SPACE HEATING
Teaching Guidelines

Subject: Physical Science
Topics: Heat
Grades: 7-12

Concepts:

- Heat transfer
- Conduction
- Convection
- Radiation

Knowledge and Skills:

- Understands the three methods of heat transfer
- Knows that emissivity of a surface is influenced by that surface's color and shininess.

Materials

For each team:

- 1 empty silver soda can
- 1 empty flat black soda can
- 2 meat thermometers

Procedure:

Prepare the Futures Channel movie, "Space Architecture," for presentation. Tell students that as they watch the movie, you want them to think about this question (which should be posted):

What qualities or characteristics would you look for in material that is used for the walls of space habitat?

At the end of the movie, ask students to work in teams of two or three for a few minutes to list answers to this question. Guide the ensuing discussion to focus on the needs of human beings for long-term survival: air, food, water, and temperature control, and tell students that it is need for temperature control that is the subject of the lesson.

Starting with the prompt, "*What is it about the walls that you would need to think about in terms of controlling the temperature of a habitat in space?*" explain or elicit the concept of "heat transfer": heat coming into the habitat from the outside, or escaping to the outside from the inside.

Describe (or review if it's already been covered) the three forms of heat transfer: conduction, convection and radiation. Ask students which of the forms would apply to heat moving into or out of a sealed habitat in the vacuum of space. Guide the class to the understanding that only radiation could transfer heat in that situation, and why that is true.

Arrange the class into teams of 3-4 members each and distribute the handouts (you may wish to do the demonstration as a whole class activity instead).

In discussing the results, in addition to guiding students to better understand how the characteristics of a surface might affect the degree to which it emits radiation, you may wish to use this as an opportunity to discuss the design of the experiment. Why is it important to have both cans be the same size, for example? Why tape the top? Why make sure that the water put into both is the same temperature? Discussion of these and similar questions should lead students to a better understanding of the importance of controlling variables outside of those being measured.

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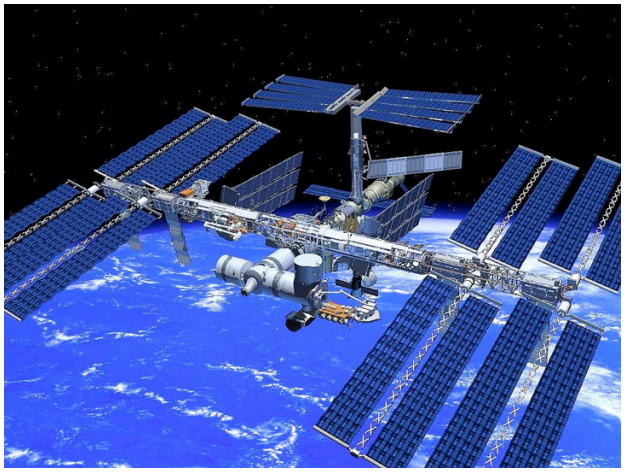

Look at this image of the International Space Station. Why do you think the outside walls are a shiny silver color?

Here's a demonstration that may help you answer that question.

Get two empty, clean soda cans which are mostly silver in color. Paint one flat black.

Get two cork coasters (or something else that doesn't transfer heat very well).

Put the two cans on the coasters inside a large saucepan that is black on the inside.

Use a funnel to fill each can with very hot water, like from a teakettle that has just boiled. BE CAREFUL with the hot water!

Carefully dry off the tops of the cans with a hand towel. REMEMBER, they are HOT!

Put a meat thermometer in each can. The two thermometers should read at the same temperature within a degree.* Then put the tape over the holes so that very little air can escape from the cans.

Write down the temperature of the thermometers. Then put the lid on the saucepan.

Remove the lid and write down the temperature of the water in the two cans every five minutes, for twenty minutes. Be sure to replace the lid each time.

What do you observe?

Why do you think this happens?

Why do you think the International Space Station is painted silver?

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* If the two cans don't read at the same temperature, put the tape over the hole in the one that is cooler first, then blow over the top of the other one until its temperature matches. Then tape the other one.