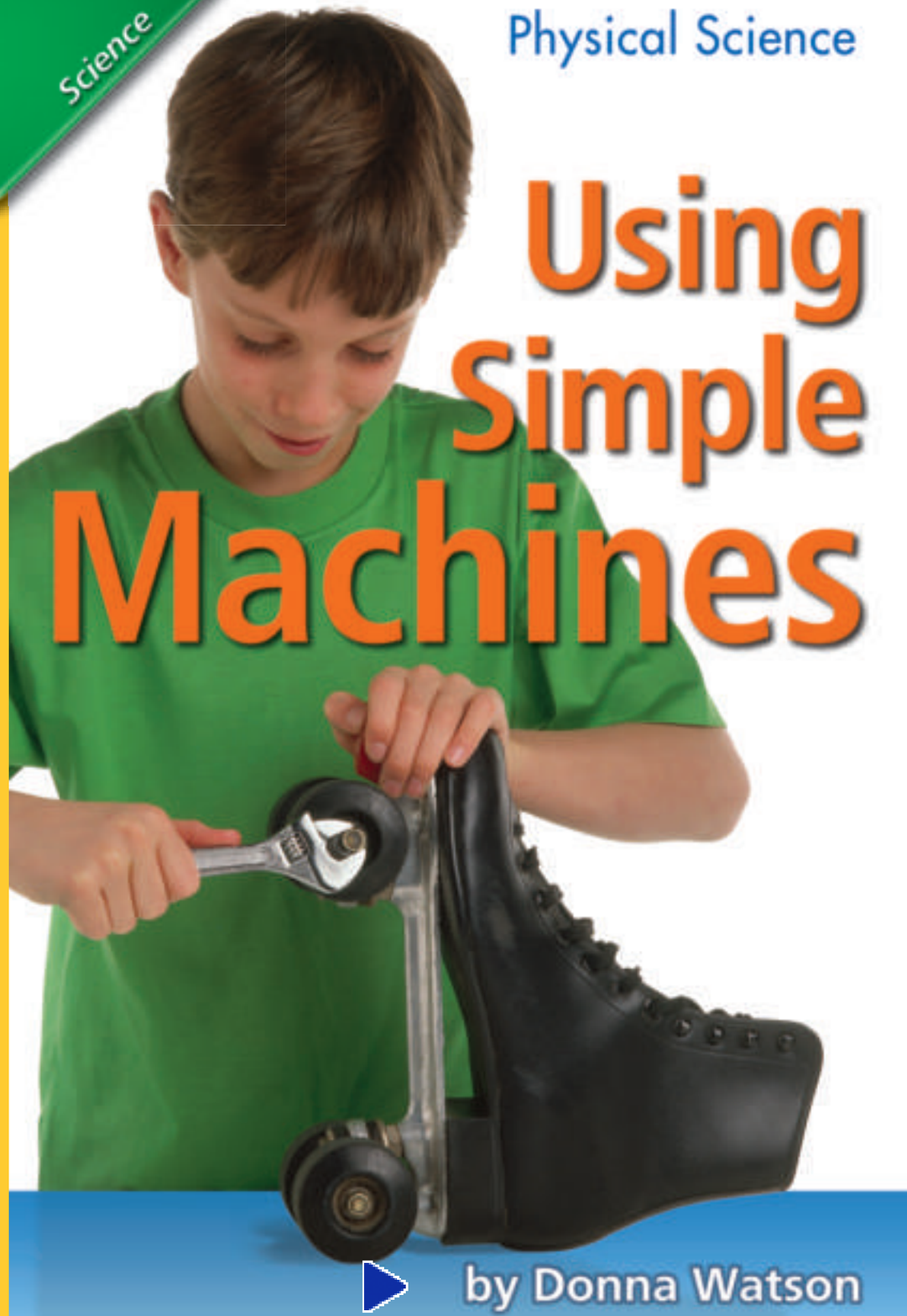
Science

Science

Physical Science

Using Simple Machines



by Donna Watson

Genre	Comprehension Skill	Text Features	Science Content
Nonfiction	Summarize	• Captions • Labels • Diagrams • Glossary	Simple Machines

Scott Foresman Science 4.16

PEARSON Scott Foresman

DK

scottforesman.com

ISBN 0-328-13905-X

9 780328 139057 90000

Vocabulary

effort
fulcrum
inclined plane
lever
load
pulley
screw
wedge
wheel and axle

Using Simple Machines

by Donna Watson

Picture Credits
Every effort has been made to secure permission and provide appropriate credit for photographic material.
The publisher deeply regrets any omission and pledges to correct errors called to its attention in subsequent editions.

Photo locators denoted as follows: Top (T), Center (C), Bottom (B), Left (L), Right (R), Background (Bkgd).

2 John and Eliza Forder/Getty Images; 6 Michael Kim/Corbis; 8 (BL) Vince Streano/Corbis; 9 Ian Cartwright/LGPL/Alamy Images; 11 Andre Jenny/Alamy Images; 13 Winston Luzier/Alamy Images.

Scott Foresman/Dorling Kindersley would also like to thank: 13 (BR) Stephen Oliver/DK Images..

ISBN: 0-328-13905-X

3 4 5 6 7 8 9 10 V010 13 12 11 10 09 08 07 06 05

PEARSON Scott Foresman

DK

Machines

Science has a special definition for *work*. Work happens any time force is used to move something or make a change. If you lived on a farm, you might have to help get a fifty-pound bale of hay into the barn. Picking that up would be too heavy! Pushing or pulling with all your strength probably wouldn't budge the hay either. No matter how tired you might be from trying, if the hay did not move, you did not do any work.

Machines make work easier. If an object is heavy, you must use a lot of force to move it. Some simple machines help you do work while using less force. It would be easier to move that bale of hay if you had some kind of simple machine to help you.

Some simple machines can change the direction of the force you use. With a simple machine, pushing or pulling in one direction can cause work to get done in a different direction.

Many simple machines are made of only one or two parts. But they need only these few parts to make work easier. The most common simple machines are the lever, the pulley, the inclined plane, the wheel and axle, the wedge, and the screw.

Doing some jobs by hand is difficult. Machines make work easier.

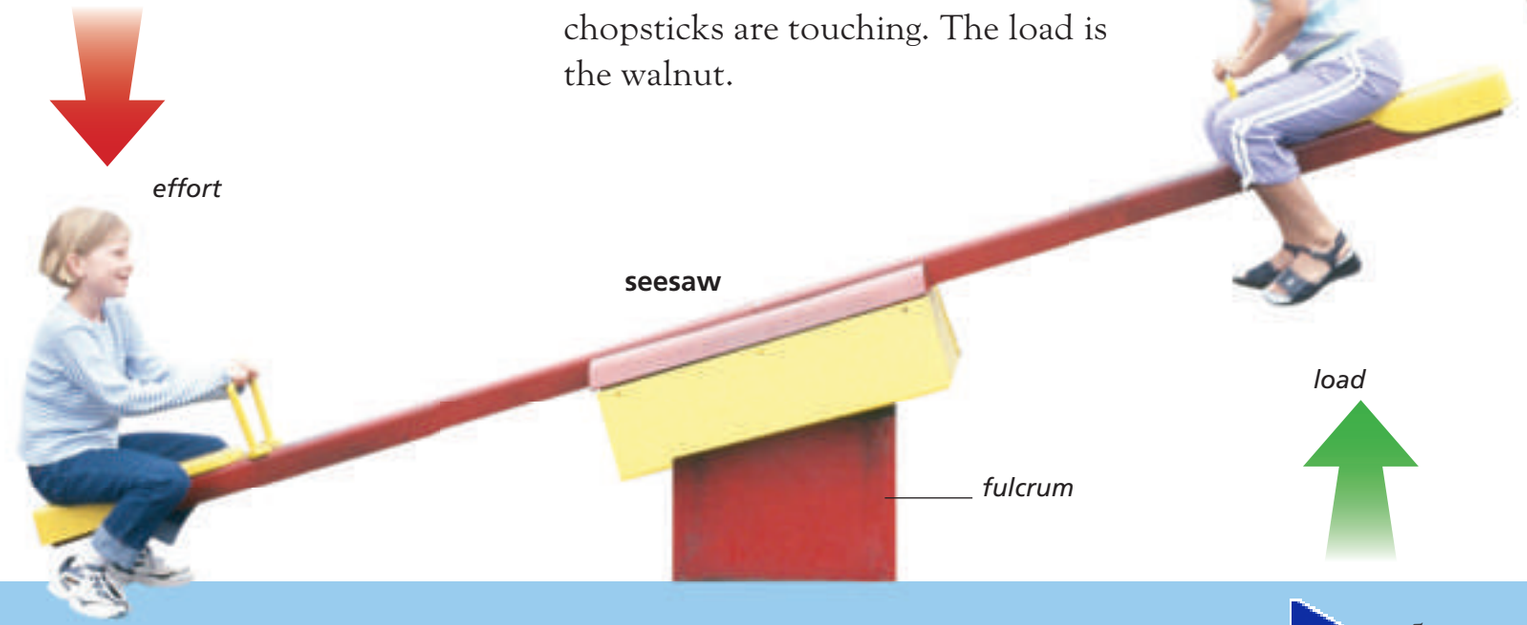
A screwdriver can be used as a lever. It can help you open a can of paint.

The Lever

A **lever** is a bar that rests on a support. The support is called the **fulcrum.** You can use a lever to help you lift an object. The **load** is the object you are lifting. **Effort** is the push or pull you apply to the lever to make the load move.

A lever does not make you stronger. It also does not make the force needed to lift the object less. A lever adds to your force. This way you can use less force to move a load. It also changes the direction of the force. Changing the location of the fulcrum changes the amount of force you need.

Have you ever used a screwdriver to pry open the top of a paint can? The screwdriver can be a lever. The fulcrum is the edge of the paint can. The load is the top of the can. The effort is your hand on the handle of the screwdriver. The lever pushes against the fulcrum and makes lifting the lid easier.



One group of levers has its fulcrum between the effort and the load. The load and effort on a seesaw change places. The person moving toward the ground is the effort. The person being lifted is the load. Then this reverses. Another group of levers has the load between the effort and the fulcrum. The wheel at the end of a wheelbarrow is the fulcrum. You supply the effort by lifting the handles. A third group of levers has the effort between the fulcrum and the load. The effort for a pair of chopsticks is where you hold them. The fulcrum is where the chopsticks are touching. The load is the walnut.

wheelbarrow

chopsticks

The Wheel and Axle

It's probably easy for you to picture a **wheel and axle.** A wheel and axle is a kind of lever that moves or turns objects. The axle is a rod that goes through the center of the wheel. Faucets can have a wheel and axle. Suppose you tried to turn on a faucet with only a thin metal rod to hold on to and rotate. You wouldn't have to turn it very far, but it would be very hard to turn. Now suppose a large knob was attached to the thin metal rod. Your hand would have to travel a longer distance as it turned the large knob, but you wouldn't have to push as hard. The knob is the wheel, and the thin rod is the axle.

Faucets use a wheel and axle to turn on and off.

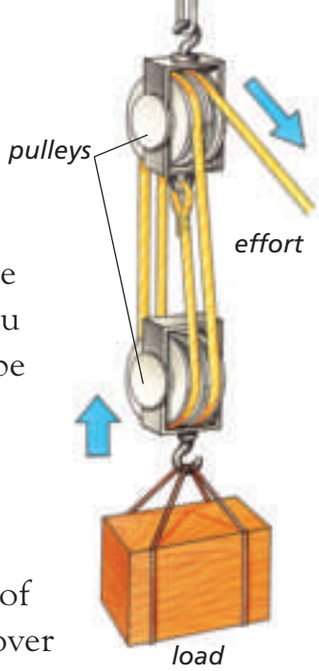
It is easy to see the wheel and axle on racing cars.

You might not think so, but a wrench is a kind of wheel and axle. A wrench is used to tighten objects such as bolts. The bolt is the axle. The wrench is the wheel. The wrench turns around in a circle, which is the same path that a wheel travels in. You could turn the bolt without using a wrench, but you would have to use more force. Using the wrench to turn the bolt allows you to do the same amount of work while using less force. But the distance that you have to turn the wrench is greater than the distance that you would turn the bolt.

We use wrenches to tighten bolts.

The Pulley

A **pulley** is a wheel with a rope, wire, or chain around it. It changes the direction of force. A pulley allows you to raise something by pulling on a rope instead of pushing the object from below. What can you pull that uses a pulley? Every time you pull the cord to raise the blinds on your bedroom window, you're using a pulley. Think of how the cord slides over a wheel as it moves the blinds. As you pull down on the cord, the blinds are raised up. Some people have a clothesline that they can pull to bring clothes closer to them. If you examine the clothesline, you'll see that it slides over a kind of wheel to form a pulley.



A flagpole also makes use of a pulley. A flag is attached to a rope. The rope wraps around a wheel, making a pulley. Pulling on the rope can raise or lower the flag.

Sometimes more than one pulley is used to pull an object. Two or more pulleys make up a system of compound pulleys. This system allows you to do work using less force. A system of compound pulleys may have one pulley that is fixed in place. Then the system is known as a block and tackle. The more pulleys you add to a system, the less effort you need to lift a load.

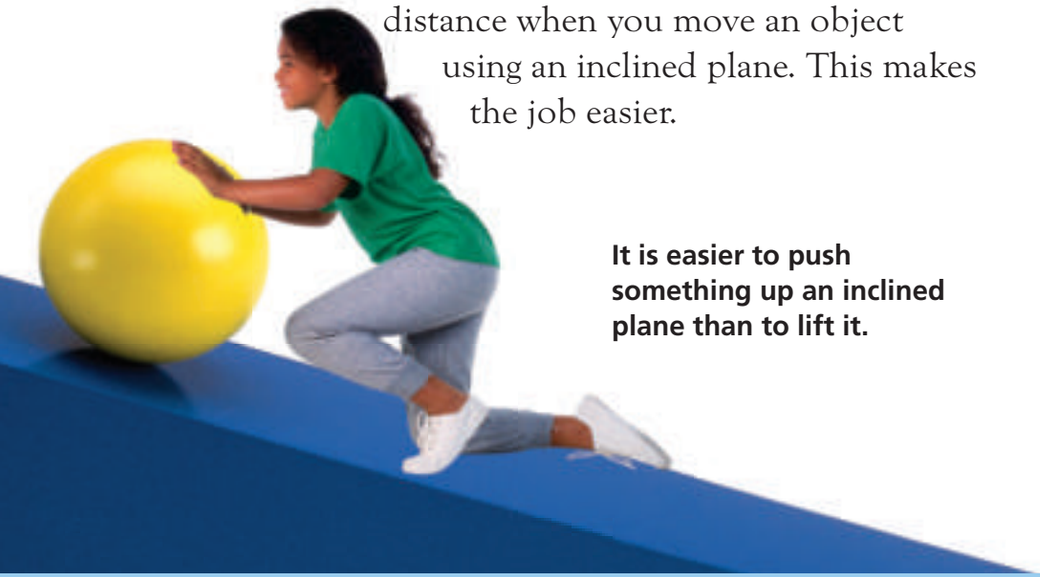
Cranes use pulleys to lift very heavy objects, such as this boat.

Machines Working Together

The Inclined Plane

Suppose you want to move a refrigerator up the front stairs into your house. What would be the easiest way to do that? The refrigerator would be too heavy to lift up the stairs. What else could you do? You could use a ramp. You could put a strong piece of wood over the steps so you could slide the refrigerator into the house. That would make your work easier.

A ramp is a simple machine called an **inclined plane.** You are still using the same amount of force when you use an inclined plane as you would if you lifted the object straight up. But you apply less force over a greater distance when you move an object using an inclined plane. This makes the job easier.

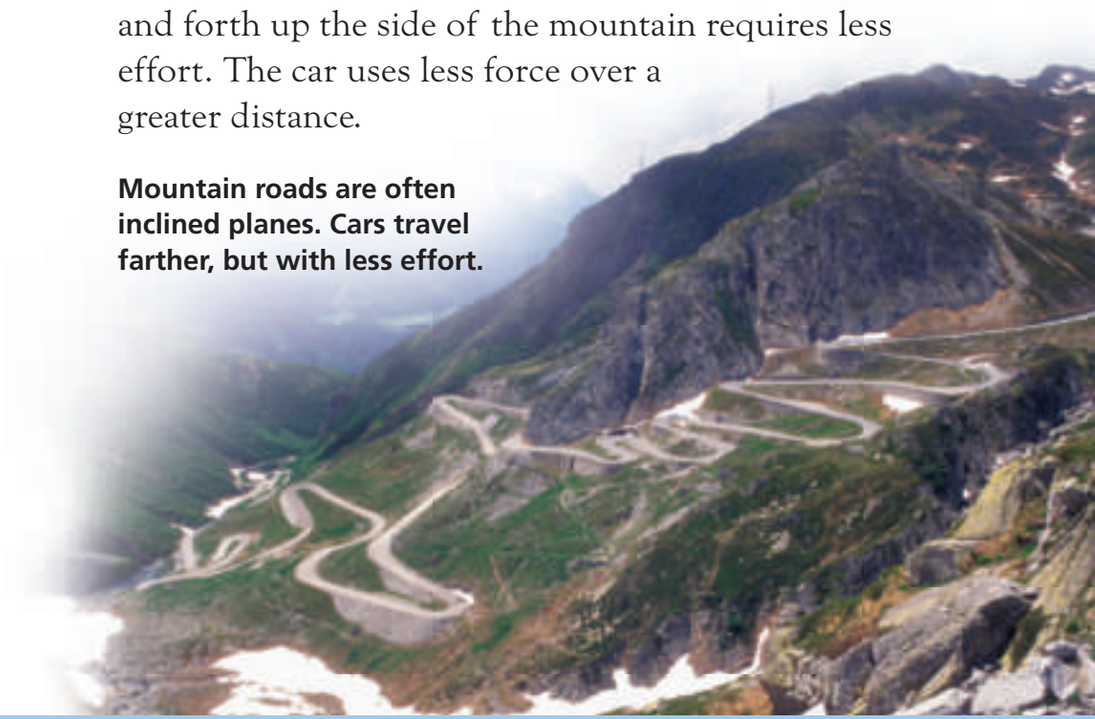


It is easier to push something up an inclined plane than to lift it.

What affects force?

Objects can move up or down an inclined plane. Friction affects how these objects move. Friction is a force that makes it harder for one substance to move against another. It slows down movement along an inclined plane. If a box at the top of an inclined plane stays in place, then the force of friction has balanced the force of gravity. What if there are wheels on the bottom of the box? Then the box will most likely roll down the inclined plane. The wheels take away most of the force of friction.

A mountain road is an example of an inclined plane. Powering a car straight up a mountain would require a great deal of effort from the car's engine. Providing power for the car to travel along a road that zig zags back and forth up the side of the mountain requires less effort. The car uses less force over a greater distance.



Mountain roads are often inclined planes. Cars travel farther, but with less effort.

chopping wood with a wedge

The Wedge

A **wedge** is a special inclined plane. You can think of a wedge as two inclined planes put together. A wedge has one wide end and one narrow end. The narrow end can be put between two objects to push or hold them apart. The narrow end moves forward when a force acts on the wide end.

Suppose two ice cubes are frozen together. A wedge can be used to separate them. You can put the narrow end of the wedge up against the ice. Then you can tap on the wide end of the wedge, driving the narrow end deeper into the ice. The shape of the wedge changes the force that moves forward into a force that moves outward. This pushes the two ice cubes apart. A wedge can also split a piece of wood in the same way.

The Screw

A **screw** is a kind of inclined plane. It is a rod that has an inclined plane wrapped around it. The inclined plane forms ridges that are called threads. Screws have many uses. They can join things together. They can lift things. You must turn a screw many times using a screwdriver.

The screw-on lid on this bottle keeps it tightly covered.

You see screws in many places. A light bulb has a screw at its base to fasten into a lamp. Without this, the bulb would fall right out of the lamp. Many jars have lids that can be screwed on. Have you wondered how you might keep jars covered if there were no screw-on lids?

The base of this light bulb is a screw.

Complex Machines

Simple machines can be used together to help us get even more work done. When one or more simple machines combine to do a job, they are known as complex machines.

You probably use complex machines every day. Anything that has a sharp edge, such as a pair of scissors, is a wedge. On a pair of scissors, the two blades that meet are each wedges, but they are also levers. They are joined at a fulcrum. That's two different machines in a regular pair of scissors.

A pair of scissors is a complex machine.

A bicycle is a complex machine. Its two wheels are wheels and axles. A chain connects the pedals with the axle of the back wheel. The chain wraps around a metal wheel, making the whole thing a pulley. The chain helps make the tires move when you do the work of moving the pedals.

A bicycle also has gears. A gear is a wheel with points. These points are called teeth. Gears are often used in pairs.

Wherever you are—whether it is at school or at home—look for machines at work. You can easily spot some of the six simple machines—the lever, wheel and axle, pulley, inclined plane, screw, and wedge. Now you can also look at other items, such as workbench tools or kitchen tools, and figure out which simple machines might be working together as a complex machine!

A bicycle is a complex machine.

Glossary

effort	a push or pull that makes a load move in some way
fulcrum	the base on which a lever and a load are supported
inclined plane	a simple machine also known as a ramp
lever	a simple machine made of a bar with a fulcrum
load	an object to lift or move
pulley	a simple machine made of a wheel with a rope, wire, chain, or cord around it
screw	a simple machine made of an inclined plane wrapped around a rod
wedge	a simple machine made of two inclined planes put together
wheel and axle	a simple machine made of a lever that moves or turns objects

What did you learn?

1. How is a screw a kind of inclined plane?

2. How could you use a simple machine to split a log into two pieces?

3. If a heavy truck was to be lifted onto a railroad car, how could it be done?

4. **Writing** in Science The position of a lever's fulcrum, load, and effort can change. Describe on your own paper how the different kinds of levers work. Use details from the book to support your answer.

5. **Summarize** If you try to push a huge boulder, you might get very tired without actually doing any work. Summarize how this could happen.