Activities inspired by children’s literature

What Goes Up Must Come Down!

By Emily Morgan and Karen Ansberry

From rolling a toy car down a ramp to watching footage of Felix Baumgartner’s record-breaking 24-mile fall to Earth, there are countless ways we can experience and observe the cause-and-effect relationships with forces and motion. In this month’s lessons, students explore these relationships to explain and predict the motion of objects.

This Month’s Trade Books

Newton and Me
By Lynne Mayer
Illustrated by Sherry Rogers
Sylvan Dell. 2010.
ISBN: 978-1-60718-8667
Grades K–2

Synopsis

Named a 2010 Outstanding Science Trade Book by NSTA and the Children’s Book Council, this rhyming book about a boy and his dog, Newton, provides a fun introduction to forces and motion.

Gravity
By Jason Chin
Roaring Brook Press. 2014.
Grades 3–5

Synopsis

With deceptively simple text and vivid illustrations, this book introduces the mysterious force that causes objects to attract each other. End matter includes explanations about gravity, including how distance and mass affect this invisible force.

Curricular Connections

The Next Generation Science Standards identify “Cause and Effect” as one of seven crosscutting concepts in science and engineering. Students throughout grades K–12 should recognize that “Events have causes, sometimes simple, sometimes multi-faceted. A major activity of science is investigating and explaining causal relationships and the mechanisms by which they are mediated” (NGSS Lead States 2013, Appendix G, p. 79). Once these cause-and-effect relationships are recognized, students can begin to predict and explain events in new circumstances. In the K–2 lesson, students recognize the simple cause-and-effect relationships on cars traveling down ramps and across different surfaces. After making observations, they apply what they have learned to complete a force and motion design challenge. This lesson explores cause-and-effect relationships in the context of the disciplinary core ideas of forces and motion and the relationship between energy and forces, along with the science and engineering practice of planning and carrying out investigations. Finally, students apply their learnings as they “determine if a design solution works as intended to change the speed and direction of an object with a push or pull” (K-PS2-2). In the 3–5 lesson, students explore cause-and-effect relationships associated with gravity, which addresses the disciplinary core idea of types of interactions (PS2.B). The NGSS suggests that cause and effect is also closely related to the practice of “Engaging in Argument From Evidence.” This lesson demonstrates this connection by asking students to apply what they have learned about gravity and falling objects to “Support an argument that the gravitational force exerted by Earth on objects is directed down” (5-PS2-1). Students learn that “down” is a local description of the direction toward the center of Earth.

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For Grades K–2: Ride Newton, Ride!

Purpose
Students explore simple cause-and-effect relationships with forces and motion and apply their knowledge to complete a design challenge.

Engage
Show students the cover of *Newton and Me*. Tell them that you are going to take a “picture walk” through the book and you’d like them to try to figure out what the book is about. As you show the pictures, have them signal when they see an illustration of something moving, such as the truck rolling down the hill, the wagon full of rocks being pulled across the yard, the ball rolling in the grass, and so on. Students will likely recognize that the book is about a boy and his dog observing how ordinary things move (CC ELA: Reading Informational Text, Key Ideas and Details). Next, show students a toy car and a plastic toy dog. Tell them that the plastic dog represents Newton, the dog from the story, and that they are going to experiment with Newton, some ramps, and a toy car before reading the book. Place Newton in the car on the floor and ask what they could do to get Newton and the car to move. Students will likely suggest you push it. Push the car and observe its motion. Next, ask if there is any other way to make it move. They might say pull it, blow air on it, wave a paper behind it, place it on a ramp, or pull it with a magnet.

Explore
Divide students into groups of four, and tell them that they are going to be making Newton and the car move in various ways. Give each group of students a toy car, a plastic dog (Newton), a piece of tape to attach Newton to the car, a 12-inch section of toy car track to make a ramp, some books or blocks to stack to change the height of the ramp, a plastic bingo marker for marking the car’s location, and a piece of felt or other highly-textured material. Lead the groups through the following activities and record their results on a class chart.

**Activity 1: High and Low Ramps**
(Before you begin, have each group use tape to securely attach their toy dog to a car. This will be referred to as “Newton’s car.”) Have students make a ramp by placing one end of the toy track on one book or wooden block. Have them release Newton’s car at the top of the ramp and record how far it moves by placing a plastic bingo marker alongside where it stops. Next, have students raise the ramp by adding another book or block. Have students release Newton’s car from the top of the higher ramp and then place the other bingo marker where it stops. Next, have them use the two markers to compare how far the car traveled. Students should notice that the higher the ramp, the farther it travels.

**Activity 2: Changing the Surface**
Have students set up a ramp with a piece of felt beneath the end of the ramp, release Newton’s car from the top, and use a bingo marker to record how far Newton travels. Next, have them place a smooth surface at the end of the ramp (or let it roll onto the floor if you have tile) and repeat. Have students use the two markers to compare how far the car traveled on each of the two surfaces. Students should notice that the car moves farther on the smooth surface than it does on the rough surface.

**Activity 3: Lightweight vs. Heavyweight**
Have students set up a ramp and place a light wooden block at the end of the ramp. Have students release Newton’s car from the top of the ramp and mark how far the block

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**Materials**
Per group of four students:
- 1 small plastic toy dog
- 1 toy car (Hotwheels or Matchbox type)
- Piece of tape
- 1 12 in. section of toy car track
- 1 approximately 12 in. square of green felt or other textured material (e.g., carpet) to represent grass
- 2 plastic bingo markers
- Lighter wooden block and a heavier wooden block
moves. Next, have them place a heavier wooden block at the end of the ramp and release the car again. Have them mark how far the heavier block moves. Ask them which moves the farthest, the lighter block or the heavier block. Students should notice that lighter block moves farther than the heavier block.

**Explain**

Ask students to share some of their observations and conclusions from each activity. Then tell students that as you read Newton and Me aloud, you would like them to signal when they hear something in the book that relates to one of the activities. When they signal, stop reading and ask them to share their connections. For example, page 6 reads, “The ball won’t roll far in the rough, grassy yard. It rolls much farther on a surface that’s smooth and hard.” Students should realize that the text and illustration on this page connects with activity 2—the grass is like the felt they used in the activity. Things roll farther on a smooth surface than a rough surface. Students should relate the hill on page 11 to activity 1 (with the ramp) and realize that the higher the hill, the faster and farther things move as they go down it. They should connect the heavy and light wagons on pages 15–17 to the heavy and light blocks in activity 3 and recognize that the heavier something is, the harder it is to get it moving. Stop after reading the last line on page 27, “Playing with Newton gave me the notion that pushing and pulling are forces of motion.” Discuss the terms push and pull. Then, have students apply these terms to the illustrations on page 30: Which show pushes? Which show pulls? Which show both? The answers are upside down at the bottom of that page. Go through each picture in the book and ask students to identify pushes and pulls in each of the illustrations.

**Elaborate**

Challenge students to apply what they have learned about force and motion to complete a design challenge. Give each group of students a toy dog taped to a toy car, a piece of felt, and a ramp. Make a “doghouse” for each group by cutting an opening in a plastic cup from the lip down (the “door”) that is large enough for Newton and the car to go through. Place the cup upside-down 1 ft. away from the end of the ramp with the door facing the ramp. Their challenge is to use the supplies to get Newton from the top of the ramp into the doghouse without touching him. Encourage students to use what they learned from the book and their explorations to set up their design. Allow them several attempts and encourage them to modify their designs until they get one that works.

**Evaluate**

Have each group demonstrate their design to the rest of the class and describe how they used the items to affect Newton’s motion, applying the words push and pull where applicable.
Purpose
Students learn the true meaning of down when it comes to falling objects.

Engage
Hold a ball in your hand and ask students what will happen to the ball if you let it go. They should realize that it will fall to the ground. Let it go, and watch it fall to the ground. Hold the ball as high as you can and ask what will happen if you let it go. Drop it and watch it fall to the ground. Now, stand on a chair and ask students what will happen if you drop the ball from there. Drop it and watch it fall to the ground. Then, give each student a copy of the Tower Drop formative assessment probe (Keeley and Harrington 2010; see NSTA Connection). Read the probe together and discuss the diagram. Have each student choose the answer they think is correct and explain their thinking in writing. Collect the probes to preassess student knowledge about gravity and falling objects.

Explore
Explain to students that there is no tower on Earth as tall as the imaginary one shown on the probe, but there is a person who jumped from a height that was four times higher than that imaginary tower! Show students a video of Felix Baumgartner’s record-breaking fall to Earth from a stratospheric balloon 24 miles above the surface (see Internet Resources). Ask students what forces were acting on Baumgartner as he fell to Earth. They will likely mention that gravity was pulling him down and the air was slowing him down. They might recognize that the parachute released at the end slowed him down and caused him to move back and forth above Earth’s surface. Point out that before the parachute opened, Baumgartner fell straight down toward Earth’s surface. Ask students why Baumgartner did not float away from Earth at 24 miles above it. From watching the video, students should realize that even at 24 miles above, Mr. Baumgartner couldn’t escape Earth’s gravity. You may also want to show them a video with Felix Baumgartner after the jump to learn more about what it was like for him and how much planning and training were involved in this jump (see Internet Resources).

Explain
Tell students that you have a book that can help them learn more about the force of gravity that pulled Felix Baumgartner to Earth. Show students the cover of Gravity. Read the book aloud, pausing periodically to ask students to guess what is on the next page. Then, tell students you are going to read the book again, but this time you would like them to look closely at Jason Chin’s illustrations. Tell students that Jason Chin is known for his beautiful paintings and his clever way of using pictures to help the reader better understand the story or idea he is sharing. Ask them to point out how his illustrations both tell a story and illustrate the concept of gravity (CC ELA: Reading Informational Text, Integration of Knowledge and Ideas). Students should notice that at the beginning of the story, the boy is at the beach when his book and toys float away. At the end of the story, his book and toys land at the girls’ lemonade stand and on the very last page, the pitcher of lemonade lands in the boy’s hands. Ask students the following questions after reading:

• Is gravity a pushing or pulling force? (pulling)
• Which way does gravity pull? (down)
• What does “down” really mean? For example, if you dropped something at the equator or the South Pole, which way would it fall? (Students should realize that “down” means toward the Earth’s surface. Explain that gravity pulls things toward the center of the Earth. So “down” really means toward Earth’s center (CC ELA: Reading Informational Text, Key Ideas and Details).

Materials
• The Tower Drop formative assessment probe (see NSTA Connection)
• Index cards
• Art supplies
Elaborate

Read the information in the “More About Gravity” section on pages 30–31, but do not show the illustrations at this point. You may want to show students PBS Learning Media’s video titled “Gravity,” as it includes some of the concepts presented in this section (see Internet Resources). Create six index cards that contain the information in each of the six paragraphs in the “More About Gravity” section. The cards should have the following titles and the corresponding informational paragraph:

1. Gravity Is Attractive
3. Weaker With Distance
4. Mass Matters
5. The Measure of Gravity
6. Gravity Keeps It All Together

Divide students into six groups and give each group one of the index cards. Tell them that they need to read the card and come up with a visual that demonstrates the fact about gravity described on the card. When each group is finished, have them share with the rest of the class and compare their drawing to Jason Chin’s illustration accompanying their paragraph. After each group shares, ask them to relate their fact about gravity to Felix Baumgartner’s fall to Earth. For example, the group that is assigned the “Weaker with Distance” card should be able to explain that 24 miles is actually pretty close to Earth when compared to the distance to the Moon (250,000 miles) or the Sun (93 million miles). Twenty-four miles is not far enough for gravity to weaken much at all.

Evaluate

Revisit the Tower Drop formative assessment probe. Ask students if their original ideas have changed or been confirmed by watching Baumgartner’s free fall and reading the book. Give them an opportunity to correct or refine their original answer using the video and book to support their choice. Students should show the ball falling down next to the tower toward the surface of the Earth. They should explain that gravity pulls falling objects “down,” meaning toward the center of the Earth. Next, tell students to imagine they have a friend who is going to visit Australia, which is in the southern hemisphere, and he is afraid he might fall off the Earth because it is located near the “bottom” of the Earth. Have students write a letter to their friend using words and pictures to convince him that he will not fall off the Earth’s surface and explain why (CC ELA: Writing).

Acknowledgment

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Reference


Internet Resources

Felix Baumgartner’s 24 mile free fall to Earth (14:02 min)
www.youtube.com/watch?v=_S5UxmW8FJc

Felix Baumgartner’s Record Breaking Fall (1:25 min)
http://win.gs/1uW4tBj

Gravity by PBS Learning Media

Interview With Felix Baumgartner on CNN’s AC 360
www.youtube.com/watch?v=mUiy6PVND80

NSTA Connection

Download the “tower drop” probe at www.nsta.org/SC1411.
Connecting to the Common Core

This section provides the Common Core for English Language Arts and/or Mathematics standards addressed in this column to allow for cross-curricular planning and integration. The Standards state that students should be able to do the following at grade level.

English/Language Arts

Reading Standards for Informational Text K–2: Integration of Knowledge and Ideas

- Kindergarten: With prompting and support, describe the relationship between illustrations and the text in which they appear (e.g., what person, place, thing, or idea in the text an illustration depicts).
- Grade 1: Use the illustrations and details in a text to describe its key ideas.
- Grade 2: Explain how specific images (e.g., a diagram showing how a machine works) contribute to and clarify a text.

Reading Standards for Informational Text 3–5: Key Ideas and Details

- Grade 3: Ask and answer questions to demonstrate understanding of a text, referring explicitly to the text as the basis for the answers.
- Grade 4: Refer to details and examples in a text when explaining what the text says explicitly and when drawing inferences from the text.
- Grade 5: Quote accurately from a text when explaining what the text says explicitly and when drawing inferences from the text.

Reading Standards for Informational Text: Integration of Knowledge and Ideas

- Grade 4: Interpret information presented visually, orally, or quantitatively (e.g., in charts, graphs, diagrams, time lines, animations, or interactive elements on Web pages) and explain how the information contributes to an understanding of the text in which it appears.
- Grade 5: Draw on information from multiple print or digital sources, demonstrating the ability to locate an answer to a question quickly or to solve a problem efficiently.

Writing across all content areas is emphasized within the common core, as seen by standard statement 10, which begins in grade 3 and states that students should “write routinely over extended time frames (time for research, reflection, and revision) and shorter time frames (a single sitting or a day or two) for a range of tasks, purposes, and audiences.

Furthermore, the Common Core for ELA provide a standard related to the Range of Text Types for K–5 where it indicates that students in K–5 should apply the Reading standards to a wide range of texts to include informational science books.

Connecting to the Standards

Standard: K-PS2 Motion and Stability: Forces and Interactions

Performance Expectation:
K-PS2-2 Analyze data to determine if a design solution works as intended to change the speed and direction of an object with a push or pull.

Science and Engineering Practice:
Analyzing and Interpreting Data

Disciplinary Core Ideas:
PS2.A: Forces and Motion
PS2.C: Relationship Between Energy and Forces

Crosscutting Concept:
Cause and Effect

NGSS Table: K-PS2 Motion and Stability: Forces and Interactions
www.nextgenscience.org/kps2-motion-stability-forces-interactions

Standard: 5-PS2 Motion and Stability: Forces and Interactions

Performance Expectation:
5-PS2-1 Support an argument that the gravitational force exerted by Earth on objects is directed down.

Science and Engineering Practice:
Engaging in Argument from Evidence

Disciplinary Core Idea:
PS2.B: Types of Interactions

Crosscutting Concept:
Cause and Effect

NGSS Table: 5-PS2 Motion and Stability: Forces and Interactions
www.nextgenscience.org/5ps2-motion-stability-forces-interactions