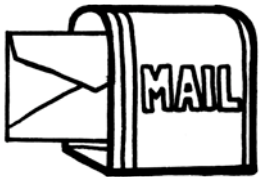
Overview: Kids will test and compare how well different materials protect against impact hazards, specifically damage from heavy moving objects.

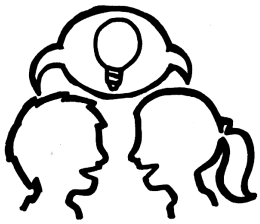
Note to Educator: In this adventure, kids attach materials to 1 side of a vinyl glove to develop glove-construction skills while testing materials. This approach enables kids to start thinking about building for a wearable design.

Be sure that the sponges are dry so that tape will adhere to them.

Duo Update (5 min)

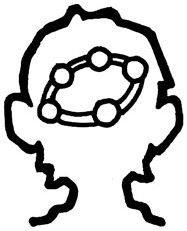


Set the Stage (10 min)



Activity (25 min)

Reflect (10 min)



Materials

For the entire group:

- ☐ *Message from the Duo*, track 6 or Engineering Journal, p. 14
- ☐ *Engineering Design Process* poster
- ☐ *Testing Results* chart and marker
- ☐ 1 glove, vinyl, large

Testing Station:

- ☐ 1 box of spaghetti
- ☐ 2 aluminum trays
- ☐ 2 deli containers, round, with lids, 16 oz.
- ☐ 2 rulers
- ☐ 2 skewers, wooden
- ☐ 200 metal washers, 1 1/4”

Materials Table:

- ☐ 1 piece of cheesecloth, 8.5” x 11”
- ☐ 1 sheet of craft foam, 8.5” x 11”
- ☐ 1 sheet of felt, 8.5” x 11”
- ☐ 1 sheet of foil, 8.5” x 11”
- ☐ 1 sheet of transparency
- ☐ 2 sponges
- ☐ 4 rolls of masking tape
- ☐ 20 straws
- ☐ 30 cotton balls

For each pair of kids:

- ☐ 1 pair of scissors
- ☐ 1 vinyl glove

For each kid:

- ☐ Engineering Journal

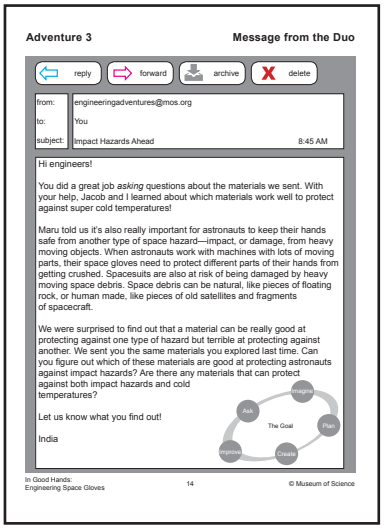
Preparation

Time Required: 25 minutes

1. Post the *Engineering Design Process* poster.
2. Have the *Message from the Duo* ready to share.
3. Post the *Testing Results* chart from Adventure 2 and add “Impact” as the title of the next column, as shown on p. 46 in this guide.
4. Set up a Materials Table with the materials listed above.
5. Prepare the testing weights. Fill each of the 2 containers with 100 washers and seal lids with masking tape.
6. Prepare a demonstration glove by placing 1 piece of pasta in each finger of a vinyl glove.
7. Set up 2 Testing Stations. Tape a skewer to the bottom of each aluminum tray, as shown on *Impact Test Procedure,* p. 50 in this guide.

Journal Pages for Adventure 3

Message from the Duo, p. 14 *Impact Test Procedure*, p. 15 *Impact Protection,* p. 16



Adventure 3 — Message from the Duo

reply | forward | archive | delete

from: engineeringadventures@mos.org
to: You
subject: Impact Hazards Ahead 8:45 AM

Hi engineers!

You did a great job *asking* questions about the materials we sent. With your help, Jacob and I learned about which materials work well to protect against super cold temperatures!

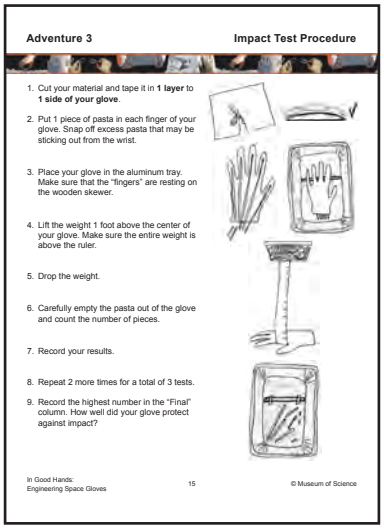
Maru told us it's also really important for astronauts to keep their hands safe from another type of space hazard—impact, or damage, from heavy moving objects. When astronauts work with machines with lots of moving parts, their space gloves need to protect different parts of their hands from getting crushed. Spacesuits are also at risk of being damaged by heavy moving space debris. Space debris can be natural, like pieces of floating rock, or human made, like pieces of old satellites and fragments of spacecraft.

We were surprised to find out that a material can be really good at protecting against one type of hazard but terrible at protecting against another. We sent you the same materials you explored last time. Can you figure out which of these materials are good at protecting astronauts against impact hazards? Are there any materials that can protect against both impact hazards and cold temperatures?

Let us know what you find out!

India

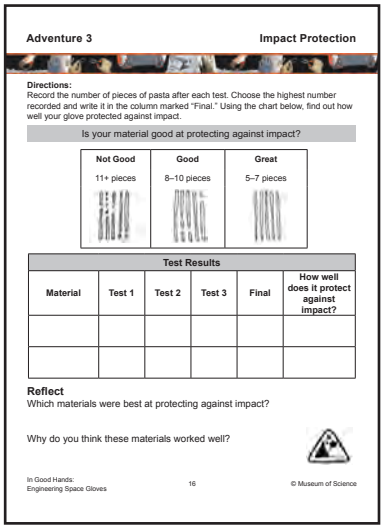
In Good Hands: Engineering Space Gloves 14 © Museum of Science



Adventure 3 — Impact Test Procedure

1. Cut your material and tape it in **1 layer** to **1 side of your glove**.
2. Put 1 piece of pasta in each finger of your glove. Snap off excess pasta that may be sticking out from the wrist.
3. Place your glove in the aluminum tray. Make sure that the "fingers" are resting on the wooden skewer.
4. Lift the weight 1 foot above the center of your glove. Make sure the entire weight is above the ruler.
5. Drop the weight.
6. Carefully empty the pasta out of the glove and count the number of pieces.
7. Record your results.
8. Repeat 2 more times for a total of 3 tests.
9. Record the highest number in the "Final" column. How well did your glove protect against impact?

In Good Hands: Engineering Space Gloves 15 © Museum of Science



Adventure 3 — Impact Protection

Directions:
Record the number of pieces of pasta after each test. Choose the highest number recorded and write it in the column marked "Final." Using the chart below, find out how well your glove protected against impact.

Is your material good at protecting against impact?

Not Good	Good	Great
11+ pieces	8–10 pieces	5–7 pieces

Test Results					
Material	Test 1	Test 2	Test 3	Final	How well does it protect against impact?

Reflect
Which materials were best at protecting against impact?

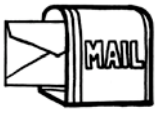
Why do you think these materials worked well?

In Good Hands: Engineering Space Gloves 16 © Museum of Science

Chart for Adventure 3

Testing Results			
Material	**Cold**	**Impact**	
cheesecloth	*Cold Results from Adventure 2*		
cotton balls			
craft foam			
felt			
foil			
sponges			
straws			
transparency			

Kids will learn:
- A space glove must protect against impact hazards.
- Some materials are better than others at protecting against heavy moving objects.



Present the Message from the Duo (5 min)

1. Tell kids that India has sent them more information about their model space gloves. Have kids turn to *Message from the Duo*, p. 14 in their Engineering Journals, to follow along. Play track 6.
2. To check for understanding, ask:
   - **What kinds of things did India say that astronauts need to protect their hands against in space?** *Astronauts need to protect themselves against impact hazards like heavy moving equipment and space debris.*
   - **What does India want us to do?** *Test different materials to find out how well they protect against impact hazards.*

Tip: Help kids make connections to everyday objects that protect against impact, such as a bike helmet, a hard hat, knee pads, an airbag, or packing materials.

Set the Stage (10 min)

1. Gather kids at a Testing Station with their Engineering Journals. Show them the demonstration glove and the weight they will use to model an impact hazard in space. Explain that the pasta pieces are a model for the finger bones in a hand. The skewer at the bottom of the tray represents a tool the glove will "hold" during testing.
2. Turn to *Impact Test Procedure,* p. 50 in this guide. Kids may turn to p.15 in the Engineering Journal. Demonstrate steps 2–4 of the impact test, but do not drop the weight. Ask:
   - **What do you think will happen when we drop this weight on the glove?** *The pasta will break.*
3. Let kids know they will test their material 3 times and record their results on *Impact Protection*, p. 16 in their Engineering Journals. They will write the highest number out of the 3 tests in the "Final" column.
4. Point out all of the materials on the Materials Table, and let kids know they will work in pairs to test 1 of the materials. Ask:
   - **Do you think any of these materials will protect the model fingers against impact? Why?** *Accept all answers.*

Tip: If kids have advanced math skills, have them determine the average number of breaks out of 3 tests and round up.

Ask: Which Material Is Best? (25 min)

1. Organize kids into pairs.
2. Have kids turn to *Impact Test Procedure,* p. 15 in their Engineering Journals.
3. Assign pairs a different material than the one they tested in Adventure 2. Have groups retrieve their materials from the Materials Table and begin working.
4. Have groups record their results on *Impact Protection*, p. 16 in their Engineering Journals, and in the "Impact" column on the *Testing Results* chart by writing whether the material was "not good," "good," or "great" at protecting against impact for the material they tested.
5. After kids test and record their results and if time permits, encourage them to continue investigating by testing a different material or combining materials.
6. Let groups know when time is winding down.

Tip: If kids need help attaching material to their glove, tell them to cut long strips of masking tape, make loops with the sticky side out, and place the loop on **1 side** of the glove.

Reflect (10 min)

1. Gather groups around the *Testing Results* chart to share their findings. Ask:
   - **Which materials were great at protecting against impact hazards? Why do you think they worked well?**
2. Encourage kids to make connections between the properties of the materials and their results from the *Testing Results* chart. For example, the softer materials like craft foam and sponges provided padding for the pasta and prevented it from breaking. Ask:
   - **Which materials were not good at protecting against impact hazards? Why do you think they did not work well?** *The thin, flexible materials like foil did not provide enough padding for the pasta.*
   - **Which materials are good at protecting against both impact and cold temperatures?**
3. Show kids the *Engineering Design Process* poster. Ask:
   - **Which step of the Engineering Design Process helped you most today?** *We* asked *which materials were best at protecting against impact.*
4. Give kids time to reflect using the bottom of *Impact Protection*, p. 16 in their Engineering Journals, so they can apply what they learned in this adventure to their final design challenge.
5. Let kids know that next time they will find out about one more hazard before they design a space glove to protect against multiple space hazards.
6. Save the Impact Testing Stations and materials for Adventures 5 and 6.

Message from the Duo

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	Impact Hazards Ahead

8:45 AM

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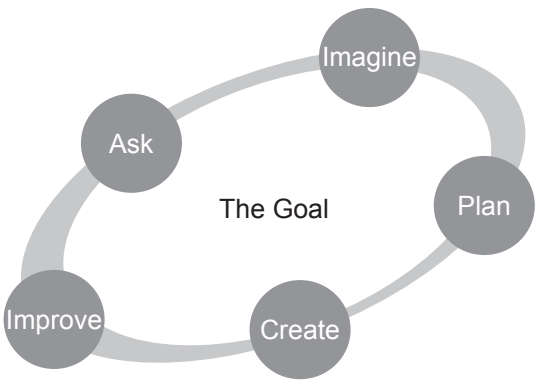

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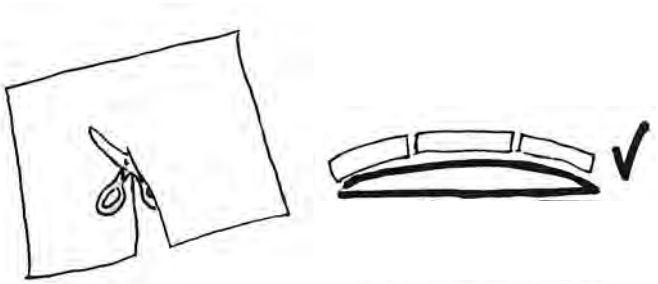

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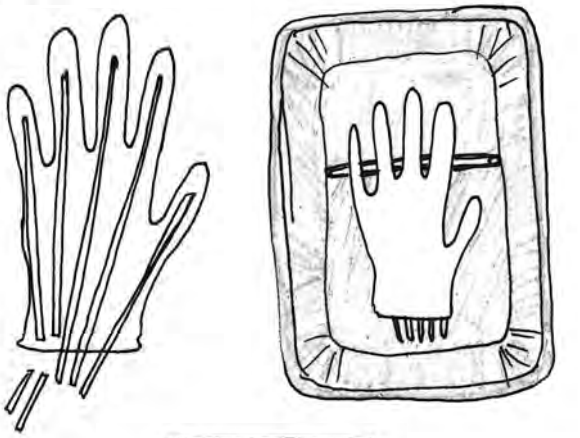

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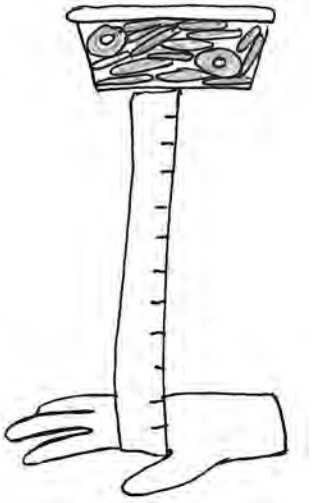
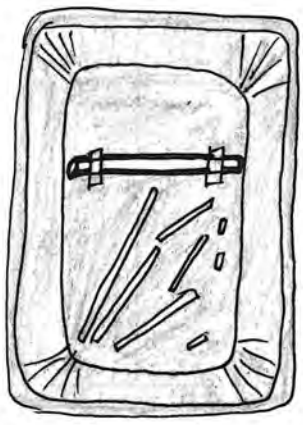
4. Lift the weight 1 foot above the center of your glove. Make sure the entire weight is above the ruler.



5. Drop the weight.

6. Carefully empty the pasta out of the glove and count the number of pieces.

7. Record your results.



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