Circus Science | Understanding Gravity with the Gravity-Defying Russian Swing Act!

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

Health: Recognize the importance of practicing safe laboratory behaviors.
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.

Materials Needed

Handout #1: Investigation #1 – Understanding Gravity
A classroom object that can be dropped
Handout #2: Investigation #2 – Explore Centrifugal Force
A small, plastic bucket with a handle, filled halfway with water

Background Teacher Notes

Ringling Bros. and Barnum & Bailey® presents *ZING ZANG ZOOM*℠ features incredible acrobats on the Russian Swing. In classic Russian Swing presentations, a heavy swing platform supporting two or more standing troupers is pumped back and forth until it is swinging in high arcs. Then, amazingly, the troupe members vault from the swinging platform, performing an array of spins and flips in mid-flight. Dangerous to perform and difficult to master, the Russian Swing act demands its performers use the physics of motion to stay safe.

This lesson teaches concepts of gravity and centrifugal force that contribute to the knowledge which Russian Swing acrobats need in order to create breathtaking acts that are also safe.

These scientific concepts can be extraordinarily difficult to define 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 this force can modify the effect of gravity.

Caution: These activities are likely 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: Understanding Gravity

1) Distribute Handout #1 *Understanding Gravity.* Review the directions and the question. Have students write down their **hypothesis.**

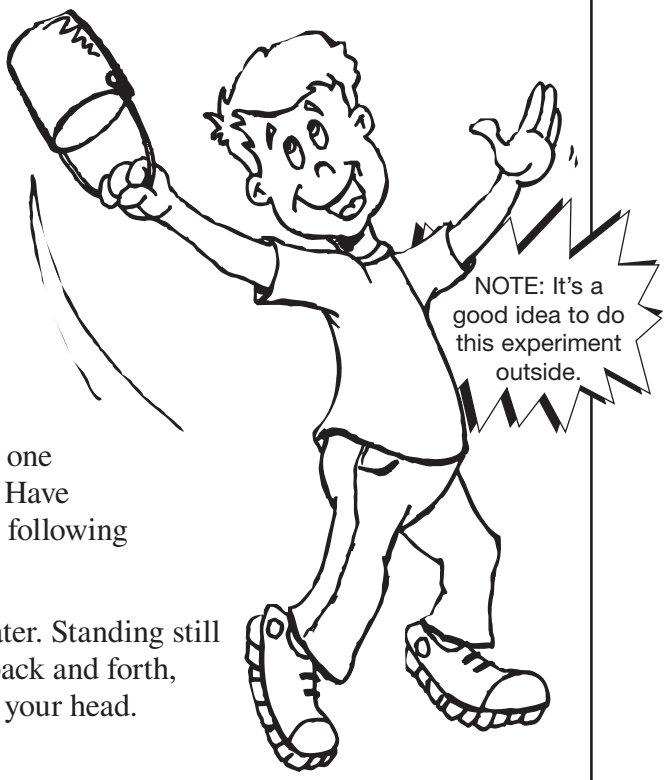
2) Ask the class how we might test this hypothesis. What kind of experiment would we need? With the class, design an experiment. Here is a suggestion:

   Have one student come to the front of the class. Give the student a small object such as an eraser, marker, etc. 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 toward 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 *Explore Centrifugal Force.* Give one to each student. Review the directions and the question. Have students complete the hypothesis. Then demonstrate the following experiment.

2) Fill a small plastic (lightweight) bucket halfway with water. Standing still and holding the bucket by its handle, 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 toward the earth.

Extension

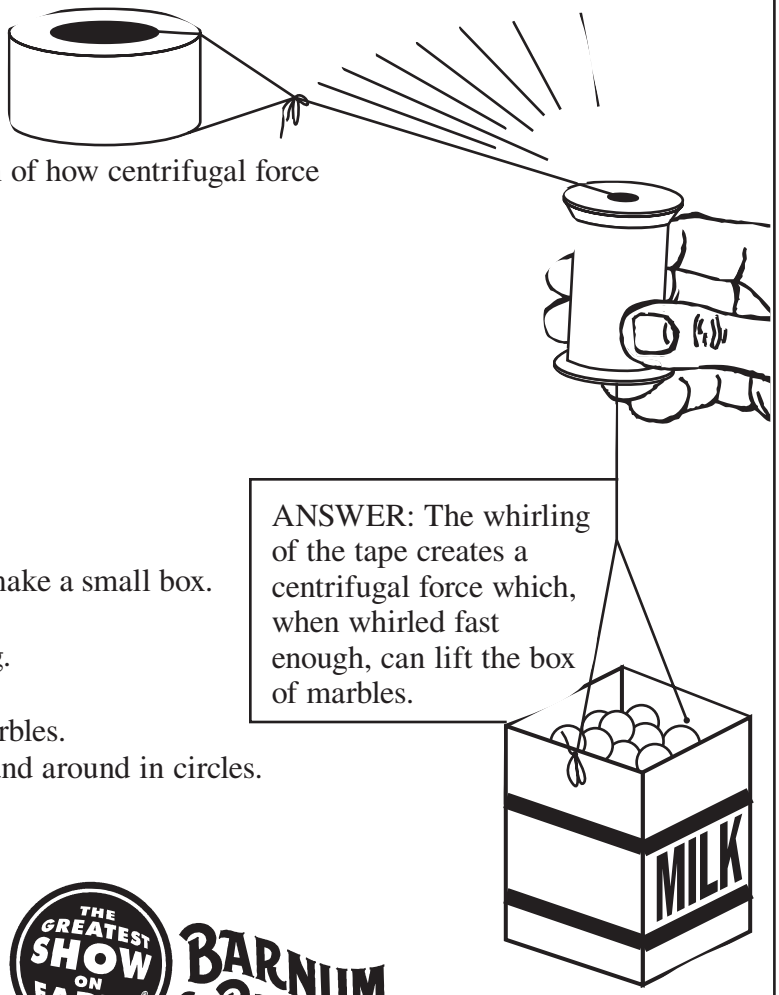
This experiment offers another demonstration of how centrifugal force can overcome gravity.

Centrifugal Lifter

Materials

- 2-foot long piece of string
- Spool
- Roll of masking or duct tape
- An empty milk carton or small box
- Several small objects such as marbles

1) Cut off the top part of 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. What happens to the box of marbles?



ANSWER: The whirling of the tape creates a centrifugal force which, when whirled fast enough, can lift the box of marbles.

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Investigation #1: Understanding Gravity

The Russian Swing performers may look like daredevils, but they think like scientists.

Understanding the physics of motion is what keeps them safe!

Today, YOU can have some fun and learn more about the science they use to keep themselves safe in their daredevil acts by using the **scientific method,** just like REAL scientists.

Question:
What will happen when you drop an object?
Curious scientists start their investigations with a question.

Hypothesis:
*What do **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 for the question.

Write what you think will happen:

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

Describe your experiment.

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

Here is what happened:

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

What happened when I dropped an object?

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Circus Science | Explore Centrifugal Force with the Russian Swing Acrobats!

Investigation #2: Explore Centrifugal Force

If gravity is pulling everything down toward the center of the Earth, what keeps the Russian Swing acrobats from falling when they launch off the Russian Swing platform? Try this experiment and find out about the force that keeps the acrobats safe.

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

Hypothesis:
What do **you think** will happen when you swing a bucket of water in a circle over your head?

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Experiment:
How will you test your hypothesis?

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Observations:
Here is what happened:

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Conclusion:
Write what you learned.

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