Engineering Adventure 3: Chilling Out: Protecting Against Cold

Educator Preview

Adventure Snapshot

Learners test and compare materials to see which ones work best to protect against cold.

Timing | 70 minutes

Get Ready & Team Up	5 min.
Which Material Is Best?	55 min.
Reflect & Wrap Up	10 min.
Total	**70 min.**

Level Up Activities 5–10 min. each

Prep Snapshot*

Prep Time 50 min.

- Set up materials stations.
- Prepare Testing Results chart.
- Print handouts.

**See Materials & Preparation for full info.*

21st Century Skills

Connection

- Critical Thinking

Habits of Mind

- Apply science knowledge to problem solving.
- Investigate properties and uses of materials.

Guiding Question

Which materials are good at protecting against cold?

Learners Will Do

Test how materials insulate against cold and consider which to use in a space glove.

Learners Will Know

Engineers must learn how different materials work for different uses.

Connecting Across Adventures

Adventure 2: Exploring Glove Uses	Adventure 3: Protecting Against Cold	Adventure 4: Protecting Against Impact
Last time, learners did simple tasks wearing different gloves and compared results. Then they learned how spacesuit gloves protect astronauts from space hazards.	**Today**, learners test how well different materials protect against cold. Later, they'll use collected data to design space gloves.	**Next time**, learners will test how well different materials protect against impact.

Activity Resources

Access videos and digital resources using the link or QR code below. More information for teaching this curriculum is available in the Educator Guide Introduction (pgs. iii–xxvi). Access more PLANETS units, research, and pathways at https://planets-stem.org/.

weblink: https://hov.to/63471629

Materials and Preparation

Materials

For the whole group

- *Our Ideas* poster (on paper or a shared digital document) Examples | Templates
  - chart paper and markers
  - 1 roll of masking tape
  - 1 roll of paper towels
  - 1 measuring cup
  - 2 buckets, 5-liter
  - 2 digital thermometers
  - 2 rulers
  - 2 sheets of thin cardboard
  - 2 timers
  - 12 cups of ice cubes
  - 20 cups of water (1-1/4 gallons total)

For each pair of learners

- 1 pair of scissors
- 2 resealable plastic bags, quart size
- Engineering Adventure 3 Cold Test Procedure Handout, pg.53

For the Materials Table

- 1 piece of cheesecloth, approx. 8.5" × 11"
- 1 sheet of craft foam
- 1 sheet of felt
- 1 sheet of foil, approx. 8.5" × 11"
- 1 sheet of transparency
- 5 sponges, dry
- 40 cotton balls
- 50 straws

For each learner

- Engineering Notebook (PDF)

Teaching Tip

The thermometer may take a little time to adjust to the ice water.

Support Learner Differences

To provide learners with audio data, you can purchase talking thermometers online.

Adventure 3 Materials Preparation (50 min.)

Ahead of Time

1. Review the "In-Use Example" in the Prep & Setup Guide (PDF) to help you think about what to add to the *Our Ideas* poster during the discussions in this adventure.
2. Place one resealable bag inside another to make an empty mitt for demonstrating.
3. Make 1 copy of Engineering Adventure 3 Cold Test Procedure Handout, pg. 53, for each pair of learners.

In Your Space

4. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally. Copy the *Testing Results* chart onto the *Our Ideas* poster so that learners can refer to it throughout the adventure. Consider including a sample or image of each material in the "Material" column for learners to reference.
5. See Cold Test Setup Instructions, pg.50.
6. Set up a Materials Table. See list above.

Support Learner Differences

You can leave space on the poster for learners to write names of materials in their preferred languages.

Teaching Tip

If time is limited, you can split this adventure into two sessions, having learners prepare the gloves in the first session and test them in the second. If you have a limited number of sessions, consider preparing the gloves yourself and having learners move directly to testing them.

Chart for Adventure 3

Testing Results

Material	[Leave blank]	[Leave blank]	[Leave blank]
none cheesecloth cotton balls craft foam felt foil sponges straws transparency	[Results will go here.]	[Leave blank.]	[Leave blank.]

Note: You will leave the last two columns blank until Adventures 4 and 5.

Teaching Tips

- Be sure sponges are dry before using them.
- Save the Testing Stations, including the model hands and thermometers, for Adventures 6 and 7.

Adventure Guide

Get Ready & Team Up (5 min.)

1. Ask: **If you did the last activity, what did you do and why?** *(We tested different types of gloves by doing simple tasks and comparing results. Astronauts use gloves when they're wearing spacesuits.)* Draw learners' attention to their work on the *Our Ideas* poster about how different gloves work well for different tasks.
2. Say: **Today you will continue the Ask phase of our engineering design process. You will explore how well glove materials protect against cold.** Share the Guiding Question with learners aloud and write it on the *Our Ideas* poster (using multiple languages as needed): **Which materials are good at protecting against cold?**
3. Organize learners into pairs.

Which Material Is Best? (55 min.)

4. Say: **You will use model hands in model mitts to test which materials are better at protecting against the cold.**
5. Gather learners at the testing area. Give each pair a copy of Engineering Adventure 3 Cold Test Procedure Handout, pg.53 and demonstrate the steps with the empty demonstration mitt. Record how many degrees colder the thermometer got in the "None" row of the *Our Ideas* poster. As needed, allow learners to feel the test setup.

Support Learner Differences

If new learners are joining you, lead an inclusion activity (pgs. xx-xxi) and use other engagement strategies as necessary (pgs. viii–xviii).

Support Thinking

- To give learners more context about this hazard, show the video Extreme Temperatures in Space (1:17 min. video length). Read the Educator Science Background (weblink) for more information.
- This adventure assumes learners are familiar with the word *temperature*. If they have not encountered this word before, you can introduce it later in the adventure after they have used thermometers. It may be useful to use the word in context and have learners define it and use it in a sentence.

Support Learner Differences

Encourage learners to identify their own strengths and the roles they would like to play during testing, and form pairs that can play a variety of roles. For example, one learner can specialize in assembling the mitt for testing, and another learner can read the temperature.

Level Up!

The Artemis III astronauts are the first humans to return to the Moon since the Apollo era and NASA chose the South Polar region of the Moon for their landing site. This area is known for having some of the coldest temperatures in the entire Solar System, even colder than Pluto! Check out this article to learn more about the Mission Objectives of the Artemis III mission: "Moon's South Pole is Full of Mystery, Science, Intrigue - NASA" (10 min.)

6. Have learners turn to *Temperature Changes*, pg. 15 in their Engineering Notebooks. Say: **You will record each material's temperature twice: once at the start, and again after 30 seconds. You will rank the materials by how much the temperature drops in 30 seconds.**

7. Assign each pair one or two materials to test. Make sure all materials are tested.

8. Let pairs visit the Materials Table and assemble their mitts.

9. As pairs are ready, have them move to Testing Stations.

Support Thinking

- If learners would benefit from an additional visual of the testing procedure, play the video How to Design and Test Space Gloves (0:26–1:00).
- To ensure learners understand the test procedure, have pairs summarize it together.

Level Up!

Explain that "cold" describes something that has a lot less heat energy than the things around it. Heat energy always moves from warmer places to colder places. So, "protects against cold" means "slows the transfer of heat energy." Materials that slow the transfer of heat energy are called ***insulators***. For example, when you're outside on a hot day and you put your hand on the metal bar of a playground, it feels really hot because metal is a poor insulator. Put your hand on something at the playground made of wood, and it doesn't feel nearly as hot because wood is a pretty good insulator. Show a NASA video about Artemis insulation, NASA Crews Spray Foam Insulation on Artemis III Rocket Hardware (1:26), and discuss why insulation is important for rockets. (5 min.)

Support Learner Differences

- If you have learners who speak multiple languages, have them discuss words for "temperature," "heat," "warm," and "cold," and things that protect against the cold in their preferred languages and notice similarities between languages.
- Give learners time to feel and become familiar with the materials before testing them.

Teaching Tip

If time is short, pause the adventure here and finish it in another session.

10. As learners finish, have them find out how much colder each material got. Have pairs record results on *Temperature Changes*, pg. 15 in their Engineering Notebooks and in the "Cold" column on the *Our Ideas* poster by writing whether the material was "not good," "good," or "great" at protecting against the cold.

Reflect & Wrap Up (10 min.)

11. Gather learners and review the *Our Ideas* poster. Revisit the Guiding Question: **Which materials are good at protecting against cold?** *(Thick materials like cheesecloth, foam, and cotton balls are good against cold.)* Ask: **Why do you think they worked well?** *(Accept all responses.)* **Which materials were not good? Why not?** *(Thin materials like foil and transparency did not work well.)* **Which would be good to use in a space glove? Why?** *(Ask learners to support answers with results from their tests.)*

Teaching Tips

- Wave the paper hand in the air between tests to bring the temperature back up to 20–22°C. That way all tests start at about the same place.
- As needed, make copies of Engineering Adventure 3 Celsius and Fahrenheit Table Handout (PDF) for learners to refer to. Note that the boiling point listed is for sea level; water boils at colder temperatures as its elevation increases.

Support Thinking

To help learners visualize which materials are better at protecting against cold, have them post a sample of each material on a wall in a spectrum from "not good" at one end to "great" at the other. Consider photographing this spectrum and printing copies for learners to reference later.

Support Learner Differences

Have learners write names or descriptions of materials in their preferred languages on the *Our Ideas* poster. Note that some languages may have several terms for a given material.

Encourage open communication within each pair. Assign one member to describe the temperature reading while another records it verbally. This way, everyone can actively participate and contribute to the experiment.

Support Learner Differences

Give learners options to express materials they think would be good, such as giving a thumbs up or thumbs down.

Support Thinking

Help learners make connections between their results and everyday objects that protect against the cold, like a Styrofoam coffee cup or the lining of a winter coat.

12. Say: **Next time, you will test materials that protect against damage from hazards like space trash.**

Level Up!

- Refer to the Engineering Design Process poster (PDF). Ask: **What phases of the Engineering Design Process did you use today?** *(The Ask phase. We asked which materials are best at protecting against cold.)* (5 min.)
- Ask this story prompt: **Can you tell me a story about something creative you did to keep warm when it got really cold?** Tell learners, if anyone asks what they did today, they can tell them "we tested materials to protect from cold in a bucket of ice," and then ask them the above story prompt. Consider returning to learners' ideas at the start of the next adventure. (5 min.)

After the Adventure

1. Clean up:
   - Keep the *Our Ideas* poster for Adventure 4.
   - Pour out water and ice, and dispose of materials that cannot be reused.
   - Save Testing Stations, model hands, and thermometers for Adventures 6 and 7.
   - If the sponges are wet, set them out to dry so that tape will stick to them in Adventure 4.
2. Plan for Engineering Adventure 4. See Engineering Adventure 4 Preparation on pg. 58. Note that you will need to prepare two Impact Testing Stations. Setup will likely take at least 25 minutes.
3. Take time to reflect on the following educator prompts. **How did learners help each other understand temperature and temperature changes?**

Space Hazards Additional Resources

Resources include All Downloads, All Videos, Family Connections, and more.

webllink: https://hov.to/940428f7

Cold Test Setup Instructions

Set up two testing stations for learners to test how well their gloves insulate against cold.

Materials for each setup:

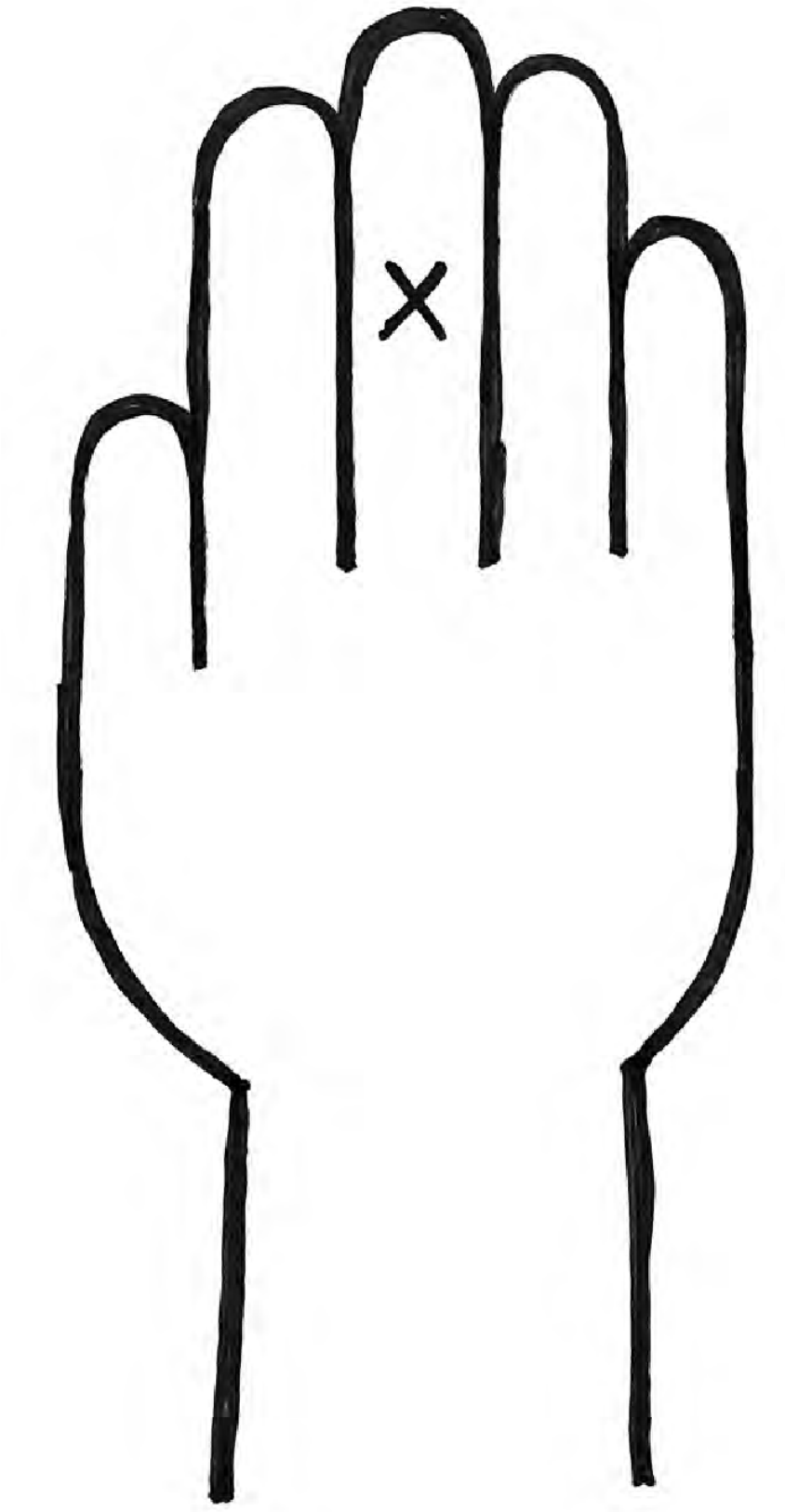
- 1 roll of masking tape
- 1 roll of paper towels
- 1 bucket, 5-liter
- 1 digital (or talking) thermometer
- 1 ruler
- 1 sheet of thin cardboard
- 1 timer
- 6 cups of ice cubes
- 10 cups of water

Prepare Testing Stations

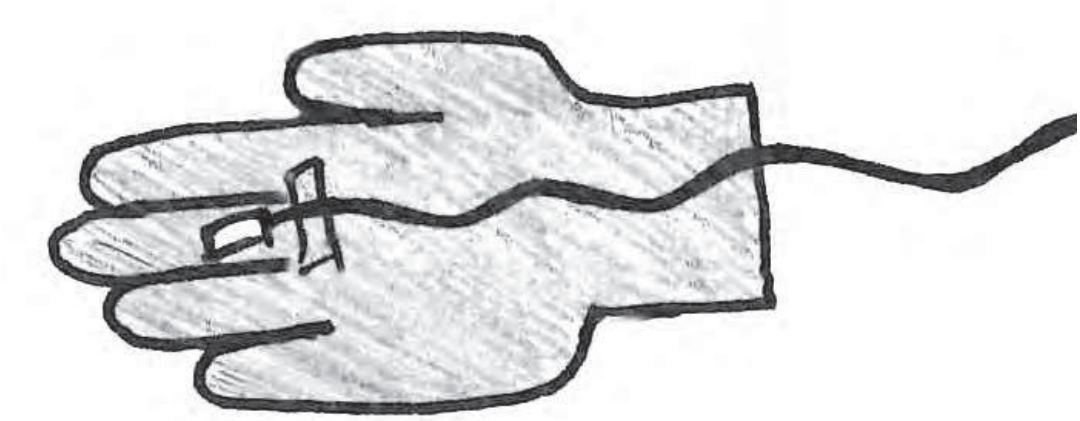
1. Fill each bucket with 6 cups of ice and 10 cups of water.
2. Arrange the buckets on a table with digital thermometers, rulers, timers, and 1 roll of paper towels.

Prepare Model Hands

3. Place the hand illustration (on the next page) onto a sheet of thin cardboard to cut out a cardboard hand.



4. Attach the thermometers with masking tape. Make sure the metal probes are positioned over the X. Be careful not to tape over the probe itself.



5. Place one model hand with the digital thermometer attached at each Testing Station.

Cold Test Procedure

1

Tape one layer of the material being tested around both sides of the outside of the bag.

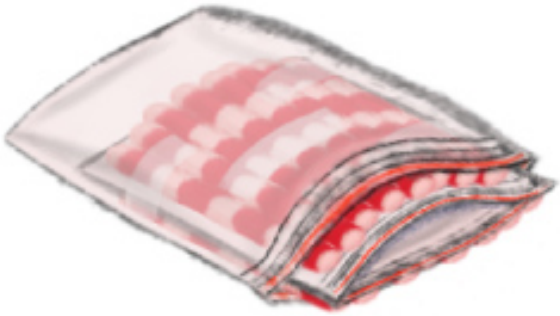
Possible materials are cheesecloth, cotton balls, craft foam, felt, foil, sponges, straws, and transparency.

Every part of the *outer surface* of the bag should be covered in one layer of the material being tested.

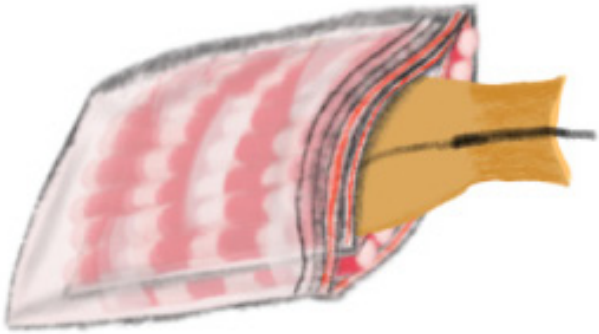
Example 1: Foil.
Cut the foil in half. Tape each half to the *outside* of the bag, on both sides.

Example 2: Straws.
Tape straws next to each other to cover the *outside* of the bag on both sides.

2 Place the plastic bag with the materials inside the other plastic bag. The materials should now be sandwiched between the 2 plastic bags. This is your mitt.

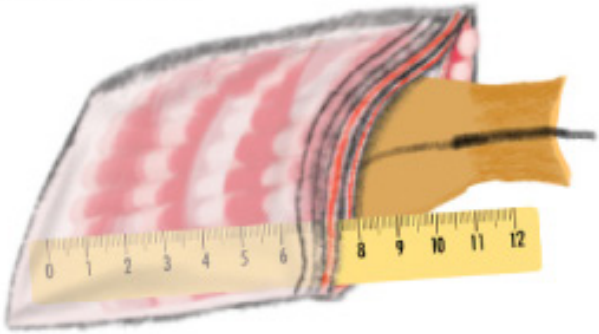


3 Put the model hand with attached thermometer into the inner bag of the mitt.



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 the water.

7 Record the temperature after 30 seconds.

8 Subtract to find the difference in temperature.

9 Record your results on *Temperature Changes* in the Engineering Notebook.