7 Pressure

CONCEPT OF PRESSURE

Whenever a force is applied on a body, it generally acts on a certain area of the body. To measure the effect of force, we need to take into account both the magnitude of force and the area on which force is applied.

Consider the following figures :

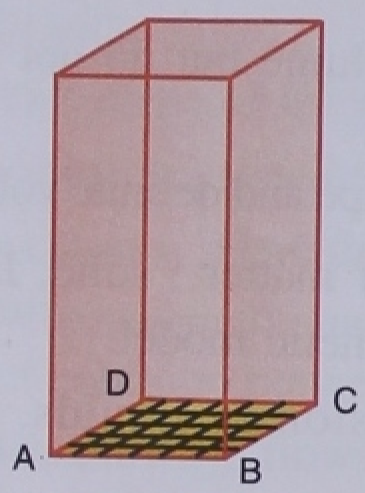

Fig. 7.1 (a)

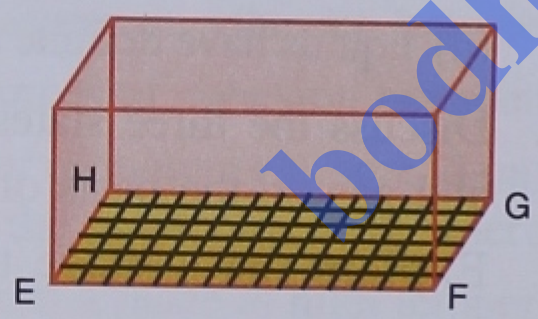

Fig. 7.1 (b)

Imagine a rectangular block placed on a table top. We may place it in such a away that its smallest face ABCD is in contact with the table (Fig. 7.1 (a)) or its largest face EFGH is in contact with it (Fig. 7.1 (b)).

When placed on face ABCD, the weight of the block is acting vertically downwards on the smallest face and when placed on face EFGH, the same weight of the block is acting vertically downwards on the largest face. In both the cases, the force (weight of the block) is same but the areas on which the force is acting are different.

The magnitude of force acting normally on unit area is called pressure.

If force (F) acts normally on an area (A), the pressure (P) is given by :

$$\text{Pressure} = \frac{\text{Force}}{\text{Area}} \quad i.e., \ P = \frac{F}{A}$$

In figure 7.1(a), the force (weight of the block) is acting on a smaller area, therefore pressure (P) is maximum, as $P = \frac{F}{A}$. Whereas in Fig. 7.1(b) the same force (weight of the block) is acting on a larger area, thus pressure (P) is less.

When the force is acting vertically downwards or normal to the surface under consideration, it is called **thrust**. Therefore, pressure can also be defined as **thrust per unit area**.

$$i.e., \ \text{Pressure} = \frac{\text{Thrust}}{\text{Area}}$$

UNIT OF PRESSURE

In the SI system, the unit of force is Newton and that of area is m^2. Therefore, the unit of pressure is N/m^2 (Nm^{-2}) or **Pascal (Pa)**.

From the relation, Pressure = $\frac{\text{Thrust}}{\text{Area}}$, we conclude that :

1. Pressure is directly proportional to the thrust applied *i.e.*, an increase in thrust causes an increase in pressure in such a way that if the thrust is doubled, the pressure also doubles and vice-versa.
2. Pressure is inversely proportional to the area on which force (thrust) is applied *i.e.*, an increase in area of contact causes a decrease in pressure in such a way that if area of contact is doubled, the pressure becomes half and vice-versa.

Let us take the following examples to understand the fact that a decrease in area increases the pressure or conversely, an increase in area decreases the pressure.

1. A nail or a board pin has one end pointed and sharp while the other end is blunt or flat. When we apply force with our thumb on the flat surface of the pin, keeping the pointed end in contact with the board, the pin will easily penetrate into the board. When we apply the same force keeping the blunt end in contact with the board the pin will not penetrate at all. Thus, it is proved that pressure and area are inversely proportional.
2. The cutting instruments like the blade, knife, the axe, *etc.*, have the cutting edge very sharp. This helps in decreasing the area of contact thereby increasing the pressure. Hence, they can easily penetrate through the given surface.
3. Heavy trucks have six to eight tyres instead of the conventional four. This is done to increase the area of contact between the tyres and the road because of which the pressure on the ground is reduced.
4. Animals like camels can walk easily in a desert as compared to horses because camels have broader feet. The broader feet exert less pressure on the sandy ground.
5. Skiers use long flat skies 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.
6. The foundations of high-rise buildings are kept wide so that they may exert less pressure on the ground and do not sink in due to extremely high pressure.

Example 1

A solid weighs 80 N. When placed on a surface, the area of contact is found to be $1{\cdot}6\ m^2$. Find the pressure exerted by the solid on the surface.

Solution :

Given, Force = Weight = 80 N

Area = $1{\cdot}6\ m^2$

P = ?

$$\textbf{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{80\ \text{N}}{1{\cdot}6\ \text{m}^2}$$

$$= 50\ \text{N/m}^2$$

$$= \textbf{50 Pa}$$

Example 2

A rectangular wooden piece weighs 25 newton. If it is placed in such a way that its 25 cm length and 10 cm width are in contact with a surface, what will be the pressure exerted by it on the surface ?

Solution :

Given, Force = Weight = 25 newton

Length = 25 cm = 0·25 m.

Width = 10 cm = 0·1 m.

Area = Length × width

= 0·25 m × 0·1 m. = 0·025 m^2

$$\therefore \quad \textbf{Pressure} = \frac{\text{Force}}{\text{Area}} = \frac{25\ \text{N}}{0{\cdot}025\ \text{m}^2}$$

$$= 1000\ \text{N/m}^2 = \textbf{1000 Pa}$$

PRESSURE DUE TO LIQUIDS

We know that solids have a definite shape but liquids do not have a definite shape. They acquire the shape of the vessel in which they are kept. Accordingly, their area of contact changes with the shape of the vessel.

A liquid exerts pressure on the base of the container (vessel) due to its weight and also exerts pressure on the walls of the container due to collisions of its molecules with the wall. Since the molecules of a liquid are regularly in motion, so they strike (collide) continuously with the walls of the container. To every collision, these molecules exert a thrust on the walls of the container, thus exerting a pressure.

Example :

To understand the pressure exerted by the liquid, let us take the following example.

Take an open narrow glass tube of length about 8-10 cm. On lower end of the tube, tie a thin stretched rubber membrane. Now hold the tube in a vertical position and pour water in the tube. You will see that, as the water is poured in the tube, the rubber membrane bulges outwards. This bulging increases in size as you pour more and more water into the tube. The

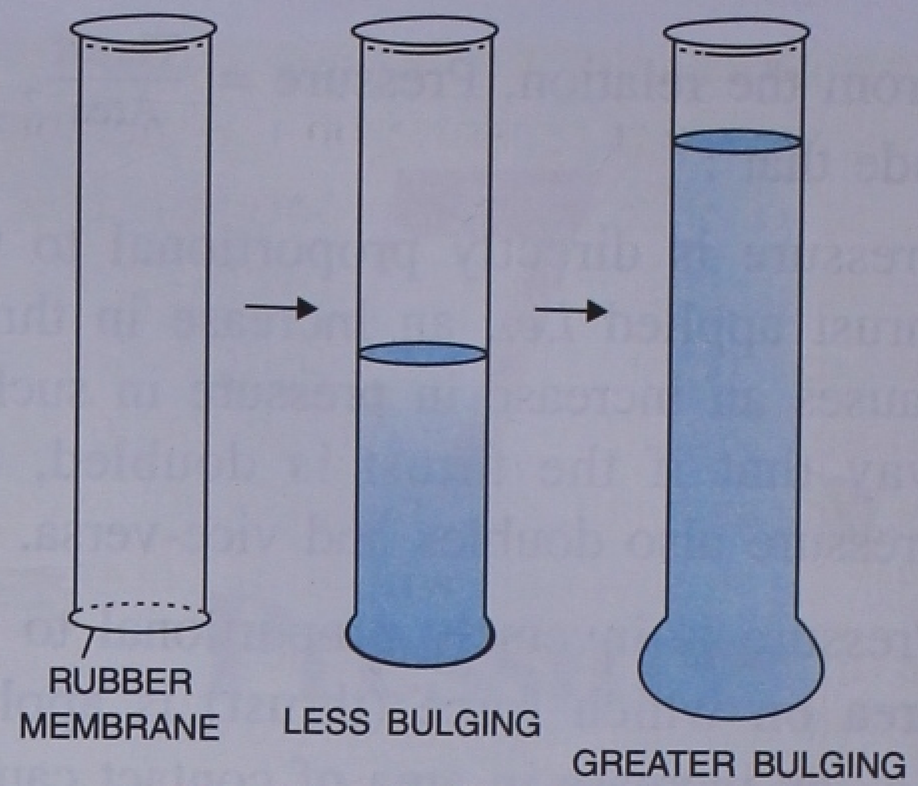

Fig. 7.2 Liquid exerts pressure

bulge is caused by the pressure exerted by the liquid due to its own weight.

We measure liquid pressure using a **manometer**. It is a simple device used to measure the liquid pressure.

We may construct a manometer and show its working. For this, we need a glass made U-tube fixed on a vertical board consisting of a scale which can measure on either side. We pour some mercury or some coloured liquid into the U-tube so that it is partially filled. The level of liquid on both sides of the U-tube will be the same. Now connect one end of the U-tube with a rubber tube and attach a thistle funnel on the open end of the rubber tube. Fix a rubber membrane to the thistle funnel as shown in Fig. 7.3.

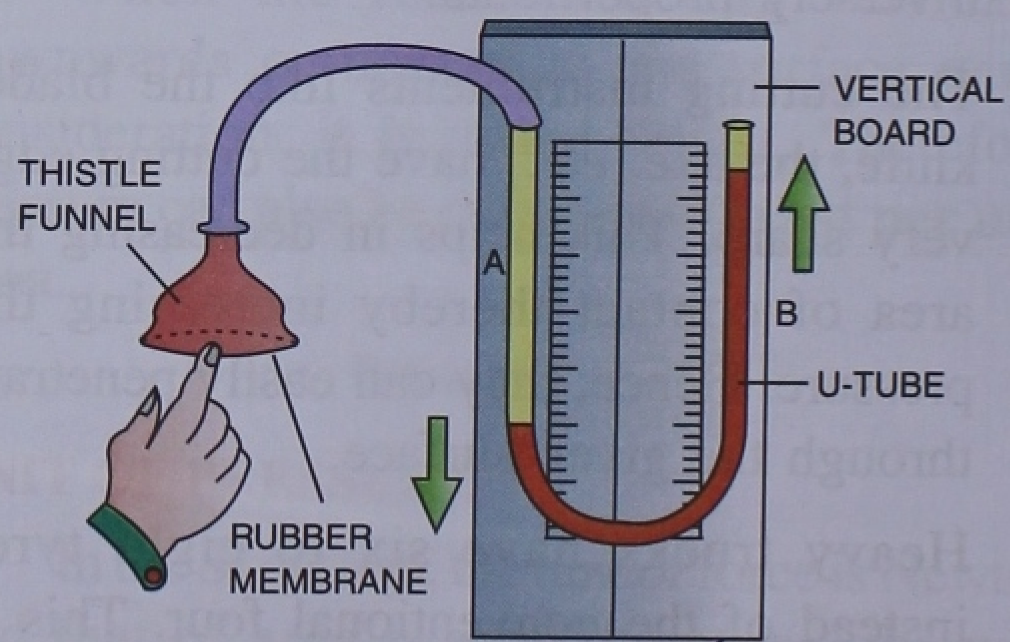

Fig. 7.3 A manometer

Now press the membrane slightly. By doing so, we exert pressure on the membrane which, in turn, exerts pressure on the air trapped in thistle funnel as well as on the rubber tube used. Due to this pressure, the trapped air exerts pressure on the liquid in the U-tube. As a result, the liquid level will go down in the arm A and will go up in the arm B. The difference in the liquid level in the two arms is the measure of pressure exerted on the rubber membrane.

LIQUID PRESSURE HAS THE FOLLOWING CHARACTERISTICS :

1. Liquid pressure increases with depth :

To show this, we need a manometer and a beaker with some water in it. Immerse the thistle funnel of the manometer into water in the beaker to a small depth of water. Note down the manometer reading *i.e.,* the difference of the liquid level in the two arms. Now dip the funnel to a greater depth of water in the beaker and note down the manometer reading again. The reading of the manometer scale will increase with an increase in the depth.

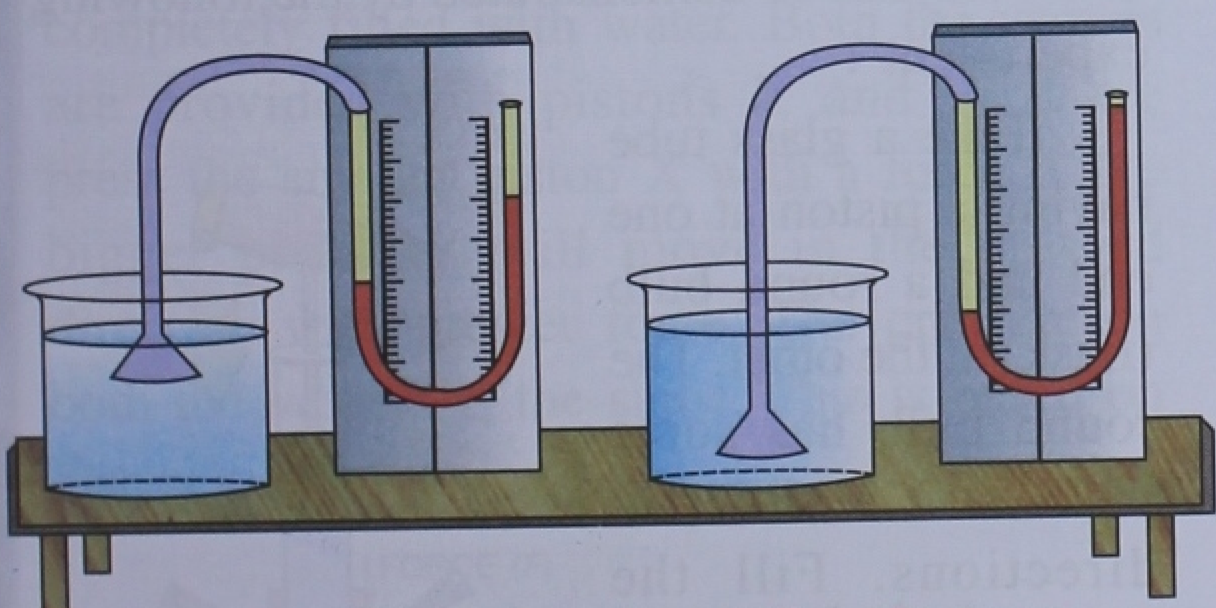

Fig. 7.4 The manometer reading shows an increase in liquid pressure with an increase in the depth of the dipped funnel

Hence, *we conclude that pressure in a liquid increases with depth.*

2. Liquid pressure remains the same in all directions at a given depth :

To show this, we need a manometer and a beaker containing some water.

Now keep the funnel at a particular depth inside the water in the beaker and change its position so that its mouth is directed upwards, downwards, to the left and to the right. Observe the manometer reading in all positions of the funnel. You will notice that the manometer reading in all the positions of the funnel remains the same.

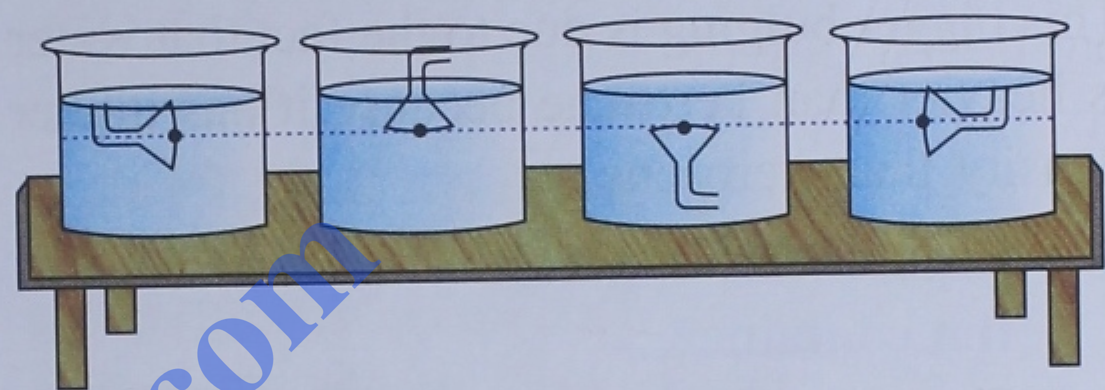

Fig. 7.5 The manometer reading is the same when the funnel is kept at the same depth

Hence, *we conclude that at a given depth, the pressure of the liquid is the same in all directions.*

Do You Know ?

Notice the walls of a dam. They are specially thickened and broaden at the base than at the top. This is done to withstand the huge pressure of water.

3. Liquid pressure depends upon the density of the liquid :

To show this, take two identical open glass tubes A and B. Tie a balloon to each of the tubes at one end and leave the other end free. Balloons tied to the two tubes must be of the same size. Now pour water into tube A and equal volume of kerosene in the tube B. Notice the bulge in the membrane in both the cases.

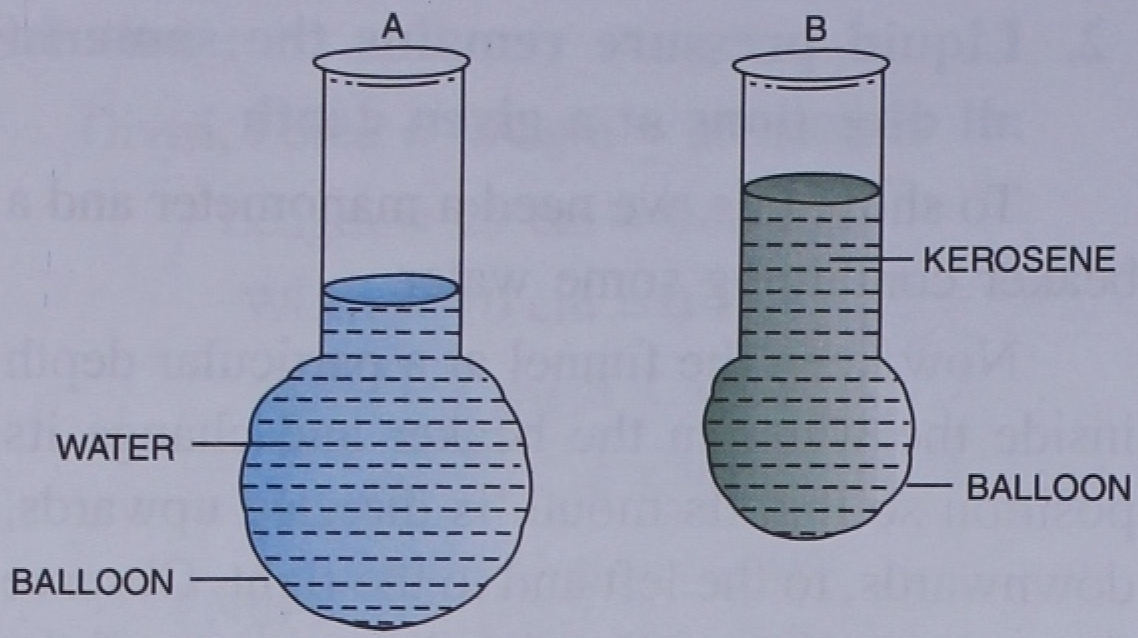

Fig. 7.6 Bigger bulge is produced by water than kerosene oil

You will observe that a bigger bulge is produced in tube A in which water is filled. This bigger bulging is due to the fact that water is heavier than kerosene because it has higher density than kerosene.

4. Liquid exerts pressure on the sides of the container :

To prove this, you need a metallic tube with a small opening near the base. Tie a rubber balloon to the side opening. Now gradually pour water into the tube. You will observe that the balloon starts bulging as you go on increasing the amount of water. This bulging is due to the fact that liquid applies pressure on the side walls also.

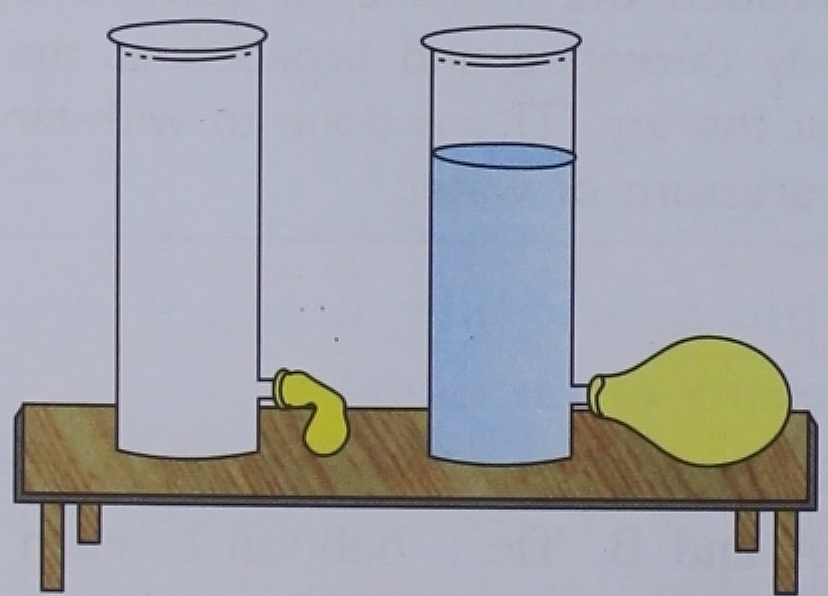

Fig. 7.7 Lateral pressure by liquids

Hence we conclude that liquid applies a **lateral pressure** at the walls of the container. The lateral pressure is exerted by the liquids and gases but not by solids.

5. A liquid seeks its own level :

To show this, we take five tubes of various shapes which are connected to a horizontal pipe. Fill water in any one of the tubes. It will be observed that from this tube, the water will move to horizontal pipe and then to other tubes connected to it. The water stands at the same height in all the tubes irrespective of the shape of the vessel (tube).

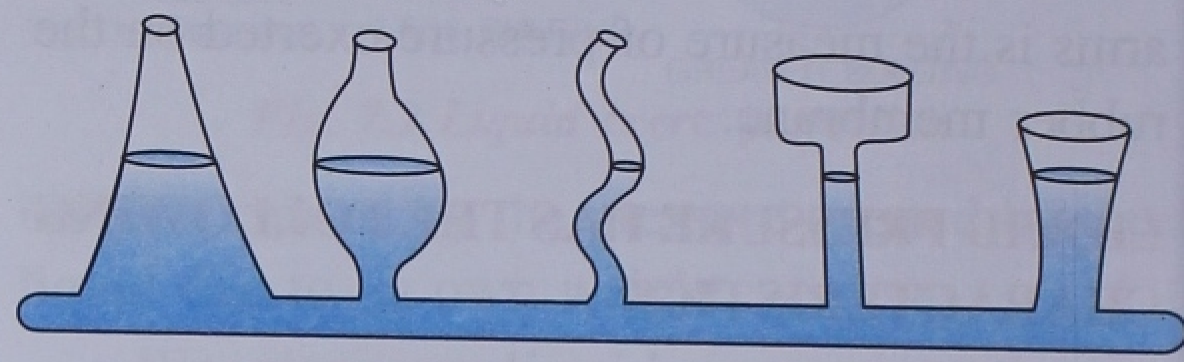

Fig. 7.8 Liquid seeks its own level

TRANSMISSION OF PRESSURE IN A LIQUID

The transmission of pressure in a liquid was first observed and established by Blaise Pascal, a French Physicist and is known as **Pascal's law**.

According to Pascal's law, the pressure exerted at any point on an enclosed liquid is transmitted equally and undiminished in all directions.

This can be demonstrated by the following experiment :

Take a glass tube having a piston at one end and a round bulb (flask) at the other. The round bulb has some holes in it in different directions. Fill the apparatus with water and press the piston. You will notice that water comes out of all the holes with equal pressure.

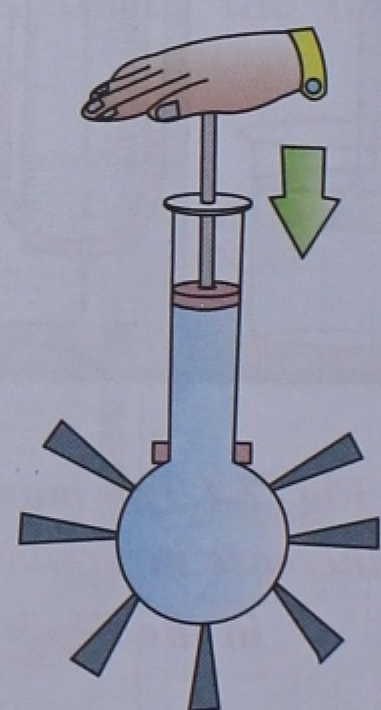

Fig. 7.9 Transmission of pressure in a liquid

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 pressure 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.

Hydraullic machine : (Based on Pascal's law). Fig. 7.10 shows two vessels A and B of different sizes connected by a tube completely filled with water. Both the vessels are provided with pistons X and Y. If we press the smaller piston X with a force F, the bigger piston Y will move in the upward direction with greater force. The pressure on both the vessels is the same. This is based on Pascal's law.

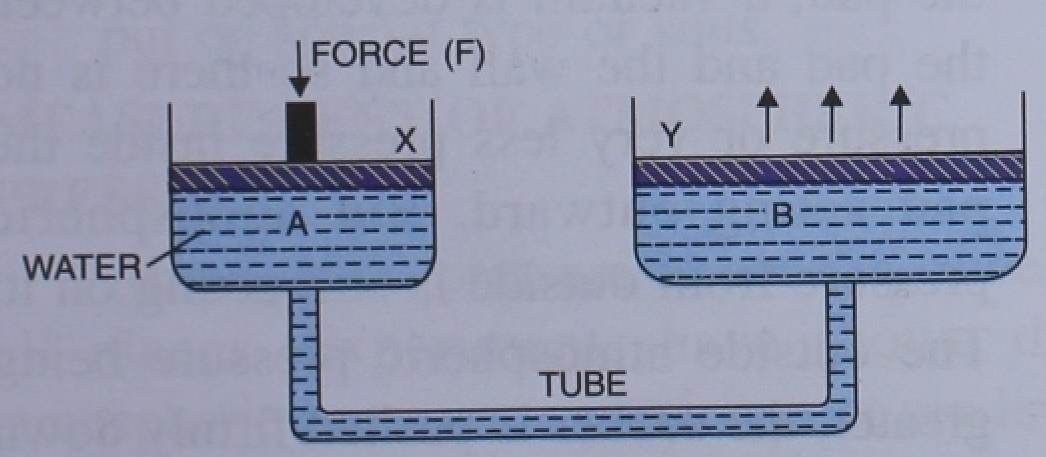

Fig. 7.10

Intext Questions

Why do we feel light on our feet when standing in a swimming pool with water up to our armpits ?

ATMOSPHERIC PRESSURE

The earth is surrounded by a layer of air up to a certain height (nearly 300 km) and this layer of air around the earth is known as the **atmosphere of earth**. As we gradually move up, the density of the layer of air continues to decrease and at a particular height, this density reduces to zero *i.e.* beyond that, there is no atmosphere.

Anything which has mass will exert force (due to its weight). We know air also has mass, so it exerts force (thrust) on the earth's surface and on the objects. This thrust acting on unit area on the earth's surface and on all the objects on the earth's surface is called the **atmospheric pressure**.

In the S.I. system, the value of atmospheric pressure is 100,000 N/m^2 or 100,000 Pa. This is actually a tremendous amount of pressure. You may imagine it to be equivalent to two elephants sitting on your head. How is our body sustaining such a huge pressure? Actually our blood pressure balances the atmospheric pressure.

To prove that air exerts pressure, let us take an example :

Take a glass filled with water up to its brim and place a post card on top of it. (See Fig. 7.11). Now press the palm of your one hand on top of the card-board, then invert the water filled glass (keeping it tightly closed with card placed) upside down and gently remove your hand from the card to release it. You will observe that the post card will not fall off the glass although the whole weight of water contained in the glass is on it. It is because the atmospheric pressure from underneath balances the downward weight of water.

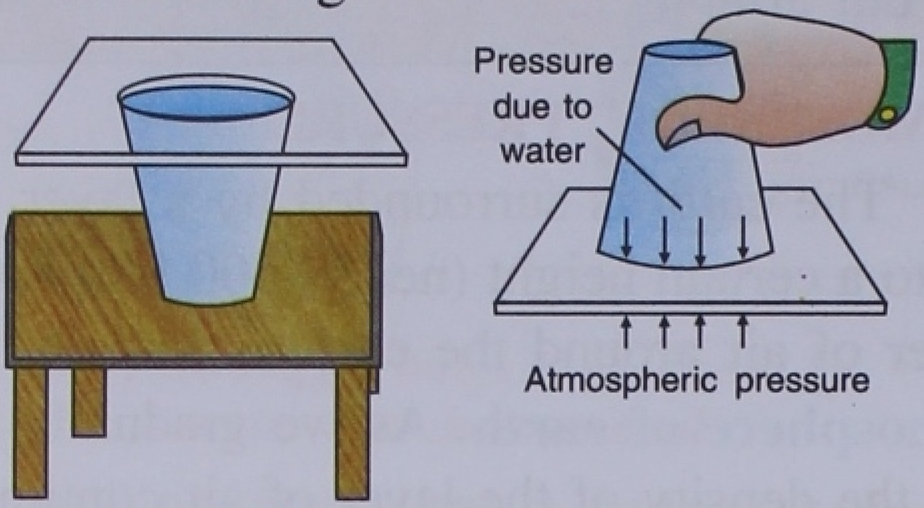

Fig. 7.11 Air exerts pressure

Hence, we conclude that air exerts pressure.

Let us consider another example known as **crushing the can experiment**.

Take an empty petrol can made of thin iron sheet and fill it with water up to its half of the volume.

Heat the can. When water in the can boils, steam is formed which drives out the air particles present in the upper half of the can. Infact, when boiling water converts into steam, its volume increases and so it (steam) pushes the air out of the can. After boiling the water for sufficient time, close the mouth of the can with an airtight cap and immediately cool the can under a cold water tap.

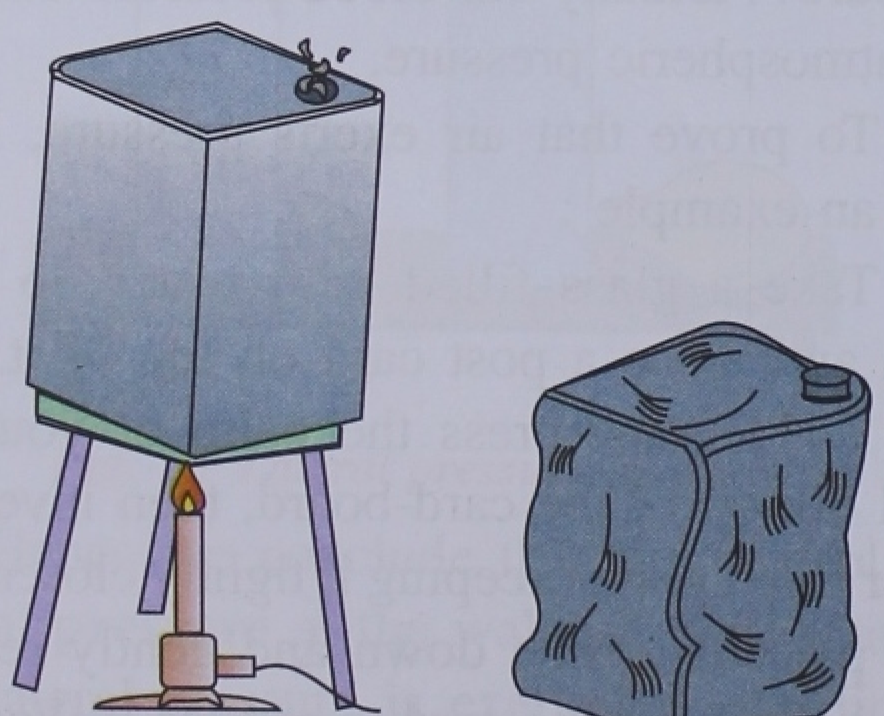

Fig. 7.12 Atmospheric pressure deforms the can

You will observe that the can immediately crushes. When the can with boiling water is sealed, it has only water and steam inside it as air has already been driven out. When the can is cooled, the steam inside it condenses (turns back into water) developing a partial vacuum inside the can, with the result, the pressure inside the can is greatly reduced. As the pressure outside the can (atmospheric pressure) is still the same, it makes pressure from outside more than the pressure from inside. This is the reason that the can bends inwards from all sides.

This experiment verifies that air exerts pressure in all directions.

Do You Know ?

Every person is under a pressure of air equal to the pressure of two elephants. How are we able to stand so much of pressure and why it does not press us down ? This is due to breathing which creates air pressure inside our bodies to balance the atmospheric pressure.

Effects of atmospheric pressure :

(a) Rubber suction pads are used in hanger knobs for hanging clothes or calenders on the walls. When a suction pad is pressed against a flat surface, air between the pad and the wall is forced to move out, reducing the pressure inside. On releasing the pad, a vacuum is developed between the pad and the wall and so there is no pressure or very less pressure inside the pad acting outward. But atmospheric pressure from outside is still acting on it. The outside atmospheric pressure being greater, the sucker is pushed firmly down and it fixes on the wall.

(b) Due to atmospheric pressure, the ink gets sucked up in the fountain pen.

(c) Lizards are able to move on the wall and stay whenever they feel like due to suction pad like function of their feet.

(d) Due to atmospheric pressure, the liquid rises in a syringe when a piston is pulled up.

(e) Nose bleeding is a common phenomenon at high altitudes. The atmospheric pressure is low at high altitudes. But the pressure inside the human body does not change. Thus the pressure inside the body which is much higher than atmospheric pressure causes bursting of arteries which are close to the inner skin of nose.

(f) Air pressure helps in drinking with a straw —
When you suck a straw, you swallow some of the air from the straw. This makes the pressure of the air inside the straw less than the pressure of the air outside. So, the outside air pushes the cold drink into the straw.

(g) The astronauts and mountaineers have to wear special type of outfits to protect themselves from adverse effects of low pressure prevailing at great heights.
Astronauts have actually to go beyond the limit of the atmosphere, there the pressure on their bodies would become negligible. This makes it necessary for astronauts to put on special type of suits.

MEASUREMENT OF ATMOSPHERIC PRESSURE

Atmospheric pressure is not the same at all places. Experiments have shown that atmospheric pressure is maximum at sea level and as we go higher up in terms of altitude *i.e.* towards the mountains, the atmospheric pressure gradually decreases.

The instrument with which we measure atmospheric pressure is called a BAROMETER. In 1643, an Italian scientist named TORRICELLI invented a simple barometer and hence was able to measure the atmospheric pressure at different places.

SIMPLE BAROMETER

To construct a simple barometer, we need a narrow glass tube of length nearly 100 cm. It should be closed at one end. We fill it completely with mercury and ensure that no air bubbles are left inside the tube. Now we place our palm of hand on the mouth of the tube and invert it into a container with mercury filled in it. Now we remove our hand. Care must be taken that the mouth of the tube remains inside the mercury in the container

It is found that some of the mercury falls from the tube to the container and then the level of mercury in the tube becomes constant (fixed). A vacuum is created in the tube above the mercury level. This vacuum is known as TORRICELLIAN VACUUM.

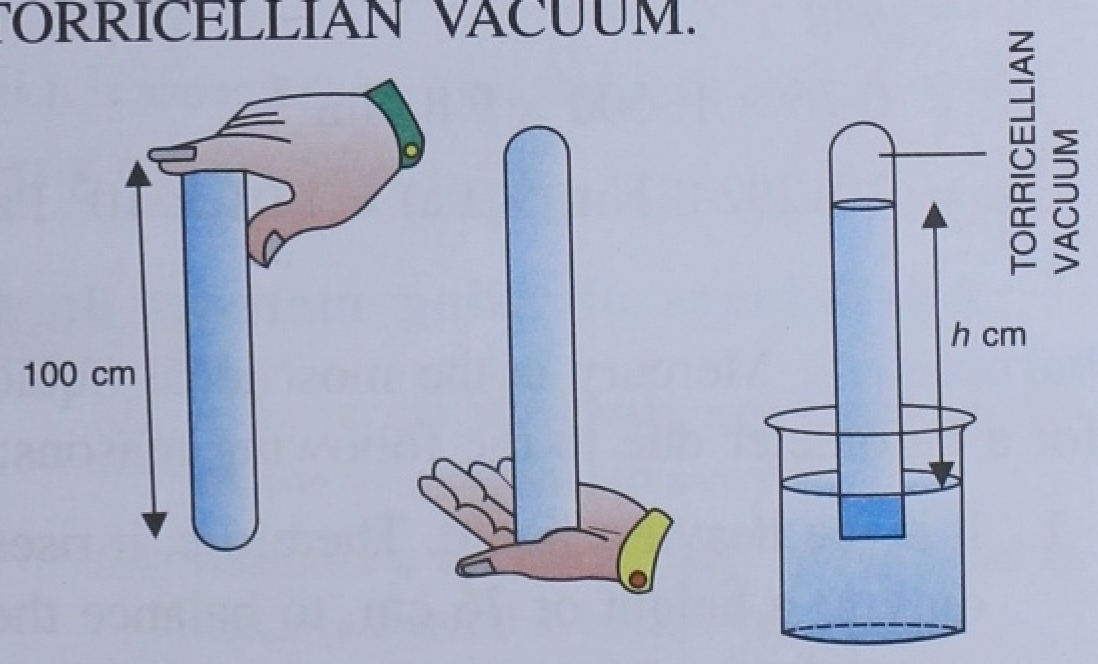

Fig. 7.13 Construction of a simple barometer

Let the level of mercury in the tube be h cm above the level of mercury in the container. Then the pressure exerted by h cm high mercury column at its base is balanced by atmospheric pressure and gives the measure of atmospheric pressure.

At sea level, mercury is found to stand at a height of 76 cm. It suggests that atmosphere exerts as much pressure at the sea level as is exerted by 76 cm high mercury column at the same place. Torricelli also proved that the shape and size of the tube does not matter for the length of mercury in the tube. He also proved that the tilting of the tube also has no effect on the barometric height.

> Let h (m) be the barometric height at a place, d (kg m^{-3}) is density of the liquid (mercury) used and g (ms^{-2}) is the value of acceleration due to gravity at that place, then atmospheric pressure at that place = hdg (Nm^{-2} or Pascal).

At the sea level, barometric height of a mercury barometer is 76 cm (0·76 m). Since, density of mercury = 13600 kg m^{-3} and $g = 9{\cdot}8\ ms^{-2}$.

$\therefore$ Atmospheric pressure at sea level

$= hdg$

$= 0{\cdot}76 \times 13600 \times 9{\cdot}8\ Nm^{-2}$

$= 101292{\cdot}8\ Nm^{-2}\ (Pa) = 1{\cdot}01 \times 10^5\ Pa$

Advantages of using mercury in a barometer : Mercury is the most ideal liquid for a barometer due to the following reasons:

1. It is the heaviest liquid. Therefore, it rises only to a height of 76 cm, to balance the atmospheric pressure.
2. It does not stick to the glass and hence gives a more accurate reading.
3. Mercury is opaque and shiny and hence can be easily seen through the glass.

Although mercury has many advantages but it also has the following drawbacks :

1. It has a long glass tube with no protection to it so, it cannot be carried easily from one place to another.
2. It requires zero adjustment before taking reading.
3. The barometer tube must be kept vertical to get correct reading.
4. The container, in which the glass tube is inverted, is open from the top so impurities may fall into it making the mercury impure.

As a result of these drawbacks, another barometer known as **aneroid barometer** is used.

ANEROID BAROMETER

It is a convenient and compact barometer. It does not have any liquid. It has an airtight and partially evacuated sealed metal box with a thin top. The metal box with the thin top acts like a spring (Fig. 7.14). An increase of pressure presses the top thin material sheet down while a decrease in pressure causes it to move up. The movement of the top thin material sheet moves

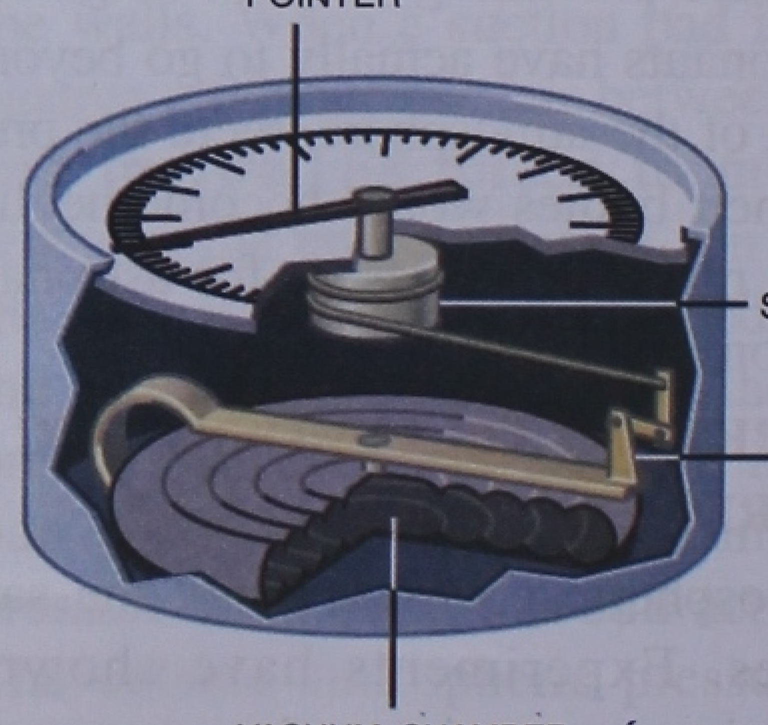

Fig. 7.14 Aneroid barometer

a system of levers and eventually, a pointer moves over a graduated scale.

An aneroid barometer can also be used as an **altimeter** with slight modifications. An altimeter measures the height (altitude) of a certain place. The pressure decreases by 1 cm for every 125 m increase in height *e.g.* if the pressure at a place is 66 cm, it is less by 10 cm compared to the pressure at sea level. Therefore, the height of the place will be 125 × 10 m *i.e.*, 1250 m above sea level. Hence, the scale of the aneroid barometer which indicates the altitude in meters is referred to as an altimeter.

RECAPITULATION

- The force acting normal on a surface is known as thrust. Thrust acting per unit area of the surface is called pressure. The S.I. unit of pressure is Pascal (Pa).
- To increase the pressure, either, force has to be increased or area of contact has to be decreased.
- Liquid pressure in a vessel increases with the depth. It also increases with the density of the liquid. It also depends on the acceleration due to gravity of the place.
- A liquid seeks its own level.
- Pascal's law states that pressure exerted at any point on an enclosed liquid is transmitted equally and undiminished in all directions.
- The thrust on unit area due to the column of air on the earth's surface is called the atmospheric pressure.
- Barometer measures atmospheric pressure.
- An aneroid barometer is a convenient and compact instrument. It can also be used as an altimeter.
- Mercury is the heaviest liquid and hence most suitable to be used in a barometer. Also, it is suitable as it does not stick to the glass. Being silvery, it is clearly visible through the glass.
- Liquids and gases exert pressure in all directions. They exert pressure on the walls of the container also.
- The pressure at a depth h in a liquid of density d is given by,
  Pressure = $h \times d \times g$; where g is the acceleration due to gravity.
- Atmosphere is the envelope of air around the earth which is about 300 km high above the earth's surface.
- Atmospheric pressure at the sea level is 76 cm (0·76 m) of mercury column.

TEST YOURSELF

A. Short Answer Questions

1. Write *true* or *false* for each statement. Rewrite the false statement correctly.

   (a) Pressure is inversely proportional to thrust and directly proportional to the area of contact.

   (b) A liquid seeks its own level.

   (c) Manometer reading remains the same for different positions at the same depth inside a liquid.

   (d) A horse can run faster and easier on the deserts as compared to a camel.

   (e) Bulldozers do not damage the ground as much as a car, due to their big wheels.

   (f) All states of matter exert pressure.

   (g) By making a knife sharp, we decrease the area of contact and hence, the pressure increases.

   (h) When we move from sea level to higher altitude, the atmospheric pressure increases.

(i) Dams and high rise buildings have a broad base to reduce pressure.

(j) An altimeter measures the pressure of liquid.

2. Fill in the blanks :

(a) The force acting normally on a given surface is called the ....

(b) Pressure is directly proportional to ...., ... and ....

(c) Liquid pressure remains the .... in all directions at a given depth.

(d) Pressure which is exerted by the liquids on the sides of the container is called ....

(e) At sea level, the atmospheric pressure is ......

(f) Higher is the altitude, ... is the atmospheric pressure.

(g) Pressure is the ratio of .... and ....

(h) To reduce pressure, the tanks move over .... rather than wheels.

(i) The unit of pressure is .... or ....

(j) Aneroid barometer can also be used as an ....

3. Tick the most appropriate answer :

(a) If F is a force acting normally on a surface of area A, then the pressure P is given by

(i) $F \times A$ (ii) $F + A$

(iii) $F \div A$ (iv) None

(b) The S.I. unit of pressure is :

(i) Pascal (ii) Joule

(iii) Newton (iv) dyne–cm^{-2}

(c) A device to measure liquid pressure is :

(i) thermometer (ii) barometer

(iii) manometer (iv) lactometer

(d) The liquid used in a simple barometer is

(i) alcohol (ii) water

(iii) mercury (iv) kerosene

(e) The feet of lizards act like :

(i) moving pads (ii) drilling pads

(iii) suction pads (iv) none of these

(f) Pressure exerted by a liquid is due to its :

(i) weight (ii) mass

(iii) volume (iv) none of these

(g) Pressure inside a liquid increases with :

(i) increase in depth

(ii) decrease in depth

(iii) decrease in density

(iv) none of these

(h) If the density of the liquid used in a barometer is increased, the pressure will :

(i) increase (ii) decrease

(iii) remain the same (iv) none of these

(i) The pressure exerted at any point on an enclosed liquid is transmitted :

(i) only in one direction

(ii) only on the sides of the container

(iii) in all directions

(iv) none of these

4. Match the following :

Column A	Column B
(a) Camel	(i) Broad and deep foundation
(b) Truck	(ii) Broad feet
(c) Knife	(iii) Six or eight tyres
(d) High building	(iv) Sharp cutting edge

5. Answer the following questions :

(a) Define pressure. Give its S.I. unit.

(b) State the three factors on which pressure in liquids depend.

(c) Define thrust. What is its S.I. unit ?

(d) Why is mercury used in a barometer ?

(e) What are the defects of a simple barometer?

(f) What are the advantages of aneroid barometer over a simple barometer ?

B. Long Answer Questions

1. Describe an experiment to show that pressure in liquids depend on the depth of the liquid.

2. Describe an experiment to show that pressure in liquids depends on its density.

3. Describe an experiment to show that a liquid exerts pressure :
   (a) at the bottom of the container
   (b) sideways
   (c) in all directions
4. Describe an experiment to show that the liquid pressure depends on :
   (a) the depth
   (b) the density of the liquid used.
5. How does the water pressure on a diver change if :
   (a) he moves horizontally ?
   (b) he moves to a greater depth ?
6. Explain the atmospheric pressure. Why does our body not feel the enormous atmospheric pressure?
7. Describe the crushing tin-can experiment. What is the conclusion of this experiment ?
8. Give reason for each of the following :
   (a) If we stand on one leg on sand, we sink more.
   (b) Dams and tall-buildings are made broader at the bottom.
   (c) A balloon collapses when air is removed from it.
   (d) In a fountain pen, ink does not run out by its own.

C. Numerical Problems

1. (a) A force of 200 N acts on an area of $0{\cdot}02\ m^2$. Find the pressure in Pascal.
   (b) What force will exert a pressure of 50000 pascals on an area of $0{\cdot}5\ m^2$?
   (c) Find out the area of a body which experiences a pressure of 500 Pascal by a force of 100 N.
   (d) Calculate the pressure exerted by a force of 300 N acting on an area of $30\ cm^2$.
   (e) What will be force required to exert a pressure of 20000 Pa on an area of $1\ cm^2$.
   Ans. (a) 10,000 Pascal, (b) 25,000 N
   (c) $0{\cdot}2\ m^2$, (d) $10\ N\ cm^{-2}$ = 100,000 Pascal, (e) 2N
2. A vessel contains water to a height of 30 cm. The density of water is $1000\ kg\ m^{-3}$ and $g = 10\ m\ s^{-2}$. Find the pressure at the bottom of the vessel.
   Ans. (a) $3000\ N\ m^{-2}$
3. The atmospheric pressure at a place is 75 cm of mercury. Calculate the pressure in Pascal. The density of mercury = $13600\ kg\ m^{-3}$ and $g = 10\ m\ s^{-2}$. **Ans.** 102000 Pascal

Projects and Activities

1. Find out why porters place a round piece of cloth on their heads. Perform this activity by putting some load on your head with and without round clothes.
2. Find out how dropper works.
3. See the lizards moving on the walls and find out why they do not fall while moving.