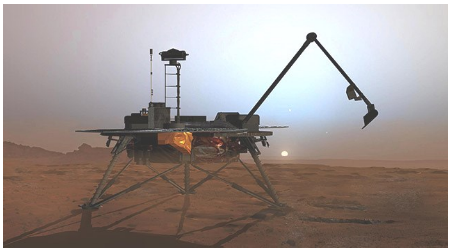
Snow day challenge: Touchdown

In this challenge, you will use what you know and can investigate about gravity, motion, and forces to design and build a shock-absorbing system that will protect two "astronauts" when they land. Just as engineers had to develop solutions for landing different vehicle types on the moon and Mars, you will follow the engineering design process to design and build a shock-absorbing system out of paper, straws, and mini-marshmallows; attach their shock absorber to a cardboard platform; and improve your design based on testing results.

Materials needed:

- 1 piece of stiff paper or cardboard – approximately 4 x 5 inches
- 1 eight to twelve oz. paper or plastic cup
- 3 index cards – 3 x 5 inches
- 2 regular marshmallows
- 10 miniature marshmallows
- 3 rubber bands
- 8 plastic straws



Background

Landing on the moon is tricky. Since a spacecraft can go as fast as 18,000 miles per hour (29,000 km per hour) on its way to the moon, it needs to slow down in order to land gently. And if there are astronauts on board, the lander needs to keep them safe, too. Similarly, spacecraft on their way to Mars may be traveling as fast as 13,000 miles per hour (21,000 km per hour) when they reach the red planet and need to slow down to land safely on the surface. Future missions to Mars will also need to safely land astronauts on the surface.

Send us a photo of your spacecraft to mstowe@newcollegeinstitute.org **OR** tag New College on social media with your photo and we will reserve a free NCI shirt for you!

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Touchdown Procedures

1. Introduction

NASA is looking for safe landing sites on the moon. Once they find one, they need to design and build a spacecraft that can land there without injuring astronauts or damaging the spacecraft. Today you'll make a lander—a spacecraft that can land safely when you drop it on the floor. As you test, you'll find ways to make it work better. Improving a design based on testing is called the engineering design process.

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.

2. Design

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.

3. Build, test, evaluate and redesign

Design a shock-absorbing system - Think springs and cushions.

Put your spacecraft together - Attach the shock absorbers to the cardboard platform.

Add a cabin for the astronauts - Tape the cup to the platform. Put two astronauts (the large marshmallows) in it. Note: The cup has to stay open -- no lids!

Test, evaluate and redesign - Drop your lander from a height of one foot (30 cm). If the "astronauts" bounce out, figure ways to improve your design. Study any problems and redesign. Once the "astronauts" stay in the aircraft consistently, add a foot to your height and try again.

Handling issues:

What if my lander tips over when it drops? Move the cup slightly away from the side that's tipping. Or, reposition the parts of the shock-absorbing system to better balance the weight.

What if my lander bounces instead of landing softly? Change the size, position, or the number of shock-absorbing parts. You can also add mini-marshmallows for landing-pad feet. Or, you can use marshmallows at key junctions in the lander's frame to help absorb energy.

Final thoughts:

- What forces affected your lander as it fell?
- 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?