HEAT TRANSFER

Topic	Heat transfer
Objectives	Students will model the process of heat transfer and test materials for insulation to help them better understand how a spacesuit works.
Standards and benchmarks addressed	06-PS1-4. Develop a model that predicts and describes changes in particle motion, temperature, and state of a pure substance when thermal energy is added or removed. 07-PS1-6. Undertake a design project to construct, test, and modify a device that either releases or absorbs thermal energy by chemical processes.

Action

Phase 1: Engage

Ask students to write a response to the following prompt in their science journal:

"The Apollo spacesuit weighs about 180 lbs., has 11 layers, and took scientists close to 5,000 hours to develop. Why do you think it took so long to build and requires so many parts?"

You may also show a video of a space walk and ask students to make a list of all the specialized equipment that they see:

https://www.youtube.com/watch?v=Wfoy_OvNDvw

https://www.youtube.com/watch?v=PG6JmKUpTsw

Phase 2: Explore

Students will jigsaw the following readings by going about the steps below:

https://spaceflight.nasa.gov/outreach/SignificantIncidentsEVA/assets/space_suit_evolution.pdf

1. Have students form four groups. Group A will be responsible for pp. 1–6 of the article; group B for pp. 6–10; group C for pp. 10–15; and group D for pp. 15–23.
2. Give students 20 minutes to read and take notes in their science journals.
3. After they do their part of the reading, ask each student to share with the class the big idea from their section.

After each student has shared, ask the group to create a scientific model of the spacesuit using poster paper. They may choose to represent just one aspect of the suit, or the whole thing. Encourage the group to use labels and colors to explain their thinking. After they have done so, have each group share out their spacesuit models.

Phase 3: Explain

Say something like, "Now we are going to focus on one aspect of the spacesuit: the need for insulation. When on a spacewalk, conditions can fluctuate between as cold as -250°F or as hot as 250°F. A spacesuit protects astronauts from those extreme temperatures. (For more, see https://www.nasa.gov/audience/foreducators/spacesuits/facts/index.html.) We are going to test three different materials for their ability to keep heat in and keep heat out."

Before you begin, ask students to predict what they think will happen in the following experiment. Then, do the following:

Wrap three coffee cups (with lids) in three different materials, such as a second cup, a wool sock, a piece of cardboard, aluminum foil, or a cotton sock. You can have students choose a material to test. Have students put a thermometer in each of the cups. Heat water in a tea kettle and pour approximately 1 cup of hot water in each of the three cups. For 15 minutes, have students take temperature readings of each of the three cups at 30 second intervals. Record data on a sheet (for reference, see this experiment: https://www.youtube.com/watch?v=yIvfS7gENs4).

In their science journals, have students create a model of what they think is happening in each of the cups. Ask them to create a picture of what they think is occurring on a molecular level in each cup.

Now watch these videos:

https://www.youtube.com/watch?v=aaUz_SqOXnI

https://www.youtube.com/watch?v=E2_BI-qg5Bw

Ask students to revise their models based on the videos.

Now students will use the same set up, but conduct a second experiment. In each of the cups, place five ice cubes and a cup of water. Repeat the experiment as above and have students make predictions in their science journals.

Phase 4: Elaborate

Students can elaborate on their learning by doing two extension activities:

Create hand warmers

https://learning-center.homesciencetools.com/article/how-to-make-homemade-hand-warmers-science-project/

https://science.howstuffworks.com/innovation/nasa-inventions/nasa-technology-keep-warm1.htm

Observe, record, and discuss chemical changes

http://www.middleschoolchemistry.com/lessonplans/chapter6/lesson11

https://www.youtube.com/watch?v=rqQSlEViNpk

Phase 5: Evaluate

Tell students that they will be on a team tasked with redesigning the spacesuit. Based on the experiments they observed, have them construct an argument that describes which of the tested materials would be most effective for the new spacesuit.