

# Thrust And Pressure

## Pressure

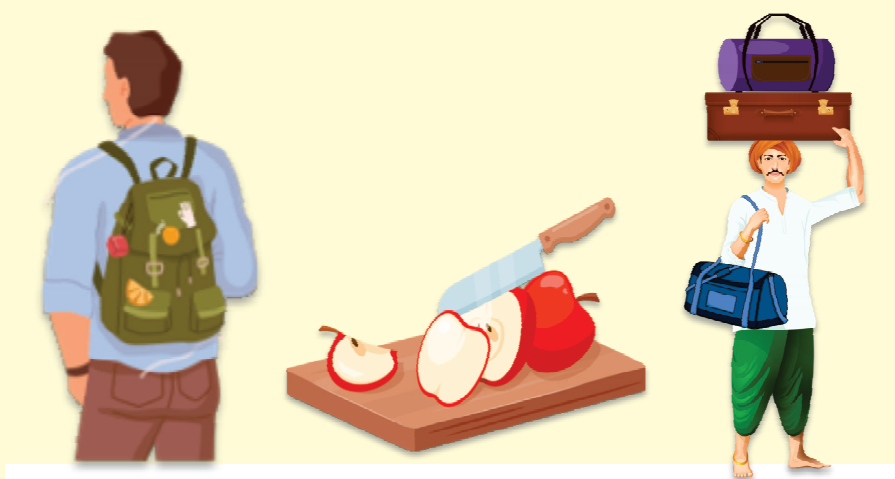
### Thrust -

The force acting on an object perpendicular to the surface is called thrust.

### Pressure -

The thrust on unit area.

$$\text{Pressure} = \frac{\text{Thrust}}{\text{Area}} = \frac{\text{Force}}{\text{Area}}$$



### SI unit of pressure:

$\text{N/m}^2$  or  $\text{N m}^{-2}$ , the SI unit of pressure is called "pascal", denoted as Pa.

$$\begin{aligned} 1 \text{ Pascal} &= 1 \text{ Newton}/(\text{meter})^2 \\ \text{or } 1 \text{ Pa} &= 1 \text{ N/m}^2 = 1 \text{ N m}^{-2} \end{aligned}$$

### Definition of 1 pascal:

If 1 newton force acts perpendicular to a surface of area  $1 \text{ m}^2$ , then the pressure acting on the surface is 1 pascal.

Pressure is a scalar quantity.

A common unit of pressure is the atmosphere (atm), i.e. the pressure exerted by the atmosphere at

sea level,  $1 \text{ atm} = 1.013 \times 10^5 \text{ Pa}$

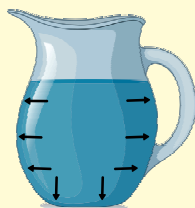
Another unit of pressure is bar,  $1 \text{ Bar} = 10^5 \text{ Pa}$

## Some more examples related to pressure

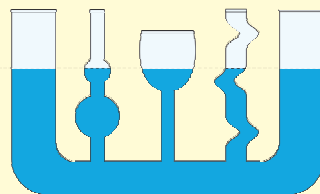
- ☆ You cannot cut vegetables with a blunt knife.
- ☆ The straps of shoulder bags are made wide (broad).
- ☆ Porters (coolies) place on their heads a round piece of cloth, when they have to carry heavy load.
- ☆ Buildings have wide foundations so that they exert less pressure on the earth.

## Pressure in fluids

Fluids can exert pressure on the base and walls of the container in which they are enclosed. Pressure increases with depth. Pressure does not depend on the shape of liquid column.



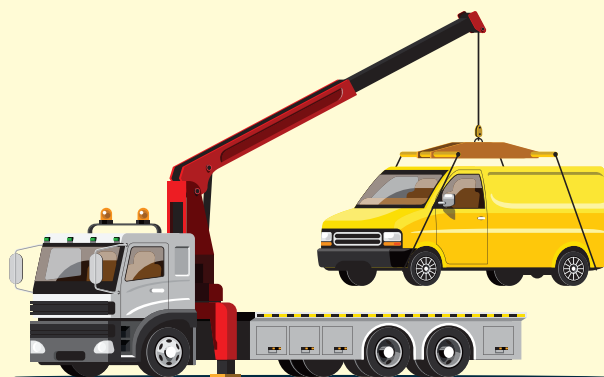
Pressure acts  
in all directions



Pressure is same at  
point on the same height

## Pascal's law

The pressure in a fluid at rest is the same at all points if they are at the same height.



## Density of a substance

The density  $\rho$  of a substance is defined as its mass per unit volume,  $\rho = \frac{m}{V}$

**S.I. unit of density:  $\text{kg/m}^3$  or  $\text{kg m}^{-3}$**

**Its C.G.S. unit is  $\text{g/cm}^3$  or  $\text{g cm}^{-3}$ .**

## What does density depend on?

Density of a material depends on following factors:

**(1) Mass of particles :** The more mass these particles have, the greater the density of the material.

**(2) Distance between particles:** The greater the distance between the atoms or molecules, the smaller the density.

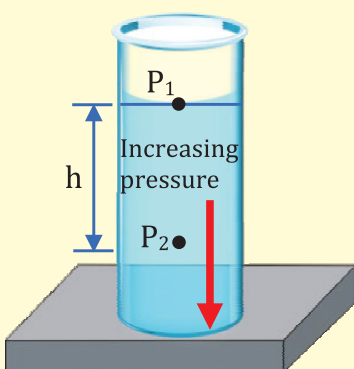
## Relative density (R.D.)

The relative density of a substance is the ratio of its density to the density of water. It is also called 'specific gravity'.

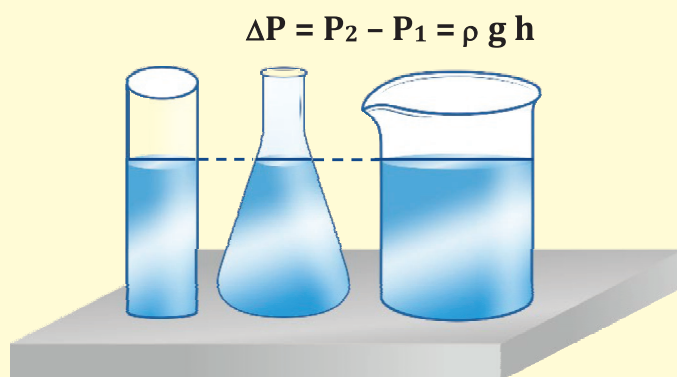
$$\text{R.D.} = \frac{\rho_s}{\rho}$$

## Variation of pressure with depth

The fluid pressure depends only on the height of the column of fluid above the surface where you measure the pressure.



Variation of pressure with depth

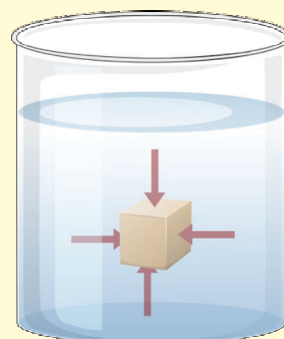


## Buoyancy

The tendency for an immersed body to be lifted up in a fluid, due to an upward force that acts opposite to the action of gravity is called buoyancy.

### The buoyant force

It is an upward force that is exerted by a fluid on any object immersed partly or wholly in the fluid.



Cause of the buoyant force

### Changing the buoyant force

An object sinks or floats depends on whether the buoyant force is smaller than or equal to its weight. The fluid exerts upward pressure on the entire lower surface of the object that is in contact with the fluid.

R.D. =

If  $W_1$  be the weight of an object in air and  $W_2$  be its weight (apparent weight) when it is completely immersed in a liquid, then,  $W_2 = W_1 - F_B$  where,  $F_B$  is the buoyant force acting on it.

$$\text{or } F_B = W_1 - W_2$$

Thus, 'buoyant force is the loss of weight of an object when it is immersed in a liquid'.



## Measuring relative density of an object using Archimedes' principle

Let us take an object having weight  $W_1$  in air. The weight  $W_1$  is measured by using a spring balance.

Now take a vessel filled with water and immerse the object completely in water [see figure(b)] and again note the spring balance reading. This reading gives the weight ( $W_2$ ) of the object in water. Thus, the buoyant force on the object due to water is given by,  $F_B = W_1 - W_2$

Now, relative density is given by,

$$\text{R.D.} = \frac{\text{Density of object}}{\text{Density of water}} = \frac{\rho}{\rho_w} = \frac{\rho V_g}{\rho_w V_g} \dots (2) \text{ (Multiplying and dividing by } V_g \text{)}$$

Where,  $V_s = V_L = V$  = volume of object = volume of water displaced, as the object is immersed completely, and 'g' is the acceleration due to gravity.

Now, weight of object in air,  $W_1 = \rho V_g \dots (3)$

Buoyant force,  $F_B = \rho_w V_g \dots (4)$

$$\text{From (2), (3) and (4), we get, } \text{R.D.} = \frac{W_1}{F_B}$$

$$\text{From (1) and (4), we get, } \text{R.D.} = \frac{W_1}{W_1 - W_2}$$

