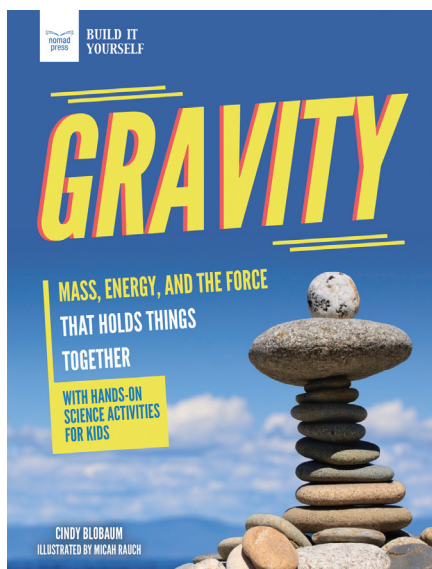


# Nomad Press

## CLASSROOM GUIDE



### What's up? What's down? What's keeping you steady?

In *Gravity: Mass, Energy, and the Force that Holds Things Together with Hands-On Science Activities*, scientists ages 8 to 12 explore the invisible but powerful force that is responsible for keeping the entire universe in place—including you! Gravity is the natural phenomenon that makes everything in the universe attracted to everything else. On Earth, that means gravity is why we fall down toward the ground, the reason we have tides, and why we weigh a certain number of pounds.

Hands-on STEM activities, entertaining illustrations, essential questions, text-to-world connections, fascinating sidebars, and links to online resources and videos in this book are as forceful as gravity itself!

Learn more at [nomadpress.net/nomadpress-books/gravity](http://nomadpress.net/nomadpress-books/gravity)

**Softcover:** 9781647410100, \$17.95  
**Hardcover:** 9781647410070, \$22.95  
**eBook:** all formats available, \$12.99  
**Specs:** 8 x 10, 112 pages, color interior

**Reading Level:** Ages 8–12  
**Interest Level:** Grades 4–7  
**Focus:** Science & Nature / Physics  
**GRL:** U



### GRAVITY

#### WORDS TO KNOW

**amniotic fluid:** the liquid in a womb that surrounds a developing infant.

**womb:** the female organ in mammals that carries an infant during its development before birth.

**proprioception:** the awareness of the position of your body.

**nervous system:** the communication system of the body, made of nerve cells that connect the brain and extend through the body.

**eardrum:** the part of the ear that separates the inside of the ear from the outside.

One thing your body—and brain—learn as you get used to gravity is how your body is positioned.

Have you ever been knocked over by a wave and been briefly confused about which way is down and which way is up? Or maybe you're a sleepwalker who's woken up while standing instead of lying in your bed and felt disoriented.

The sense that tells you where your body is in the space around you is

**proprioception.** Let's take a closer look at the connections between the force of gravity and proprioception.

This newborn foal isn't quite ready to test the effects of gravity yet!



### GETTING TO KNOW GRAVITY

#### Walking Wonder!

Watch this horse stand minutes after being born. Why can some mammals stand shortly after birth, but not humans? Scientists have discovered that all mammals stand at about the same time in the development of their brains. Those that can have better developed muscles, bones, and brains! They also need to be able to walk to get away from potential predators.

Can you think of some other animals that can and can't walk immediately after their birth?



BBC newborn foal

#### UP OR DOWN?

Back in babyhood, while your muscles were getting stronger, your brain was learning to use information sent by other parts of your body. When you are held upright or are standing, gravity is pulling all your matter toward the bottom of your feet. Your **nervous system** sends information to your brain which learns to recognize this feel of gravity's pull as down. Your eyes learn what you usually see when you look up, down or side to side.

Your body continues to send signals to your brain when you are lying down, standing on your head, sitting on a stool, or doing a cartwheel. Your brain uses these signals to figure out which way is down or up. That's how you can control your muscles and make them do what you want, whether you're running up the stairs, doing a backflip on a trampoline, or simply sitting down to eat dinner.

Another way your body figures out which way is down is through your ears. If you could look inside an ear past the **eardrum**, you would see three tiny tubes bent in the shape of horseshoes and two tiny pockets.

# SAMPLE GLOSSARY

**absorb:** to soak up a liquid or take in energy, heat, light, or sound.

**adhesion:** when particles of different substances stick together.

**air resistance:** the force of air pushing against an object.

**amateur:** doing something, such as a sport or hobby, for pleasure and not as a paid job.

**amniotic fluid:** the liquid in a womb that surrounds a developing infant.

**anatomy:** the study of the structure of living things, including naming all the parts and their functions.

**anti-gravity:** free from the force of gravity.

**aqueduct:** a pipe or bridge that moves water using gravity.

**artesian well:** a well drilled through rock. The water is under pressure because it is flowing downhill from higher ground.

**asteroid:** a small rocky object that orbits the sun.

**astronaut:** a person trained for spaceflight.

**astronomy:** the study of the stars, planets, and space. An astronomer studies astronomy.

**atmosphere:** the blanket of air surrounding the earth.

**atom:** a very small piece of matter. Atoms are the tiny building blocks of everything in the universe.

**attraction:** an invisible force that pulls things together.

**avalanche:** a large amount of snow that slides down a mountain very quickly.

**balance:** a tool that shows if the mass of two objects is even.

**BCE:** put after a date, BCE stands for Before the Common Era and counts down to zero. CE stands for Common Era and counts up from zero. This book was published in 2023 CE.

**black hole:** a place in space where gravity is so strong even light gets pulled in.

**calcium:** a mineral found in shells and bones.

**calculus:** a branch of mathematics that deals with calculating things such as the slopes of curves.

**cantilever:** a beam with one end supported and the other end free.

**capillary action:** the way water pulls itself up into another material.

**carat:** the unit of weight for gems and pearls. One carat equals 200 milligrams.

**center of balance:** the point on an object where its mass is even all the way around.

**center of gravity:** the point on an object where it can be supported and stay in balance.

**centrifugal force:** the outward force on an object moving in a curved path.

**centrifuge:** a machine with a rapidly rotating container that applies centrifugal force to its contents to separate fluids of different densities.

**centripetal force:** the inward force that keeps an object moving at a steady speed in a circular path around another object.

**cohesion:** the sticking together of particles of the same substance.

**comet:** a ball of ice and dust that orbits the sun.

**compressed:** pressed together very tightly, so it takes up less space.

**counterweight:** a weight that balances another weight.

**crops:** plants grown for food and other uses.

**culture:** a group of people who share beliefs and a way of life, including religion, language, art, clothing, food, and holidays.

**dam:** a large, strong wall built across a river to hold back and control the water.

**dark matter:** particles that do not absorb, reflect, or emit light.

**data:** information in the form of facts and numbers.

**dense:** describes something that is tightly packed, such as the matter in an object.

**diameter:** a straight line running from one side of a circle to the other through the center.

**disoriented:** having lost one's sense of direction.

**eardrum:** the part of the ear that separates the inside of the ear from the outside.

# ESSENTIAL QUESTIONS

## BEFORE READING:

### Establish Background Knowledge

- What do you already know about how gravity works?
- Why is it important to study things that might feel like they are already well known, such as gravity?
- What are some ways gravity keeps us safe?

### Skill Introduction

- What do you do when you come to a word or phrase you do not know?
- How do photographs, videos, and charts help someone learn about a topic?

*CCSS.ELA-Literacy.SL.5.1a Come to discussions prepared, having read or studied required material; explicitly draw on that preparation and other information known about the topic to explore ideas under discussion.*

*CCSS.ELA-Literacy.RF.5.3a Use combined knowledge of all letter-sound correspondences, syllabication patterns, and morphology (e.g., roots and affixes) to read accurately unfamiliar multisyllabic words in context and out of context.*

## DURING READING:

### Check for Understanding

- What is matter? What are some things that have matter? What are some things that don't have matter? Does gravity have matter? Does gravity act on matter?
- What are some of the different types of scientists and engineers who study and use gravity?
- What were some of the first ways thinkers studied gravity? How has the scientific study of gravity changed?

*CCSS.ELA-Literacy.L.5.4c Consult reference materials (e.g., dictionaries, glossaries, thesauruses), both print and digital, to find the pronunciation and determine or clarify the precise meaning of key words and phrases.*

*CCSS.ELA-Literacy.SL.5.1c Pose and respond to specific questions by making comments that contribute to the discussion and elaborate on the remarks of others.*

*CCSS.ELA-Literacy.SL.5.1d Review the key ideas expressed and draw conclusions in light of information and knowledge gained from the discussions.*

## AFTER READING:

### Summary and Expansion

- How is gravity important to how the human body operates?
- Why doesn't gravity work on people in space? What kinds of things do astronauts do so they can exist without gravity?
- How are rocketships able to break away from the pull of Earth's gravity?
- How does your nervous system know which way is up? How does your body adjust when it gets new clues about which way it's oriented in space? Why are your ears important to your sense of balance?
- What is a center of gravity? How can you adjust your own center of gravity? Why might you do this?
- How do scientists measure gravity?
- What is the "Vomit Comet"? What is it used for? Would you like to ride in it?
- How do scientists and engineers use gravity when designing weapons, buildings, and cars and trucks?
- What was Sir Isaac Newton's role in the study of gravity? What kind of science did he develop to help explain the force of gravity?
- What are some of the things that affect the force of gravity on different objects?
- How are weight and gravity related?
- How are gravity and tides related to each other?
- What is the difference between centripetal and centrifugal force?

*CCSS.ELA-Literacy.L.5.6 Acquire and use accurately grade-appropriate general academic and domain-specific words and phrases, including those that signal contrast, addition, and other logical relationships (e.g., however, although, nevertheless, similarly, moreover, in addition).*

*CCSS.ELA-Literacy.RF.5.4c Use context to confirm or self-correct word recognition and understanding, rereading as necessary.*

*CCSS.ELA-Literacy.RI.5.8 Explain how an author uses reasons and evidence to support particular points in a text, identifying which reasons and evidence support which point(s).*

*CCSS.ELA-Literacy.W.5.7 Conduct short research projects that use several sources to build knowledge through investigation of different aspects of a topic.*



## ACTIVITY!

# GROWING DOWN

Plant roots grow down and stems grow up. Roots bring plants the water they need. Stems hold leaves up toward the sun so they can make food. **Why do roots grow down? Is it because water is stored in the soil or because gravity pulls them down? Make a hypothesis, do an experiment, and record your thoughts on a new scientific method worksheet in your science journal. Then, track the results to see if you are right!**

- **Fold each paper towel in half, then fold it again.** Put one in each bag. It should fill the bottom half of the bag.
- **Pour about 2 tablespoons of water into each bag.** You want the paper towels to be damp, but not dripping wet.
- **Staple each bag in three evenly spaced places about 2 inches from the top of the bag.** This makes four spots for seeds.
- **In one bag, place a bean in each space between the staples.** Change the direction of the bean each time. Start with the first bean facing up, then down, then right, then left. Repeat this in the same order for each bag.
- **Zip the bags shut.** Find a window that gets a lot of sunlight. Tape one bag to the window with the zipper on top. Tape one bag to the window with the zipper at the bottom. Tape one bag to the window with the zipper facing right or left. Lay one bag flat on the windowsill or a flat surface with the same sunlight.
- **Check on your seeds every day.** In what direction are the roots growing? Is gravity at work? Record your observations. Is it what you **predicted**? Note that it is possible that some beans might not sprout.

## TOOL KIT

- 4 paper towels
- science journal
- 4 zippered sandwich bags
- tablespoon
- stapler
- 16 dried beans (soaked in water overnight)
- sunny window with sill or flat surface
- tape

## Try This!

What happens if you change the direction of the bag after the roots have started to grow? Do they continue to grow in the same direction or do they change?

## WORDS TO KNOW

**predict:** to estimate what might happen before it happens.



## ACTIVITY!

## BUILD THE BEST SWIMMER

When you swim, the water is pushing you up while gravity is pulling you down! If your weight is distributed evenly, you can float flat with ease. If you have more mass at one end of your body or the other, that end will sink a bit.

➤ **Fill the bowl with water.** It should be about three-quarters full of water.

➤ **Use the rubber bands to secure a metal washer near each corner of the Styrofoam block.** These represent a swimmer's muscular arms and legs. Use your pencil to mark one end as the head.

➤ **Put the block in the water.** This represents a perfectly balanced swimmer. Record your observations (including measurements above and below water) in your science journal.

➤ **Put one finger on the leg end edge and gently push the swimmer forward in the water.** How much resistance do you feel?

➤ **Remove the block from the water and move the washers from the head end closer to the middle of the block.** This represents a low center of gravity (more mass near the bottom). Return the block to the water and record your observations.

➤ **Remove the block from the water.** Move the washers to create and test a swimmer with a high center of gravity, with more mass near the head end. What happens?

### WHAT'S HAPPENING?

As you add matter and mass to the foam block, you increase the gravitational pull. When you move the washers forward, backward, and side to side, you change the block's center of gravity and how it floats in the water. Which model is built best for doing the side stroke? On which side?

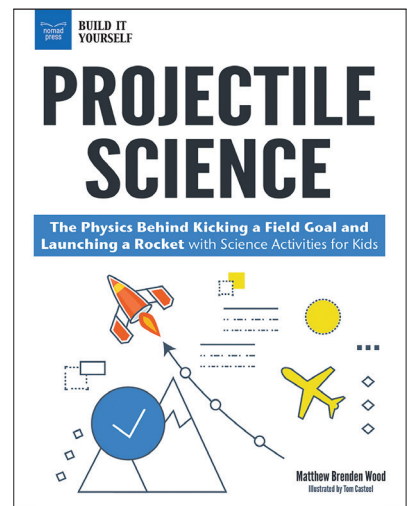
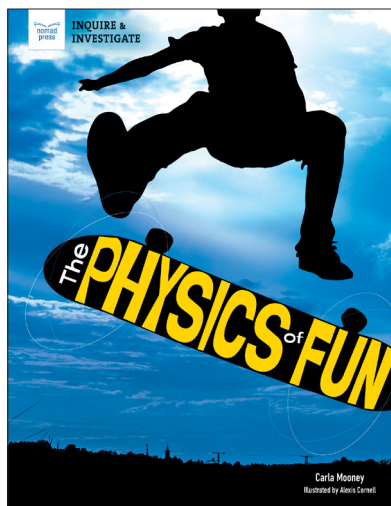
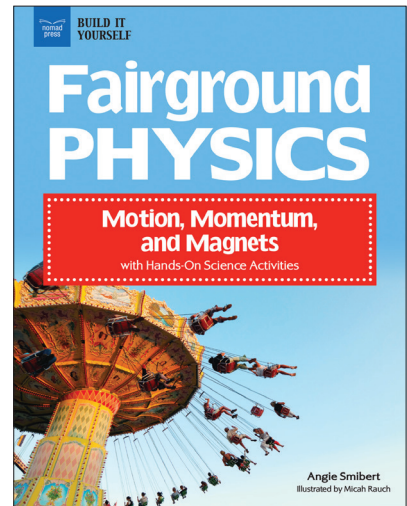
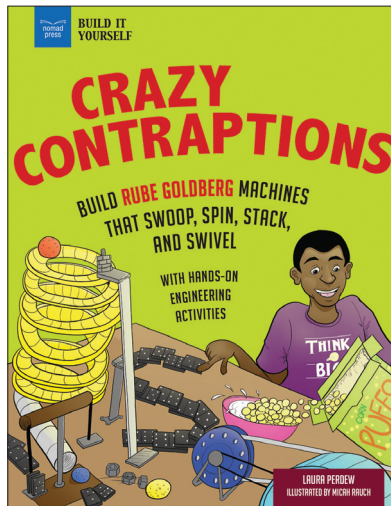
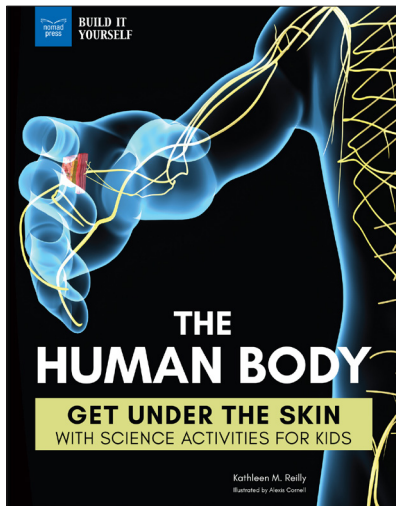
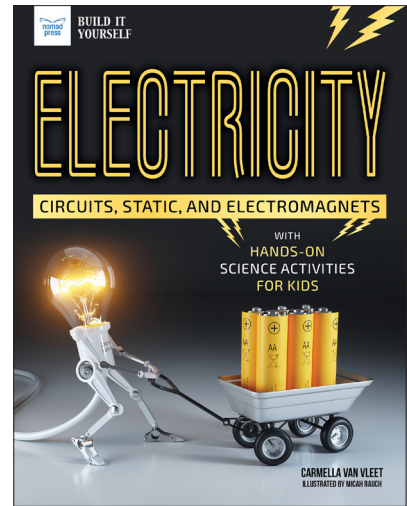
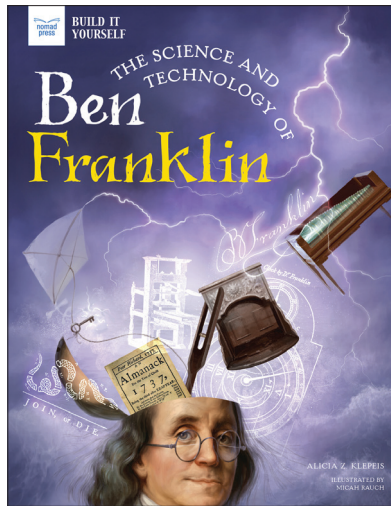
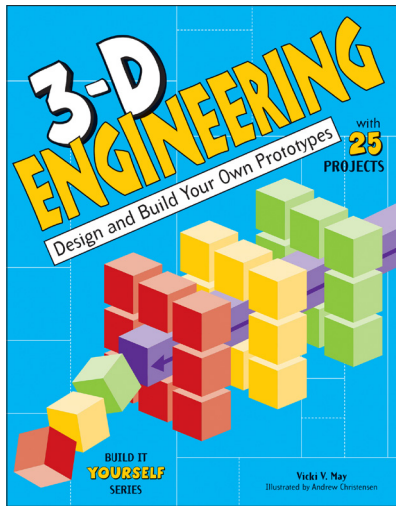
### TOOL KIT

- large clear plastic bowl/tub
- water
- rectangular Styrofoam block (small enough to fit in bowl)
- large rubber bands
- metal washers
- pencil
- science Journal
- ruler

### Try This!

Add more washers to the front, to the back, to one side, to opposite sides. Make careful observations of what happens each time. Can you think of any real-life instances where swimmers have bodies with similar balances to those you construct?

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