

# GRAVITY AND CENTRIFUGAL FORCE

## Learning Objectives

### Students will:

- Understand that a force is a push or a pull
- Explain that gravity is a force that pulls things towards the center of the earth
- Demonstrate how other forces can work against gravity
- Understand the importance of practicing safe behaviors
- Expand science vocabulary
- Use the scientific method to analyze an experiment

## Standards

**Physical Science:** Students can identify forces acting on a single object: gravity and centrifugal force

**Investigation and Experimentation:** Use the steps of the scientific method; communicate the steps and results from an investigation

**Health:** Recognize the importance of practicing safe behaviors

## Materials Needed

- Handout #1: The Scientific Method: Gravity
- Classroom object that can be dropped
- Handout #2: Centrifugal Force
- A small plastic bucket with a handle, filled halfway with water

## Teacher Notes

Circus performers cause audiences to gasp and hold their breath with their daredevil acts. At *The Greatest Show On Earth*<sup>®</sup>, you will see a group of motorcycles speeding up to 65 miles per hour inside a steel globe.

While these circus performers appear to defy gravity, it is actually their understanding of gravity and the laws of motion (physics) that permit them to perform these incredible acts safely. In short, circus performers are not so much daredevils, but scientists who know how to make difficult science concepts thrilling and accessible to young learners.

This lesson teaches concepts of gravity and centrifugal force. These concepts can be extraordinarily difficult. They are difficult to define, touch or measure. Yet they affect us in every way and at all times.

The following investigations bring a whole new meaning to the scientific method with activities that provide “hands-on” experiences with gravity and centrifugal force. A centrifugal force can be created by students and they will see that this force can modify the effect of gravity.

Caution: These activities are apt to be so enjoyable that you run the risk of having your students miss the point. Encourage students to correctly use the words force, gravity and centrifugal force throughout the investigations.



## Activity Directions

### Investigation #1: *The Scientific Method: Gravity*

- 1) Distribute Handout #1 The Scientific Method: Gravity. Review the directions and the question. Have each student write down a hypothesis.
- 2) Ask the class how we might test this hypothesis? What kind of experiment would we need? With the class, design an experiment. Here is a suggestion:

Have one student come to the front of the class. Give the student a small object such as an eraser or marker. Tell the student to hold up the object so that everyone can see it and then drop it.

**Ask:** “What happened to the (name of object)?”

“Why did it go down?”

“Why didn’t it go up?” (Let students give their own answers.)

- 3) Have students record their observations and write a conclusion. Explain that something is pulling the object down, towards the earth. Explain that there is a force pulling on the object. A force is a push or a pull. Gravity is a force. It cannot be seen, but it causes everything on Earth to fall down towards the earth.
- 4) **Ask:** “Can any of you overcome gravity?” Explain that when they jump in the air, their muscles help them to overcome gravity for a brief time. Eventually, gravity “wins,” and they come back down to Earth.

### Investigation # 2: *Explore Centrifugal Force!*

- 1) Distribute Handout #2 Centrifugal Force. Give one to each student. Have students review the concept of gravity by drawing an arrow to show which direction gravity is pulling on the picture of the clown. Review the directions and the question. Have students complete the hypothesis. Then demonstrate the following experiment:

- 2) Fill a small, lightweight plastic bucket halfway with water. Standing still and holding the bucket next to your side, begin to swing it back and forth, faster and faster, until it rotates in a complete circle over your head.

**Ask:** “Why didn’t the water fall out of the bucket when I spun it in a circle? Part of the time the bucket was upside down. Why didn’t gravity pull the water down to the earth?”

- 3) Explain that the spinning of the bucket created another pull or force on the water. This force was strong enough to keep the water from falling out of the bucket. This force is called “centrifugal force.”

**Ask:** “When you are in a car, and the car turns around a corner, what happens to your body?” (Look for students to show you with their bodies how they are forced to lean out against the center of the turn.)

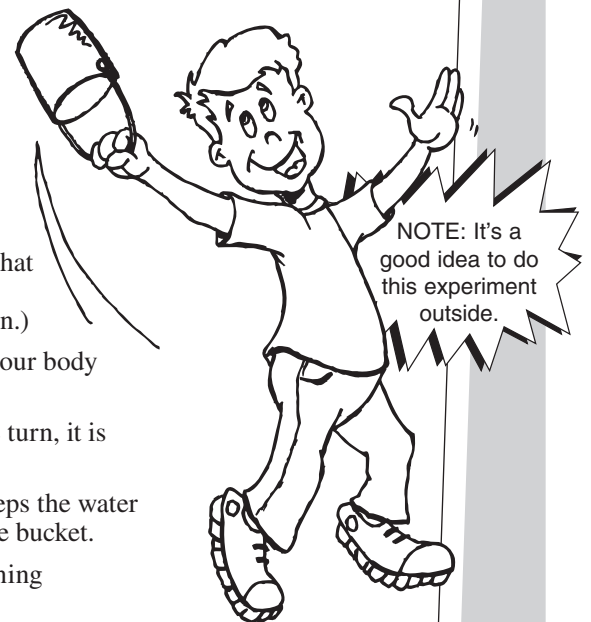
“Has anyone ever been on a rollercoaster ride? What happens to your body when you take a fast turn?”

Explain that when their body is pulled away from the center of the turn, it is centrifugal force that is causing the pull.

- 4) Rotate the bucket of water again. Review that centrifugal force keeps the water from falling out of the bucket while it is spinning. Stop rotating the bucket.

**Ask:** “What happens to the bucket and the water when I stop spinning them around?”

Explain that when the spinning stops, gravity takes over and pulls the bucket and the water down towards the earth.



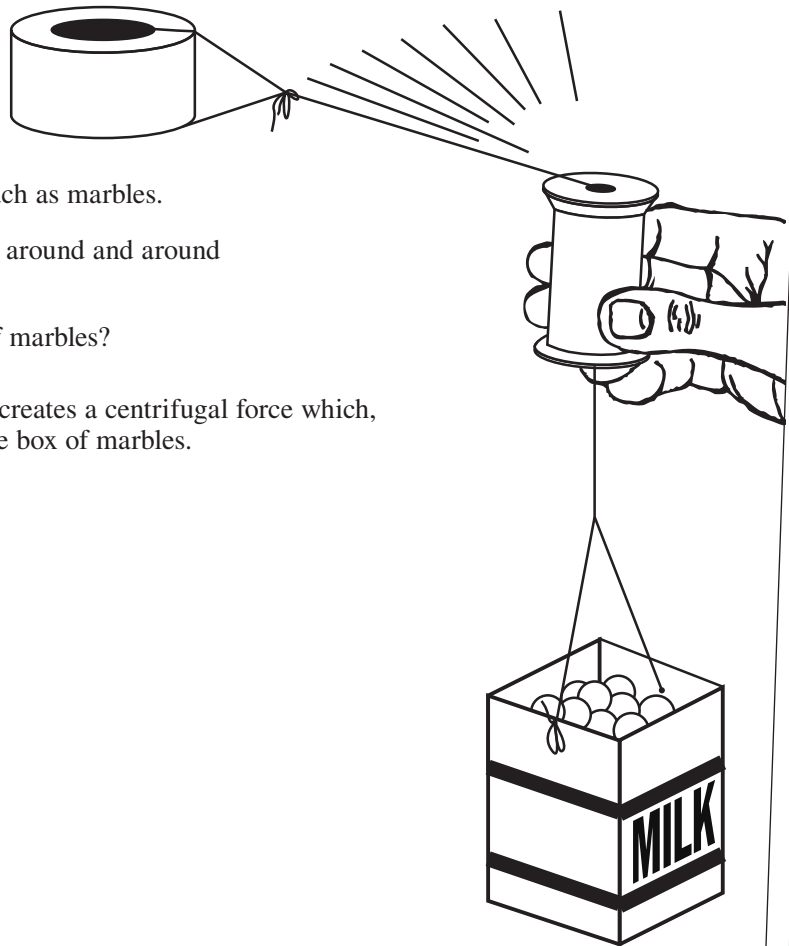
## THE CENTRIFUGAL LIFTER

### Extension

With your class, build a centrifugal lifter to demonstrate how centrifugal force can overcome gravity. You will need the following materials; a two foot long piece of string, a spool, a roll of masking or duct tape, an empty milk carton or small box and several small objects such as marbles.

#### To make the centrifugal lifter:

- 1) Cut the top part off the milk carton to make a small box.
- 2) Thread the string through the spool.
- 3) Tie the roll of tape to one end of the string.
- 4) Tie the box to the other end of the string.
- 5) Fill the box with small objects such as marbles.
- 6) Holding the spool, whirl the tape around and around in circles.



**Ask:** What happens to the box of marbles?

Explain that the whirling of the tape creates a centrifugal force which, when whirled fast enough, can lift the box of marbles.



## THE SCIENTIFIC METHOD: GRAVITY

NAME \_\_\_\_\_

### Investigation #1: *Let's Test Gravity!*

Understanding physics helps to keep the motorcycle daredevils at *Ringling Bros. and Barnum & Bailey*® safe as they career —four or more at time—in a metal globe that barely has room for the riders and their motorcycles.

Today, YOU can have some fun and learn more about the science these extreme circus performers use to keep themselves safe in their daredevil act by using the scientific method, just like REAL scientists! There are five steps to the scientific method. Let's start with the simple concept of Gravity.

**1) Question:** *What do you think will happen when you drop an object?*

Curious scientists start their investigations with a question.

**2) Hypothesis:** *Explain what you think will happen if you drop something?*

Next scientists come up with a hypothesis, which is a big word that simply means that they think up an answer to the question.

**Write what you think will happen:**

---

---

---

**3) Experiment:**

Scientists create an experiment to try and find an answer to the question.

**Describe your experiment:**

---

---

---

**4) Observations:**

During the experiment, a scientist carefully observes and records, or writes down, everything that happens.

**Describe what happened in your experiment:**

---

---

---

**5) Conclusion:**

After the experiment is over, scientists write down an answer to their question called a conclusion.

---

---

---

# CENTRIFUGAL FORCE

## Investigation # 2: Explore Centrifugal Force!

1) **Question:** *What will happen when you swing a bucket of water in a circle over your head?*

2) **Hypothesis:** *Write what you **think** will happen when you swing a bucket of water in a circle over your head.*

---

---

---

3) **Experiment:**  
How will you test your hypothesis?

---

---

---

4) **Observations:**  
Here is what happened:

---

---

---

5) **Conclusion:**  
Write what you learned.

---

---

---

**Bonus!**  
Discuss with your classmates what other questions and hypotheses you could test. Work with your teacher to develop an experiment to help prove your hypotheses. Share your results with the class.