



Pressure: When you press down the handle of a bicycle pump, the pressure of air within the pump increases and this in turn inflates the bicycle tyre. When you push the handle of a bicycle pump you apply a force on the surface area of its piston. So, the effect of a force also depends on the area of the object over which it works. "This effect of force on a given area is called Pressure." Thus, we conclude that pressure depends on two factors:

1. Force applied and
2. Area over which force acts.

Pressure is the force per unit area. **Pressure = Force/ Area**

From the above formula, following conclusions can be drawn about pressure:

1. The lesser the area of contact of a given body, the more is the pressure exerted by it.
2. The more the area of contact of a given body the lesser the pressure it will exert.
3. The more the force acting on a body, the more the pressure it will exert.

We have just defined pressure in terms of force. Pressure can also be defined in terms of another force called thrust. The force acting on a body perpendicular to its surface is called thrust. Actually, thrust is the total force acting on the surface of a body. So, we can also define pressure as thrust per unit area. $\text{Pressure} = \text{Thrust} / \text{Area}$. The SI unit of pressure is Pascal (Pa).

Examples of Pressure:

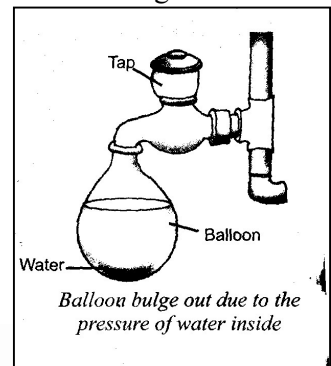
1. It is difficult for us to walk on sand, because our feet sink into it. On the other hand a camel which is much heavier can easily walk on sand. This is because a camel has broad feet. The weight of the camel is spread over the large area covered by its feet. Thus, the pressure exerted by its body on the sand is less.
2. A school bag has wide strap made of thick cloth so that the weight of bag falls over a large area of the shoulder of the child. This produces less pressure on the shoulder and hence can carry heavy school bag more comfortable. If the school bag has thin straps, then the weight of school bag will fall over a small area of the shoulder. This will exert a large pressure and will become very painful for the child to carry the heavy school bag.
3. It is easier to walk on soft sand with flat shoes rather than shoe with sharp heels (or pencil heels). A flat shoe has a greater area in contact with the soft sand due to which there is less pressure on the soft ground that is why, flat shoes do not sink much in soft sand and it is easy to walk on it. While, a sharp heel has a small area in contact with the soft sand and so exerts a greater pressure. So the sharp heels sink deep into soft sand and it is difficult for the wearer to walk on soft sand.
4. When a man walks on the ground the pressure on ground is more than when he is standing, the weight of man falls on a smaller area and thus produce more pressure on the ground. On the other hand, when the man is standing, then both his feet are on the ground. Due to this the weight of the man falls on a larger area of the ground which exerts less pressure on the ground.
5. A woodpecker hammers at tree trunks with its beak which is sharp, pointed and long. The force falls on the small area at the tip of its beak. Hence, due to its large effect it can make a hole in the wood very fast.
6. It is easier to cut an apple from the sharper side than blunt because the sharper side has less area.
7. The tip of a sewing needle is made sharp, so as to put large pressure on a very small area of cloth. Similarly, a nail has a pointed tip, so that when it is hammered, the force of hammer falls on a very small area of wood or wall to create a large pressure which penetrates the nail into wood or wall easily.
8. The skis used by skiers are long and flat which reduce the pressure on the snow. This makes the skiers to slide over the snow easily and their feet do not sink in the ground.





9. The tyres of buses and trucks have broad and double wheels, so that the pressure on the tyres is reduced and they do not burst. The bigger the wheel, the less is the pressure on them, so that they can carry greater weight.
10. Porters wear turbans while carrying heavy loads on heads. By doing this pressure on their heads gets reduced due to the increase in area of contact.
11. An army tank weighing more than a thousand tonne rests upon a continuous chain. This chain is a wide steel belt provided over the wheels of the tank so that they exert less pressure on the ground and do not sink into it.
12. Wooden sleepers are kept below the railway lines so that there is less pressure of the train on the ground and railway lines may not sink into the ground.
13. The foundation of high rise buildings are kept very wide, so that the weight of the building produces less pressure on ground and the building may not sink into the ground.

Pressure in liquids: Like solids, all liquids and gases (together called fluids), apply pressure. Unlike solids, the liquids do not have a definite shape. They take the shape of the containing vessel. Unlike solids the pressure in the liquids is not the thrust per unit area. It depends upon the depth (height) and the density of the liquid. Solids exert pressure on a surface due to their weight. Fluids also have weight. So, they also exert pressure on the base and walls of container in which they are enclosed. What happens when you fill a balloon with water? The walls of the balloon bulge outwards due to the pressure of the water inside. If you keep on filling water in the balloon, what do you think will happen? The balloon will burst because the pressure on the walls of the balloon will increase beyond what its walls can withstand.



Activity: to understand the pressure exerted by water.

Aim: To prove that liquids exert pressure.

Materials Required: A glass test tube with open ends, balloon with water.

Procedure: Tie a balloon to the lower end of the test tube. Hold the tube vertically and pour some water into it. You will observe that the rubber membrane of balloon bulges out. Now add more water. The rubber membrane bulges more. Again, if you pour more water in the test tube the rubber membrane bulges more.

Conclusion: So, this concludes that pressure exerted by a liquid increases with the height of the liquid column.

Pressure at a depth in a liquid depends upon two factors:

1. The height of the liquid column: The greater the height, the greater the pressure.
2. The density of the liquid: The greater the density, the greater the pressure.

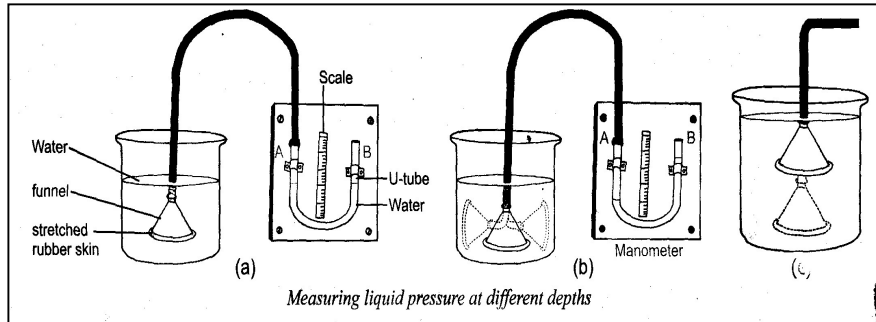
Liquid pressure is measured with manometer.

- A liquid exerts pressure in all directions i.e. downward, upward and sideways.
- The pressure is the same in all directions at the same depth.
- Pressure increases with depth.

From all the above examples, we conclude that the objects appear to be less heavy when submerged in water than they are in air. It is due to the fact that the water exerts an upward force on them. In fact, every liquid exerts an upwards force on the objects immersed in it. The tendency of a liquid to exert an upward force on an object placed in it, is called **buoyancy**. And thus, the upward force acting on an object immersed in a liquid is called **buoyant force**. In other words, the buoyant force is also known as **up thrust**.



Measuring Liquid Pressure: The Manometer: A manometer is a simple device used to measure liquid pressure. It has a U-shaped glass tube which is fixed to a wooden board having a scale. The U-tube is filled with colored water such that its limbs are half filled. One end of the U-tube is open. The other end is fixed to rubber tube which in turn is connected to a thistle funnel. This improvised apparatus is called as manometer. Take this apparatus and cover the mouth of thistle funnel with a tight thin rubber sheath taken from a balloon. If you press the rubber sheath lightly with your fingers, the pressure on it increases. Due to this the water level in limb A will go down and in limb B will go up. You can read the difference in water levels on the scale. This is a measure of pressure exerted on the rubber sheath.



Measuring liquid pressure in different directions at the same depth: Now keeping the funnel at the same level change the direction of mouth of funnel to sideways in fig. (b). The rise in level of water in U tube remains the same. This shows that liquid pressure does not change. This proves that at the same depth a liquid exerts equal pressure in all directions. Liquid pressure increases with depth.

Consequences of liquid pressure:

1. We know that the pressure exerted 'by water in the oceans increases with depth. Very deep down the pressure is enough to crush the human body. That is why deep-sea divers wear special suits, which can withstand such high pressures and prevent their bodies to crush.

2. When deep sea fishes are brought up to the surface of sea, their bodies flow at a very high pressure. At the surface of sea, the pressure outside suddenly decreases. Due to this difference in pressure their bodies burst open. Submarines are built of hard thick sheets of metal to withstand the high pressure under water.

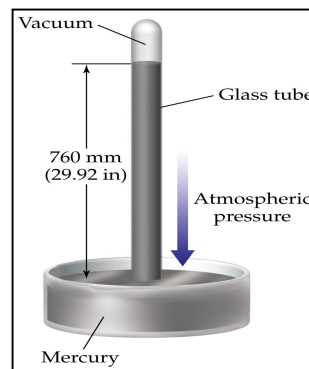
PRESSURE IN AIR: Our earth's surface is covered with a thick layer of air called the atmosphere. It extends up to a height of 200 km. The air is thick near the surface of Earth. It becomes thinner and thinner as we go higher up. Sufficient air for breathing is present only up to about 15 km above the Earth. This lowermost layer is called the troposphere. In this layer clouds are formed. Jet airplanes fly at about 20 km above the Earth in a layer of air called the stratosphere. This layer extends from 15 km to 50km above the Earth. Like all gases, air also has weight and hence it exerts pressure. The air in an average living room weights over a 100 kg. Just as water pressure is caused by the weight of water, the weight of all the air above the Earth exerts the atmospheric pressure. The force exerted by the atmosphere on unit area is called atmospheric pressure. What happens when, you fill the air in a balloon? The balloon inflates due to the pressure of the air inside it. If you fill too much air in the balloon what will happen? The balloon will burst because the pressure on the walls of the balloon will increase beyond which its walls can withstand. Air exerts pressure in both upwards and downwards direction.

NOTE: the water of dead sea contains much more salt than the water in other seas. This denser water exerts a lot of buoyant force which makes it easy to float in dead sea.





Measuring atmospheric pressure: An instrument called barometer is used to measure atmospheric pressure. It consists of long and thin tube filled with mercury and closed at one end. The open end of the tube is placed in a small trough full of mercury. The pressure exerted by air on the mercury of trough is able to hold certain height of the mercury column. When the air pressure is low, the mercury will move down, and when the air pressure increases the height of the mercury column increases. We can measure the pressure by the weight of mercury column in mm of Hg. **Note:** At sea level, the atmospheric pressure is 760 mm of Hg and is taken to be equal to 1 atmospheric pressure, i.e., 760 mm of Hg = atmospheric pressure at sea level.



Making use of air pressure in daily life:

1. Filling medicine in a dropper and ink in a fountain pen: When we dip a medicine dropper into some liquid medicine and press the rubber bulb, we see the bubbles of air escapes. Now when we release the bulb, the medicine fills the tube. It is because when the bulb is pressed, the air inside the tube is forced out. When the bulb is released, the pressure inside the tube becomes less but pressure of air outside is more. So, the larger pressure of air outside pushes the medicine in the glass tube of dropper. The same process occurs when we fill ink in fountain pen.

2. Filling medicines in syringe: Doctors use syringe for injections. The medicine in the syringe is also filled due to air pressure when we push the piston of the syringe inside, air is pushed out through the narrow hole in the needle. When we put the needle in the liquid medicine and pull the handle outside, air pressure pushes the medicine into the syringe.

3. Air pressure helps in drinking with a straw: We drink cold drinks with the help of a straw. This is also based on the air pressure. When you suck a straw, you swallow some of the air from the straw. This makes the pressure of air inside the straw less than the pressure of the air outside. So, the outside air pushes the cold drink into the straw.

4. Air pressure helps in making a fountain: We can set - up a fountain by making use of air pressure. Let us take a big bottle. Fit it with a stopper and make two holes on the stopper. Put a straight and a long glass tube in one hole. The upper end of the tube should have narrow mouth. Put a bent glass tube in the second hole. Now put some water in the bottle. The end of the straight tube should dip in the water and that of bent tube should remain outside the water. Put the stopper and make it air tight. Now blow air through bent tube. When we blow air through bent tube, the pressure inside the bottle increases. This pushes the water to rise through the second tube. It comes out in the form of a fountain.

5. Air pressure forces liquids through a siphon: Siphon is used to draw liquids from big vessels. It is a tube of glass, metal or rubber. The tube consists of shorter arm and longer arm. The shorter arm of the tube is put into the liquid in the big vessel. The longer arm is put into the empty container. Air is sucked from the longer arm. The pressure inside the tube decreases and liquid rises in the tube from shorter end and starts coming out. The liquid is collected in the other vessel at a lower level. It continues to flow until the level in the two vessels become equal or complete liquid is drawn out.

6. Air pressure can push the things: Air Exerts pressure and push the things. The sail boat moves use of air pressure. Wind mill and flying kites are also of common examples.

Variation of Atmospheric Pressure:

1. The atmospheric pressure changes from place to place time to time. This is due to changes in temperature and quantity of water vapour in the air. The density of moist air is less than



that of dry air. The density also decreases with an increase in temperature. Hence, the atmospheric pressure also decreases.

2. Atmospheric pressure at a place is due to the weight of the air above it, therefore the pressure will decrease as we go higher above the sea-level. Thus, the atmospheric pressure decreases with increasing altitude.

Consequences of atmospheric pressure:

1. Our body and atmospheric pressure: Our body and the bodies of other organisms are made up of cells which have fluids that exert pressure from within. The air and other fluids inside our bodies exert an outward pressure equal to atmospheric pressure. Hence, we always remain under balanced position, i.e., net pressure on our body is zero under normal conditions. The atmospheric pressure reduces as we go at higher altitude. Since, the air becomes less dense the air pressure at the height at which a jet plane flies is very low. At such heights the pressure exerted by the blood in our body is much higher than the outside pressure. This can cause blood vessels to burst, which can lead to problems like bleeding from the nose. At that height the amount of oxygen in the air is also not sufficient for us to breathe. That is why, the inside pressure in an aeroplane is maintained at the normal ground level atmospheric pressure.

2. A fountain pen leaks at higher altitudes, because the air pressure inside the ink tube of pen is higher than the air pressure outside. When we breathe in, our ribs move outwards our diaphragm moves down. the volume of the chest cavity increases and the air inside is spread over a larger space. This reduces the pressure inside. The air pressure outside is greater and pushes air into the lungs.

3. Studying the pressure of different parts of the atmosphere helps meteorologists to make predictions about the weather. Ships out at sea carry barometers to warn them of storms. Airplanes carry altimeter, a special kind of barometer which helps them measure the altitude at which they fly.

NOTE:

- About 300 years ago scientist Otto Von Guericke, did a marvellous experiment in Germany. With the help of a vacuum pump, he removed the air from two large hollow metallic hemispheres fitted together to form an airtight sphere, He then tied sixteen horses, eight on each hemisphere to pull them apart. But the force of air pressure was so great that the two hemispheres could not be separated.
- A vacuum cleaner works removing some of the air inside itself. This reduces the Pressure inside it. So, the air pressure outside is greater than the air pressure inside it. The air pressure outside the vacuum cleaner pushes air into it, taking dust and dirt with it.

