7

PRESSURE

We use the word 'force' in our daily conversation. You may have noticed that 'force' is an external effort, which we use to 'push' or 'pull' and it can produce motion in a stationary body. The motion of a moving body can change, the direction of its motion or sometimes its shape can also change.

When we apply force on an object, we touch that object. But, there are many forces in which things do not need to come into contact. For example, the iron piece is pulled towards the magnet, after combing the dry hair and pulling the small pieces of paper, or falling off the objects due to gravitational force of the earth. The effect of forces exerted at a distance does not depend on the area of contact, but the effect of contact forces depends on the area of contact. To understand this, let us take a few examples, such as imagine that you first place a weight directly on the head and then put the same weight on the head with a turban on it, then you think, in which case you will get more convenience and why?

In this way, if we lift one leg up while standing on the sand, then why does the other leg move deeper in the sand? Let us read this lesson to know the answer to many such questions.

OBJECTIVES

After reading this lesson you will be able to:

- explain the thrust and pressure;
- know the fluids and air pressure; and
- describe flotation.

7.1 THRUST AND PRESSURE

Put a book on your palm. A force equal to the weight of the book acts on your arm in a perpendicular direction, because you know that the weight of any object is the force with which the earth pulls that object towards its center. Similarly, when you place a pin on the notice board, then you use force in a vertical direction on the board. Even in closing the door, we apply force in the vertical direction on the surface of the door. In all these examples you saw that the force seems perpendicular to the surface, that we call it thrust.

Fig. 7.1 Hand held thrust

Now we will see how the contact between two surfaces depends on the area - let's do some activities:

ACTIVITY 7.1

What you need to do: See how the effect of thrust depends on the area of contact.

What you need: a pointed nail, a blunt nail, a large piece of wood and a hammer.

How to do you:

1. Place the pointed nail on a piece of wood and hit it with a hammer from a height.
2. Now put the blunt nail on a piece of wood, hit it with the same height with a hammer. See which nail penetrates deeper into the wood. You will find that the spiked nail goes inside the wood comfortably, while the blunt nail does not penetrate as compared to pointed nail.

Now if you use more and more force on the blunt nail, then you will find that this nail will also penetrate more into the wood.

This shows that the effect of force also depends on the force applied, which means that the effect of the force is directly proportional to the magnitude of the force applied.

What do you conclude from this, That is, if we increase the area

of contact, the effect of force decreases and the effect of force increases when the area of contact decreases.

Fig. 7.2 Nail in wood

In the above action, we saw that the thrust is almost the same in both the states, But the effect of thrust varies with the contact area, that is, if you increase the contact area, then the effect of the thrust used is less and if you decrease the contact area then the effect of the thrust used is more. Therefore, it remains in proportion to the area of contact area. This effect of force is commonly called force or pressure. In mathematical terms, we can write it in this way- Thrust Area In other words, we can define pressure as the force exerted on the area per unit.

Since the unit of force is newton (N) and the unit of area or distance (m), the unit of pressure will be newton per meter (Nm2), also called Pascal.

ACTIVITY 7.2

What you have to do: Demonstrate that the effect of force depends on the area of contact between two surfaces.

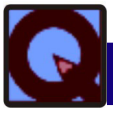
What you need: 10 five-rupee coins, a thin cardboard piece, two large pieces of wood.

How to do it:

1. Place the cardboard strip on the pieces of wood.
2. Make a pair of two coins parallel to the length of the cardboard strip and keep all ten coins.
3. Then place all the 10 coins one on top of each other and place the stack in the center of the cardboard strip.

You will find that the strip in the first position is slightly bent in the middle and more in the second position than the first position.

From this you can conclude that the effect of force is greater when it is concentrated in a small area. If the same force is spread over a relatively long area, its effect decreases.



INTEXT QUESTIONS 7.1

1. Fill in the blanks:

   (i) Pressure is directly proportional to …….

   (ii) Pressure is inversely proportional to .....

   (iii) The unit of thrust is …….

   (iv) Pascal is a unit of …….

2. Why are two wide rear tires used in heavy trucks?

3. Why are the walls of a furnace widened?

4. Why is the knife edge sharpened?

7.2 PRESSURE OF LIQUIDS

The size of a solid is fixed, but the fluid has no fixed size. Fluids form the shape of the vessel in which they are kept. The fluid exerts pressure on the bottom and walls of the vessel.

Let us study the pressure of liquid.

ACTIVITY 7.3

What you have to do: See that the fluid exerts pressure on the bottom and other surfaces of the vessel.

What do you need: A plastic bottle, a balloon, cutter and water.

How to do it:

1. Cut the bottom of the bottle with the help of a cutter.
2. Close the bottom of the bottle with a balloon.
3. Hold the bottle vertically.
4. Add some water in it and see what is the effect on the balloon tied in the bottom?
5. Fill more water in the bottle and see its effect on the balloon.

What you noticed: As we pour water into the bottle, the size of the balloon increases downwards.

Conclusion: From this you can make a natural conclusion that if the water is filled in the vessel, then there is pressure on its bottom.

ACTIVITY 7.4

What you have to do: Understand that there is partial pressure in the liquid.

What do you need: A plastic 'T' shaped pipe, a plastic pipe, two balloons and water.

How to do it:

1. Attach one pipe and two balloons with a 'T' pipe as per the picture.
2. Now connect the second part of the pipe to the tap and open the tap.

What you saw: Balloons start to swell when the tap is opened. By this action it is clear that the pressure of the fluid is not only in the bottom of the vessel but also on the walls of the vessel.

Let us now discuss other symptoms of pressure in fluid.

Fig. 7.3 Partial pressure of liquids

ACTIVITY 7.5

What you have to do: Show that the pressure of the fluid increases with depth.

What you need: a cylindrical powder case, a stool, a pin, a little clay.

How to do you:

1. Make three holes in the cylindrical case at different heights.
2. Fill the holes with clay and close them.
3. Fill the pot with water.
4. Now remove the clay.

What you saw: You will see that the pressure of water coming out from the bottom hole is maximum, while the pressure of water coming from the top most hole is the minimum.

Conclusion: It is evident that the water pressure increases with the depth of the water. As the water pressure in the ocean floor is higher than the surface, the diver wears a special type of clothing, so that the balance of pressure on the body remains in the water.

ACTIVITY 7.6

What you have to do: See that the fluid has the same pressure in all directions at a certain depth.

What you need: a cylindrical case of powder, stools for holding utensils, pins for piercing, clay.

How to do you:

1. Make six holes of equal size in the cylindrical case at the same height.
2. Fill the holes with clay.
3. Fill the pot with water.
4. Now remove the clay.

What you saw: Water is flowing at the same pressure through all the holes, that's why it falls on the ground at the same distance from the vessel.

Conclusions: From this you can conclude that fluid has the same pressure in all directions at the same depth.

INTEXT QUESTIONS 7.2

1. Why do divers in the sea need special type of clothing?
2. State whether the sentences given below are correct or incorrect.
   (i) Water pressure varies in all directions at a certain depth.
   (ii) Pressure increases with depth in the fluid.
   (iii) The fluid exerts pressure only on the vessel walls.
3. Why are water tanks placed slightly above the ground?

7.3 AIR PRESSURE

We all know that we live at the bottom of the immeasurable ocean of air and this air surrounding the earth is called 'Atmosphere'. The expansion of the atmosphere is about 100 km. Due to the gravitational pull of the Earth, air is more dense near the Earth's surface. This density decreases as we move upwards. Since we live on the surface of the atmosphere and the air is dense, due to this we are subjected to air pressure which is called 'atmospheric' pressure.

Let us do some activities related to air pressure.

ACTIVITY 7.7

What you have to do: See that air also exerts pressure.

What you need: a plastic bottle, hot water and cold water

How to do it:

1. Fill the bottle with enough hot water.
2. After some time, remove half the water from the bottle and put a lid on its mouth.
3. Now keep this bottle in the fridge or add ice water and cool it.

What did you see: Cooling will crack the bottle.

From this you can conclude that after cooling the bottle, the steam inside the bottle turns into drops of water and only a

little water remains in the form of steam, so the pressure inside the bottle slightly decreases. The pressure of atmospheric air does not change, so this excess pressure outside distorts the bottle.

Fig. 7.4 Air also exerts pressure.

Through the above action we saw that air also exerts pressure.

Vacuum

An experiment showing the predominance of atmospheric pressure was conducted in 1640 by Auto van Guerich. Two hollow hemispherical iron cylinders were assembled and all the air was pumped out with the help of a vacuum pump.

As a result of atmospheric pressure from opposite directions, the hemispheres joined tightly and were separated only when pulled by eight horses on each side. By doing this, the atmospheric pressure between the hemispheres decreased, and there vacuum was created.

Use of vacuum: You must have seen the lizard sticking to the walls or ceiling. Have you thought about how they stick to the

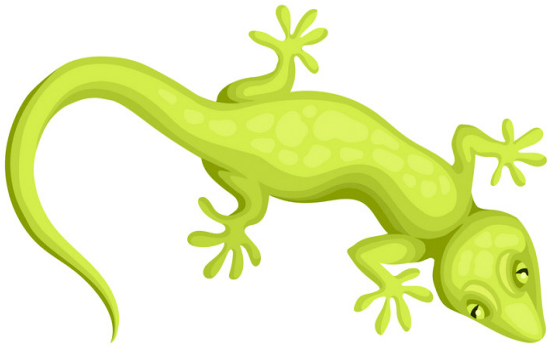


Fig. 7.5 Lizard and his paw

wall? It uses the same principle that we use to stick vacuum-based hooks to the wall. When we press the hook with a hemispherical shape on the wall, the air between it and the wall is removed and the atmospheric pressure keeps it pressed against the wall. Similarly, there is some space under the paws of the lizard and as soon as it presses the paws on the wall, air escapes between the paws and the wall. When a vacuum is formed between the paws and the surface and due to atmospheric pressure it sticks to the wall and is able to walk on the wall and roof.

Inside the vacuum cleaner the pump sucks the dust particles as well as the air and cleans the surface.

Our body and atmospheric pressure

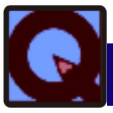
The body of all living beings is made up of cells, some of which are filled with fluid. Whose pressure is outward which is equal to atmospheric pressure. Think what would happen if you put a similar cell in a vacuum? Due to unbalanced pressure inside the

cell, it will burst. You may have noticed that astronauts wear special types of clothing to go into space. These garments maintain the same pressure as atmospheric pressure between the clothes and the body even in space.

At high temperatures, the atmospheric pressure decreases compared to the internal pressure of our body. Due to this, the pressure inside the body becomes high and some blood vessels rupture and start bleeding. It is common for people who travel in airplanes or climb mountains etc. to miss a nose bleed.

Use of air pressure in daily life

1) In inflating balloons and tires.
2) To fill the ink in the fountain pan.
3) Doctor's injection.
4) When drinking cold drinks through staws.



INTEXT QUESTIONS 7.3

1 What changes in atmospheric pressure as you rise above the surface of the Earth?

2. What is a barometer?

3. How does vacuum based hook sticks to your bathroom tile?

4. Describe a simple action that clarifies that air pressure exerts.

7.4 FLOTATION

It is a simple matter that when an object is placed in water, its weight decreases. You feel more light weighted in a bathtub or while swimming. Similarly, when you drain water from the tank or well, the bucket feels light as long as it remains submerged in the water, but when the weights come above the surface of the water, it becomes heavy. In all these situations, it is the upward pressure of water, which we call flotation, due to which the body becomes lighter. Let's do some more activities:

ACTIVITY 7.8

What you have to do: Show that water also pressurizes the body.

What you want: spring balance, thread, a stone, mug and water.

How to do you:

1. Hang a stone in a spring balance with the help of thread.
2. Read the stone weight scale by the indicator of spring balance.
3. Now let this stone sink in the water kept in the mug and again read the scale indicator of spring balance.

What you saw: Submerging underwater reduces the load on the stone.

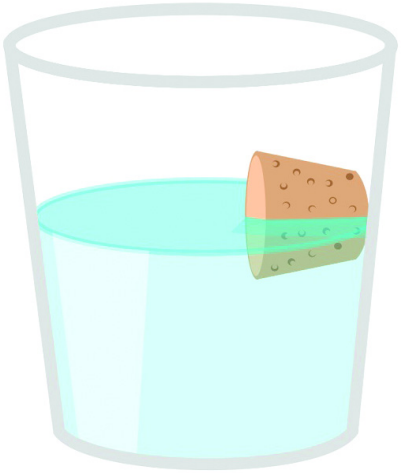


Fig. 7.6 Reduction in load of stone immersed in water

When a body is placed in a liquid, two forces act on it, the gravitational force of the Earth, which pulls this body downward and the force exerted by the fluid, which lifts it upward. This force exerted by the liquid is called buoyant force.

The factors on which flotation is dependent are as following -

1) The volume of the body - the larger the size of the body, the greater the flotation will be.

2) Density of liquid - The Density of the liquid in which the object is placed, the higher its density, the greater its buoyancy.

In an activity, if you place a stone tied with spring balance, and dip in honey instead of water, you will find that the weight of the stone will decrease further. Since the density of honey is higher than water, its flotation will also be higher.

The mass of water removed by a body is the measure of the flotation of that fluid.

Archimedes Principle

To understand the principle of Archimedes, let's do some activities:

ACTIVITY 7.9

What you need to do: To study the weight loss of a body in a liquid.

What you need: a cane, a stone, water, thread, glass, spring balance.

How to do it:

1. Tie the stone with a thread and hang in the hook of spring balance and find its weight.
2. Fill water to the drain pipe in the effluent cane. Place an empty glass near the drain pipe.
3. Slide the spring balance and allow the stone to sink into the cane water.
4. Find the weight of stone in water.
5. Find the weight of water collected in the glass.

What you saw: The weight of the stone would have decreased after weighing in the water, which is equal to the weight of water collected in the glass of water it has removed.

Conclusion: This observation is the principle of Archimedes.

The principle of Archimedes:

According to this, when an object is completely or partially immersed in water or in any other liquid, its weight decreases which is equal to the weight of the fluid removed by it.

Principle of Flotation

When placing a body in a liquid, there are two forces acting on it, first is its self weight and second is buoyancy force. Now there can be three conditions.

Stage-1 : If the weight of the object is more than the flotation force then the object will sink. For example, if you keep five coins of 2-2 rupees in the camera reel box and keep this box in water then it will sink.

Phase-2 : If the weight of the object is equal to the force of buoyancy then the object floats. For example, if you take out two coins from the camera reel box, you will see that the box is floating in the water.

Phase-3 : If the weight of the object is less than the force of buoyancy, then the object in the water emerges on the surface and floats in such a way that there is only that part within the surface of the liquid, which is equal to the weight of the object in water. Removes. For example, if we remove 2 more coins from the camera reel box and only one coin remains in the box, you will see that the box floats on the surface of the water and only part of it is under water.

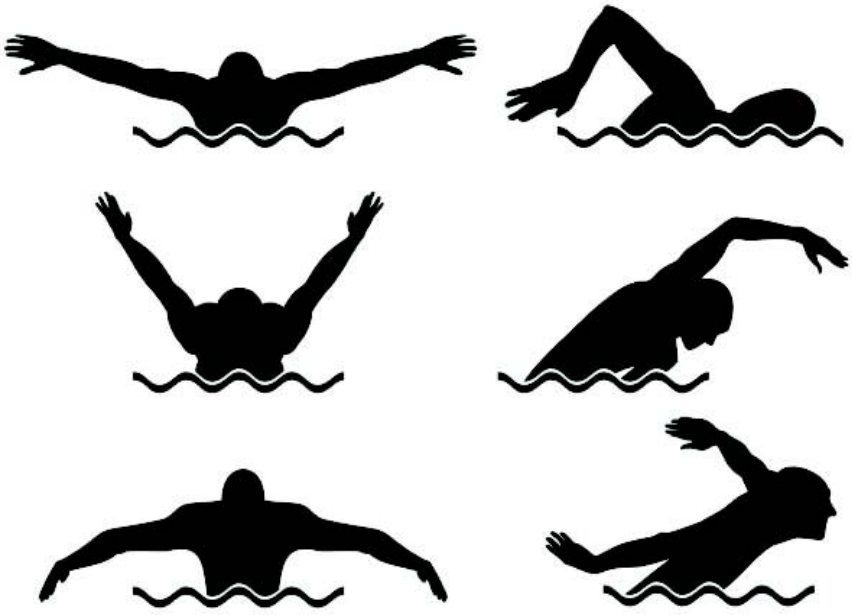


Fig. 7.7 Floating states

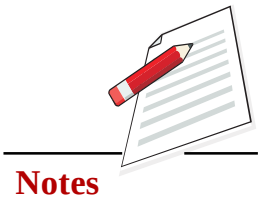
We can summarize these three conditions in this way.

Weight - Buoyancy force sinking of object.

Load Buoyancy force floating of an object completely submerged in water.

Load flotation force of object on the surface (only a small part remains underwater).

The principle of flotation is used in water ships, submarines and icebergs.



ACTIVITY 7.10

let us increase our knowledge a little bit more

Activity: making of obedient tin water

What do you need: An empty oil tin.

How to do it:

1. Make holes in the tin one on the bottom and other on a lid.
2. Cover the bottom hole with the finger and fill water in the tin.
3. Close the top hole with the finger and remove the finger from the bottom hole. Does tin drop water?
4. Remove finger from the top hole. what happens now?

What did you see, when you close the hole on the lid, the water from the bottom hole stops and then when it opens, then the water starts coming out. You have received a magically obedient case in your hand. Close the hole of the lid and say 'stop', then the water stops. Remove the finger from the hole and say 'flow' then water flows.

You must have understood the scientific principle of the obedient box. By placing the finger on the lid of the tin, the pressure of the atmosphere on the water inside the box is not effective. Therefore, the atmospheric pressure from the bottom to top of the bottom hole does not let it come out due to the pressure of the water inside the box.

ACTIVITY 7.11

Activity: To show that air also pressures

What you need:

a glass, water and a little thick cloth that can bear the weight of the glass.

How to do you:

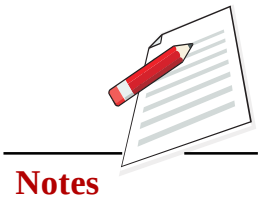
1. Fill the glass with boiling water.
2. Cover it with a cloth.
3. Now hold the cloth tightly with a glass bottom.
4. Invert the glass.

What you saw:

Despite the reverse, the glass water does not filter and fall down. What do you conclude from this? The water is down. It is clear that the effective atmospheric pressure on the cloth from below prevents the water from falling.

INTEXT QUESTIONS 7.4

1. What do you understand by measurement of flotation?
2. Write two uses of the principle of the flotation.
3. If the weight of the object is exactly equal to the buoyancy force, will the object float?



WHAT HAVE YOU LEARNT

- Force is the effort of pushing or pulling in any form.
- A thrust is a force that acts perpendicular to a surface and the international unit of force - Newton.
- Pressure - thrust /area.
- The unit of pressure is Newton per meter ().
- The pressure emitted by the liquid increases with increasing depth within the liquid.
- At any given depth, the liquid has the same pressure in all directions.
- The vessel in which liquid is kept exerts pressure on the bottom and wall of the vessel.
- The pressure generated by air is called atmospheric pressure. Atmospheric pressure is measured with a barometer.
- Atmospheric pressure varies at different places and at different times.
- If an object is poured into a liquid, the upward force on the object is called buoyant force.
- Archimedes' theory states that if an object is fully or partially inserted into a liquid, the buoyancy force exerted by it is equalto the weight of the liquid removed by the object.

TERMINAL QUESTIONS

1. Give a definition of buoyancy force.
2. State the principle of Archimedes.
3. State the difference between force, thrust and pressure.
4. Match the words 'B' in the column 'A':

	Column (a)		Column (b)
(i)	Archimedes principle	(A)	Barometer
(ii)	Force	(B)	Pressure field
(ii)	Pressure	(C)	Force on the unit area
(iv)	Atmospheric pressure	(D)	When an object is placed in a liquid, its load decreases
(v)	Buoyancy force	(E)	The liquid removed by the object then the weight of that liquid is equal to the buoyancy force exerted on the object.

5. Answer the following questions in one sentence:
   (A) What is the relationship between force and pressure?
   (B) State the pressure unit.
   (C) Describe the unit of buoyant force.
   (D) What do you understand by pressure?

(E) Describe the factors on which, on which pressure is dependent on a point within the liquid.?

(F) What happens if the weight of a body is less than the buoyancy force

(G) When the bucket filled with water is kept inside the waterof the well, why does it feel lighter?

(H) How will you prove that the pressure of a liquid with depth increases?

(I) What changes in atmospheric pressure is observed as you go up?

6. Fill in the blanks:

(i) At some point inside the liquid, the pressure will be…….. at the same depth.

(ii) The weight of the object in the liquid and the buoyancy force exerted on it act …….. on each other.

(iii) At atmospheric pressure due to ..... some people suffer from nosebleeds at high places.

(iv) By ……. the contact area, the pressure can be reduced.

(v) Pressure is directly proportional to ..…… and inversely proportional to ..…….

(vi) Force per unit area is known as …….

ANSWERS TO INTEXT QUESTINS

7.1

1. (i) Force, (ii) Area, (iii) Newton, (iv) Pressure
2. So that the surface area of the tires is more and they feelless pressure even in the state of being overweight.
3. Reduce pressure for more force.
4. When the edge is thin, its area will be less, consequently applying less force will also exert more pressure.

7.2

1. So that it can withstand the pressure exerted by changing the depth of water, and maintain a balance of pressure in the body.
2. (i) False, (ii) True, (iii) False
3. So that the pressure of the fluid (water) increases.

7.3

1. is low.
2. Atmospheric pressure measuring instrument.
3. Pressing the hook removes the air inside, creating a partialvacuum there. The hook is sticky due to high externalpressure.
4. inflating of balloon when filled with air.

7.4

1. The mass of a fluid removed by a body is a measure ofthe flotation of that fluid.
2. Swimming of ships and icebergs.
3. Yes,