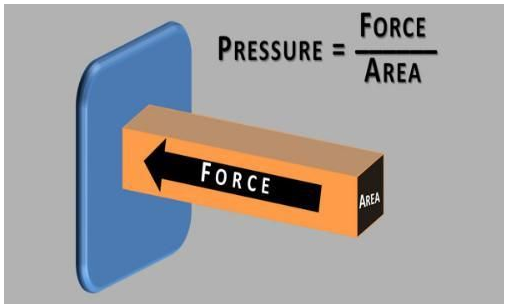
Pressure

Pressure (P) is defined as the force (F) applied per unit area (A) perpendicularly. It is measured in Pascal i.e. Newton per meter square.

Measurement of Pressure

Solution,

Let us consider a body having a cross-sectional area (A) exerting the pressure (P) by the force (F).



Now,

The pressure is directly proportional to the force.

That is, $p \propto F$**.....**(a)

Also,

The pressure is inversely proportional to the area.

That is, $p \propto 1/A$..... (b)

Again, combining equation (a) and (b)

$P \propto F/A$

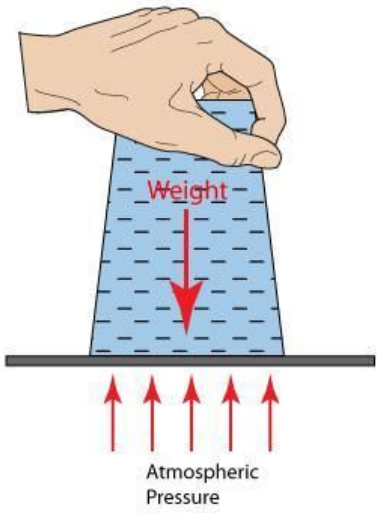
Or, P = k x F / A (where k is proportional constant having value 1)

Or, P = 1 x F/ A

Or, P = F/ A
Hence, P = F/ A proved.

Atmospheric pressure

The Earth is surrounded by the thick layer of air which is known as atmosphere. It is extended up to 10,000km from sea level. The air has also mass. So, it exerts a certain pressure on the earth. The pressure exerted by air is called atmospheric pressure. It is exerted equally in all directions. At sea level, atmospheric pressure is 76 cm of mercury or 760 mmHg. It reduces with increase in height above sea level. Changes in atmospheric pressure bring about changes in weather. The nose of some people starts bleeding at high mountains because of the decrease in air pressure outside and more pressure inside our body.



Activity 1

Air exerts pressure on all sides.

1. Take a glass filled with water.
2. Cover the glass with cardboard or thick paper in such a way that no air passes in or out.
3. Invert the glass by placing one hand on the cardboard and the other at the bottom of the glass.
4. After pressing the board remove the hand from the board.
5. Now see what happens.

You can see that the cardboard does not fall. The cardboard does not let the water fall from the glass.

The pressure exerted by air holds the cardboard without any external agent.

Importance of Atmospheric pressure

Due to atmospheric pressure, we are able to do various activities. Some of the activities done by atmospheric pressure are:

1. To fill ink in the pen.
2. To fill the air in the tire of the bicycle by the pump.
3. To fill medicine in the syringe.
4. To make the water pump.

Activity 2

Air occupies space.

1. Take a glass filled with water.
2. Put the straw in the glass and suck the pipe.
3. Now see what happens.

When you suck the pipe there will be the low air pressure in the pipe. Due to atmospheric pressure water enters into the pipe and a person sucking the pipe gets water in his/her mouth. Likewise, while filling ink on pen and filling the syringe of medicine there will be the difference in the inner and atmospheric pressure. So, the pen gets filled with ink and syringe gets filled with medicine.

Liquid pressure

Matter occupies space and has weight. It can exert pressure as well. The pressure of a body depends on the weight as well as on the surface area occupied by it. The liquid is a state of matter. Since the matter has weight and occupies space, the liquid also occupies space and has weight. A body which has weight can exert pressure. Therefore, the liquid can also exert pressure.

The pressure exerted by the liquid is called liquid pressure. The pressure in a liquid increases with depth, but at the same depth, the pressure is the same in all directions. Liquid pressure depends on the height of the liquid, the density of the liquid and the acceleration due to gravity.

Measurement of Pressure of Liquid

Let's consider the liquid having density "d" is filled into the vessels having a cross-sectional area of "A" meter square. The liquid is filled up to height 'h'. If 'g' is the acceleration due to gravity and 'V' be the volume of liquid then we have,

$$\text{Pressure}(p) = \frac{\text{Weight of the liquid}(w)}{\text{Cross-sectional area of vessel}(A)}$$

$$p = \frac{w}{A}$$

$$p = \frac{\text{mass}(m) \times \text{acceleration due to gravity}(g)}{A} \quad (w = mg)$$

$$= \frac{\text{density}(d) \times \text{volume}(v) \times g}{A} \quad (m = d \quad v)$$

$$= \frac{d \times v \times g}{A}$$

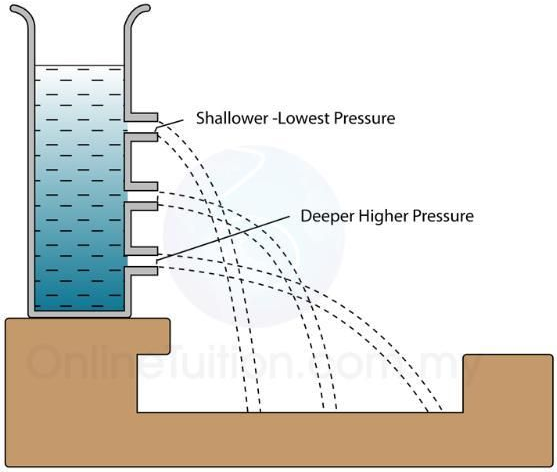
$$= \frac{d \times A \times h \times g}{A} \quad (v = A \quad h)$$

$$p = dhg$$

Activity 3

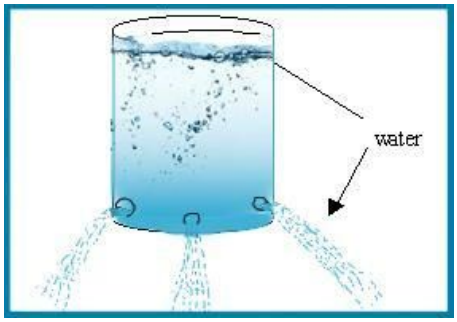
Liquid pressure increases with the depth.

1. Take a cylindrical tin can. Remove its lid.
2. Make three holes of the same width at three different levels from the top.
3. Cover the holes with the help of cello tape.
4. Fill the Cylindrical can with water up to the brim.



Activity 4

The liquid pressure is same in all directions at the same depth.



1. Take an empty tin can.
2. Make five holes of the same width at the same depth all around it.
3. Cover the holes with cello tape.
4. Fill the can with water.

5. Lift it with some string so that its bottom is horizontal.
6. Remove the cello tape from the holes.
7. The water rushes out through holes and falls at the same distance from the bottom of the can on all sides. This indicates that water rushes out through the holes with the same pressure.
8. This proves that water pressure (the pressure exerted by water) at the same depth, is the same in all directions.

Example: The weight of a box is 100N and its base area is 2-meter square. Calculate the pressure exerted on the ground by the box.

Solutions,

Weight (w) = 100N

Area (A) = 2 m

Pressure (P) =?

We know,

P=F/A

Or, P = F/ A

Or, P = 100/ 2

= 50 Pascal # Answer

Density

Density is a physical property of matter. It can be defined as a ratio of mass per unit volume. The qualitative definition can be the measure of the relative heaviness of an object with constant volume. For example, rock is denser than the piece of paper though they occupy the same volume (differ in the quantity of mass occupied in the same volume).

The formula for measuring density is density= mass/volume. Unit of density is $kg/m^{3.}$

Relative density

Relative density is the ratio of the density of the substance to the density of water at 4 degree Celsius of the same volume is called relative density. Relative density does not have a unit. According to the density of the liquid, upthrust differs. If the liquid has higher density,then upthrust exerted by it increases. That is why an egg does not float on pure

water but floats on salt water. With the addition of salt, we increase the density of water. Due to higher density, the egg floats.

Floating and Sinking

Some substance float whereas some objects sink in water. Generally, the substance which has the higher density than that of water sinks in water and substance with lower density floats in water.