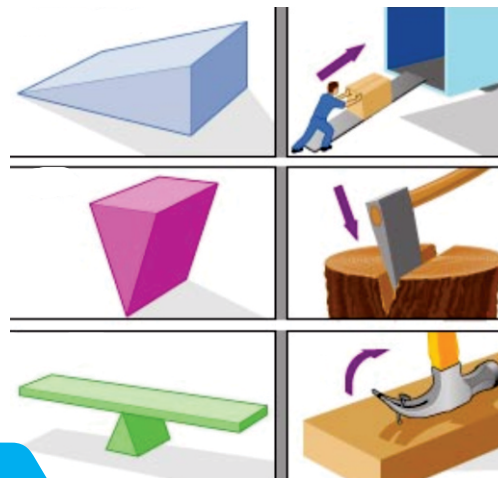


UNIT 5

FORCES AND MACHINES



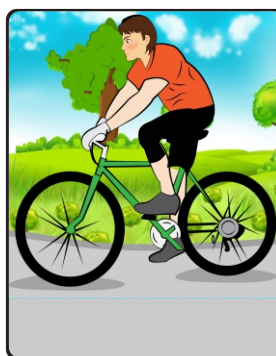
In this unit, we will learn:

- Friction
- Advantages and disadvantages of friction
- Methods to reduce friction
- Gravitational force
- Simple machines
- Lever and kinds of lever

We use force when we do work. We use force when we write on a paper, open a door, pedal a bicycle or push an iron nail into the wood. We cannot see a force but we can see its effects.

5.1 Friction

What happens when we stop pedalling a bicycle? Why a rolling ball stops after moving some distance on the ground? There is a force which opposes the motion of the bicycle and the rolling ball (Figure 5.1).



Pedalling a bicycle



Kicking a ball

Figure 5.1

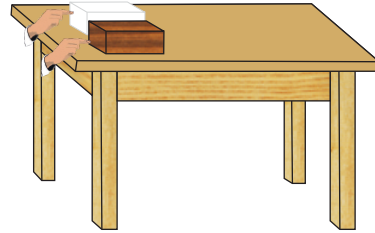
A force which slows down and stops the things from moving is called frictional force or friction.

Friction appears when a moving object is in contact with another. It is a

contact force. There is less friction when smooth surfaces such as glass and a marble slide over each other. There is more friction when rough surfaces such as sand paper and bricks slide over each other.

Activity 5.1

- Place equal sized wooden and ice blocks side by side on a table. Push them to slide over the surface of a table as shown in the figure.
- Which of the two blocks needs lesser force to slide over the table and why?



Roughness of the surfaces increases friction. No surface is perfectly smooth. A surface that appears smooth also has roughness when seen under a microscope (Figure 5.2).

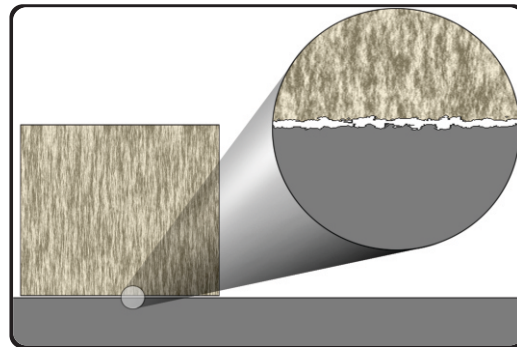


Figure 5.2: A magnified view of a smooth surface under a microscope

Some materials are deformed (deshaped) under pressure. Deformed materials also cause friction (Figure 5.3). So, roughness of surfaces and deformations are the causes to increase the friction.

Objects moving in liquids and gases also face friction. Water

resistance is a force which slows the objects moving through water. Air resistance is a force which slows the objects moving through air.

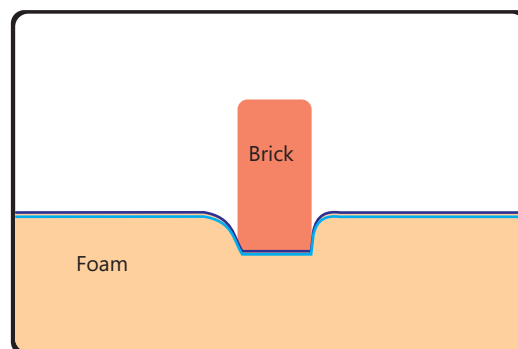


Figure 5.3: Deformation causes friction

Advantages of Friction

Many of our daily life activities such as walking, writing and stopping the fast moving vehicles by applying brakes are due to friction.

We cannot write if there is no friction between paper and the pencil (Figure 5.4). When we write and rub a pencil on the paper, friction is produced due to which carbon particles leave a mark on the paper. Friction between our shoes and the Earth enables us to walk or run on the ground. When the grooves on the sole of our shoes slide on rough surface of the floor, friction is produced. It gives our shoes the grip we need to walk (Figure 5.5). Similarly, friction between the tyres of the vehicles and the ground enables them to stop when brakes are applied. Birds cannot fly if there is no air resistance. The reaction of pushed air enables the birds to fly (Figure 5.5).



Figure 5.4

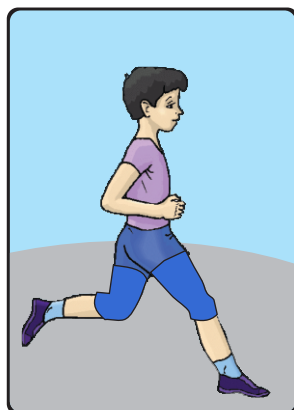


Figure 5.5

Disadvantages of Friction

Despite friction is very important to us, it has many disadvantages too. Friction offers resistance to a moving object at high speed and reduces the speed of moving objects.

We know that worn out tyres of the vehicles are replaced after some period. What is the cause of wear and tear of tyres? The answer is friction. Similarly, if we do not grease the chain of a bicycle, the chain and the pulley will wear out soon due to friction. The moving parts of engines and machines which rub against each other become very hot. This increases the wastage of energy. The sole of our shoes is worn out due to friction with the ground.

Methods to Reduce Friction

Friction can be reduced by the following methods:

1. Polishing of surfaces

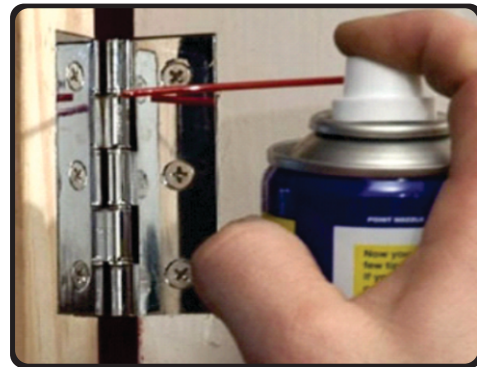
Polishing of surfaces of the objects reduces the friction (Figure 5.6).

2. Using lubricants

Use of lubricant (oil or grease) between the moving parts of machines can reduce friction (Figure 5.6).



Polishing of surface



Using lubricants

Figure 5.6

3. Using rollers or wheels

Friction in rolling an object over another is much less as compared to sliding. Therefore, rollers or wheels are used to pull a cart or a TV trolley on the floor. They reduce friction and make our work easier.

4. Using ball bearings

Ball bearings change sliding friction into rolling friction. They are usually placed around an axle, so the rotation of the wheel becomes easier (Figure 5.7).



Use of wheels



Ball bearing

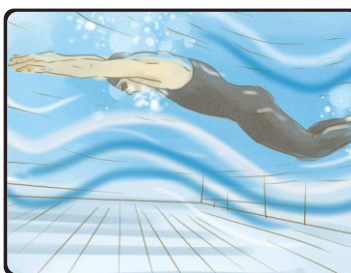
Figure 5.7

5. Streamlining the bodies

Cyclists use very narrow and hard tyres in their bicycles to reduce friction with the road. They wear tight dress and bend their bodies to give themselves a streamline shape which moves through the air easily. This shape faces minimum air friction when moving. For example, sports cars are always streamlined so that they can move fast. Similarly, the swimmers also acquire streamlined shape to reduce the water friction. Aeroplanes, ships and boats have streamlined shapes and they face less friction to move (Figure 5.8).



Cyclist



Swimmer



Boat

Figure 5.8 Streamlining bodies

For your information

Skating is the movement on ice using ice skates. The metal blades at the bottom of the shoes glide with very little friction over the surface of ice. Edges of the blades dig into the ice and increase the friction which helps skaters to control their movements.

Parachutists use air friction to slow down their fall. During downward fall, their weight and air friction, which are opposite in direction, balance each other. This makes their landing safe.



5.2 Gravitational Force

We know that when a ball is thrown upward it comes back to the Earth. It is easy to go down stairs as compared to moving upstairs. A cricket ball thrown upward, comes downwards. Similarly, an apple or an orange from a tree always falls downward (Figure 5.9). Why does everything fall down? Actually, Earth attracts all the bodies towards itself. This force of attraction is called gravitational force (force of gravity).



Figure 5.9

Gravitational force not only exists between the Earth and other bodies but also exists between all the objects around us. It is a pulling force. It depends

upon the mass of the objects and the distance between their centres. The greater the mass of an object, the greater will be gravitational force. The larger the distance between the centres of the objects, the smaller will be the gravitational force.

Do you know?

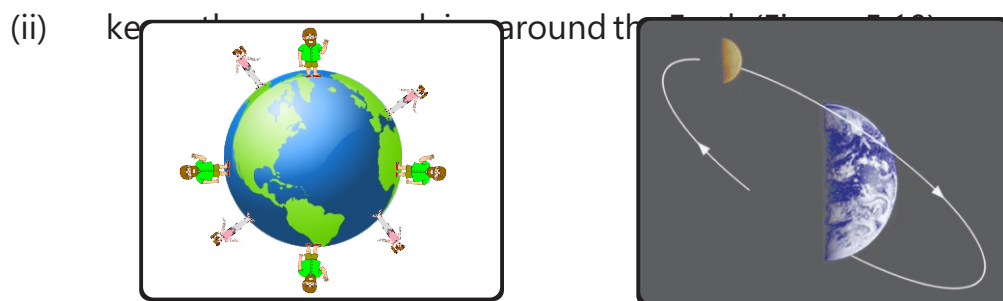
The gravitational force of the Earth is stronger at its poles than at the equator.

Gravitational force between small objects is too small to be noticed. It can easily be observed with massive objects such as the Sun, the Earth and the other planets.

Gravitational force of the Sun pulls the Earth and other planets to orbit around it.

It is the gravitational force of the Earth that:

(i) holds us on the surface of the Earth and stops us floating away into the space (Figure 5.10).

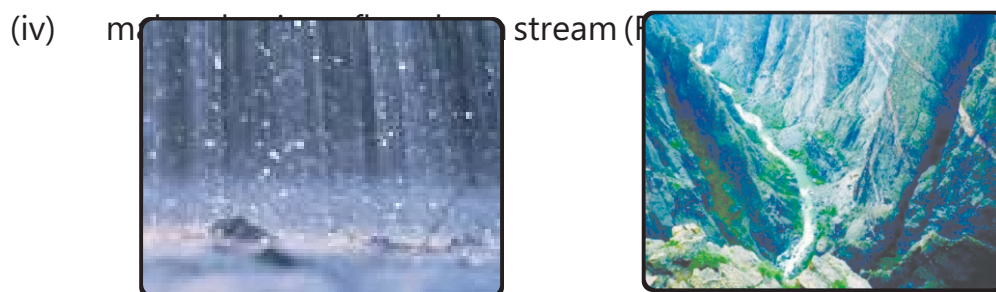


Earth's gravitational force

Moon revolving around the Earth

Figure 5.10

(iii) makes rain fall on the Earth (Figure 5.11).



Rainfall

River

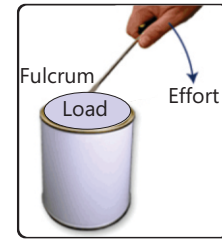
Figure 5.11

Do you know?

The Moon's gravitational force is about six times less than that of the Earth.

5.3 Lever

A lever is a simple machine which turns about a fixed point. When a force is applied at one end of the lever, it turns about the fixed point to lift the load at the other end (Figure 5.12).



Lid opener
Figure 5.12

The fixed point about which a lever turns is called its fulcrum (F). The force which is applied on the lever is called effort (E) and the weight which is lifted is called load (L). Scissors, pliers, claw hammer, door, and staplers, etc., are the examples of the levers.

There are three kinds of lever based on relative positions of the fulcrum (F), the effort (E) and the load (L).

First kind of lever

In the first kind of lever, the fulcrum is between the effort and the load (Figure 5.13). First kind of levers can produce large force from a small effort. In this case the effort arm which is the distance between effort and

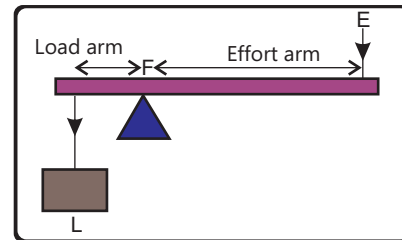


Figure 5.13 First kind of lever

fulcrum, is long whereas the load arm, the distance between load and fulcrum is short. By a longer effort arm, greater force will be produced. Scissors, pliers, lid opener, and claw hammer, etc., are the examples of the

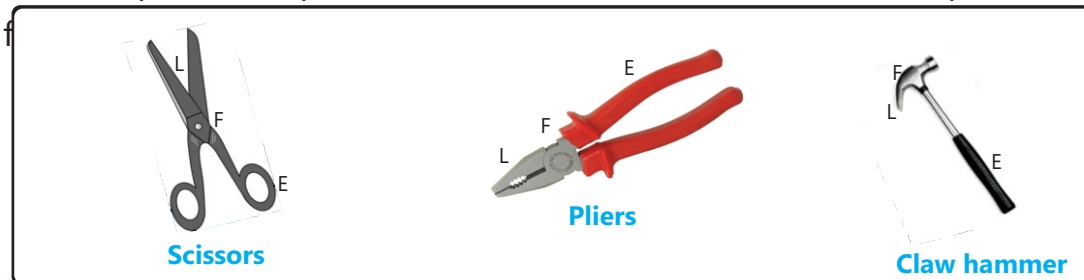


Figure 5.14

Second kind of lever

In the second kind of lever, the load is between the fulcrum and the effort (Figure 5.15).

Bottle opener, wheelbarrow, nut cracker, paper cutter and door, etc., are the examples of second kind of

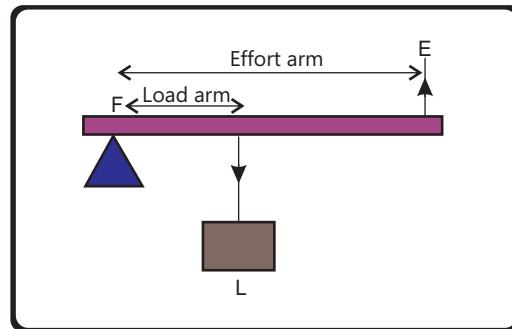


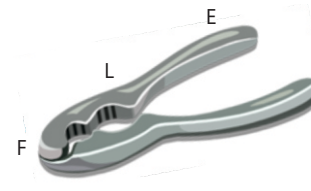
Figure 5.15: Second kind of lever



Bottle opener



Wheelbarrow



Nut cracker

Figure 5.16

Third kind of lever

In the third kind of lever, the effort is between the fulcrum and the load (Figure 5.17).

In this case the effort moves a short distance, whereas the load moves a long distance.

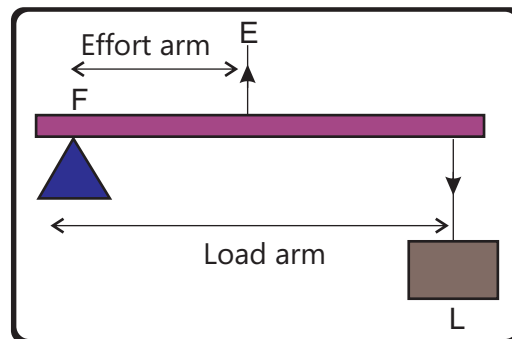
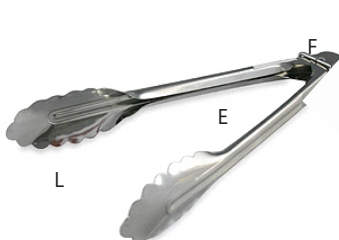


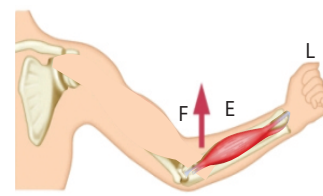
Figure 5.17: Third kind of lever



Pair of tongs



Broom



Arm

Figure 5.18

Pair of tongs or forceps, broom, and the human arm, etc., are the examples

Science, Technology, Society and Environment

Today is the age of machines. Wheel was the first invention which initiated a revolution in technology and man's life. Think about the tasks which we do using simple machines like wedge, bottle opener, scissors, pliers, stapler, fishing rod, etc. Can we do the same tasks easily and precisely without using machines?

KEY POINTS

- The force which slows down and stops the things from moving is called friction.
- The force of attraction between any two objects is called gravitational force.
- Lever is a simple machine which turns about a fixed point.
- There are three kinds of lever based on relative positions of load (L), effort (E), and fulcrum (F).
- Scissors, pliers and claw hammer etc., are the examples of first kind of lever.
- Bottle opener, nutcracker and wheelbarrow are the examples of second kind of lever.

QUESTIONS

5.1 Encircle the correct option.

i. Friction produces:

- a. heat
- b. cooling
- c. motion
- d. roughness

ii. Which of the following is not a way to reduce friction?

- a. use of lubricant
- b. smoothening the rubbing surfaces
- c. increasing roughness of the surfaces
- d. changing the sliding friction to rolling friction

iii. Which of the following is not a simple machine?

- a. bicycle
- b. screw driver
- c. wheel
- d. wedge

iv. Simple machine is a tool that:

- a. gives energy to other machines
- b. does only one job
- c. makes the work easier
- d. made of many small parts

v. The point about which a lever turns is called:

- a. effort
- b. load
- c. fulcrum
- d. weight


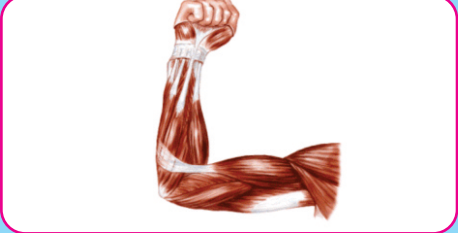



vi. Wheelbarrow is an example of the lever of:




- a. first kind
- b. third kind
- c. second kind
- d. both first and second kind

vii. Which of the following is an example of second kind of lever?

a. scissors

b. bottle opener

Machine	Figure	Kind of lever
Fishing rod		
Human arm		
Fodder machine		
Bottle opener		
Stapler		

Machine	Figure	Kind of lever
Hand pump		
Claw hammar		
Shovel		

5.2 Classify the kind of lever.

5.3 Define (i) friction (ii) lever.

5.4 What are the causes of friction?

5.5 State the advantages and disadvantages of friction.

5.6 Suggest some methods to reduce friction.

5.7 What do the cyclists and swimmers do to reduce friction?

5.8 Why does it become dangerous to walk on a wet or polished smooth floor?