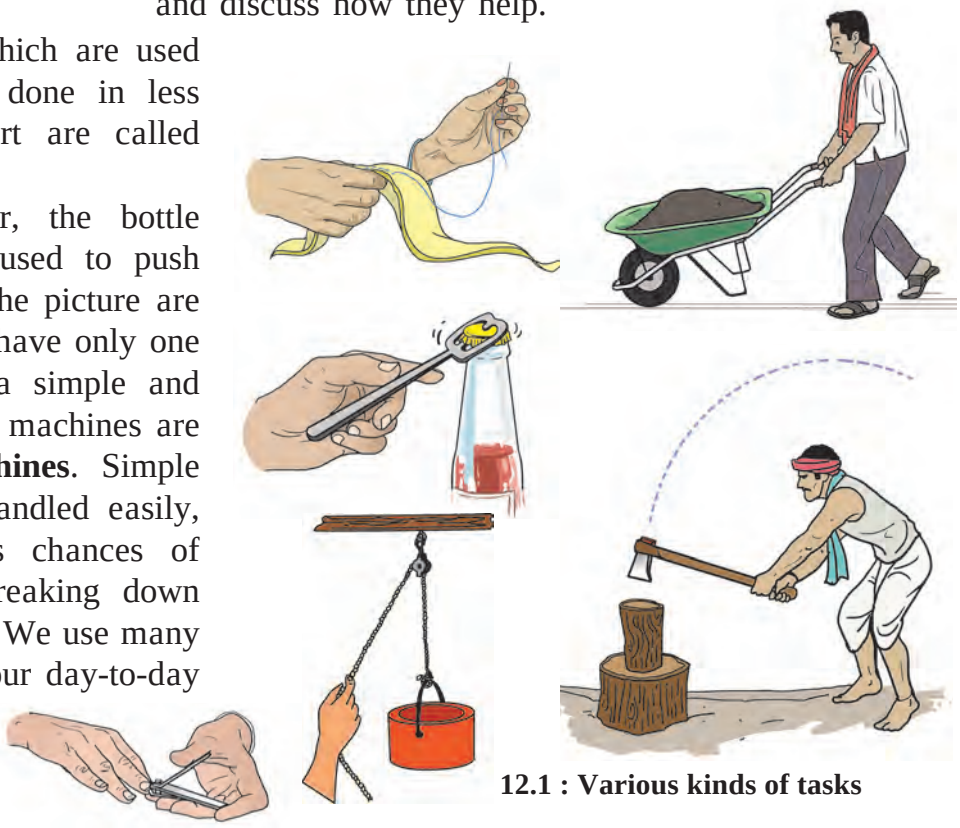
12. Simple Machines

Observe and discuss.

In the following pictures, certain devices are used to accomplish certain tasks more easily. Name the devices and discuss how they help.

Such devices which are used to get more work done in less time and less effort are called **machines**.

The nail cutter, the bottle opener, the wheel used to push the load shown in the picture are all machines. They have only one or two parts and a simple and easy structure. Such machines are called **simple machines**. Simple machines can be handled easily, and there are less chances of these machines breaking down or getting damaged. We use many such machines in our day-to-day life.



12.1 : Various kinds of tasks

Can you tell?

Observe the machines shown in the following pictures. For what purposes are they used? Can you name some other machines of this kind?

12.2 : Various machines

These machines have many parts which carry out many processes for completing a task. For this purpose, the parts are joined to one another. Therefore, these machines are called **complex machines**. Some of the parts of such complex machines are actually simple machines. The structure of complex machines is complicated.

In our day-to-day life, we use simple or complex machines depending upon the task to be carried out and the time and efforts required to do it.

Let us learn about some simple machines.

An inclined plane

A heavy drum is to be loaded onto a truck. Ravi chose the plank A while Hamid chose the plank B. Rahi did not use a plank at all.

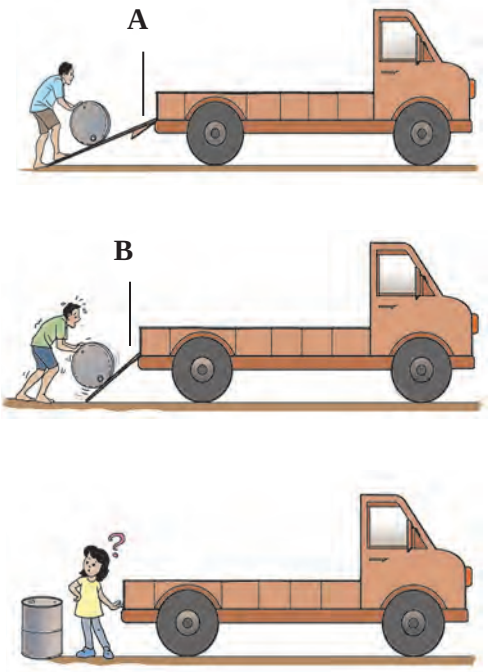
1. Who would find the drum heaviest to load?
2. Who would find it lightest?

Which one of the planks A and B is longer?

Which one has a steeper slope?

What can we conclude from this?

If a slanting plank is used to lift a weight, we have to bear less of the weight and lifting it becomes easier. Such a plank is called an 'inclined plane'. The more gradual the slope, the lesser is the weight we bear. But, such an inclined plane is longer. The steeper the slope, the shorter the inclined plane. But we have to bear a greater weight.



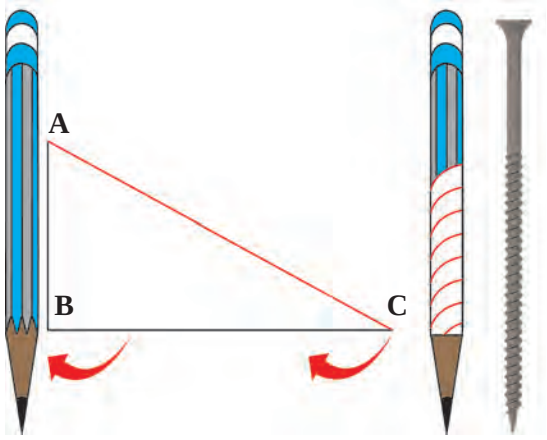
12.3 : Loading a drum onto a truck

Let's try this.

Cut out a triangular piece of paper ABC. Draw a red line along the edge AC. Roll this paper around a pencil as shown in the picture. What do you see?

The inclined side AC of the triangle descends gradually from A to C.

The threads on a screw are made in the same way. That is why, when a screw is fitted in wood it goes in as if it is going down an inclined plane. Therefore, less force is required to fit a screw than to hammer a nail. In other words, a screw is like a rolled up inclined plane made of an iron strip.



12.4 : The screw as an inclined plane

A winding road or ghat that goes up a mountain is also like an inclined plane wrapped around the mountain. It helps big vehicles to climb up and down the mountain easily.

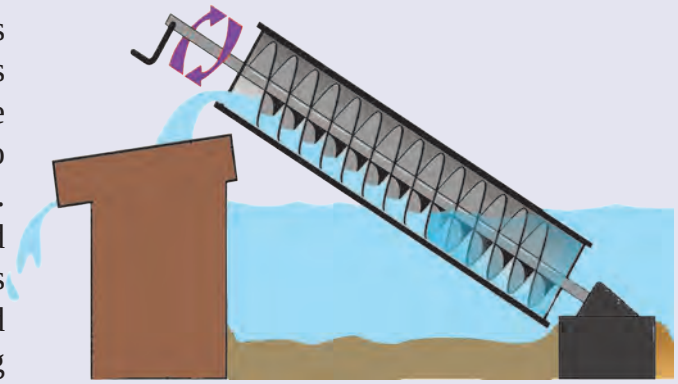
12.5 : Ghat

Observe and discuss.

Two routes, namely, a pathway and a road are available to climb the mountain shown in the picture. Compare the time and strength and your convenience required to reach the mountain top.

In the past...

The Greek scientist Archimedes invented the machine shown in this picture. That is why, it is called the **Archimedes' Screw**. It was used to lift water from the hold of a ship. Archimedes used a round pipe fitted with a rod inside it. The pipe was placed at an angle of 45^0 with one end inside the water and the rod resting on a flat surface. When the rod was turned, water got lifted in this device.



Archimedes' screw

A wedge

An axe is used for cutting wood. A sharp tool is formed on joining two inclined planes. Such a tool is called a **wedge**. A wedge in used for breaking an object into two pieces or to seperate objects stuck together. An axe, a knife or a chisel are some examples of this simple machine.

A needle and a nail are also kinds of wedges.

12.6 : Wedges

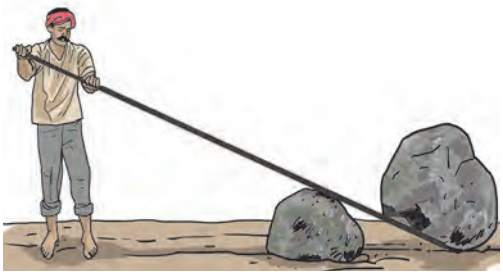
Use your brain power !

A needle is required for stitching cloth. We use a knife for cutting fruit. If the tip of a needle or the edge of a knife becomes blunt, then the needle does not penetrate the cloth and the knife does not cut into the fruit. Why is this so?

A lever

A farmer is using a strong crow-bar to remove the big stone bogged down in the farm. Such a machine is called a **lever**.

A lever has three parts, namely, effort, load and fulcrum.



12.7 : Removing a large stone

1. The support at which the rod of a lever is rested is called the 'fulcrum of a lever'. The lever rotates about the fulcrum.
2. The weight lifted by a lever or the force against which the lever acts is called the 'load'. The arm of the lever from the fulcrum to the load is called the 'load arm'.

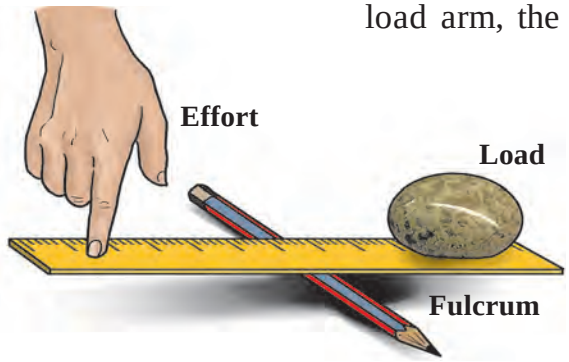
Use your brain power !

Which tasks can be done using a lever?

3. The force applied on the other end of the rod to lift the load is called the 'effort'. The part of the lever from the fulcrum to the effort is called the 'effort arm'.

Let's try this.

1. Place a pencil on a table. Place a ruler on it at right angles with it. Put a paperweight on one end of the ruler. Press the other end with your finger to lift the weight. Which are the load arm, the effort arm and the fulcrum of this lever?



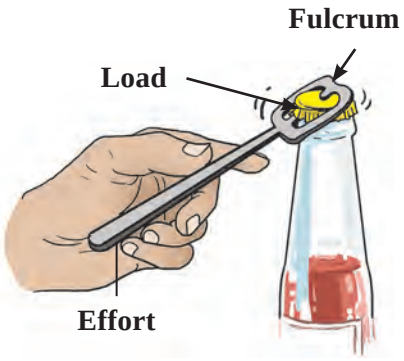
12.8 : Lifting a paperweight

Now, go on increasing the distance between the paperweight and the pencil by four centimetres every time and see whether the paperweight can be lifted when placed at each of those distances.

What do you find?

As the effort arm becomes longer and longer compared to the load arm, less and less force is required to lift the paperweight. Such a lever is called a lever of the first order.

2. The picture shows how we use an opener to remove the cap of a sauce bottle. Try to do the same yourself. To remove the tight-fitting cap, the opener is rested on the cap and we apply a force on the opposite end of the opener to pull it upwards. The cap also gets pulled up as the opener rotates about the fulcrum. Where are the fulcrum, load and effort in this case?

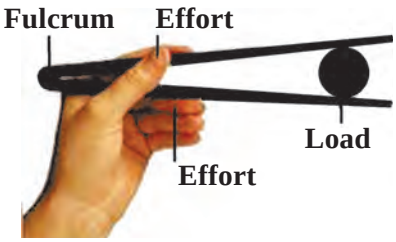


12.9 : Removing the lid

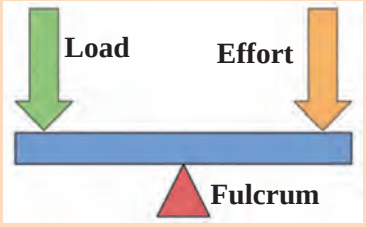
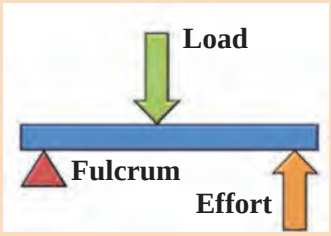
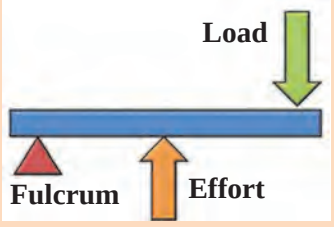
3. How do we lift an object using tongs?

The weight or the load is at one end of the arms of the tongs. We apply effort in the middle of the arms. It means the effort is applied in the middle of the lever, while the fulcrum and the load are at the opposite ends.

There are three types of levers depending upon the positions of the effort, the fulcrum and the load.



12.10 : Picking up an object

Lever of the first order	Lever of the second order	Lever of the third order
The fulcrum is in the centre, the load is at one end while the effort is at the other end.	The load is in the centre, the fulcrum on one side, and the effort, on the other side.	The effort is in the centre, the fulcrum on one side, and the load on the other side.
		

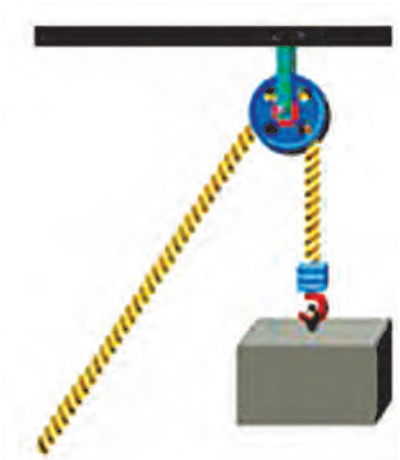
Use your brain power!

Some machines we use in our day-to-day life are shown in the picture. What is the type of lever in each of these?

Let's try this. **A pulley**

Take a pencil, some sticking tape, an empty reel of thread, half a metre of thick thread, a weight such as an eraser that can be tied to the thread, play dough.

Place the pencil on the table so that it juts over the edge of the table. Fix it firmly to the table using the sticking tape. Insert the reel over the part of the pencil that juts out. Put a lump of the play dough on the tip of the pencil so that the reel does not come off. Draw the thick thread having the weight at one end over this reel. What happens when the loose end of the thread is held and pulled down? The weight tied at the other end gets lifted up.



12.11 : A pulley in everyday life

Such a device with a grooved wheel and thread designed to lift weights is called a **pulley**.

How does it help to use a pulley?

If we use a pulley, force can be applied in the downward direction for lifting the weight in an upward direction. This is convenient and easy. You must have seen some examples of pulleys in day-to-day use. Make a list of these.

Can you tell? **A wheel and axle**

1. All of you must have enjoyed sitting on a giant wheel. What makes the giant wheel go round?

The giant wheel is fitted to a rod at its centre. This rod is called an 'axle'. When the axle starts rotating with the help of electricity, the wheel fitted to it also starts rotating. This combination of an axle and a wheel is a simple machine. We see innumerable examples of its use.

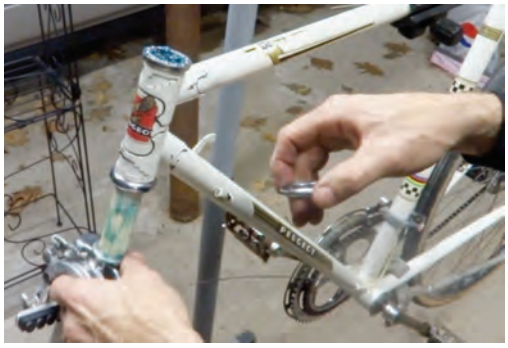
2. When the pedal of a bicycle is rotated, the wheel starts rotating. How does this happen?

12.12 : A giant wheel

Maintenance of machines

Parts of machines rub against one another when they are used. Soiled, dusty parts create more friction. Some parts, affected by the weather, rust and erode. Machines get damaged, or become useless due to such wear and tear. To avoid this, it is very important to take care of machines.

During the maintenance of a machine, all its parts are wiped clean. Oil or lubricant is released betweem parts that rub against each other, so that there is less friction between them and the wearing is reduced. Machines are covered when not in use to prevent dust settling on them. To prevent the effect of weather, metallic parts in a machine are painted externally, and the machines are always kept dry.



12.13 : Maintenance of machines

Do you know?

Big factories have a separate department for the maintenance of machines.

Factories are closed at regular, fixed periods for the maintenance of machines.

Always remember...

If machines are not properly maintained they will be of no use when we actually need them.

Before we use a machine, we must learn how to handle it properly so that there are no accidents.

What we have learnt–

- Machines are used for reducing efforts, and doing more work in less time.
- Some machines are simple while others are complex.
- The wedge, the lever, the inclined plane, the pulley and the wheel and axle are simple machines.
- There are three types of levers based on the positions of effort, load and fulcrum.
- Machines should be maintained properly to keep them in good working condition.

Science watch ...

To carry out a task efficiently, sometimes we have to use a trick. The trick can be effected with a machine. Try to make a useful machine from old, unused, junk material.

- Find an old fountain pen and use it to devise a machine.

Exercise

1. Classify the following as a lever, a pulley and an inclined plane :

A wedge, a needle, a staircase, a slide, the wheel of a flagpole, nutcrackers, scissors, an opener, an axe, a crane, a knife.

2. Fill in the blanks using the proper word and complete the statements.

(a) The ……. in the centre, the ……. on one side and the …… on the other side make a lever of the first order.

(b) The ….. in the centre, the …….. on one side and the …… on the other side make a lever of the second order.

(c) The ……. in the centre, the ……. on one side and the……..on the other side make a lever of the third order.

3. Which machines will you use to do the following work? Write their types.

(a) To remove the lid of a tin.

(b) To lift bricks to the top of a tall building.

(c) To cut vegetables.

(d) To draw water from a well.

(e) To hold a papad for roasting it.

4. Write the answers to the following questions in your own words.

(a) What is meant by simple machines?

(b) Mention the advantages of using a machine.

(c) What is meant by complex machines?

(d) What is a lever? How are the orders of the lever determined?

5. Why is this so?

(a) Traveller's bags have wheels.

(b) Machines have to be maintained.

(c) A bicyle is said to be a complex machine.

6. Name the levers mentioned in the following passage. Identify the fulcrum, load and effort of each and say which type of lever it is.

Ravi and Savita sit on a sea-saw in a garden. In the mean time, a gardener is trimming trees in the garden. He puts the leaves and other garbage in the wheelbarrow. Later, Ravi gets thirsty and he buys lemon sherbet. The sherbet seller cuts the lemon and squeezes it using a lemon squeezer. He puts small pieces of ice in the glass with the help of the tongs.

Activity :

- Make a list of the various machines used in your home and neighbourhood and write their types.
- Go to a bicycle repair shop, observe how a bicycle is repaired, and note down the information.

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