FACTORS AFFECTING PRESSURE

The pressure on a surface depends on the following two factors :

1. On the area of the surface on which thrust acts,
2. On the magnitude of thrust acting on the surface.

1. Dependence of pressure on the area of surface :

When you stand on sand, a thrust equal to your weight acts on a smaller area and so exerts more pressure on sand, hence you sink more. But when you lie down on sand, the same thrust acts on a larger area and so exerts less pressure, hence you sink less. Similarly, when you hammer a nail with its flattened end resting on a wooden block, thrust exerted by you acts on a larger area, so less pressure acts on the nail. Hence, it does not go into the block. But when you hammer the nail with its sharp end resting on the block, the same thrust acts on a smaller area, so more pressure acts on the nail. Hence, it easily prenetrates into the block.

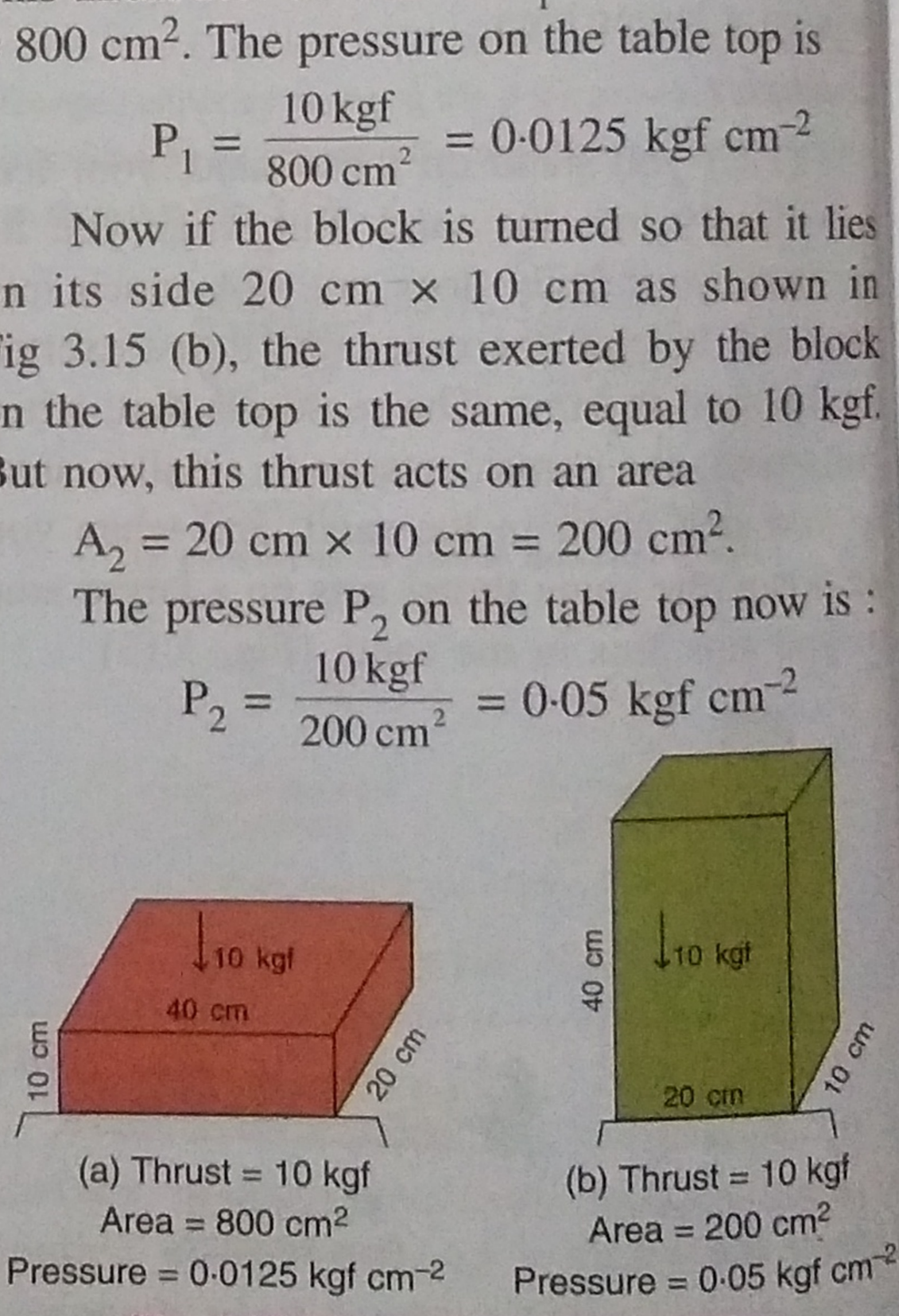
Fig 3.15 (a) shows a block of mass 10 kg and dimensions 40 cm × 20 cm × 10 cm lying on a table top on its side 40 cm × 20 cm. The thrust exerted by the block on the table top is equal to the weight of the block *i.e.* 10 kgf. This thrust acts on an area $A_1 = 40\ cm \times 20\ cm = 800\ cm^2$. The pressure on the table top is

$$P_1 = \frac{10\ kgf}{800\ cm^2} = 0{\cdot}0125\ kgf\ cm^{-2}$$

Now if the block is turned so that it lies on its side 20 cm × 10 cm as shown in Fig 3.15 (b), the thrust exerted by the block on the table top is the same, equal to 10 kgf. But now, this thrust acts on an area $A_2 = 20\ cm \times 10\ cm = 200\ cm^2$.

The pressure P_2 on the table top now is :

$$P_2 = \frac{10\ kgf}{200\ cm^2} = 0{\cdot}05\ kgf\ cm^{-2}$$



(a) Thrust = 10 kgf
Area = 800 cm²
Pressure = 0·0125 kgf cm⁻²

(b) Thrust = 10 kgf
Area = 200 cm²
Pressure = 0·05 kgf cm⁻²

Fig. 3.15 Lesser the area of surface, more is the pressure

Thus, pressure exerted by a body depends on the surface area on which the thrust of the body acts. *Smaller the surface area, more is the pressure exerted by the thrust and larger the surface area, lesser is the pressure exerted by the same thrust.*

This can also be demostrated by the following activity.

ACTIVITY 1

Push a sharp pin into a piece of wood as shown in Fig 3.16 (a). Now try to push a nail with your thumb into the wood [Fig. 3.16 (b)]. You will not be able to push the nail into the wood but you will be able to push the pin into the wood. The reason is that the tip of the nail is of large area than the tip of the pin, so pressure exerted on nail is less than on the pin, hence pin gets inserted but the nail does not. Now, to insert the nail into the wood, hammer it as shown in [Fig. 3.16(c)]. You will find that the nail now gets inserted into the wood because thrust on it has increased the pressure.

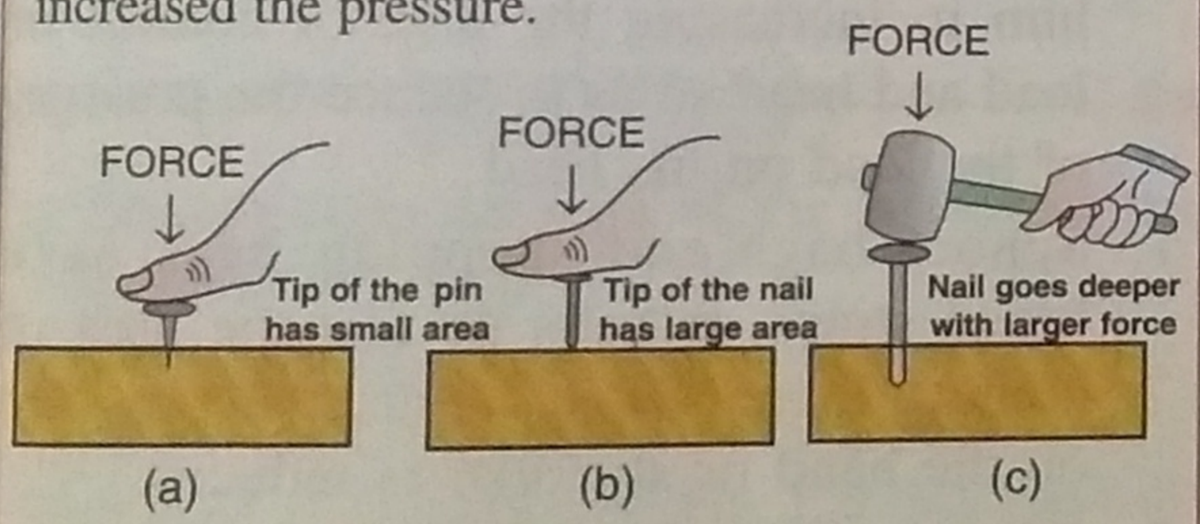


Fig. 3.16 Pressure increases when area decreases and force increases

2. Dependence of pressure on the thrust (or force):

In Fig. 3.17 (a), a thin boy is standing on bricks kept on a bed. He exerts some pressure due to his weight. But in Fig. 3.17 (b), a fat boy is standing on the same bricks kept on the bed. In this case, the pressure exerted by the fat boy is more due to his excess weight. Thus, greater the thrust on a surface

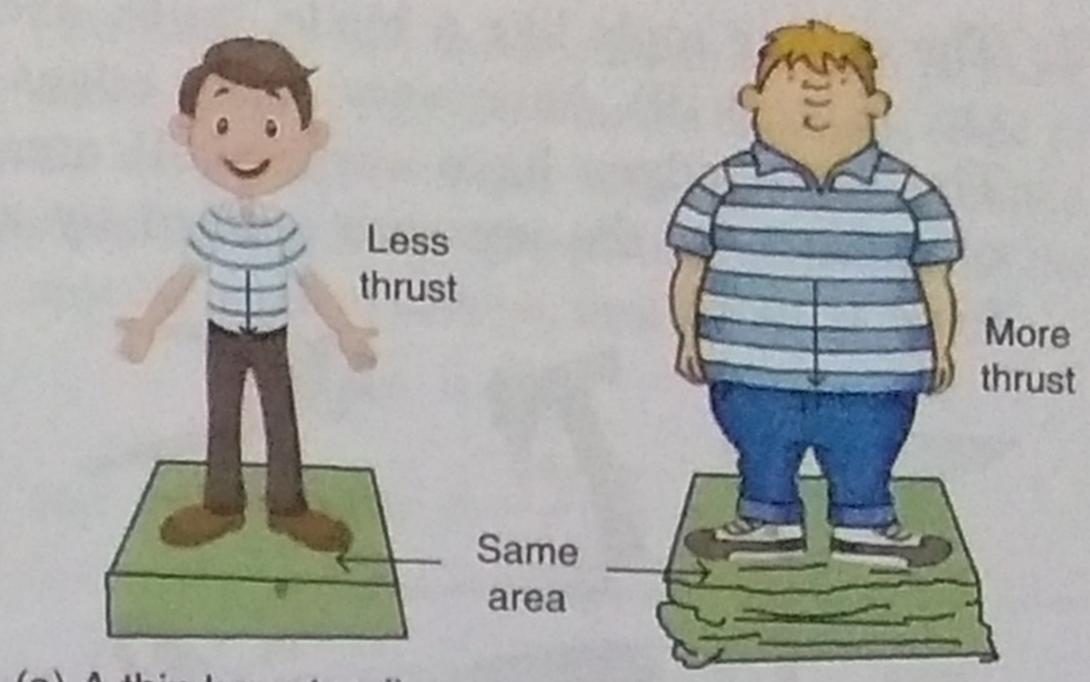


Fig. 3.17 More the thrust, more is the pressure

more is the pressure on it while smaller the thrust on the same surface, less is the pressure on it.

This can be demonstrated by the following activity.

ACTIVITY 2

Take three identical blocks of solid wood X, Y and Z. Place these blocks on mud as shown in Fig 3.18. You will notice that the block X alone sinks less into the mud, but the blocks Y and Z placed one above the other, sink into the mud deeper.

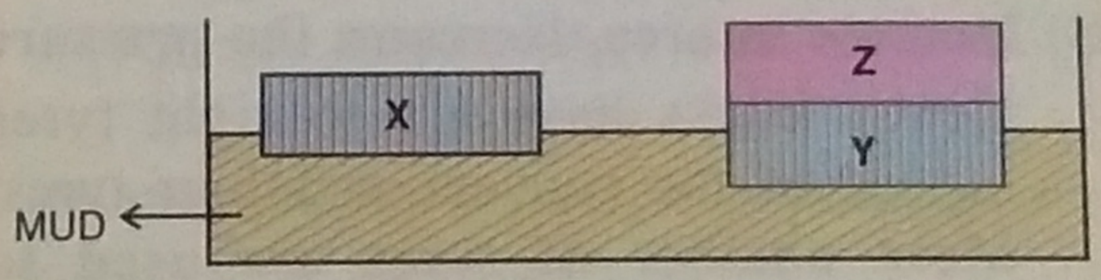


Fig. 3.18 X sinks less while Y and Z together sink more

EXAMPLES OF PRESSURE IN OUR DAILY LIFE

(A) Decrease in area increases the pressure

1. A nail or a board pin has one end pointed and sharp while the other end is blunt and flat. On applying force, the pointed end will exert greater pressure as the area of contact is small and hence, it will go deep into the given surface.

2. The cutting tools like a blade, knife, axe etc, (Fig. 3.19), have very sharp edges. The sharp edges have very small area of contact, so the pressure applied by a force is more.

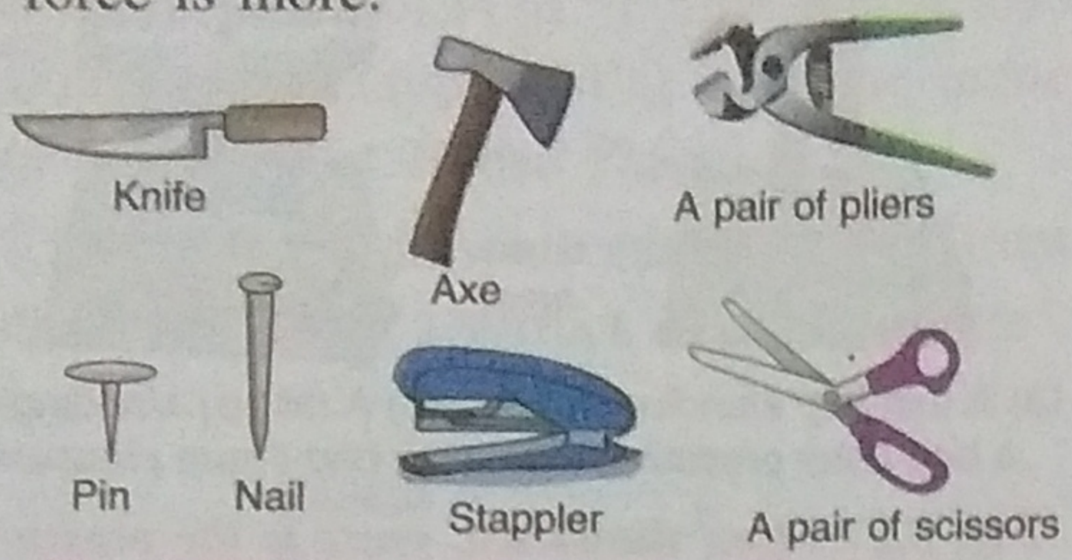


Fig. 3.19 Some cutting tools with sharp or pointed edges

3. The pointed heels of footwear exert more pressure on the ground than the regular flat heels. Therefore, a lady with pointed heel sandals finds it difficult to walk on a muddy road than on a tarred road.
4. The narrow heeled sandal of a girl hurts more than the broad heeled shoe of a boy. This is because more pressure is exerted by the girl than that exerted by the boy as her heel is more narrow than the heel of the shoe.

(B) Increase in area decreases the pressure

1. Heavy trucks have six to eight tyres instead of the conventional four tyres. More number of tyres are used to increase the area of contact and thereby reduce the pressure on the ground.
2. A camel can move more conveniently on sand as compared to a horse. The reason is that the camel has broader feet than that of a horse. The broader feet of the camel provide lesser pressure on the sand and it becomes easier for the camel to walk. In the case of a horse, the area of the feet is less, due to which the pressure is more and hence the feet show a tendency to sink inside the sand, making it difficult to walk.
3. Skiers use long flat skis to slide over the snow. The larger the area of contact, the lesser is the pressure on the snow. This helps the skier to slide comfortably without sinking in the snow.
4. Army tanks are usually very heavy and they exert large pressure on the ground, if they move on wheels. Hence they are made to move over the broad steel tracks called caterpillar wheels of tanks. These tracks are used to increase the surface area so as to reduce the pressure on the ground and hence avoid sinking of their wheels in the ground.
5. Foundation of buildings are kept wide so that the weight of the building may act on larger area. As a result, it will exert less pressure on the ground. This avoids sinking of buildings into the earth.
6. A porter wears turban on his head when he has to carry heavy loads. This helps him in increasing the area of contact of load and head so as to reduce the pressure of the load on his head.
7. School bags and shopping bags have broad straps or belts so that the area of contact increases and thus the pressure on the hand or shoulder is reduced.
8. Wide wooden sleepers are placed below the railway tracks (Fig 3.20) so that the pressure exerted by the rails on the ground becomes less.

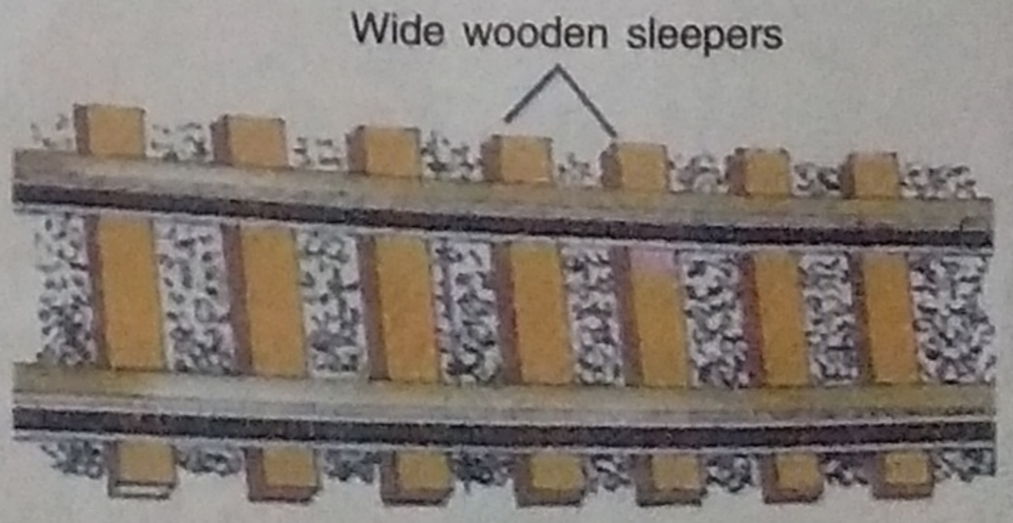


Fig. 3.20 Railway track having wide wooden sleepers

Difference between thrust and pressure

Thrust	Pressure
1. Thrust is the sum total of force acting perpendicular to a surface.	1. Pressure is the thrust acting per unit area.
2. It is independent of the area over which the force is applied.	2. It depends on the area on which the force acts.
3. It's S.I. unit is newton (N).	3. The S.I. unit is $N\ m^{-2}$ or Pa.

LIQUID PRESSURE

A solid exerts pressure on a surface due to its own weight. Similarly, liquids have weight. They also exert pressure on the container in which they are kept. A solid exerts pressure only on the surface at its bottom. But a liquid exerts pressure not only on the surface of its container at the bottom, but also sideways, that is, in all directions. This can be demonstrated by the following activities.

ACTIVITY 3

A liquid exerts pressure at the bottom of its container.

Take a glass tube. Tie a balloon at its lower end. Hold it vertically straight as shown in Fig. 3.21 (a). Pour some water in the tube [Fig. 3.21 (b)]. You will notice that the balloon bulges out.

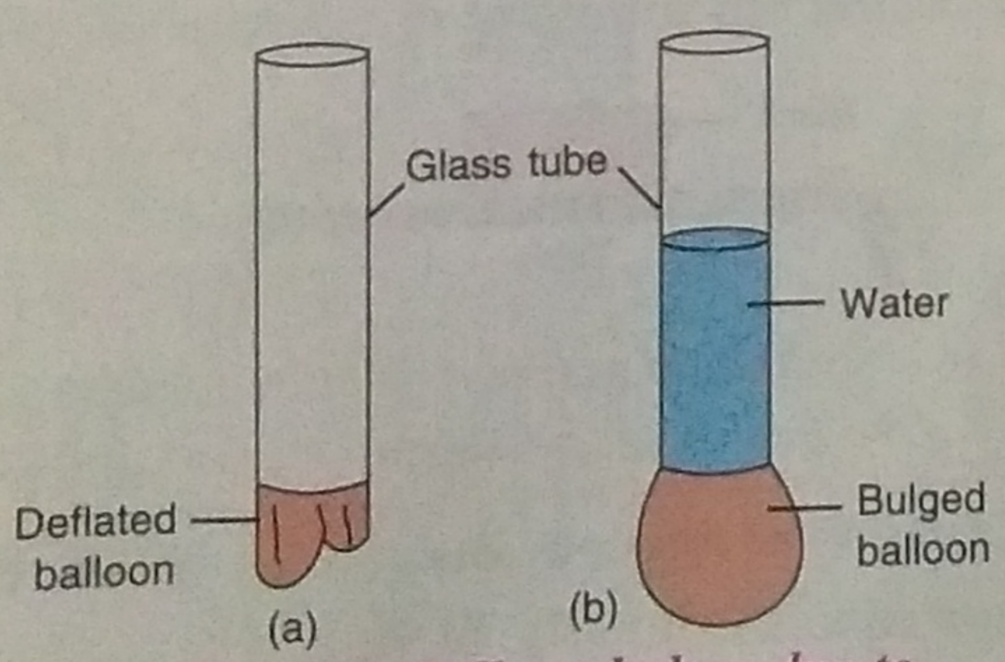


Fig. 3.21 Balloon bulges due to pressure of water column

Conclusion : The water column exerts a pressure on the balloon. The force on the balloon is equal to the weight of the water column which is called thrust. If W is the weight of water column and A the area of mouth of balloon, then

$$\text{Thrust} = W$$

and $$\text{Pressure} = \frac{\text{Thrust}}{\text{Area}} = \frac{W}{A}$$

ACTIVITY 4

A liquid exerts pressure sideways also on the walls of container.

Take a glass tube closed at one end and having an opening in its side near the bottom. Tie a balloon at the side opening of the tube. Hold the tube vertically as shown in Fig 3.22 (a). Pour some water in the tube [Fig. 3.22 (b)]. You will notice that the balloon bulges out.

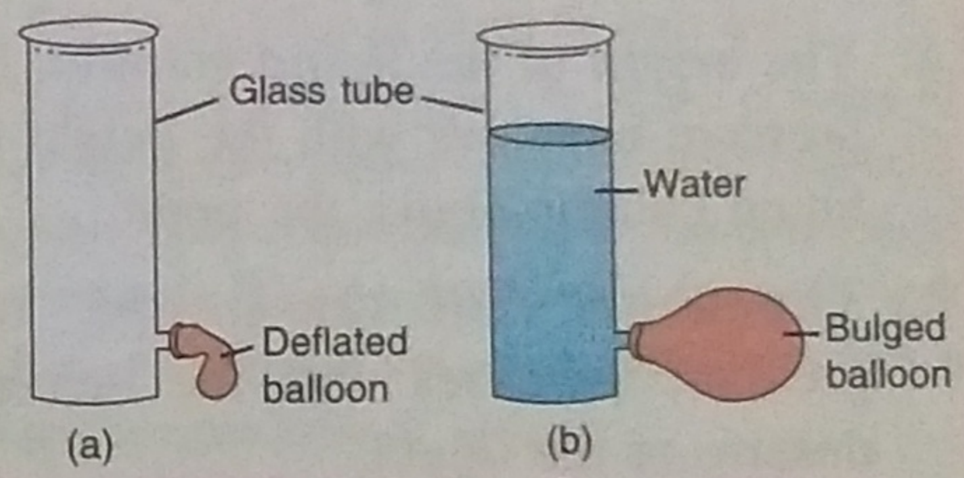


Fig. 3.22 Balloon bulges due to pressure of water on the sides of glass tube

This shows that liquids exert pressure sideways also on the walls of the container.

ACTIVITY 5

A liquid exerts pressure in all directions

1. Take a plastic mug and water in a bucket. Invert the mug and try to press it so as to immerse the mug into water. You will experience an upward push on your hand. This is because of the pressure exerted by water in the upward direction. Thus, liquids exert pressure in the upward direction also.

Class - 8

Work sheet

Q-1 What is thrust?

Q.2 Why do camels or elephants have broad feet?

Q-3 A sharp pin works better than a blunt pin. Explain the reason.

Q-4. It is easier to cut with a sharp knife than with a blunt one. Explain.

Q.5 State two factors on which the pressure at a point in a liquid depends.

Q.6 Describe a suitable experiment to demonstrate that a liquid exerts pressure sideways also.

Q.7 Calculate the pressure in pascal exerted by a force of 300 N acting normally on an area of 30 cm^2.