Lesson 10
Touching Down on Mars

GRADE LEVEL(S)
4 – 6

LENGTH
60 minutes

MATERIALS
- Giant Destination Mars Map
- One piece of stiff paper or cardboard, approx. 4x5" (per lander)
- One small plastic or paper cup (per lander)
- Three 3x5" index cards (per lander)
- Two regular-sized marshmallows (per lander)
- Ten miniature marshmallows (per lander)
- Three rubber bands (per lander)
- Eight plastic straws (per lander)
- Rulers
- Scissors
- Tape

VOCABULARY
- Potential energy
- Kinetic energy
- Shock absorption
- Acceleration
- Air resistance
- Measurement

ESSENTIAL QUESTION
How are spacecraft designed to protect astronauts when they land?

LESSON OBJECTIVE(S)
Students will:
- Learn about the engineering design process
- Design a simulated spacecraft shock absorbing system
- Be introduced to safety aspects of space travel

ENGAGEMENT
1. Tell kids why a spacecraft that can land gently is important for getting astronauts to and from Mars safely. Have them observe any similarities between previous spacecraft landing sites on the Giant Destination Mars Map while contemplating their design.
2. Demonstrate the first step of creating a successful spacecraft, a spring made from an index card for shock absorption, by folding an index card several times into an accordian. Explain the following about the importance of shock absorption:

   When you jump off a high step, you bend your back and knees to absorb some of the energy and break your fall. That's what a shock absorber does—absorbs

the energy of an impact. Soft things, like marshmallows, cotton balls, foam, and bubble wrap absorb shock well. You can also use paper, like this index card made into a spring by folding it like an accordion.

3. Discuss the following questions:
    - **What kind of shock absorber can you make from these materials to help soften a landing?** *Mini-marshmallows can serve as soft footpads. Cards can be folded into springs. Straws can provide a flexible structure. Rubber bands can flex and hold things together.*
    - **How will you make sure the lander doesn't tip over as it falls through the air?** *Making the parts below the platform weigh more than the parts on the top helps the lander fall straight down. Also, it helps to evenly distribute the weight on top of the platform.*

EXPLORATION

1. Have the students begin building their landers, first by building the shock-absorption system. Attach this to a sturdy (cardboard) platform. Finally, add a "cabin" for the astronauts by affixing the cup to the platform.
2. Next, have the students test their landers on the Mars Map. Have them drop their landers from one foot above the ground.
    - If the "astronauts" bounce out, help them figure out ways to improve their designs. Study any problems and redesign.
    - For example, if their spacecraft tips over as it falls through the air, make sure it's level when it's released. Also check that the cup is centered on the cardboard. Finally, check that the weight is evenly distributed.
    - If the "astronauts" bounce out of the cup, add soft pads or change the number or position of the shock absorbers. Also, make the springs less springy so they don't bounce the marshmallows out.
3. Redesign and retest as necessary for all students to succeed. *Perhaps have students who succeed early on help struggling students.*

EXPLANATION

1. Have the kids show each other their landers and talk about how they solved any problems that came up. Emphasize the key ideas in today's challenge by asking:
    - **What forces affected your lander as it fell?** *It accelerated [sped up] as it fell due to the pull of gravity. Air also pushed on it, and this air resistance slowed it down.*
    - **After testing, what changes did you make to your lander?**
    - **Engineers' early ideas rarely work out perfectly. How does testing help them improve a design?** *Testing helps you see what works and what doesn't. Knowing this lets you improve a design by fixing the things that aren't working well or could work even better.*
    - **What did you learn from watching others test their landers?** *In general, kids will see that there are many ways to successfully tackle a challenge.*
    - **Mars is covered in a thick layer of fine dust. How might this be an advantage? A disadvantage?** *If the dust layer is soft, it would help cushion a landing. However, if it is too soft, a lander could sink into it and get stuck. Also, the lander's rocket engine could send up clouds of dust, which could get into the machinery and cause it to jam or malfunction.*

EXTENSION

1. Hold a "How High Can You Go?" contest. Have kids drop their landers from two feet. Eliminate all landers that bounce out their "astronauts." Next, raise the height to three feet. Continue in this fashion until a winner emerges. You can also increase the challenge by having kids add a third marshmallow "astronaut" to their cups.
2. Test springs of different sizes. Have kids see if the number of folds in an index card makes a difference in the amount of force the spring can absorb. Have them fold index cards with two, four, and six folds. Have them test to see how much of a difference these different springs make in how softly a lander touches down.

EVALUATION

1. During this lesson, the teacher is encouraged to use formative assessment such as questioning and examining student responses/notes throughout the lesson to elicit evidence of learning and deepen student understanding.
2. Teachers are encouraged to create their own grade-level and ability-level assessments so as to best meet the needs of their students.