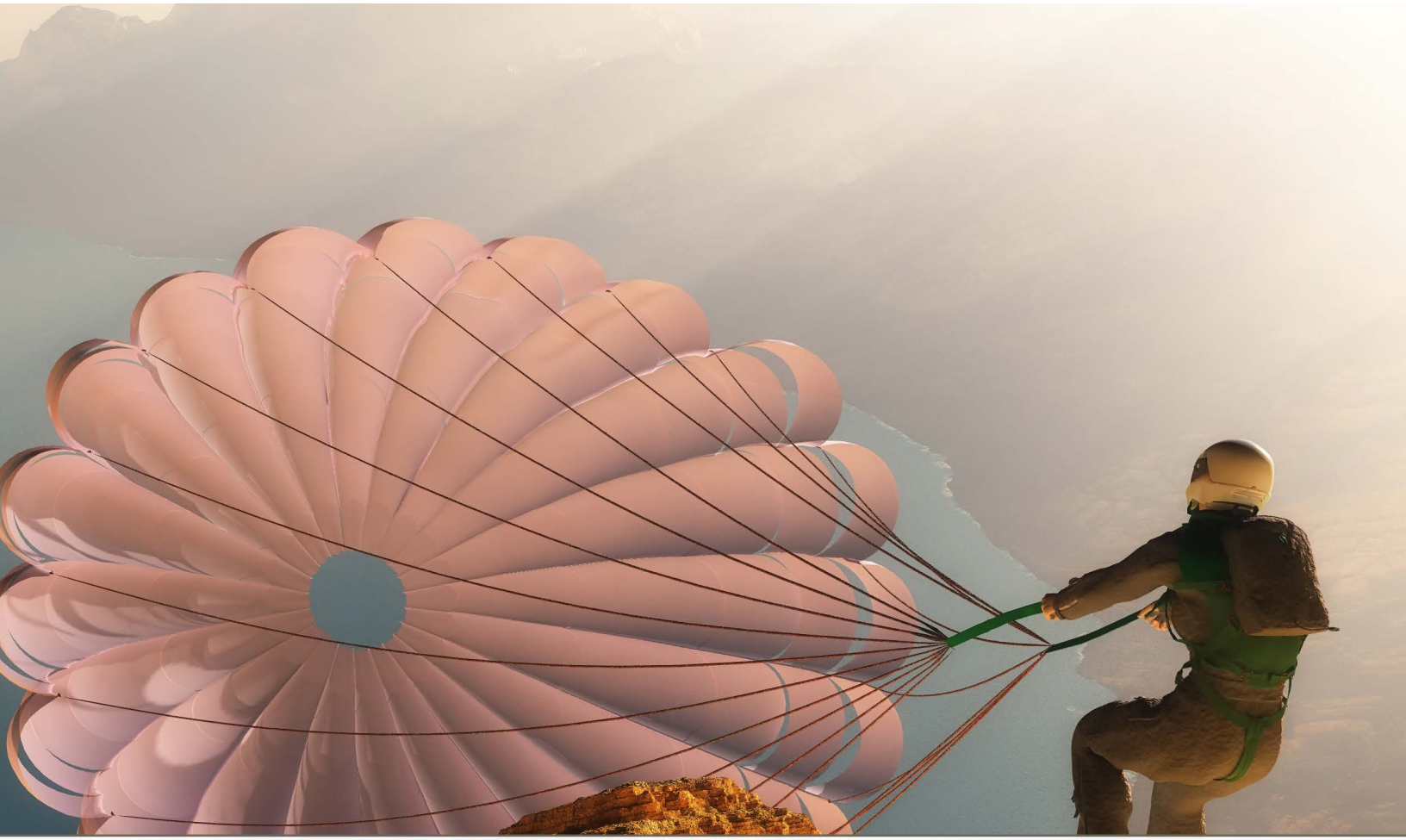
MeTEOR Learning Modules

STEM MEA (Model Eliciting Activity)

Designing a Parachute



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METEOR
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Designing a Parachute

Reflective Planning

Description/Summary of Lesson:
Students will complete research on parachutes to see how math and science are used in a real- world setting. They will explore the physics exploited by engineers in designing parachutes, including the Laws of Motion, drag, gravity, aerodynamics, fluid flow, surface area and polygonal geometry. After completing research, students will design and build a parachute they would like to enter into the class contest. For their parachute to be operational, it must be free falling, and able to carry an egg to the ground without breaking it open. The model they make will be made from various types of materials. Throughout this activity, students will consider the efficiency and safety of the parachute they are constructing. In addition, students will gain an understanding of how the math and science processes they are performing relate to various careers in the world, such as engineering.

Essential Questions:

- How does air resistance play a role in flying?
- Can a parachute be used to slow the movement of a falling or horizontally moving object?
- Can the laws of motion be used to determine the effects of forces on the motion of objects?
- How do we use parachutes as a form of transportation?

Suggested Grade Level: Grade 6-8

Approximate Time: Two-three days (50 minute class periods)

Teacher's Role: Facilitator

Class Set-Up: Groups of two students at tables or desks put together

Success Standards:

- Students can solve problems involving the area of circles and polygons.
- Students can describe the laws of motion.
- Students can solve real world problems using force and motion.
- Students can define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution — taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
- Students can develop and use models.

- Students can engage in argument from evidence.

Learning Purpose:

- Students will define the problem.
- Students will communicate their problem solving plan.
- Students will develop a procedure to design and build a free falling parachute.
- Students will use social, interaction skills for completing projects with peers.

Vocabulary:

- Aerospace
- Force
- Chute
- Hemisphere
- Canopy
- Rigging
- Newton's Laws of Motion
- Risers
- Drag
- Gravity
- Harness
- Gores
- Apex Vent
- Suspension Lines
- Air Resistance
- Terminal Velocity
- Bellow
- Impact
- Panels
- Acceleration
- Descent

Math Practices:

- MP 1: Make sense of problems and persevere in solving them.
- MP 3: Construct viable arguments and critique the reasoning of others.
- MP 4: Model with mathematics.
- MP 6: Attend to precision.

Depth of Knowledge:

- DOK Level 3: Strategic Thinking

Materials:

Teacher Materials

- Coffee Filter, String, Single Hole Punch, Washer (to pre-make a parachute for the demonstration)
- Challenge Letter to Students
- Copies of Rubric
- Exit Slip
- Eggs for day three (one per team)

Student Materials

Student groups need a zip-lock bag per group with the following items:

- Washer
- 2 Small Paper Cups (bathroom size)
- 4 Coffee Filters (two large and two small)
- 6 Feet of Yarn
- Roll of Tape
- Ruler
- Stop Watch
- 2 Pieces of Construction Paper
- 3 Cotton Balls
- Sheet of Tissue Paper

- Single Hole Puncher
- Pair of Scissors

Summary of Tasks/Experiences

Spark Activity:

What is the purpose of a parachute? What is the role of a parachute in skydiving? Imagine you are jumping out of a plane 10,000 feet 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? The design of a parachute is very important, especially in an extreme sport such as skydiving 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. (NOTE: *At this point, complete the teacher demonstration where you drop your parachute from as high as you can hold your hand up.)* Today you are going to be working together in teams to research parachutes. Then, you will build your parachute design to see if you can create a soft landing for the payload. After testing and adjusting your parachute you will enter into the class challenge. You will exchange the washer payload for an egg. Your goal is to keep the egg from breaking open. You will be given a zip-Lock bag with materials to aid you in your design.

Lesson Descriptions:

Introduction: Day 1

The teacher will:

- conduct a short demonstration.
- discuss the real world challenge listed above.
- hand out the informational letter to each group.
- show the students the materials in the zip-lock bags they get to use on day two.
- hand out copies of the rubric for evaluation.
- allow students to collaborate around a plan of action to accomplish their goal.

Day 1

The students will:

- research information needed on computers or student electronic devices regarding parachutes.
- apply the thoughts gained from their research to the design of their parachute and the scale model in groups.
- discuss learned information regarding ideas for the parachute and construction process.

- fill out their information sheet explaining and defending what type parachute they are going to build for both efficiency and safety along with a drawing of what the design will look like.

Day 2 and 3

The students will:

- build and test their parachute.
- make adjustments to the parachute to use in the class challenge.
- test the parachute with the egg payload.
- answer questions to their exit slip independently. (If needed, students can finish for homework and turn in the next day.)

Teacher facilitates class asking guiding questions as students work in pairs:

- Can you explain why it is important for engineers to know how parachutes work?
- How does the effects of gravity and friction enter into your parachute design?
- How does a parachute work?
- What will you do to have your parachute land as slowly and softly as possible?
- What causes gravity?
- What is friction?
- What might make a better parachute?
- 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?

Student Engagement

Social/Emotional Engagement: Students will use social, interaction skills for completing projects with peers.

Physical Engagement: Students will collaborate while completing research regarding parachutes through the use of electronic devices and discourse while working in groups of two.

Cognitive Engagement: Students will work together using math and science concepts such surface area, drawings, air resistance and the laws of motion to complete their task.

Evidence of Learning

Checks for Understanding/Expected Outcomes:

- Students will complete their information sheet.
    - The information sheet should have parachute design they are going to make with an explanation of why they are going to build that type of parachute.
- Students will build their parachutes.
    - The structure should match their design.
- Students will complete an exit slip.
    - The exit slip will allow the students to show they did some reach as requested and reflect on their success or lack thereof.
- Students will be evaluated using the included rubric.
    - The rubric should be given as a guide to help students as they write their explanations and make their designs for the type of parachute they are making.

Designing a Parachute
RUBRIC

CATEGORY	4	3	2	1
Research	Research shown with much detail about the needs for an effective parachute.	Research shown with some detail about the needs for an effective parachute.	Research shown with little detail about the needs for an effective parachute.	Research shown with little to no detail about the needs for an effective parachute.
Function	Parachute functions extraordinarily well, has a soft landing with washer and egg does not break.	Parachute functions, has a soft landing with washer, but egg breaks.	Parachute functions, but does not have a soft landing and unable to carry egg.	Flaws in function due to incomplete parachute or unable to carry a washer.
Testing	Evidence of testing and redesigning parachute.	Evidence of testing parachute, but no redesigning took place.	No evidence of testing or redesigning parachute.	Incomplete and not tested.
Group Member	The student worked well with team member throughout the entire course of the project and was present each day.	The student worked well with team member throughout most of the project and was present each day.	The student worked with team member on some of the project and was absent one day.	The student worked with team members only slightly throughout the project, and was absent more than one day.

Challenge Letter to Students:

The goal of this task is for you and your team member to design a parachute that will carry a metal washer for a slow, soft landing. Before creating your parachute design, you are to research parachutes. Then, brainstorm and collaborate with your team member to decide what type of parachute you will design and build. Be sure to include why this design would be the most efficient model to build in your explanation. Include as many math and science words in your explanation as possible. You are to draw your design in the given space and follow it as you build your parachute from any of the materials in the provided zip-lock bag.

You will test your design and make changes until you are satisfied with your improved parachute performance. Make sure to time the descent of your parachute to aid in this decision. After finalizing all changes, you will test your parachute outside, but change the payload from a washer to an egg. Your final goal will be to have your parachute land slowly and softly, without breaking the egg.

You are to calculate the area of your parachute.

Team Members:

Explanation of Design:

Picture of Design:

Shape of Parachute: _____

Area of Parachute: _____

Time of Descents: 1 ___ 2 ___ 3 ___

Redesigned and tested: _____

Redesigned and tested: _____

Designing a Parachute
Exit Slip

Name:

Upon completion of this lesson you are to answer the following:

1. Name at least two reasons we use parachutes?

2. Why are parachutes used?

3. What is the Law of Falling Bodies and what wasn't taken into account?

4. Explain Newton's Third Law:

5. Compare and contrast the two types of parachutes:

6. What are apex vents used for?

7. Describe terminal velocity:

8. How could you have designed your parachute to be more effective in landing slowly and softly?

9. Name something new you learned about how parachutes are built:

ADDITIONAL TEACHER INFORMATION:

Answers to Information Sheet:

- Answers will vary, must include a drawing, timed results and the area of their parachute. As the teacher, accept all complete explanations that are convincing due to their design.
- Students should use some math and science vocabulary words in describing and defending their design:
- Students must have checked off they redesigned and tested their parachute.

Answers to Exit Slip:

1. Jumping from an aircraft, slowing down a race car, slowing down the space shuttle, landing a payload on a planet.
2. Safe jumps, decrease speed or slow down object, create a slower, softer landing.
3. This law states that all objects regardless of their mass fall at the same speed, and that their speed increases uniformly as they fall. However, air resistance was not taken into account.
4. For every action there is an equal and opposite reaction.
5. One is a dome canopy made of fabric in a shape that ranges from a hemisphere to a cone; the canopy traps air inside its envelope, creating a region of high pressure that retards movement in the direction opposite the entering air flow. The other is a rectangular parafoil, or ram-air canopy, consisting of a series of tubular cells; commonly used by sport jumpers, the parafoil acts as a wing, allowing the jumper to "fly" toward a target.
6. A hole or vent in the center to release pressure.
7. Motion continues until a constant speed is achieved.
8. Answers will vary, should include larger surface area of the parachute to create greater air resistance.
9. Answers will vary.