

11

Simple Machines

We'll cover the following key points:

- Machines
- Simple Machines
- Complex Machines



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Learning Outcomes

By the end of this chapter, students will be able to:

- Understand the concept of simple machines and their importance in making work easier.
- Identify and differentiate between different types of simple machines such as levers, pulleys, inclined planes, screws, wedges, and wheels and axles.
- Explore examples of simple machines in everyday life, like a seesaw (lever), flagpole (pulley), ramp (inclined plane), and screws in furniture.
- Learn how simple machines help reduce effort and are used in combination to perform complex tasks efficiently.

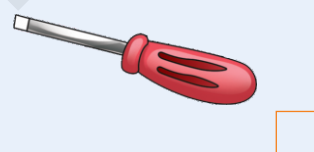
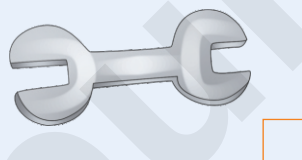
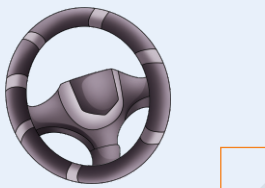
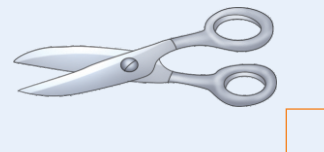
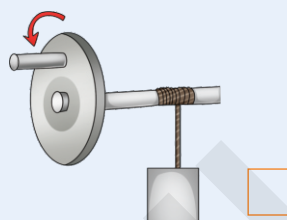
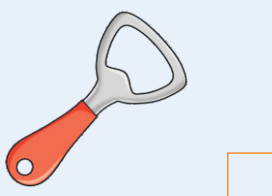
Guidelines for Teachers

The teacher can start the chapter by introducing the concept of simple machines, encouraging students to observe and identify examples of simple machines around them. Discussions can focus on the different types of simple machines, their features, and how they work to make tasks easier. The teacher can also emphasize the practical applications of simple machines in daily life and explain how they contribute to reducing human effort and improving efficiency.



Here are pictures of some simple machines we use in our day-to-day life. Write the correct letters to say what kind of machine each one is. Some of the options can be used more than once.

- a. Lever b. Wheel and Axle c. Pulley
d. Inclined Plane e. Screw f. Wedge



Fun Fact



Simple machines like levers, wheels, and pulleys were humanity's first inventions to make tasks easier. The wheel and axle revolutionized transport, while the inclined plane allowed ancient civilizations to build wonders like pyramids. The screw is essentially an inclined plane wrapped around a cylinder. By combining these tools, humans created complex machines like cranes and clocks.

Machines

In early times people used to make use of their hands, legs and teeth to do difficult work. However, as time passed, they felt the need for certain devices that would help them do their work easily. These were termed as machines. The purpose of a machine is to reduce the effort (force) required to perform a simple task. Machines can be further categorized into simple and complex machines.

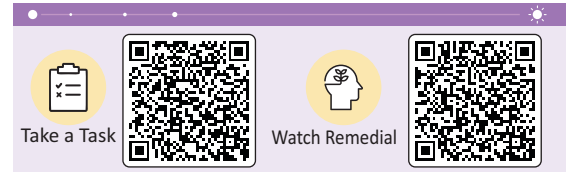
A simple machine is one that makes our lives easier as it helps us to do work with the application of less force. In other words, a simple machine doesn't decrease our work but decreases the force required to do a particular work. Examples of simple machines are levers, screws, inclined planes etc. On the other hand complex machines are a collection of many simple machines working together. A bicycle is a perfect example of a complex machine. It has many simple machines in its parts like the breaks which are levers, the pedals and wheel make the



wheel and axle and its various other parts are fixed together by screws.

Simple Machines

Simple machines are of immense importance in our day to day life. Many items of our everyday use are examples of simple machines. For example the knife that we use to cut vegetables, the screw that we put in a wall to hang a painting, and a bottle opener that we use often are all simple machines. There are six different types of simple machines.



1. Inclined Plane: It is a flat surface that is slanting or inclined so that it can help move things easily. Common examples of inclined planes are a ramp adjacent to the staircase at a hospital, a wooden plank used to load things in a truck, a slide in a park etc. Inclined planes are useful since they reduce the force required to move an object vertically. If the slope of an inclined plane is gentle, one has to push or pull the object over a longer distance but with little effort. But if the slope of the inclined plane is steep, one has to push or pull the object over a short distance but with more effort.



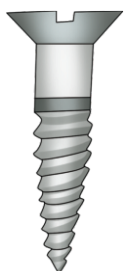
2. Wedge: A wedge is a simple triangular tool made either of metal, wood or stone that has one blunt end and the other tapering sharp end to cut or split objects. Some examples of wedges are an axe, a knife and even our teeth. The longer and thinner (sharp) the wedge is, the more work it does with little effort.



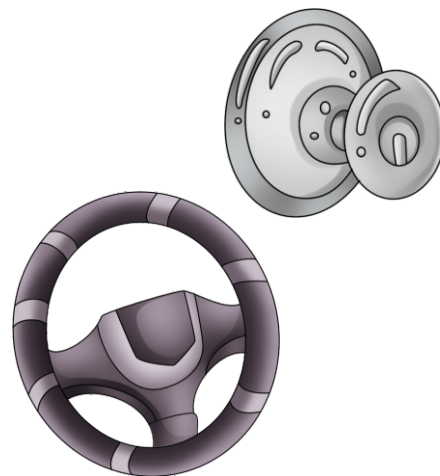
Did you know ?

The beauty of simple machines is seen in the way they are used as extensions of our own muscles, as well as in how they can redirect or magnify the strength and force of an individual. They do this by increasing the efficiency of our work, as well as by what is called a mechanical advantage. A good example of this is when a person uses a small input force on a jack handle and produces an output force large enough to easily lift one end of an automobile.

3. Screw: A screw is an inclined plane around a cylinder. The winding edge is called a thread due to the presence of which it becomes easy to insert it into a surface by turning it round with the help of a screwdriver. The cylinder may be seen as having a head at one end and is pointed at the other end. Screws help in holding things together. They can also be used to tighten the things.



4. Wheel and axle: The wheel is considered to be one of the most significant inventions in the history of the world. This simple machine called a wheel and axle consists of two circular objects, a large disc and a smaller cylindrical rod joined at the centre. The larger discs are the wheels and the smaller cylindrical rod is called the axle. Both the wheel and the axle join together to make a simple machine. A door knob is a perfect example of a wheel and axle. To open the door, we have to turn the knob which acts as the wheel which in turn rotates the axle and helps in opening the door. Wheel and axle also act as class 1 levers which we shall study later in the chapter. The steering wheel of a car and a screw driver are other examples of wheel and axle.



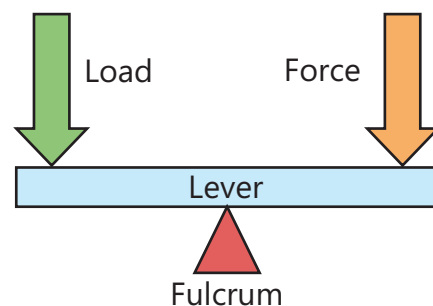
Did you know ?

One of the first people to use a screw as a lifting machine was the ancient Greek scientist, Archimedes (287-212BC). He invented a screw pump that could raise water, causing water to flow against the force of gravity.

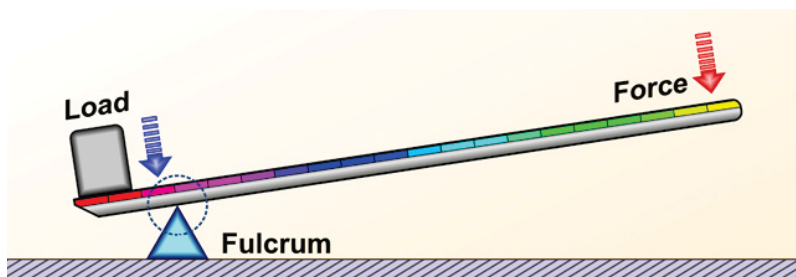
5. Pulley: A pulley is a simple machine with a wheel and a groove in it. Through the groove passes a rope. The groove helps the rope to be in its place. A pulley helps in lifting up or lowering heavy objects. The object to be lifted is tied to one end of the rope and force is applied to the other end of the rope by pulling it downwards. The pulling force downwards helps to lift the load upwards. Pulleys can be seen being used to draw water from wells, in construction sites to lift materials to the top floors, and blinds on windows are also pulled up and down using pulleys.



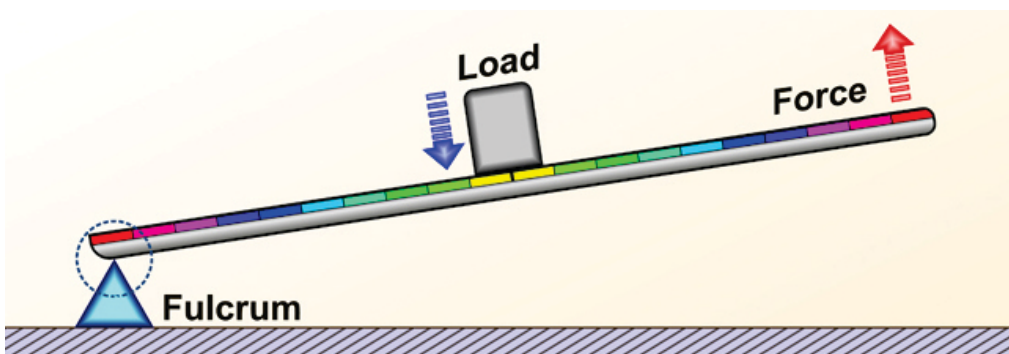
6. Levers: A lever is a type of simple machine that has the following four parts. It has **an arm** or a straight part, a **fulcrum** or the pivot point on which the lever rests, the **load** and the **effort**. Depending on the position of the fulcrum, load and effort, levers can be classified into the following three types:



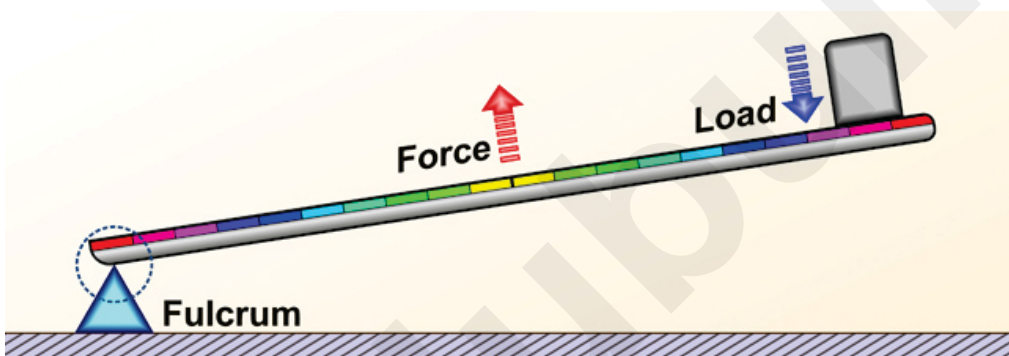
Class 1 lever: In this class of lever, the fulcrum is in between the load and the effort. Examples of class one levers are seesaws, bottle openers, scissors, pliers etc. In order to reduce the effort needed to lift something using a first class lever, the fulcrum should be moved closer to the load.



Class 2 levers: In class 2 levers, the load is in between the fulcrum and the effort. Examples of class two levers are wheelbarrows, crowbars and nutcrackers etc.



Class 3 levers: In class 3 levers, the effort lies in between the fulcrum and the load. Examples of class 3 levers are tweezers, staplers, hockey sticks etc.



Did you know ?

From ancient times, humans sought easier ways to work, reducing muscle effort. Early ancestors, like Homo habilis ("handy man"), used basic tools like levers (sticks for moving heavy objects), wedges (sharp rocks for scraping), rolling logs (primitive wheels), and natural inclined planes (slopes). Simple machines helped early civilizations meet their needs and shape their environment.

Check 'N' Mate

Critical Thinking

Write 'T' for true and 'F' for false statements.

1. Lever, screw and inclined plane etc. are simple machines.
2. A wedge is a simple triangular tool made either of metal, wood or stone.
3. A pulley is a complex machine.
4. Nut cracker, crowbar and wheel barrow are examples of class two levers.

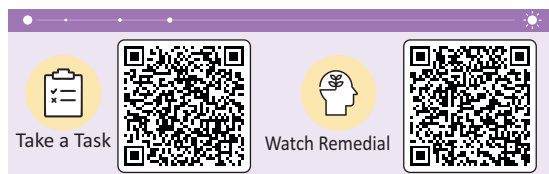
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Complex Machines

Complex machines are a collection of simple machines working together. They are capable of doing more complex work than individual simple machines. They are a combination of many simple machines.

Imagine a situation when during your summer holidays your mom asks you to help her pick up a heap of stones lying in your garden and put them in your backyard. It is a task that can be quite tedious if you try to do it all by yourself with the help of your hands. Therefore it is most likely that you will try to use a few equipment that will help you do this work efficiently and with less effort. You can try using a shovel which is a combination of a wedge and a lever. The wedge part of it helps to scoop the stones and then, when pressure is put on the lever (the handle), the stones can be easily picked up. A wheel barrow is a combination of many simple machines such as levers, wheels and axles, screws and inclined planes. It is therefore a complex machine that can help you to move a huge pile of stones from one place to another which would have otherwise taken you a lot of time and effort.

Other examples of complex machines that we use at our homes are stapler, vegetable chopper, a lawn mower, bicycle, sewing machine, car etc.



Check 'N' Mate

Critical Thinking

Fill in the blanks with correct words.

1. Complex machines are a collection of _____ (simple/complicated) machines.
2. _____ (Shovel/Wheel) is a combination of wedge and lever.
3. _____ (Stapler/Knife) is the example of complex machine.

Key Words

Improving Vocabulary

Simple machine	: Basic machines that include wheel and axle, pulley, inclined plane, wedge, screw and levers.
Axle	: A shaft on which a wheel turns.
Wheel	: A circular rotating part in a machine that moves around an axle.
Lever	: A bar that tilts about a pivot to move a load.
Fulcrum	: A pivot on which a device such as a lever is supported so that it can balance, tilt or swing.
Mechanical advantage	: The time saved and energy gained by using a machine to do work.

Time to Apply

Applying and Creating

1. An electric fan is made up of several simple machines. Tell where you would find an inclined plane on a fan. Also, tell where you would find a wheel and axle.
2. A broom is a lever. Where is the fulcrum? Explain.



Time to Discuss

Pondering and Communicating

1. Explain how the shoelaces on your shoes are similar to pulleys.
2. The floor of a bathtub is an inclined plane. Explain.



In a Nutshell

- ✦ A simple machine is one that makes our lives easier as it helps us to do a work with the application of less force.
- ✦ Examples of simple machines are inclined planes, wedges, screws, wheels and axles, pulleys and levers.
- ✦ An Inclined Plane is a flat surface that is slanting or inclined so that it can help move things easily.
- ✦ A wedge is a simple triangular tool made either of metal, wood or stone that has one blunt end and the other tapering sharp end to cut or split objects.
- ✦ A screw is an inclined plane wrapped around a cylinder.
- ✦ A wheel and axle is a class of rotating machines in which effort applied to the wheel produces a useful movement in the axle or vice versa.
- ✦ A pulley is a wheel with a grooved rim through which a rope, chain or belt is pulled to lift a load.
- ✦ A lever is a simple machine with a bar that tilts about a pivot to move a load.
- ✦ Levers can be classified into class 1, class 2 and class 3 depending on the position of the fulcrum, load and effort.
- ✦ In class 1 lever, the fulcrum is in between the load and the effort.
- ✦ In class 2 lever, the load is in between the fulcrum and the effort.
- ✦ In class 3 lever, the effort is in between the fulcrum and the load.
- ✦ Complex machines are a combination of simple machines working together.



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EXERCISE

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A. Objective Type Questions.

1. In order to reduce the amount of effort needed to lift something using a first class lever, we should:
 - a. Move the fulcrum to the middle of the lever
 - b. Move the fulcrum closer to the load
 - c. Move the fulcrum closer to the effort
2. A rod attached to the centre of a wheel is called:
 - a. A wedge
 - b. A pulley
 - c. An axle
3. Which simple machine does a flagpole make use of ?
 - a. Lever
 - b. Screw
 - c. Pulley
4. Which of these can help a person in a wheelchair to get up the stairs of a hospital?
 - a. Inclined plane
 - b. Wheel and axle
 - c. Screw
5. Of the list given below, which is an example of a lever:
 - a. Pulley
 - b. Ramp
 - c. Pliers
6. An axe and a chisel are examples of which type of simple machine?
 - a. Lever
 - b. Wedge
 - c. Wheel and Axle
7. Which Greek philosopher is credited with first discovering and describing simple machines?
 - a. Plato
 - b. Archimedes
 - c. Socrates

B. Fill in the blanks :

1. When we join two inclined planes together in the opposite direction ,we get a _____.
2. _____ are used for holding things together or opening them up.
3. A pivot on which a device such as lever is supported is called a _____.
4. Roller skates are an example of _____.
5. The time saved and energy gained by using a machine to do work is called _____.

6. Tweezers are an example of _____ levers.
7. A screw is a _____ wrapped around a cylinder.

C. Very Short Answer Questions.

Name the following simple machines :

1. A log splitter _____
2. A staircase _____
3. A stapler _____
4. A doorknob _____
5. A nut cracker _____
6. A hammer _____

7. If we are using a screw driver to twist out a screw, the two simple machines that we are using are _____ and _____.



D. Short Answer Questions.

1. How are simple machines important in our lives?
2. Name six different types of simple machines.
3. What are levers? What are its main parts? Name the three different types of levers.
4. Give a few examples where a pulley is used.

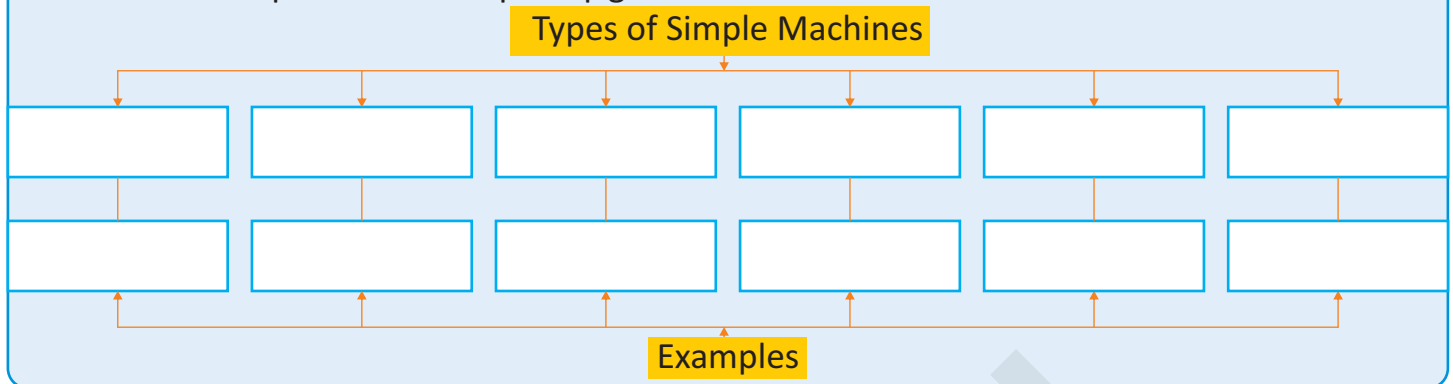
E. Long Answer Questions.

1. What are the six different types of simple machines? Explain with examples.
2. Explain giving suitable examples how a wheel and axle works?
3. Why do hills have gradual (less steep) slopes? Explain.

Time to Recall

Remembering and Analysing

Recall and complete the concept map given below.



Time to Observe

Observing, Critical Thinking, Analysing

Activity to show the relation between a screw and an inclined plane.

At the beginning, the students are handed over a screw to look and feel it. They are encouraged to examine the threads of the screw and their angles.

They are now required to make such a screw each. Each student should take a pencil to represent the cylindrical part of a screw. They are also given a paper in the shape of a right angled triangle, a marker and glue.

The students should draw a dark line along the edge of the long side of the paper.

Now they should be asked to roll the short side of the paper around the pencil starting with the short side and rolling towards the opposite point.

It is seen that the dark edge or the inclined side will roll up around the pencil forming the pattern of a screw.



Time to Create

Creating and Collaborating

Try to hammer the bolt in to the block of wood. Think about why a bolt cannot be hammered into the wood. Compare the nail with the bolt. Now, try to hammer the nail into the wood. The nail is a wedge so it is easier to hammer into the wood. There is a sharp edge on the nail because it has two inclined planes fixed together. This lets the nail separate the wood.