Archimedes Principle

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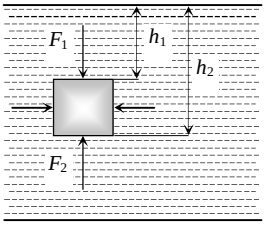
When a body is partly or wholly immersed in a fluid, the fluid exerts force on the body due to hydrostatic pressure. At any small portion of the surface of the body, the force exerted by the fluid is perpendicular to the surface and is equal to the pressure at that point multiplied by the area. The resultant of all these constant forces is called up thrust or buoyancy.

To determine the magnitude and direction of this force consider a body immersed in a fluid of density σ as shown in figure. The forces on the vertical sides of the body will cancel each other. The top surface of the body will experience a downward force.

$F_1 = AP_1 = A(h_1\sigma g + P_0)$ [As $P = h\sigma g + P_0$]

While the lower face of the body will experience an upward force.

$F_2 = AP_2 = A(h_2\sigma g + P_0)$



As $h_2 > h_1, F_2$ will be greater than F_1, so the body will experience a net upward force

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

If L is the vertical height of the body $F = A\sigma gL = V\sigma g$ [As $V = AL = A(h_2 - h_1)$]

i.e., F = Weight of fluid displaced by the body.

This force is called upthrust or buoyancy and acts vertically upwards (opposite to the weight of the body) through the centre of gravity of

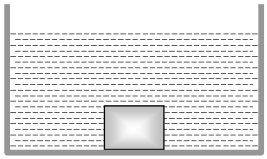
Floatation

Translatory equilibrium : When a body of density ρ and volume V is immersed in a liquid of density σ, the forces acting on the body are

Weight of body $W = mg = V\rho g,$ acting vertically downwards through centre of gravity of the body.

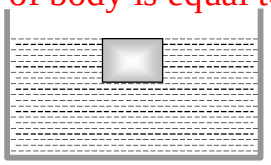
Upthrust force = $V\sigma g$ acting vertically upwards through the centre of gravity of the displaced liquid *i.e.*, centre of buoyancy.

If density of body is greater than that of liquid $\rho > \sigma$



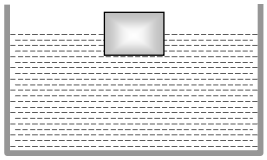
Weight will be more than upthrust so the body will sink

If density of body is equal to that of liquid $\rho = \sigma$



Weight will be equal to upthrust so the body will float fully submerged in neutral equilibrium with its top surface in it just at the top of liquid

If density of body is lesser than that of liquid $\rho < \sigma$



Weight will be less than up thrust so the body will, move upwards and in equilibrium will float and partially immersed in the liquid Such that, $W = V_{in}\sigma g \Rightarrow V\rho g = V_{in}\sigma g$

$V\rho = V_{in}\sigma$ Where V_{in} is the volume of body in the liquid