

# Force And Pressure 11

## IN THIS CHAPTER

- Force
- Effect of force
- Friction forces
- Gravitational force
- Magnetic force
- Electrostatic force
- Pressure

## INTRODUCTION

Look all the objects around you. Some objects are moving while some are not. The shape of some things such as dough can be changed easily. What do you do to make a stationary object move or to stop a moving object ? How do you change the shape of dough to make chapattis ?

### Force

From our day-to-day experience, we all are familiar with the concept of force while opening a door, lifting a bucket or a bag, kicking a football or throwing a stone. We have to act differently and in many ways. We are either pushing or pulling the objects. Non-living objects do not move on their own. We have to apply the effort in the form of push or pull.



Different types of push and pull.

This pull or push is called force. Thus a force is an external energy that displaces or tends to displace a body from its position of rest. The direction in which the object is pushed or pulled is called the direction of the force. Force has both magnitude and direction. It is a vector quantity.

### What can Force do?

Force can make a stationary object move. When you kick a stationary football, you make it move, when you pick up a glass of water, you make it move.

Force can change the speed of a moving object. A goalkeeper applies force to stop a football and reduce its speed to zero. If he is not able to stop the ball properly, it may only slow down and not come to a position of rest. When a player kicks a moving football, it starts moving fast.



Efforts of force

A goalkeeper slows down or stops a football by applying force in the opposite direction to which the football is moving on the other hand, to makes the ball move faster, the player applies a force in the same direction in which the ball is moving.

Force can change the direction of motion of a moving object. When a batsman hits a ball with his bat, he applies force to change the direction of the motion of the ball.

If you allow a moving ball to hit the palm of your hand, a force is exerted on the ball which changes its direction of motion. Force can change the shape or size of an object. If you squeeze a sponge, its shape changes. If you pull a rubber band, it becomes longer. You can use the force of your hand to change the shape of plasticine. In the kitchen, force is applied to change the shape of dough to make thin circular chapattis, you can pull a spring to increase its length and push it to reduce its length.

## Frictional Force

What happens when you stop pedalling a bicycle ? It slows down and stops after some time. If you kick a small block of wood, it slides for sometime and then comes to rest. Why ? This happens because of a force called friction. It is a force that slows things down or stops things from moving over another surface, the force of friction acts on the surfaces. It always opposes the motion. There is friction between the tyres of bicycle and the road, and between the block of wood and the floor, observe the surface of a table with a powerful magnifying lens.

You will notice that it is rough and has very small grooves and ridges. You can see the grooves and ridges more clearly on very rough surfaces such as that of sandpaper. When one surface moves over another these grooves and ridges get caught up with each other and slow down the motion. This causes friction.

This means that the smoother a surface is, the lesser will be the friction on it. This is why a ball rolled on a smooth surface will travel a longer distance before coming to rest, than when rolled over a rough surface.

## Advantages of Friction

It would be impossible for us to walk without friction. It is because of friction between our feet or shoes and the ground that we are able to walk by pushing our feet against the ground. Without friction we would slip as soon as we step on a very smooth and polished floor. This is because the friction on these surfaces is very little.

Cars and buses are able to move on the road because of friction between the tyres and the surface of the road.

Brakes on cycles or cars work because of friction when brakes are applied, the 'shoes' of the brakes rub against the wheels. The friction between them reduces the speed.

## Disadvantages of Friction

Friction causes wastage of energy. This is because anything that moves has to overcome the force of friction. Friction wears out the rubbing surfaces. The soles of your shoes wear out in a few months due to friction. The moving parts of a machine wear out with time because of friction.

Friction generates heat. Sometimes this can be harmful. The heat produced in a fast moving machine is very high. Proper arrangements have to be made to cool the machine, otherwise it can get damaged. If the cooling arrangement in a car does not work properly, the engine can get jammed.

## Minimising Friction

Since friction is due to roughness of surfaces; any process that makes the contact surfaces smooth will reduce friction.

### By Polishing

Polishing a rough surface smoothens it and reduces friction.

### By Lubrication

Friction is decreased by lubricating with oil, grease or graphite. The sliding surfaces then have a thin layer of the lubricant between them. The friction is then between the surfaces and the lubricant layer which is much less. Graphite is used as a lubricant in machines where the moving parts reach at a very high temperature.

### By Streamlining

A streamlined shape is narrow in front and broader at the back. The bodies of aeroplanes, missiles, rockets, cars, etc. are streamlined to reduce friction with air, called air resistance. Ships also have streamlined shapes to reduce friction with water. Nature has given birds and fish streamlined bodies.



Streamlined shape

## By using Wheels and Ballbearings

When a spherical or cylindrical object rolls on a surface it encounters less friction than if it slides on the surface. Thus rolling friction is less than sliding friction. That is why vehicles use wheels. This principle also used in a ball bearings which contain steel balls or rollers. Ball bearing used between the wheel and axle of a car reduce friction considerably. Most machines with moving parts use ball bearings.



Ball bearing

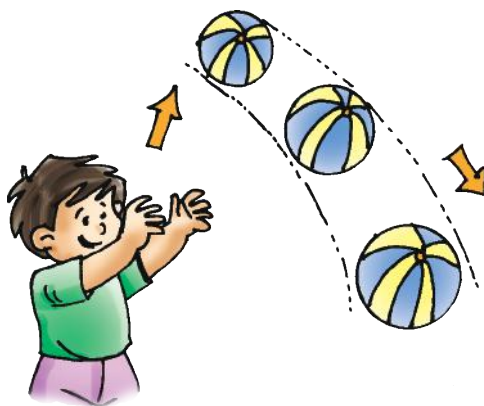
## Increasing Friction

It is sometimes desirable to increase friction to avoid slipping, friction can be increased by making the surfaces rough.

1. Tyres have designs and patterns with grooves on the surface to increase resistance with the road. This prevents slipping of the tyres on a wet road.
2. Sand and gravel is thrown on slippery ground during the rainy season to increase friction. It is then easier to walk on the ground.
3. Spikes are provided in the soles of shoes used by players and athletes to increase friction so that they get a firm grip on the ground.

## Gravitational Force

A force that acts on you and on all objects around you all the time is the force of gravity. Gravity is the force with which the earth pulls everything towards itself. It is due to gravity why things on earth fall downwards and not upwards.



Gravitational force

Gravity is actually the force of attraction between particles of matter. Every object exerts this force on every other object. The magnitude of this force depends on the masses of the two objects and the distance between them. Two cars pull each other but the force of gravity between them is very small.

Because the earth has such a large mass, objects on the earth are pulled towards the earth more than they are pulled towards each other. The earth pulls a car towards itself with a force which is about 30,00,000 times more than force with which two cars pull each other.

## Spring Balance

A spring balance is a device used to measure the weight of an object. It can also be used for the measurement of forces.

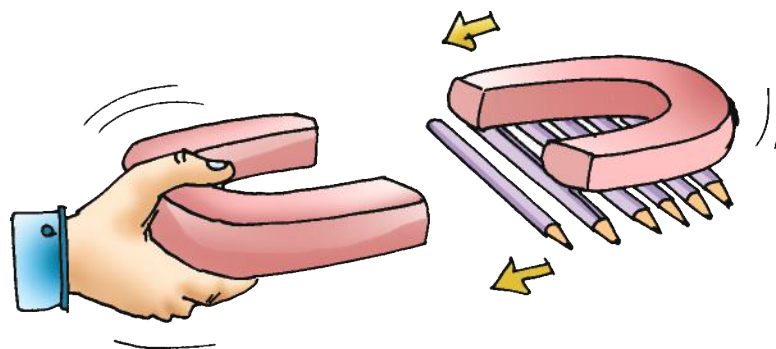
Weighing machines which are used in schools or hospitals for weighing are also spring balances.



Weighing machine

## Magnetic Force

Look at a large magnet which is being used to pick out scraps of iron from the garbage. It is using force to lift the iron pieces. This force is called magnetic force or magnetism. It is exerted by a magnet on certain metals such as iron. When you bring a small magnet near some iron nails, the iron nails are pulled towards the magnet even when they are a little distance away from it. This is because magnetic force can act from a distance. A magnet is surrounded by an invisible field of force. When iron pieces get close to that field of force, they are pulled towards the magnet.



Magnetic force

Magnets attract iron pieces such as nails. However what happens when two magnets are brought close together. Take two bar magnets bring them close together end to end. What happens ? Do they attract or repel each other ?

Now bring the other end of the magnets near the second magnet and try again. What happens now ? You will find that their behaviour is opposite to what you observed earlier depending on which ends are facing each other.

## Electrostatic Force

When you rub a comb into your dry hair for some time, the comb acquires a property called electrostatic charge. This comb when brought near bits of paper, exerts a electrostatic force on them. Because of this force, these bits of paper move towards the comb.

The force exerted by the electrostatic charge is called electrostatic force. Electrostatic force, like magnetic force, also acts from a distance. Now a days, electrostatic force is used to separate solid pollutant.



Electrostatic force

## Pressure

Consider a force applied on an object. You have already seen the effects that the force can produce on the object. But how do we find out how much effect the force will have on the object? The effect that a force produces on an object depends in two factors.

The amount of force applied, the greater the force the greater is its effect.

The area over which the force is applied or area of contact between the two objects.

When you cut an apple with a knife, the area of contact is the edge of the knife. If the knife is sharp, the area is small. But if the knife is blunt, the area becomes larger. In which case is it easier to cut the apple when the knife is sharp or when it is blunt? What does this show? This shows that the smaller the area of contact the larger the effect of the force.

## Unit of Force

In the SI system the standard units of length, mass and time are metre, kilogram and second respectively. In this system the standard unit of force is Newton (N). In the CGS system the unit of pressure is dyne.

To measure and describe the effect of the force acting on a surface, we need a quantity that takes into account both the amount of force applied and the area over which it is applied. Such a quantity is pressure. Pressure is defined as the force exerted per unit area.

It is clear from this that smaller the area over which a force acts, the greater is the pressure, and therefore, the greater is the effect of the force.

## Unit of Pressure

In the SI system, the unit of pressure is Newton per metre square or  $N/m^2$ . This unit of pressure is commonly known as pascal. After the French scientist Blaise Pascal pressure can also be measured in  $Kg/m^2$ .

In the CGS system, the unit of pressure is dyne per centimetre square or  $dyne/cm^2$

## Application of Force and Pressure in Daily Life

Have you ever tried to run on sand? It is difficult because your feet sink into the sand. A camel is able to move fast on sand because it has flat broad feet. This increases the area of contact with the sand. Hence, the pressure exerted by the camel on the sand is reduced and the camel's feet sink very little in the sand.

Trucks meant to carry heavy loads have eight rather than four tyres to increase the area of contact with the road. Heavy tanks have broad chains called caterpillar tanks which considerably increase the area of contact. Because of this, tanks can even cross ground which is sinking as the pressure exerted on the ground is comparatively less.



tanks have broad chains that increase the area of contact

Cutting and piercing tools, such as knives, needles and saws, have smaller area of contact so that they exert great pressure with a comparative small force. It is easier to hammer a sharp nail into wood than a blunt one. Can you say why ?

### Pressure Exerted by Liquids

Now, take a vessel with a tap-like opening at its side. Tie a balloon to the opening and fill the vessel with water.

You will notice that the balloon bulges outwards. This shows that liquids exert pressure not only on the base of the container but also sideways on the walls of the container. This sideways pressure is exerted by liquids but not by solids.

### Liquid Pressure Varies with Depth

Liquid pressure can be measured by an instrument called a manometer. You can easily make your own manometer.

The pressure in a liquid increases with depth, but at the same depth the pressure is the same in all directions.

The pressure at the bottom of the sea is much greater than near the surface. Deep sea divers have to wear special suits to prevent their bodies from being crushed.

### Atmosphere Pressure

The earth is surrounded by a layer of air called the atmosphere. We live at the bottom of this layer. The air above presses down on us with a force equal to that exerted by a mass of 1 kg on every square centimeter. This is called the atmosphere pressure. The area of the palm of your hand is about 100 square centimetre. Thus a force equal to that exerted by a mass of about 100 kg acts on your palm.

You cannot feel it because an equal force is pressing up on the other side of your hand. The two forces balance each other.

#### Do You Know ?

An instrument called manometer is used to measure the pressure of a liquid at various depths.

Atmospheric pressure is measured with an instrument called barometer.



### Know the Keywords :

**Force :** It is a push or a pull that can be used to change the speed, direction or shape of a body.

**Gravity :** It is the force with which the earth pulls a body towards it.

**Newton :** S.I unit of force.

**Magnetic force :** Force with which a magnet pulls objects made of certain metals for example iron towards itself.

**Spring balance :** A device used to measure the weight of a body.

**Muscular force :** The force exerted by the muscles.

**Electrostatic force :** Force exerted by an object with electric charge on it.

**Pressure :** The force acting per unit area of the surface.

**Thrust :** The total force acting on a given surface.

## Point to Remember

- A force is an external energy that displaces or tends to displace a body from its position of rest.
- Polishing a rough surface smoothness it and reduces friction.
- A force that acts on you and on all objects around you all the time is the force of gravity.
- A spring balance is a device used to measure the weight of an object.
- The earth is surrounded by a layer of air called the atmosphere.

## EXERCISE TIME

### A. Answer the following questions :

1. What is force ? What are the four main things that it can do ?
2. Gravitational force exists between you and a building. Why are you not pulled towards the building ?
3. Why does friction occur when two surface are in contact ?
4. Mention two advantages and two disadvantages of friction.
5. What is streamlining ? How is it useful ?
6. On what principle do ball bearings work ?
7. How does lubrication reduce friction ?
8. What is pressure ?
9. Why it is difficult to cut vegetables with a blunt knife ?
10. How does the pressure exerted by a liquid change with depth ?

### B. Answer in one word :

1. If a body is moving with uniform speed in a particular direction on a perfectly smooth surface no force is acting on it. Is it true or false ?
2. All pushes and pulls are forces. Is it true or false ?
3. Only the earth exerts gravitational force on all objects. Is it true or false ?
4. Which type of force is exerted by an electrostatic charge ?
5. Which force tends to slow down objects or stops them from moving ?
6. Friction cause wastage of energy. Is it true or false ?
7. The larger the area over which the force acts. The greater is the pressure. Is it true or false?



8. Atmosphere pressure increases with height. Is it true or false ?
9. What is the earth's gravitational pull on an object. It is weight or mass ?
10. Does pressure exerted by a liquid increase or decrease with depth?

**C. Tick (✓) the correct option :**

1. Friction is :

- (i) always a disadvantage
- (ii) always an advantage
- (iii) sometimes a disadvantage and sometimes an advantage

2. There is one force which is exerted by all matter on all other matter. Which force is this ?

- (i) magnetic force
- (ii) frictional force
- (iii) gravitational force

3. It is difficult to walk on ice because :

- (i) pressure is high
- (ii) pressure is low
- (iii) frictional is force



## Creative Work

- **Take two plastic bottles. Use a ballpoint pen to make a tiny hole at the side on each of the bottles. Holding the neck of one balloon, push a balloon into each bottle. Then stretch the neck of the balloon over the mouth of the bottle and tie it. Similarly, tie the other balloon on the second bottle. Give the bottle without the hole to a friend and see who is faster at blowing up the balloon inside a bottle. Your friend will not be able to blow the balloon. Why ?**

- **To show that atmospheric pressure provides the force.**

**Fill the tumbler with water to the brim. Cover the tumbler with the cardboard piece. Place the palm of your hand over the piece of cardboard, and quickly invert the tumbler. Slowly remove your hand supporting the piece of cardboard. What happens? You will see that the cardboard piece will not fall, as expected, but will be able to support a full glass of water. Why do you think this happens? This is because the atmospheric pressure provides enough – force to push the cardboard piece upwards.**

