NATIONAL MUSEUM OF THE UNITED STATES AIR FORCE™

Parachutes: Is It Surface Area or Shape?

Students will practice their math and science skills while building and testing a variety of shapes and sizes of parachutes.

LESSON PLAN

Learning Objectives:

The students will:

- Work in small groups to construct parachutes
- Measure the area of various geometric shapes
- Measure time of descent
- Collect data, create charts, and graph data
- Use data to make inferences about the surface area and shape of parachutes and the time of descent.

Purpose:

Students will investigate how the surface area and shape of a parachute affects its descent. Students will construct parachutes of different shapes containing the same surface area, drop them, and measure their time of descent. Students will also construct several parachutes of the same shape but with different surface areas, drop them, and measure their time of descent. Data will be collected in chart form and then graphed. The charts and graphs will be used to make inferences about the surface area and shape of parachutes and their time of descent.

Introduction:

Parachutes have been around since the late eighteenth century and have played an important part in military and civilian operations. Parachutes have come a long way in science understanding and research development. Materials are less likely to fail, there is less strain on the user and the ability to steer is easier than ever before. We first need to learn about the science behind parachutes. When someone jumps from an airplane, they experience a multitude of forces acting upon them. They experience the air resistance that is present due to the particles in the air reacting to someone's movement and they also experience the terminal velocity of falling from thousands of feet. At the peak of terminal velocity, they are falling at a speed of about 125 mph. This is where a parachute creates an opposite force against the air resistance. Parachutes create an opposite force called drag which reduces velocity. This allows the person parachuting to land at a slower speed and steer safely in different directions. Parachutes vary in their purpose and shape, but they all abide by the same scientific phenomena.

Grade Level: 6 - 8

Ohio Learning Standards/Science (2018)
Expectation of Learning
Nature of Science

Physical Science
6.PS.2: Changes of state
6.PS.3: Energy: kinetic & potential
6.PS.4: Motion: speed & direction
7.PS.4: Energy can be transferred
8.PS.2: Forces can act to change motion

Ohio Learning Standards/Mathematics (2017)
Statistics & Probability
6.SP.4: Display numerical data in plots
6.SP.5:Summarize numerical data sets

Geometry
7.G.2: Draw geometric figures
7.G.6: Solve real-world problems involving area, volume, etc.
8.G.4454345: Understand two-dimensional figures

Expression & Equations
8.EE.5: Graph proportional relationships

Materials Required:

- Several sheets of paper of the same size
- Pencils, colored markers or pencils
- Paper to construct tables
- Graph paper
- Scissors
- String
- Adhesive dots or tape
- Rulers
- Stopwatch or watch with second hand
- Handful of large metal paper clips
- Large plastic garbage bags

Procedure:

A. Warm-up

1. Review equations:
   a. Circle - Area = πr^2, where r = radius
   b. Square, rectangle, parallelogram - Area = (b)(h), where b = base, and h = height
   c. Triangle – Area = ½ (b)(h), where b = base, and h = height
   d. Trapezoid – Area = ½ (h)(a + b), where a and b are the parallel sides

2. Using several pieces of the same size paper, crumple one into a ball. As one student drops the ball, another times its descent, and a third observes its motion.

3. Drop another piece of paper flat without crumpling it. Observe it and time its descent.

4. This time crumple the piece of paper and then smooth it out before dropping it. Time it and observe its motion.

5. Next, ask students to discuss their observations and compare the times of descent. List inferences that can be made.

6. Ask these questions to guide the discussion:
   - Which piece of paper would have made the most effective parachute? Why?
   - Which do you predict would have more effect on the descent of a parachute – surface area or shape? Why?

B. Activity: Part 1

1. Have each group of students measure and cut several different shapes of the same area out of the plastic garbage bags. Suggested shapes include: square, rectangle, trapezoid, parallelogram, triangle, and circle.

2. Cut four pieces of string, each the same length, for each shape. It is important that all the string used is the same length, so that the shape of the parachute is the only variable.

3. Attach the four pieces of string equidistant around the edge of each shape with the tape (three pieces on the triangle).

4. Gather up the loose ends of the strings, being careful not to tangle them and tie together with a small loop or fasten with another piece of tape.

5. Attach one of the large metal paper clips to each of the loops. The plastic part of the finished parachute is called the canopy and the strings the shroud.

6. Drop each finished parachute several times from the same height. Observe the motion of each parachute as it falls and measure the time of its descent.

7. Develop a data table to record results. Then compute the average descent time for each canopy

shape and record it in the data table.

8. Construct a bar graph to show the results.

C. Activity: Part 2

1. Choose at least three of the shapes tested in Part One. For each shape chosen, measure and cut out another 3 to 5 plastic bag pieces of the same shape, but make each piece a different surface area. Record the area for each piece.

2. Again cut four pieces of string of the same length for each parachute, fastening them equidistant along the edge of each canopy with the tape.

3. Gather the loose ends of each parachute and tie or fasten together with a loop.

4. Attach a large metal paper clip to each of the loops.

5. Drop each finished parachute from the same height as you did in part one. Observe the motion of each parachute as it falls and record its descent time in a data table.

6. Find the average for each shape and surface area and record it in the data table.

7. Prepare a bar graph to display the results.

D. Wrap-up

Bring groups together to discuss results as a whole class. Discuss what effect the surface area and the shape of the canopy have on the time of descent of a parachute.

Assessment/Evaluation:

Students will be evaluated on their ability to measure areas of different geometric shapes and their ability to explain the relationships among canopy surface area, canopy shape, and time of descent. The graphs produced should be well organized and easily understood.

Extensions:

1. Make the parachute canopies out of another material such as fabric. Do the results change?

2. Cut a small hole in the center of each parachute. What happens?

3. Try different lengths of string (shrouds). What length seems to work best? What relationship does it have to the surface area of the canopy?

4. Add different weights to the parachutes. How does this affect the time of descent?

Resources/References:

https://www.history.com/this-day-in-history/the-first-parachutist
https://www.explainthatstuff.com/how-parachutes-work.html
https://skydivecal.com/2019/11/08/science-behind-parachutes/
https://sciencing.com/a-parachute-work-4564095.html
https://www.sciencebuddies.org/science-fair-projects/project-ideas/Aero_p017/aerodynamics-hydrodynamics/parachutes-does-size-matter

Picture of Design