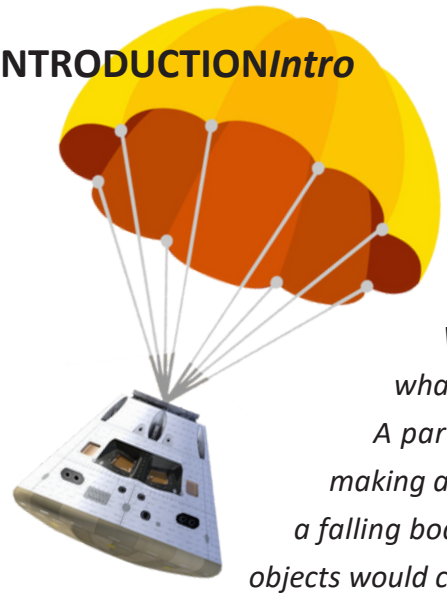
An **ESBAŞ** Enterprise.

PARACHUTE ENGINNERING ACTIVITY

ACTIVITY TAG	
Purpose	Parachutes have played a part in the safe return of objects to Earth since the beginning of the space program and will continue to play a major part in the future of spaceflight. This hands-on activity let students explore and compare different types of parachutes by building their parachute and dropping it from a height.
Short Description of the Activity	In Parachute Engineering activity students design and test parachute landing systems to successfully land a payload. After testing, students can optimize their parachutes by experimenting with different materials and shapes for their parachute designs. Students then retest their designs to see if the changes they made resulted in improved performance of the parachute. Their goal is to land a payload as slowly and softly as possible with their parachutes.
Materials	Coffee filters, tissue paper, ribbon, string, ruler, small plastic cups, foam cups, hole punch, payload (small marbles), masking tape, scissors, cotton balls
Duration	1 hour • Introduction: 5 minutes • Design: 20 minutes • Test: 10 • Redesign: 10 minutes • Retest: 10 minutes • Review: 5 minutes
Educational Objectives	Students will: • Describe why parachutes are needed. • Use teamwork to construct a parachute as a group. • Observe their constructed parachutes as they carry a weight. • Understand how air resistance plays a role in flight. • Use modeling, testing, evaluating, and modifying to transform ideas into practical solutions. • Determine which type of materials work best by testing different options. • Experience the process of a scientific investigation with the parachute they designed. •Learn about air resistance, friction, drag, freefall, velocity, force of gravity, acceleration, surface area & Newton's Laws of Motion
School subjects and topics concerned	Space Sciences, Engineering, Technology, Geometry, Mathematics, Physics
Science Standards	• Science as Inquiry • Science and Technology
Science Process Skills	• Communication • Hypothesizing • Problem Solving • Reasoning • Designing and Testing

INTRODUCTION*Intro*



Welcome future engineers. In this activity, you will explore parachutes and then compare different types of parachutes by building two parachutes and dropping them from a height.

What is the purpose of a parachute?

Imagine you are jumping out of a plane 3000 meters in the air. What type of material would you want your parachute to be made of and what size would you want it to be?

A parachute is an umbrella-shaped device of light fabric used especially for making a safe jump from aircraft. Due to the resistance of air, a drag force acts on a falling body (parachute) to slow down its motion. Without air resistance, or drag, objects would continue to increase speed until they hit the ground. The larger the object, the greater its air resistance.

How Does a Parachute Work?

Parachutes operate on the principle of air resistance, a force that counteracts the pull of gravity on a falling object. When an individual jumps out of an aircraft, the parachute, resembling an umbrella-shaped device made of lightweight fabric, opens up. As the parachute unfolds, it catches air, creating a significant amount of drag. This drag force acts on the falling body, in this case, the parachute, slowing down its descent. Without the resistance of air, objects would free-fall, accelerating until they hit the ground. The larger the object, the greater the air resistance, emphasizing the importance of parachute size. This fundamental concept of utilizing air resistance ensures a controlled descent, allowing for a safe landing, a critical aspect in various scenarios, from recreational skydiving to spacecraft re-entry and exploration missions.

Parachute Systems

Parachutes have used since the earliest days of spaceflight. Anything that we wished to come down gently and safely needs a parachute. While the heat shield protects astronauts and capsules from heat as they re-enter the atmosphere, it doesn't completely slow us down. When NASA lands a spacecraft on another planet or object in our solar system, it is important to have a soft landing so the spacecraft is not damaged on impact. When humans are on spacecraft, it's even more important to have a soft landing. The larger and more massive the spacecraft, the more difficult it is to achieve a soft landing. NASA's new vehicle Orion has been recently undergoing parachute testing.

Orion Parachutes

The Orion capsule employs parachutes for a controlled descent into water upon entering Earth's upper atmosphere. These parachutes, gradually opening to regulate speed, ensure a gentle landing. This technology is not only applicable on Earth but is also crucial for future Mars missions, offering a similar parachute system for safe spacecraft landings on the Martian surface. This method plays a vital role in both space exploration and human space travel.

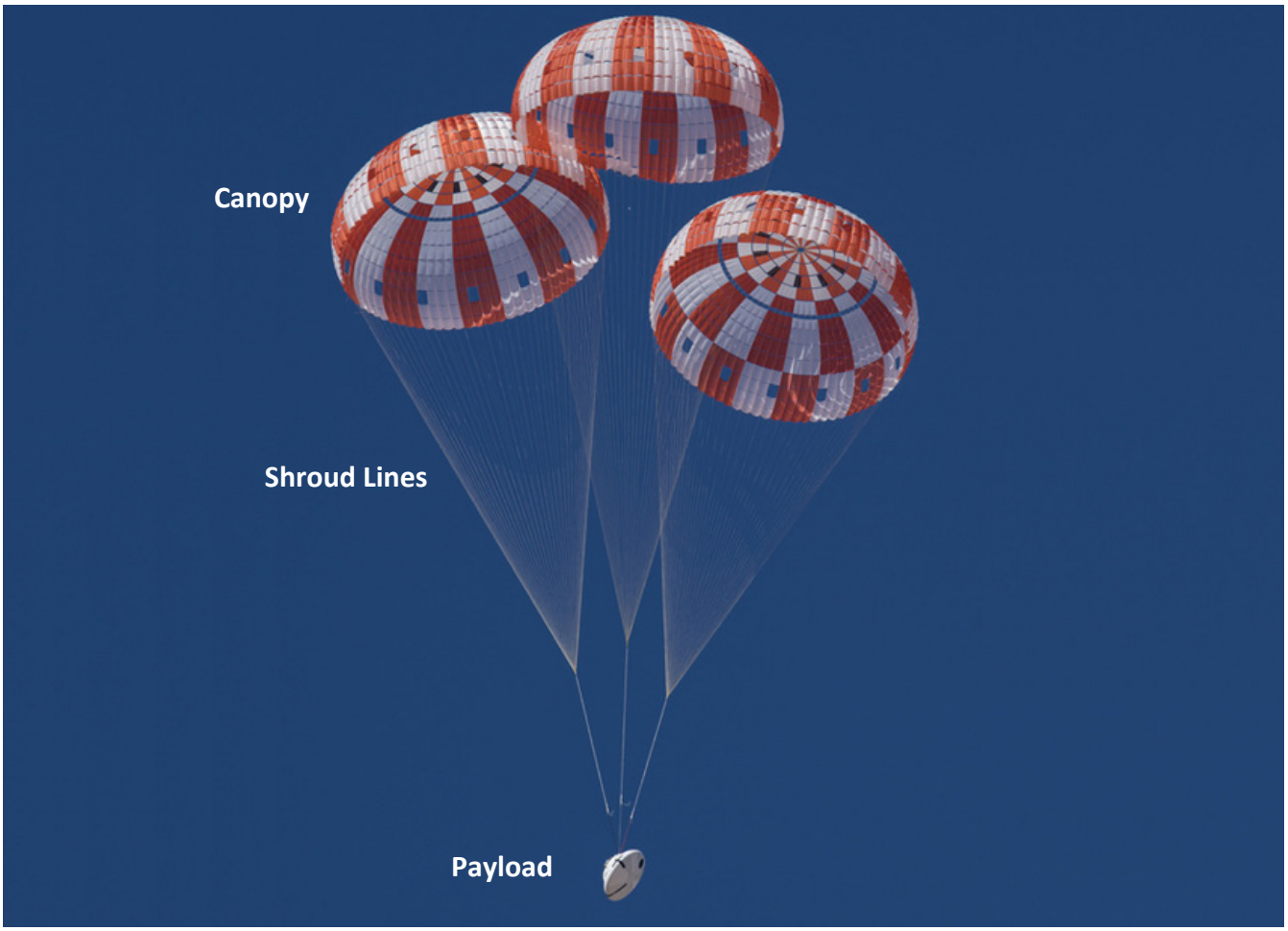
We brake for Mars

During a journey to Mars, parachutes are vital for a spacecraft's entry and descent. Tailored for Mars' distinct atmosphere, these parachutes gradually open to control the spacecraft's speed by utilizing air resistance. Staged and large parachute openings facilitate a safe and gentle landing, crucial for future Mars explorations and human missions.

Parts of a Parachute

The design of a parachute is very important because someone's life is dependent on the parachute functioning correctly. Engineers thoroughly test the materials and designs of parachutes to ensure that they open as intended and reliably and are strong enough to withstand the air resistance needed to slow skydivers to safe landing speeds.

There are three main parts of the parachute that we will be building: the canopy, the shroud lines, and the payload. A large canopy is used to increase air resistance in parachutes. Thus, a slow fall and a soft landing are provided.



We will be building our parachutes in groups of 2-3 (Let the students group up).

Materials

Go over the materials and explain that students how they will use the materials.

- For the canopy, they may choose between tissue paper and coffee filters.
- For the shroud lines, the choices are ribbon and string.
- For the payload, each group can get a marble. The groups can choose between a small plastic cup and a foam cup to hold the payload. They can use tape and some cotton balls to help pack the payload in securely.

Material Limits

Go over how many supplies from each category the students will be allowed for each group.

- Canopy: Students may select at most two items.
- Shroud Lines: Students may select at most six lengths of their choice (Can be mixed types).
- Payload: Students may select one capsule to hold the marble.

DESIGN *Future engineers!*

If you are ready you can start to design your parachutes s a group.

- Let the students work in groups of 2-3 students to design their parachutes using the materials they choose.
- Leave the last slide of the presentation displayed, so the students can keep an eye on how many supplies they may have.
- According to the age group, if necessary, the following directions can be made.

- Cut a canopy shape (cricle, square , etc) from the chosen paper.
- Make a hole in the center of the shape.
- Stick tape to the paper corners where string will be attached so that it is resistant.
- Cut six pieces of equal length string or ribbon.
- Tape or connect them at equal distances around the edge of the shape.
- Use the hole punch to punch the materials.
- Tape or connect the other ends of the string to a payload.

TEST: *Now it is time to test your parachutes!*

Engineers redesign their design and materials to achievebetter results. Just like an engineer, you can carefully examine your parachute during the test and use these results in the redesign process if necessary.

- Have the students to take their parachutes with them.
- Take the assessment sheet to record results.
- Take the students to the testing zone to test out their parachutes.

- Show the students, using the designed parachute, how to safely drop test their parachutes.
- Remind students that the goal is to land as slowly and softly as possible.

So we are going to follow how long your first parachute takes to land the payload so we can compare the result to the performance of your next parachute design.

- Parachutes should be dropped one at a time, but two to three students can be in the launch zone at a time.
- Have students drop their parachutes from the same height.
- Record the results of each group on the assessment sheet.
- Parachutes are successful if they inflate and don't drop the payload. Basically if the payload comes down slower than if it didn't have a parachute, the test is a success.
- Discuss parachute performances.

*Why did parachutes that looked very similar perform differently? (*Hints: Perhaps wind interfered, the timing was imprecise or the parachutes weren't exactly the same)

- Engage the students in the engineering design process to attempt to build a better parachute by comparing the strengths and weaknesses of parachute performance during tests.
- Challenge groups to brainstorm ideas and change their parachute design.
- Instruct them to discuss in their teams which of the available materials they would like to use for their new parachute.
- Remind them that the goal is to descend slowly and provide a soft landing for the payload.
- Encourage student's creativity - let them try some "crazy" ideas (as long as they are safe). Sometimes, design ideas that seem like they will not work perform amazingly well.
- Repeat the drop tests and record the results.

- Share the results on the assessment sheet and ask students what they have learned.
- Discuss parachute performances by asking the following questions to the students.

- How the parachutes helped the payload come down smoothly (or why not)?
- What type of paper is the best material to make a parachute? Why?
- What materials did not work well? Why?
- What changes could you make to improve your design?

Rubric for Parachute Performance Assessment

Criteria	1 point Beginning	2 points Developing	3 points Proficient	4 points Advanced
Construction	Parachute is not constructed.	Parachute is constructed incorrectly.	Parachute is constructed correctly.	Parachute shows good craftsmanship and creativity.
Result	Parachute not tested.	Parachute fell quickly to the ground.	Parachute fell gently to the ground.	Parachute fell very slowly to the ground.
Redesign	Group did not attempt to improve the original design.	Group is unsuccessful at improving their original parachute design.	Group created a parachute that works slightly better than their first one	Group created a parachute that works much better than their first one

Parachute Performance Assessment Sheet

Criteria	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6	Group 7	Group 8
Construction								
Result								
Redesign								
Total Point								