CHAPTER-10

GRAVITATION

Module-4
Class-IX (PHYSICS)

Thrust and Pressure:

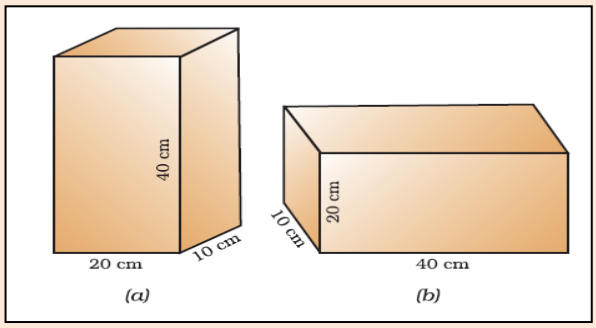
The force acting on an object perpendicular to the surface is called thrust. It is vector quantity and SI Unit of thrust is Newton.
Thrust per unit Area is called Pressure.

$$\text{Pressure} = \frac{Thrust}{Area} = \frac{F}{A} = \frac{mg}{A}$$

The SI unit of pressure as N/m^2 or $N\ m^{-2}$. In honour of scientist Blaise Pascal, the SI unit of pressure is called Pascal, denoted as Pa.

At constant thrust or force, Pressure is inversely proportional to contact area. For example *That is Why is it difficult to hold a school bag having a strap made of a thin and strong string because it make small contact area on our shoulders and feel more pressure.*

Example: A block of wood is kept on a tabletop. The mass of wooden block is 5 kg and its dimensions are 40 cm × 20 cm × 10 cm. Find the pressure exerted by the wooden block on the table top if it is made to lie on the table top with its sides of dimensions as shown in fig. (a) 20 cm × 10 cm and (b) 40 cm × 20 cm



. Solution:

The mass of the wooden block = 5 kg
The dimensions
= 40 cm × 20 cm × 10 cm
Here, the weight of the wooden block applies a thrust on the table top.
That is,
Thrust = $F = m \times g$
= 5 kg × 9.8 m s^{-2}
= 49 N
Area of a side = length × breadth
= 20 cm × 10 cm
= 200 cm^2 = 0.02 m^2
From Eq. (10.20),

$$\text{Pressure} = \frac{49\,\text{N}}{0.02\,\text{m}^2}$$

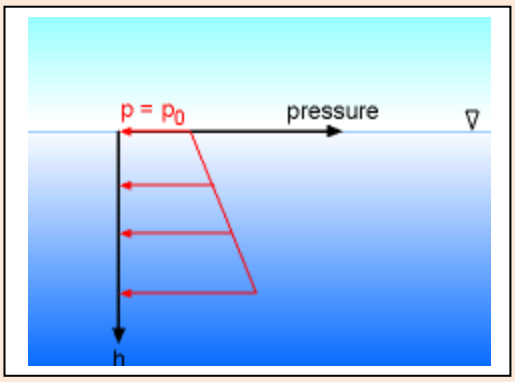
= 2450 N m^{-2}.
When the block lies on its side of dimensions 40 cm × 20 cm, it exerts the same thrust.
Area= length × breadth
= 40 cm × 20 cm
= 800 cm^2 = 0.08 m^2
From Eq. (10.20),

$$\text{Pressure} = \frac{49\,\text{N}}{0.08\,\text{m}^2}$$

= 612.5 N m^{-2}
The pressure exerted by the side 20 cm × 10 cm is 2450 N m^{-2} and by the side

PRESSURE IN FLUIDS:

All liquids and gases are fluids. A solid exerts pressure on a surface due to its weight. Similarly, fluids have weight, and they also exert pressure on the base and walls of the container in which they are enclosed.



1.Fluid pressure is directly proportional to depth of fluid. that is fluid pressure is increases with depth.
2. Fluid pressure is directly proportional to density of fluid. It means fluid pressure is increasing of density
3. Fluid pressure is depends on g, but at certain place it Value is constant.

Fluid pressure is given by,

$$P = h.d.g$$

Where, h = height of vertical coloum.
d = density of fluid.
g = acceleration due to gravity.

Buoyancy and Buoyant Force:

Have you ever had a swim in a pool and felt lighter?
Have you ever drawn water from a well and felt that the bucket of water is heavier when it is out of the water?
Have you ever wondered why a ship made of iron and steel does not sink in sea water, but whether the same amount of iron and steel in the form of a sheet would sink?
These questions can be answered by taking buoyancy in consideration. Let us understand the meaning of buoyancy.
When an object is immersed in fluid(any gas or liquid) completely or partially then the object experienced a force in upward direction, this force is called buoyant force or upthrust, while an upward force exerted by a fluid that opposes the weight of a partially or fully immersed object.
In fact, all objects experience a force of buoyancy when they are immersed in a fluid. The magnitude of this buoyant force depends on the density of the fluid.
Mathematically,
Buoyant force = v.ρ.g
Where, v = volume of liquid displace by immersed part of the body.
ρ = density of fluid
g = acceleration due to Gravity.

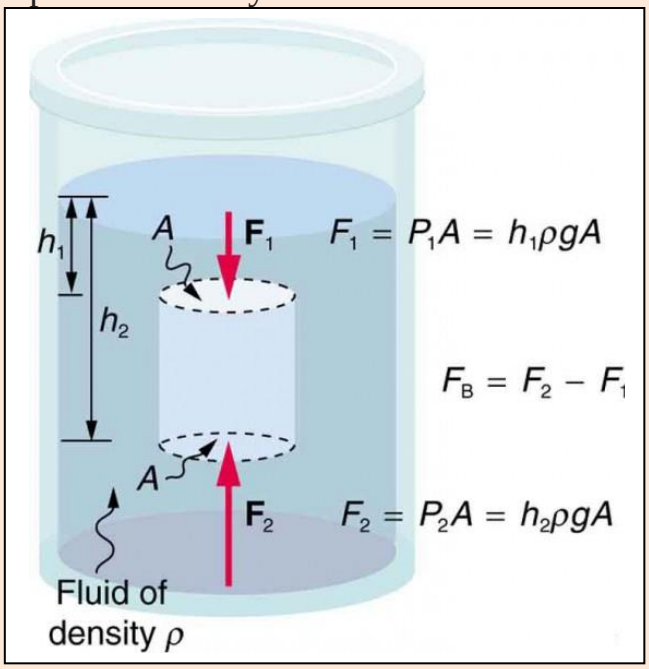
Cause of Buoyancy:

Let a cylindrical object is completely immersed in a liquid as shown in fig.

$$P = h.d.g$$

Always,
$P_{2\ (at\ lower\ surface)} > P_{1(at\ upper\ surface)}$
(because $h_2 > h_1$)

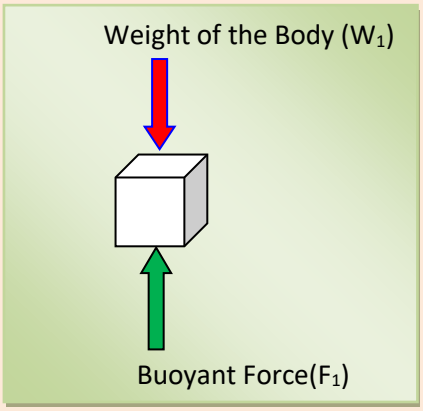
$F_{2\ (at\ lower\ surface)} > F_{1(at\ upper\ surface)}$
Resultant force is always upward.



Why objects float or sink when placed on the surface of water?

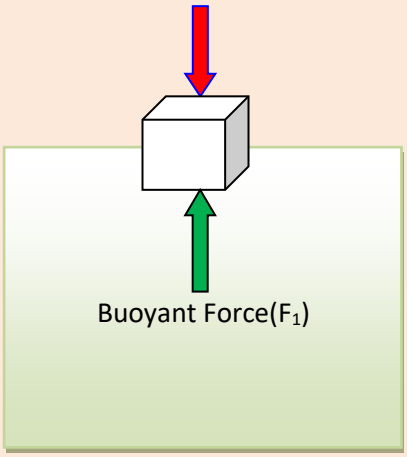
The force due to the gravitational attraction of the earth acts on the object in the downward direction. So the object is pulled downwards. But the water exerts an upward force on the Object (that is buoyant force). So there are three possibility

Case –I: Weight of the Body (W_1) > Buoyant Force (F_1) ⟶ Object will Sink



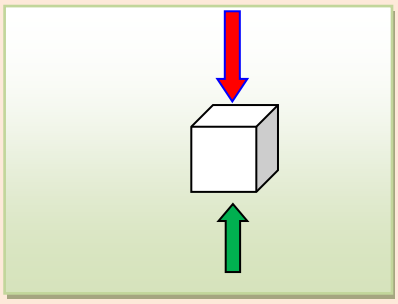
Case-I ($W_1 > F_1$) ➡ Sink

Case –II: Weight of the Body (W_1) < Buoyant Force(F_2) ⟶ Object will Float



Case-II ($W_1 < F_1$) ➡ Float

Case –III: Weight of the Body (W_1) = Buoyant Force (F_2) ⟶ Object will Float inside the liquid surface



Case-III ($W_1 = F_1$) ➡ Float inside the liquid