SCIENCE FAIR CENTRAL

Maker Corner Activity

PARACHUTE PRECISION

Grade Level: High School

MAKE. CREATE. EXPLORE.

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What does the ideal parachute look like?

Overview

After learning about the forces of flight as well as the many ways that parachutes have been used throughout history, students will work in teams to create an innovative design for their own parachute. They will use a variety of materials to bring their design to life, and they will be challenged to deliver a payload both safely and accurately.

This activity focuses on the **"Defining the Problem", "Designing Solutions", "Creating or Prototyping"**, and **"Refining and Improving"** stages of the Engineering Design Cycle.

Engineering Design Cycle

- **Defining the Problem**
- **Designing Solutions**
- **Creating or Prototyping**
- **Refine or Improve**
- Communicating Results

Have you ever wondered...

When was the first parachute invented?

In 852 AD, Armen Firman constructed a huge cloak that he intended to use like wings as he jumped from a tower in Spain. He was able to survive with only minor injuries thanks to the air resistance of his cloak—and the first primitive version of the parachutes we know today! Several centuries later in the early 1480s, Leonardo da Vinci's sketches also included parachute-like designs. Da Vinci was known for being extremely interested in flight, and his sketches contained a "pyramid-shaped canopy held open by a square wooden frame". However, it wasn't until 1783 that the first recorded modern parachute build and jump was actually made by inventor Louis-Sebastien Lenorman in France[1].

Objectives

Students will be able to:

Understand the various forces that affect the flight of a parachute.

Create a design and model of a parachute that takes these forces **into consideration.**

Assess their model's performance and **optimize** its design.

What are parachutes used for today?

Parachutes are used across a wide range of fields, from sports and car racing to the military and aerospace. In sports, parachutes are used frequently for skydiving and parasailing. Parachutes also assist racecars in drag racing: with the help of a parachute, the highspeed cars require a shorter section of track to slow down and stop. Some airplanes, particularly smaller planes, contain a parachute recovery system that can be employed if the pilot has lost control. Along the same lines, parachutes are also used commonly in aerospace to help spacecrafts and rockets slow down when they land. Alternatively, the military uses parachutes to drop supplies and equipment[2].

Materials

- Device with internet access and projection capabilities, one for the teacher
- Parachute image, to project
- Parachute video, to play
- *A Brief History of the Parachute* article, for students to access on laptops or other devices (Note: This article may also be printed and photocopied if devices are unavailable.)
- Parachute Precision Research Notes Handout, one per student
- Parachute Precision: Design, Create and Improve Handout, one for every three students
- Parachute Precision Notes Sheet, one for the teacher
- 8 hex nuts, enough for half the class

The class can share the following parachute construction materials:

- Different types of trash bags and plastic bags: such as Option 1, Option 2 and Option 3
- plastic sheeting
- Tarp
- String
- Paper bags
- Paracord
- Coffee filters
- Duct tape
- Hot glue gun and hot glue
- Stop watch
- Measuring tape
- Scissors

Make connections!

How does this connect to students?

The future of avionics is nearly impossible to predict...but if you consider that the first manned airplane flight took place in 1903 and today—less than 120 years later—companies are vying to bring tourists to outer space, the potential for avionic expansion is virtually limitless!

An understanding of the forces of flight design will help students better comprehend STEM innovations as this field continue to rapidly advance... and perhaps even inspire them to enter an avionics STEM field one day!

How does this connect to careers?

Avionics Engineers: Avionics engineers perform research and solve problems associated with aviation, including landing system development and other safety systems for both aircraft and space vehicles.

Parachute Riggers
Parachute riggers work with parachutes while they are on the ground, and they are responsible for repairing, handling, and packing them. Parachute riggers can be employed by the military as well as private organizations.

Aircraft Systems Engineers are responsible for creating innovative, lightweight, and safe aircraft designs. They work on aircraft mechanical systems, which may include parachutes!

How does this connect to our world?

Parachutes are used around the world...and beyond! Here are just a few of the interesting ways parachutes are used:

Deep Space: NASA recently successfully tested a parachute that they plan to use to land a rover on Mars![3]

Humanitarian Aid: Parachutes are used occasionally to drop emergency food and supplies to people living in war-torn countries.

Thrill-Seekers: Around the globe, people flock to beautiful locations like Hawaii, Australia, the Alps, the Andes Mountains, and even Dubai to see the landscape from a birds-eye view as they skydive.

Blueprint for Discovery

Prior to class arriving

- Prepare the parachute image and video projection.
- Ensure that students will have devices available to read the article.
- Copy the three handouts.
- Set up a spot for the parachute challenge:
    - Find an area where a small parachute can be dropped from at least 8 feet in the air (and preferably higher!). A staircase would work perfectly, but climbing safely on a chair may work if a staircase is unavailable.
    - Use tape to create a one-foot by one-foot square on the floor directly under the drop point.
- Set up a spot where students can test their designs as they build their parachutes:
    - Ideally, this will be the same area as above—but if not, a test area that resembles the challenge spot will work too! Place a stopwatch and measuring tape at this location for students to use.
- Display the parachute materials in an area of the room that is easily accessible to students.

During class

1. Project the parachute image.
2. Instruct students to brainstorm with a partner: How may a parachute work to protect people?
3. After a couple minutes have passed, write three terms on the board: air resistance, gravity, and acceleration. Explain to students that you are going to show a short video. Following the video, students will be asked to develop a more detailed answer using these three words.
4. Show this video and then give students a couple minutes to work together to construct a response. Then invite a few pairs to share, and collaborate as a class to build a working explanation. Before moving on, ensure students understand that: When an object begins to fall, it has downward acceleration due to gravity. When a parachute opens, its air resistance creates an upward net force that works against the downward pull of gravity. This is what causes the person to fall more slowly.
5. Divide students into groups of three or four students. Explain that each group is going to be challenged to build their own parachute. The groups will then compete to see who can build the safest and most accurate model! Before they begin their build, groups will complete research to see what they can learn from past designs.

6. Pass out a Parachute Precision Research Sheet to each student and review the directions provided. Students should read this *Popular Mechanics* article (using this shortened link: bit.ly/2PNrpox) and take notes on their research sheet.
7. Once students have finished their research, further explain their parachute challenge by reading the following:

   You have been contracted by an old parachute manufacturer that is hoping to boost its sales with a new design. The company is holding a design competition to find one new parachute design. The competition only has two criteria: 1) The parachute must bring a payload to the ground as slowly as possible, and 2) The parachute must land as accurately as possible.
8. If needed, explain that the "payload" is the parachute's cargo, e.g. what the parachute is bringing to the ground. Then distribute eight hex nuts to each group and explain that this is the payload that each parachute must help land safely.
9. Distribute one Parachute Precision: Design, Create and Improve Handout to each group. Tell students that they will follow the three steps outlined on this handout to design, construct, and improve their parachutes. Before students begin, quickly review:
   a. Where students can find the parachute construction materials.
   b. Where the parachute drop will occur, as well as the target they will try to meet.
   c. Where students can test their parachute during the design phase.
   d. How long students will have to complete steps 1, 2, and 3.
10. When there are about 10–15 minutes remaining, assemble students with their parachutes near the testing area. Designate a class:
    a. Timer: This person will use the stopwatch to record the time it takes the payload to reach the ground.
    b. Measurer: This person will use the measuring tape to determine how far the parachute dropped from its target.
    c. Recorder: This person will be in charge of recording each parachute's fall-time and accuracy measurement on the Parachute Precision Notes Sheet.
11. One by one, call on groups to come to the testing area. Before they drop their parachute, challenge each group to explain one element of their design and justify why this design element is included. They should then test their parachute.
12. Once all of the parachutes have been tested, help the Recorder rank each of the parachutes based on their speed and accuracy and then announce the top three winners based on their average overall score!

Take action!

Possible Extension Activities:

1. Encourage groups to pair together, consider how their parachutes performed, review their parachutes' design decisions, and provide recommendations for improvement. Students may then revise their parachutes based on these discussions, and—if time allows—retest their design!
2. Add an extra challenge to the students' parachute design: It must safely cushion the fall of either a hard-boiled egg or a water balloon! Student groups can confer to see what design modifications will need to be made. They can then test their design to see if their parachute is safe enough for these fragile payloads!

National Standards

Science

Next Generation Science Standards

HMS-ETS1-3: Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.

MS-ETS1-4: Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

Technology Education

International Technology and Engineering Educators Association

Students will develop an understanding of Design. This includes knowing about:

- Attributes of design.
- Engineering design.
- The role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

English Language Arts

Common Core

CCSS.ELA-LITERACY.RST.6-8.1
Cite specific textual evidence to support analysis of science and technical texts.

CCSS.ELA-LITERACY.RST.6-8.9
Compare and contrast the information gained from experiments, simulations, video, or multimedia sources with that gained from reading a text on the same topic.

CCSS.ELA-LITERACY.CCRA.SL.4
Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience.

Sources

1—"Parachute." New World Encyclopedia. newworldencyclopedia.org/entry/Parachute.

2—Turner, Graham. What are parachutes used for today? Sciencing. https://sciencing.com/parachutes-used-today-7450870.html.

3—Bartels, Meghan. Tests Supersonic Parachute for Mars Rover Landings. space.com/41752-nasa-launch-tests-supersonic-mars-2020-parachute.html.

Parachute Precision Research Sheet

Directions: As you prepare to build your own parachute, it is important to understand how parachutes were used in the past as well as how they continue to be used today.

Scroll through the slides once to get the gist of the text. Then reread the text and stop to take notes below on at least three different parachutes that may be beneficial to keep in mind as you create your own.

Purpose: What was this parachute used for?	How was the parachute designed to optimally complete this task? What key design takeaways may I want to remember?

Parachute Precision:
Design, Create and Improve Handout

Step 1: Design

Work with your group to sketch your parachute design below. Use the research you completed to guide your design process. Remember: Your goal is to create a parachute that falls as slowly *and* as accurately as possible!

Step 2: Create

Use the materials available to bring your design to life!

Step 3: Improve

Now give your parachute a few trial runs. Load the payload into your parachute and see how it falls. Then consider how the design of your parachute affects its performance and make tweaks accordingly. Continue re-testing the design to see if you are headed in the right direction!

Trial	**Fall Time** (to the .00 of a second)	How could the fall time be increased to improve safety?	**Accuracy** (inches from target)	How could the accuracy of the drop be improved?
1				
2				
3				

Parachute Precision Notes Sheet

Group	**Fall Time** (to the .00 of a second)	**Fall Time Ranking** *To be filled in at the end*	**Accuracy** *(inches from target)*	**Accuracy Ranking** *To be filled in at the end*	**Average Overall Ranking** *(Fall Time + Accuracy)* *To be calculated at the end*