

EGG DROP ACTIVITY

THIS ACTIVITY WAS ADAPTED FROM NASA'S *LIVE FROM MARS* CURRICULUM.

Background Information

Pathfinder will enter the upper atmosphere of Mars at 7.6 kilometers per second at a 14.2 degree angle (90 degrees would be straight down). It will meet its peak atmospheric shock, encountering forces 25 times Earth's gravity, at 32 kilometers above the surface. At 10 kilometers above the ground, a parachute will deploy at nearly twice the speed of sound (400 meters per second). Rockets inside the backshell will fire to further slow the lander's descent. Shortly before landing, a set of airbags will inflate to cushion the impact. After a few seconds, the tether attaching the lander to the backshell and parachute will be severed, and, with 90 percent of the fuel expended, the rockets will carry the shell and other debris away from the landing area. Then, protected (hopefully) by its airbags, *Pathfinder* will bounce on the Martian surface, perhaps as high as a ten-story building, before finally coming to rest after its 8-month journey.

Objective

Upon completion of this activity, students will be able to:

- demonstrate an understanding of the challenges of soft landing a spacecraft on Mars
- design, build and test their own "interplanetary lander."

Instructional Time

45–90 Minutes

Materials per team:

1 raw egg, or light bulb
Square yard of tightly woven nylon material
5 feet of string
Paper lunch bag
Plastic shopping bag
2–3 balloons
2 paper clips
3 8½ x 11 sheets of paper
Masking tape

Materials per whole group:

Box of paperclips
Ladder
Sensitive scale (for example: postal scale)

TEACHER PAGE

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Procedure

1. From the top of a ladder or table, drop a box of paper clips to the floor. It's noisy and messy, but nothing's broken.
2. Ask students to think of ways they might safely land a fragile spacecraft on another planet.
3. Tell them that in this activity, they are going to play the role of NASA engineers, and are going to design, build and test their own interplanetary landers.
4. Divide the class into Engineering Teams.
5. Distribute a set of the above materials to each of the teams.
6. Tell them they have exactly one class period to design and build a lander out of some or all of the materials they have received.
7. The fragile payload they will be challenged to land safely is the egg or light bulb which, when placed in their "descent module", must survive a fall of three stories without breaking.
8. Give the students teams an additional challenge of keeping the overall size of their lander to a certain volume, e.g., no more than 12 inches cubed.
9. You may also wish to use this activity as a take home assignment and possible allow students to get advice from parents. This may prove an unfair advantage, however, to students with engineers in the family.
10. If the activity is not a take home assignment, then at the end of the class period, put away their landers. The landers will be retrieved on the first fair weather day available for testing.
11. Tell students that each team is in competition with the others for an all important NASA contract and that the team which builds the lightest lander that successfully lands an unbroken egg or light bulb will be the winner.
12. When the big day arrives, record the weight of each lander and then, amid appropriate pomp and ceremony, have a colleague or parent volunteer drop each entry, one by one, out of a third story window, or off the school's roof.
13. An exciting alternative is to invite your local fire department to take part using one of their big hook and ladder trucks. Invite the local news media to cover the event.

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Discussion

In the above discussions, students may suggest the use of retro-rockets as in the Apollo moon landings or as seen in many science fiction films. Explain to students that while retro-rockets do work, they add significant size and weight to a spacecraft and, if their thrust is applied too close to a planet's surface, they can seriously disturb or contaminate the things scientists wish to study. Thus, in this activity, they will be challenged to come up with small, light-weight alternatives that don't use retro-rockets for safely landing a very fragile payload on the surface of Mars.

Extensions

- In this Activity, students tested their creations on home ground. As a follow up, challenge them to research relevant similarities and differences between Earth, the Moon and Mars and draw conclusions as to how these might affect the design of their lander. The Moon has no atmosphere. Parachutes would be useless in slowing down landers on the Moon. Mars does have an atmosphere, but it's very thin. Therefore, a descent device that relied solely on a parachute to slow it down would not work nearly as well on Mars as on Earth, unless it were much bigger. This, in turn, adds weight and volume to the spacecraft. Mars has only about one third of Earth's gravity. Therefore, objects fall more slowly on Mars. Dropping something from a relatively low height on Earth would cause the object to have the same speed on impact.
- Students studying physics will have ample opportunities to take this activity further. They can, for example, study a lander's changing potential and kinetic energies as it falls. They can also study the rate of fall of the lander and compare final velocities, with and without parachutes, while learning about drag. Also noting that the force of gravity on Mars is only 38% of that on Earth, they can calculate how high a drop on Mars would result in the same velocity upon impact as a drop from a three story building on earth.
- Write a news report for July 4, 1997, the day Pathfinder landed on Mars. Research the descent and landing sequence and what scientific data it collected as it descended through the Martian atmosphere. Do the same for the Sojourner rover as it leaves the lander and begins to traverse the Martian landscape. How is it powered, how long will it function, what data will it be sending back to Earth? Research MARS '96, the Russian mission slated to take off in mid-November 1996, but to arrive at Mars after Pathfinder. Report to the class on similarities and differences between the Russian and American missions in terms of the rocket being used and the design of the lander.