Fluids

Pressure exerted by a liquid

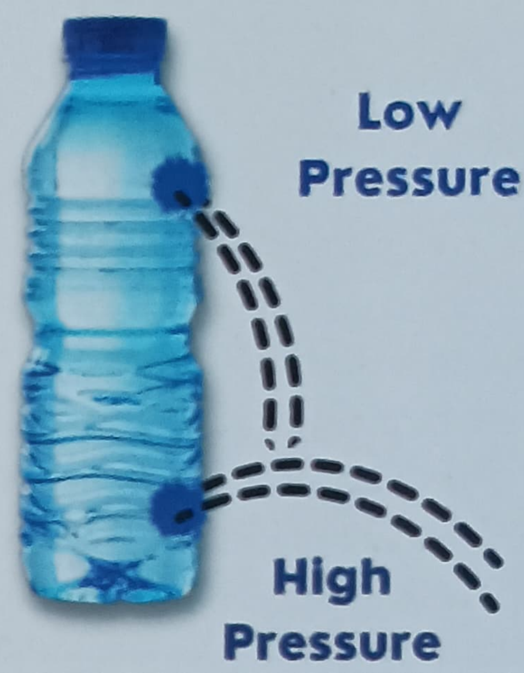
$$p = \rho g h$$

Up/Down accelerating container

$$p = \rho g_{eff} h$$

Horizontal accelerating container

$$\tan\theta = \frac{a}{g}$$



Pascal's Law

The increase in pressure at a point in the enclosed liquid in equilibrium is transmitted equally in all directions in the liquid.

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

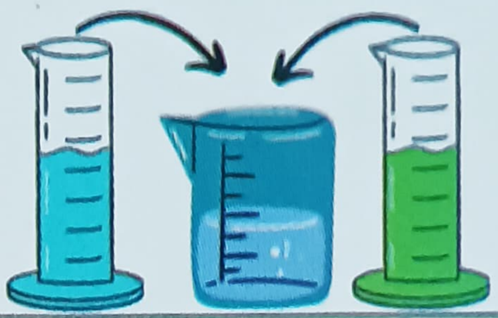
Here
P1 = P2

Relative Density
(Specific Gravity)
ρ_l = density of liquid
ρ_w = denisty of water

$$\frac{\rho_l}{\rho_w}$$

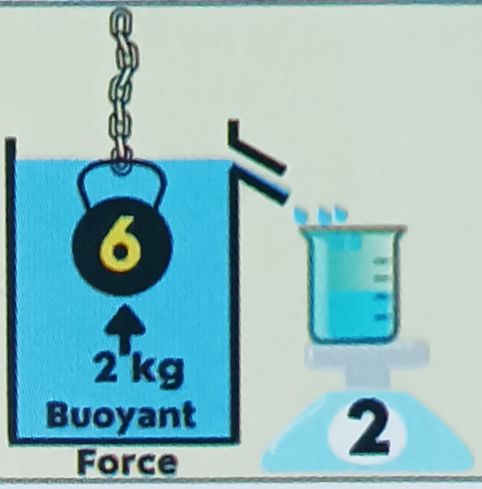
Density of a Mixture of Substances

For Same Mass	For Same Volume
$\rho_M = \frac{2\rho_1\rho_2}{\rho_1+\rho_2}$	$\rho_M = \frac{\rho_1+\rho_2}{2}$



Archimedes Principle

When a body is partially or fully immersed in a liquid, it loses some of its weight and it is equal to the weight of the liquid displaced by the immersed part of the body.

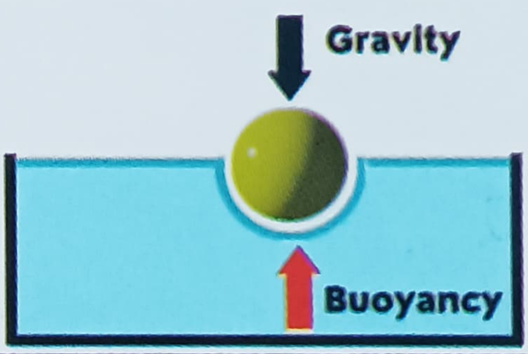


Buoyancy

v = volume of submerged solid

ρ = density of the liquid

$$F = v\rho g$$



Hydrodynamics

Equation of Continuity

If a liquid is flowing in streamline flow in a pipe of non-uniform cross-sectional area, then rate of flow of liquid across any cross-section remains constant.

$$av = \text{constant}$$

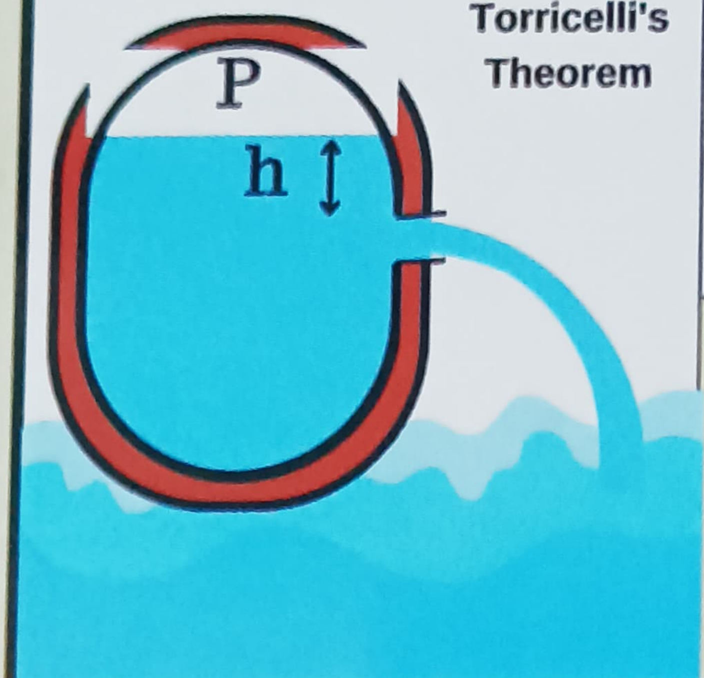
$$a_1v_1 = a_2v_2$$

$$a_1v_1 = a_2v_2$$

Bernoulli's Theorem	$p + \frac{1}{2}\rho v^2 + \rho g h =$ constant

If an ideal liquid is flowing in streamlined flow, then total energy, i.e. sum of pressure energy, kinetic energy and potential energy per unit volume remains constant at every cross-section of the tube.

Torricelli's Theorem



Velocity of Efflux

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

h = depth of orifice below the free surface of liquid

Time required to make the tank empty

$$t = \frac{A}{A_0}\sqrt{\frac{2H}{G}}$$

Viscous Force (Viscocity)

$\frac{dv}{dx}$ = velocity gradient

A = area of cross-section

η = coefficient of viscocity

$$F = -\eta A \frac{dv}{dx}$$

Stoke's Law

When a small spherical body falls in a liquid column with terminal velocity, then viscous force acting on it is

$$F = 6\pi\eta r V_T$$

Terminal Velocity σ = density of object ρ = density of liquid	$V_T = \frac{2r^2(\sigma - \rho)}{9\eta} g$	$\sigma < \rho$: Body falls down $\sigma > \rho$: Body moves up

Rate of Volume Flow through Pipe (Poiseuille's Formula)	$Q = \frac{\pi \Delta p r^4}{8\eta l}$

Surface Tension

Surface Tension	$S = \frac{F}{l} = \frac{E}{A}$ = Force per unit length. = Energy per unit area
Surface Energy	$\Delta E = S\Delta A$
Work done in Splitting a Bigger drop into n smaller Droplets $W = 4\pi S R^2 (n^{1/3} - 1)$	**When n liquid drop coalesce to form one drop** **Percent Loss in Energy** $Loss\ \% = \left(\frac{1}{n^{1/3}} - 1\right) \times 100$
Excess Pressure inside a Liquid Drop $P_i - P_0 = \frac{2S}{R}$	**Excess Pressure inside a Soap Bubble** $P_i - P_0 = \frac{4S}{R}$
Radius of Interface in Double Bubble $\frac{1}{R} = \frac{1}{R_1} - \frac{1}{R_2}$	**Radius under isothermal condition two bubble coalesce** $r = \sqrt{r_1^2 + r_2^2}$
Ascent of Liquid in a Capillary Tube	$h = \frac{2S\cos\theta}{r\rho g}$