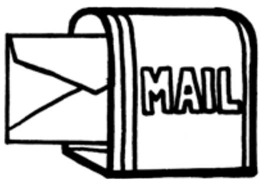
Overview: Kids will test and compare different materials to see which ones work best to protect against cold temperatures.

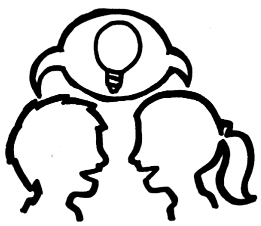
Note to Educator: In this adventure, kids use materials to make a mitt so they can gain experience testing a material prior to developing glove-construction skills. Be sure that the sponges are dry before testing them in the mitt.

Save the *Testing Results* chart for use in later adventures. Save the Testing Stations, including the model hands and thermometers, for use in Adventures 5 and 6.

Duo Update (5 min)

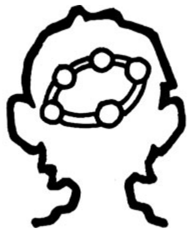


Set the Stage (10 min)



Activity (20 min)

Reflect (10 min)



Materials

For the entire group:
- ☐ *Message from the Duo*, track 5 or Engineering Journal, p. 11
- ☐ *Engineering Design Process* poster
- ☐ chart paper and markers
- ☐ 1 roll of masking tape
- ☐ 1 roll of paper towels

Testing Stations:
- ☐ 1 measuring cup
- ☐ 2 buckets, 5 liters
- ☐ 2 digital thermometers
- ☐ 2 rulers
- ☐ 2 sheets of thin cardboard
- ☐ 2 stopwatches
- ☐ 12 cups of ice cubes
- ☐ 20 cups of water

Materials Table:
- ☐ 1 piece of cheesecloth, approx. 8.5” x 11”
- ☐ 1 sheet of craft foam
- ☐ 1 sheet of felt
- ☐ 1 sheet of foil, approx. 8.5” x 11”
- ☐ 1 sheet of transparency
- ☐ 5 sponges, dry
- ☐ 40 cotton balls
- ☐ 50 straws

For each pair of kids:
- ☐ 1 pair of scissors
- ☐ 2 resealable plastic bags, quart size

For each kid:
- ☐ Engineering Journal

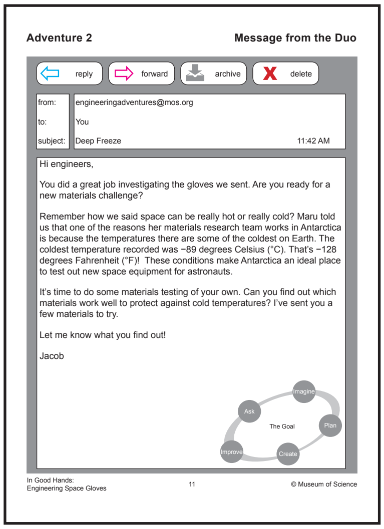
Preparation

Time Required: 30 minutes

1. Post the *Engineering Design Process* poster.
2. Have the *Message from the Duo* ready to share.
3. Copy the *Testing Results* chart, p. 34 in this guide, onto chart paper.
4. Set up a Materials Table with the materials listed above.
5. Cut 2 model hands out of thin cardboard, using the *Model Hand Template*, p. 41 in this guide.
6. Set aside 1 pair of resealable bags to use for the demonstration mitt.
7. Review *Cold Test Procedure*, p. 40 in this guide.
8. Set up 2 Testing Stations by filling each bucket with 6 cups of ice and 10 cups of water. Arrange them on a table with digital thermometers, rulers, stopwatches, and 1 roll of paper towels.
9. Optional: Make copies of *Celsius and Fahrenheit Table*, p. 43 in this guide, for each pair of kids.

Journal Pages for Adventure 2

Message from the Duo, p. 11



Adventure 2 — Message from the Duo

reply | forward | archive | delete

from: engineeringadventures@mos.org
to: You
subject: Deep Freeze — 11:42 AM

Hi engineers,

You did a great job investigating the gloves we sent. Are you ready for a new materials challenge?

Remember how we said space can be really hot or really cold? Maru told us that one of the reasons her materials research team works in Antarctica is because the temperatures there are some of the coldest on Earth. The coldest temperature recorded was −89 degrees Celsius (°C). That's −128 degrees Fahrenheit (°F)! These conditions make Antarctica an ideal place to test out new space equipment for astronauts.

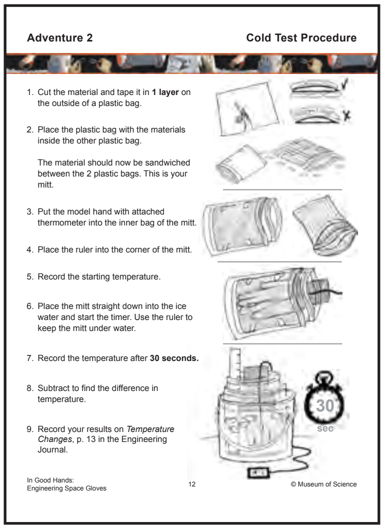
It's time to do some materials testing of your own. Can you find out which materials work well to protect against cold temperatures? I've sent you a few materials to try.

Let me know what you find out!

Jacob

In Good Hands: Engineering Space Gloves — 11 — © Museum of Science

Cold Test Procedure, p. 12



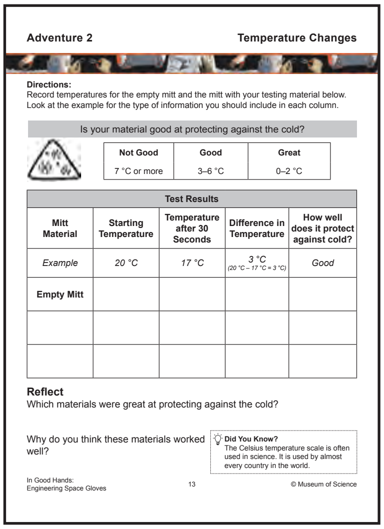
Adventure 2 — Cold Test Procedure

1. Cut the material and tape it in **1 layer** on the outside of a plastic bag.
2. Place the plastic bag with the materials inside the other plastic bag.

   The material should now be sandwiched between the 2 plastic bags. This is your mitt.
3. Put the model hand with attached thermometer into the inner bag of the mitt.
4. Place the ruler into the corner of the mitt.
5. Record the starting temperature.
6. Place the mitt straight down into the ice water and start the timer. Use the ruler to keep the mitt under water.
7. Record the temperature after **30 seconds.**
8. Subtract to find the difference in temperature.
9. Record your results on *Temperature Changes*, p. 13 in the Engineering Journal.

In Good Hands: Engineering Space Gloves — 12 — © Museum of Science

Temperature Changes, p. 13



Adventure 2 — Temperature Changes

Directions:
Record temperatures for the empty mitt and the mitt with your testing material below. Look at the example for the type of information you should include in each column.

Is your material good at protecting against the cold?

Not Good	Good	Great
7 °C or more	3–6 °C	0–2 °C

Test Results

Mitt Material	Starting Temperature	Temperature after 30 Seconds	Difference in Temperature	How well does it protect against cold?
Example	*20 °C*	*17 °C*	*3 °C* *(20 °C – 17 °C = 3 °C)*	*Good*
Empty Mitt				

Reflect
Which materials were great at protecting against the cold?

Why do you think these materials worked well?

Did You Know?
The Celsius temperature scale is often used in science. It is used by almost every country in the world.

In Good Hands: Engineering Space Gloves — 13 — © Museum of Science

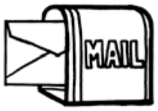
Chart for Adventure 2

Testing Results			
Material	**Cold**		
cheesecloth			
cotton balls			
craft foam			
felt			
foil			
sponges			
straws			
transparency			

Tip: Draw in 2 additional columns in the chart, but leave the headings blank until kids are ready to record their "Impact" and "Dust" data in Adventures 3 and 4.

Kids will learn:

- A space glove must protect astronauts from extreme temperatures in space.
- Some materials are better than others at protecting against the cold.



Present the Message from the Duo (5 min)

1. Tell kids that Jacob sent another message. Have kids turn to *Message from the Duo*, p. 11 in their Engineering Journals, to follow along. Play track 5.
2. To check for understanding, ask:
   - **What did Jacob ask you to investigate today?** *Materials that protect against cold temperatures.*

Set the Stage (10 min)

1. Let kids know that they will line mitts with different materials and test them to find out which materials are better at protecting against the cold.
2. Assemble an empty mitt by placing 1 resealable bag inside another. Hold up the empty mitt with your hand in the inner bag. Ask:
   - **Do you think this mitt will be good at protecting against cold temperatures? Why or why not?** *Accept all answers.*
3. Gather kids at the testing area. Explain that they will take 2 temperature readings. Demonstrate the steps using *Cold Testing Procedure*, p. 40 in this guide or p. 12 in the Engineering Journal, with the empty mitt.

> **Note:** The thermometer takes a little time to adjust, so when the mitt is inserted in the ice water, the temperature may go up slightly before it starts to go down.

4. Have kids record the data on *Temperature Changes*, p. 13 in their Engineering Journals. Ask:
   - **Do you think this mitt is good at protecting against the cold? Why or why not?** *Accept all answers.*
5. Explain that if the temperature changes a lot (7 degrees or more) in 30 seconds, it means the heat is moving quickly out of the mitt, and the material is "not good" at protecting against the cold.

> **Tip:** If kids are interested, explain that materials that do not allow heat to move through them quickly are called insulators.

6. Tell kids if the temperature changes only a little (2 degrees or less) in 30 seconds, the heat is moving slowly out of the mitt, and the material is "great" at protecting against the cold.
7. Show kids the Materials Table with the cheesecloth, cotton balls, felt, craft foam, foil, sponges, straws, and transparency. Ask:
   - **Which materials do you think will be great at protecting against the cold? Why?** *Accept all answers.*

Ask: Which Material Is Best? (20 min)

1. Organize kids into pairs.
2. Assign each pair 1 or 2 materials to test so that all materials are tested.
3. Allow pairs to visit the Materials Table and begin assembling their mitts.
4. As groups are ready, have them move to a Testing Station.
5. Have pairs record their results on *Temperature Changes*, p. 13 in their Engineering Journals, and in the "Cold" column of the *Testing Results* chart by writing whether the material was "not good," "good," or "great" at protecting against the cold.

Tip: Kids may ask about empty space between materials in the mitt. Because of the different properties of the materials, 1 layer of material may have more empty space in some mitts than others.

Reflect (10 min)

1. Gather kids near the *Testing Results* chart to share their observations. Ask:
   - **Which materials were great at protecting against the cold? Why do you think they worked well?**
2. Encourage kids to make connections between the properties of the materials and their results. If there are different results for the same material, consider testing it again to decide how to categorize it. Ask:
   - **Which materials were not good at protecting against cold temperatures? Why not?**
   - **Which material do you think would be good to use in a space glove? Why do you think so?** *Accept all answers.*
3. Have kids gather around the *Engineering Design Process* poster. Ask:
   - **What step of the Engineering Design Process did you use today?** *We* asked *questions about materials that protect against cold temperatures.*
4. Let kids know that next time, they will *ask* questions about how well certain materials protect against impact, or damage from heavy moving objects.
5. Save the *Testing Results* chart for use in the next adventure. Save the Testing Stations, model hands, and thermometers for use in Adventures 5 and 6. If the sponges are wet, set them out to dry so that tape will stick to them in the next activity.

Tip: To standardize the test results, wave the paper hand in the air between tests to bring the temperature back up to 20–22 °C.

Tip: If kids are unfamiliar with Celsius, make and distribute copies of the *Celsius and Fahrenheit Table*, p. 43 in this guide, so they can compare the 2 temperature scales.

Tip: Help kids make connections from their results to everyday objects that protect against the cold, like a styrofoam coffee cup, or the lining of a winter coat.

Extension (10 minutes)

To deepen kids' understanding of materials properties and how cheesecloth can protect against the cold, kids will explore what happens when a second layer of cheesecloth is added to the mitt.

1. Bring out another piece of cheesecloth, approximately 8.5" x 11".
2. Ask the kids who tested cheesecloth to cut and tape the second piece of cheesecloth onto their mitt in a second layer.
3. Have the pair test the new two-layer mitt at a Testing Station.
4. Add another row to the *Testing Results* chart labeled "cheesecloth–2 layers"
5. Have a volunteer record the results on the "cheesecloth - 2 layers" row of the *Testing Results* chart by writing whether the material was "not good," "good," or "great" at protecting against the cold.
6. Ask:
   - **Which was better at protecting against the cold, one layer of cheesecloth or two layers?** *Two layers of cheesecloth.*
   - **Did the results surprise you?** *Accept all answers.*
   - **What do you think would happen if you added a second layer of a different material to another mitt?** *Accept all answers.*
   - **Which do you think would be better to use in a space glove—one layer or two layers? Why do you think so?** *Accept all answers.*

reply | forward | archive | delete

from:	engineeringadventures@mos.org
to:	You
subject:	Deep Freeze

11:42 AM

Hi engineers,

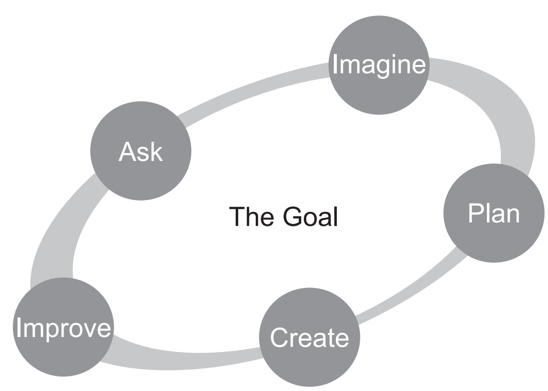
You did a great job investigating the gloves we sent. Are you ready for a new materials challenge?

Remember how we said space can be really hot or really cold? Maru told us that one of the reasons her materials research team works in Antarctica is because the temperatures there are some of the coldest on Earth. The coldest temperature recorded was −89 degrees Celsius (°C). That's −128 degrees Fahrenheit (°F)! These conditions make Antarctica an ideal place to test out new space equipment for astronauts.

It's time to do some materials testing of your own. Can you find out which materials work well to protect against cold temperatures? I've sent you a few materials to try.

Let me know what you find out!

Jacob

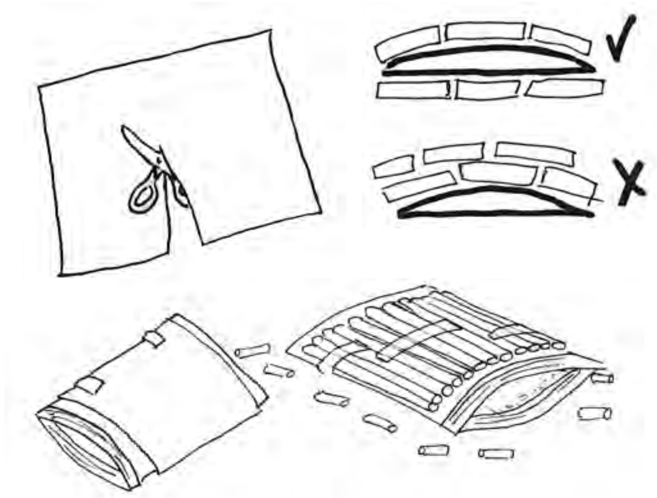


Cold Test Procedure

1. Cut the material and tape it in 1 layer on the outside of a plastic bag.

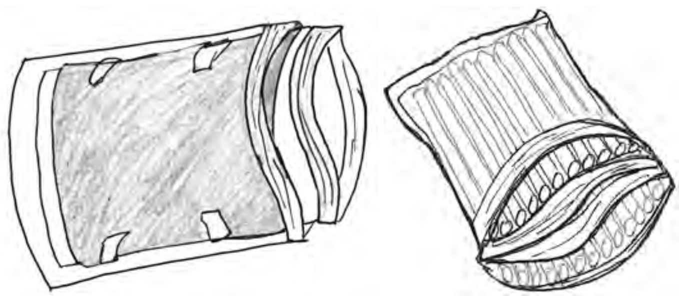
2. Place the plastic bag with the materials inside the other plastic bag.

   The material should now be sandwiched between the 2 plastic bags. This is your mitt.



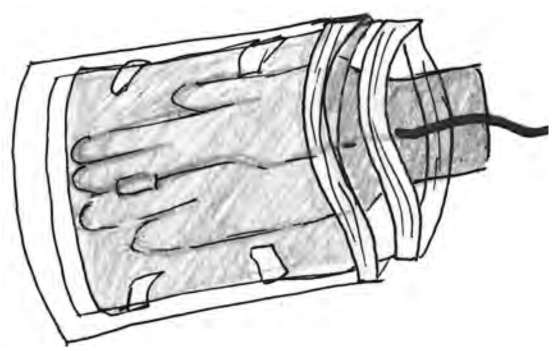
3. Put the model hand with attached thermometer into the inner bag of the mitt.

4. Place the ruler into the corner of the mitt.



5. Record the starting temperature.

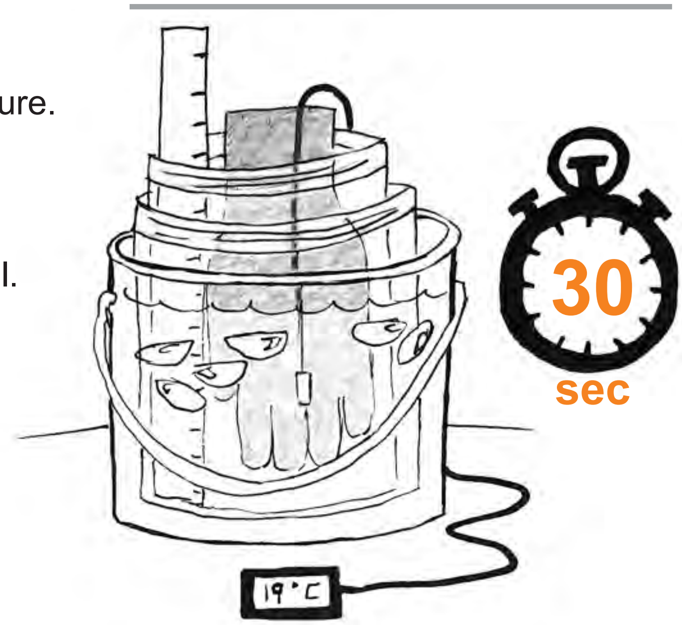
6. Place the mitt straight down into the ice water and start the timer. Use the ruler to keep the mitt under water.



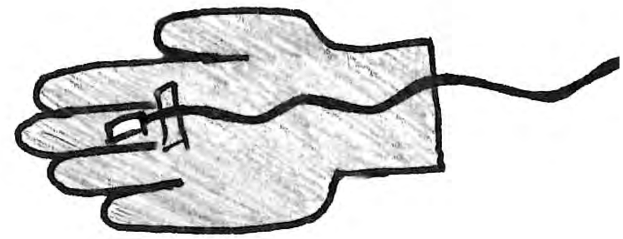
7. Record the temperature after **30 seconds.**

8. Subtract to find the difference in temperature.

9. Record your results on *Temperature Changes*, p. 13 in the Engineering Journal.



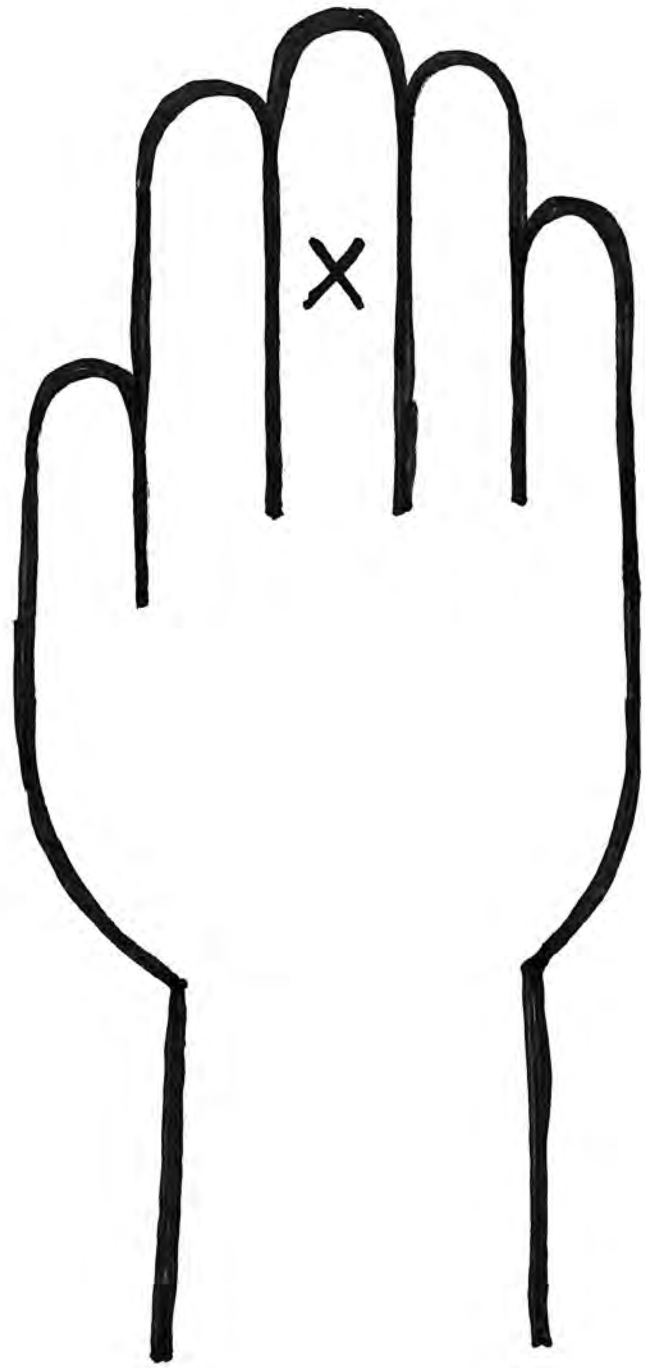
How to Make the Model Hand

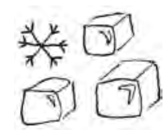


Prepare a model hand for each of the 2 Testing Stations.

1. Cut out the hand below.
2. Trace the hand onto thin cardboard and cut it out.
3. Attach the thermometer with masking tape.

   Make sure the metal probe is positioned over the X. Be careful not to tape over the probe itself.
4. Place 1 model hand with the digital thermometer attached at each Testing Station.



Celsius (°C)	Fahrenheit (°F)	
–20 **°C**	–4 **°F**	
–10 **°C**	14 **°F**	
0 **°C**	32 **°F**	→ water freezes 
10 **°C**	50 **°F**	
20 **°C**	68 **°F**	→ room temperature
30 **°C**	86 **°F**	
40 **°C**	104 **°F**	
50 **°C**	122 **°F**	
60 **°C**	140 **°F**	
70 **°C**	158 **°F**	
80 **°C**	176 **°F**	
90 **°C**	194 **°F**	
100 **°C**	212 **°F**	→ water boils