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- Apparent decrease in weight of body = upthrust = weight of liquid displaced by the body.
- Floation :
 - A body floats in a liquid if the average density of the body is less than that of the liquid.
 - The weight of the liquid displaced by the immersed part of body must be equal to the weight of the body.
 - The centre of gravity of the body and centre of buoyancy must be along the same vertical line.

1.2 Fluid Dynamics

Steady Flow (Stream Line Flow)

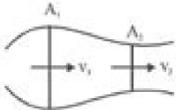
The flow in which the velocity of fluid particles crossing a particular point is the same at all the times. Thus, each particle takes the same path as taken by a previous particle through that point.

Line of flow

It is the path taken by a particle in flowing liquid. In case of a steady flow, it is called streamline. Two streamlines can never intersect.

1.2.1 Equation of Continuity

In a time Δt , the volume of liquid entering the tube of flow in a steady flow is $A_1 V_1 \Delta t$. The same volume must flow out as the liquid is incompressible. The volume flowing out in Δt is $A_2 V_2 \Delta t$.

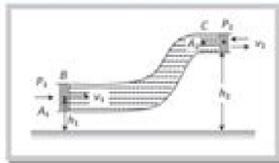


- $A_1 V_1 = A_2 V_2$
- mass flows rate = ρAV
(where ρ is the density of the liquid.)

1.2.2 Bernoulli's Theorem

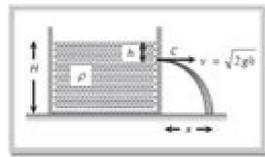
In a stream line flow of an ideal fluid, the sum of pressure energy per unit volume, potential energy per unit volume and kinetic energy per unit volume is always constant at all cross section of the liquid.

$$P + \rho gh + \frac{\rho V^2}{2} = \text{Constant}$$



- Bernoulli's equation is valid only for incompressible steady flow of a fluid with no viscosity.
- Application of Bernoulli's Theorem.

(a) Velocity of Efflux



Let us find the velocity with which liquid comes out of a hole at a depth h below the liquid surface. Using Bernoulli's theorem,

$$P_A + \frac{1}{2} \rho V_A^2 + \rho gh_A = P_B + \frac{1}{2} \rho V_B^2 + \rho gh_B$$

$$\Rightarrow P_{atm} + \frac{1}{2} \rho V_A^2 + \rho gh = P_{atm} + \frac{1}{2} \rho V^2 + 0$$

(Note: $P_B = P_{atm}$, because we have opened the liquid to atmosphere)

$$\Rightarrow V^2 = V_A^2 + 2gh$$

Using equation of continuity

$$AV_A = aV$$

A : area of cross-section of vessel

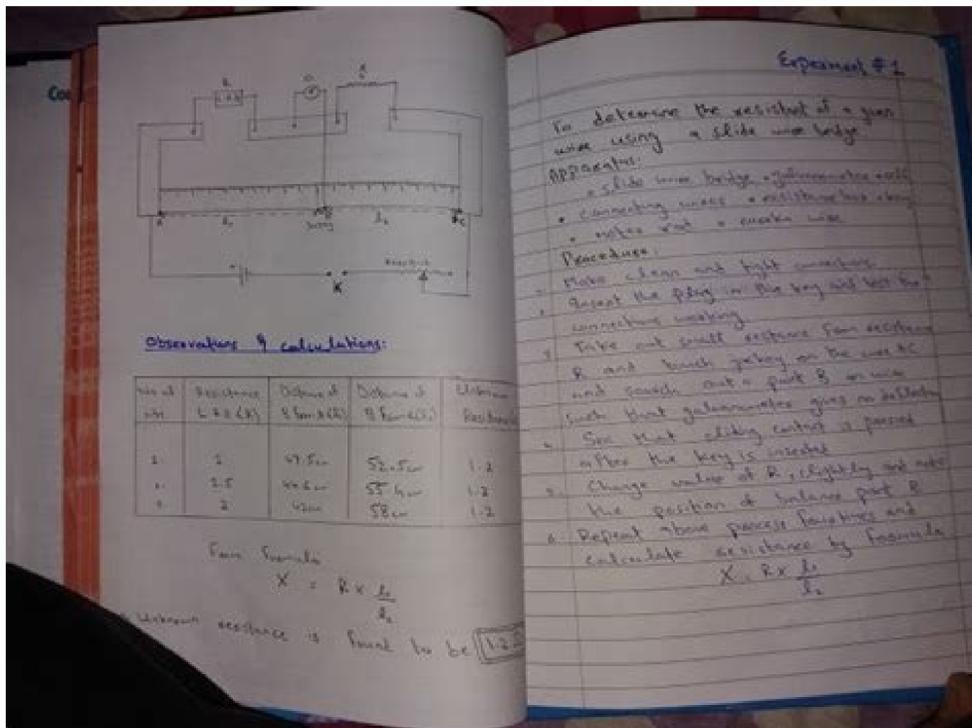
a : area of hole

$$\Rightarrow V^2 = \frac{a^2}{A^2} V^2 + 2gh$$

$$\Rightarrow V = \frac{\sqrt{2gh}}{\sqrt{1 - a^2/A^2}} = \sqrt{2gh} \quad (\text{if the hole is very small})$$

(b) Venturi Meter

This is an instrument for measuring the rate of flow of fluids.



Quantity	Symbol	SI Unit
Pressure	P	N m^{-2}
Force	F	N
Area	A	m^2
Volume	V	m^3
Mass	m	kg
Weight	W	N
Height	h	m
Velocity	V	m s^{-1}
Acceleration	a	m s^{-2}
Angular velocity	ω	rad s^{-1}
Angular acceleration	α	rad s^{-2}
Work done	W	J
Power	P	W
Energy	E	J
Potential energy	U	J
Kinetic energy	K	J





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