4. Heat Transfer

Lesson Overview: In this lesson, students work in small groups to create demonstrations that show the three ways that heat can be transferred.

Lesson Goal: Increase students' understanding of how heat is transferred.

Objectives: Students can create a way to demonstrate the three methods of heat transfer.

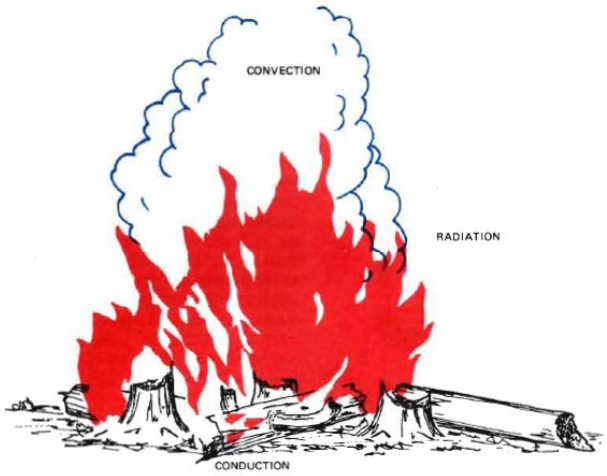
Subjects: Science, Reading, Writing, Speaking and Listening, Arts
Duration: 45 minutes (or less)
Group size: Whole class working in small groups
Setting: Indoors
Vocabulary: *heat transfer, radiation, convection, conduction*

Standards:		9th	10th	11th	12th
Common Core ELA	Speaking/Listening	1, 2, 4, 6		1, 2, 4, 6	
	Language	1, 2, 3, 4, 7, 10		1, 2, 3, 4, 7, 10	
NGSS	Earth's Systems	ESS2.D			
	Earth and Human Activity	ESS2.D, ESS3.B			
EEEGL	Strand 1	A,C,D,E,F,G			

Teacher Background: This lesson is a review of the mechanisms of heat transfer. See the "Procedure" section.

Materials and Preparation:

- Download ***Heat Transfer image.pptx*** (shown at right)
- Props such as bags of candy, balls of yarn, pingpong balls, etc.



Procedure:

1. Project ***Heat Transfer image.pptx*** and use it to review the three methods of heat transfer: conduction, convection, and radiation.
    - **Conduction**: Heat is transferred through direct contact between atoms or molecules within solid objects. In wildland fire, conduction enables heat to

move from an object's outside to its inside and from one solid object to another one that is touching it.

- **Convection**: Heat is transferred by hot gases as they expand into the cooler gases surrounding them. Since Earth's atmosphere becomes "thinner" (less dense) as you go up in altitude, "up" has less resistance to the expanding gases than "sideways" or "down." Thus hot air generally rises.
- **Radiation**: Heat is transferred through space from the object where it is generated to the first atom or molecule that intercepts it. For example, heat from the sun travels through almost 100 million miles of space before it is intercepted by the leaves of plants, where photosynthesis occurs or our skin, where sunburn occurs. Radiation from a wildland fire can heat the fuels before they are actually ignited.

2. Ask the class to point out the strengths and weaknesses of the models. Maybe have students vote on the model that most clearly represents each method of heat transfer.

Assessment: Explain: Students will work in groups to model the three methods of heat transfer. Students can use props, group members, conversation, narration, skits, etc., to model how each method of heat transfer works.

Here we give 1 possible example of each demonstration:

- **Radiation:** Students can demonstrate radiation by using balls of yarn, pieces of candy, or other small objects to represent heat. One student could represent the heat source (sun, fire, or other), and other students could represent molecules in air and in solid objects, including fuels. The heat source would throw the objects, and only the molecules they touch are heated.
- **Conduction:** Students can demonstrate conduction by standing side by side in a long line, shoulder to shoulder. The students would represent atoms within a solid object, like a metal. Heat would be represented by a bag of candy or other small objects. The students would pass the bag from one student to the next, each one taking a piece from the bag (i.e., absorbing some heat) and passing the bag on to the next student…. all the way to the end of the line or until the bag is empty.
- **Convection:** Students can demonstrate convection by lining up shoulder-to-shoulder. They should imagine that their line is vertical rather than horizontal. One or two students represent a parcel ("bubble") of hot air; they carry a bag of candy or other small objects. They walk from one end of the line (the imaginary bottom of a column of air) toward the other end (the imaginary top). Their bubble of hot gases is expanding from the bottom toward the top, transferring heat (small objects) to the surrounding air and thus cooling as they go. If they empty the bag of objects, they stop. This means that their air bubble has roughly the same amount of energy per molecule (is the same temperature) as the molecules in the air around them.

Evaluation: This is a credit/no credit activity. Evaluate students on their contributions during the planning process, engagement in the presentations, and follow-up discussion.