

Simple and Complex Machines

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KEY ELEMENTS USED IN THIS BOOK

The Big Idea: Machines help us do work more quickly, easily, and/or safely. Machines reduce the amount of force required to do work but often require working over a greater distance. Seven types of simple machines can be found in familiar devices. One or more simple machines may be combined to form a complex machine. Understanding how various machines work will help students to choose appropriate machines and use them properly.

Key words: axle, complex machine, distance, energy, first-class lever, force, friction, fulcrum, gear, inclined plane, knife, lever, lift, machine, pull, pulley, push, ramp, robot, screw, second-class lever, seesaw, simple machine, third-class lever, tool, turn, wedge, weight, wheel, wheel and axle, work

Key comprehension skill: Cause and effect

Other suitable comprehension skills: Compare and contrast; classify information; main idea and details; identify facts; elements of a genre; interpret graphs, charts, and diagrams; using a glossary and boldfaced terms; using a table of contents and headings

Key reading strategy: Summarize

Other suitable reading strategies: Ask and answer questions; connect to prior knowledge; visualize; retell

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Reading Levels

Learning A-Z	N
Lexile	530L

Correlations

Fountas and Pinnell*	M
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*Correlated independent reading level



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Introduction

How do you eat soup? Did you know that a spoon is a tool? A tool is a **simple machine**.

A **machine** uses energy to do **work**. Machines that have only a few parts are called simple machines. Some machines are made of many simple machines. A bike is a **complex machine**. In this book, you will learn how machines make work easier.

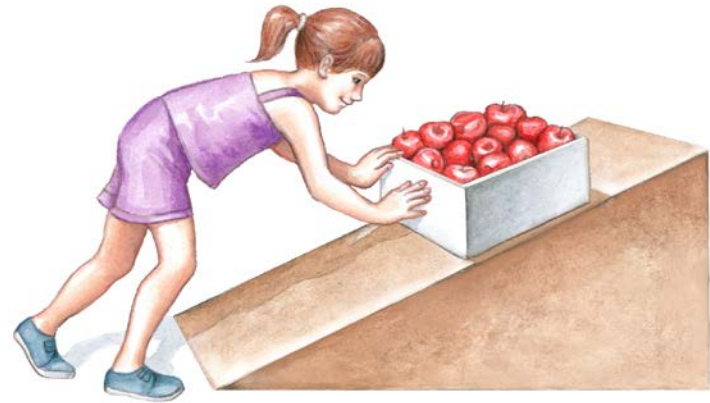
Do You Know?

Animals use tools, too! Apes use sticks to get ants. Sea otters use rocks to open clamshells.



In science, *work* has a special meaning. It means making something move. To move something, you use **force**. If you push hard to move something, you use a lot of force. If you use a lot of force, you do a lot of work. If you push only a little to move something, you use a little force. If you use a little force, you do a little work.

When you do work, you also move something over a distance. If you move something a short way, you do a little work. If you move something a long way, you do a lot of work.

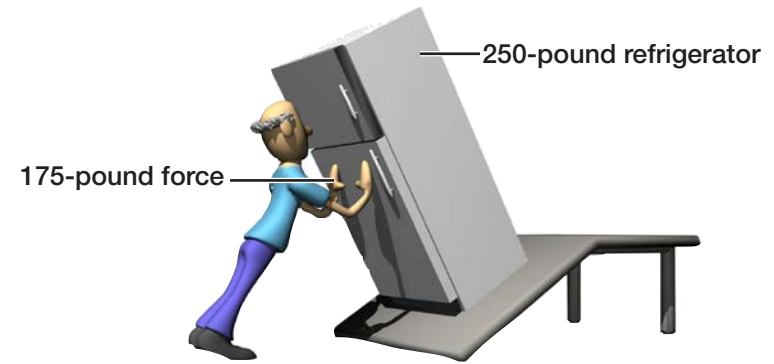


Both ramps do the same amount of work. The top ramp requires twice as much force as the bottom ramp. The bottom ramp covers twice as much distance. Which ramp would you rather use?

Machines often help you move something (do work) using less force. But there is a trade-off. When you use less force, you have to move the thing farther. The total amount of work stays the same.

Types of Simple Machines

These are the simple machines you will read about in this book.



Inclined Plane

The **ramp** is a simple machine. It is also called an **inclined plane**.

A ramp helps people move heavy objects up or down. Movers use ramps. It is easier to slide a box up an inclined plane than to lift a box straight up. Using a ramp takes less force.

If you use a longer inclined plane to move a box up the same height, you need less force. But remember, you also have to push the box farther.

Do You Know?

The Egyptians used inclined planes to build pyramids. They used long ramps to move heavy stones to the top.



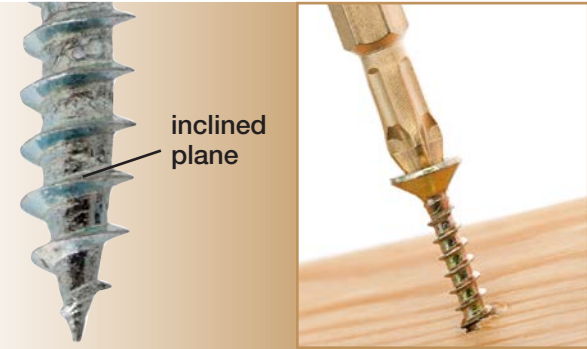
Wedge

A **wedge** is made of two inclined planes put together. A wedge helps you push things apart. The blade of a knife is a wedge. Your front teeth are also wedges. A narrow wedge moves things apart more easily than a wider wedge.



A wedge can split a piece of wood.

An inclined plane wraps around the center of a screw. As the screw turns, it moves into the object.



Screw

A **screw** is an inclined plane that wraps around a rod. The thread of a screw is the inclined plane. When you turn a screw, the thread goes into the wood. Screws hold two things together. Screws can also move things by pushing them along using the thread.



Screws hold things together.

Lever

A **lever** is a machine that can move heavy things. A lever has two parts. One part is a board or bar. The board rests on a point called the **fulcrum**. The board pivots, or turns, on the fulcrum.

A seesaw is a lever. On a seesaw, you can balance with someone much heavier than you.



When the fulcrum is close to an object, the object can be lifted more easily but not as high.



With the fulcrum far away from an object, the object is harder to lift, but it can be lifted higher.

If you put the object you want to move close to the lever's fulcrum, it is easier to move. If you put the object on the lever far from the fulcrum, it is harder to move.

Where you use force matters, too. If you push on the lever close to the fulcrum, it's harder to lift the object. If you push far from the fulcrum, it's easier to move the object.

First-Class
Lever



Second-Class
Lever



Third-Class
Lever



You can put the fulcrum in different places. On a seesaw, the fulcrum is between the object and the force. On a wheelbarrow, the object is between the fulcrum and the force. And sometimes the force is between the object and the fulcrum.

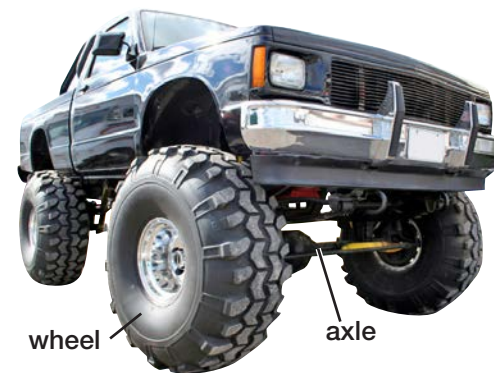


Ancient people believed that if you had a lever long enough, you could raise Earth. Do you think this is possible? Explain why or why not.

Wheel and Axle

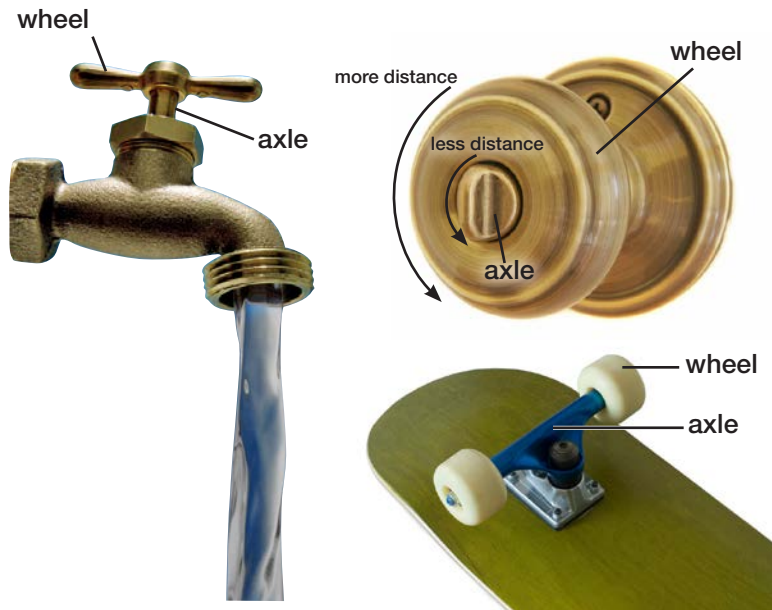
A **wheel and axle** is another simple machine. It is made of a **wheel** on a rod, or **axle**.

The wheel is wider than the axle. When the wheel turns, the axle also turns. The wheel turns a longer distance, and the axle turns a shorter distance. The wheel turns with less force than the axle. The axle turns with more force than the wheel. A doorknob is a wheel and axle.

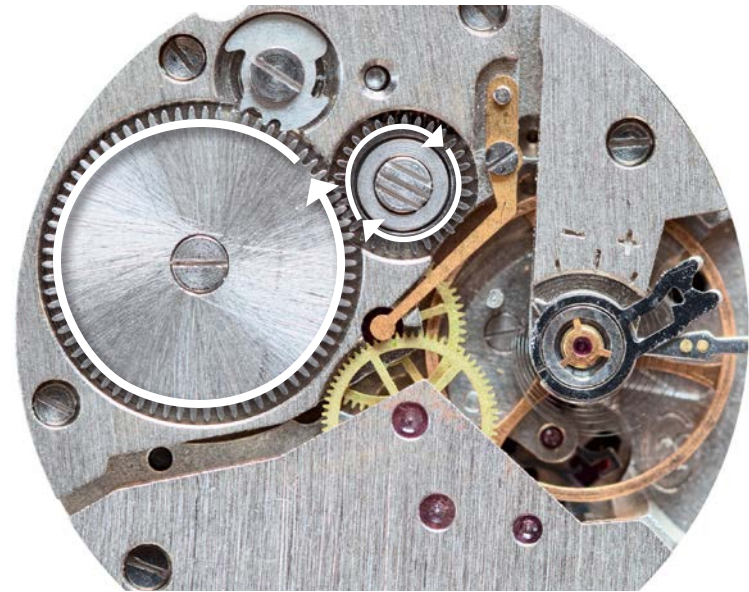


Wheels and axles are used in cars, trucks, and bicycles.

Friction is a force that comes from two things rubbing together. If two things touch in many places, they make a lot of friction. If they touch in only a few places, they make less friction. A wheel helps to get rid of friction. A wheel only touches the ground in one small place at a time. That means less friction is made between the object and the ground.



Examples of wheels and axles



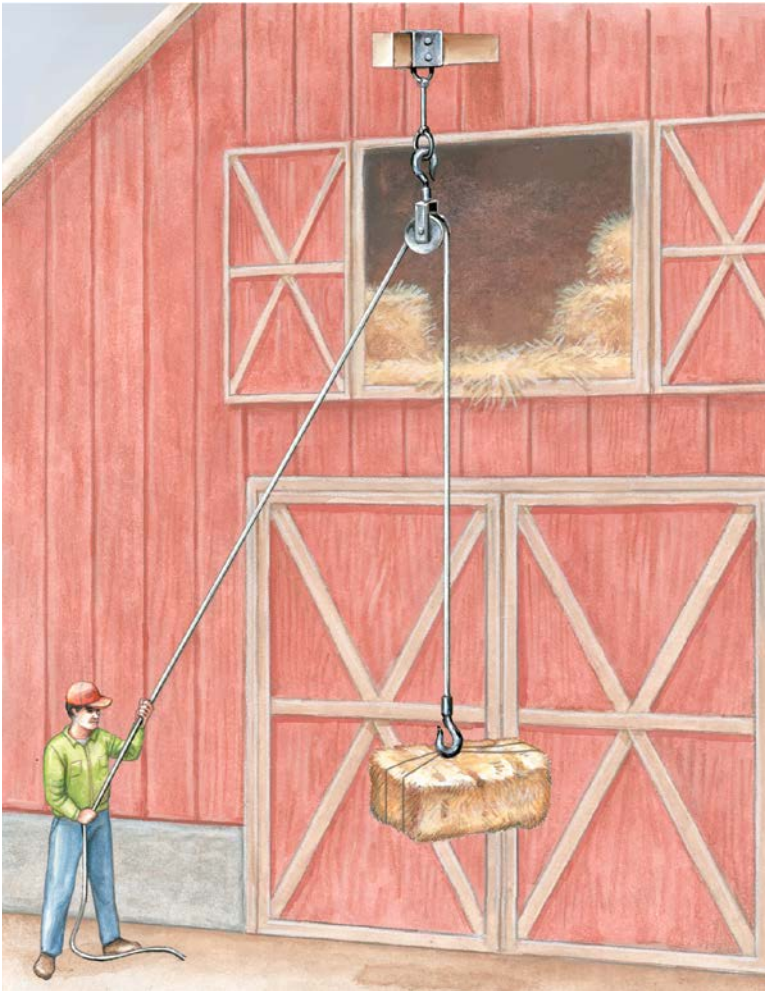
Every time the large gear turns, the small gear turns more than once. The large gear has more force. The small gear turns faster.

Gear

A **gear** is a wheel with teeth. Gears are attached to axles. They can make an object move faster or slower. They can make it take more or less force to move. A large gear turns more slowly than a small gear. But the large gear turns with more force than the small gear.

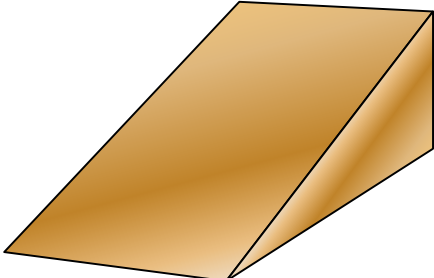
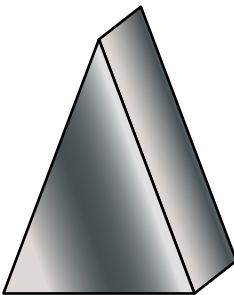
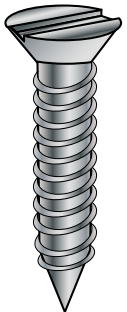
Pulley

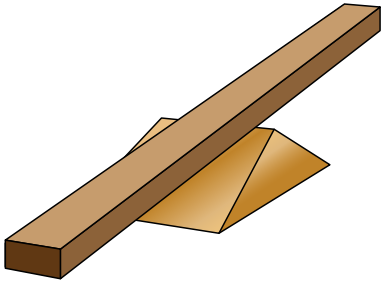
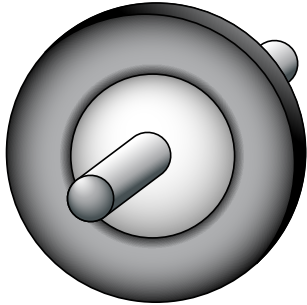

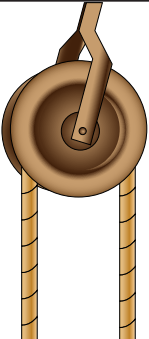
A **pulley** is a wheel and a rope that work together. The rope changes a force's direction.



Pulling down on the rope makes the hay rise.

Simple Machine Summary

Simple Machine and Use	Drawing
<p>Inclined Plane To raise or lower heavy objects</p>	 A 3D perspective drawing of a brown, rectangular inclined plane.
<p>Wedge To split things apart</p>	 A 3D perspective drawing of a dark grey, triangular wedge.
<p>Screw To hold things together</p>	 A 3D perspective drawing of a silver screw with a flat head and a pointed tip.

<p><u>Lever</u> To lift heavy things</p>	
<p><u>Wheel and Axle</u> To reduce friction and make it easier to move something</p>	
<p><u>Gear</u> To reduce the force needed to move something</p>	
<p><u>Pulley</u> To lift heavy objects</p>	

Complex Machines

Complex machines are made of simple machines. A wheelbarrow is a lever with a wheel and axle. A bicycle has pulleys, gears, and wheels and axles. A can opener uses a wedge, a lever, and a gear.

Complex machines make hard, complicated, or dangerous tasks easier. Electric mixers help us mix batter. Cranes help us build buildings. Robots help us build cars.





Top: A robot might explore the seas on Jupiter's moon Europa.

Right: A robot explores an active volcano in Alaska.



Some machines do things that people can't do. Robots can work in heat that would hurt a person. We also send robots to explore space and the ocean.

Conclusion

We use machines to help us do work. Machines can be simple. The inclined plane, wedge, screw, lever, wheel and axle, gear, and pulley are all simple machines. Complex machines combine simple machines. Machines help us do tasks that are too hard or dangerous for a person. But all machines either use less force over more distance, or more force over less distance. What machines have you used today?



Glossary

axle	a pin or pole around which a wheel revolves (p. 14)
complex machine	any device made up of more than one simple machine; a compound machine (p. 4)
force	the strength or energy that moves an object (p. 5)
friction	the force that builds up when two objects rub against each other (p. 15)
fulcrum	the point around which a lever pivots or turns (p. 11)
gear	a toothed wheel that connects with another toothed object to change speed or direction; a type of simple machine (p. 16)
inclined plane	a slanted surface that makes it easier to move an object between a lower level and a higher level; a type of simple machine (p. 8)
lever	a rigid bar that pivots or turns around a fulcrum; a type of simple machine (p. 11)
machine	any device that uses energy to help a person do work (p. 4)
pulley	a circular lever, usually a wheel with a rope around it; a type of simple machine (p. 17)

ramp	a sloped path used to move things between a lower level and a higher level (p. 8)
screw	an inclined plane wrapped around a rod, often used to hold things together; a type of simple machine (p. 10)
simple machine	any basic device that works with the use of a single force (p. 4)
wedge	a simple machine with one narrow or pointed end and one wide end, used to separate two objects or parts (p. 9)
wheel	a round object that turns around a central point (p. 14)
wheel and axle	a round object that turns around a pin or pole; a type of simple machine (p. 14)
work	the act of moving something (p. 4)

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