

# GRAVITY: An Introduction

## Teacher information:

Gravity is a force that acts at a distance, unlike a "contact" force that we might use to push a chair across the floor. In 1661 Isaac Newton formulated the Universal Law of Gravitation, which states that two objects do not need to be in contact to exert forces on one another. Newton's explanation of gravity states that two objects attract each other with a force that depends on how much mass they possess and the distance between them. The greater the masses, the greater the force of attraction. The greater the distance between them, the weaker the force.

More formally, Newton's Universal Law of gravitation states that every object attracts every other object with a force that is directly proportional to the mass of each object and inversely proportional to the square of the distance between them.

When an object falls to the ground, it does so because a force of attraction exists between the mass of the object and the mass of the Earth. They pull each other. The combined masses of the Earth and the object give rise to the force of attraction. We usually don't think of the object contributing to the force of gravity, because when an object (such as a ball of clay) is dropped, the ball is the only object that moves because the Earth is so much more massive than the ball of clay.

## Galileo's Experiment:

According to books of the time (in 1588) things fell at a rate proportional to their weight. That's what Aristotle had said. The heavier things were supposed to fall faster. Galileo had other ideas. According to the story, he tested his idea by lugging an iron cannon ball and a wooden ball of an equal size (but less weight) up the Leaning Tower of Pisa. He dropped both of them at the same time. They hit smack in the middle of the town square, striking the ground at the same instant.

It proved that bodies fall at the same rate no matter what they weigh.

## Objectives:

1. Students will be able to define force, weight, and gravity.
2. Students will learn that objects of different weights fall at the same speed.
3. Students will be able to explain what produces the force of gravity.
4. Students will begin to create a notebook of pictures, definitions, and observations about the physics behind toys to take with them at the end of the series of lessons.

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**Vocabulary:**

Force: A push or pull acting on a body.

Weight: The measure of how strong the force of gravity is between an object and the Earth.

Gravity: The force of attraction existing between two bodies.

**Materials needed:**

- small objects that do not bounce (one for each student)
- two objects of different weights
- two film canisters for each group of students – one empty and one filled with weights
- “You Be Galileo” activity sheets – one for each student
- pencils
- weight on other planets sheets (one for each student)
- calculators (one for each group)

**Introduction:**

What is a force? A push or pull acting on a body. (A force usually causes some distortion of the body, a change in velocity, or both.)

Ask the students to show some examples of forces. Ask them for examples of forces around us.

**Activity 1: Dropped Objects***Materials needed:*

- small objects that do not bounce (one for each student)

*Procedure:*

1. Give each student an object to drop. Have students drop their objects. Ask: “Where did it fall? Will it fall to the ground the next time you drop it?”

2. Trade objects and have students drop them again. Ask: "Is someone or something pushing or pulling on the object to make it fall to the ground?"

If students answer “no” explain that an invisible force called gravity is causing their objects to fall.

3. Explain that the force of gravity causes all objects to fall and keeps all objects on the ground.

4. Tell students that when they push a chair, they are producing the force on the chair. Ask, “What produces the force of gravity?” (The force of attraction existing between the mass of the object and the mass of the Earth.)

**Activity 2:** Will objects of different weights fall at different speeds?

*Materials needed:*

- two objects of different weights
- two film canisters for each group of students – one empty and one filled with weights
- "You Be Galileo" activity sheets – one for each student
- pencils

*Procedure:*

1. Show the students two objects of different weights. Ask which one will hit the ground first if you drop them both at the same time.
2. Explain that Galileo did an experiment to test if objects of different weights will fall at the same rate. They will do a similar experiment with film canisters. (See teacher information for a story about Galileo.)
3. Divide students into groups of four or five. Set up a dropping station for each group - stepladder, table edge, chair on table – the higher the better. Check that stations are sturdy.
4. Ask: Do heavy objects fall faster than lighter ones? How can we tell if one object falls faster than another? How will we know if the objects hit the ground at the same time? What senses can we use? (vision, hearing)
5. Give groups light and heavy film canisters to test. Ask: Does gravity pull equally on heavy and light objects?
6. Give each student the "You Be Galileo" activity sheet. Have each group do the activity. (Note: This activity can be done together as one large group for younger students who may not be able to read the activity sheet.)
7. Discuss the results of the experiments.

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**Activity 3:** Weight

*Materials needed:*

- weight on other planets sheets (one for each student)
- pencils
- calculators

*Procedure:*

1. What is weight? The measure of how strong the force of gravity is between an object and the Earth (or other large body).

2. In this activity the students will learn that weight is different on different planets. Explain that how much something weighs depends on the force of gravity. Different planets have different masses. A planet of larger mass will have a stronger force of gravity and therefore something would weigh more on the planet.

3. Do the weight on different planets activity.

4. Ask: "What would happen if you tried to play with certain toys on planets with large mass?"

"Are there any toys you have that might not work if you were on Jupiter? How about Pluto?"

#### **Activity 4:** Art activity

Every day in this series the students will be invited to draw a picture or write about their experience that day. Today they may begin by drawing pictures about gravity. Encourage students to write the definitions of words they learned today.

#### *Materials needed:*

- drawing paper
- markers, pencils, or crayons

#### *Procedure:*

1. Draw pictures with the title: "Gravity at Work."
2. Write the definitions of some of the words they learned today.

#### *Optional wrap-up:*

Finish by reading the story "Chicken Little."

#### *Resources:*

Terrific Science Press. Teaching Physics with TOYS; TAB Books, 1995, pp 11–14.  
Allison, Linda. Gee, Wiz!; Little, Brown & Company, 1983, pp 120–121.

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YOU BE GALILEO!!

Do heavier objects fall faster than lighter objects?

What do you think?

If you drop a heavy canister and an empty canister at the same time, will the heavy one fall faster?

\_\_\_ Yes \_\_\_ No

Let's find out!!

1. Assign jobs.

- DROPPER places a heavy and light canister on the edge of a surface. When Starter says, "GO!" the Dropper knocks both off at exactly the same time.
- STARTER says, "GO!" and makes sure canisters fall at the same time.
- EYES and EARS wear safety glasses. They lie on the floor to see when objects hit. They listen as objects hit. Are the hit sounds together or apart?

2. Run four trials. Rotate jobs so everyone fills all jobs.

Which canister hit the ground first?

The heavier (H), the lighter (L), or both at the same time (S)?  
Record H, L, or S on this chart.



	Trial #1	Trial #2	Trial #3	Trial #4
Dropper				
Starter				
Eyes & Ears 1				
Eyes & Ears 2				

**Wrap-up**

Do heavy objects fall faster than lighter ones?

Were the trials easy to judge?

Explain why or why not.