

## Teacher Resource Sheet

# Heat Transfer Lesson Plan

### Standards

MS-PS3-3 Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer.\*

MS-PS3-4 Plan an investigation to determine the relationships among the energy transferred, the type of matter, the mass, and the change in the average kinetic energy of the particles as measured by the temperature of the sample.

### **Other standards this could align to:**

MS-ESS2-6: Develop and use a model to describe how unequal heating and rotation of the Earth cause patterns of atmospheric and oceanic circulation that determine regional climates.

### Science and Engineering Practices

MS-ETS1-1 Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.

MS-ETS1-4 Develop a model to generate data for interactive testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

### Objective

SWBAT investigate and describe how heat and thermal energy affect molecular motion

SWBAT investigate and explain how heat is transferred through conduction, convection and radiation

SWBAT use evidence from the investigation to design and conduct an experiment to slow down the process of heat transfer

### Engage:

- Students and teachers will activate prior knowledge by anchoring in a phenomenon of condensation water droplets collecting outside a cup
- Teacher asks students to make possible claims as to the source of the water on the outside and some possible tests/experiments to test it
- Teacher explains the phenomena: water molecules in the air get cooled by the drink, causing it to condense
- Water is not flowing, heat is. Water is a substance so it is obvious to see, but heat is a form of energy not a substance

### Explore

- Teacher makes a connection to molecular movement and heat and thermal energy
- Teacher poses question: What does heat have to do with molecules moving?
- Demonstrations: hot water, cold water, watching the molecules spread out quickly
- Teacher asks do you think only affects liquids? Heat affects solids and gases too!

- Demonstration: Students take an empty water bottle (teacher note that the bottle is filled with air), dip the tip of the bottle into soap and place the bottom into hot water, cold water
- Students should see a bubble forming in the hot water and the bubble rescinding in the cold water

### **Explain**

- Thermal energy is that average motion of particles
- Heat is thermal energy being transferred from one place to another
- The more heat molecules have, the faster they move, the more space they take up
- Students can dance: slow song: don't worry be happy or a song with a lot of energy, you take up more space
- Heat can be transferred from hot objects to cold objects
- Three ways heat can be transferred is by
- Conduction: heat moves through direct contact
  - Examples: touching a hot pan, flat ironing your hair
- Convection: heat moves through warmed matter like air or water
  - Examples: convection oven, water boiling, hair dryer
- Radiation: heat moved through empty space (without direct contact)
  - Examples: UV light, lightbulb

### **Elaborate**

- How do you slow down heat transfer?
- Insulators and Conductors
- Insulators are things that slow down heat transfer: cotton, wool [connection: jackets, wool hats and scarves]
- Conductors: metals [connection: why its hot when you touch a car or why you don't use a metal spoon to stir your pot]
- Things to consider: what can speed up heat transfer? What can slow down heat transfer?
- Students can search around their homes for some recyclable materials to design and build a cup that would slow down heat transfer
- Think about lunch boxes, which would be the best at keeping things cool?

### **Evaluate**

In summary: Heat is a form of thermal energy that can be transferred between two objects of different temperatures.

- Thermal energy is the average motion of molecules
- Heat is thermal energy that can be transferred by conduction, convection or radiation

- Insulators can slow down the heat transfer process
- Conductors facilitate heat transfer
  - Students will test their thermal cups to see which one stays either the hottest or the coldest for the longest period of time.

Here's how you get started.

1. Plan your design and consider some materials you'd like to use for a thermal cup
2. Grab two cups, one will be your control
3. You can use some recycled newspaper, aluminum foil and paper towels or anything you think would be suitable that you could find around the house
4. Wrap one cup with the materials in whichever order you best see fit
5. Fill both cups with either HOT or COLD water
6. Test how long it takes for the cups to get to room temperature
7. Determine whether or not your design worked
8. After testing, and evaluating the design, go back and redesign it.

Now, go ahead and try it!

**Additional Resources:**

Additional resources for this lesson and other lessons available [www.wtulocal6.net](http://www.wtulocal6.net)

#KeoScience to show your designs