—: FLUID MECHANICS :—

(liquid or Gases) (Motion)

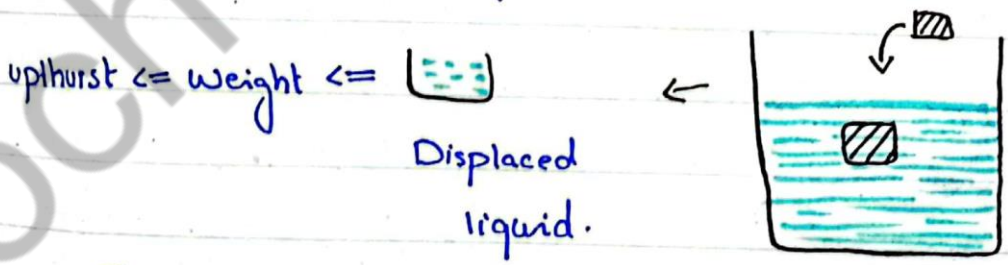
"Every thing that flow and do motion is called fluid."

Upthrust:—

A reactional force offered by a fluid when the external object passes from it.

Example:-

When you push the water with your hand you can feel the opposite or reactional force on your hand from the water on your hand.

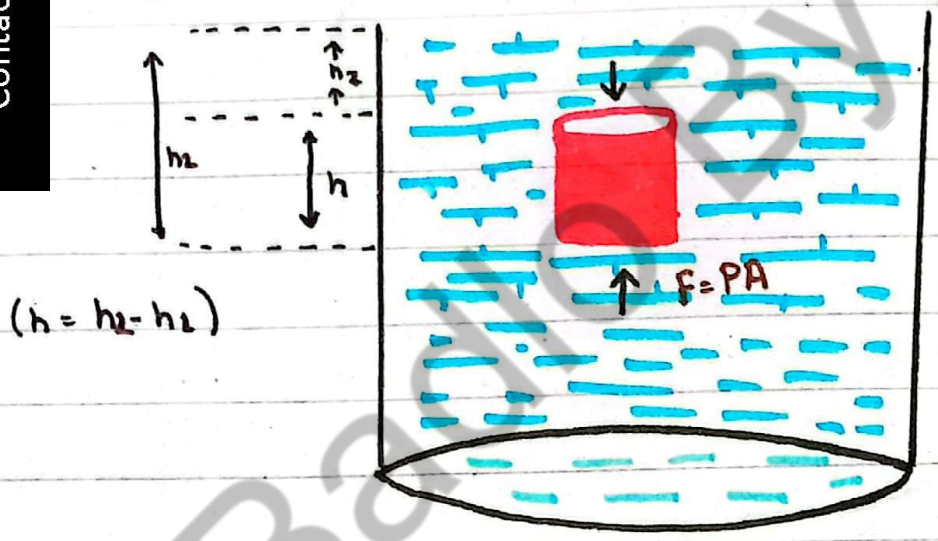


The value of upthurst is equal to the displaced ~~object~~ liquid in it.

When an object is partially or completely immersed in water a force of upthrust acts on the object whose magnitude is equal to the amount of water displaced by a object.

LECTURER # 51

Archimedes particle :— (buoyancy)



$(h = h_2 - h_1)$

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

Pressure :—

$P_1 = \rho g h_1$ —(i) $P_2 = \rho g h_2$ —(ii)

Force :—

Since,

$$P = \frac{F}{A} \rightarrow F_1 = PA_1 \text{ (iii)} \quad F_2 = PA_2 \text{ (iv)}$$

Putting eq(i) and eq(ii) in eq(iii) and (iv) respectively.

$\Rightarrow F_1 = \rho g h_1 A$ $\qquad F_2 = \rho g h_2 A$

Since upthurst is given by:

$$\text{Upthurst} = F_2 - F_1 = \rho g h_2 A - \rho g h_1 A$$

$$F_2 - F_1 = \rho g A (h_2 - h_1)$$

Since $h_2 - h_1 = h$

$$F_2 - F_1 = \rho g A (h)$$

$$F_2 - F_1 = \rho g (Ah)$$

$$F_2 - F_1 = \rho g V \qquad \because \text{volume} = Ah$$

$$\boxed{\text{Upthurst} = \rho g V}$$

ρ ← medium density.

upthrust $\propto$ volume

upthrust $\propto$ density ← object density

LECTURER # 52

VISCOUS DRAG AND TERMINAL VELOCITY :-

→ viscosity

VISCOUS DRAG :-

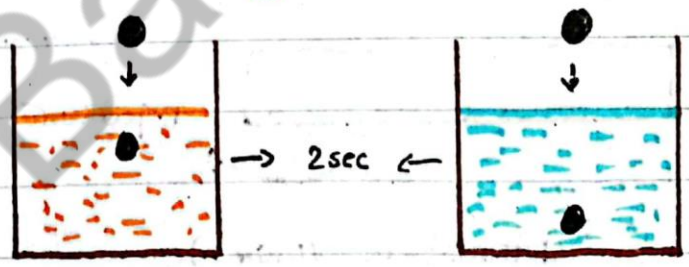
The resistance offered by different layer of a fluid to its flow is called ~~viscous~~ drag viscocity. OR

Viscous drag :- / Drag Force :-

The retarding force (resistance) experience by an object moving through a fluid is called drag force or viscous fluid.

Example :-

Honey and water



Honey water

Honey is more viscous than water

Viscosity :-

The measurement of opposing force is viscosity.

جو زیادہ Thick ہوتا ہے وہ زیادہ viscous ہوتا ہے

High resistance between different layer = High viscosity

low resistance between different layer = low viscosity

Justify :—

: MDCAT / ECAT

Q The Viscosity of liquid decrease on the increase of temperature.

OR

The Viscosity of Gases increase on the increase of temperature.

Factor Affecting on Drag Force:-

1- Speed
2- Shape
3- Volume
4- Viscosity
5- Orientation

Do not out your hand through window of car or ship in water.

The orientation of wings play a crucial role in how air brakes function. When air brakes are deployed; they can alter the angle of the wings relative to the air flow affecting lift and drag slowing down the plane.

Factor Affecting on Drag Force:-

1- Speed
2- Shape
3- Volume
4- Viscosity
5- Orientation

Do not take out your hand through window of car or ship in water.

The orientation of wings play a crucial role in how air brakes function. When air brakes are deployed ; they can alter the angle of the wings relative to the airflow affecting lift and drag slowing down the plane.

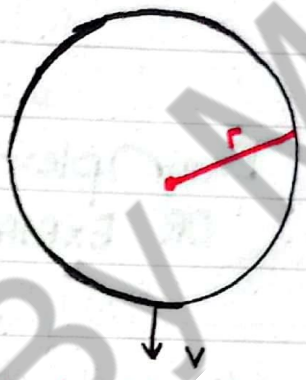
Stocks law
Stoke law :—

STOKE'S LAW :—

$F_D \propto r$ —(i)

$F_D \propto v$ —(ii)

$F_D \propto \eta$ —(iii)



(Combining eq (i), (ii) and eq (iii) then.

$\because \eta$ = ela = Viscosity

$F_D \propto \eta r v \Rightarrow F_D = (\text{constant})\, \eta r v$

Experimentally constant value is determind as "6π"

$$F_D = 6\pi \eta r v$$

#53

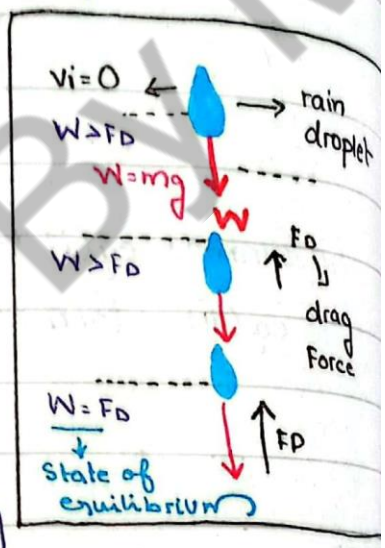
→ Constant Maximum velocity

TERMINAL VELOCITY (V_T)

It is defined

"The maximum constant velocity acquired by a freely falling object in a viscous medium is called terminal Velocity"

Example:— OR EXPLANATION:—



Freely falling Initially the velocity of object / droplet is minimum ($v_i = 0$) So, the value of drag force act is also minimum But After few seconds the velocity of an object gets increase (Body accelerates) So the value of drag force is also increase. Ultimately The weight of an object will become equal to the drag force

$(W = F_{drag})$

Therefore:- The object will attain a constant maximum velocity that will be termed as

"Terminal Velocity"

$\because F_{net} = 0$

$\because a = 0$

Derivation:—

When a free falling object acquried terminal Velocity

$F_{net} = W + (-F_{Drag})$

$F_{net} = W - F_{Drag}$ $\quad \because F_{net} = 0$

$0 = W - F_{Drag}$

$\boxed{F_{Drag} = W}$ —(i) $\quad \because F_{Drag} = 6\pi\eta r v$

Putting values of drag force, weight

$6\pi\eta r v_T = \text{Weight} \quad \because W = mg$

$6\pi\eta r v_T = mg$

$v_T = \frac{mg}{6\pi\eta r}$

$\boxed{v_T = \frac{mg}{6\pi\eta r}}$ —— (ii)

As we have,

$\boxed{\rho = \frac{m}{V}}$ $\quad \because$ since, the volume of spherically object $V = \frac{4}{3}\pi r^3$

$\rho = \frac{m}{4/3\pi r^3}$

$\rho = \frac{3m}{4\pi r^3}$

$\boxed{m = \rho\left(\frac{4}{3}\pi r^3\right)}$ —— (iii)

Put eq (iii) in eq (ii)

$$V_T = \frac{\rho\left(\frac{4}{3}\pi r^3\right)g}{6\pi\eta r}$$

$$V_T = \frac{\rho\left(2\pi r^3\right)g}{9\pi\eta r}$$

$$V_T = \frac{\rho\, 2\pi r^2 g}{9\pi\eta} \Rightarrow \frac{2\rho g r^2 \pi}{9\pi\eta}$$

$$\boxed{V_T = \frac{\rho 2 r^2 g}{9\eta}} \rightarrow (v)$$

Conclusion:—

Thus, we conclude that

$$V_T = \left(\frac{2\rho g}{9\eta}\right) r^2$$

$$V_T = (\text{constant}) \times r^2$$

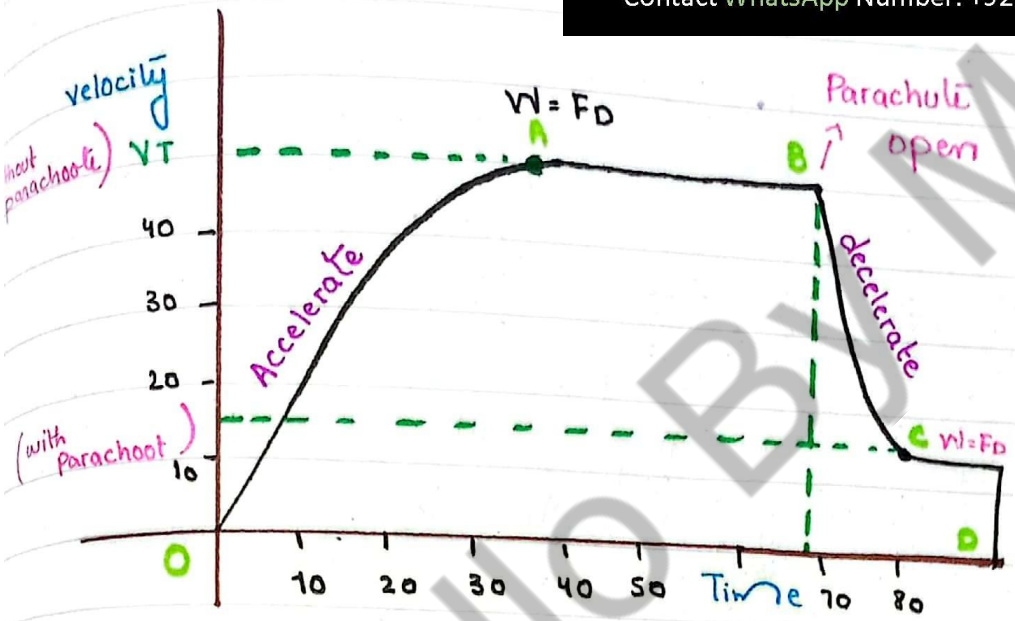
$$\boxed{V_T \propto r^2}$$

This shows that the small mass will attain terminal speed first whereas the large mass will attain terminal velocity depends on the square of the radius of the sphere and inversely proportional to the viscosity.

LECTURER # 54

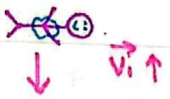
Application of Terminal Velocity :—

Paratrooper's jump :—



Parachute close :—

(i) O → A



(velocity of Paratrooper increase W > FD)

(ii) At point A

(The weight and drag force become equal. So, the paratrooper attain terminal velocity)

(iii) A → B

The paratrooper freely falls with 1st terminal velocity (without parachute) constant velocity.

-. Parachute open :—

(iv) B → C

When the paratrooper open the parachute then, its velocity will suddenly decrease (decelerates)

↑ F_D

(v) At point C

At point "C" the weight of Paratroper with parachute become equal with drag force and will attain a constant/uniform terminal velocity.

(vi) C → D

When $F = W_D$ then the paratrooper with parachoot moves with terminal velocity.

SLO Based Questions?

Q How the paratrooper gain terminal velocity? graphically

Q What conditions the paratrooper do terminal velocity?

Q Explain the terminal velocity of paratroper graphically in two cases.

(a) When the parachute is not open.
(b) When the parachute is open

Q

LECTURER # 55

FLUID FLOW

A fluid is a substance that can flow like liquid or gases.

There are two type of flow

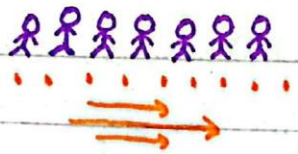
1. Streamline flow (Laminear flow)
2. Turbulent flow

Steamline flow:— (Liminear flow)

If every particle that passes a particular point moves along exactly the same smooth path followed by previous particle that has passed that point earlier ; then such flow is called Steamline flow.

Example:—

Aps students during any activity



Middle layer flow faster.

Turbulent flow:—

Irregular flow of fluid is called turbulent flow

It is resulting from excessive Speed of the flow or sudden change in the direction or size of tube or pipe.

Example:—

Eating / Taking food in any Wedding

Ideal fluid is easy to understand. Real fluid is so complex and difficult to understand

PAKISTANI JUGAR IS BAD

When people open car window due to make some bagat of petroleum but it is actually bad and consume more petroleum than usual because due to air resistance the air will fill your car m and make it heavy and difficult to move so it consume more petroleum.

#56

Example:-

① When we close the some area of pipe then its velocity increase and a specific mass released

② When we not close the area of pipe then its velocity somehow not increase and its mass is same as in 1st condition.

—: HOT TOPICS :-

Equation of C

of ideal fluid d
This leads to c
relationship called Quar "Equation of Continuity"

" The product of cross-Sectional Area and the Speed of the fluid at any Point along pipe is Constant "

Mathematically:-

$$A_1V_1 = A_2V_2$$

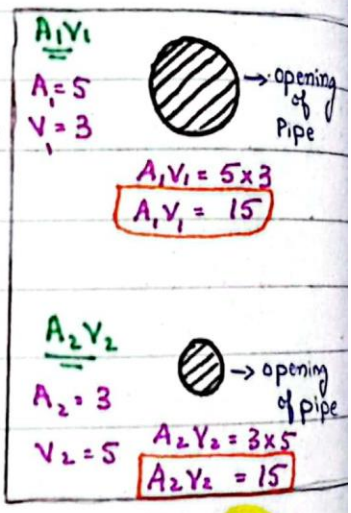
$$A_1V_1 = A_2V_2 = \text{Constant}$$

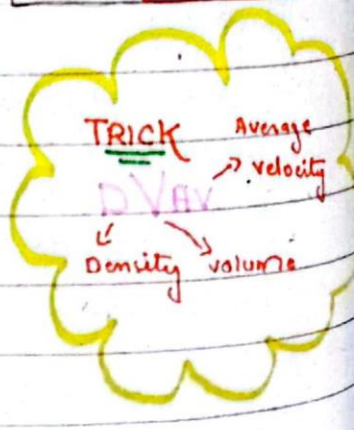
Generally we use

$$AV = \text{Constant}$$

$$A = \frac{\text{constant}}{V}$$

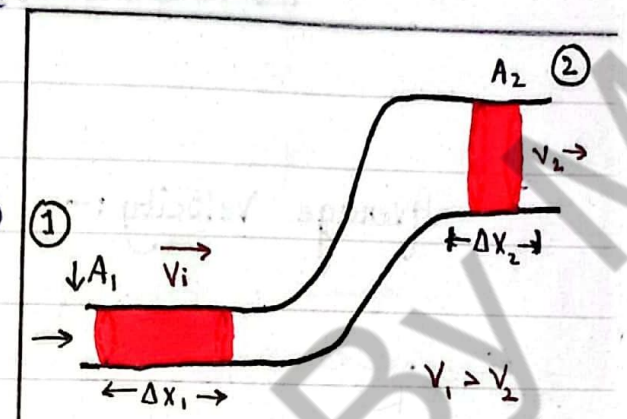
$$A \propto \frac{1}{V}$$





Explanation :—

Consider an ideal fluid flowing through a pipe of non-uniform size as illustrated in figure.



The particles in the fluid move along stream line in steady flow. As, there is no source or sink in the pipe so equal mass will flow through each end of the pipe. Therefore, the law of Conservation of mass is valid in equation of Continuity that is given by

A fluid moving with steady flow through a pipe of varinging cross-sectional area ($A_1 < A_2$) The volume of fluid flowing through area A_1 at time 't' must be equals to the volume flowing through 'A_2' in the same time interval 't'.

$$\Delta m_1 = \Delta m_2 = \Delta m$$

Derivation :—

Density :—

As from the defination of density

$$\Rightarrow \rho = \frac{\Delta m}{\Delta V} \Rightarrow \boxed{\Delta m = \rho \Delta V} \quad -(i)$$

Volume :-

As, By the concept of volume

$$\boxed{\Delta V = A \Delta x} \quad -(ii)$$

$\because V = L \times W \times h$

$V = A \times H$

Average Velocity :-

As the average velocity is given as

$$\Rightarrow V = \frac{\Delta x}{\Delta t} \Rightarrow \boxed{\Delta x = V \times \Delta t} \quad (iii)$$

Putting eq(iii) in eq(ii)

$$\Delta V = A \times V \times \Delta t$$

$$\boxed{\Delta V = AV\Delta t} \rightarrow (iv)$$

Putting eq(iv) from eq(i) then,

$$\boxed{\Delta m = \rho A v \Delta t} \rightarrow (v)$$

For Segment 01 :-

The fluid that move through the lower end of the pipe in the time 'Δt' has a mass given by

$$\Rightarrow \boxed{m_1 = \rho A_1 v \Delta t} \rightarrow (vi)$$

For Segment :- 02

The fluid that moves through the upper end of the pipe in the time Δt has a mass given by :-

$$\Rightarrow \boxed{m_2 = \rho A_2 v_2 \Delta t} \rightarrow (vii)$$

Now, from law of Conservation of mass we can compare (vi) and (vii) then,

$$\cancel{\rho} A_1 v_1 \cancel{\Delta t} = \cancel{\rho} A_2 v_2 \cancel{\Delta t}$$

$$\boxed{A_1 v_1 = A_2 v_2}$$

Volume of flow Rate :-

v_s from eq (vii)

(iv) we have :-

$$\Rightarrow \Delta V = A v \Delta t$$

$$\Rightarrow A v = \frac{\Delta V}{\Delta t}$$

Since Av constant

$$\frac{\Delta V}{\Delta t} = \text{constant}$$

The volume of fluid passing through any point in unit time through a pipe of non uniform cross-section is constant in the steady flow.

MAK Special Tip

As $\Delta m = \rho \Delta V$. $\because \rho$ = constant

Δm = constant ΔV

$\Delta m \propto \Delta V$

LECTURER # 57

BERNOULLI EQUATION

Bernoulli Equation that relates the pressure, (P) flow Speed (v) and elevation (h) for flow of an ideal fluid.

Tips Short form

[PKD]KU]

W → K.E → P.E

Mathematically it is given as :-

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

Generally it is represented as

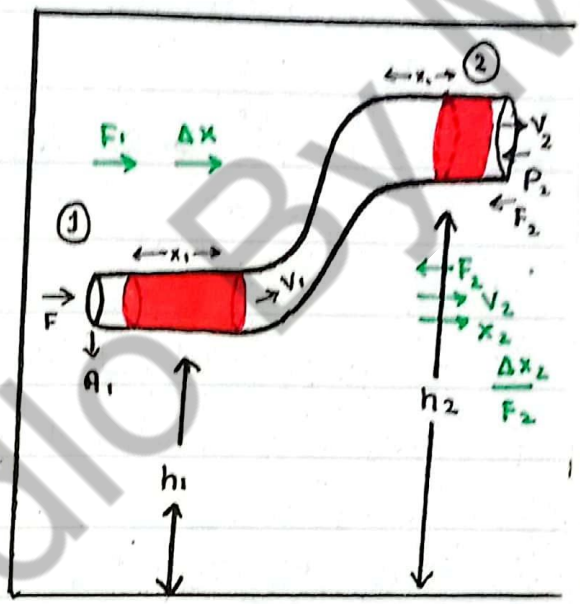
$$P + \frac{1}{2}\rho v^2 + \rho g h = \text{Constant}$$

Bernoulli's principal is based on "law of Conservation of Energy"

Explanation :—

we derive the Bernolli equation by applying the law of conservation of Energy.

let us consider the two different Segment /Regions as shown in figure.



An ideal fluid flows through the pipe in time interval Δt. The work "W" is due to forces must be equal the change in the total mechanical energies (Kinetic plus potential Energy) associated with the fluid element.

=> Workdone = Change in Total Energy

=> $W_T = \Delta K.E + \Delta P.E$

$W_T = \Delta K.E + \Delta U$

$W_1 + W_2 = \Delta K.E + \Delta U$

WORK DONE :-

FOR Region 01 :-

By Defination of workdone

$$\Rightarrow W_1 = \vec{F} \times \vec{d}$$

$$W_1 = \vec{F_1} \cdot \Delta\vec{x_1}$$

$$W_1 = F_1 \Delta x_1 \cos\theta$$

Since $\vec{F_1}$ and $\Delta\vec{x_1}$ are parallel so,

$$\theta = 0^\circ$$

$$W_1 = F_1 \Delta x_1 \cos(0^\circ) \qquad \because \cos(0) = 1$$

$$\boxed{W_1 = F_1 \Delta x_1} \quad \text{---(i)}$$

FOR Region 02 :-

As

$$\Rightarrow W_2 = \vec{F_2} \cdot \vec{\Delta x_2}$$

$$W_2 = F_2 \cdot \Delta x_2 \cos(\theta)$$

$$W_2 = F_2 \Delta x_2 \cos\theta$$

Since $\vec{F_2}$ and $\vec{\Delta x_2}$ are antiparallel So,

$$\theta = 180^\circ$$

$$W_2 = F_2 \Delta x_2 \cos(180^\circ) \qquad \therefore \cos 180^\circ = -1$$

$$W_2 = F_2 \Delta x_2 (-1)$$

$$\boxed{W_2 = -F_2 \Delta x_2} \quad \text{---(ii)}$$

PRESSURE :—

Since, Pressure is given as

$$\Rightarrow \quad P = \frac{F}{A} \qquad \Rightarrow \quad F = PA$$

For Region :- 01 $\quad F_1 = P_1 A_1$ — (iii)

For Region :- 02 $\quad F_2 = P_2 A_2$ — (iv)

Putting eq (iii) in (i) and (iv) in (ii)

$$W_1 = P_1 A_1 \Delta x_1 \longrightarrow (v)$$

$$W_2 = -P_2 A_2 \Delta x_2 \longrightarrow (vi)$$

VOLUME :—

Since, volume is given as

$$\Delta V = A \Delta x$$

For Region :- 1 :- $\quad \Delta V_1 = A_1 \Delta x_1$ — (vii)

For Region 2 :- $\quad \Delta V_2 = A_2 \Delta x_2$ — (viii)

Putting eq(vii) in eq(v) and (viii) in eq (vi) then,

$$W_1 = P_1 \Delta V_1 \quad — (ix)$$

$$W_2 = P_1 \Delta V_2 \quad — (x)$$

Density :-

Since density is given as :-

$$\rho = \frac{\Delta m}{\Delta V} \Rightarrow \Delta V = \frac{\Delta m}{\rho}$$

ΔV

For Region 01 :- $\Delta V_1 = \frac{\Delta m_1}{\rho}$ — (xi)

For Region 02 :- $\Delta V_2 = \frac{\Delta m_2}{\rho}$ — (xii)

Putting eq (xi) in (ix) and eq (xii) in eq (x) then,

$$W_1 = P_1 \frac{\Delta m_1}{\rho} \quad \text{— (xiii)}$$

$$W_2 = -P_2 \frac{\Delta m_2}{\rho} \quad \text{— (xiv)}$$

So, the total workdone will be given as :-

$$W_T = W_1 + W_2$$

$$\Rightarrow W_T = \frac{P_1 \Delta m_1}{\rho} + \left(-\frac{P_2 \Delta m_2}{\rho}\right)$$

$$\Rightarrow W_T = \frac{P_1 \Delta m_1}{\rho} - \frac{P_2 \Delta m_2}{\rho} \quad \text{— (x)}$$

Kinetic Energy :- ($\Delta K.E$)

The net change in the Kinetic Energy is given by

$$\Delta K.E = (K.E)_2 - (K.E)_1$$

$$\boxed{\Delta K.E = \frac{1}{2}\Delta m_2 v_2^2 - \frac{1}{2}\Delta m_1 v_1^2} \quad -(xv)$$

Potenial Energy :- (ΔU)

$$\Rightarrow \Delta P.E = (P.E)_2 - (P.E)_1$$

$$\Rightarrow \boxed{\Delta U = \Delta m_2 g h_2 - \Delta m_1 g h_2} \quad -(xvi)$$

Putting eq (z), (xv) and (xvi) in eq(z) then,

$$\Rightarrow \frac{P_1}{\rho}\Delta m_1 - \frac{P_2}{\rho}\Delta m_2 = \frac{1}{2}\Delta m_2 v_2^2 - \frac{1}{2}\Delta m_1 v_1^2 + \Delta m_2 g h_2 - m_1 g h_1)$$

Since, from law of Conservation of mass

$$\boxed{\Delta m_1 = \Delta m_2 = \Delta m}$$

$W_1 + W_2 = \Delta K.E + \Delta U$

Work = change in Energy = Energy Principle

$$\Rightarrow \frac{P_1}{\rho}\Delta m - \frac{P_2}{\rho}\Delta m = \frac{1}{2}\Delta m v_2^2 - \frac{1}{2}\Delta m v_1^2 + \Delta m g h_2 - \Delta m g h_1$$

Taking "Δm" common from both sides and then cancel.

$$\cancel{\Delta m}\left(\frac{P_1}{\rho} - \frac{P_2}{\rho}\right) = \cancel{\Delta m}\left(\frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 + gh_2 - gh_1\right)$$

$$\frac{P_1}{\rho} - \frac{P_2}{\rho} = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 + gh_2 - gh_1$$

Take ρ from ~~Right~~ left side and multiply it on Right left side

$$\frac{1}{\rho}(P_1 - P_2) = \frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 + gh_2 - gh_1$$

$$P_1 - P_2 = \rho\left(\frac{1}{2}mv_2^2 - \frac{1}{2}mv_1^2 + gh_2 - gh_1\right)$$

$$P_1 - P_2 = \frac{\rho}{2}v_2^2 - \frac{1}{2}\rho v_1^2 + \rho g h_2 - \rho g h_1$$

$$\boxed{P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2}$$

$$\boxed{P + \frac{1}{2}\rho v^2 + \rho g h = \text{Constant}}$$

Conclusion:-

Thus, Bernoulli's equation States that sum of the pressure, Potential Energy per unit volume and the kinetic energy per unit volume will remain constant.

LE

Application of Bernoulli's Principal :-

When we increase pressure the space decrease a small area left for particle to move Hence there speed also decrease.

Key Point
Speed ↓
Pressure ↑
Pressure ↓
Speed ↑

$$\text{Pressure} \propto \frac{1}{\text{Speed}}$$

Q How Speed of Particle decrease with increase in pressure.

V ↓ P ↑
V = kam

V ↑ P ↓
V = zada

SIO BASED QIA :—

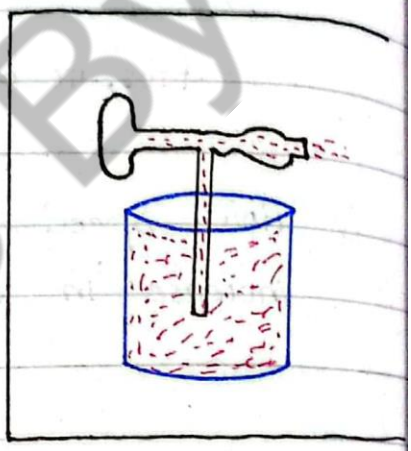
Q Why lighter things like snaks ya napers move ya when a fast moving car pased by them.

Q Why it is danger to stand near the fast moving train?

Q Why two pages come closer when we blow air between them?

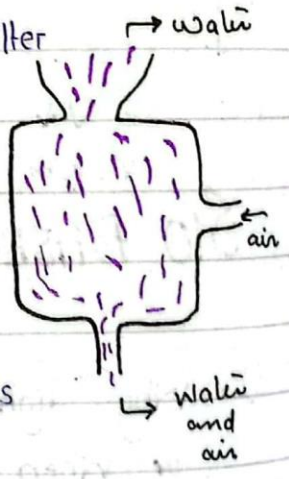
- **ATOMIZER :-**

When air enters through the nozzle the particles gain high energy (kinetic energy)



- **FILTER ~~PAPER~~ PUMP :-**

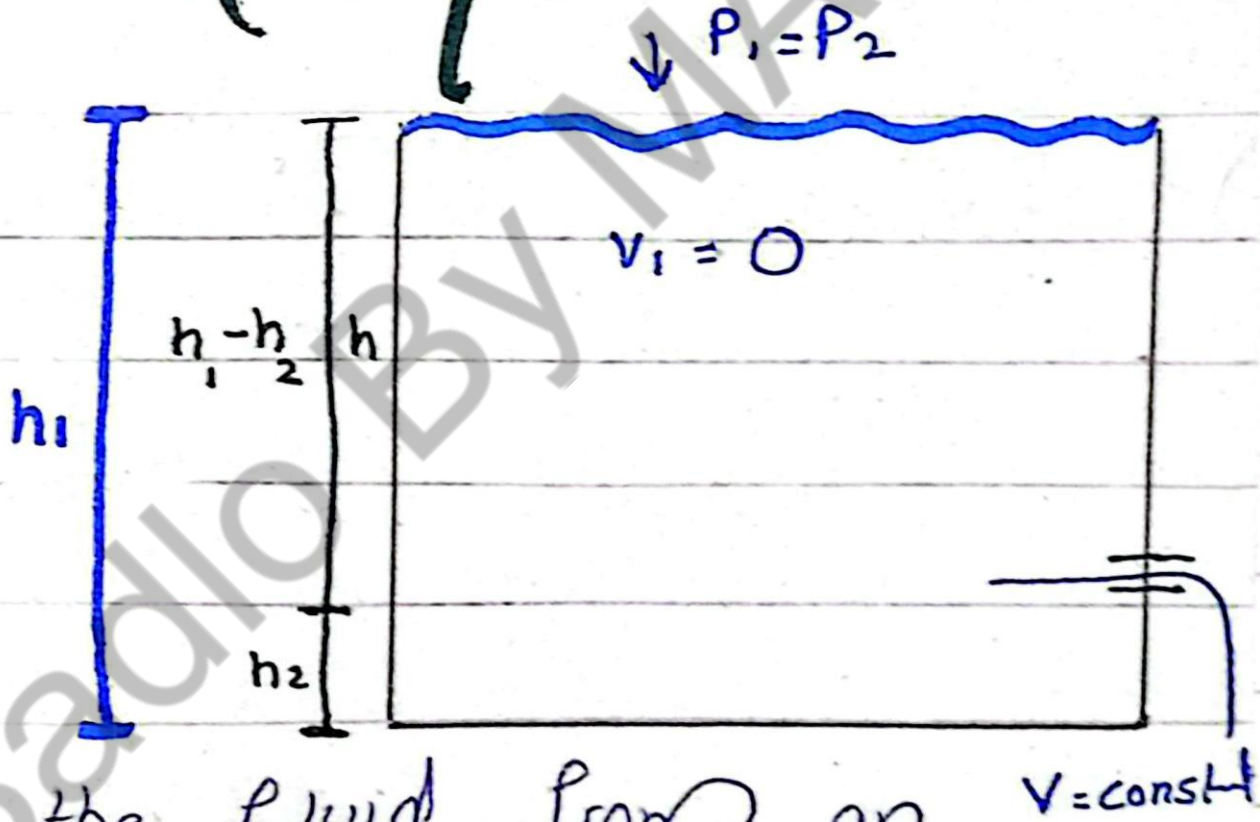
A filter pump has a jet in middle when water from up reaches the jet its speed increases and hence cause a drop in pressure near it, so the water from up starts to cover that area and air and water are forced to the bottom of the filter.



TORRICELLI THEOREM :—

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 =$$

$$P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$



Statement

According to the Theorem " The Speed of the flow of the fluid from an Orifice at depth 'h' below the top

Suiface of the liquid is equal to Speed gain by the fluid in free falling through the height "h"

Derivation:—

Consider a tank filled with some fluid and has an orifice near the bottom of tank. The top suiface of water of height h_1 of and opening near water is height h_2 At the top of suiface is negligible as compared to velocity of efflux V_2, So According to Burnoulli equation we have

$$P_1 + \frac{1}{2}\rho V_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho V_2^2 + \rho g h_2$$

$$V_1 = 0 \quad \& \quad V_2 = V$$

$$P_1 + \frac{1}{2}\rho(0) + \rho g h_1 = P_2 + \frac{1}{2}\rho V^2 + \rho g h_2$$

$$P_1 + \rho g h_1 = P_2 + \frac{1}{2}\rho V^2 + \rho g h_2$$

As $P_1 = P_2 = P$

$$P + \rho g h_1 = P + \frac{1}{2}\rho v^2 + \rho g h_2$$

$$\rho g h_1 - \rho g h_2 = \frac{1}{2}\rho v^2$$

$$\rho g (h_1 - h_2) = \frac{1}{2}\rho v^2$$

$\therefore h - h_2 = h$

$$g(h) = \frac{1}{2}v^2$$

$$v^2 = 2gh$$

$$\boxed{v = \sqrt{2gh}}$$

LECTURE # 61

Help us to find Speed difference Pressure difference

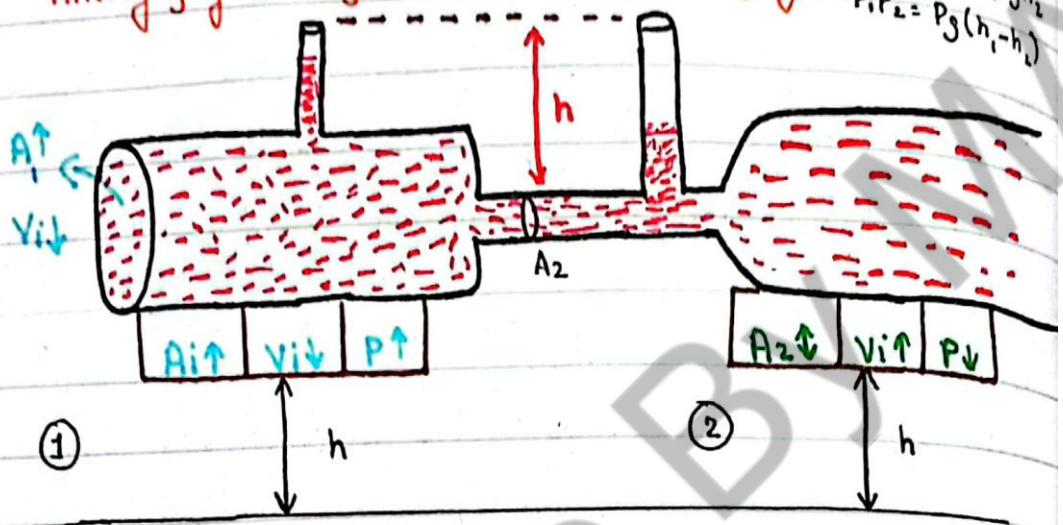
VENTURI METER :—

level sab kay niklay gay lekin niklay gay in kay jo Particles stay karay ga.

$P_1 = \rho g h_1 + P = \rho g h_2$

$P_1 - P_2 = \rho g h_1 - \rho g h_2$

$P_1 P_2 = \rho g (h_1 - h_2)$



Statement :—

Venturi meter is ~~used~~ to is a device used to measure the flow Speed or flow rate through a pipe System.

WORKING PRINCIPAL :—

It work on the principal of pressure difference between restricted and uniestricted flow region

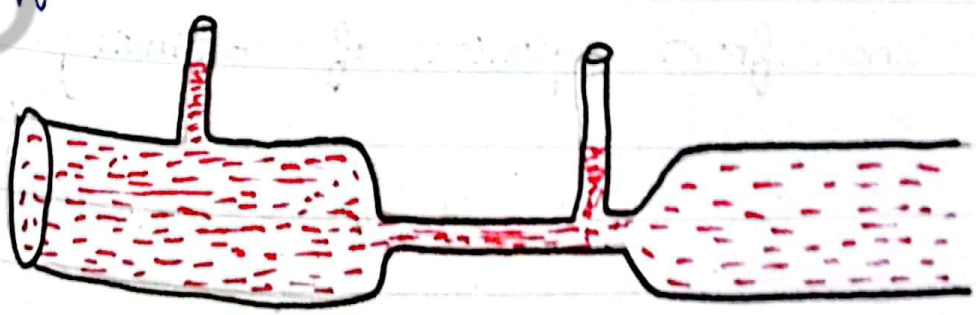
Explanation :—

Consider the flowing liquid is incompressible and negligible internal

friction. The liquid having high pressure "P_1" in area "A_1" with low velocity v_1 converted to the low pressure "P_2" in area "A_2" with high velocity. The point where the fluid has low pressure and high velocity is the palace where the venturi meter is used.

Construction:—

The venturi meter is constructed as show in figure. Venturi meter is so designed as to ensure the stream line flow of liquid through a pipe section Area "A," with a flow velocity "v_1" and pressure "P_1". In the narrow Section (the throat) with Area "A_2" the fluid flow with flow Speed "V_2" and has pressure "P_2". As a Result, the two meters connected along the two tubes at point 1 and 2, indicates the difference in pressure by means of a height difference h.



MATHMATICAL DERIVATION :—

To derive expression for the piessure difference we use the Buernoulli's equation and continuity equation. First applying Bernoulli equation to the portion '1' and '2'. we have

$$P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2$$

Since $\boxed{h = h_1 = h_2}$

$$P_1 + \frac{1}{2}\rho v_1^2 + \cancel{\rho g h} = P_2 + \frac{1}{2}\rho v_2^2 + \cancel{\rho g h}$$

$$P_1 + \frac{1}{2}\rho v_1^2 = P_2 + \frac{1}{2}\rho v_2^2$$

$$P_1 - P_2 = \frac{1}{2}\rho v_2^2 - \frac{1}{2}\rho v_1^2$$

$$\boxed{P_1 - P_2 = \frac{1}{2}\rho\left(v_2^2 - v_1^2\right)} \quad \text{— (x)}$$

Since from equation of continuity

$$A_1 v_1 = A_2 v_2$$

$$V_2 = \frac{A_1 V_1}{A_2} \quad \text{— (i)}$$

Putting eq (i) in eq (x) then

$$P_1 - P_2 = \frac{1}{2}\rho\left(\left(\frac{A_1 V_1}{A_2}\right)^2 - V_1^2\right)$$

$$P_1 - P_2 = \frac{1}{2}\rho\left[\left(\frac{A_1^2 V_1^2}{A_2^2}\right) - V_1^2\right]$$

$$P_1 - P_2 = \frac{1}{2}\rho V_1^2\left[\frac{A_1^2}{A_2^2} - 1\right] \quad \text{— (ii)}$$

Since pressure difference is

$$P_1 - P_2 = \rho g h \quad \text{— (iii)}$$

$P_1 = \rho g h_1$, $P_2 = \rho g h_2$

$P_1 - P_2 = (\rho g h_1 - \rho g h_2)$

$P_1 - P_2 = \rho g (h_1 - h_2)$

$P_1 - P_2 = \rho g h$

Putting eq(iii) in eq (ii)

$$\cancel{\rho} g h = \frac{1}{2}\cancel{\rho} V_1^2\left[\frac{A_1^2}{A_2^2} - 1\right]$$

$$g h = \frac{1}{2} V_1^2\left[\frac{A_1^2}{A_2^2} - 1\right]$$

$$V_i^2 = \frac{2gh}{\left[\frac{A_1^2}{A_2^2} - 1\right]}$$

Taking Square roots on both Sides

$$\sqrt{V_i^2} = \sqrt{\frac{2gh}{\left[\frac{A_1^2}{A_2^2} - 1\right]}}$$

$$V_i = \sqrt{\frac{2gh}{\left[\frac{A_1^2 - A_2^2}{A_2^2}\right]}}$$

$$V_i = \sqrt{\frac{2gh \times A_2^2}{A_1^2 - A_2^2}}$$

$$V_i = A_2 \sqrt{\frac{2gh}{A_1^2 - A_2^2}} \quad \text{— (y)}$$

Conclusion:—

If "A_1", "A_2" and h are known then, we can find V_i by using (Y) and V_f by using (z) and hence, the flow rate can be calculated using equation of Continuity.

..Just for Entertainment :-

$$A_1V_1 = A_2V_2$$

$$\boxed{V_1 = \frac{A_2V_2}{A_1}}$$

$$P_1 - P_2 = \frac{1}{2}\rho\left[(V_2)^2 - \left(\frac{A_2V_2}{A_1}\right)^2\right]$$

$$P_1 - P_2 = \frac{1}{2}\rho\left[V_2^2 - \frac{A_2^2V_2^2}{A_1^2}\right]$$

$$P_1 - P_2 = \frac{1}{2}\rho V_2^2\left[1 - \frac{A_2^2}{A_1^2}\right]$$

$$P_1 - P_2 = \frac{1}{2}\rho V_2^2\left[\frac{A_1^2 - A_2^2}{A_1^2}\right] \quad \text{— (i)}$$

Put this eq (i) in following

$$P_1 - P_2 = \rho gh$$

$$\rho gh = \frac{1}{2}\rho V_2^2\left[\frac{A_1^2 - A_2^2}{A_1^2}\right]$$

$$V_2^2 = \frac{2gh}{\left[\frac{A_1^2 - A_2^2}{A_1^2}\right]}$$

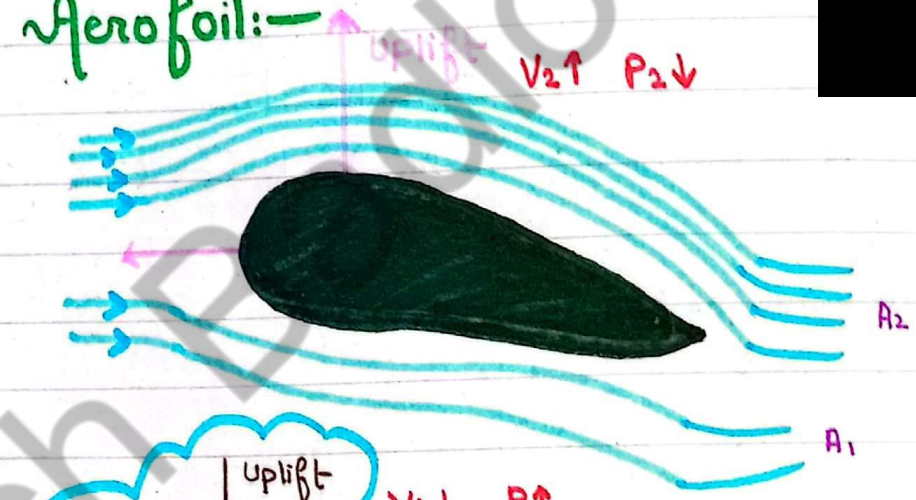
$$V_2^2 = \frac{2gh \times A_1^2}{A_1^2 - A_2^2}$$

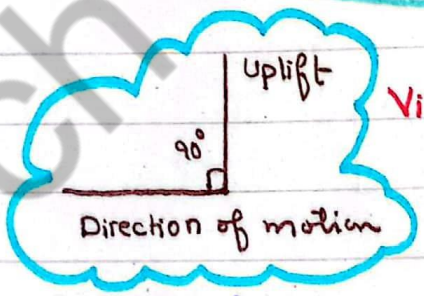
$$\sqrt{V_2^2} = \sqrt{\frac{2gh \times A_1^2}{[A_1^2 - A_2^2]}}$$

$$V_2 = A_1 \sqrt{\frac{2gh}{[A_1^2 - A_2^2]}}$$

LECTURER # 6 & 2

Aerofoil:—





$V_1 < V_2$

$P_1 > P_2$

Uplift force is created due to difference in pressure at lower end $p_1 > p_2$ (upward Pressure)

→ Pressure difference should be created due to difference in speed

Example:—

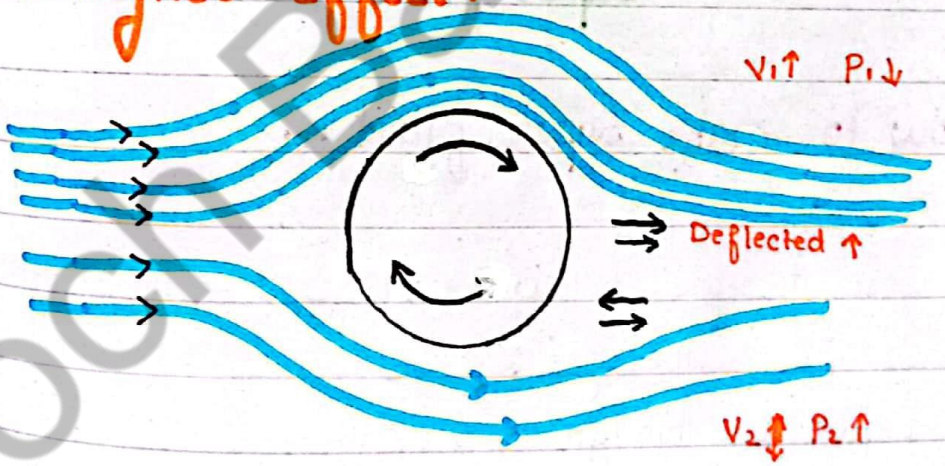
1. Plane wings
2. Birds feather

Due to the shape of wing the pressure is high and a velocity decrease. in lower region.

Q1. Who lift of aerofoil help in take-off the plane?

Q2. Why velocity is low in aerofoil at its lower region.

Magnus Effect:—



Playing cricket as a Spinner make you believe in Magnus Effect

LECTURER # 63

SUPER FLUIDITY :—

unusual behaviour.

Different Fluid

" Super fludily is the condition in which the viscosity between the layers of fluid is zero "

—: MIND MAP :—

Viscosity :— (η)

It is the measurement of resistance / opposite b/w the layers of fluid when it flows.

No Viscosity , No Franction Means Super fluid

How to make Super fluid :—

1- Cool the gas below -273°C.
2- Compress the gas.
3- Expell it through small nozzle
4- Gas expands.
5- It rapidly cools.