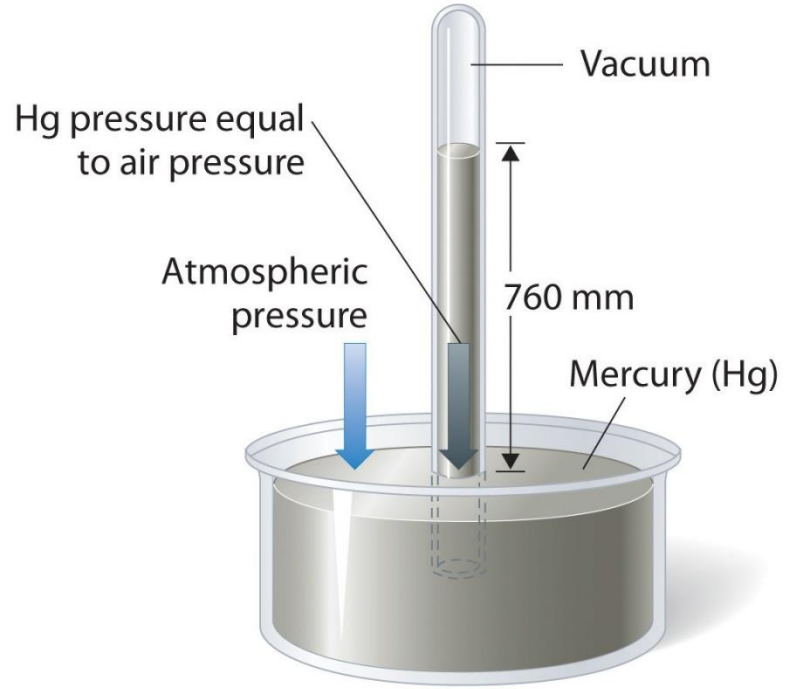
$$P_{Total} = P_{Fluid} + P_{atm}$$



KEY CONCEPT

MERCURY BAROMETER
HYDRAULIC SYSTEM
U-TUBE MANOMETER

MERCURY BAROMETER



MERCURY BAROMETER

A simple mercury barometer measures atmospheric pressure.

The mercury experiences atmospheric pressure outside the column (at Y).

The height, X, represents the atmospheric pressure. (76cm Hg)

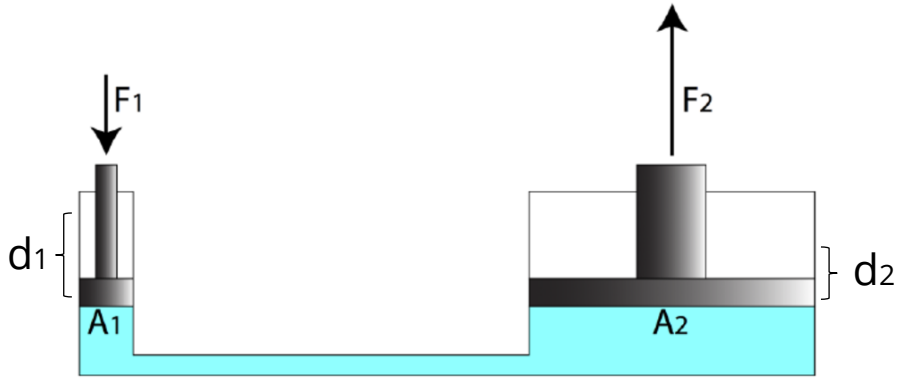
The volume of mercury in the column will increase or decrease with changes in atmospheric pressure such that Pressure at y = Height of X

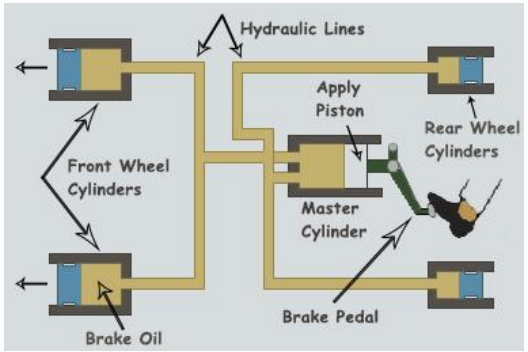
Atmosphere (atm) and centimetres of mercury (cm Hg) are common units for atm pressure

At sea level, it is 1 atm or 76cm Hg.

Scenario	Explanation
Water is used instead	As water's density is much lower while atmospheric pressure remains constant, the height of the water column will be much higher. (P = pgh)
The glass tube is tilted	Perpendicular height of mercury column to the reservoir is unchanged as pressure is dependent on the vertical height and not the length of the column.
The barometer is brought to a higher altitude	As the air is thinner at higher altitude, atmospheric pressure is lowered. Hence, height of mercury column decreases.
There is a crack in the glass tube along the mercury column above the reservoir	Height of mercury decreases to the same level as the reservoir as air will move from outside the tube to inside until the pressure difference is zero.

HYDRAULIC SYSTEM





HYDRAULIC SYSTEM

A hydraulic system multiplies the effort so a small effort can be used to lift a much greater load.

Formula:

Pressure throughout the liquid is equal.

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

Volume of water is equal.

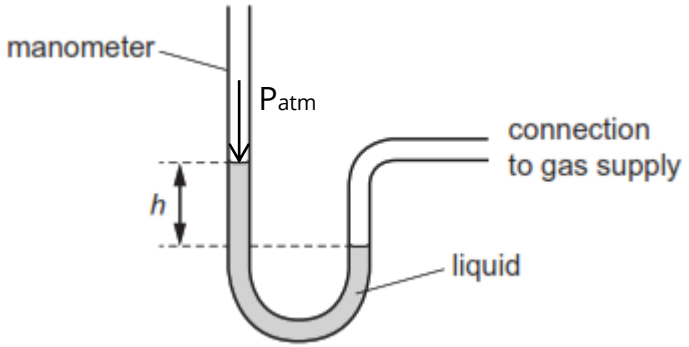
$$V = A_1 d_1 = A_2 d_2$$

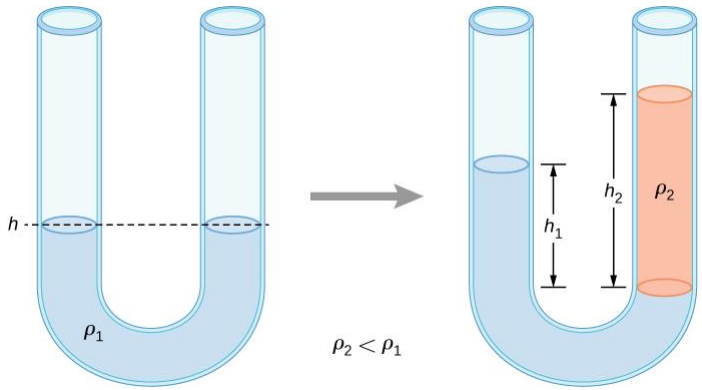
Application: Car Brakes

When a driver steps on the brake pedal, the force on the small piston exerts pressure on the brake fluid.

The brake fluid transmits the pressure to the larger pistons. The pressure exerts a greater force on the larger pistons, which clamps the disc and shows down the car.

U-TUBE MANOMETER





U-TUBE MANOMETER

U-tube manometer is used to measure the pressure due to a gas (when atm is known).

The difference in gas pressure and atmospheric pressure is the excess pressure.

Formula:

Pressure of gas supply = Liquid pressure + Atmospheric pressure

$$(P_{Fluid} + P_{atm})$$

If both ends are exposed to air,

$$P_{fluid} = P_{Fluid}$$

$$\rho gh = \rho gh$$

$$\rho h = \rho h$$

(compare density & height only)
(atmospheric pressure cancels out)

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