PHYS1002

DENSITY

Density [ρ] is a material property:

Ratio of mass to volume (kg/m^3)

$$\rho = m/v$$

An object will float if its density is less than the density of the fluid.

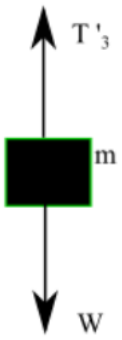
WEIGHT

Weight refers to a force due to gravity and mass refers to the amount of matter.

$$W = (m \times g)\ N$$

m = mass
g = gravity 9.8m/s^2

CONSIDER:



An object suspended on a rope. It is stationary.

Tension force in rope = Weight force

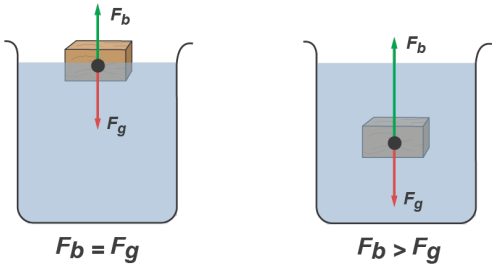
This is an example of a *static equilibrium*, where forces add to produce a zero resultant.

Forces are represented by vectors with magnitude and direction.

BUOYANCY

Immersion of an object in a fluid produces a buoyant force which **partially** counteracts the weight.

When an object floats $F_b = F_g$



Archimedes' Principle

When an object is immersed in a fluid, there is an upward buoyant force *equal to the weight of the volume of the fluid displaced by the object.*

If bag of water was immersed, the buoyant force would be equal to 0 as no water is displaced.

FLOTATION

How to determine how far a floating object is above waterline.

Iceberg example

1. Iceberg is in static equilibrium. $F_w = F_b$
2. Buoyant force = $V_{sea} \times \rho_{sea} \times g$
3. Weight force = $V_{ice} \times \rho_{ice} \times g$
4. $V_{sea/} V_{ice} = \rho_{sea/}\rho_{ice}$

PRESSURE

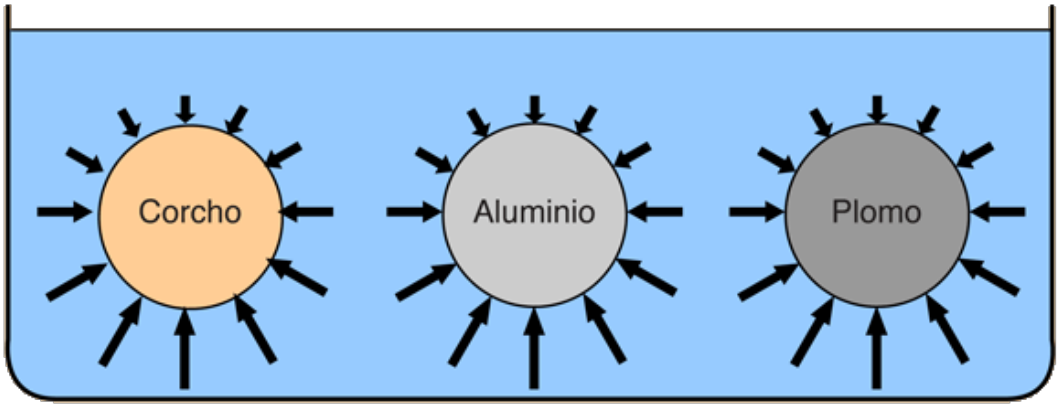
Buoyant force occurs due to pressure from surrounding fluid, a force that acts inwards from all directions on the object.

Pressure occurs **at a point** in a fluid measured in pascals (Pa). Pressure is not a force.

Pressure acting on a surface produces a force. The force is

- Perpendicular to the surface
- Proportional to fluid pressure *p (Force)*
- Proportional to source area *A*

F = p x A



Pressure on all the above samples are the same as area is the same. Pressure at every point, at a given horizontal level in single body of fluid at rest must be equal.

Example: What is the pressure acting on the floor of a pool 50m long, 25m wide, 2m deep?

Weight of water = 50 x 25 x 2 x 9.8 = F
Pressure = F/A

Therefore if depth is double, pressure is doubled.

So $p = p_0 + kd$ where d is depth. Depth is proportional to additional pressure.

Pressure at a point at a distance d below the surface of the fluid is due to the weight of fluid above that point. This is in addition to any pressure p_0 that may be acting on the surface.

$$p = p_0 + \rho gd$$

Gauge Pressure – minus atmospheric pressure