SIEMENS STEM DAY | Science Technology Engineering Math

GRADES K–2

SIEMENS STEM DAY ACTIVITY

GERONIMO!

1 HOUR

REAL-WORLD SCIENCE TOPICS

- An exploration of forces and motion
- An exploration of friction (air resistance)

OVERVIEW

In this activity, students will test the effectiveness of different parachute designs.

TOPIC

Air resistance

OBJECTIVE

Students will gain an understanding of how air resistance affects the motion of an object.

MATERIALS NEEDED FOR TEACHER DEMONSTRATION

- pictures of people parachuting (optional)
- 2 sheets of paper
- single-hole punch
- yarn
- small action figure, toy car, or similar small, dense object
- chair, stool, step ladder, or other high place to drop objects from (ideally 10–20 feet)
- ruler
- pencil
- scissors
- tape

MATERIALS NEEDED FOR STUDENT TEAMS (GRADES 2–3)

- blank or lined paper (several sheets)
- graph paper (several sheets)
- single-hole punch (optional)
- yarn
- small action figure, toy car, or similar small, dense object
- ruler
- pencil
- scissors
- tape

TEACHER NOTES

Use your discretion on the best way to conduct this activity based on the individual level of your class. For some of the younger K–1 classes, you may wish to perform some or all of the steps of the activity, encouraging children to make predictions and observations. If the group is older or more advanced in their abilities, students can take a more hands-on role in performing the related tasks. Leveled methodologies for K–1 and 2–3 grade levels are provided, where appropriate, throughout the activity. Use your knowledge of each class to determine what the best option is for your particular group.

TEACHER PREPARATION

Students will have the easiest time attaching their parachutes to the objects if the yarn can be easily tied to them. Small action figures are ideal, but other objects that would work well include small rocks, wooden blocks, or even bundles of sand or pebbles wrapped in aluminum foil or plastic wrap. The objects should be dense enough to fall straight down.

NGSS THREE-DIMENSIONS

Science and Engineering Practices	Disciplinary Core Idea	Crosscutting Concepts
Analyzing and Interpreting Data Analyze data from tests of an object or tool to determine if it works as intended.	**ETS1.C: Optimizing the Design Solution** Because there is always more than one possible solution to a problem, it is useful to compare and test designs.	**Structure and Function** The shape and stability of structures of natural and designed objects are related to their function(s).

STEPS FOR GERONIMO!

1. **Warm-up Activity:** hold up two sheets of paper. Point out that they are identical—they are the same size and weight. Crumple one of the sheets into a tight ball. Have two volunteers come to the front of the room. Ask students to predict what will happen to each sheet of paper when they are dropped. give one student the balled-up piece of paper and the other the flat sheet of paper. Tell them you are going to count slowly to 3, and on 3 they should drop the paper. The ball of paper should drop to the ground quickly. The flat sheet should float and twist and land well after the ball lands. Discuss what happened with the students.
2. Have the students jump once. Ask them what pulled them back to the ground. Explain to the students that gravity pulls their bodies down to the ground so they do not float away. Gravity also pulled the pieces of paper downward when they were dropped. When they were dropped, air also played a part. Air particles hit the pieces of paper, pushing up on them from below. This upward force is called drag. The drag on an object partly cancels the downward pull of gravity. The greater the upward force on the paper, the slower it falls. There was a greater upward force on the flat sheet of paper because there was more room across it for the air particles to hit. If you have images of parachutists available, show them to students. Explain that a parachute increases the drag on a person so that the person falls slowly and safely to the ground, even from a great height. Explain to students that in this experiment they will investigate the effects of different shapes of parachutes on a falling object.
3. Discuss with the students their ideas about the factors that make the flat piece of paper fall more slowly than the crumpled piece of paper. Demonstrate how to make a parachute from the materials so students will understand the procedure. Divide students into no more than four groups and distribute the materials and their **Geronimo!** student handouts. Have groups work together to design a parachute out of paper that will slow the figure down the most. They should sketch their design on student handout. You can determine based on the abilities of the students if they are able to use the hole punch themselves. If not, be available to assist students with that task so that they can punch holes in the edges of their parachutes and tie yarn through the holes. have them use the yarn to tie the parachute to the action figure (or other small mass).

4. If possible, stand on a chair, stool, or step ladder for the drops. It is important that all of the drops start at the same height every time. The greater height provided by the chair, stool, or step ladder will make it easier for students to time the fall. Hold an action figure (without a parachute attached) up as high as you can. Drop the figure and have the students count the seconds it takes for it to hit the ground. Have students record the time on the chart under question 2 of the student handout. Repeat the drop three more times, having students record each time on their handout.
5. Students will now drop their parachutes themselves. Have each group in turn bring their parachutes up to the front of the classroom. Hold up each group's parachute as high as you can and drop it (ideally from the chair, stool, or step ladder). Have students count the seconds it takes the figure to hit the ground. Drop each group's figures four times total. Each group should record their times in the chart under question 3 on their student handout.
6. Discuss the student's first observations. Have them work together in their groups to decide how to adjust their parachute designs to make them more effective. Allow them to modify their designs and test them again. As each group completes its redesign, have them bring it to you for their drop test (again, ideally from the chair, stool, or step ladder). They will again count the seconds it takes for the figure to hit the ground and record the number of seconds under question 4 of their student handout. Repeat the drop three more times, having them record each time.
7. **Wrap-up Activity:** Ask students to share how they chose their designs. Ask students if their redesign was more successful than the original. Ask them why they think one design worked better. Explore which groups had the most successful design. If the drop of the most successful parachute was not witnessed by the whole class, invite that group up to perform a demonstration drop of that most successful design. Guide students to understand that, in general, the most effective parachutes have the most area across them for the air particles to hit. Ask students to share their experiences. Prompt discussion by asking some of the following questions:?
    - How does the shape of the parachute change how quickly or slowly it falls?
    - How did you decide what shapes to test?
    - Did you have an idea that did not work well? What did you do to solve the problem?

GERONIMO! EXTENSION ACTIVITIES

1. Have the students find objects of various shapes and size, such as feathers, coins, pencils, notebooks, etc. have the students choose two objects. have those objects "race" to see which one hits the ground first by dropping them from the same height at the same time. Discuss with the students which objects have more room across them for the air particles to hit and how this affects the speed at which they fall.
2. Try the parachute drop again, but use different materials for the parachute. Use squares of plastic from freezer bags, plastic wrap, aluminum foil, cloth, etc., to observe which material works better as a parachute.

BACKGROUND INFORMATION

What is gravity?

Gravity is a force between two objects that pulls them toward one another. The strength of the pull depends on the size of the objects. The more mass an object has, the more it attracts other objects. The sun is the most massive object in our solar system. Its gravitational pull is what causes planets and other celestial bodies to rotate about it.

How does air resistance affect a falling object?

When an object falls through Earth's atmosphere, it hits molecules in the air. These particles resist the object's movement through the atmosphere. This is called a drag force. This force is not strong enough to slow the motion of very dense objects by much, but its effect on less dense objects is easier to see. For example, the force of air resistance on a parachute is strong enough to slow the speed of a person falling through the air, and the force of air resistance on a feather causes it to fall quite slowly through the atmosphere.

KEY VOCABULARY

gravity: A force between two objects that pulls them toward one another

parachute: An object with a large surface and small mass used by people to fall safely from high altitudes

air resistance: The force put forth by air molecules hitting a falling object

drag: Another term for air resistance

GERONIMO!

1. Sketch the design of your parachute in the space below. Be sure to label each part.
   [Sample answer: Images will vary.]

2. Count the seconds it takes for the figure without a parachute to hit the floor. Record the data in the chart below.
   [Sample answers included in the chart]

Test Number	Time for figure to hit the floor
1	**[2 s]**
2	**[3 s]**
3	**[2 s]**
4	**[4 s]**

3. Bring your parachute design to the teacher for dropping. Count the seconds it takes for your figure to hit the floor. Record the data in the chart below.

PARACHUTE DESIGN 1:	
Test Number	**Time for figure to hit the floor**
1	**[2 s]**
2	**[3 s]**
3	**[2 s]**
4	**[4 s]**

4. Try to modify your parachute design to make the figure drop more slowly. Sketch your new design in the chart. Bring your redesigned parachute to the teacher for dropping. Count the seconds it takes for your figure to hit the floor. Record the data in the chart below

PARACHUTE DESIGN 2 SKETCH: [IMAGES WILL VARY]	
Test Number	**Time for figure to hit the floor**
1	**[2 s]**
2	**[3 s]**
3	**[2 s]**
4	**[4 s]**

5. Which parachute design slowed the figure the most? Why do you think this was the case?
[Sample answer: Parachute design 4 slowed the figurine the most. I think this was because it was the widest parachute of all of them, and so there was more air resistance to slow the figurine.]

6. How could you modify this design in the future?
[Sample answer: I would make the parachute even wider. I might also use a lighter material.]

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Test Number	Time for figure to hit the floor
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3	
4	

3. Bring your parachute design to the teacher for dropping. Count the seconds it takes for your figure to hit the floor. Record the data in the chart below.

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PARACHUTE DESIGN 2 SKETCH

PARACHUTE DESIGN 2 SKETCH:	
Test Number	**Time for figure to hit the floor**
1	
2	
3	
4	

5. Which parachute design slowed the figure the most? Why do you think this was the case?

6. How could you modify this design in the future?