Roller Coasters

Description

Learners explore ways to change the speed and direction of a rolling object by building roller coasters out of pipe insulation. They investigate the idea that gravity affects all objects equally by conducting dropping races with everyday items.

Suggested Grade Levels: K–4

Lesson Objectives Connecting to the Standards

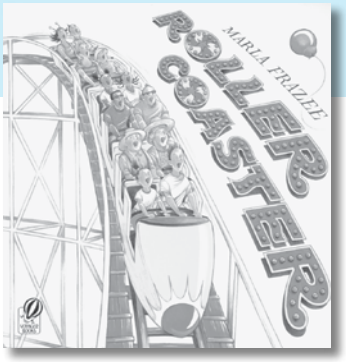
Content Standard A: Scientific Inquiry

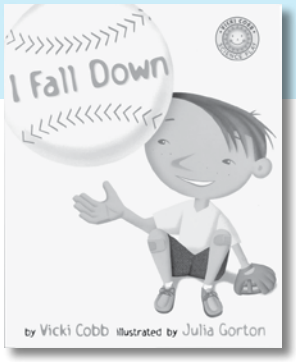
- Ask a question about objects, organisms, and events in the environment.
- Plan and conduct a simple investigation.

Content Standard B: Physical Science

- Understand that the position and motion of an object can be changed by pushing or pulling.

Featured Picture Books





Title	*Roller Coaster*	*I Fall Down*
Author	Marla Frazee	Vicki Cobb
Illustrator	Marla Frazee	Julia Gorton
Publisher	Harcourt	HarperCollins
Year	2003	2004
Genre	Story	Non-narrative Information
Summary	Twelve people set aside their fears and ride a roller coaster, including one who has never done so before.	Simple experiments introduce the basic concept of gravity and its relationship to weight.

Time Needed

This lesson will take several class periods. Suggested scheduling is as follows:

Day 1: **Engage** with *Roller Coaster* read aloud. **Explore/Explain** with Roller Coaster Design Challenges.

Day 2: **Elaborate** with *I Fall Down* read aloud and Dropping Races.

Day 3: **Evaluate** with Falling Objects Quiz.

Materials

Roller Coaster supplies for each pair of students:

- 6 ft. length of foam insulation to fit a 1 in. pipe (split lengthwise) with a plastic 20 oz. cup taped to the end
- Ball that will roll in the split pipe insulation prepared above, such as a foosball, large marble, or ball bearing.

Supplies to use during *I Fall Down* read aloud:

- Penny
- Key

Dropping races supplies for pairs of students: tennis ball, marble, paperclip, penny, book

- Notebook paper
- Dry sponge
- Bar of soap
- Heavy shoe
- Lightweight shoe
- 2 identical large rubber bands

Student Pages

Roller Coaster Challenges

My Roller Coaster

Dropping Races

Falling Objects Quiz

Background

The National Science Education Standards recommend that students explore and describe motion by pushing, pulling, throwing, dropping, and rolling a variety of everyday objects. The Standards suggest that K–4 students begin to focus on the position and motion of objects as well as the motion and forces required to control the objects. By making careful observations and recording data, students in even the earliest grades can begin to look for patterns in their work with motion and can determine the speed of an object as fast, faster, or fastest. In this lesson, students investigate how to control the speed of a model roller coaster and discover how gravity affects the motion of objects as they fall.

Gravity is a force that pulls all objects toward the center of the Earth. Earth's gravity keeps us on the ground and causes objects to fall. It also keeps the Moon in orbit. The Sun's gravity keeps the planets in orbit around it. Although most roller coasters are pulled up the first hill by a chain, what you may not realize as you're cruising down the track at 60 miles an hour is that the coaster has no engine. Gravity is the main force responsible for the movement of the roller coaster. Most of the time, the first hill on a roller coaster slopes down about 50 degrees. This is the most exciting drop of the ride! The roller coaster goes faster and faster the closer it gets to the ground.

One common misconception that many children and adults have about Earth's gravity is that heavier objects fall faster than lighter objects. This is not true. Gravity affects all objects equally no matter how much they weigh. We all know that a feather falls slower than a hammer when dropped on Earth. This is because the feather is more affected by *air resistance.* If you could get rid of the air, the hammer and feather would hit the ground at the same time. The astronauts on the Apollo 15 Mission proved this to be true by dropping a feather and a hammer on the Moon from the same height at the same time. Both hit the ground at the same time. You can see actual video footage of the Apollo 15 astronauts dropping a feather and a hammer on the Moon at: *http://nssdc.gsfc.nasa.gov/planetary/lunar/apollo_15_feather_drop.html.*

Engage

Roller Coaster Read Aloud

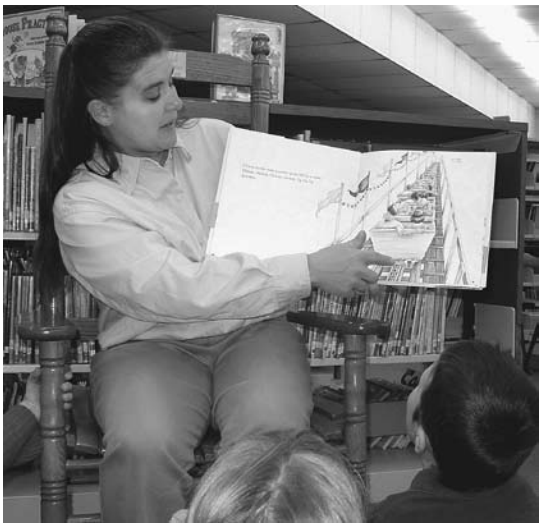
Making Connections: Text to Self/Turn and Talk

Show students the cover of the book, *Roller Coaster*. Introduce the author and illustrator, Marla Frazee. Tell students that Marla Frazee has three sons who love roller coasters. One summer, their family spent a week on a driving vacation and the whole time her boys talked about roller coasters: which boy was bravest, which coaster was scariest, which drop was highest. This gave Marla Frazee the idea for making this book. (There is more information about Marla Frazee and her family on the book jacket and at *www.marlafrazee.com.)*

Before reading, ask

? Have you ever been on a roller coaster? What was it like? If you've never been on one, what do you think it would be like?

Have students turn and talk to a partner.



Roller coaster *read aloud*

Inferring

Begin reading the book, but stop after reading pages 14 and 15, where the roller coaster is slowly going up the hill. Ask

? What do you think the next picture in the book will look like?

Have students turn and talk to a partner.

Visualizing: Sketch to Stretch

Continue reading the book, but stop after reading page 27 ("Wheeeeeee!"). Have students close their eyes and imagine what it would feel like to be on the roller coaster in the book. Ask

- How would you feel if you were on this roller coaster?
- What do you think your face would look like if you were riding this roller coaster?

Have students make a sketch on a sticky note of what they think their face would look like if they were on the roller coaster. They can share their picture with a partner. (For fun, have the whole class make their roller coaster faces on the count of three.) Then, finish reading the book aloud.

Explore/ Explain

Roller Coaster Design Challenges

Announce to students that they are going to work with a partner to design their own roller coaster. Hold up a piece of foam pipe insulation with a plastic cup taped to one end. Tell them that this will be the track. Show students a ball and tell them that this will be the roller coaster car. Caution them not to throw the ball or push it down the track. They should simply release the ball and let it roll. Show them the cup and ask

- What do you think the cup is for? (to catch the ball or to stop the ball from rolling away)

Give each pair of students these supplies and the Roller Coaster Challenges student page. Have them complete the challenges below:

- Can you make the ball roll from one end of the track and stop in the cup?
- Can you make the ball roll faster?
- Can you make the ball roll more slowly?
- Can you make the ball go over a hill on your roller coaster?
- Can you make the ball go over two hills on your roller coaster?
- Can you make the ball go through a loop on your roller coaster?

Allow students several minutes to work on the challenges. Encourage them to make observations about where on the track the ball moves fastest and slowest. Then bring students back together and ask

- How did you make the ball roll faster? (by raising one end a lot higher than the other)
- How did you make the ball roll more slowly? (by raising one end only a little higher than the other)
- How did you make a hill on your roller coaster? (by bending the middle up) Were you able to make two hills?
- Which was the highest, the first hill or the second hill? (The first hill had to be the highest to get the ball going fast enough to go over the second hill.)
- How did you make the ball go over the hills or around loops on your roller coaster? (by making the beginning of the track steep)
- Did the ball ever fall off of the roller coaster? What made it fall?
- What causes the ball to go down the track? (Answers may vary; the next activity will introduce students to the concept of gravity.)

Next, hand out the My Roller Coaster student page. Tell students that they will draw a roller coaster using what they have learned from making their model roller coasters. Tell them they can make as many hills and loops on their roller coaster track as they wish, as long as they think the roller coaster would actually work in real life. Encourage them to use color and add details to their roller coaster car. They can even draw people in it if they like. Tell students to label where the roller coaster would be moving the fastest and where it would be moving the slowest.

Before they begin, ask

Making "roller coaster faces"

? What do you need at the beginning of the ride to get the roller coaster car moving fast? (a high hill)

? Can a second hill be higher than a first hill? (No, the first hill has to be the highest.)

When they are finished, evaluate their understandings about motion by asking them questions such as

? Where on the track does your roller coaster car move the fastest? (toward the bottom of the hills)

? Where on the track does your roller coaster car move the slowest? (toward the top of the hills)

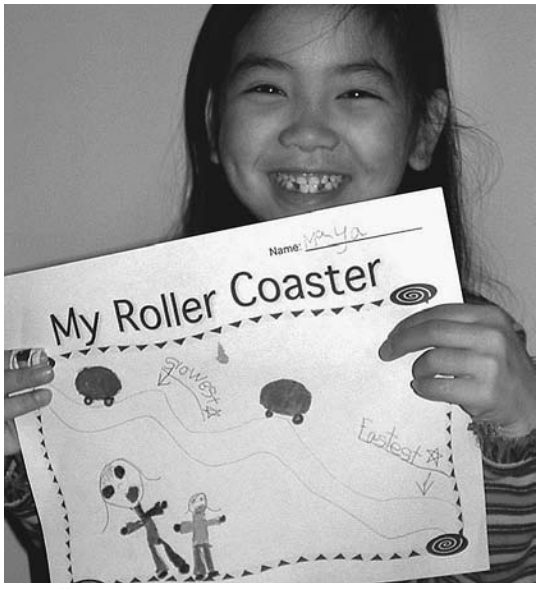
elaborate

I Fall Down Read Aloud

Explain to students that there is a force that pulls everything toward the ground. On Earth, it is impossible to escape the pull of this force. It affects everything we do every day of our lives. In the case of our model roller coaster, this force pulls the ball toward the ground. Tell students that you have a book that will tell them more about this incredible force!

Note: Vicki Cobb suggests that the best way to use her book *I Fall Down* is to do the activities described in the book, without rushing, as they

Making a loop



My roller coaster

come up during the reading. Before you begin reading, make sure you have all the necessary supplies at hand. The author also suggests not turning the page to the explanation until *after* the child has made the discovery. That way, the book will reinforce what the child has discovered through experience. See "Note to the Reader" on page 3 of *I Fall Down*.

Inferring

Introduce the author and illustrator of *I Fall Down*. Ask

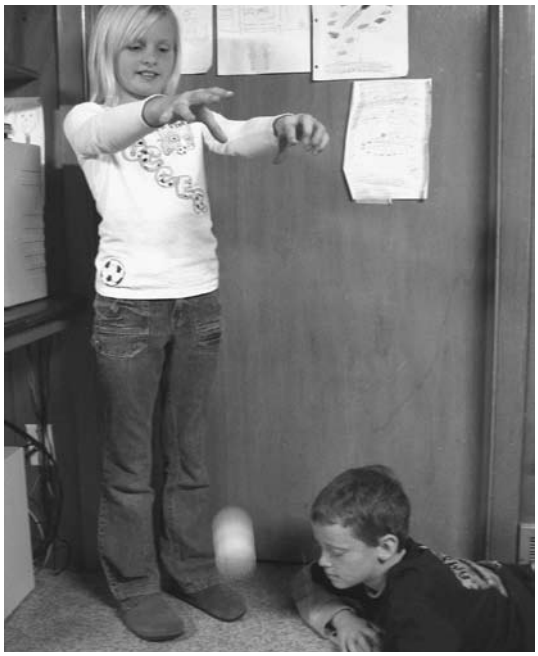
? Look at the title and the picture on the cover. What do you think this book might be about?

Determining Importance

Ask students to signal (by touching an ear, raising a hand, or some other method) when they hear the name of the force that makes things fall. Then read pages 1–11 (stop reading after "down, down, down") and ask

? What's the name of the force that is always pulling things "down, down, down"? (gravity)

Continue reading aloud to page 15 (stop reading after the pages that describe dropping the penny and the key). Hold a penny and a key in the same hand and ask



Dropping races

? What will happen if I open my hand? (The penny and key will fall.)

? What causes them to fall? (Gravity pulls them down.)

? Which one will hit the ground first? (Answers will vary.)

Ask students to watch the ground closely as you open your hand to see which object hits the ground first. Be sure that the penny and key are released at the same exact time. Students should notice that the penny and key hit the ground at the same time. You may need to do this several times to convince students!

Dropping Races

Pass out the supplies for dropping races (tennis balls, marbles, paper clips, pennies, books) and the Dropping Races student page, and allow students time to try all of the dropping races.

Have students share their results for the dropping races. Students should discover that all of the races result in a tie. If students are not convinced that all races resulted in a tie, perform some whole-class demonstrations of the dropping races.

Then read pages 16 and 17 aloud (about dropping races). Explain that gravity affects all objects equally. This means that heavy objects fall at the same rate as lighter objects. Some students may ask about objects like a feather or a piece of paper that they have observed falling slowly. Tell students that when you drop something that the wind could easily blow away, it does fall slowly because, as mentioned on page 17, air is "fighting" against gravity with very light objects. Drop a sheet of notebook paper and have students observe the paper "fighting" against gravity as it slowly drifts down.

Continue reading through page 19 "Astronauts proved this on the Moon … every dropping race was a tie." Some students may have trouble believing that, if there were no air, every dropping race would be a tie. One way to demonstrate this is to do the following additional activity (not described in the book):

1 Take a book and a piece of paper smaller than the book, and drop them at the same time from the same height. Students will observe that the paper falls more slowly. Explain that because the paper is lighter and more spread out, air "fights" against gravity.

2 Ask

? What do you think would happen if I put the paper on top of the book and dropped them together so that the book pushes the air out of the way?

Have students make their predictions.

3 Place the paper on top of the book and drop them together. The book and paper land together, because the book is "fighting" the air, not the paper.

Read pages 20 and 21 ("Which hits your hand harder, the sponge or the soap?"), and then demonstrate the activity with a dry sponge and a bar of soap. Ask for a student volunteer to hold his or her hand outstretched and palm up. Drop

A dropping race demonstration

the sponge into the student's hand. Repeat with the bar of soap. Ask

? Which hits harder, the sponge or the soap? (the soap)

? Why? (because it is heavier)

Next, read pages 22–29 aloud. Show students an example of a heavy shoe and a light shoe tied to rubber bands. Ask students

? Which shoe is heavier? (The one that stretches the rubber band the longest.)

Read the rest of the book aloud. Ask

? How much would you weigh if there was no gravity? (Nothing, without gravity we would all be weightless.)

evaluate

Falling Objects Quiz

Review the concepts that have been explored in this lesson, and then give students the Falling Objects Quiz. Answers are:

1. c
2. b
3. b
4. b
5. a
6. b

Inquiry Place

Have students brainstorm testable questions such as

- Which rolls faster, a heavier ball or a lighter ball?
- Which surface lets a ball roll farthest?
- Which falls faster, a feather or a sheet of paper?
- How can you slow the fall of an object?

Then have students select a question to investigate as a class, or have groups of students vote on the question they want to investigate as a team. After they make their predictions, have them design an experiment to test their predictions. Students can present their findings at a poster session or gallery walk.

More Books to Read

Berenstain, J. and S. 1998. *The Berenstain Bears ride the Thunderbolt*. New York: Random House Books for Young Readers.

Summary: Readers will love spending a day at the Bear Country Amusement Park, where they'll experience the stomach-dropping, heart-stopping thrills of a giant roller coaster right along with the Berenstain Bears.

Cole, J. 1998. *Magic school bus plays ball: A book about forces*. New York: Scholastic.

Summary: Mrs. Frizzle and her class shrink to fit inside a physics book where they enter a page about a baseball field with no friction. The kids learn about how throwing, running, and catching would work in a world without friction.

Llewellyn, C. 2004. *And everyone shouted "Pull!": A first look at forces and motion*. Minneapolis: Picture Window Books.

Summary: Hop on the cart, and join the farm animals as they find out how to take their heavy load on the hilly journey to market.

Stille, D. 2004. *Motion: Push and pull, fast and slow*. Minneapolis: Picture Window Books.

Summary: Up, down, forward, and back. Sideways or around and around. See how things get moving—and what makes them stop—in this lively book on motion. Includes a table of contents, glossary, simple experiments, and a FactHound website with links to other safe, fun websites.

Whitehouse, P. 2003. *Rolling*. Chicago: Heinemann Library.

Summary: Brief text, colorful photographs, and simple, hands-on activities explain the properties that make rolling easy or difficult.

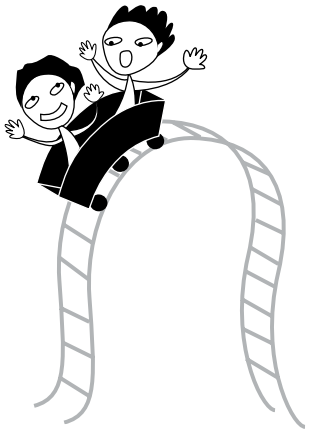
Websites

Funderstanding Roller Coaster
www.funderstanding.com/k12/coaster

Amusement Park Physics: What are the forces behind the fun?
www.learner.org/resources/series136.html

Name: _____

Roller Coaster Challenges



Can you do the challenges below?

Check ☑ yes or ☑ no.

1. Can you make the ball roll from one end of the track and stop in the cup?

   ☐ yes ☐ no

2. Can you make the ball roll faster?

   ☐ yes ☐ no

3. Can you make the ball roll more slowly?

   ☐ yes ☐ no

4. Can you make the ball go over a hill on your roller coaster?

   ☐ yes ☐ no

5. Can you make the ball go over two hills on your roller coaster?

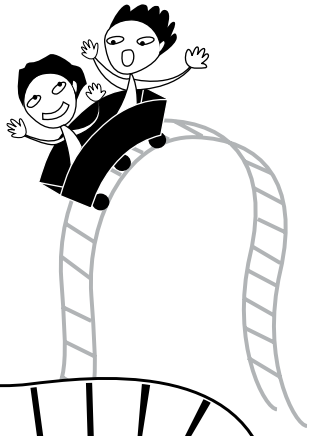
   ☐ yes ☐ no

6. Can you make the ball go through a loop on your roller coaster?

   ☐ yes ☐ no

Name: _____

My Roller Coaster



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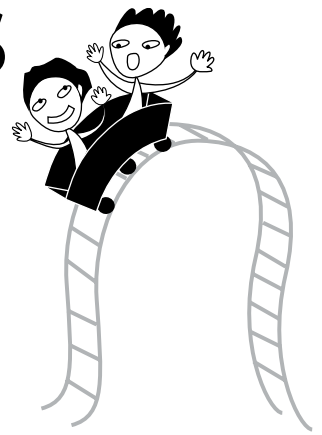
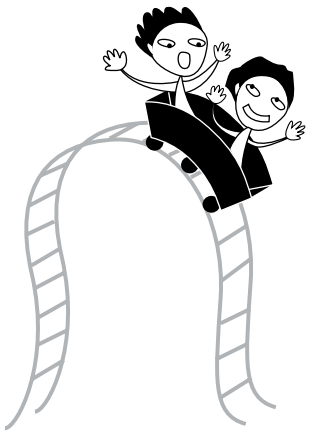
Dropping Races



Drop the following objects at the same time from the same height. Check ☑ the winner of each dropping race.

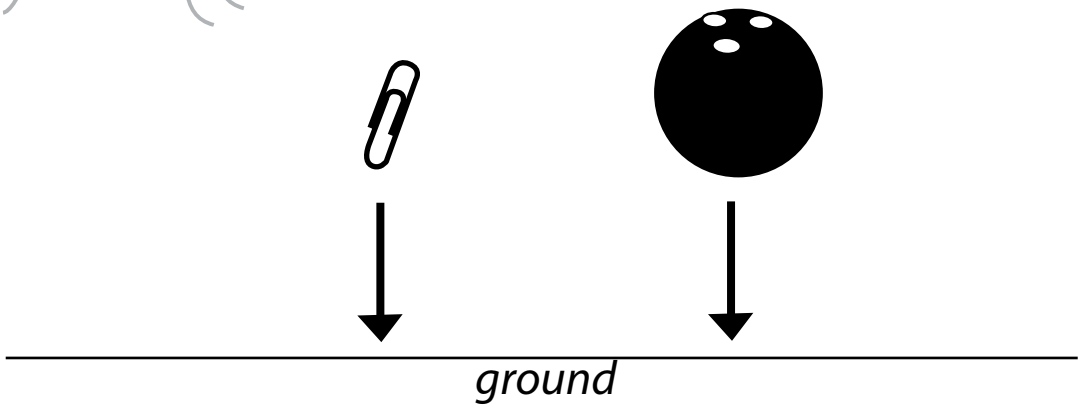
1. Tennis Ball ☐	Marble ☐	Tie ☐
2. Tennis Ball ☐	Paper clip ☐	Tie ☐
3. Tennis Ball ☐	Penny ☐	Tie ☐
4. Penny ☐	Book ☐	Tie ☐
5. Paper clip ☐	Book ☐	Tie ☐

Name: _____



Falling Objects Quiz

Anna drops a bowling ball and a paper clip from the same height at the same time.



1. Which will hit the ground first?
   a. paper clip
   b. bowling ball
   c. Both will hit at the same time.

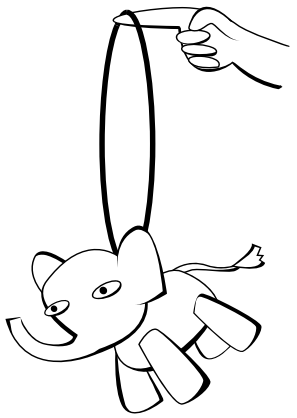
2. Which will hit the ground the **hardest**?
   a. paper clip
   b. bowling ball
   c. Both will hit just as hard.

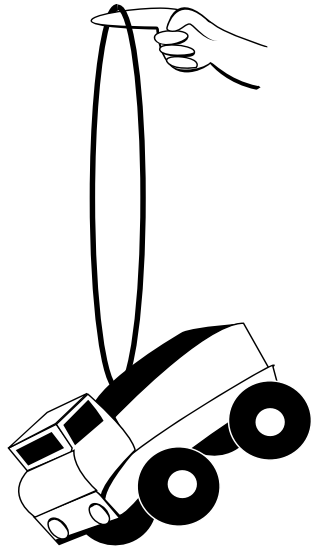
3. What force causes objects to fall?
   a. friction
   b. gravity
   c. air

Name: _____

Falling Objects Quiz cont.

Jesse tied the same rubber band to two of his toys.





4. Which toy is the heavier?
   a. the toy elephant
   b. the toy truck
   c. They weigh the same.

5. Gravity is always:
   a. pulling things
   b. pushing things
   c. lifting things

6. Where on the track below would a roller coaster be going the fastest? Circle the letter.