MOTION AND SIMPLE MACHINES

3-8 Science Unit Study

THE GOOD AND THE BEAUTIFUL

Motion and Simple Machines

CREATED BY THE GOOD AND THE BEAUTIFUL TEAM

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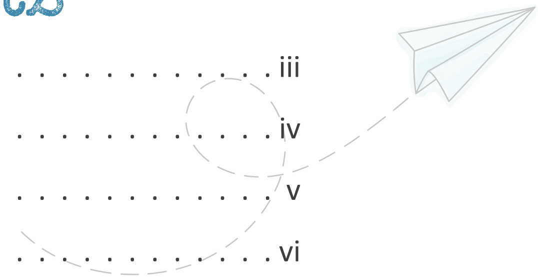


Unit Information

Science Journal

All The Good and the Beautiful science units include activities in a student journal. Each student should have his or her own student journal, and the parent or teacher will direct the student regarding when to complete the activities in the lessons. The journal can be purchased by going to **goodandbeautiful.com/science** and clicking on the *Motion and Simple Machines* unit link.

Science Wall

All The Good and the Beautiful science units include vocabulary words to be placed on your science wall, which is a wall or tri-fold presentation board in your learning area on which you can attach the vocabulary words and other images. Cut out the vocabulary word cards at the beginning of the unit. The course will indicate when to place them on the wall.

Lesson Preparation

All The Good and the Beautiful science units include easy-to-follow lesson preparation directions at the beginning of each lesson.

Activities

Many of The Good and the Beautiful science lessons involve hands-on activities. An adult should always closely supervise children as they participate in the activities to ensure they are following all necessary safety procedures.

Unit Videos

Some lessons include videos that were created by The Good and the Beautiful. Have a device available that is capable of playing the videos from **goodandbeautiful.com/sciencevideos** or from the Good and Beautiful Homeschooling app.

Content for Older Children

Some lessons include extra content that is more applicable for older children (grades 7–8). Parents or teachers may choose to skip this content if instructing only younger children.

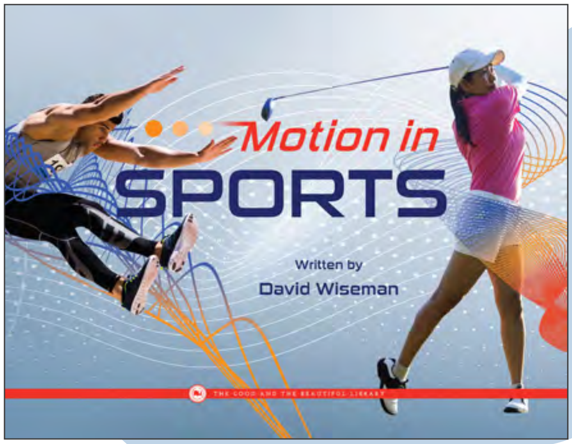
Content for Younger Children

Some lessons include extra content that is more applicable for younger children (grades 3–6). Parents or teachers may choose to skip this content if instructing only older children.

Read-Aloud Book Pack

The books below are optional read-aloud books that complement this unit. These books can be purchased as a book pack by going to **goodandbeautiful.com/science** and clicking on the *Motion and Simple Machines* science unit product page.

The Story of Invention
by David Wiseman



Motion in Sports
by David Wiseman

CORRELATED BOOKS

The Good and the Beautiful Library has several books that correlate well with the *Motion and Simple Machines* unit. It can be a wonderful experience for children to read books at their levels that are related to the subjects they are learning. The library includes both fiction and nonfiction books organized according to reading level. Find the Correlated Books by going to **goodandbeautiful.com** and clicking on the *Motion and Simple Machines* unit product page.

GRADES 7–8

Lesson Extensions

How the Extensions Work

Each lesson has an optional lesson extension for children in grades 7–8. Complete the lesson with all the children, and then have the older children complete the self-directed lesson extension. These extensions are located in the *Grades 7–8 Student Journal*.

Answer Key

The answer key for the lesson extensions can be found on the free Good and Beautiful Homeschool app in the science section. Visit **goodandbeautiful.com/apps** for information on accessing the app. The app can be accessed from a computer, phone, or tablet.

Flexibility

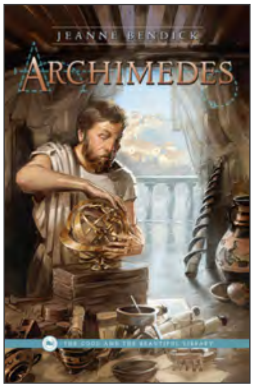
The amount of time it will take to complete each lesson extension will vary for each child. The average time is about 10–15 minutes per extension. Parents, teachers, and children may choose to omit parts of the lesson extension if desired. Encourage the children to stretch their capabilities, but also reduce work if needed.

Taking Notes

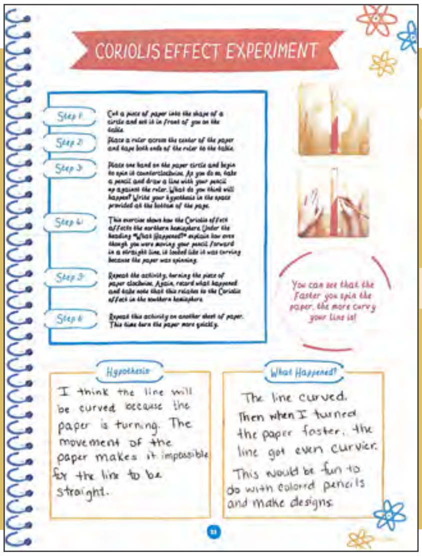
Some of the grades 7–8 lesson extensions have the children summarize the material read. Teach the children to look for key information, summarizing the most important points. Students can also add notes with their thoughts and the facts that are most interesting to them.

Optional Grades 7–8 Reading Book

We recommend *Archimedes* as extra reading for students in grades 7–8. This book can be purchased by going to **goodandbeautiful.com/science** and clicking on the *Motion and Simple Machines* unit link.



Archimedes
by Jeanne Bendick



CORIOLIS EFFECT EXPERIMENT

Step 1 Cut a piece of paper into the shape of a circle and set it in front of you on the table.

Step 2 Place a ruler across the center of the paper and tape both ends of the ruler to the table.

Step 3 Place one hand on the paper circle and begin to spin it counterclockwise. As you do so, take a pencil and draw a line with your pencil up against the ruler. What do you think will happen? Write your hypothesis in the space provided at the bottom of the page.

Step 4 This exercise shows how the Coriolis effect affects the northern hemisphere. Under the heading "What Happened?" explain how even though you were moving your pencil forward in a straight line, it looked like it was curving because the paper was spinning.

Step 5 Repeat the activity, turning the piece of paper clockwise. Again, record what happened and take note that this relates to the Coriolis effect in the southern hemisphere.

Step 6 Repeat this activity on another sheet of paper. This time turn the paper more quickly.

You can see that the faster you spin the paper, the more curvy your line is!

Hypothesis

I think the line will be curved because the paper is turning. The movement of the paper makes it impossible for the line to be straight.

What Happened?

The line curved. Then when I turned the paper faster, the line got even curvier. This would be fun to do with colored pencils and make designs.

Supplies Needed

This section lists all the extra supplies needed for the activities within the lessons.

Lesson 1

- Kitchen chair
- Sofa (or other very heavy object)
- Heavy book (like a Bible or dictionary)
- Pillow (larger and weighing less than the book)

Lesson 2

- 10 pennies
- Index card
- Cup (glass or ceramic is best)
- Marble or ping-pong ball
- 8"x10" piece of sandpaper (or other similar surface like cement, grass, roadway, or sand tray)
- 8"x10" piece of felt (or other similar surface like a sweater or cloth)

Lesson 3

- Meterstick, yardstick, or ruler
- Marble (or other ball)
- Masking tape
- Timer
- Calculator
- Compass (optional)

Lesson 4

- Ping-pong ball
- Marble
- Drinking straw (for each child)
- Scissors (for each child)
- Glue (for each child)

Lesson 5

- Timer
- Small toy car
- 6 thick books
- Cookie sheet (or ironing board or long piece of cardboard)
- Piece of scrap paper
- Calculator
- 2 different-sized balls (not a ping-pong ball) like a marble, golf ball, basketball, soccer ball, tennis ball, baseball, etc.
- Pencil (optional)
- Piece of string about 6 inches long (optional)
- Paper clip (optional)

Lesson 6

- Apple or other similar item (orange, tennis ball, rock, etc.)
- Balloon
- Access to a doorknob
- One red and one blue colored pencil per child
- Tape
- Drinking straw
- Thread (7–10 feet long)

Lesson 7

- Empty spool (for each child) Rubber band (for each child) (Note: you want the rubber band length to be similar to the spool length.)
- Washer (for each child)
- Paper clip (for each child)
- Pencil (for each child)
- Tape
- Ruler (grades 7–8 only)
- 2 sheets of blank paper (grades 7–8 only)

Supplies Needed

(CONTINUED)

Optional Activity Supplies (per child):

- Balloon
- Empty toilet paper roll
- Scissors
- Tape
- Marshmallows, pom-poms, or cotton balls

Lesson 8

- A container of crayons
- Broom
- Dishcloth
- Scissors (for each child)
- Glue stick

Lesson 9

- Snack for each child (such as an apple, a carrot, string cheese, etc.)
- Pencil
- Ruler (a firm, not flimsy one)
- 10 pennies
- 5-oz can of food (like tuna or cat food)
- Tape
- Ping-pong ball
- Red and blue colored pencils (for each child)

Lesson 10

- Access to a doorknob

Optional Activity Supplies:

- Raw potato (per child)
- Knife (to cut potatoes)
- 7–9 craft sticks (per child)
- Cardboard or cardstock, at least 8.5"x11" (per child)
- 3–6 brads, at least ¾ inch (per child)
- 1 pushpin (per child)
- Pointed scissors or a screwdriver (to poke holes through the cardboard)

Lesson 11

- Timer
- Screw
- Nail
- 1 empty spool or bobbin
- 2 paper clips
- 2 pencils or skewers
- Paper or disposable plastic cup
- 6-inch string
- 6-foot string
- Items to fill a paper cup, such as toys, cereal, marbles, cards, LEGO® building blocks, etc.
- Tape

Lesson 12

- A variety of supplies for the children to build with, such as straws, cups, string, tape, craft sticks, pencils, toilet paper rolls, rubber bands, bobbins, washers, toothpicks, spools, screws, LEGO® building blocks, etc.
- A device that can record video (optional)

Vocabulary

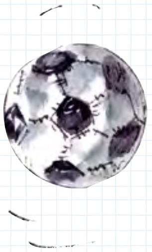
Instructions: Cut out the vocabulary cards in this section. Place them on your science wall when prompted to do so in the lessons. Review the vocabulary words several times during this unit and, if desired, at various times throughout the school year.

Force

a push or pull that causes an object to have a change in movement or direction

Motion

the change in position of an object



Newton's First Law

an object in motion stays in motion; an object at rest stays at rest until acted upon by an external force; the tendency for objects to respond this way is also known as inertia

Gravity

a force of attraction between two masses

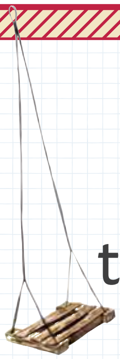
Newton's Third Law

when an object pushes on another object, the object being acted upon pushes back with equal force

Law of Conservation of Energy

the amount of energy doesn't change; energy is not created or destroyed; it is only converted to other forms of energy

Potential Energy



the stored energy an object has because of its position or state

Motion AND Simple Machines
LESSON 1

Force and Motion

Objective

Help the children understand force and motion. Learn about Sir Isaac Newton and his important discoveries about force and motion.

Preparation:

None

Activity Supplies:

- Kitchen chair
- Sofa (or other very heavy object)
- Heavy book (like a Bible or dictionary)
- Pillow (larger and weighing less than the book)

☐ The Motion of Swings

Read to the children: Think about being on a swing. <u>What does it feel like?</u> <u>How would you teach someone else to use a swing?</u> **Discuss with the children. Point to the picture below.**

See how the child is pushing her legs forward? To get up into the air, she will need to pull her legs back and then push them forward again at the right moment, transferring energy into the swing to make it go higher. A push from her mother will also help her to get moving and go higher even more quickly.

LESSON 1

We live in a universe that is constantly in ***motion***, and ***force*** is what puts all things into motion. In this unit we are going to learn about force and motion, how they work, and what influences them.

☐ Science Wall

Place the vocabulary cards FORCE and MOTION on your science wall. Read and discuss the words and definitions.

☐ Force and Motion Study in Art

Read to the children: Examples of motion are all around us! We use force and motion all the time without even putting much thought into it.

Have the children turn to the painting titled "The Sick Dachshund" by Franz von Defregger in Lesson 1 of their student journals. Then have them take a moment to observe and study the painting.

What do you like about the painting? Let's look for examples of force. How many examples of pushing and pulling can you find? **Allow the children to observe the artwork and point to examples of force, identifying each as a PUSH or a PULL.**

☐ Pushing and Pulling Force Activity

Give the children a bed pillow and a heavy book. (You can use other items; the point is to have one be heavier and smaller than the other that is larger and lighter.) Have the children take turns PUSHING and then PULLING the items across the floor. Have the children determine which item requires MORE FORCE. Then have the children take turns pushing or pulling a kitchen chair and a sofa (or other very heavy object). Have the children determine which item requires more force.

Discuss: Did the bigger items always require more force to move them? [no]

Why do you think bigger items were sometimes easier to push or pull?

What did it feel like when you tried to move the heavier objects?

☐ Force, Motion, and Isaac Newton Video

Watch the video called "Force, Motion, and Isaac Newton" at goodandbeautiful.com/sciencevideos.

☐ Sir Isaac Newton

Have the children turn to the "Isaac Newton" page in Lesson 1 of their student journals and follow the instructions to complete the page. The older children will also use the "Isaac Newton Quotes" page in Lesson 1 of their student journals.

Read to the children: Isaac Newton made important discoveries that we still continue to use today! He made these discoveries by being observant and pondering the things that he noticed happening around him. We, too, can make great discoveries about our lives and the beautiful world we live in by taking time to observe, study, and ponder the things that we see and experience. Christ has told us, "Ask, and it shall be given you; seek, and ye shall find; knock, and it shall be opened unto you" (Matthew 7:7).

☐ Lesson 1 Extension

Have the children grades 7–8 complete the self-directed Lesson 1 extension titled "A Deeper Look at Force" in their student journals.

Speed and Velocity

Objective

Help the children learn what speed and velocity are and what the impact of acceleration is on an object.

Preparation:

☐ Cut out "The Tortoise and the Hare Story Cards."

Activity Supplies:

- Meterstick, yardstick, or ruler
- Marble (or other ball)
- Masking tape
- Timer
- Calculator
- Compass (optional)

☐ Speed and Acceleration Video

WATCH ONLINE

Watch the video called "Speed and Acceleration" at goodandbeautiful.com/sciencevideos.

Ask the following questions about the video: What travels faster than anything else? [light] Who first calculated and recorded ***speed***? [Galileo]

☐ The Tortoise and the Hare Story Cards

Place "The Tortoise and the Hare Story Cards" on the table. Have a child find and read Card #1 (or read it to him or her). Then have the children find the matching illustration for Card #1. Then ask: Do you think a tortoise and a hare can race at the same speed? [Any answer is acceptable; this will be discussed more later.]

Repeat the process for Cards #2 and #3, and then ask: Are the tortoise and the hare going the same speed right at this moment? [no]

Have a child find and read Card #4 (or read it to him or her). Then have the children find the matching illustration for Card #4. Then ask: Who has a quicker speed now? [the tortoise]

Repeat the process with Card #5, and then ask: Why did the tortoise win the race? [He didn't take breaks.]

☐ Science Wall

Place the vocabulary cards DISTANCE and SPEED on your science wall. Read and discuss the words and definitions.

The hare did not travel at the same speed throughout the race. It is common for a traveling object to change its speed because of acceleration, friction, or other outside forces acting on the object. So when scientists talk about the speed of an object, they are actually talking about average speed. Average speed is the speed right in the middle of the fastest and slowest speeds. The ***distance*** traveled and the time it took to travel that distance are used to calculate speed.

☐ Calculating Speed

7–8

If applicable, have the older children turn to the "Speed & Velocity" page in Lesson 3 of their student journals

The Tortoise and the Hare Story Cards

Card #1:

There once was a young hare who sat lazily on a grassy hillside. As the sun shone down into the glittering water, he watched as wise, old Tortoise carefully crawled down the hill toward the cool water. The hare chuckled and said, “Boy, am I glad it doesn’t take me so long to get anywhere!”

Tortoise replied, “It doesn’t take me as long as you might think. Let’s run a race, and I will prove it to you!”

Card #2:

Hare pictured himself running a race against Tortoise and chuckled again. He could not fathom how Tortoise could beat him! But the thought of the challenge amused him, and he did always enjoy a morning jog. So he took Tortoise up on his challenge. They decided to meet at the giant red oak tree in the meadow the next morning.

Card #3:

Just as the sun was peeking above the eastern mountains, the two racers took their starting places at the giant oak tree. Fox, who agreed to be the judge, gave the signal, and they both started across the meadow.

Hare’s long strides and agile movement quickly sent him so far ahead that Tortoise, with his short, steady strides, was soon out of sight.

Card #4:

Hare continued swiftly on until he had worked up quite a sweat. The noonday heat was approaching, and he was hot and tired. “Tortoise is nowhere in sight! I’ll sit behind this rock and rest for just a moment.” Soon, Hare was fast asleep, dreaming of his win crossing the finish line.

Meanwhile, Tortoise continued with steady and diligent steps onward. He did not stop and did not slow down, even when he unknowingly passed the sleeping Hare.

Card #5:

Several hours passed, and Hare awoke with a start. “Oh, no! I fell asleep.” He jumped up and ran swiftly toward the finish line where Fox was waiting. Up ahead he could see Tortoise nearing the winning mark. As Hare ran with all his might, he neared the tortoise, but Tortoise, with his steady pace, still beat him by a hair.

Gravity

Objective

Help the children understand what gravity is and how it works. They will learn that the more mass an object has, the greater force gravity exerts upon it.

Preparation:

None

Activity Supplies:

- Timer
- Small toy car
- 6 thick books
- Cookie sheet (or ironing board or long piece of cardboard)
- Piece of scrap paper
- Calculator
- 2 different-sized balls (not a ping-pong ball) like a marble, golf ball, basketball, soccer ball, tennis ball, baseball, etc.
- Pencil (optional)
- Piece of string about 6 inches long (optional)
- Paper clip (optional)

☐ God's Laws

Read to the children: Have you watched a baseball hurling into the air and wondered if there was a chance it could just keep flying into space?

There are so many questions about how our world works! Scientists like Isaac Newton have learned many things about how the world works by watching and questioning the seemingly normal things around them.

We also have been observing how things work and interact through the experiments and activities we have done. We have made hypotheses, or guesses, at how something will act or why an object does something a certain way. Sometimes we are right and sometimes we are wrong, but either way we are learning and continuing to grow in our understanding of how our world works. Scientists are still doing that, and even with all the research being conducted, they cannot explain everything in our world. God is the Master and Creator of all. Ultimately, all things work the way they do because of HIS laws. **Have one of the children read the following scripture:**

> Let every soul be subject unto the higher
> powers. For there is no power but of God: the
> powers that be are ordained of God.
> –Romans 13:1

☐ Newton's First Law

Read to the children: Today we are going to race a matchbox car down ramps at different heights and time the car to see if the height affects the acceleration.

Set up: Place one book on the ground and set the cookie sheet facedown and on the edge of the book so that the cookie sheet angles down to the floor to create a ramp. (If desired, you may make a longer ramp using an ironing board or cardboard box.) Set the car at the top of the ramp and have someone ready to start the timer as soon as the car is set loose. Stop the time when the car hits the end of the ramp, and record the time on a piece of scrap paper.

Add two more books to the pile (total of 3) and repeat. Then repeat one more time with a stack of 6 books.

Newton's Third Law

Objective

Help the children learn Newton's Third Law: when an object pushes toward another object, the object being acted upon pushes back with equal force.

Preparation:

None

Activity Supplies:

- Apple or other similar item (orange, tennis ball, rock, etc.)
- Balloon
- Access to a doorknob
- One red and one blue colored pencil per child
- Tape
- Drinking straw
- Thread (7–10 feet long)

☐ Reactive Forces

Read to the children: Take your two index fingers and slowly push the tip of each finger against the other.

<u>Do you notice that both finger tips flatten with the force from the other finger?</u>

Rest one of your palms faceup on the table and push your other index finger against your palm.

<u>What do you notice?</u>

Your palm indents with the force from your finger. And even though you are not pushing back with your palm, your finger tip also indents. It's also being acted upon!

Now, push your index finger against the tabletop. Even though your finger is exerting the force, it is also being pushed back on by the table. That might sound completely impossible because you can't see the table pushing back, but science is made up of all sorts of things that are difficult to see with our eyes!

Let's see if we can feel this invisible force. Hold out your hand with your palm faceup. Take a moment to see how your hand feels. **Place an apple (or other similar object) into a child's hand. Give each child a turn.**

<u>Do you notice that the apple is exerting a force on your hand and that your hand is pushing back against the apple?</u>

Let's try one more. Stand in front of a wall (about 1 foot away from the wall). Place your hands out in front of you and touch the wall with the palms of your hands. <u>Do you think that if you push on the wall hard enough, you could feel it push back on you?</u> Let's try it! Push on the wall until you start to feel yourself tipping backwards. **Allow the children time to push against the wall until they start to tip backwards.**

tasks are both work. Some work takes a lot more force or energy to move an object. Really big or heavy items may take more force than your body can provide.

Can you think of anything that would have made it easier to move the sofa? We could get more people to help push it; that would spread the work out so that one person doesn't have to exert as much force. Or maybe there are items you could use to help lift or push, or even a machine that would make the job much easier! **Spend a few minutes brainstorming and discussing logical and/or creative ways to move the sofa more easily. If needed, prompt the children to think of things like ropes, a ramp, a hot-air balloon, a tractor, putting it on wheels, a catapult, or even something as silly and creative as an elephant grabbing the sofa with its teeth!**

☐ Science Wall

Place the vocabulary card SIMPLE MACHINE on your science wall. Read and discuss the word and definition.

Simple Machine

☐ Introduction to Simple Machines Video

WATCH ONLINE

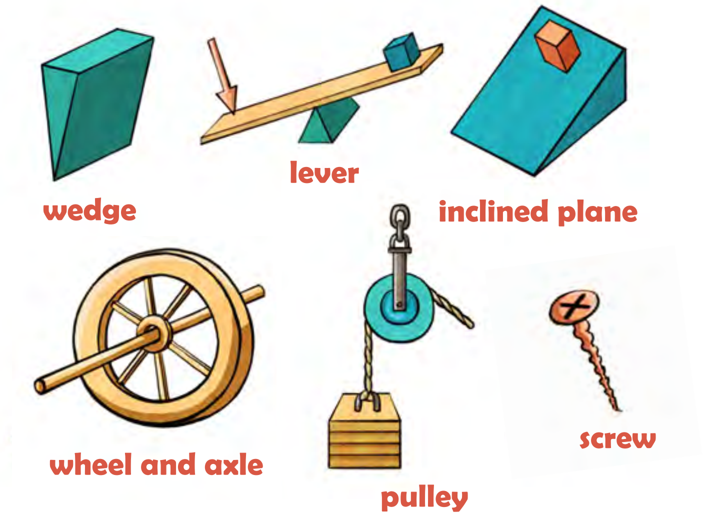
Watch the video called "Introduction to Simple Machines" at goodandbeautiful.com/sciencevideos.

☐ Machines

Read to the children: Machines include any object that we use to accomplish work or make work easier. Cars, bicycles, tractors, cranes, scissors, and shovels are just a few examples of machines that we use every day. Many of these machines are complex, meaning they are made up of several simple machines.

As we learned in the video, there are six basic machines, or simple machines, that are used to make up all other more complex machines: wedges, levers, inclined planes, wheels and axles, pulleys, and screws.

☐ Conserving Energy



Read to the children: As human beings, we don't have enough energy to accomplish all the work that is done in our world, and much of it requires more force than we can give. Simple machines help us to conserve our energy by adjusting the force we need to provide to be able to move the object. The amount of energy needed to perform the work is the same. Remember, energy cannot be created or destroyed, but it can be transferred into different forms. Simple machines can help to transfer energy or transform it into another type of energy.

☐ Three Ways Machines Make Work Easier

Read to the children: Simple machines make work easier in three ways by adjusting the force we need to provide. **Have the children take turns picking one of the "Three Ways Machines Make Work Easier" cards and reading the back of each card.**

As we take a deeper look at the six simple machines in the next few lessons, you may be surprised at how many machines we use every day! **Have the children turn to the "Simple Machines" page in Lesson 8 of their student journals and draw their favorite ideas.**

☐ Lesson 8 Extension

7–8

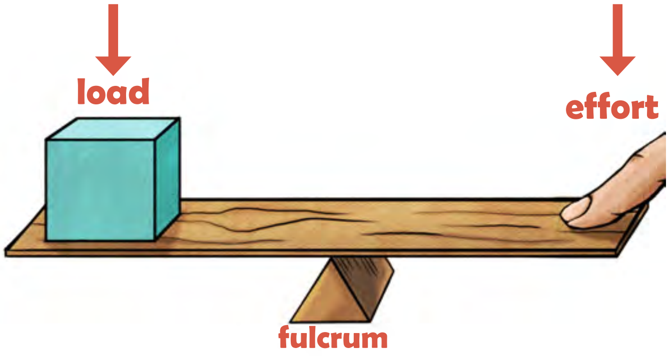
Have the children grades 7–8 complete the self-directed Lesson 8 extension titled "Early Simple Machines: The Elevator" in their student journals.

A lever reduces the amount of input force by spreading it over a larger distance. Just like a wedge, the longer the lever is, the less effort is needed to move an object.

☐ Levers

Read to the children: There are three classes, or types, of levers. A first class lever works with the effort on one side and the load on the other with the fulcrum, or pivot, in between.

Demonstrate a first class lever by placing a pencil on the table. This will work as our pivot or fulcrum.

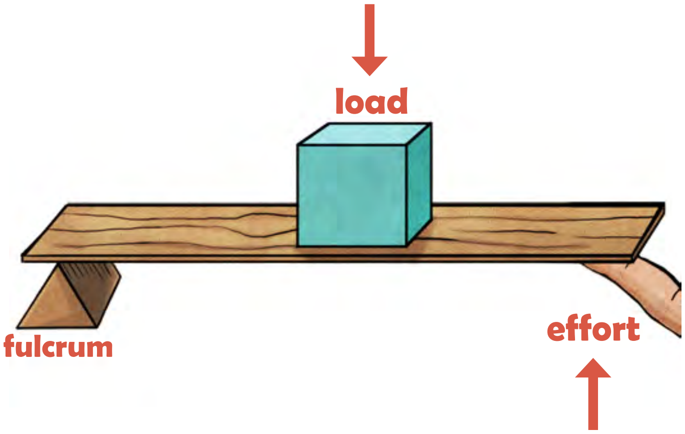


Place a ruler on top of the pencil in a perpendicular direction. This is our long bar.

Then place ten pennies on one end of the ruler as shown. The pennies are our load. When I pull down on this other end of the ruler, I am applying effort. Using a lever makes lifting the pennies much easier. The longer the bar, the more mass you can easily lift. **Allow the children to have a turn applying the effort at the end of the ruler. Then have them experiment with moving the fulcrum (the pencil) closer to or farther from the pennies.**

A second class lever works with the effort on one side, the pivot on the other side, and the load in the middle.

Place the ruler on the table with 1 inch hanging off the edge. The end of the ruler that is not hanging off the edge of the table is able to act as the pivot in this example.



Demonstrate to the children how the ruler pivots around the far end of the ruler when the other end is lifted up.

Now place the can of food 2 inches from the end of the ruler (on the side that is hanging off the table) and tape it into place on the ruler. The can of food is our load.

Lift the can by lifting up on the end of the ruler (the end that is hanging off the table). This lever helped us lift the load.

Motion and Simple Machines

LESSON 10

Inclined Planes, Wheels, and Axles

Objective

Help the children be able to identify inclined planes as well as wheels and axles, and how they are used to make work easier.

Preparation:

None

Activity Supplies:

- Access to a doorknob

Optional Activity Supplies:

- *Raw potato (per child)*
- *Knife (to cut potatoes)*
- *7–9 craft sticks (per child)*
- *Cardboard or cardstock, at least 8.5"x11" (per child)*
- *3–6 brads, at least ¾ inch (per child)*
- *1 pushpin (per child)*
- *Pointed scissors or a screwdriver (to poke holes through the cardboard)*

☐ Inclined Planes

Have the children turn to the “Wheel and Axle/Inclined Plane” page in Lesson 10 in their student journals and look at the picture of Machu Picchu at the bottom of the page as you read and discuss the following questions.

In the top right corner of this picture, you can see Machu Picchu, one of the New Seven Wonders of the World. It was built by ancient Incas in what is now modern-day Peru in about AD 1450. Why do you think the road to Machu Picchu goes back and forth, instead of just straight up the mountain? **Pause for response.**

Is there more distance that has to be traveled along the switchbacks up Machu Picchu than would be traveled if you made a road straight up the mountain? **Pause for response.** Yes, the road that switches back and forth covers more distance than would a route straight up a mountain. But going straight up the mountain would require more force. Remember, one of the ways that simple machines make work easier is by increasing the distance over which work is happening. **Remind the children of the picture from Lesson 8 on the right.** Just like it takes much more force to lift heavy boxes straight up onto a truck compared to driving them up a ramp, it takes much more force for us to walk straight up a steep mountain; by reducing the steepness and lengthening the distance over which the force is exerted, it makes the work much easier.

The road to Machu Picchu is an inclined plane. An inclined plane is any type of ramp. Ramps allow you to move forward and upward at the same time, compared to a ladder that only allows you to go straight up. Can you think of other types of inclined planes? **Discuss ideas together, making sure to identify the following: stairs, wheelchair ramps, slides, dump trucks, slanted roofs, mailbox chutes, and loading truck ramps.**

☐ History of Wheels Video

Read to the children: We live in a time in which we are surrounded by simple machines like the many inclined planes we just discussed, but simple machines

☐ Pulleys

Read to the children: A pulley makes work easier by changing the direction that the force is applied. It's much easier to pull something down or toward you than to lift it up or away from you. Imagine trying to lift a box above your head. By displacing the direction of the force and using a rope, it makes the job much easier! Multiple pulley systems make work even easier! Using multiple pulleys at one time reduces the amount of force needed to lift an object by distributing the work over multiple segments of rope (or over a longer distance).

☐ Screws and Pulleys Video

Read to the children: Screws can also be used to lift heavy objects. We are going to watch a video to find out how. We will also be introduced to another simple machine, called a pulley, that is great for lifting heavy loads as well.

Watch the video called "Screws and Pulleys" at goodandbeautiful.com/sciencevideos.

Read to the children: In the video we learned that both screws and pulleys can be used to lift heavy objects.

What are examples of objects that can be lifted by a screw? [a screw jack lifts cars, is used in airplanes, and levels and lifts foundations of buildings]

What are examples of objects that can be lifted by a pulley? [window blinds, flags, sails, construction, people on a zip line or ski lift]

☐ Types of Pulleys Match and Learn Game

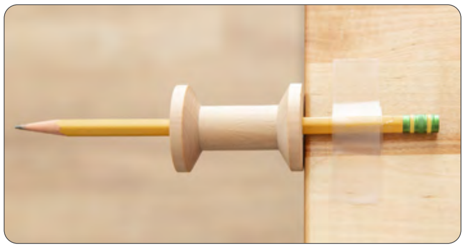
Instructions: Have the children take turns picking a "Types of Pulleys" card and reading the information on each card.

Place each of the cards on the table and have the children try to match the "Pulley Examples" cards to the "Types of Pulleys" by placing them below the appropriate cards. Be sure the children only look at the front of the "Pulley Examples" cards. After they have placed them, have the children take turns flipping each card over and reading the card to see if it was placed in the correct spot.

☐ Build a Pulley

Have the children complete the following steps to create a fixed pulley.

Fixed Pulley:

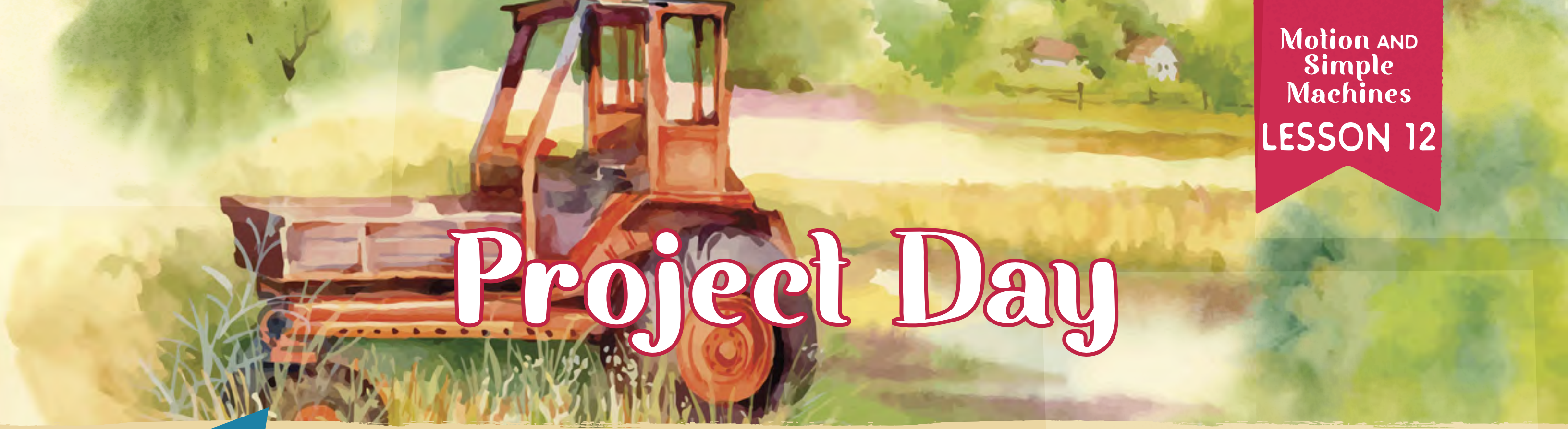


1. **Place the pencil or skewer through the spool.**
2. **Tape one end of the pencil to a table or desk so that the spool hangs off the edge of the table.**

3. **Take your paper cup and poke two holes on either side of the top of the cup. String a 6-inch piece of string through the two holes of the cup and tie both ends to the cup so that it looks like a bucket handle.**

4. **Slide a paper clip through the string, and then tie the 6-foot string to the other end of the paper clip.**
5. **Place the cup on the ground underneath the pencil and spool and fill it with a load of items, such as snacks, cereal, small toys, marbles, etc.**
6. **Take the loose end of the string and lay it over the top of the spool.**

Project Day



Objective

Help the children review simple machines and understand and define complex machines.

Preparation:

None

Activity Supplies:

- A variety of supplies for the children to build with, such as straws, cups, string, tape, craft sticks, pencils, toilet paper rolls, rubber bands, bobbins, washers, toothpicks, spools, screws, LEGO® building blocks, etc.
- A device that can record video (optional)

☐ Artwork

Read to the children: Over the past few lessons, you have learned all six simple machines. **Have the children turn to the painting "The Village Peddler" by Fritz Beinke in Lesson 12 of their student journals and observe the painting. Have them see how many examples of simple machines they can find in the picture.**

☐ Science Wall

Read to the children: We have learned that simple machines surround us and that we use them every day, but we also use many other machines that are made up of more than one simple machine. These machines are called complex machines.

Place the vocabulary card COMPLEX MACHINE on your science wall. Read and discuss the word and definition.

Complex Machine

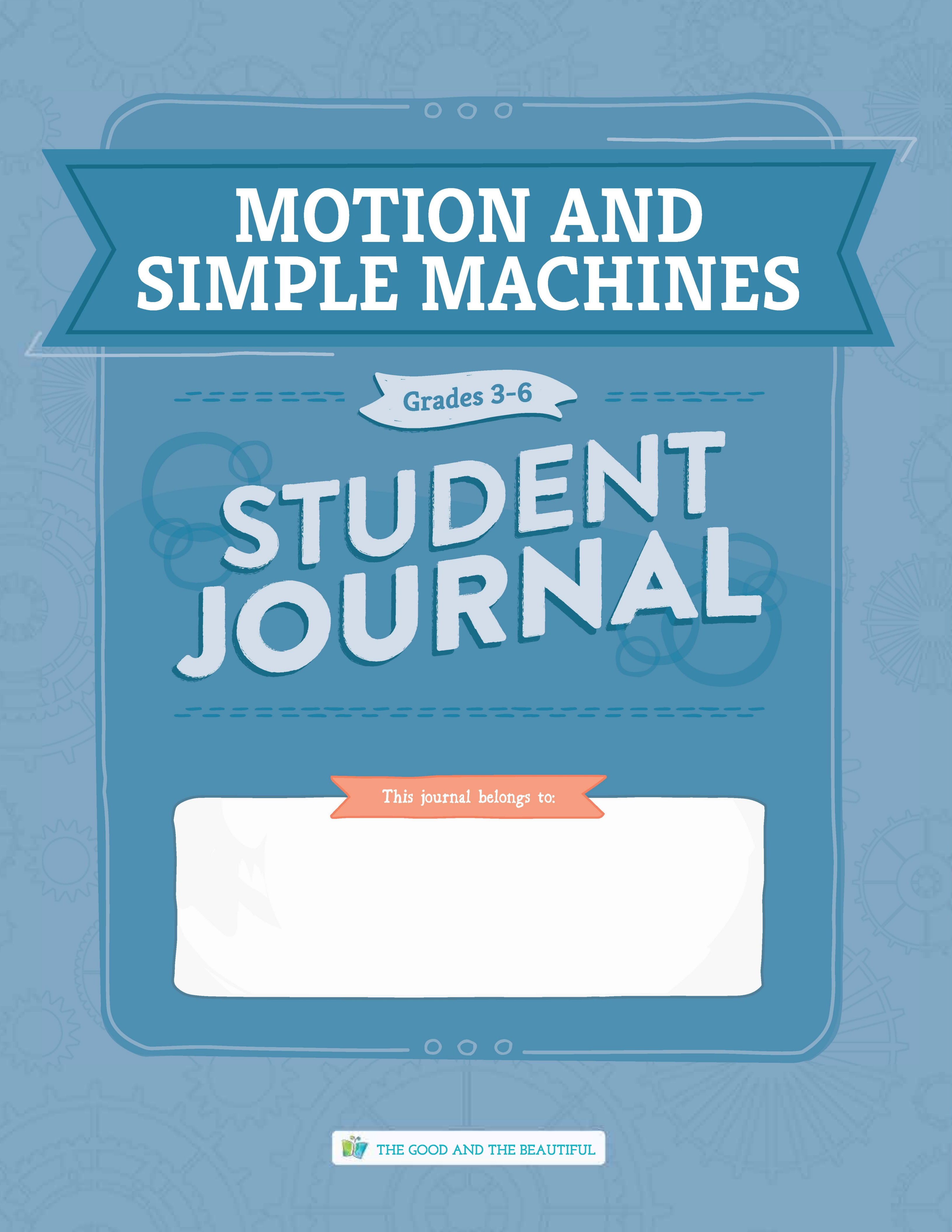
☐ Complex Machines

Read to the children: Lawn mowers, bicycles, escalators, and cranes are all examples of complex machines. What other examples of complex machines can you think of? **Have the children turn to the "Complex Machines" page in Lesson 12 of their student journals and follow the directions.**

☐ Create a Machine Project

Give the children access to a variety of supplies that they may use to design and build their own machines using one or more of the following options. (NOTE: There is a page available in their student journals to sketch ideas first if desired.)

1. Demonstrate and explain what you have learned about simple machines. **[Examples include but are not limited to the following: the child may find an item that can be used as a wedge and demonstrate how it can help to pull apart another object; find an item that can be used as a lever and demonstrate how it can help you lift something; use a wheel or rolling pin to flatten play dough; create a LEGO® car and demonstrate**



MOTION AND SIMPLE MACHINES

Grades 3-6

STUDENT JOURNAL

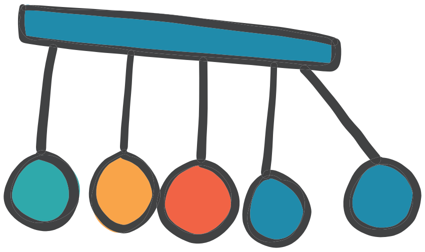
This journal belongs to:

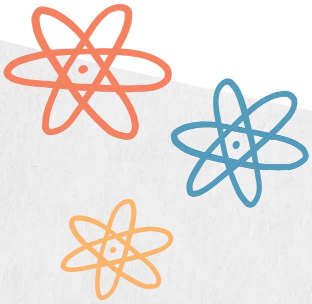
THE GOOD AND THE BEAUTIFUL

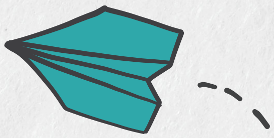
INSTRUCTIONS

This student journal accompanies *The Good and the Beautiful Motion and Simple Machines* science unit. It contains all the worksheets and journal pages that are needed to complete the unit. Each student will need his or her own copy of the science journal.

Have each student take his or her time to create high-quality work as the activities and worksheets are completed. Students may enjoy looking back on their past discoveries when they've finished.







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Newton's First Law

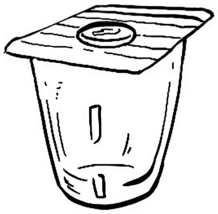
An object in motion stays in ____________ ; an ____________ at rest stays at ____________ until ____________ upon by a ____________.

Word Bank

- rest
- acted
- force
- motion
- object

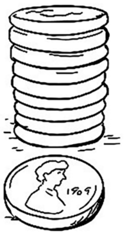
ACTIVITY #1

Write or draw what happened when the card was flicked:



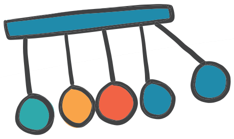
ACTIVITY #2

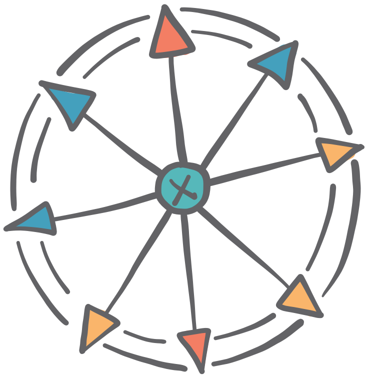
Write or draw what happened when the penny was flicked:



Lesson
3

Speed & Velocity



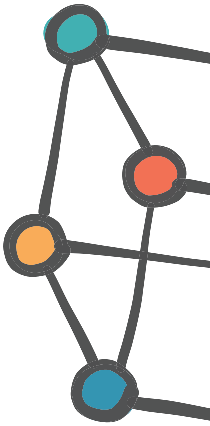


How long does it take a ball to roll 4 feet?

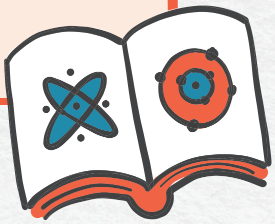
Time: ______________

DEFINITION MATCH:

Match the term to the correct definition.

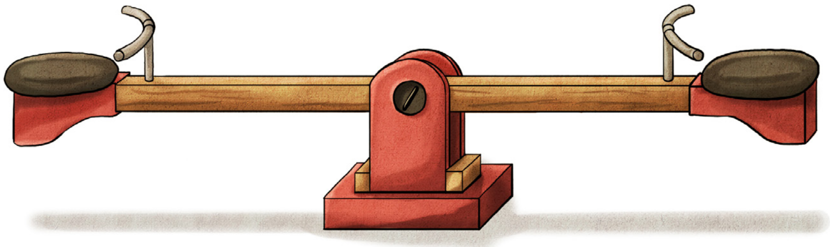


Distance:	the rate at which an object travels in a certain amount of time
Speed:	the speed and direction of an object
Instantaneous Speed:	any change in direction and/or speed, either faster or slower
Velocity:	the speed of an object at a specific instant in time
Acceleration:	how much ground has been covered during the movement of an object



Newton's Second Law

☐ = ☐ × ☐



Directions: Cut out the words at the bottom of the page. Place and then glue them in the correct order to create the definition for Newton's Second Law.

______ ______ ______ ______,

______ ______ ______ ______

______ ______ ______ ______.

Word Bank Cutouts

- the greater
- to
- an object
- of
- will
- the mass
- it
- force
- the greater
- the object
- need
- accelerate

I SPY: WEDGES AND LEVERS

Circle all the wedges in red and all the levers in blue.
NOTE: Four items can be circled for both types of simple machine.



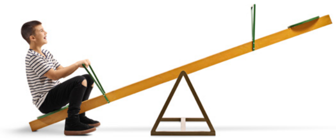










Draw or list the simple levers you see around you.

MOTION AND SIMPLE MACHINES

Grades 7-8

STUDENT JOURNAL

This journal belongs to:

THE GOOD AND THE BEAUTIFUL

INSTRUCTIONS

This student journal accompanies *The Good and the Beautiful Motion and Simple Machines* science unit. It contains all the worksheets and journal pages that are needed to complete the unit. Each student will need his or her own copy of the science journal.

The Motion and Simple Machines lesson extensions are also found here. These extensions are optional for older students (grades 7–8) to complete on their own. Each extension is accompanied by lined paper so the student can keep his or her work in one place.

Have each student take his or her time to create high-quality work as the activities and worksheets are completed. Students may enjoy looking back on their past discoveries when they've finished.

TABLE OF CONTENTS

Isaac Newton

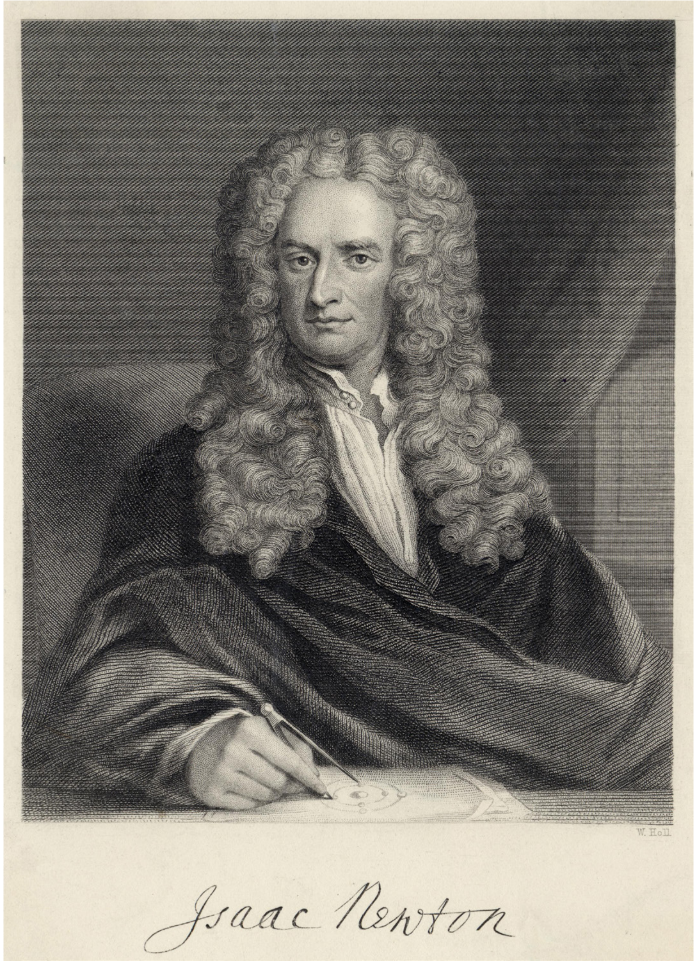
Directions: Read the quotes by Isaac Newton on the "Isaac Newton Quotes" page. Pick your favorite one and copy it in the space provided below.

Three inspiring things about Isaac Newton:

1

2

3



Isaac Newton Quotes

"If I have seen further it is because I have stood on the shoulders of giants."

"I believe the more I study science, the more I believe in God."

"Genius is patience."

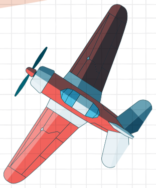
"He who thinks half-heartedly will not believe in God; but he who really thinks has to believe in God."

"It is the perfection of God's works that they are all done with the greatest simplicity. He is the God of order and not of confusion."

EXTENSION

Instructions:

1. Read the information below.
2. Define and describe the difference between scalar and vector quantities in your science journal.
3. Look at the images of different vector and scalar quantities and match each one to the correct description.



Vector and Scalar Quantities

Measuring is an important part of a scientist's job. When physicists measure motion and the movement of objects, there are several factors that they must consider. Physicists measure the movement of objects as either a ***scalar quantity*** or a ***vector quantity***.

Scalar Quantities

Scalar quantities consist of measurements that only include a numerical size (numbers that measure length, size, or an amount of something). Scientists call these types of measurements ***magnitude***. So anything that can be measured with numbers has a magnitude. Examples of scalar quantities include measurements of mass, volume, distance, time, speed, temperature, energy, etc. All these things can be measured with numbers. For example, when a pilot measures the time it takes to travel from one destination to another, he or she records that measurement as a magnitude because it is a number.

Vector Quantities

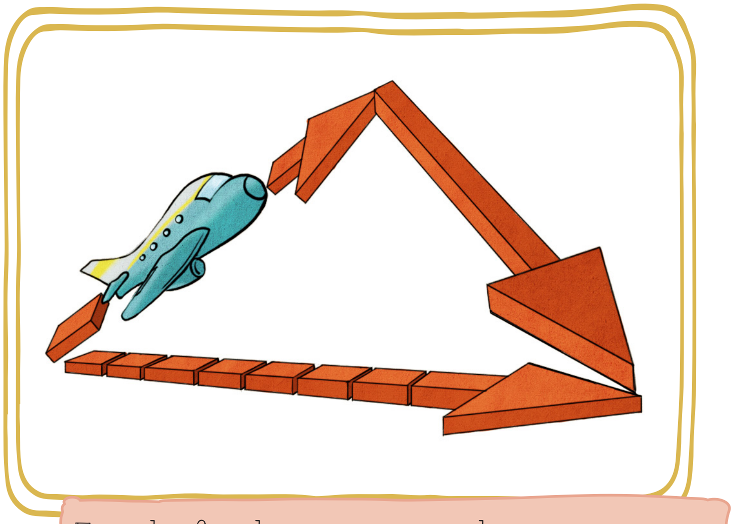
Vector quantities have both magnitude and direction. Velocity is a vector quantity because it measures both speed and direction. For pilots to be able to reach their destination, they are going to need to know more than just how long to fly the plane. They will also need to know which direction to go and how fast to accelerate at different stages of the trip so that they can fly the plane safely and effectively to the correct destination.

Velocity is not the only type of vector quantity. Other things that can be measured as vectors are force, momentum, acceleration, magnetic fields, currents, etc.

Vectors are also used to measure ***displacement***. Displacement is when something is moved from one place to another. If you are standing in line at the grocery store, and someone offers for you to move ahead of them in line, then as you move forward one spot, you are experiencing displacement. You can measure this as a number (one spot, or the actual distance may also be measured), and you can measure this as a direction (forward, or toward the cashier). The important thing about displacement is that it is about the difference between the starting and ending spots, not about the total distance traveled. For example, if you were to run exactly one lap on a circular track, then there would be no displacement because you started and ended in the same place.

For you to have displacement, you would have to arrive somewhere different from where you started.

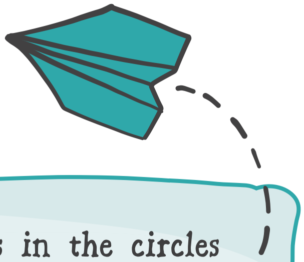
Vectors are often represented on graphs as lines with pointed arrows to show the direction of the object. Many times there are multiple vectors that need to be considered. Let's say a pilot is navigating through strong headwinds. The pilot needs to understand how velocity vectors work in order to adjust the speed of the aircraft to stay on course. Ground speed (the speed relative to the ground) and airspeed (the true speed at which the plane is traveling in its own power with respect to the air) may vary depending on the wind's effect on the plane. The pilot can adjust the velocity (speed and angle/direction) of the plane accordingly in order to stay on course.



Example of an alternate course a pilot may take during strong headwinds to stay on course

Conversely, if an airplane is experiencing tailwinds (wind coming from behind), those winds will push on the plane in a forward direction with more force, causing the plane's velocity to increase. These vectors can be added together on a graph to show the outcome of external (outside) forces on an object. In these scenarios the shape created on a graph often looks like a triangle.

You can see that understanding vectors is crucial for pilots, but transportation is not the only place vectors are used. Astronauts, doctors, meteorologists, engineers, sea captains, and scientists of all kinds use scalar and vector quantities.



Look at the various examples of vector and scalar quantities in the circles below. Cross out the scalar quantities. In the circles that describe vector quantities, circle the magnitude and underline the direction in each example. Remember, a vector has to have both! Then match the vector quantities to the box that best represents each description.

Wind speeds of 20 knots blowing NW

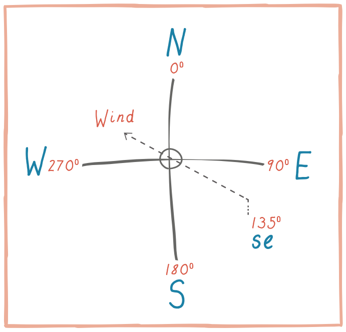
A car going 70 miles per hour

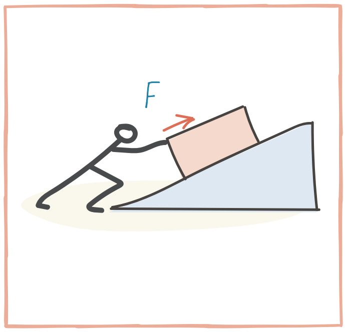
A football is thrown and caught (displaced) 10 yards down the field

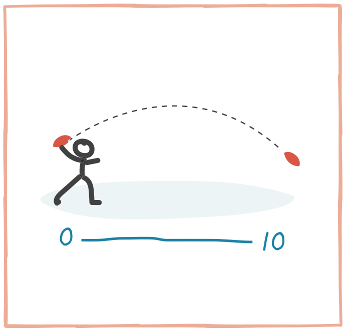
An apple falling from a tree at the acceleration of 9.8 (m/s²)

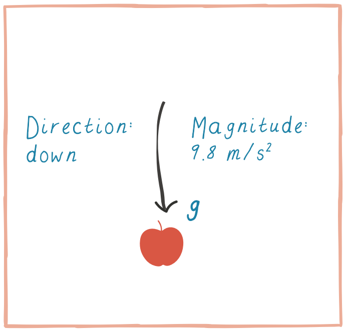
Pushing a box with a force of 40 Newtons to the right

Waking up at 7:15

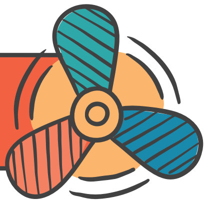








Gravity



DROPPING DIFFERENT BALLS EXPERIMENT

My hypothesis:

The outcome:

Gravity is a __________ of attraction between ________ masses.

Lesson 6 | Grades 7-8

EXTENSION

Instructions:

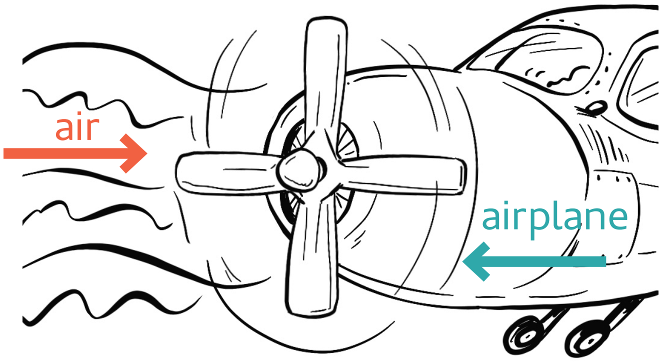
1. Read the information below.
2. In your science journal, draw a diagram of how each of the following works: an airplane, a rocket, and a jet. Be sure to include Newton's Third Law of Motion.

Airplanes, Rockets, and Jets, Oh My!

Newton's Third Law is what makes it possible to fly airplanes and launch rockets. Remember that Newton's Third Law states that when an object pushes toward another object, the object being acted upon pushes back with equal force. We are going to see how this applies to flight!

Airplanes

Think of an airplane propeller on the front of a plane. Propellers are designed with a curved shape that pushes air back *toward* the body of the plane when they spin. At first, you might think it would be counterproductive to cause air to push back on a plane that you want to move forward. But according to Newton's Third Law, what will happen if air is pushed toward the body of the plane?

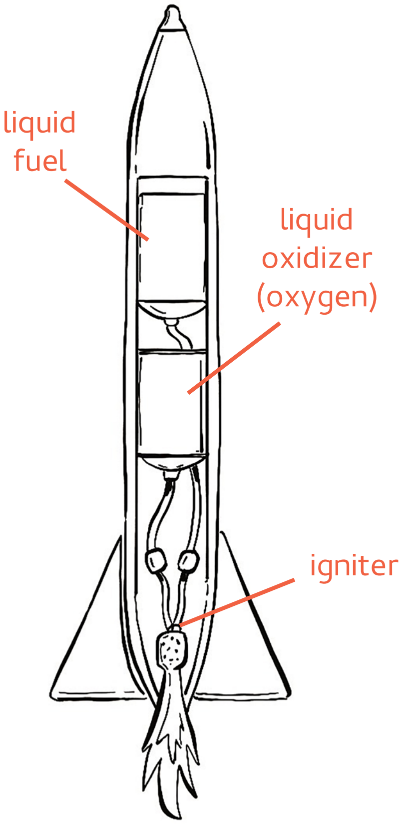


The air behind the propeller will push back! So it actually pushes the plane forward.

This works wonderfully for planes flying within our atmosphere, but the farther you get from Earth's surface, the fewer air molecules there are. By the time you get to space, there are no air molecules at all. So that's why if you want to get to space, you can't do it in an airplane.

Rockets

Rockets are designed completely differently from airplanes, although they still use Newton's Third Law to reach great heights. Since rockets cannot rely on outside forces to help propel them, they carry propellants within the rocket. Propellants are a blend of fuels that explode when mixed with oxygen and ignited. This explosion creates gases that exit through the bottom of the rocket. This allows Newton's Third Law to propel the rocket forward as the gases push out the back.



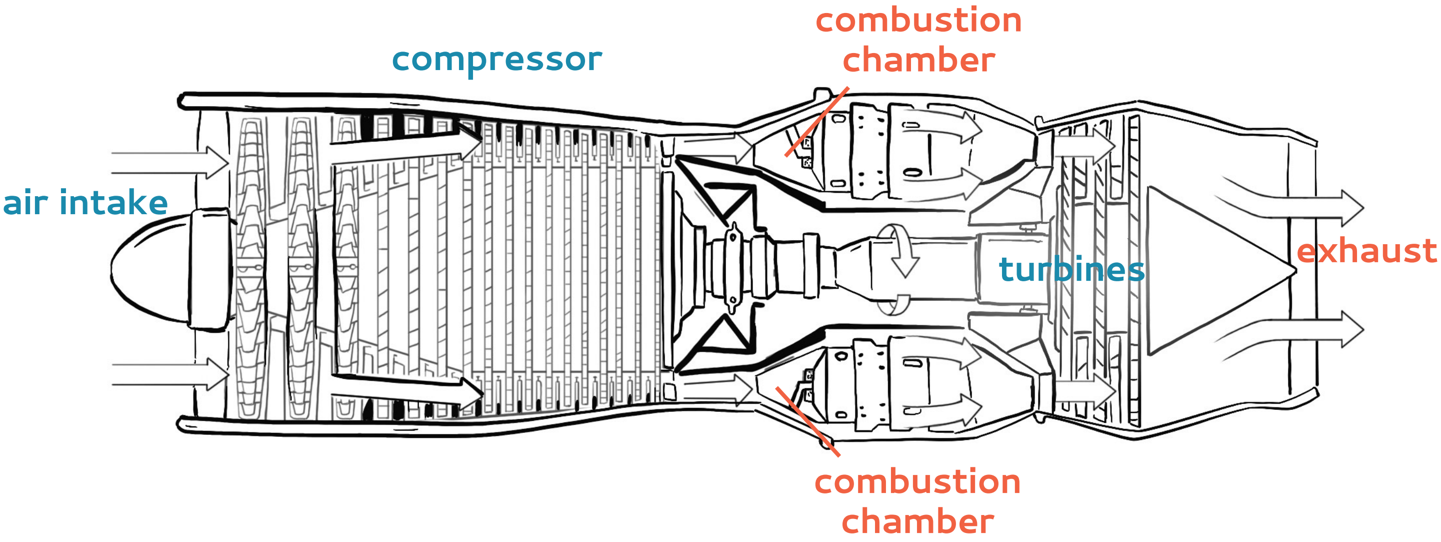
Jets

Now, jets are built differently from both propeller planes and rockets. Scientists take a piece of both designs and are able to create airplanes that can fly at very fast speeds.

Jets have fans located near the back of the plane or along the wings that pull air into the plane engine, just like a propeller does. This does provide some thrust, but the rest of the air goes through a compressor which squeezes the air, giving it a higher pressure. This compressed air is then pushed into the ***combustion*** chamber**.** Combustion is the process of burning something. This chamber is where the fuel is stored, and when the compressed air mixes with the fuel, it ignites the fuel, which explodes the same way a rocket engine does (but at a smaller scale). Jets also have a second set of fans installed at the back of the plane called turbines. When the explosive air passes through these fans, the fans are able to use the power they create by spinning to send power back up to the compressor to keep it running.

Now and Then

Isn't it incredible that Newton was able to develop these laws of motion hundreds of years ago by observing how things around him worked? And now we are able to use these laws to create machines that can transport us across the world in hours and send astronauts into space! You never know what kind of influence you will have for generations to come.



"Native American Bow Hunting"
by Hamilton Irving Marlatt (1867-1929), 1915

EXTENSION

Instructions:

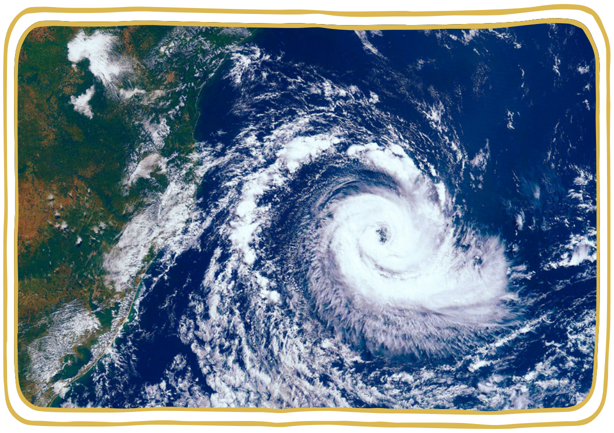
1. Read the information below.
2. Complete the experiment listed on the next page. Then record your observations in the space provided.

Coriolis Effect

Do you remember Newton's First Law? An object at rest will stay at rest, or an object in motion will stay in motion as it moves in a straight path until it is acted upon by another force. While this is true, there are situations that affect the appearance of this straight path.

Coriolis Effect

The ***Coriolis effect*** is a phenomenon of rotating spheres, like Earth, where objects above the sphere are displaced by the rotation of the sphere. In other words, since the sphere is rotating, even an object moving straight will not arrive at a point straight ahead because the rotating sphere beneath it moved!



Motion is the change in location of an object, and it is relative, meaning it is understood and measured from a frame of reference or point of view. In our case the reference point we observe from is on Earth. What we perceive can appear differently depending on exactly where we are on Earth.

The earth is slowly rotating, or spinning, on an invisible axis in an eastward motion, but that motion looks different depending on the hemisphere you are in. If you were looking at Earth from the North Pole, the rotation would appear counterclockwise. If you were looking at Earth's rotation from the South Pole, the rotation would appear clockwise. An object moving straight ahead freely for a long distance will curve right in the Northern Hemisphere and curve left in the Southern Hemisphere. This is due to the Coriolis effect.

Hurricanes

Let's think for a moment about a hurricane. The Coriolis effect plays an important role in the formation of hurricanes. Air moves toward areas of low pressure in all directions. As large masses of air move straight toward an area of low pressure, the earth beneath it still continues to spin, so the air curves right or left depending on the hemisphere it is in. This curving motion creates a cyclone, and if the air speeds become fast enough, a hurricane is formed.

Although the Coriolis effect isn't noticeable in movements over small distances, like throwing a paper airplane across your yard, it does show up in the movements of objects over more significant distances or at high speeds. Airplanes, rockets, and large masses of air are all examples of objects in motion that can be affected by the Coriolis effect.

Other Planets

Earth is not the only place the Coriolis effect takes place. It happens wherever there is spinning motion, so all planets experience this phenomenon. The other planets actually spin much more quickly than Earth does, so the Coriolis effect is more noticeable on these celestial bodies. Jupiter has the fastest rotation of all the planets in our solar system. It completes a full rotation in just under 10 hours. This rapid motion changes the direction of the winds that are blowing faster than 380 miles per hour (611.551 kilometers per hour). This type of movement creates storms so big that we can see them from space. Jupiter's Great Red Spot is the largest and most famous storm. Now, whenever you see an image of Jupiter or think about the weather or an approaching storm, you will know that it is all influenced by the Coriolis effect.

CORIOLIS EFFECT EXPERIMENT

Step 1: Cut a piece of paper into the shape of a circle and set it in front of you on the table.

Step 2: Place a ruler across the center of the paper and tape both ends of the ruler to the table.

Step 3: Place one hand on the paper circle and begin to spin it counterclockwise. As you do so, take a pencil and draw a line with your pencil up against the ruler. What do you think will happen? Write your hypothesis in the space provided at the bottom of the page.

Step 4: This exercise shows how the Coriolis effect affects the Northern Hemisphere. Under the heading "What Happened?" explain how even though you were moving your pencil forward in a straight line, it looked like it was curving because the paper was spinning.

Step 5: Repeat the activity, turning the piece of paper clockwise. Again, record what happened and take note that this relates to the Coriolis effect in the Southern Hemisphere.

Step 6: Repeat this activity on another sheet of paper. This time turn the paper more quickly.

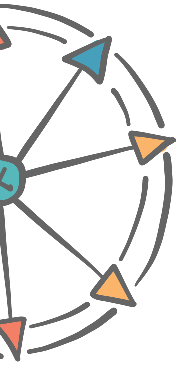
You can see that the faster you spin the paper, the more curvy your line is!

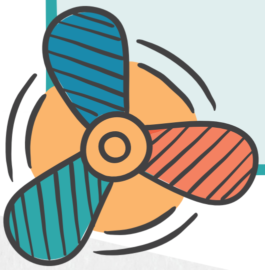
Hypothesis:

What happened?

SIMPLE MACHINES

Draw a way to make it easier to move a sofa with simple machines.





EXTENSION

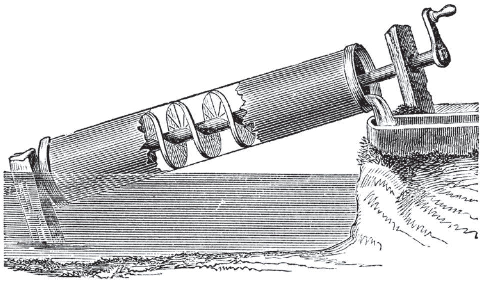
Instructions:

1. Read the information below.
2. Draw and label the three main components of an Archimedes screw in your science journal.
3. With permission from your parent or teacher, research a current use of the Archimedes screw. Write a 5—8-sentence paragraph in your science journal describing how it is used.

The Archimedes Screw

Screws are most commonly used to hold things together. We have also learned that they can be used to lift heavy objects, but do you think a screw could lift or push water? Well, a brilliant inventor and mathematician born in Sicily in 287 BC thought so. We know that moving water, especially from a lower elevation to a higher one, presents a difficult dilemma. Archimedes developed a screw of mammoth proportions to move water from a lower elevation to a higher one; it is known as the Archimedes screw.

Archimedes' screw is made up of three main components: a screw, a hollow pipe, and a crank. The screw fits inside the hollow pipe, which is set at an angle in the water. The screw is turned by the crank, and then water is pulled from the bottom of the screw sitting in the water to the top end. Therefore, the screw effectively lifts the water to a new location above the water source. The crank can be turned by hand, windmill, livestock, or (in modern times) a motor.



Ancient Uses of the Archimedes Screw

In ancient times the screw was primarily used to irrigate fields and pump water. Instead of electric power, the pump was powered by oxen or people. Used in the Nile River for centuries, the Archimedes screw allowed farmers to efficiently irrigate their crops.

Historians believe the Archimedes screw also could have been used to irrigate the Hanging Gardens of Babylon, which is one of the Seven Wonders of the Ancient World.

Modern Uses of the Archimedes Screw

In 2001 this versatile invention was used to stabilize the Leaning Tower of Pisa. In this case the screw was not used to move water but to lift soil. By removing small amounts of soil saturated by groundwater, the weight of the tower corrected the lean.

At the famous Windsor Castle in England, an Archimedes screw functions as a generator providing power to the castle.

SeaWorld Adventure Park in San Diego, California, employs two Archimedes screws to lift water for the Shipwreck Rapids ride.

In a partnership between the US Department of Energy and the Utah Water Research Lab at Utah State University, new energy-saving methods are being discovered for water-powered screws used to produce electric power.

A machine called the Hemopump has been developed to assist heart surgeons. This machine uses a tiny Archimedes screw, the diameter of a pencil eraser, to keep blood pumping during heart surgery.

Archimedes never knew that his invention to haul water would be used in so many incredible ways. Maybe something you do will one day affect many people in ways you will never know!

COMPLEX MACHINES

Write down examples of complex machines. Pick one to draw in the orange box, and then label the simple machines it is made with.