

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

Table of Contents

Unit Information	iii
Read-Aloud Book Pack.	iv
Grades 7–8 Lesson Extensions	v
Supplies Needed	vi
Vocabulary	ix
Lesson 1: Force and Motion.	1
Lesson 2: Newton’s First Law	3
Lesson 3: Speed and Velocity	7
Lesson 4: Newton’s Second Law	11
Lesson 5: Gravity	15
Lesson 6: Newton’s Third Law	17
Lesson 7: Energy and Motion	19
Lesson 8: Simple Machines	22
Lesson 9: Wedges and Levers	29
Lesson 10: Inclined Planes, Wheels, and Axles	33
Lesson 11: Pulleys and Screws	36
Lesson 12: Project Day.	45



© 2022 The Good and the Beautiful, LLC | goodandbeautiful.com

All rights reserved. This digital publication is licensed for individual use only. It may be printed or copied for personal, noncommercial use by the original purchaser and their immediate household. This file may not be posted online, uploaded to file-sharing platforms, emailed, distributed electronically, or resold in printed or digital form without prior written permission of the copyright owner. Any unauthorized duplication, distribution, or commercial exploitation of this work is strictly prohibited and may result in legal action.

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. **Adult supervision is recommended for all activities and experiments as some require sharp objects, heat sources, or small objects that could be a choking hazard for young children.**

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 Homeschool 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.

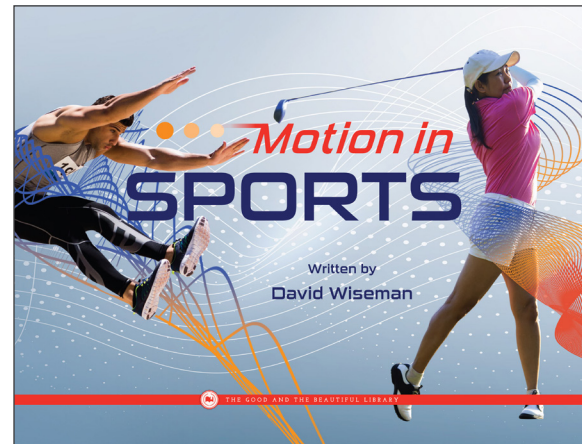


Read-Aloud Book Pack

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.



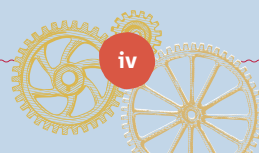
The Story of Invention
by David Wiseman



Motion in Sports
by David Wiseman

CORRELATED BOOKS

The Good and the Beautiful Bookshop 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 level that are related to the subjects they are learning. The bookshop includes both fiction and nonfiction books organized according to reading level. Find the correlated books by going to goodandbeautiful.com/science and clicking on the *Motion and Simple Machines* unit product page.



GRADES 7–8

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.

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.

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

Archimedes
by Jeanne Bendick

► CORIOLIS EFFECT EXPERIMENT

- | | |
|--------|---|
| Step 1 | <p>Cut a piece of paper on the shape of a circle and cut it in <i>four</i> of <i>you</i> on the table.</p> |
| Step 2 | <p>Place a ruler across the center of the paper on <i>top</i> both ends of the ruler in the table.</p> |
| Step 3 | <p>Place one hand on the paper circle and begin to <i>spin</i> and <i>draw</i> a line with <i>your pencil</i> up against the ruler.</p> |
| Step 4 | <p>This exercise shows how the Coriolis effect affects the Northern Hemisphere. Under the heading "If this happens?" explain how <i>strong</i> you were moving your pencil. <i>Force</i> in strength line. Is landline while it was curving because the paper was spinning.</p> |
| Step 5 | <p>Repeat the exercise, turning the paper of paper circle. Again, record what the pencil and landline that the relation to the Coriolis effect in the Southern Hemisphere.</p> |
| Step 6 | <p>Repeat this activity on another sheet of paper to see how the other side would work.</p> |

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

What happened?

The line curved. Then when I turned the paper faster, the line got even more curved. The paper spinning makes it look like the line isn't straight.

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, such as cement, grass, roadway, or sand tray)
- 8"x10" piece of felt (or other similar surface, such as 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), such as a marble, golf ball, basketball, soccer ball, tennis ball, baseball, etc.
- Pencil (optional)
- Piece of string about 15 cm (6 in) 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 (2–3 m or 7–10 ft 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)

o o o

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
- 142-g (5-oz) can of food (such as 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 2 cm ($\frac{3}{4}$ in) (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 plastic disposable cup
- 15-cm (6-in) string
- 2-m (7-ft) 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.

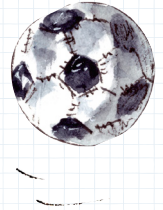


Force

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

Motion

the change in position of an object



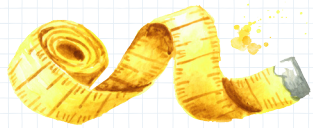
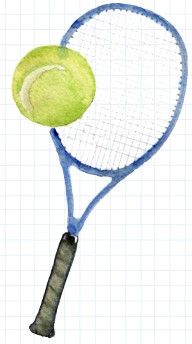
Newton's First Law

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



Friction

the resistance to motion when two objects rub against one another



Distance

how much ground has been covered during the movement of an object

Speed

the rate at which an object travels in a certain amount of time
(speed = distance ÷ time)



Instantaneous Speed

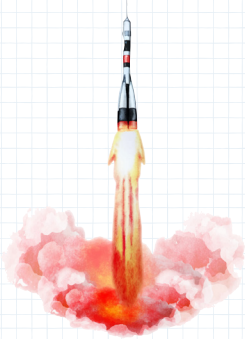
the speed of an object at a specific instant in time





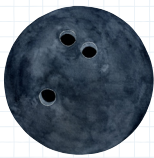
Velocity

the speed and direction of an object



Acceleration

any change in direction and/or speed, either faster or slower



Mass



the measurement of how much matter is in an object; objects with greater mass feel heavier, and objects with less mass feel lighter, regardless of size

Newton's Second Law



the greater the mass of an object, the greater force needed to accelerate the object
(force = mass x acceleration)



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. What does it feel like? How would you teach someone else to use a swing? **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.

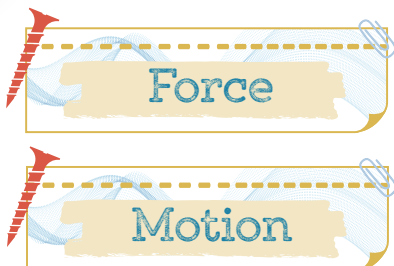
We live in a universe that is constantly in ***motion***, and ***force*** is what puts all things into motion. In this unit we are going to learn about force and motion, how they work, and what influences them.



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
- Marbles (or other ball)
- Masking tape
- Timer
- Calculator
- Compass (optional)

☐ Speed and Acceleration Video



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]

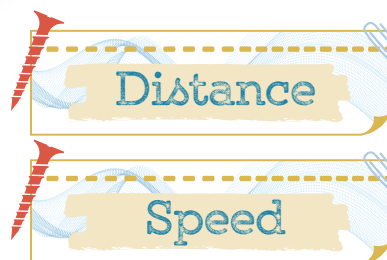
Have a child find and read Card #4 (or read it to him or her). Then have the children find the matching illustration for Card #4. Then ask: Who has a quicker speed now? [the tortoise]

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



If applicable, have the older children turn to the “Speed & Velocity”



page in Lesson 3 of their student journals and write down the equation for “Speed.” (Have them wait until directed to fill out the rest of the page.) Read to the children: Let’s say that the tortoise and the hare ran 10 miles, and it took the tortoise 5 hours to cross the finish line. Since the hare was just a couple of seconds behind him, (for calculation’s sake) we will also round his time to 5 hours. Let’s calculate their speeds using the equation $distance \div time = speed$. On a whiteboard or piece of paper, write “10 miles $\div$ 5 hours = 2 miles per hour.” Their average speeds were the same, even though at times the hare was faster, and at times he wasn’t moving at all.

Science Wall

Read to the children: Knowing how fast something is moving at an exact moment is important. It’s important when driving in a car so that you don’t exceed the speed limit. When you ride in a car, the speedometer tells the speed of your car. This is called *instantaneous speed*.



Place the vocabulary cards **INSTANTANEOUS SPEED**, **VELOCITY**, and **ACCELERATION** on your science wall. Read and discuss the words and definitions.



Velocity



Read to the children: We are going to observe *velocity* and *acceleration* as we roll a marble or ball. Velocity tells us how fast something is going AND in what direction. Let’s first determine which direction our ball is going to roll. **Help the children choose where to roll the ball.** If you have



a compass, you can use it to determine the cardinal direction, or you can label the direction according to what it’s moving toward (like the door or the

chair). Then help the children complete the following:

1. Place a piece of masking tape on the ground. Measure 122 cm (4 ft) toward the determined direction and place down a second piece of masking tape.
2. Start rolling the ball before the first piece of tape and start the timer as soon as it crosses the line.
3. Stop the timer when it crosses the second piece of tape and have the children record it on the line labeled “TIME” in their student journals.

Have older children use this number to calculate the speed by dividing the time by the distance (122 cm or 4 ft). Have them write this number and label it with the direction the ball was moving (e.g., 1 foot per second toward the door) on the line labeled “VELOCITY.”



Acceleration



Read to the children: Let’s accelerate the ball by increasing its speed. **Allow the children to blow on the ball or give it an additional push.** Remember, velocity is the speed and direction of an object, and acceleration happens anytime we change the velocity. We often think of acceleration as only speeding up, but if the velocity (speed or direction) changes in *any way*, even slowing down, then it’s still accelerating.

This time, accelerate the ball by slowing it down. **Allow the children to slow the ball by pushing or blowing from the front.** Let’s accelerate the ball by making it change direction. **Allow the children to experiment with knocking the ball in a different direction.**

Student Journals



Have the children complete the “Definition Match” in their student journals.

Lesson 3 Extension



Have the children grades 7–8 complete the self-directed Lesson 3 extension titled “Vector and Scalar Quantities” in 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), such as a marble, golf ball, basketball, soccer ball, tennis ball, baseball, etc.
- Pencil (optional)
- Piece of string about 15 cm (6 in) 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 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 toy car down ramps at different heights and time the car to see if the height affects the acceleration.

Setup: 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.) 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 three) and repeat. Then repeat one more time with a stack of six books.



LESSON 5

Do you remember our equation for force? [$F = ma$]
Force equals mass times acceleration. Was the mass of the car the same for each run? [yes]

Was the acceleration the same for each run? [no] Did you change the amount of force you exerted on the car when you released it? [no]

According to our equation, the force has to be greater for the runs that had greater acceleration in order to balance our equation. What else do you think could be increasing the force? There is an important force called **gravity** that we are going to learn about today. The force of gravity that pulls the car down the ramp increases when our ramps are set to greater heights.

Science Wall



Place the vocabulary card **GRAVITY** on your science wall. Read and discuss the word and definition.



Gravity Video



Watch the video called “Gravity” at goodandbeautiful.com/sciencevideos.

Paper Clip Gravity (Optional)



Have the children take a pencil and tie a string around it, and then tie a paper clip to the other end. Have them hold the pencil up and experiment with twisting and turning it different ways. Point out that no matter what the pencil does, the paper clip always hangs (or falls) down.

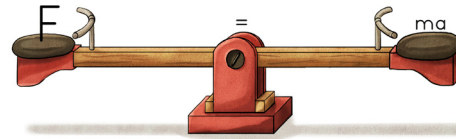
Gravity with Greater Mass Activity



Read to the children: We are going to drop two balls with differing masses and watch how gravity interacts with them. **Have the children get out the two balls of differing mass, such as a marble and a basketball. Have the child hold one ball in each hand. The child can stand on a chair and/or lift his or her hands above his**

or her head to provide more height. Have the child simply let go of the balls at the same time so that they drop toward the ground. Allow each child to take a turn.

What happened? [The balls landed at (or nearly at) the same time.] This may seem surprising, so let's think back to our teeter-totter to figure out why this happened.



We saw that each ball had an equal amount of acceleration. That means the “a” in each equation will be the same. We can also identify the mass for each object as being heavier or lighter. If the mass was greater for the heavier ball, what else has to increase in order for the teeter-totter to stay in balance? [force]

Gravity produces the same exact acceleration for all falling objects. (The rate at which an object accelerates because of the force of gravity is 9.8 meters per second squared.) In the last lesson, we discovered that heavier objects require more force to move them. So if a heavier object falls as fast as a lighter object, gravity must exert a greater force to pull down heavier (greater mass) objects.

Gravity Facts



Have the children complete the “Gravity” pages in their student journals by writing down the outcome of the activity, filling in the definition, and drawing or writing 2–3 facts about gravity from the lesson and/or video in the “Other notes” section.

Lesson 5 Extension



Have the children grades 7–8 complete the self-directed Lesson 5 extension titled “Tides and Gravity” in their student journals.



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 (2–3 m or 7–10 ft long)

□ Reactive Forces



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

Do you notice that both fingertips flatten with the force from the other finger?

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

What do you notice?

Your palm indents with the force from your finger. And even though you are not pushing back with your palm, your fingertip 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 face up. 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.**



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

Let's try one more. Stand in front of a wall (about 30 cm [1 ft] away from the wall). Place your hands out in front of you and touch the wall with the palms of your hands. Do you think that if you push on the wall hard enough, you could feel it push back on you? Let's try it! Push on the wall until you start to feel yourself tipping backward. **Allow the children time to push against the wall until they start to tip backward.**

What happened? What did you feel or notice? The greater the force you applied to the wall by pushing on



it, the more the wall pushed back on you. Even though you couldn't see it, you could feel that the wall pushed back with a force equal to the amount of force you provided. That is exactly what **Newton's Third Law** is all about!

Science Wall



Place the vocabulary card **NEWTON'S THIRD LAW** on your science wall. Read and discuss the word and definition.



Have the children turn to the “Newton's Third Law” page in Lesson 6 of their student journals and follow the instructions on that page to find the hidden message. (Have them wait until directed to fill out the rest of the page.)

Newton's Third Law in Action

Read to the children: Newton's Third Law is found all around us. Let's stand up and try to jump. Try doing it without bending your knees down. **Allow the children to try jumping without bending down.** Now bend your knees and jump. Why did it work this time? **Pause for response.** Newton's Third Law! Because you pushed downward, it provided you with an equal and opposite force that propelled you upward! **Allow the children to experiment with how high they can jump in relation to how much they bend their legs.**

We also see this law in action when playing basketball. You throw the ball down so that it will come back up. When you are swimming, you push your arms through the water backward so that you can move forward. This is the same when paddling a canoe; the paddles are pushed backward through the water to make the boat move forward. Can you think of any other examples? [walking and running, birds flying, etc.]

Balloon Rocket Activity



Pull a piece of thread through a drinking

straw. Tape or tie one end of the thread to a doorknob, cupboard handle, or chair. Pull the thread taut and tape or tie it to another handle or chair. Blow up a balloon and hold the end so the air doesn't blow out. **DO NOT TIE IT.** Then have a child tape the balloon to the straw (while you continue to hold on to the end of the balloon). Pull the balloon on the straw back to one end of the thread so that the side of the balloon with the opening is touching one end of the thread.

Watch to see what happens when I release the air. Let go of the end of the balloon so the air releases.



What happened to the air when I released the balloon? In what direction did the air go? [It went backward.]

What happened to the balloon? In what direction did it go? [It went forward.]

The balloon reacted to the force of the air releasing in the opposite direction and with an equal amount of force.

Allow the children to experiment with the balloon several more times by filling the balloon with different amounts of air and observing how the force reacts.

Science Journals



Have the children draw or write down one or more examples of Newton's Third Law in their student journals.

Lesson 6 Extension



Have the children grades 7–8 complete the self-directed Lesson 6 extension titled “Airplanes, Rockets, and Jets, Oh My!” in their student journals.



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

8.5"x11" (per child)

Optional Activity Supplies:

- Raw potato (per child)
- Knife (to cut potatoes)
- 7–9 craft sticks (per child)
- Cardboard or cardstock, at least

- 3–6 brads, at least 2 cm ($\frac{3}{4}$ 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 Inca 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; reducing the steepness and lengthening the distance over which the force is exerted 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 were not always around—they had to be discovered and invented! One of the greatest simple machines invented is the wheel. **Watch the video** called “History of Wheels” at goodandbeautiful.com/sciencevideos.

Wheels and Axles

Have the children look at the bike below and identify the wheels. Read to the children: Can you tell what is attaching the wheel to the bike?



Here is a closer look:



See the silver rod that goes through the center of the wheel? This rod is called an axle, and it connects the wheel to the rest of the bike. Wheels and axles work together as a single simple machine.

Another example of a wheel and axle is a doorknob. **Have the children walk over to a doorknob. Have the children identify the axle (the rod that connects the knob to the door) and then the wheel (the knob).**

Imagine if there were only an axle (straight rod) and no wheel (knob on the end).

Would it be more difficult to open the door?

What other examples of wheels and axles can you think of? **Discuss the following:** steering wheel, car wheel, drill, pizza cutter, windmill, skateboard, ceiling fan, Ferris wheel, rolling pin, electric mixer, paint roller.

Friction and Wheels



Have the children rub their hands back and forth against each other. Do you remember what friction is? [Friction is the resistance to motion when two objects rub against each other.] When there is friction, it requires more force to continue to keep objects moving past each other. So if you can reduce friction, it makes your work much easier! This is why wheels are such an important simple machine—wheels reduce friction and, in turn, reduce the required force.

Inclined Planes and Wheels and Axles



Have the children look back at the “Wheel and Axle/Inclined Plane” page in Lesson 10 of their student journals and write or draw examples of wheels and axles and then inclined planes under the appropriate heading.

Gears (Optional Activity)



Read to the children: Do you know what this is a picture of?

This is the inside of a mechanical watch.

You can see that it is made of several wheels. These wheels are called gears. They have notches around the outside of each wheel that allow the wheels to fit together, and when one wheel spins, it turns the other wheel. The smaller



wheels spin more quickly than larger ones; this is what makes the different hands spin at different speeds and keep accurate time. Today you will build your own gears to better understand how they work.

If the children are old enough to safely handle a knife, give each of them a potato and allow them to slice the potatoes into several round circles as shown below. Otherwise, slice the potatoes for the children. You want the slices to be about 0.5 cm ($\frac{1}{4}$ in) thick. (You may also need to assist with preparing the hole in the cardboard in Step 3.)

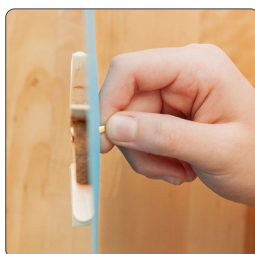
Then have the children create gears by completing the following steps:

1. Use scissors to cut the craft sticks into about 3-cm (1-in) pieces (4 per stick).

2. Select two large potato slices that are about the same size. Push the craft stick pieces down into the edge of the potato. Use at least six pieces and space them evenly apart.

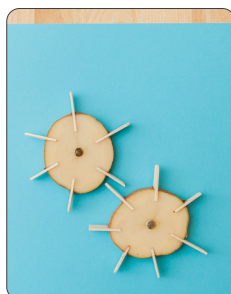


3. Poke a hole through the center of the cardboard using the pointed end of a pair of scissors or a screwdriver.



4. Place one of the prepared potato slices flat on the cardboard, over the center of the prepared hole. Push a brad through the center of the potato and all the way through the cardboard.

5. Hold on to the bottom of the brad and twist it around a few times so that the potato easily spins. Then press the ends of the brad down flat.

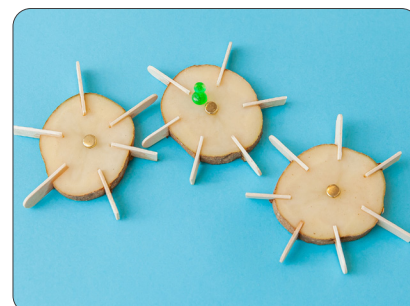


6. Place the other prepared potato next to the first one. Place it close enough so that the adjoining craft stick pieces can slide past each other. Secure it with another brad as you did in Steps 4 and 5.

7. Stick a pushpin into the top of the first potato. This will be your handle to spin the gears. Spin the gears and observe what happens.



8. Then select a smaller potato slice and prepare it the same as the others. (It can have fewer craft sticks, but you still want them evenly spaced.) Place this potato slice next to the other slice, and then spin the handle and observe what happens.



9. Add as many gears as you desire. Experiment with where you place them and observe what happens.

Lesson 10 Extension



Have the children grades 7–8 complete the self-directed Lesson 10 extension titled “Canals and Inclined Planes” in their student journals.



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 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.)

- 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 how much more easily it moves than a LEGO® with no wheels; create a pulley system and demonstrate how it works; use a screw to hold something together; create an inclined plane and demonstrate how it makes it easier to carry a load by pushing something up or down it; etc.]

2. Combine several simple machines to create your own complex machine. **Some examples are shown below.**

Remind the children that when they are creating their own designs, it may take trial and error for something to work. With that being said, what they create does

not need to “work”; simply allow the process of creation and discovery to take place.

Optionally, a child may decide to review one of Newton’s Laws of Motion by creating an activity that demonstrates one of the laws. Then help him or her to make a video of his or her demonstration.

Lesson 12 Extension

Note: There is no extension for this lesson.

