Egg Drop Challenge

Overview:
For exploration missions that land on a planet (landers, rovers, human exploration missions) getting there is only half the story. Spacecraft, or astronauts, must survive the entry, descent, and landing phase before they can begin their operations. In this activity, students will design, build, and test a lander to protect an egg payload.

Goals:

- Learn about the engineering design process.
- Understand the challenges of landing a spacecraft on Mars.
- Design, build, and test a lander to protect their egg payload.

Time Required: 2 hours

Materials:

- Assorted craft, packing, and recyclable materials such as: cardboard, egg cartons, cotton balls, straws, pipe cleaners, wooden skewers, rubber bands, bubble wrap, newspaper, foam peanuts, tape, balloons, plastic bags, string, etc.
- Raw Egg for each group
- Plastic Easter Egg for each group for testing/design purposes only
- High location to drop eggs from (bleachers, playground equipment, ladder, etc)
- Trash Bags, paper towels for cleanup

Procedure:

Before the activity:

1. Select a location to drop the landers from, try and choose a location with a hard surface that will be easy to clean up. If you choose to drop from playground equipment, you may want to consider putting down a square of plywood or other hard surface to drop the landers onto (playground surfaces are designed to absorb impact).
2. Recommended that you build and test a lander from your chosen location. This will give you an idea of how to structure the activity for your students. The higher your drop, the more generous you might want to be with supplies.

3. Develop a set of rules that all students must follow. Adjust the rules based on the materials you have and the height of your drop location. Suggested rules include:
    a. Students can only use the materials provided.
    b. Students can only use specific amounts of provided materials, for example two feet of masking tape, etc.
    c. Students can only use 10 materials (1 pipe cleaner = 1 piece)
    d. The complete device must fit inside a 1x1x1 foot cube.
    e. Design must allow for the egg to be easily put into the lander and removed. You must be able to easily access the egg to check to see if it is broken (you cannot permanently wrap the egg in duct tape).
    f. Students will be allowed 1 test drop using the dummy egg (plastic egg), after which they can redesign their lander.
    g. Decide if you will allow students to use parachutes in their design.
    h. How long will students have to work?
4. You may want to create a rules document to provide to students. Science Buddies has an editable document you can use as a starting point.

Design/Build:

1. Show students one of the videos about the challenges of landing on Mars:
    a. Curiosity's seven minutes of terror: https://mars.nasa.gov/resources/20049/challenges-of-getting-to-mars-curiositys-seven-minutes-of-terror/
    b. Perseverance lands on Mars: https://mars.nasa.gov/resources/25473/perseverance-arrives-at-mars-feb-18-2021-mission-trailer/
    c. Computer animation of the Spirit/Opportunity rover landing on Mars: https://www.youtube.com/watch?v=tijyybrmfsM&t=309s
2. Remind students that launching a rocket is only part of the story. Spacecraft must safely land on the planet.
3. Show students the Engineering Design Process. Talk about how engineers design solutions to different problems.
4. Tell your students they will design, build, and test a device to safely deliver a payload to the surface. Show or tell students the location (height) where their object will be dropped. You may want to drop a raw egg, unprotected, from the site to give students a visual.
5. Have students Identify the Problem on their worksheet. Encourage them to state the problem in their own words.

6. Lead student in a discussion to generate ideas:
    a. What features did you notice from the video(s) that helped the spacecraft land safely?
    b. Have you done an activity like this before? What did you learn?
    c. What are other devices designed to protect fragile things (helmets, air bags, parachutes, etc)?
    d. How do they work? What are they made of?
7. Review the rules and requirements for the activity. Show them the materials and let them know the time they will have to work. Remember these are called Engineering Constraints. Have students record these constraints on their worksheet.
8. Give students a chance to brainstorm ideas. Encourage them to draw 2-3 ideas on their worksheet and list the materials they will need.
9. Have students get in their groups and share designs. They will need to come up with one single design to build and test. This design could be a combination of several ideas. Students should draw a picture of their final design and make a list of the materials needed.
10. Build the lander. Students should work together to build their lander. Keep in mind that they may need to make changes to their design as they begin to build.
11. Encourage students to test out their design. They can perform a test drop by having a member of their group hold the lander as high as they can and drop it. Make changes based on how the lander does in the test drops.
12. Students should record observations and changes they make to their design as they work.
13. Once time is up, have students turn in their designs for the final test. Add the egg to the lander right before the drop to avoid any accidents. Instructor should drop all eggs, be sure to practice appropriate safety guidelines for climbing to a height.
14. Cycle through and drop each egg and check to see if the egg breaks. Intact eggs can be dropped a second time, third time, etc. until all the eggs are broken. Groups should record the number of successful drops for their lander on their worksheet.
15. Give students a chance to reflect and answer the questions on their worksheet.
16. As a class, reflect on the activity:
    a. What ideas did people have? Any similar ideas? Any unique ideas?
    b. What problems did you have? How did you solve them?
    c. What did you learn in your initial test? What changes did you make?
    d. What were the results of the final test?
    e. Which devices survived the most drops? Did they have anything in common?
    f. Record these and other thoughts on your worksheet.

Common problems / Additional guidance:

- Drop eggs from increasing heights, for example 1st drop is 3 feet off the ground, 2nd drop is 6 feet, 3rd drop is 9 feet, etc. until only one egg is left unbroken.
- Print out a copy of the rules for student.
- Northeastern University has a version where groups are given a budget for their materials. https://stem.northeastern.edu/programs/ayp/fieldtrips/activities/eggdrop/
- Allowing parachutes can make this activity easier for younger students. Eliminate the use of parachutes for more advanced groups.
- Provide more materials for younger groups, limit materials for advanced students.

Adapted from the following lessons:

- Science Buddies, Teach Engineering Design with an Egg Drop: https://www.sciencebuddies.org/teacher-resources/lesson-plans/egg-drop-engineering-design
- NASA Mars Pathfinder Egg Drop : https://www.nasa.gov/sites/default/files/544868main_E3_MarsPathfinderEggDrop_C5.pdf