GRAVITATION

PRESSURE AND THRUST

THRUST AND PRESSURE THRUST:

Force acting normally on a surface is called the thrust. Thrust is a vector quantity and is measured in the unit of force, i.e., newton (N).

PRESSURE:

The thrust acting on unit area of the surface is called the pressure. If a thrust F acts on a area A, then pressure

$$(P) = \frac{Thrust(F)}{Area(A)}$$

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

Pressure is directly proportional to the force.

Pressure in inversely proportional to the area.

For the examples:

Ex. A sharp knife cuts easily than a blunt knife by applying the same force.

Ex. A sharp needle pressed against our skin pierces it. But a blunt object with a wider contact area does not affect the skin when pressed against it with the same force.

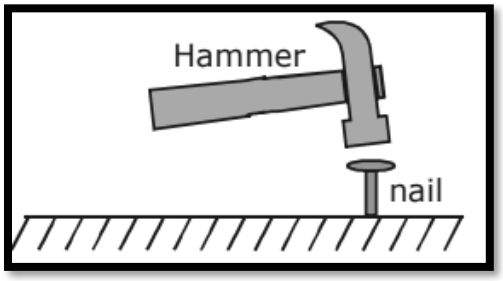
Newton's Thought

When you push a nail using a hammer into a wooden plank by its head, the nail cannot be inserted in the plank. When you push the nail by the pointed end, the nail can easily be inserted in the plank. Why?

Explanation

When you apply a force on the nail using a hammer with its head touching the wooden plank, the pressure exerted on the plank is quite small. This is because pressure is inversely

proportional to area i.e., the larger the area, smaller the pressure on a surface for the same force. When you apply the same force on the nail with its pointed end touching the plank, pressure exerted on the plank is sufficient to insert it into the plank. This is because the area of the pointed end of the nail is much smaller than that of its head.



Some interesting aspects of pressure

1. The foundation of a building or a dam has a large surface area so that the pressure exerted by it on the ground is less. This is done to prevent the sinking of the building or the dam into the ground.

2. The tyres of a bus or a truck have larger width than those of a car. Further, the number of tyres of heavy vehicles is more than four. This is done to enable the tyres to carry more weight and to prevent sinking into ground.

3. A sleeping mattress is so designed that when you lie on it, a large area of your body comes in its contact. This reduces the pressure on the body and sleeping becomes comfortable.

4. Railway track are laid on large sized wooden or iron sleepers.

$$We\ Know, \Pr essure = \frac{Thrust}{Area}$$

The weight (i.e., thrust) of the train is spread over a large area of the sleepers. Therefore, the pressure acting on the ground under the sleepers is reduced. This prevents the sinking of the ground under the weight of the train.

5. A sharp knife is more effective in cutting the objects than a blunt knife.

$$We\ Know, Exerted = \frac{Thrust}{Area}$$

The area under the sharp knife is less than the area under the blunt knife. Hence, the pressure exerted by the sharp knife is more than the pressure exerted by the blunt knife on an object. Therefore, the sharp knife penetrates easily into the object than the blunt knife when same force is applied in both the cases. Hence, a sharp knife cuts the objects easily than a blunt knife.

6. A camel walks easily on the sandy surface than a man inspite of the fact that a camel is much heavier than a man.

This is because the area of camel's feet is large as compared to the area of man's feet. So the pressure exerted by camel on the sandy surface is very small as compared to the pressure exerted by man. Due to large pressure, sand under the feet of a man yields (i.e. sink) and hence he cannot walk easily on the sandy surface.

7. A sharp needle, pierce the skin easily but not a blunt needle although the force applied on both the needles is same.

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

The area under the pointed end of the sharp needle is very small as compared to the area under the pointed end of the blunt needle. So pressure exerted by the sharp needle is much

more than the pressure exerted by the blunt needle. Hence a sharp needle pierces the skin easily than the blunt needle.

8. It is painful to hold a heavy bag having strap made of a strong and thin string.

We know, Pressure $= \frac{Thrust}{Area}$

When we hold a heavy bag having strap made of a strong and thin string, then the area under the strap is small. Hence, large pressure is exerted by the strap on our fingers or shoulder. Due to this large pressure, the strap tends to cut the skin and hence pain is caused.

9. The army tank has a large weight. Therefore to avoid large pressure on the ground its weight is distributed throughout the tank. This is done by making the tank run on a steel track rather than on wheels. The steel tracks reduce the pressure of the ground .

UNITS OF PRESSURE

The SI unit of pressure is called pascal (Pa) in honor of **Blaise Pascal**. I Pa = 1 N/m^2

One pascal is defined as the pressure exerted on a surface area of 1 m2 by a thrust of 1 N (acting normally on it).

Other units:

(i) In C.G.S unit of pressure is dyne/cm^2

(ii) 1 bar = 105 N/m^2

(iii) millibar = 102 N/m^2

(iv) 1 atmospheric pressure (1 atm) = 101·3 k Pa = 1·013 bar = 1013 m bar = 760 mm of Hg

(v) 1 Torr = 1mm of Hg

LAWS OF PRESSURE

1. Pressure exerted by the liquid is the same in all directions about a points

2. Pressure exerted is the same at all points in a horizontal plane as well as in a stationary liquid.

3. Pressure at a points inside a liquid increases with depth from the free surface.

4. Pressure at a particular depth is different for different liquids, i.e. P = hdg where, h = height of the column of liquid. d = density of the liquid g = acceleration due to gravity

5. The pressure exerted anywhere in a confined liquid is transmitted equally and undiminished in all directions throughout the liquid which is called 'Pascal's law'.

(A) Hydrostatic Pressure:

The normal force (or thrust) exerted by a liquid at rest per unit area of the surface in contact with it is called "pressure of liquid or hydrostatic pressure."

(B) Atmospheric Pressure:

The pressure exerted by atmosphere is called atmospheric pressure.

(i) At sea level, atmospheric pressure is the pressure exerted by 0.76 m of mercury column i.e. h = 0.76 m.

(ii) The density of mercury, d = 13.6 × 103 kg m^{-3} and g = 9.8 ms^{-2}. ⇒ atm pressure = P = hdg = 1.013 × 10^5 Nm^{-2} or P