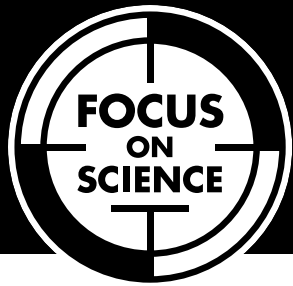


Basic Level



Physical Science

Force and Motion

# Force, Motion, and Simple Machines

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Assessments and  
Reading Activities

# Force, Motion, and Simple Machines

How do simple machines help us move objects?

## CORE CURRICULUM STATEMENTS

**Energy and matter interact through forces that result in changes in motion.**

The position or direction of motion of an object can be changed by pushing or pulling.

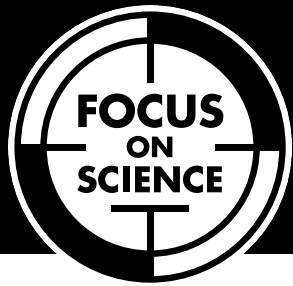
The force of gravity pulls objects toward the center of Earth.

The amount of change in the motion of an object is affected by friction.

Mechanical energy may cause change in motion through the application of force and through the use of simple machines such as pulleys, levers, and inclined planes.

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Basic Level



Physical Science

Force and Motion

# Student Book

*Force, Motion, and Simple Machines*

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BL

## Force, Motion, and Simple Machines

How do simple machines help us move objects?

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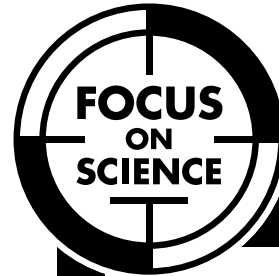
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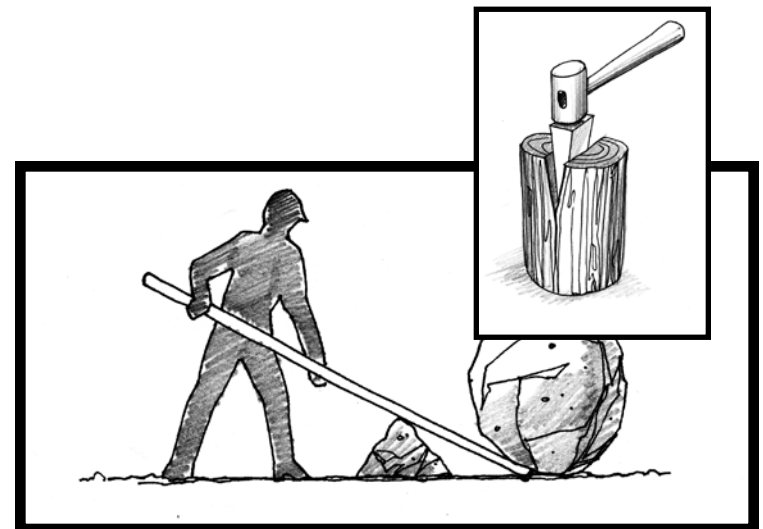


Physical Science

Force and Motion

# Force, Motion, and Simple Machines

by Michael Silverstone



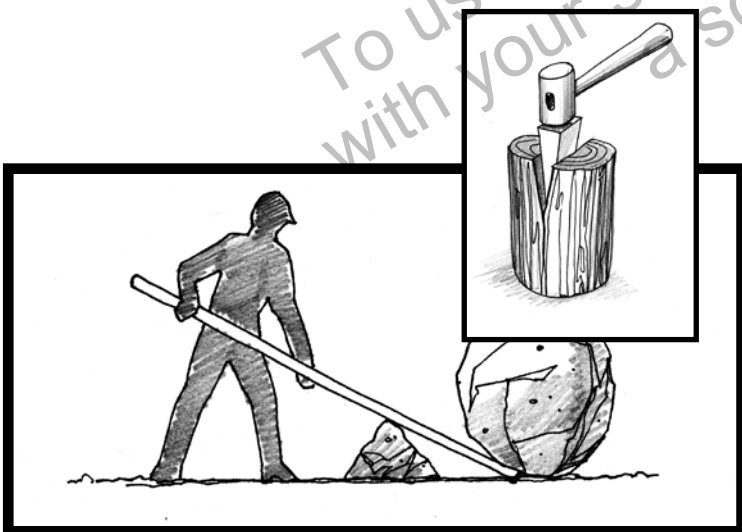


Physical Science

Force and Motion

# Force, Motion, and Simple Machines

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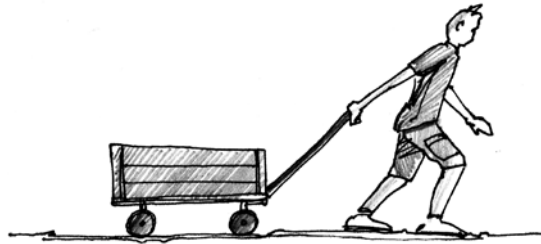
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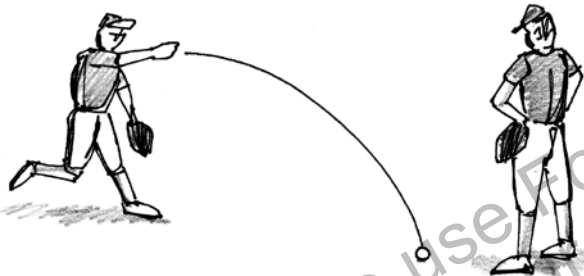
*–Predict–*

*What do you think you will  
learn from this book?*

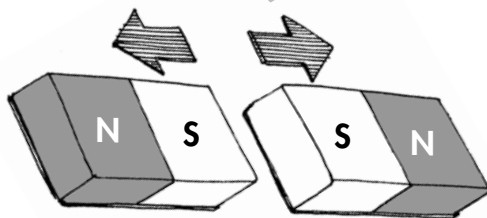
## Objects Move When Forces Push or Pull on Them



A pull from an outside force



A pull from gravity



A push from the force of magnets

## INTRODUCTION

# Motion Is Caused by Force

Look at a playground. All around, there is movement. Bikes roll on the ground. Children swing and slide. All these events are examples of **mechanical energy** causing changes in motion.

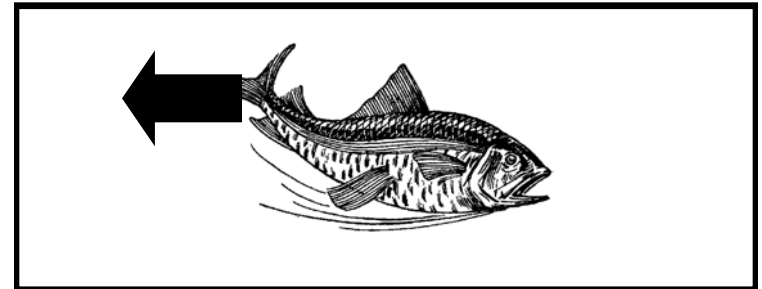
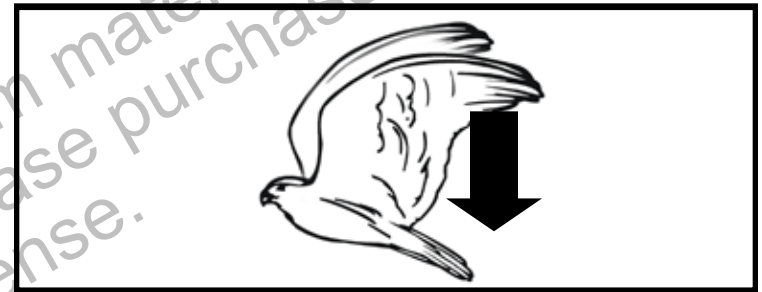
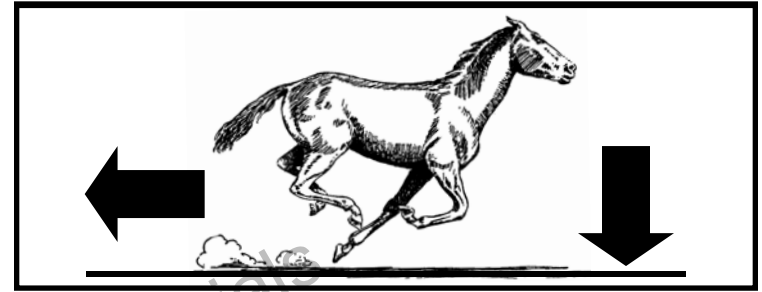
Everything on the playground is moved by force. Force result from pushing or pulling of objects. There are different types of forces that affect motion. They are gravity, friction, collision, and magnetism. Read on to learn more about these forces.

**mechanical energy:** energy an object has due to its motion, position, or condition

## Pushes and Pulls

Pushes and pulls are forces that usually start objects moving. For example, humans and animals push with their legs to move. Birds push with their wings. People attach ropes to objects and pull to move them.

Inventions have allowed us to move faster and farther than we could using only our muscles. They all rely on pushes and pulls to move objects.



*People and animals push against the ground with their feet and legs to move. A bird's wings push the air. A fish's tail pushes water to start movement.*

*–Apply–  
What creates thrust when you walk?*



---

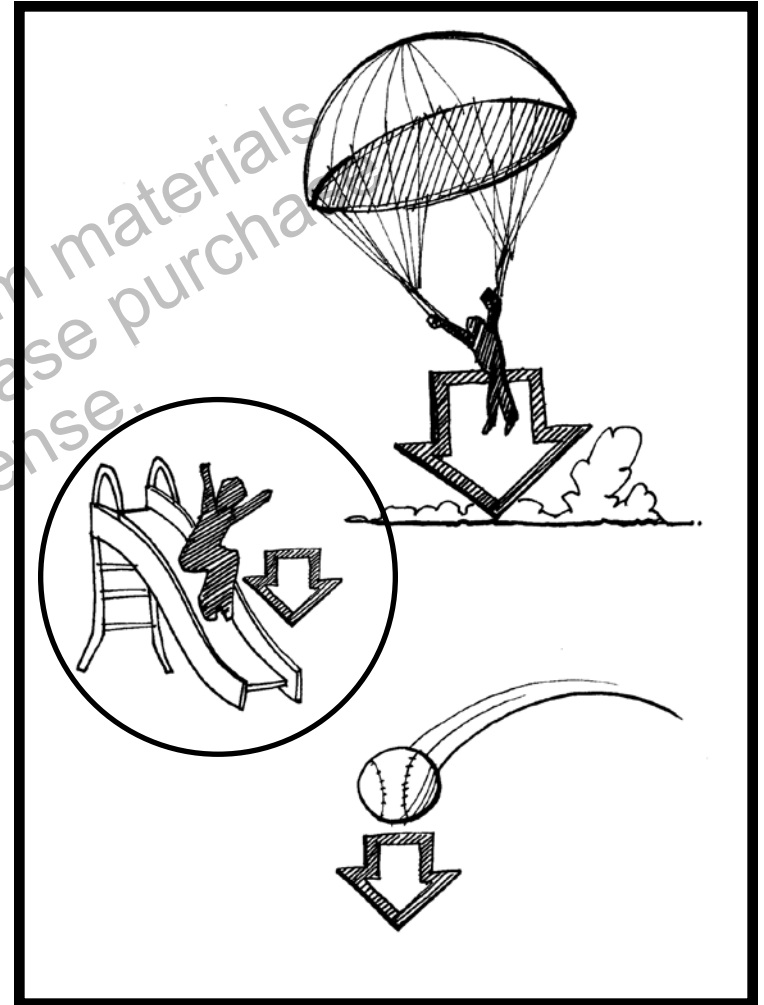
## Gravity

The force that pulls things to Earth is gravity. It is invisible. Still, we can see the results of gravity whenever something falls.

Gravity is a pull that objects have on other objects. The more massive the object, the stronger gravity's pull. Earth's gravity is so strong it pulls everything on it toward its center.

---

## The Force of Gravity



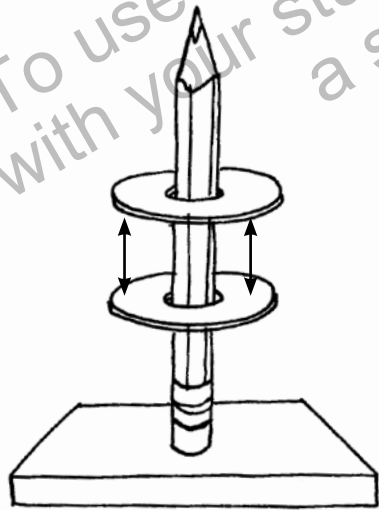
*The force of gravity pulls all objects on Earth toward the planet's center.*

---

## Magnetism

Long ago, people discovered magnetism. Iron passing close by certain rocks was pulled toward the rocks. People use these rocks to make magnets. Magnets can attract or repel each other. This force can be stronger than gravity.

Look at the drawing below. The magnet on the bottom is fixed to the pencil. The magnet on top is being forced away by the bottom magnet. The magnetic force is stronger than the force of gravity. The top magnet will not drop.



---

## Collision

What happens when you hit a baseball with a bat? The ball changes direction. When objects bump into each other, they slow down, change direction, or stop. This is called a collision.

What happens if two objects collide from opposite directions? Whichever has more energy and mass affects the direction. The bat has more energy and **mass** than the baseball. So, the baseball changes direction.



*What will happen if these two marbles roll at the same speed and collide directly into each other? What if the small one is going much faster? What if one hits the other from the side while the other is going straight ahead? Make a prediction and try it to see what happens.*

**mass:** the amount of matter in an object

# Friction

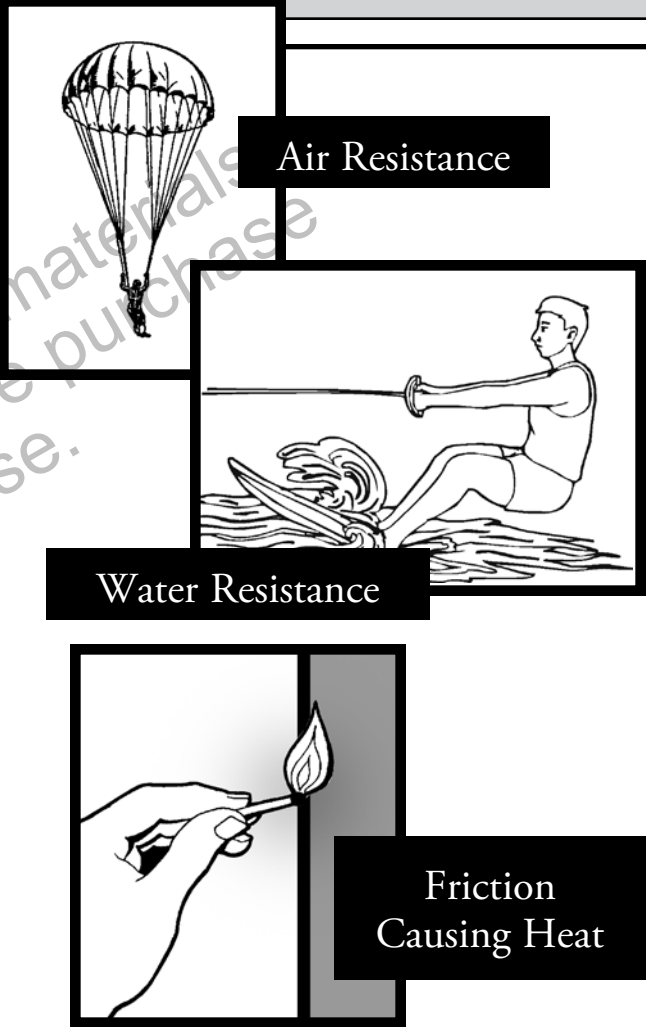
Friction is caused by an object rubbing against another object. Friction slows down the movement of objects.

Have you ever tried to run underwater? You know that water's friction, or **resistance**, makes this hard. Air has resistance. This is what makes a parachute work.

Friction also turns the energy of movement into heat. Rub your hands together quickly. Explain what happens to a friend.

**resistance:** when something pushes against an object to slow it down or stop it from moving

## Different Types of Friction and Resistance



The diagram is titled "Different Types of Friction and Resistance" and is enclosed in a large rectangular frame. It contains three distinct illustrations, each with a corresponding label in a black box:

- Air Resistance:** An illustration of a parachute with a person hanging from it, positioned in the upper left quadrant.
- Water Resistance:** An illustration of a person rowing a boat on water, positioned in the middle right quadrant.
- Friction Causing Heat:** An illustration of a hand rubbing a matchstick, which has a flame, positioned in the lower right quadrant.

*–Analyze–*  
*Where is the friction in each picture?*

---

## Reducing Friction

A heavy box of books is hard to push on carpet. Yet, it moves easily on ice. Why is this? It is easier to move objects when friction is reduced.

### Reducing Friction Between Surfaces

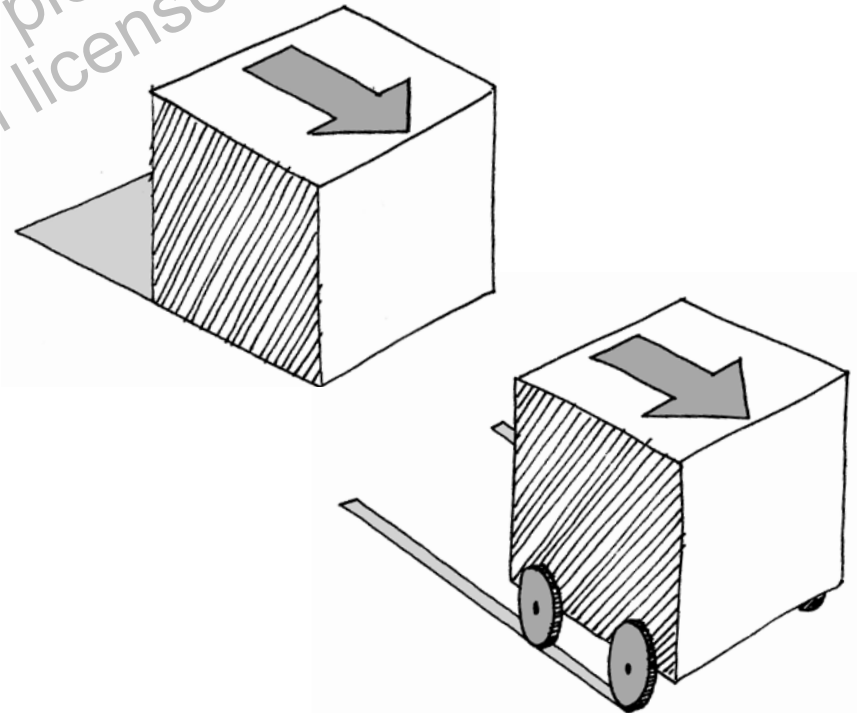
The ground is rough. Rough surfaces have more places to rub against. This creates more friction.

Ice is smooth. Smooth things have less friction. That makes your feet slip more easily on ice.

*–Explain–  
Identify and explain forces that  
affect the motion of an object.*

---

Here is another example. A box on wheels moves much more easily than one without them. Only the small area at the bottom of each wheel touches the ground. Without wheels, the entire surface of the box touches the ground. This creates more friction, making it harder to move the box.

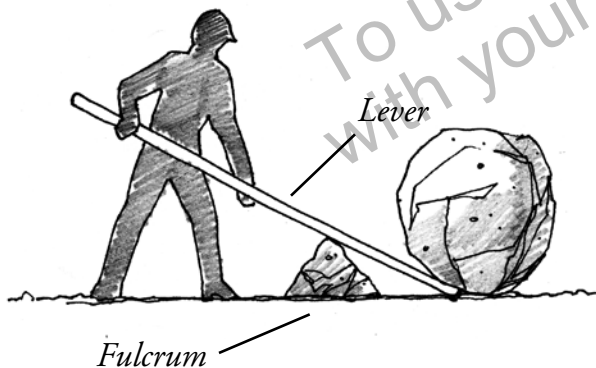


## Simple Machines

Simple machines are **devices** that help us perform work more easily. They allow us to use a smaller force to overcome a larger force.

### Lever

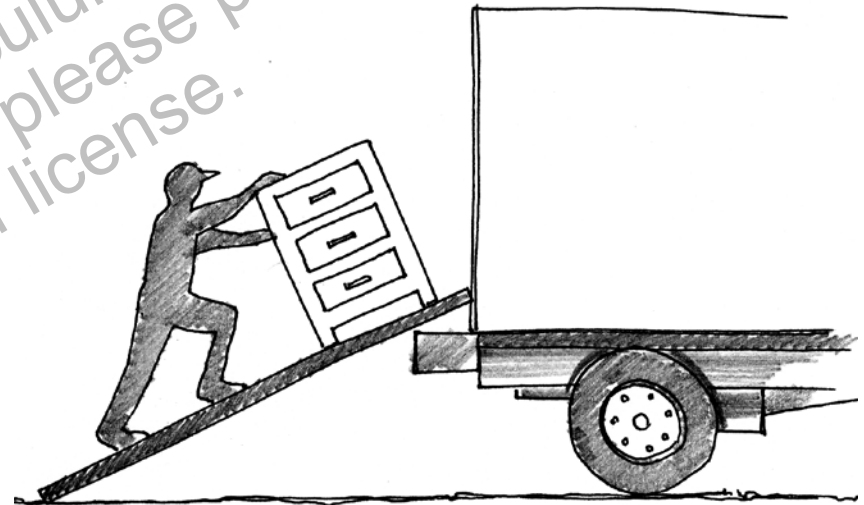
A lever is a straight, stiff bar that rests on a **fulcrum**. An object that a lever lifts is called the **load**. The closer the load is to the fulcrum, the easier it is to lift.



**devices:** things made or invented for a special use  
**fulcrum:** the support or fixed point that a lever rests on  
**load:** an object that is lifted or about to be lifted by a lever

### Inclined Plane

An inclined plane is a slanting surface. It allows you to move an object to a lower or higher place. You can apply a smaller force over a longer distance. This makes moving the object easier.

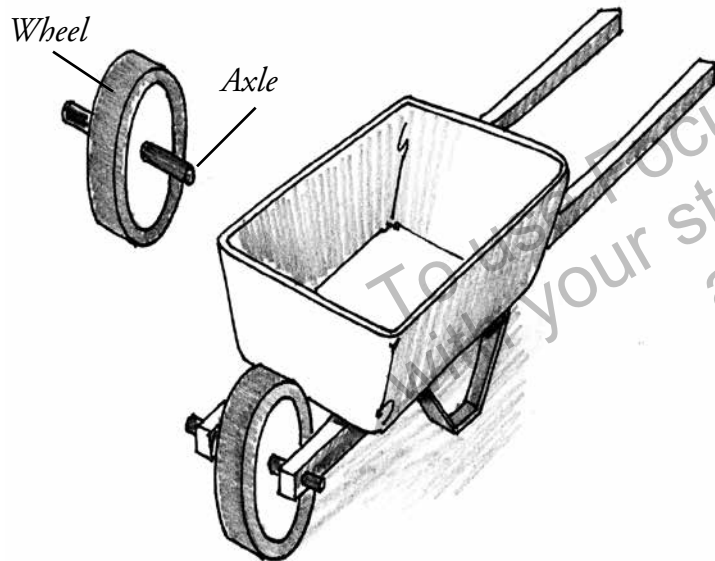


*Less force is required to move this object because of the longer distance of the ramp.*

---

## Wheel and Axle

The wheel and axle is another simple machine. A wheel is attached to a post called an axle. This allows the wheel to turn around the axle. It makes it easier to move things from place to place.

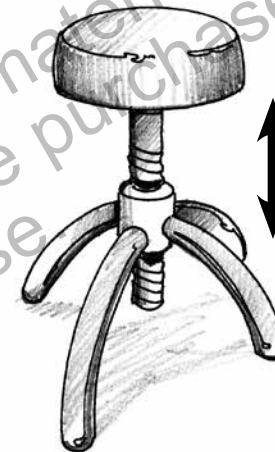


*A wheelbarrow uses a wheel and axle to make it easier to move heavy dirt.*

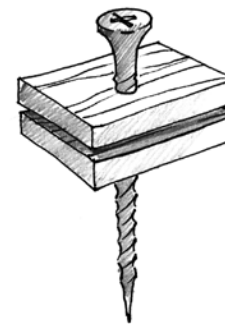
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## Screw

A screw is a simple machine used to lower and raise things. Screws are also used to hold objects together.



*A screw can be used to raise or lower this seat.*

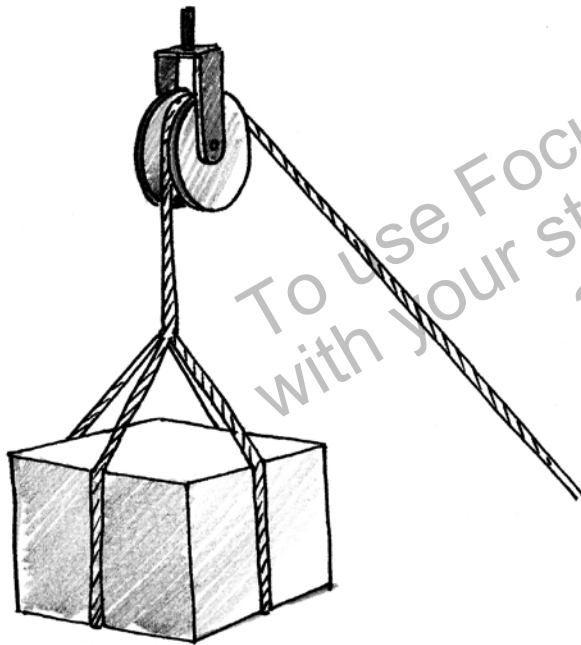


*A screw can be used to hold things together.*

---

## Pulley

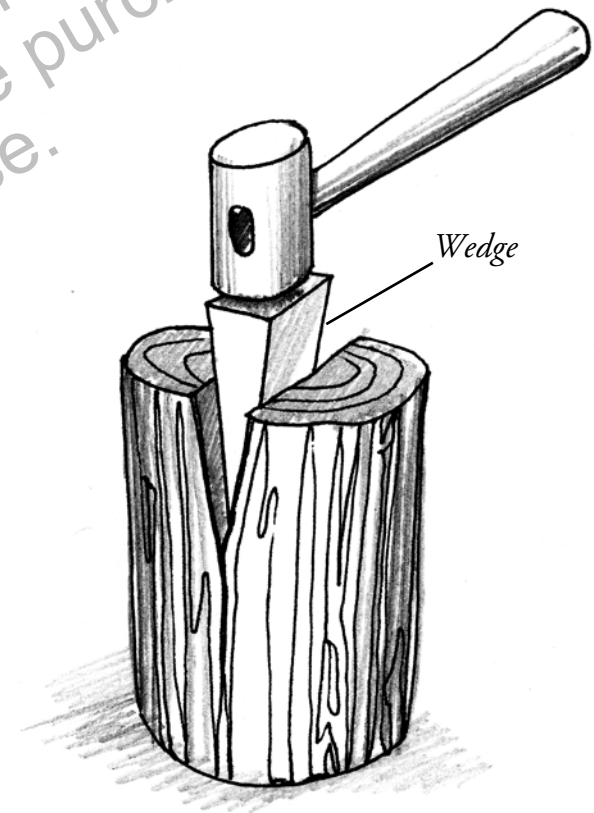
A pulley allows you to lift a large load with a much smaller force. It is made with a grooved wheel, axle, and a rope. One end of the rope is attached to the load. When you pull on one side of the pulley, the wheel turns. Then the load moves more easily.



---

## Wedge

A wedge is a simple machine used to separate two objects. A wedge has a sharp edge. A fairly weak force can split things apart. For example, the knife you use to eat with is a wedge. It cuts or split food apart.



---

## Glossary

**devices**—things made or invented for a special use

**fulcrum**—the support or fixed point that a lever rests on

**load**—an object that is lifted or about to be lifted by a lever

**mass**—the amount of matter in an object

**mechanical energy**—energy an object has due to its motion, position, or condition

**resistance**—when something pushes against an object to slow it down or stop it from moving

---

## To Find Out More . . .

Want to learn more about force and motion?

### Try these books

*Force & Motion* by Peter Lafferty. Dorling Kindersley, Inc., 1992

*Speed and Acceleration* by Richard Spilsbury. Heinemann Library, 2007.

### Access these Web sites

The Little Shop of Physics  
<http://littleshop.physics.colostate.edu/>

Fizzics Fizzle! An Interactive Guide to Physics  
<http://library.thinkquest.org/16600/>

### Write for more information

National Student Research Center  
606 Lafitt Street  
Mandeville, Louisiana 70448

National Academy of Engineering  
500 Fifth Street, NW  
Washington, DC 20001



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# Assessments

*Force, Motion, and Simple Machines*

Print pages 20–22 of this PDF for the assessments.

# Check Understanding

Shade the circle next to the correct answer or write your answer on the lines provided.

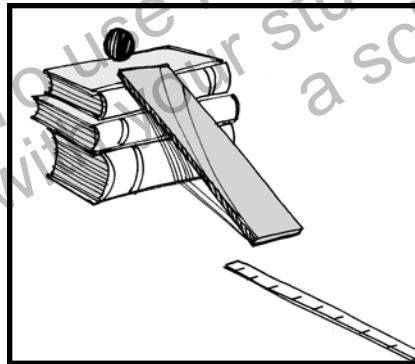
1. A plastic cup rests, motionless, on the table. Which force is acting on the cup?

- Ⓐ gravity
- Ⓑ friction
- Ⓒ magnetism
- Ⓓ electricity

2. Students want to measure how far a marble rolls on different surfaces. The following pictures shows the set-up for the experiment.

Why will the marble roll further on glass than on dirt?

- Ⓐ Glass has less mass than dirt.
- Ⓑ Glass has less friction than dirt.
- Ⓒ Glass has more resistance than dirt.
- Ⓓ Glass has more resistance than dirt.



3. Resistance occurs when something pushes against an object. This slows the object down or stops it from moving. Identify **two** types of resistance.

- 1) \_\_\_\_\_
- 2) \_\_\_\_\_

Give an example of each type of resistance.

\_\_\_\_\_

\_\_\_\_\_

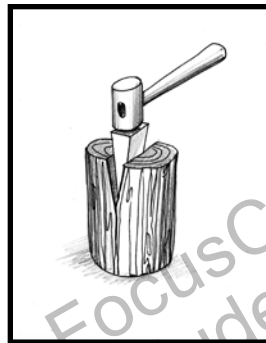
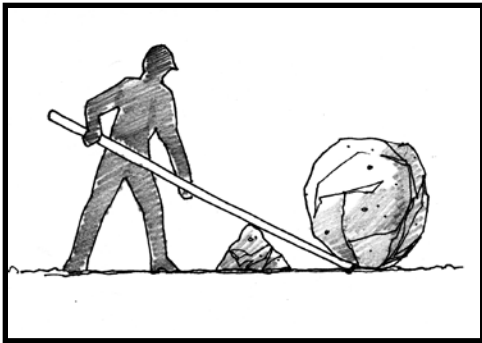
\_\_\_\_\_

\_\_\_\_\_

# Check Understanding

Shade the circle next to the correct answer.

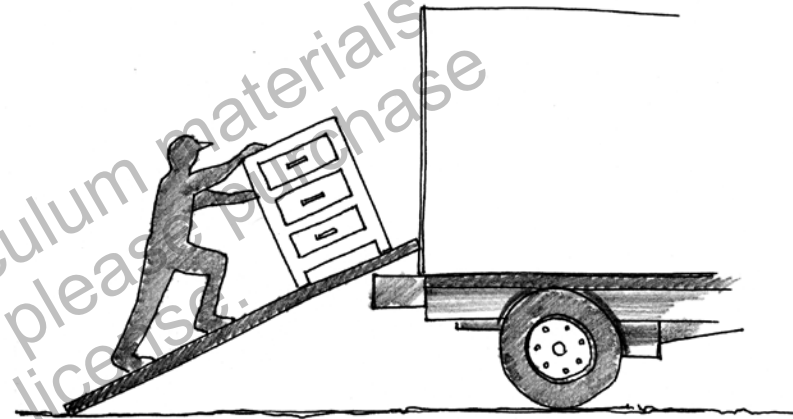
4. The wedge and lever shown below use mechanical energy to move an object.



The wedge and lever are examples of

- (A) gravity
- (B) friction
- (C) simple machines
- (D) loads

5. The diagram below shows a person moving a load up.



What simple machine is the person using?

- (A) inclined plane
- (B) screw
- (C) balance
- (D) wheel and axle

# Assessment Scoring Guidelines

1. Answer A is correct. D is a common misconception
2. Answer B is correct.
3. Answers will vary but may include:
  - Water resistance**  
Water pushes against a water skier.
  - Air resistance**  
Air pushes against a parachute.
4. Answer C is correct.
5. Answer A is correct.

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# English Language Arts Activities

Force, Motion, and Simple Machines

Print pages 24–28 of this PDF for the reading activities.

# Make Inferences

## TRY THE SKILL

To make an inference, you think about what you have read and what you already know. Then you reach a decision.

### Read this passage:

Yesterday, cars slipped and slid on the streets. That led to many accidents. Yet today drivers have no trouble moving up and down the streets without running into each other.

### What inference can you make?

You learned in this book that objects slide easily when friction is reduced. Those objects include cars on the street. What do you know that can reduce friction on streets? Ice, snow, and even rain can do it.

Now you can infer that yesterday the weather was snowy or rainy. Friction between car tires and the street was reduced. The cars slipped easily. However, today the streets must be dry. Friction between the tires and the street keeps cars from sliding.

**Read this passage. Then make an inference.**

You are building a wooden race car. You carved the wheels out of wood, too. Someone tells you to make sure that you sand those wheels well. How will sanding the wheels help you win races?

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# Use Graphic Organizers

## TRY THE SKILL

Graphic organizers help you understand information by taking it out of the text and putting it in the form of a picture. Often, when you see a set of facts, the facts make more sense than when you read them in the text.

**Use this organizer to show the differences between gravity, collision, and friction. Use the information in the box to complete the organizer.**

Gravity	Collision	Friction

- caused by matter rubbing together
- the pull of matter on other matter
- turns energy of movement into heat
- changes direction of matter
- object with more mass affects the direction of another
- pulls things to Earth
- slows down the movement of objects
- invisible



# Antonyms

## TRY THE SKILL

Antonyms are words that have opposite meanings. Some examples of antonyms are:

*chilly* and *warm*

*find* and *lose*

*huge* and *tiny*

*strong* and *weak*

**Read the paragraph. Look for the antonyms.**

Ice is smooth. Smooth things have less friction. That makes them easier to move. The ground is rough. Rough surfaces have more places to rub against. This creates more friction.

**What are the antonyms?**

*Smooth* and *rough* are antonyms. *Less* and *more* are antonyms, too.

**Read the paragraph. Underline the antonyms.**

Long ago, people discovered magnetism. Iron passing close by certain rocks was pulled toward the rocks. These rocks contained magnetite, a raw material that people now use to make magnets. Magnets can attract or repel each other. This force can be stronger than gravity.

**Think of other antonyms that have to do with motion. Write them in the space below.**

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# Cause and Effect

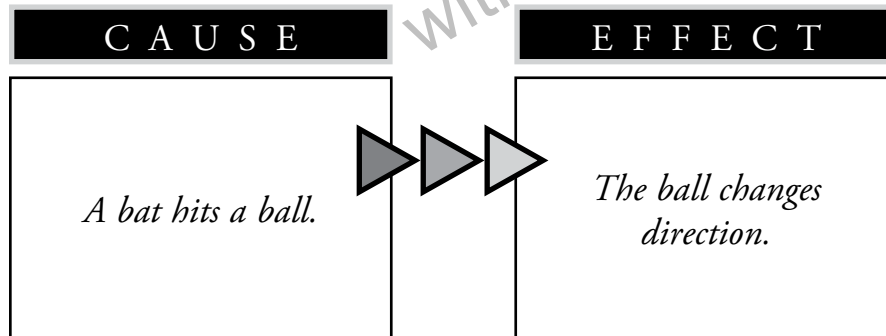
## TRY THE SKILL

To find out an effect you ask, "What happened?" To find out a cause, you ask, "Why did that happen?" Identifying cause and effect is a way to understand what you read.

**Read this passage from the book.**

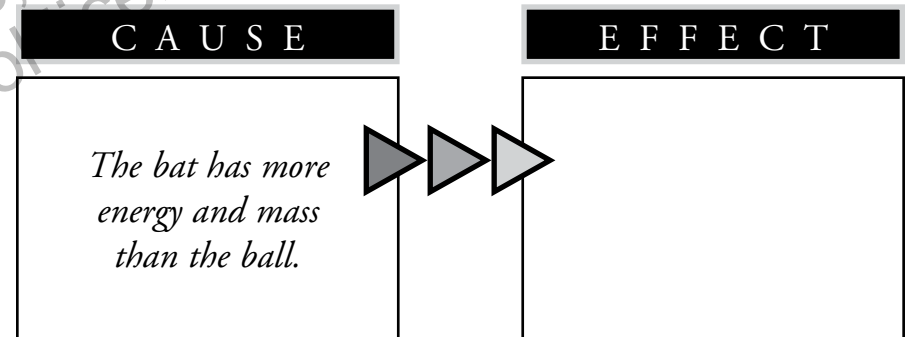
What happens when you hit a baseball with a bat? The ball changes direction. When objects bump into each other they slow down, change direction, or stop. This is called a collision.

**This graphic explains the cause and effect.**



**Read this passage. Then complete this graphic organizer. Tell what effect the bat has on the ball.**

What happens if two pieces of matter collide from opposite directions? Whichever has more energy and mass will affect the direction. The bat has more energy and mass than the baseball. So, the baseball changes direction.



**There are certain words that signal a cause and effect relationship. What word is used in the paragraph to signal this cause and effect?**

---

# Answer Key

## Make Inferences

Inference: Sanding the wheels will make the surface smoother, so the wheels will have less friction as they roll down the track. Reducing friction will help the race car move faster.

## Use Graphic Organizers

### Gravity

invisible; the pull of matter on other matter; pulls things to Earth

### Collision

changes direction of matter; object with more mass affects the direction of another

### Friction

caused by matter rubbing together; slows down the movement of objects; turns energy of movement into heat

## Antonyms

*attract* and *repel* are antonyms

Other antonyms could include *stronger* and *weaker*, *pulled* and *pushed*, *close* and *far*, *faster* and *slower*.

## Cause and Effect

**Cause:** The baseball changes direction

**Signal word:** *So*