

MISSION BRIEFING

Activity: Build a Heat Shield

Prep time:  15 min

Activity length:  60 min

Task: Participants will build a heat shield that will protect crew module contents from simulated atmospheric reentry.

By the end of this activity participants will

- Know that some materials resist heat better than others.
- Understand that crew modules can be damaged upon reentry due to exposure to extreme heat.
- Employ methods of thermal resistance.

Materials

- Cardboard scraps (shoe boxes, milk cartons)
- Foam scraps (packing peanuts, plates, food trays)
- Infrared thermometer (recommended)
- Paper
- Unwrapped candy bars without nuts
- Scissors
- Tape
- Metric rulers
- 5-oz paper cups
- Hair dryer
- Digital scale or balance
- Tongs
- Stopwatch
- Eye protection
- Construction paper
- Cotton balls
- Bubble wrap
- Index cards
- Oven mitts/gloves
- Electrical tape
- Pens
- Steel wool
- Newspaper
- Wire mesh or cloth

Preparation

1. Gather and prepare all listed supplies.
2. Set up testing stations with safety equipment, hair dryer, tongs, infrared thermometer (recommended), scale, and a metric ruler. At most, allow three teams per testing station.

Quick Tips and Tricks

- If presenting videos or web-based resources, test the links and the classroom technology ahead of time.
- Wire or mesh cloth (also known as hardware cloth or welded wire fabric) can be purchased online. It should be strong enough to provide structure for the design.



The Orion heat shield will protect the crew module during reentry after the spacecraft's first uncrewed flight test with NASA's Space Launch System rocket. To learn more about the Orion heat shield visit www.nasa.gov/feature/ames/turning-up-the-heat-on-orion-s-heat-shield-x2.

MISSION GUIDANCE...

DO

- Ask probing questions to prompt participants' creativity.
- Allow groups to test individual materials prior to building.

MAYBE

- Carry out sample "tests" as a demonstration.
- Have participants document the results of their tests.

DON'T

- Critique participant designs.
- Tell participants which items appear to repel heat the best.

Procedure

1. Ask participants to develop a list of building materials, then allow one participant from each group to gather materials.
2. Participants build their heat shield to fit over the open end of the cup.
3. Load the candy bar astronaut into the cup, and then use a rubber band to attach the heat shield to the front of the cup.
4. Hold the hair dryer 10 cm away from the cup.
5. Turn the hair dryer on (facing the heat shield) for 1 min.
6. Check to see if the candy bar has melted.
7. Repeat steps 5 and 6 (do this 7 times total).
8. Give participants 15 min to alter their heat shield based on observations.
9. Repeat steps 3 to 7 using the new design.

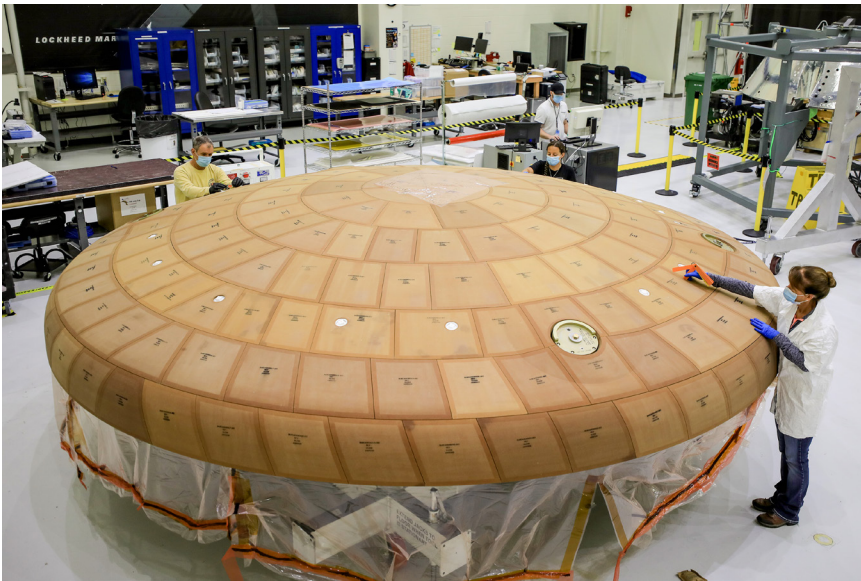
Note: Heat shield is properly designed when the candy bar remains solid after 7 min of heating (steps 3 to 7).

Extension

- Use an alternative substance as an astronaut, such as wax or ice.
- Provide participants with an engineering budget and assign a price to each piece of building material.

Challenge Questions

- Which design characteristics provide the most protection to the crew on board?
- What information could engineers working on this project learn from your team's results?
- What other tests or calculations would you do before making recommendations to NASA for their heat shields?



Technicians at NASA's Kennedy Space Center in Florida meticulously applying more than 180 blocks of ablative material to the heat shield for the Orion spacecraft.