RADIANT 2026

Physics

Upthrust in Fluid, Archimedes' Principle and Flotation

Lecture – 01

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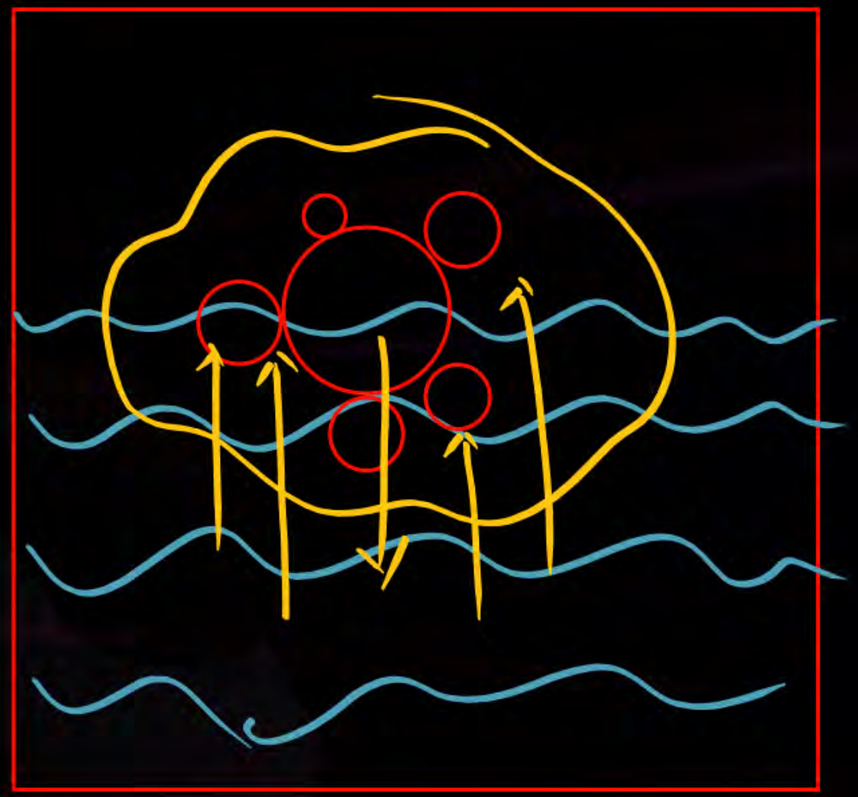
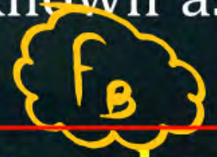
Topics *to be covered*

1. Buoyancy and Upthrust
2. Characteristic Properties of Upthrust
3. Archimedes' Principle



Buoyancy and Upthrust

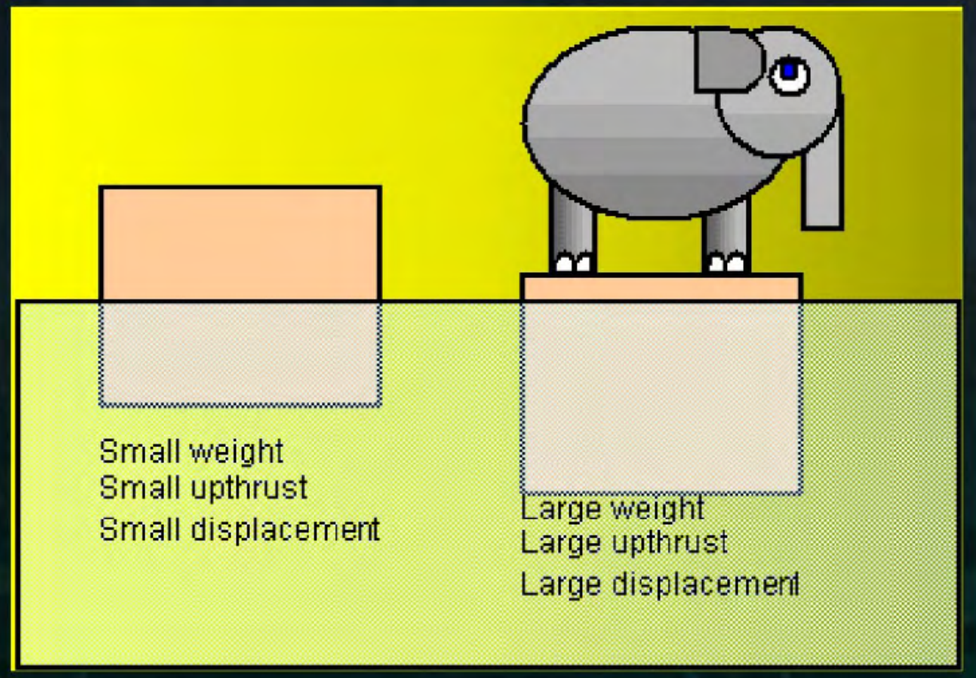
When a body is partially or wholly immersed in a liquid, an upward force acts on it. This upward force is known as **upthrust** or **buoyant force.** It is denoted by the symbol F_B. Thus



The upward force exerted on a body by the fluid in which it is submerged, is called the upthrust or buoyant force.

The property of liquid to exert an upward force on a body immersed in it, is called **buoyancy**. This property can be demonstrated by the following experiments.

Buoyancy and Upthrust


Small weight
Small upthrust
Small displacement
Large weight
Large upthrust
Large displacement

Buoyancy and Upthrust

Depending upon the density of the fluid, the maximum buoyant force F_B' can be greater than, equal to or less than the weight W of the given body. Whether the body will float or sink in a fluid, depends on the relative magnitudes of forces W and F_B' (buoyant force when the body is fully immersed).

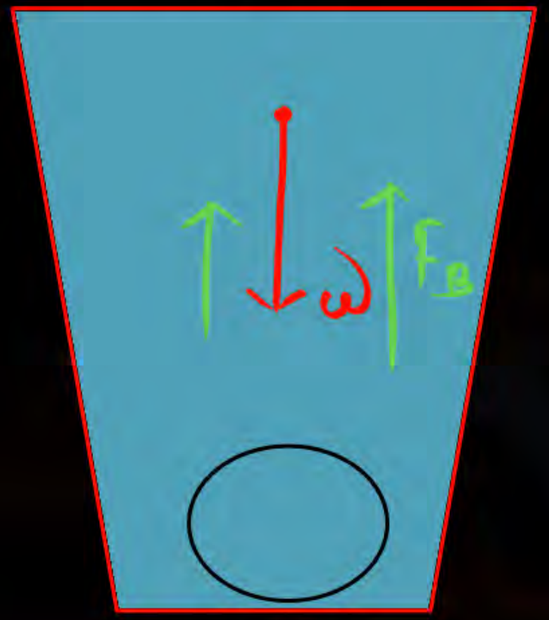
(i) If $F_B' > W$ or $F_B' = W$, the body will float (it will not sink). If $F_B' > W$, the body will B float partly immersed with only that much part of it inside liquid, the upthrust F_B due B to which becomes equal to the weight W of body (i.e., $F_B = W$). But if $F_B' = W$, the B body will float with whole of it immersed inside the liquid. Thus for a floating body, net force acting downwards (i.e., apparent weight) is zero.

Buoyancy and Upthrust

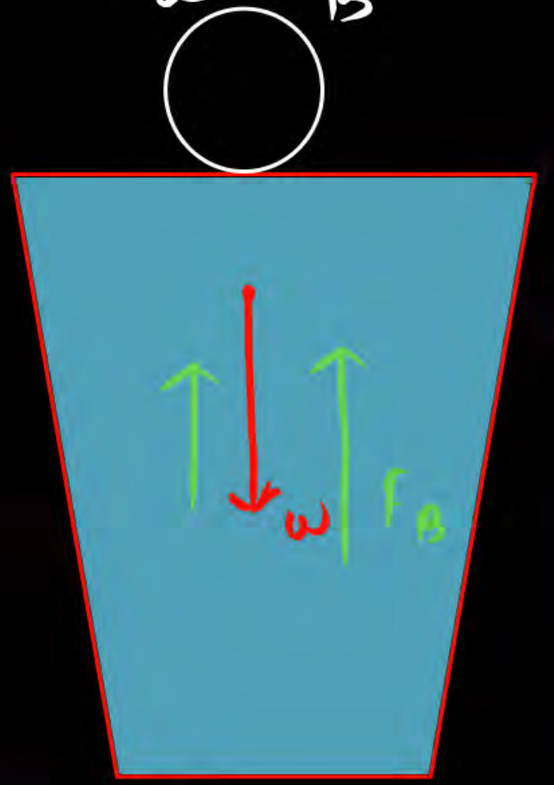
(ii) If F_B' < W, the body will sink due to the net force (W- F_B') acting on the body downwards. If m is the mass of body, it will go down into the liquid with an acceleration a such that ma = W – F_B' or a = (W – F_B')/m. Here we have ignored the viscous force of the liquid.

Unit of upthrust: The upthrust, being a force, is measured in newton (N) or kgf.

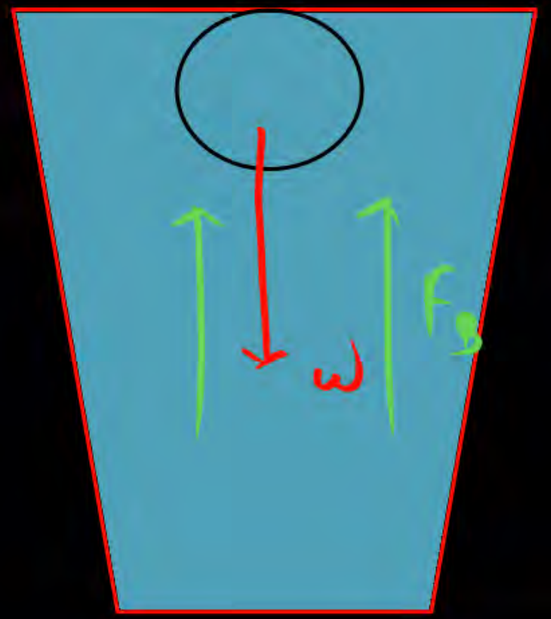
$\omega > F_B$

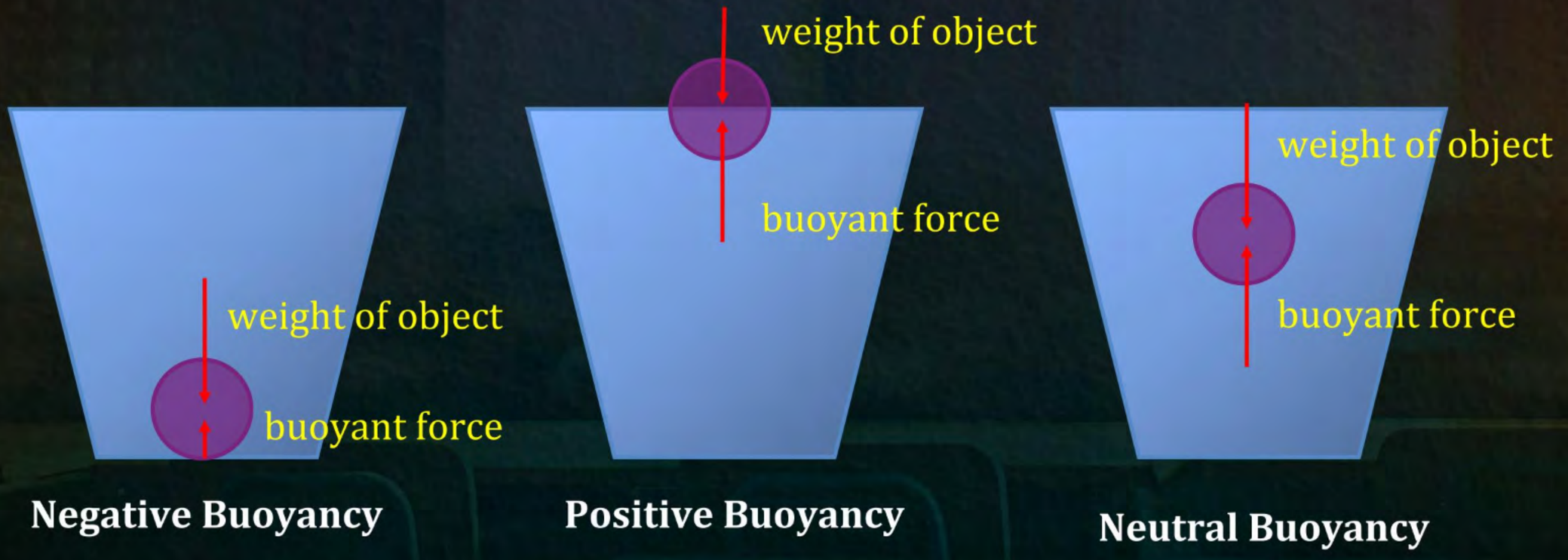


$\omega < F_B$



$\omega = F_B$




weight of object
buoyant force
weight of object
buoyant force
weight of object
buoyant force
Negative Buoyancy
Positive Buoyancy
Neutral Buoyancy

Characteristic Properties of Upthrust

(i) Larger the volume of body submerged in a fluid, greater is the upthrust.

(ii) For same volume inside the fluid more the density of fluid, greater is the upthrust.

(iii) The upthrust acts on the body in upward direction at the centre of buoyancy i.e., the center of gravity of the displaced fluid.

Upthrust is Equal to the Weight of Displaced Liquid

At depth h_1, pressure on the upper surface PQ

$$P_1 = h_1 \rho g$$

$P = \frac{F}{A}$ $F = P \times A$

$\therefore$ Downward thrust on the upper surface PQ

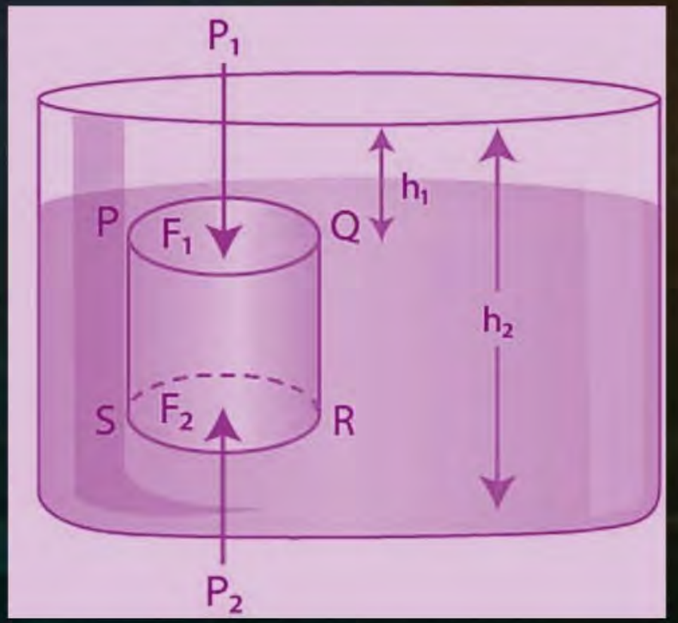
F_1 = pressure × area = $h_1 \rho g$ A = F_1 .....(i)

At depth h_2, pressure on the lower surface RS

$$P_2 = h_2 \rho g$$

$\therefore$ Upward thrust on the lower surface RS

$F_2 = h_2 \rho g$ A .....(ii)



Calculation for Upthrust

Upthrust is Equal to the Weight of Displaced Liquid

The horizontal thrust at various points on the vertical sides of body get balanced because liquid pressure is same at all points at the same depth.

From above eqns. (i) and (ii), it is clear that $F_2 > F_1$ because $h_2 > h_1$ and therefore, the body will experience a net upward force.

Resultant upward thrust (or buoyant force) on the body

$$F_B = F_2 - F_1$$

$$= h_2 \rho g A - h_1 \rho g A$$

$$= A(h_2 - h_1)\, \rho g$$

But $A\,(h_2 - h_1) = V$, the volume of the body submerged in liquid.

$\therefore$ Upthrust $F_B = V\rho g$ ..... (5.1)

Upthrust is Equal to the Weight of Displaced Liquid

$F_B = V\rho g$ $F_B = mg$

or $V\rho g$ = Volume of liquid displaced × density of liquid × acceleration due to gravity.

- = mass of liquid displaced × acceleration due to gravity.
- = Weight of the liquid displaced by the submerged part of the body.

Hence, Upthrust = Weight of the liquid displaced by the submerged part of the body.

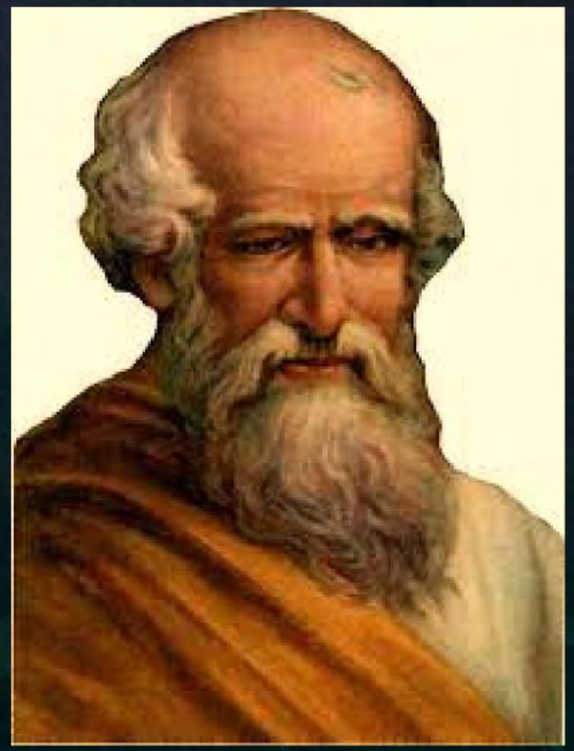
Factors Affecting the Upthrust

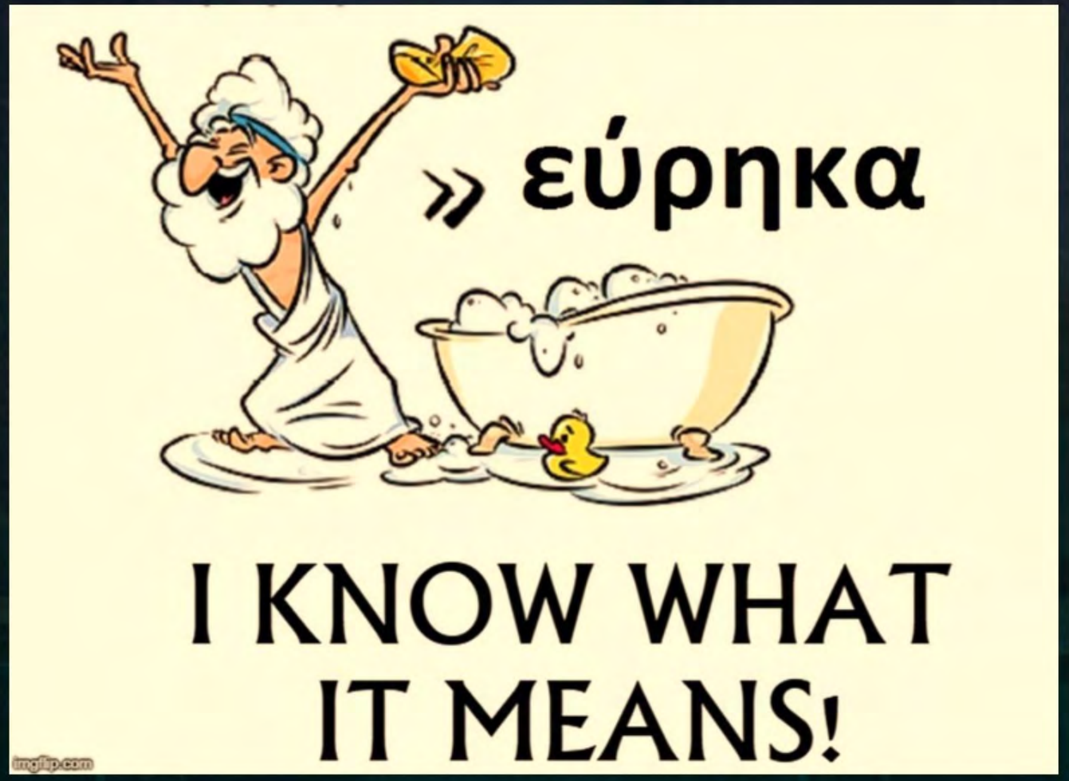
From the above discussion, it is clear that the magnitude of upthrust on a body due to a liquid (or fluid) depends on the following two factors:

(i) volume of the body submerged in liquid (or fluid), and

(ii) density of the liquid (or fluid) in which the body is submerged.

Effect of upthrust: The effect of upthrust is that the weight of body immersed in a liquid appears to be less than its actual weight. This can be demonstrated by the following experiment.

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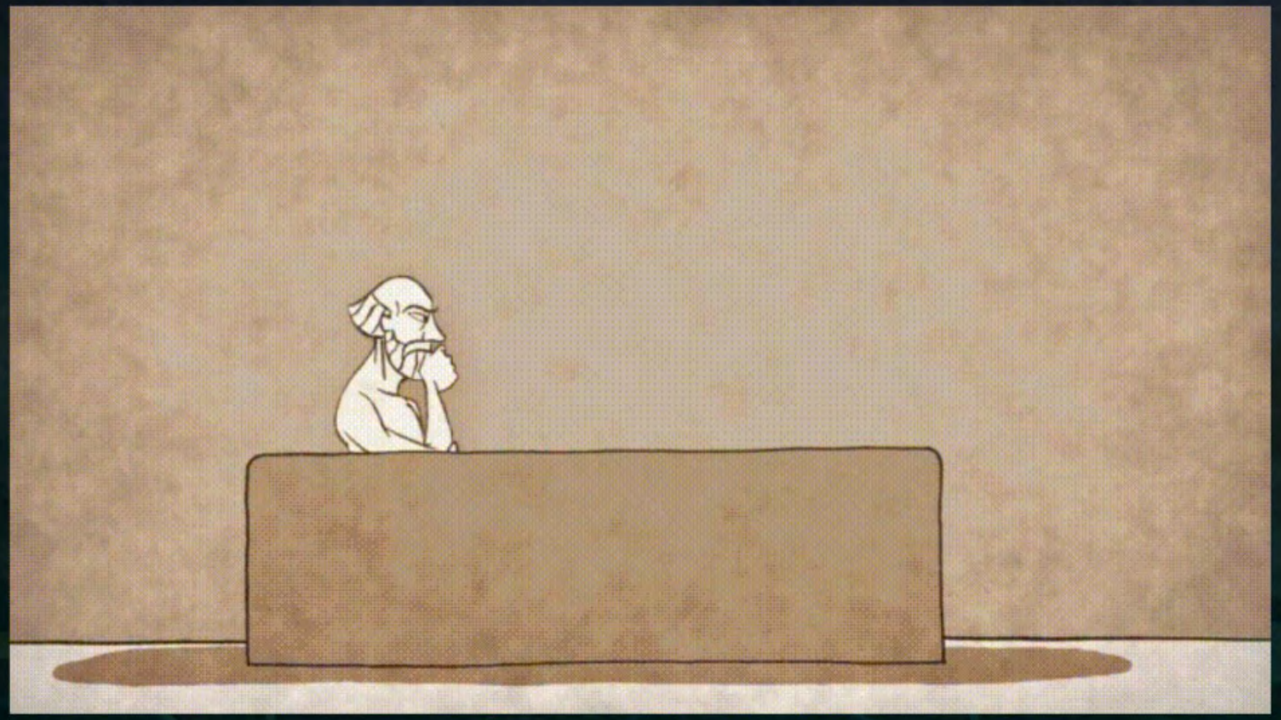
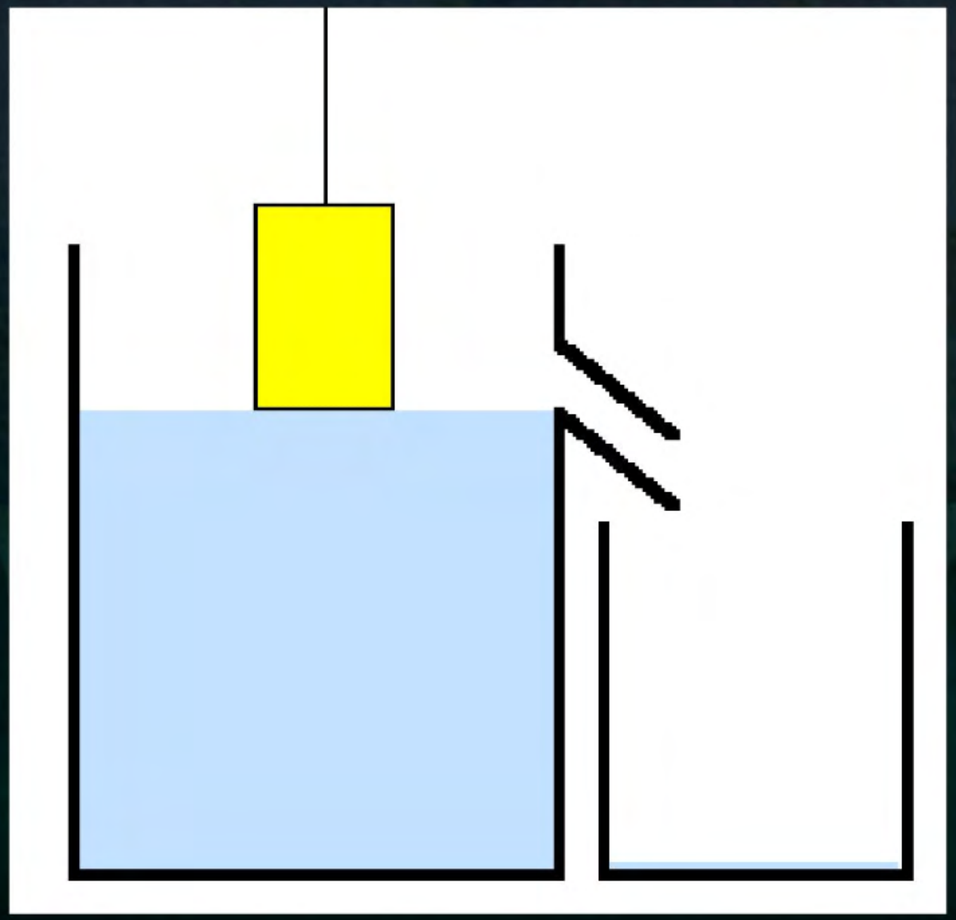
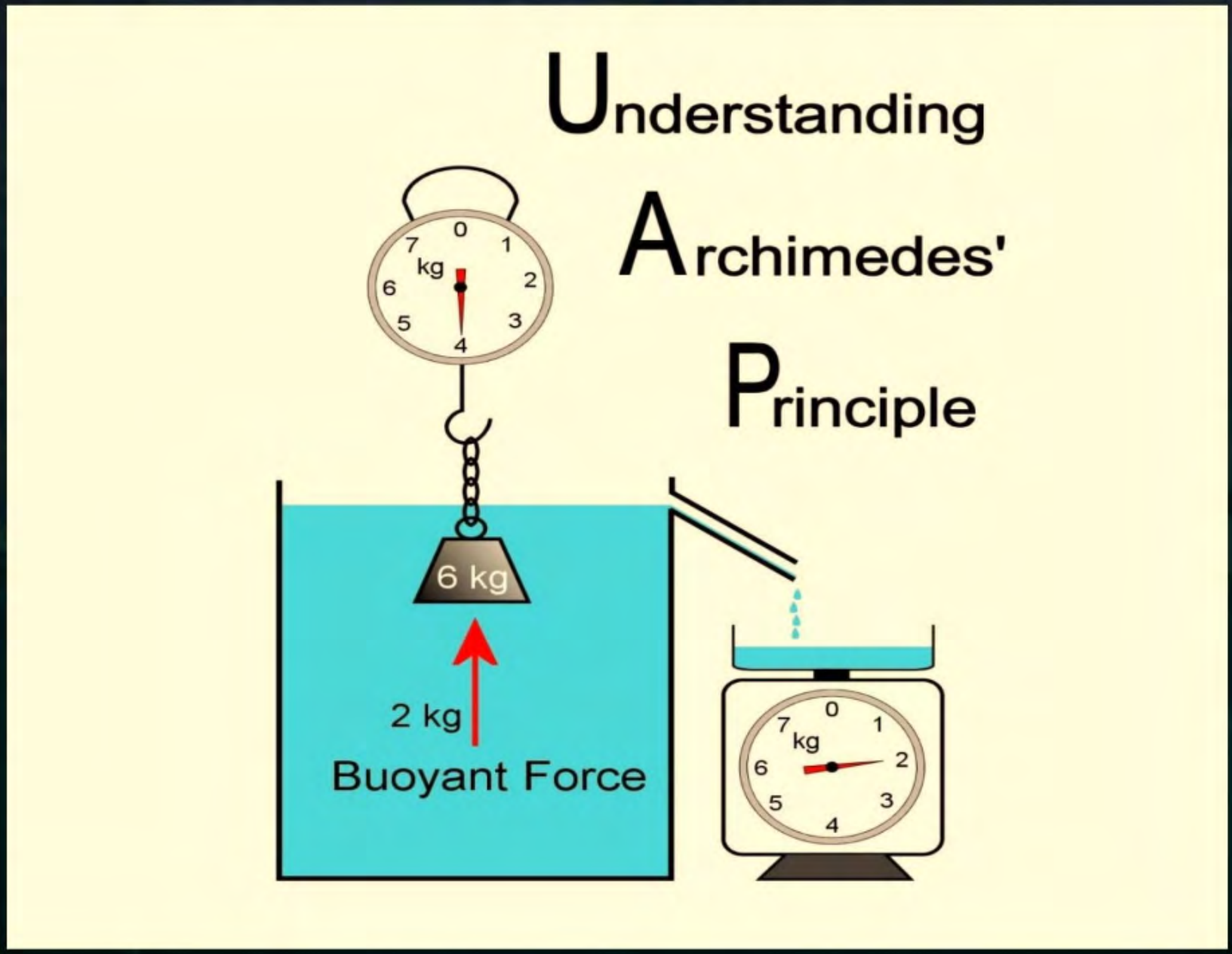


Archimedes' Principle



Archimedes' Principle



Archimedes' Principle

Archimedes' principle states that when a body is immersed partially or completely in a liquid, it experiences an upthrust, which is equal to the weight of the liquid displaced by it.

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