THE FRANKLIN INSTITUTE

Be a **Space Scientist!**

Be a **Spacesuit Designer**

Educator Guide

Big Question: How can we design a spacesuit that protects astronauts from radiation and micrometeoroids?

GSK Science in the Summer™

In collaboration with GSK

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Be a Space Scientist! Big Ideas

These are the themes you'll find running through all five *Be a Space Scientist!* activities.

- ***Space science is about exploring and traveling outside our planet.*** *Space scientists study questions like:*
  - *What kinds of things are in the universe?*
  - *How can we learn more about them?*
  - *How might people (and other living things) travel or live in space?*
- ***Space is really big! Almost everything in space is too far away and hard to reach for space scientists to visit and study.*** *Instead they:*
  - *Use tools and machines to* ***gather information*** *and send it back to Earth*
  - ***Compare*** *what they see in space to things they know about on Earth*
  - ***Use models*** *to represent things that are too big, too small, or too far away to study directly*

Core Four Strategies

Use the Core Four Strategies as you guide your learners through this activity.

- **Ask questions** to spark curiosity and encourage new ideas
- **Encourage scientific thinking** with chances to observe, make predictions, and test ideas
- **Cultivate rich dialogue** with chances to talk together, share ideas, and use science words
- **Make connections** between learners' experiences, science careers, and this activity

Ask Questions

Encourage Scientific Thinking

Cultivate Rich Dialogue

Make Connections

Be a Spacesuit Designer

Big Question: *How can we design a spacesuit that protects astronauts from radiation and micrometeoroids?*

MATERIALS:

Per class:

- Spacesuit designer career card
- Lab notebooks
- Pencils
- Science skills stickers

Per group of 2–3 learners:

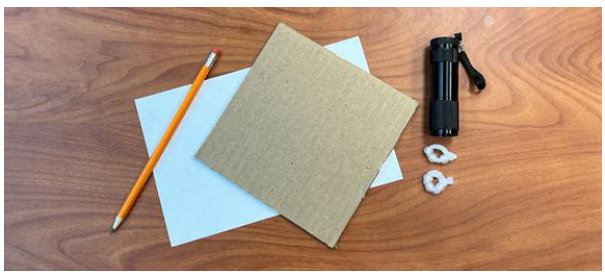
- 1 UV flashlight
- 4 UV bead tester loops (¼ of a pipe cleaner and 3 beads per loop; directions below)
- 1 sharpened pencil
- 1 large plastic cup

Per group of 2–3 learners continued:

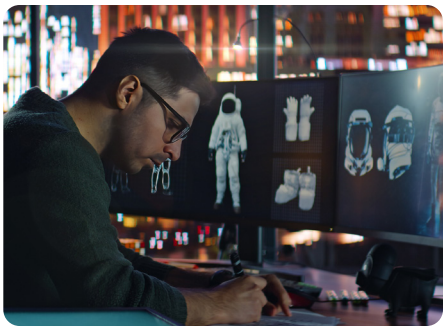
- Test materials, approx. 5-inch square of each:
  - Red or orange cellophane
  - Yellow cellophane
  - Blue or purple cellophane
  - Wax paper
  - Cardboard
  - Felt
  - Thin woven cotton
  - Knit or spandex fabric

Prepare

- Make 4 bead testers for each group of 2–3 learners:
  1. Cut a pipe cleaner into quarters or thirds
  2. Add 3 UV beads to each pipe cleaner piece
  3. Twist the ends of pipe cleaner together to make a loop
- Have a set of materials available for demonstration:
  - Sharp pencil
  - Sheet of paper or other weak material
  - Hard plastic lid, thick cardboard, or other strong material
  - UV flashlight
  - Two bead tester loops



Engage



1. Introduce the spacesuit designer career by showing the group the career card and asking questions to encourage students to think about what a spacesuit designer might do:
   - *What do you notice about this picture? What do you think this person is doing?*
   - *This is a spacesuit designer! What kinds of things do you think a spacesuit designer might do as part of their job?*
   - *What does a spacesuit need to do for an astronaut? What parts does it have?*
2. Explain that a spacesuit designer needs to consider materials that will help protect an astronaut in space.
   - *What kinds of things do you think an astronaut needs to be protected from in space?*
   - *What kinds of materials do you think spacesuits might be made of?*

3. Introduce the storyline like this:
   - Imagine we are part of a team that is designing a new spacesuit for astronauts. **Our job is to choose the best materials to make the suit from.**
   - We're going to test some different materials to see how well they protect against two specific dangers astronauts worry about in space: radiation and micrometeoroids.
     - *Radiation:* invisible energy that can be harmful if the body absorbs it (for example, the part of sunlight that can hurt your eyes or give you a sunburn)
     - *Micrometeoroids:* tiny pieces of rock, but moving so fast they can punch through a spacesuit like a pin popping a balloon
   - We will then think about which materials we might want to use for different parts of the spacesuit.
     - *How do you think we could test spacesuit materials here in our lab?*

Explore

For younger groups, start with just the UV radiation testing (Part 1). Skip the pencil test for micrometeoroids (Part 2), or save it for a later time, and move directly to the Faceplate Design section.

Part 1: Radiation

1. Introduce the flashlight and explain that it gives off some light that we can see, but also some radiation called UV that we can't see.
2. Explain that since we can't see the radiation, we need something to help us detect whether radiation is getting through the material. Introduce the UV beads. Demonstrate shining the UV flashlight on the beads and ask students to make observations. Shine directly on the beads of one tester loop. Use a second tester

loop to demonstrate how your hand blocks the radiation. (Make sure to keep it pointed away from anyone's eyes!) Ask learners:

- *What happens to the beads when I shine the flashlight on them?*
- *What happens if I shine it on the beads, but my hand is in the way?*
- *What happens to the beads after they've been out of the flashlight beam for a while?*
- *How could we use these beads to help us find out if a material blocks UV rays?*

3. Before releasing learners to explore, review safety rules for using these science tools:
   - UV radiation from flashlights is not enough to hurt your skin but could hurt your eyes
   - Keep the flashlights pointed down, away from anyone's eyes
   - Turn flashlights off between tests
4. Give each group a flashlight and 4 bead tester loops. Invite them to test the sample materials by holding the material between the flashlight and the UV beads and turning on the flashlight. Encourage them to write or draw about their results on page 21 of their lab notebooks.

Facilitation tips:

- Beads take a few minutes to return to white. For a fair test, groups should start each test with a new tester loop, not one that still has colored beads.
- Encourage students to shine the light for the same amount of time during each test (for example, a slow count to ten) -- the UV light may penetrate some materials more slowly.

For younger learners: It is helpful to use two testers at a time: block one tester with the material but not the other; shine the light on both at once to give a visual comparison.

For older learners: Challenge them to see if they can find ways to make the non-protecting materials work better (by using multiple layers, combining different materials, etc.)

5. Have a group check-in to discuss results:
   - *Which materials worked the best for blocking the UV radiation? Which were the worst?*
   - *Were there any materials that surprised you?*

Part 2: Micrometeoroids

6. Explain that you will now test which materials would protect astronauts best from micrometeoroids.
7. Since we don't have actual tiny space rocks and can't safely throw things at high speeds, you'll be using a model—a simpler version—to test how a material protects against small, strong objects. Show learners the pencil and cup.

- *What do you think the pencil could represent in this model?*
- *How can we use the pencil, materials, and cup to safely test micrometeoroid protection?*

8. Demonstrate the testing process: Ask a volunteer to hold a piece of paper tightly over the mouth of a plastic cup. Push the point of the pencil downward against the paper for 5 seconds. **Point out that you are not stabbing, but pushing slowly and forcefully for safety reasons!** Repeat with the plastic lid or cardboard. Ask the group to make observations.
   - *What happened to the paper when our model "space rock" hit it?*
   - *What happened to the plastic lid?*
   - *Which would do a better job of protecting an astronaut in space?*
9. Divide learners into groups of 2–3. Give each group a sharp pencil, a cup, and a set of material samples. Ask them to test the materials as demonstrated to find out which ones are strongest. Encourage them to record their results in their lab notebooks on page 22.

Facilitation tips:

- Remind students to notice differences in how the materials behave:
  - *Did it break easily?*
  - *Did you have to push hard before it broke?*
  - *Did it bend or deform without the pencil breaking through?*
- Challenge older students to think of ways to make weak materials work better—using multiple layers, combining materials, etc.

10. Have a group check-in to discuss results:
    - *Which materials worked the best for blocking the micrometeoroids? Which were the worst?*
    - *Were there any that surprised you?*
    - *Which material would you choose to protect an astronaut from BOTH radiation and micrometeoroids?*

Part 3: Faceplate Design

11. Explain that our group of spacesuit designers has been asked to start by choosing a material for the faceplate of the spacesuit's helmet.
    - *Besides protecting the astronaut, what else does the faceplate material need to do for an astronaut? (be able to see through it)*
    - *Which materials do you think are better to see through AND also protect from UV and micrometeoroids?*
12. Ask teams to return to their materials and find (or make) a material that keeps the astronaut safe from both UV radiation and tiny space rocks but also lets the astronaut see through it.
13. Encourage teams to think of creative ways to change or combine materials to meet their goal (layers, combinations, stretching out or bunching up, etc.) and record ideas in their lab notebooks on page 23.
14. Remind them to keep re-testing their materials with the UV detector beads and the pencil test as they work.

Reflect

1. Bring the whole group together to discuss their results:
   - *What did you find out about which materials protect best against radiation?*
   - *What did you find out about which materials protect best against tiny space rocks?*
   - *What did you try that didn't work? Did anything surprise you?*
   - *What should we tell the rest of our team about the best materials for protecting astronauts?*
   - *What material(s) should we recommend for the faceplate part of the spacesuit?*
2. Help the group connect their work to the spacesuit designer career. Refer to the career card and the science skills stickers:
   - *How were you like a spacesuit designer today?*
   - *What did you do that was like what a spacesuit designer does?*
   - *What science skills did you use?*

Background

- Spacesuits used for spacewalks outside of the spacecraft are designed like mini spaceships that fit the human body! **Just like the spaceship itself, the spacesuit must protect astronauts from radiation, dust, debris, and extreme temperatures and provide life support.**
- Radiation is a danger in space as astronauts don't have Earth's atmosphere to protect them. **Spacesuits have layers to protect astronauts from physical radiation while their helmet visors reflect incoming sun rays.**
- Micrometeoroids are tiny space rocks. This space debris can fly around at high speeds and potentially puncture an astronaut's spacesuit. **Spacesuits, therefore, include a layer of a strong fiber called Kevlar that prevents micrometeoroids from poking holes in their spacesuits**. Spacesuit helmets are also made from a high-impact plastic.
- The helmet of a spacesuit includes a protective visor that keeps the pressure bubble inside from getting bumped or scratched and also includes a sun visor and sun shade. **The sun visor has a special gold coating that works like sunglasses** to protect the astronaut from the sun's strong rays, while still allowing astronauts to see.
- The helmet on the suits that will be worn for Artemis missions will feature a quick-swap protective visor that protects against the abrasive dirt of planetary bodies. The helmet for these new suits also features an elliptical shape that provides a better view of the ground around the spacewalker's feet.
  Adapted from NASA: https://www.nasa.gov/centers-and-facilities/johnson/spacewalk-spacesuit-basics/

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Spacesuit Designer Quick Guide

EDUCATORS DO:	EDUCATORS ASK:	LEARNERS DO:
ENGAGE		
Introduce Career • Use career card • Ask discussion question • Explain what spacesuit designers do	*What do you notice about this picture?* *What kinds of things do you think a spacesuit designer might do as part of their job?* *What kinds of things do you think an astronaut needs to be protected from in space?*	• Make observations about the image • Make connections to their own experience • Share their ideas
Introduce Story • Explain that we are spacesuit designers and we must design a spacesuit to protect against radiation and micrometeoroids	*How do you think we could test spacesuit materials here in our lab?*	• Imagine being spacesuit designers • Discuss their ideas about how to test spacesuit material
EXPLORE		
Part 1: Radiation • Introduce the UV beads and flashlights • Invite learners to test how different materials block UV light	*What happens to the beads when I shine the flashlight on them? What about when I block them with my hand?* *Which materials worked the best for blocking the UV radiation? Which were worst?*	• Observe UV bead demonstration • Test how different materials affect the UV beads while shining the flashlight on them
Part 2: Micrometeoroids • Introduce the model • Demonstrate the testing process • Invite learners to test how different materials stand up to micrometeoroids	*What do you think the pencil could represent in this model? How can we use these materials to safely test micrometeoroid protection?* *Which materials worked the best for blocking the micrometeoroids? Which were worst?*	• Describe parts of the model • Observe the testing process • Test how different materials stand up to the pressure of the pencil

***Quick Guide continues on the following page.*

Spacesuit Designer Quick Guide

EDUCATORS DO:	EDUCATORS ASK:	LEARNERS DO:
Part 3: Helmet Design • Explain that we must choose a helmet faceplate material • Invite learners to test and choose a material	*What else does the faceplate material need to do for an astronaut?* *Which materials do you think are better to see through AND also protect from UV and micrometeoroids?*	• Test and choose materials that protect from UV, tiny space rocks, AND can see through
REFLECT		
Share Group Results	*What did you find out about which materials protect best against radiation? Against tiny space rocks?* *What material(s) should we recommend for the faceplate part of the spacesuit?*	• Draw conclusions • Make recommendations
Make Career Connections	*How were you like a spacesuit designer today?* *What science skills did you use?*	• Use skill stickers • Draw/write reflections

Notes

Notes