RADIANT 2026

Physics

Pressure in Fluid and Atmospheric Pressure

Lecture – 03

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Topics *to be covered*

1. Thrust and Pressure
2. Units of Pressure
3. Pressure in Fluids

4) Atmospheric Pressure


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ATMOSPHERIC PRESSURE

The earth is surrounded by air up to a height of about 300 km from its surface. This envelope of air around the earth is called **atmosphere.** The weight of air column exerts a thrust on the earth surface. The thrust exerted on unit area of the earth surface is called the atmospheric pressure. Thus

The thrust exerted per unit area on the earth surface due to column of air, is called the atmospheric pressure on the surface of earth.

Escape Velocity

$\simeq 11.2$ km/s

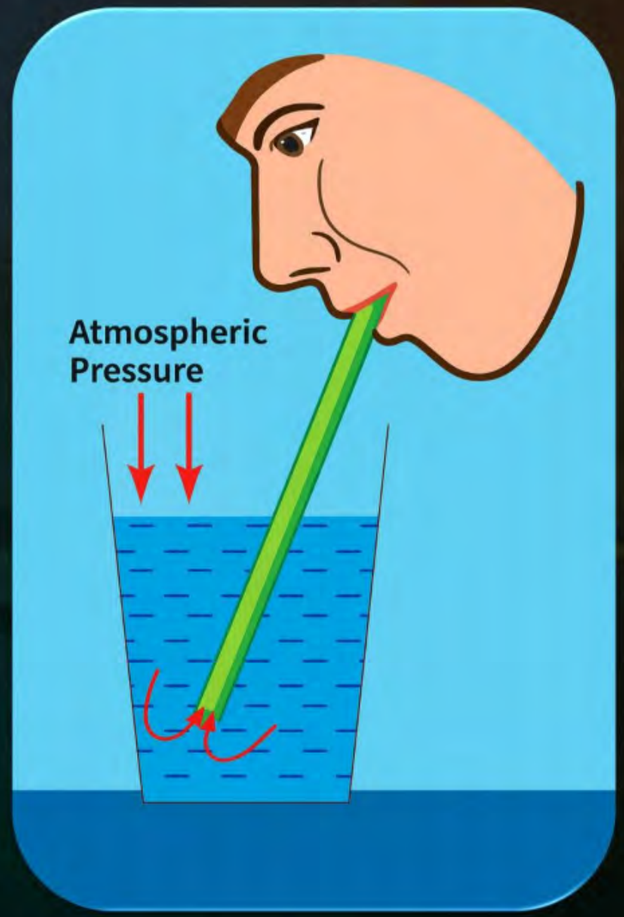
Note:

- The weight of air column over 1 cm^2 area on the earth surface is nearly 1 kgf, so the atmospheric pressure on the earth surface is about 1 kgf per cm^2 (= 1kgf/1 cm^2 = 10 N/10^{-4} m^2 = 10^5 N m^{-2}).
- This implies that a thrust of about 100,000 N acts on every 1 m^2 of the surface of objects on the earth. The average surface area of a human body is about 2 m^2, therefore the atmosphere exerts a total thrust of about 2 × 10^5 N on our body.
- However, we are not aware of this enormous thrust (or load) on us because the pressure of our blood (*i.e.*, blood pressure), balances it.
- The blood pressure is slightly more than the atmospheric pressure. However, at high altitude, the atmospheric pressure becomes less because the height of air column above that altitude is less than at the earth surface.
- As a result, at high altitudes the blood pressure becomes much more than the atmospheric pressure and nose bleeding may occur due to excess blood pressure.

RAISING A LIQUID IN A STRAW

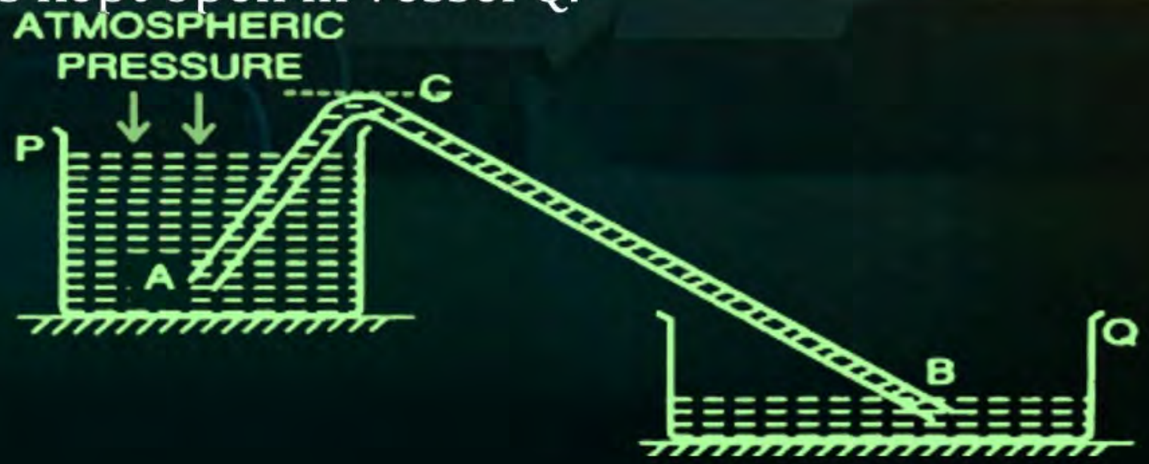
When a person suck through the straw, the pressure in the straw become low.

The atmospheric pressure outside which is higher will force the water into the straw and consequently into the mouth.



ACTION OF A SIPHON SYSTEM

- Water is supplied from a higher level to a lower level using a siphon system. Fig. shows the siphon system in which there are two vessels P and Q.
- Vessel P is at a higher level than the vessel Q.
- Water contained in the vessel P is passed to the vessel Q by means of a glass (or rubber) tube AB with one end A kept immersed inside water in vessel P, while the other end B is kept open in vessel Q.



To transfer water from vessel P to vessel Q, first air is sucked out from the tube at the lower end B of it, so that pressure inside the tube decreases.

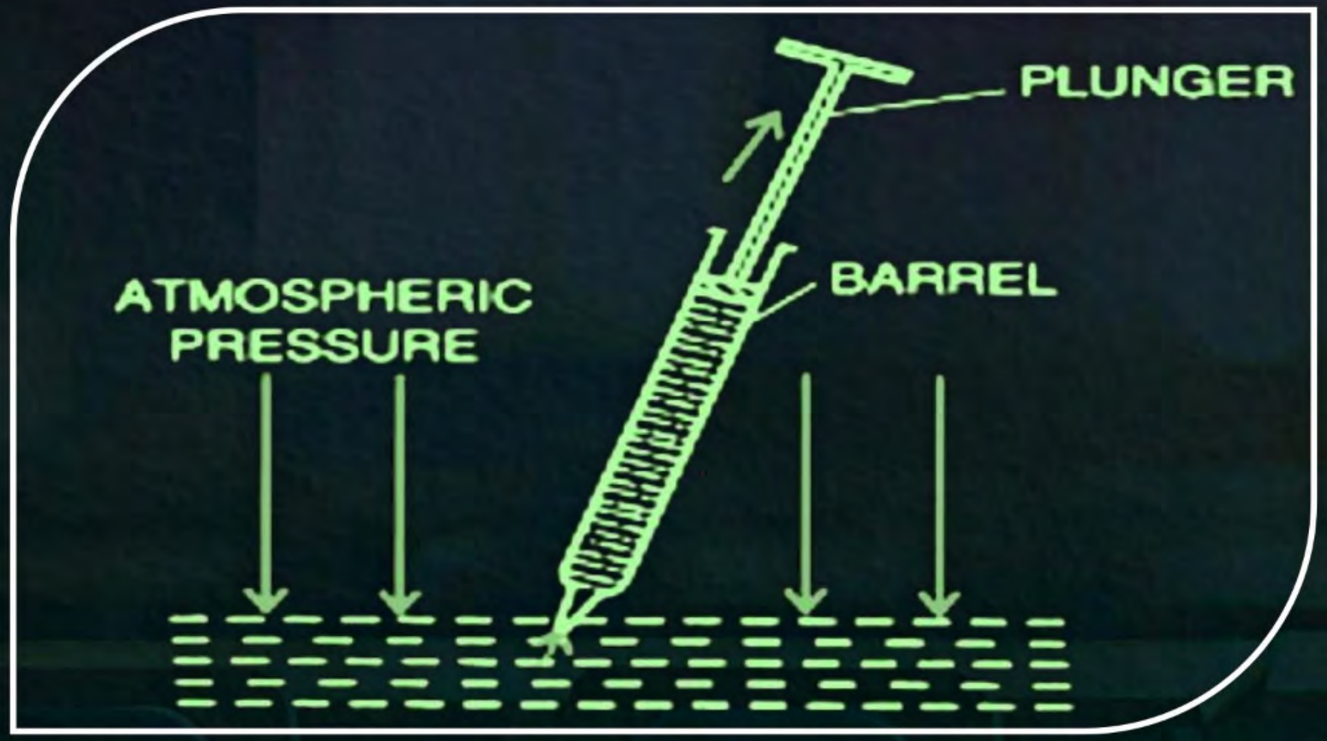
It becomes less than the atmospheric pressure acting above the water surface in vessel P. Due to excess pressure at A, water rises in the tube through the end A, so as to reach up to the level C.

Then water flows down through the tube from the higher level C to the lower level B in the vessel Q due to the difference in pressure of water at the levels C and B.

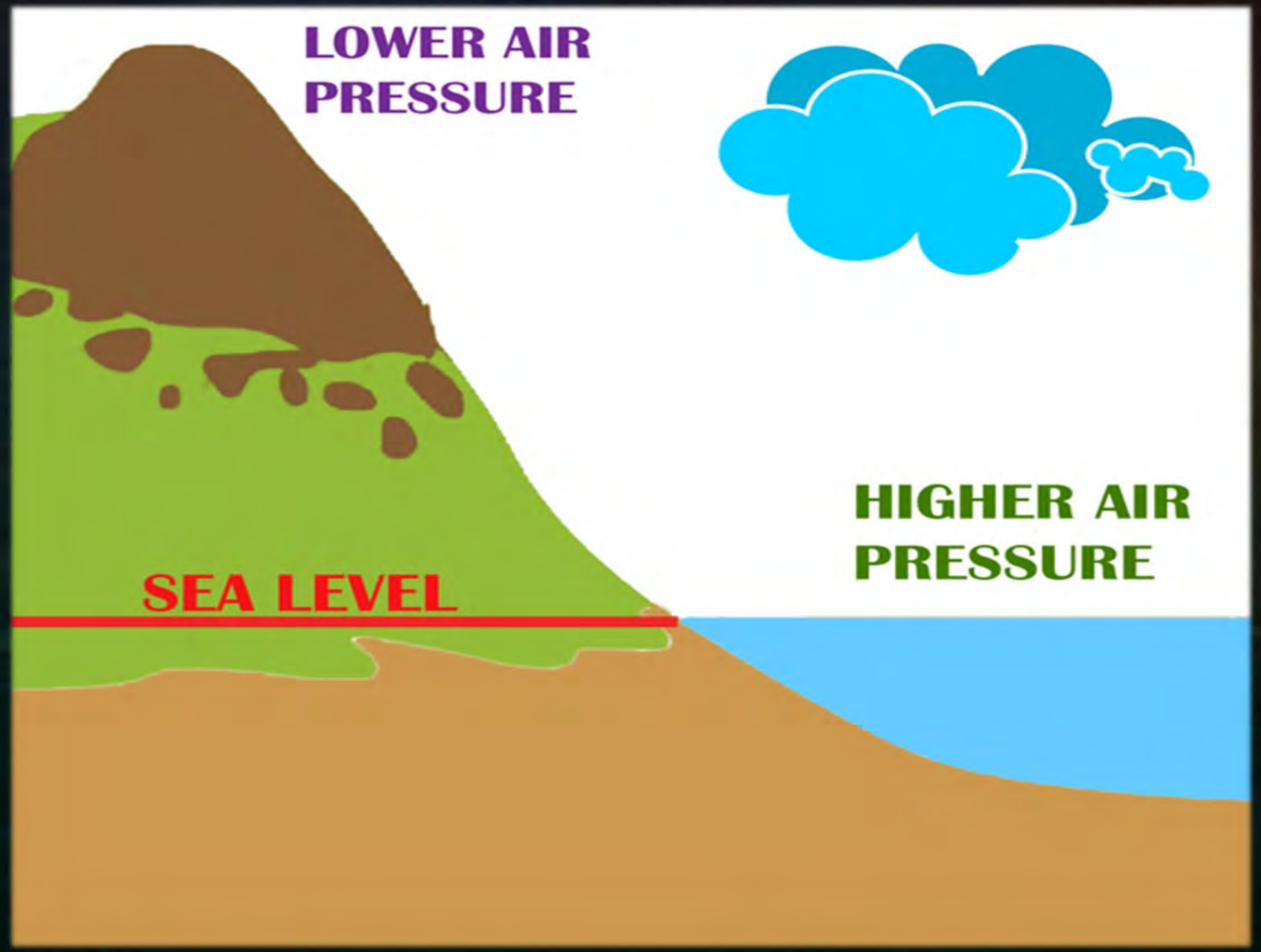
FILLING A SYRINGE WITH A LIQUID

- ✓ When syringe is kept with its opening just inside a liquid and its plunger is pulled up in the barrel,
- ✓ the pressure of air inside the barrel below the plunger becomes much less than the atmospheric pressure acting on the liquid.
- ✓ As a result, the atmospheric pressure forces the liquid to rise up in the syringe.

Action of syringe



In a similar manner, in a water pump, water is drawn up from a well on pulling the piston.


LOWER AIR
PRESSURE
HIGHER AIR
PRESSURE
SEA LEVEL

MEASUREMENT OF ATMOSPHERIC PRESSURE

Atmospheric pressure at a place is measured by barometer. Thus The following three types of barometers are commonly used :

(i) Simple barometer

(ii) Fortin's barometer

(iii) Aneroid barometer

A barometer is an instrument which is used to measure the atmospheric pressure.

Unit & P

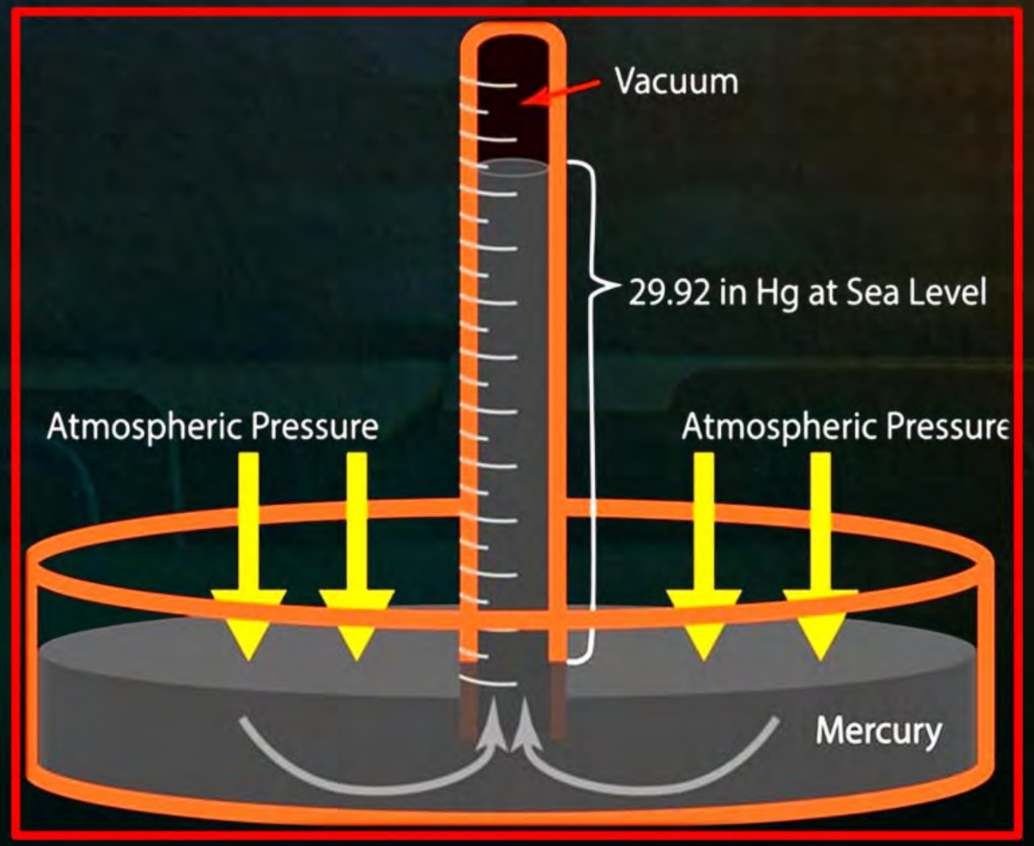
A → T N/m²

B → T N/m

C → T N/m

Simple Barometer

In **1643**, Torricelli first designed a simple barometer using mercury as the barometric liquid.



Barometric height at normal temperature and pressure

The barometric height at normal temperature and pressure at sea level is 0.76 m (or 76 cm or 760 mm) of mercury.

Factors affecting the barometric height

The barometric height at a place changes only when the atmospheric pressure at that place changes.

ADVANTAGES OF USING MERCURY AS A BARMOTRIC LIQUID

$\rho = 13.6 \times 10^3$ kg/m^3

A barometer can be made by using any liquid, but the use of mercury as a barometric liquid is preferred for the following reasons:

- The density of mercury (= 13.6×10^3 kg m^{-3}) is greater than that of any other liquid, so only 0.76 m height of mercury column is needed to balance the normal atmospheric pressure.
- Use of other liquids require much longer tube.
- The vapour pressure of mercury is negligible, so the vapours in the torricellian vacuum does not affect the barometric height.
- The mercury neither wets nor sticks to the glass tube therefore it gives the accurate reading.
- The surface of mercury is shining and opaque. Therefore, it is easily seen while taking the observation.

It can easily be obtained in a pure state.

Disadvantages of using water as a barometric liquid

If water is used in a barometer, it has the following disadvantges :

- The density of water is low (= 10^3 kg m^{-3}), so nearly 10.4 m height of water column is needed to balance the normal atmospheric pressure. But it is highly inconvenient to take a tube of height 10.4 m for a barometer.
- The vapour pressure of water is high, so its vapours in the vacuum space will make the reading inaccurate.
- Water sticks with the glass tube and wets it, so the reading becomes inaccurate.
- Water is transparent, so' its surface is not easily seen while taking the observation.

Demerits of a simple barometer

(i) There is no protection for the glass tube.

(ii) The surface of mercury in the trough is open therefore there are chances that the impurities may fall in and get mixed with the mercury of the trough.

(iii) It is inconvenient to move the barometer from one place to another i.e. it is not portable.

(iv) A scale can not be fixed with the tube (or it can not be marked on the tube) to measure the atmospheric pressure. The reason is that when the atmospheric pressure changes, the height of mercury column in the tube changes. As a result, the level of free surface of mercury in the trough changes due to the flow of mercury in or out of the tube. Therefore, the free surface of mercury in trough will not remain coinciding with the zero mark of scale if a scale is fixed with it to measure the barometric height.

The above demerits have been removed in the Fortin barometer.

A → 76 cm

B → 16 mm

C → 76 km

D → .76 cm


Thank You