Educator Guide

Engineering Adventure 5: Dangerous Dust: Protecting Against Dust

Educator Preview

Adventure Snapshot

Learners test how dust resistant materials are.

Timing | 60 minutes

Get Ready & Team Up	5 min.
Which Material Is Best?	45 min.
Reflect & Wrap Up	10 min.
Total	**60 min.**

Level Up Activities 5–45 min. each

Prep Snapshot*

Prep Time 40 min.

- Set up materials stations.
- Print handouts.
- Prepare ice for Adventure 6, as noted in Materials & Preparation.

**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 dust?

Learners Will Do

Test how materials protect against dust 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 4: Protecting Against Impact	Adventure 5: Protecting Against Dust	Adventure 6: Creating a Space Glove
Last time, learners tested how well different materials protect against impact.	**Today**, learners test how well different materials resist dust. Later, they'll use collected data to design space gloves.	**Next time**, learners will plan, create, and test gloves to protect against space hazards.

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/71ed50aa

Materials and Preparation

Materials

For the whole group

- 1 container of UV glow powder
- 1 roll of paper towels
- 1 tablespoon measure
- 2 aluminum trays, 12" × 10"
- 2 black lights, handheld
- 2 craft sticks
- 2 cups of gravel
- 2 hand lenses
- 6 cups of sand
- 8 resealable plastic bags, quart size
- 10 washers, 1.25"

For each pair of learners

- 1 pair of scissors
- 1 vinyl glove
- Engineering Adventure 5 Dust Test Procedure Handout, pg. 72

For each learner

- Engineering Notebook (PDF)

Support Learner Differences

Glow powder makes dust that gets on the gloves visible, so learners can collect data visually. To provide data that is not visual, use an indicator detectable by smell, such as a powdered spice, alongside or instead of glow powder. After testing, learners can measure the amount of dust on the glove by the intensity of the scent. Demonstrate wafting the scent to avoid inhaling powder.

For the Materials Table

- 2 pieces of cheesecloth, 8.5" × 11"
- 2 sheets of craft foam, 8.5" × 11"
- 2 sheets of felt, 8.5" × 11"
- 2 sheets of foil, 8.5" × 11"
- 2 sheets of transparency, 8.5" × 11"
- 4 rolls of masking tape
- 4 sponges
- 40 straws
- 60 cotton balls

Adventure 5 Materials Preparation (40 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. Make 1 copy of Engineering Adventure 5 Dust Test Procedure Handout, pg. 72, for each pair of learners.

In Your Space

3. Place the *Our Ideas* poster in a visible place in your learning setting or prepare to share it digitally. Title the last column for test results "Dust."
4. See Dust Test Setup Instructions, pg. 71.
5. Set up a Materials Table. See list above.

Support Learner Differences

Get ready to adjust the activity or materials for any learner whose physical abilities make it difficult to use gloves. Ask learners in advance what they need to complete the activity. They are the experts at knowing their physical capabilities. You can have alternative tools like tongs or scoops available, but don't assume they cannot do the activity as written.

Teaching Tips

- In this adventure, learners attach materials to a vinyl glove to develop construction skills and think about wearable designs. Be sure sponges are dry so tape will stick to them.
- Save the materials and Testing Stations for Adventures 6 and 7.

Ice Preparation for Other Adventures

6. Be aware that you will need 12 cups of ice 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 measured how well glove materials protected spaghetti against a falling weight.)* Draw learners' attention to their work on the *Our Ideas* poster about impact.
2. Say: **Today you will explore how different glove materials do or do not pick up dust.** 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 dust?** Say: **This is the last hazard you will explore before you start designing your space gloves.**
3. Ask: **Which phase of our engineering design process do you think we are in right now?** *(The Ask phase.)* Say: **Once you are finished testing materials, you will move to the Imagine, Plan, and Create phases as you design space gloves.**
4. Organize learners into pairs and distribute Engineering Notebooks.

Which Material Is Best? (45 min.)

5. Gather learners at the Testing Station. Turn on the black light and pass it over the trays. Say: **The glowing powder represents dangerous dust.**

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 Dangerous Dust (1:08). Read the Educator Science Background (weblink) for more information.

Support Learner Differences

- If you have learners who speak multiple languages, encourage them to share the word for *dust* in their preferred language. If you can, provide an example from a language you know. Note that different languages and cultures may have different concepts of dust. Take time to learn learners' words and use them throughout the adventures.
- 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 attaching materials to the glove, and another learner can count the areas with dust.

Teaching Tip

Make sure learners do not look directly into the black light at any time.

6. Give each pair a copy of Engineering Adventure 5 Dust Test Procedure Handout, pg. 72. Demonstrate the test procedure with a plain, uncovered glove and record the result in the "None" row on the *Our Ideas* poster. As needed, allow learners to carefully feel the test setup.
7. Explain that each pair will use one material to design both sides of the glove. They will record their results on *Dust Protection*, pg. 17 in their Engineering Notebooks, and in the "Dust" column on the *Our Ideas* poster.
8. Give each pair a glove and a material. (If necessary, assign some pairs two types of materials so all materials are tested.) Let learners collect materials and start working. Remind them that their fingers must be able to move in the glove.
9. Have each pair record results on *Dust Protection* and on the *Our Ideas* poster by writing "not good," "good," or "great."

Support Learner Differences

If learners cannot see the powder under the black light, turn off overhead lights. Add 1/2 tablespoon of glow powder between tests.

To support learners who would benefit from smelling the powder, replace with scented spices as necessary, but be careful of very strong or aggravating scents. If using this option, demonstrate wafting the scent to avoid anyone inhaling powder. Score using scent as follows:

- **Not Good**: Intense smell in any zone, smell in 4 areas
- **Good**: Moderate smell in any zone, smell in 2–3 areas
- **Great**: Faint or no smell in any zone, smell in 0–1 areas

Support Learner Differences

As needed, provide groups with a tub or other container to hold their materials. Give learners time to examine the materials before they begin testing.

Support Thinking

- If learners would benefit from an additional visual of the testing procedure, play How to Design and Test Space Gloves (1:33–2:11).
- To help learners visualize which materials are better at protecting against dust, 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.

Reflect & Wrap Up (10 min.)

10. Gather at the *Our Ideas* poster. Ask: **Which materials picked up a lot of dust? Why?** *(Porous or fuzzy materials caught a lot of dust in their creases and fibers.)* Revisit the Guiding Question: **Which materials are good at protecting against dust? Why?** *(Smooth materials let dust shake off easily.)*

11. Say: **Next time, you will design a space glove to protect astronauts on a mission.**

After the Adventure

1. Clean up:
   - Keep the *Our Ideas* poster for Adventure 6.
   - Save any leftover materials and Testing Stations for use in Adventures 6 and 7.
2. Plan for Engineering Adventure 6. See Engineering Adventure 6 Preparation on pg. 77. Note that you will need to prepare two Final Testing Stations, in addition to the Cold, Impact, and Dust Testing Stations you have prepared already. You will need another 12 cups of ice for the Cold Testing Stations. Setup is likely to take at least 30 minutes.
3. Take time to reflect on the following educator prompt. **How did you support learners to make connections between this adventure and their lives?**

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 dust.)* **What other technologies protect objects from dust?** *(Instrument cases, laptop/tablet cases, dust jackets, vacuums.)* (5 min.)
- If you can, show the video clip Lunar Dust Is Difficult (1:00) to help learners understand the hazards of dust on the surface of the Moon. (5 min.)
- Dust is a very big problem for astronauts and rovers exploring other planets. Here's an article from NASA about some of the hazards and mitigation strategies that astronauts are considering for exploration of the Moon: "Dust: An Out-of-This World Problem." (5 min.)
- Invite a family or community member to come in as a special guest and share their knowledge about hazard-related topics. (45 min.)
- Ask this story prompt: **Can you tell me a story about something creative you did to keep yourself or your clothes from getting dirty?** Tell learners, if anyone asks what they did today, they can tell them "We tested how well materials protect against dust," and then ask them the above story prompt. Consider returning to learners' ideas at the start of the next adventure. (5 min.)

Space Hazards Additional Resources

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

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

Dust Test Setup Instructions

Set up two testing stations for learners to test how well their gloves protect against dust.

Materials for each setup:

- 1 container of UV glow powder
- 1 roll of paper towels
- 1 tablespoon measure
- 1 aluminum tray, 12" × 10"
- 1 black light, handheld
- 1 craft stick
- 1 cup of gravel
- 1 hand lens
- 3 cups of sand
- 4 resealable plastic bags, quart size
- 5 washers, 1 1/4"

Prepare Testing Stations

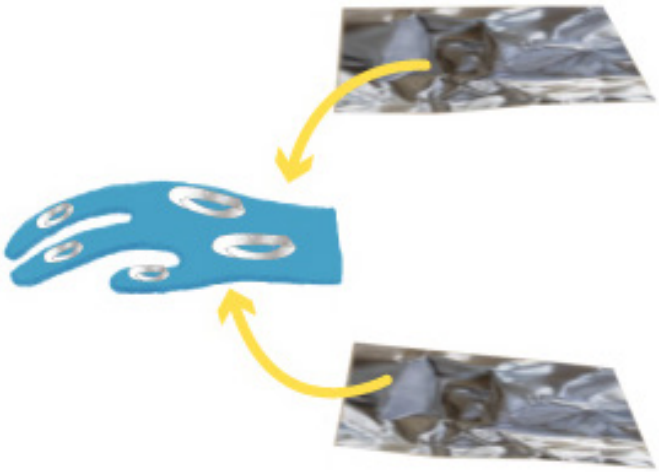
1. For each Testing Station, combine 1 cup of gravel, 3 cups of sand, and 1 tbsp. of glow powder in a 12" × 10" tray.
2. Mix thoroughly using a craft stick.
3. Bury 5 washers in each tray.
4. Place a black light, craft stick, 4 resealable plastic bags, and paper towels by each tray.

Dust Test setup

Dust Test Procedure

1. Cut your material.

2. Use loops of masking tape to attach 1 layer of the material to *both* sides of the glove.



3 Open the plastic bag.

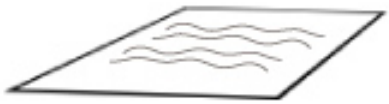
4 Use your gloves to dig in the dust and find the 5 metal washers.

5 Use your glove to place the 5 metal washers in the plastic bag.

6 Use a paper towel to wipe extra dust off your glove.

7 Look at the palm of your glove with the hand lens and black light to find places that glow.

8 Record the number of areas with glowing dust in your Engineering Notebook.



Reset

1. Bury the 5 metal washers back in the sand.
2. Mix the sand using the craft stick.