Thermal Energy

Teachers: Ben Lyne
Rebecca King
Length of Unit: 2 weeks

Next Generation Science Standards:
- 07-PS3-3. Apply scientific principles to design, construct, and test a device that either minimizes or maximizes thermal energy transfer
- 07-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.
- 07-PS3-5. Construct, use and present arguments to support the claim that when the kinetic energy of an object changes, energy is transferred to or from the object.

Disciplinary Core Ideas:
- PS3-A: Definitions of Energy
  - Temperature is a measure of the average kinetic energy of particles of matter. The relationship between the temperature and the total energy of a system depends on the types, states, and amounts of matter present (07-PS3-3)
- PS3-B: Conservation of Energy and Energy Transfer
  - When the motion energy of an object changes, there is inevitably some other change in energy at the same time. (MS-PS3-5)
  - The amount of energy transfer needed to change the temperature of a matter sample by a given amount depends on the nature of the matter, the size of the sample, and the environment. (MS-PS3-4)
  - Energy is spontaneously transferred out of hotter regions or objects and into colder ones. (MS-PS3-3)

Vocabulary:
- heat (thermal) energy, temperature, thermal equilibrium, thermal expansion, radiation, conduction, convection, transferred energy, conserved energy
### Heat & Heat Transfer NOTES

#### I. Temperature

<table>
<thead>
<tr>
<th>Definition:</th>
<th>This Means:</th>
</tr>
</thead>
<tbody>
<tr>
<td>In other words,</td>
<td></td>
</tr>
</tbody>
</table>

**Temperature**

**Tool used to measure temperature:**

**Units:**

<table>
<thead>
<tr>
<th>Definition:</th>
<th>This Means:</th>
</tr>
</thead>
</table>

#### II. Heat & Density
## II. Heat & Heat Transfer

<table>
<thead>
<tr>
<th>Heat Transfer</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Thermal Equilibrium:**

Whenever thermal equilibrium is reached, ____________________________

## III. Thermal Expansion

<table>
<thead>
<tr>
<th>Thermal Expansion</th>
<th>Definition</th>
<th>Example</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### IV. 3 Ways Heat Is Transferred

<table>
<thead>
<tr>
<th></th>
<th>Definition:</th>
<th>Examples:</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1. Conduction</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Conductors</td>
<td>Examples:</td>
<td>Insulators</td>
</tr>
<tr>
<td><strong>2. Convection</strong></td>
<td>Definition:</td>
<td>Examples:</td>
</tr>
<tr>
<td><strong>3. Radiation</strong></td>
<td>Definition:</td>
<td>Examples:</td>
</tr>
</tbody>
</table>
"Heat vs. Temperature" Worksheet

FILL IN THE BLANKS Complete each statement using a term or terms from the list below. Write your answers in the spaces provided. Some words may be used more than once.

less heat
lower temperature
expand
how fast molecules vibrate

degrees
related
higher temperature
Joules
not
the number of molecules
more heat

1. Heat and temperature are ____________________________ but they are ____________ the same.
2. Temperature depends upon ____________________________.
3. Heat depends on ____________________________
and also on ____________________________ that vibrate.
4. Faster vibrating molecules mean a ____________________________
5. Slower vibrating molecules mean a ____________________________
6. More vibrating molecules usually mean ____________________________
7. Fewer vibrating molecules usually mean ____________________________
8. Temperature is measured in units called ____________________________
9. Heat is measured in units called ____________________________
10. Heat makes matter ____________________________

TRUE OR FALSE
Write "true" if the sentence is true. Write "false" if the sentence is false.

_________ 1. Heat comes from vibrating molecules only.
_________ 2. Molecules always vibrate at the same speed.
_________ 3. The faster molecules vibrate, the less heat they give off.
_________ 4. Temperature measures the average kinetic energy per molecule.
_________ 5. Temperature is measured in calories.
_________ 6. We measure temperature with a barometer.
_________ 7. Heat depends only on how fast molecules vibrate.
_________ 8. An ice cube has energy.
_________ 9. An ice cube has the same amount of energy as a block of ice.
_________ 10. Heat energy is measured in Joules.
Mixing Water Lab

**Problem:** How does temperature and amount of water affect thermal energy?

**Background Information:** Thermal energy is the internal energy contained by a substance because of the vibration and movement of the atoms and particles of the object. Heat is the transfer of thermal energy from one object to another object. Heat always moves from areas of high temperature to areas of lower temperature until it reaches thermal equilibrium and spreads out evenly.

**Hypothesis:**

**Description:** Three different large containers, labeled A, B and C, are filled with different amounts of hot and cold water from smaller cups.

\[ \text{HOT} = \text{A} \]

\[ \text{HOT} + \text{HOT} + \text{COLD} = \text{B} \]

\[ \text{HOT} + \text{HOT} + \text{HOT} + \text{COLD} + \text{COLD} = \text{C} \]

All of the small hot and cold cups contain the same amount of water. The water in every cup of hot water has the same temperature. The water in the cold cups is at room temperature. After the water is added to A, B and C the temperature of the mixed water in each container is measured.

**Ranking Instructions Part 1:** Rank the temperature of the water in containers A, B and C in order from warmest to coolest. Place ties in the same blank.

**Ranking Order:**

1. Warmest
2. Cold
3. Coolest

OR

The water in all three containers is at the same temperature.

Carefully explain your reasoning for ranking this way.
Materials:
5 cups
10 containers
Hot water
Room temperature (cold) water
Thermometer

Part 1

Procedures:
1. Using one of your cups, carefully pour in hot water to the fill line. Pour the hot water into container A. Record the temperature of container A and place in data table.
2. Using two of your cups, carefully pour in hot water to the fill line. In a third cup, carefully pour in the room temperature water to the fill line. Pour all three cups into container B. Record the temperature of container B and place in data table.
3. Using three of your cups, carefully pour in hot water to the fill line. In your other two cups, carefully pour in the room temperature water to the fill line. Pour all five cups into container C. Record the temperature of container C and place in data table.

Data Table:

<table>
<thead>
<tr>
<th>Container</th>
<th>Temperature (°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td></td>
</tr>
<tr>
<td>B</td>
<td></td>
</tr>
<tr>
<td>C</td>
<td></td>
</tr>
</tbody>
</table>

Rank Actual Results: Using the data table above, rank the containers according to warmest to coolest.

Ranking Order:
Warmest 1__________ 2__________ 3__________ Coolest

OR

_______ The water in all three containers is the same temperature.

Compare your prediction ranking to your actual results.
Part 2

Rank the amount of available heat energy in the water in containers A, B and C in order from most energy to least energy. Place ties in the same blank.

**Ranking Order:**

Most energy 1___________  2___________  3___________ Least energy

OR

_____ The water in all three containers is the same amount of energy.

Carefully explain your reasoning for ranking this way.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

Actual Ranking Order:

Most energy 1___________  2___________  3___________ Least energy

OR

_____ The water in all three containers is the same amount of energy.

Carefully explain your reasoning for ranking this way.

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

**Analysis:**

Based on the lab, how does temperature and amount of water effect thermal energy?

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________

________________________________________________________________________
Problem: What happens to the temperature of ice water, room temperature water, and hot water when it sits for 30 minutes?

Background Information: Thermal energy is the internal energy contained by a substance because of the vibration and movement of the atoms and particles of the object. Heat is the transfer of thermal energy from one object to another object. Heat always moves from areas of high temperature to areas of lower temperature until it reaches thermal equilibrium and spreads out evenly.

Hypothesis: If I have 100 mL of hot water, 100 mL of ice water, and 100 mL of room temperature water that sit out for 30 minutes, then

Prediction: Based on your hypothesis, create a graph showing what you think the temperature of each container of water will do over the 30-minute period.

<table>
<thead>
<tr>
<th>Temperature of Water (°C)</th>
<th>(For each Container)</th>
<th>Time</th>
</tr>
</thead>
</table>

Materials:
3 beakers
graduated cylinder
100 mL of ice water
100 mL of hot water
100 mL of room temperature water
3 different colored pencils

Procedures:
1. Fill one beaker with 100 mL of Ice water. Put the temperature probe into the ice water beaker and record the initial temperature.
2. Fill one beaker with 100 mL of room temperature water. Put the temperature into the room temperature beaker and record the initial temperature.
3. Fill one beaker with 100 mL of hot water. Put the temperature into the hot water beaker and record the initial temperature.
4. Record the temperature in each beaker every minute on your data table.
5. Using three different colored pencils, graph the temperatures from the data table onto one set of axes.
Thermal Equilibrium Lab

**Data Table**

<table>
<thead>
<tr>
<th>Time (Minutes)</th>
<th>Temperature (Degrees C°)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Ice Water</td>
</tr>
<tr>
<td>Initial Temperature</td>
<td></td>
</tr>
<tr>
<td>5 min</td>
<td></td>
</tr>
<tr>
<td>10 min</td>
<td></td>
</tr>
<tr>
<td>15 min</td>
<td></td>
</tr>
<tr>
<td>20 min</td>
<td></td>
</tr>
<tr>
<td>25 min</td>
<td></td>
</tr>
<tr>
<td>30 min</td>
<td></td>
</tr>
</tbody>
</table>

**Data Graph:** Use three different colored pencils, draw a graph representing the data you collected above.

![Graph Grid](Image)

Temp of Water (degrees C°)

Time (min)
Thermal Equilibrium Lab

**Analysis Questions:**

1. Explain how the temperature of the ice water, room temperature water, and hot water changed during the 30-minute time frame. Be sure to use the actual numbers from your data table in your explanation.

2. What trends or patterns do you see in the graph you made? What happens to the three lines in the graph?

3. How did the heat transfer in the ice water? From where did the heat transfer? Did this heat transfer slow down or stop during the 30-minute time frame? Why?

4. How did the heat transfer in the room temperature water? From where did the heat transfer? Did this heat transfer slow down or stop during the 30-minute time frame? Why?

5. How did the heat transfer in the hot water? From where did the heat transfer? Did this heat transfer slow down or stop during the 30-minute time frame? Why?

6. Do you feel like you were able to collect accurate and precise data? Explain why or why not. Did you or your group members make any errors while collecting the data?

7. How does this lab demonstrate thermal equilibrium?
Worksheet for Cooling Curves of Water

Experimental Description

Two identical beakers with exactly the same amount of warm water were prepared. The first beaker was allowed to cool by sitting in a classroom with an air temperature of 23°C. The second beaker was placed in a large bucket of ice water at 0°C. The temperature of each was measured every minute for 45 minutes. The data are shown below.

Use this graph to answer the following questions.

1) Which beaker of water starts off at higher temperature?

2) Which beaker of water ends up at higher temperature?

3) Which beaker of water had a larger temperature drop overall?

4) After 10 minutes, what are the temperatures of the two beakers of water?

5) After 10 minutes, what was the drop in temperature of the two beakers of water?

After 10 minutes, which beaker transferred more heat? How do you know?
# How Heat Travels Content Organizer

## How Are They Alike?

<table>
<thead>
<tr>
<th>Conduction</th>
<th>Convection</th>
<th>Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## How Are They Different?

<table>
<thead>
<tr>
<th>Conduction</th>
<th>Convection</th>
<th>Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

## Everyday Examples

<table>
<thead>
<tr>
<th>Conduction</th>
<th>Convection</th>
<th>Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
In each of the following situations, identify the method of heat transfer taking place (conduction, convection, radiation). More than one process may be occurring.

1. Hot coffee is stirred with a spoon, the spoon gets hot due to ____________.

2. A chair is placed several feet from a fire in a fireplace. The fireplace has a glass screen. The side of the chair facing the fireplace gets warm because of ____________.

3. A certain type of decorative lamp contains colored liquids. These liquids form globs that break off and rise to the top of the liquid. The globs rise due to ____________.

4. Near the ceiling of a room the air is warmer. The warm air rises because of ____________.

5. A college student holds the back of his hand near an iron to see if it is hot. Heat is transferred to his hand by ____________.

6. A heater is placed under one corner of a water bed mattress. Warm water moves throughout the mattress because of ____________.

7. A certain type of stainless steel cookware has a layer of copper applied to the bottom to help it heat evenly. The copper transfers heat to the pan by ____________.

8. In a swimming pool, the water near the surface is slightly warmer. The warm water rises because of ____________.

9. One end of a copper rod is placed in a flame of a Bunsen burner. Small pieces of wax placed along the rod melt at progressively larger distance from the flame. Heat is transferred through the rod by ____________.

10. A house burns down. On the house across the street, all of the vinyl siding is twisted and warped by the heat. The heat was transferred across the street by ____________.

11. Warm air over the beach rises while cooler dense air from the ocean rushes in due to ____________.

12. The metal skewer gets so hot that you drop your marshmallow in the campfire because of ____________.

13. A huge rock at the state park gets so hot during the day that you can’t sit on it from ____________.

14. You lay on that same rock at night so that you can keep warm by ____________.

15. A fireman feels a door and it is hot from the fire on the other side due to ____________.

16. The cause of weather systems on earth is ____________.

17. You are in the top bunk of a bunk bed and you want to turn the air conditioner on while your friend on the bottom bunk is fine is caused by ____________.
In the boxes below, draw an example of each type of heat transfer. Explain how heat is being transferred in your example.

<table>
<thead>
<tr>
<th>Conduction</th>
<th>Convection</th>
<th>Radiation</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Explaination: 

In each of the following situations, identify the method of heat transfer taking place. Write conduction, convection, or radiation on the line next to the statements. Choose the best answer.

1. You are stirring a bowl of hot soup with a metal spoon. The spoon starts to feel warmer because of __________________________.

2. You buy a lava lamp from the store. As the lamp heats up, blobs of liquid rise to the top then sink back down to the bottom. This process continues because of __________________________.

3. You are doing your homework at a desk that is underneath a lamp. You start to feel hotter because of __________________________ from the lamp.

4. Your best friend has a bunk bed. You move from the bottom bunk to the top bunk and notice that the air is warmer. The warm air rises because of __________________________.

5. You are in science class and want to see if the hot plates were used recently. You place your hand over the hot plate. Without touching the hot plate, your hand feels warmer. Heat is transferred to your hand by __________________________.

6. You are roasting marshmallows at a campfire. The metal skewer (stick) that you’re cooking your marshmallow on burns your hand because of __________________________.
Heat Transfer

Using words from the word boxes below, complete the paragraph about heat transfer.

<table>
<thead>
<tr>
<th>faster</th>
<th>hot</th>
<th>less</th>
<th>solid</th>
<th>fluid</th>
</tr>
</thead>
<tbody>
<tr>
<td>conduction</td>
<td>more</td>
<td>convection</td>
<td>energy</td>
<td>emit</td>
</tr>
<tr>
<td>warmer</td>
<td>matter</td>
<td>transfer</td>
<td>absorb</td>
<td>temperature</td>
</tr>
<tr>
<td>radiation</td>
<td>contact</td>
<td>cold</td>
<td>vibrate</td>
<td>waves</td>
</tr>
</tbody>
</table>

All ____________ has heat. Heat is a form of ____________ caused by particles in an object that ____________. The ____________ the particles of an object vibrate, the ____________ the object will be. Because particles of an object are always moving, heat ____________ is always happening. Heat always flows in the same direction: from ______ to ______. Heat transfer will stop once two objects reach the same _________________. This is known as equilibrium.

There are three key ways that heat transfers. With _______ objects, heat transfers when the objects come into direct ____________ with other things. This is known as ________________. Liquids and gases are different. Because these two states of matter flow, or are ____________, heat transfer happens when warmer, ______ dense particles rise and cooler, ______ dense particles sink. This ongoing process is known as a ________________ current. Heat can also be transferred through space (distance) in the form of ________________. This process is known as ________________. All objects give off, or ____________, some heat. All objects also take in, or ______, heat.

Identify the method of heat transfer that takes place in each illustration. Write the method of heat transfer underneath the picture.

1. 

2. 

3. 

4. 

5. 

6.
Conduction, Convection, or Radiation

Objective: Students will know how to separate the different types of thermal energy.

Matching: Use these definitions to help you with the rest of the worksheet.

<table>
<thead>
<tr>
<th>Radiation</th>
<th>A. Heat transfer from a heat source through a solid.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Convection</td>
<td>B. Infrared heat waves like in the Electromagnetic spectrum.</td>
</tr>
<tr>
<td>Conduction</td>
<td>C. Heated gas or liquid particles rise.</td>
</tr>
</tbody>
</table>

Label each example with the appropriate type of heat transfer: radiation, convection, or conduction. Explain why you think so for each example (hint: use the definitions above to help you).

1. ______________ Heat we feel from the sun.
   a. Why? _________________________________

2. ______________ The heat you feel when you touch a hot stove.
   a. Why? _________________________________

3. ______________ Heat you feel when you put your hands above a fire.
   a. Why? _________________________________

4. ______________ My spoon is hot after leaving it on the pot that was on the stove.
   a. Why? _________________________________

5. ______________ This is responsible for making macaroni rise and fall in a pot on the stove.
   a. Why? _________________________________

6. ______________ The heat my snake feels from the heat lamp above him.
   a. Why? _________________________________

7. ______________ Transfer of heat by the actual movement of the warmed matter (i.e. gas or liquid).
   a. Why? _________________________________
8. ____________ The reason heating vents are usually placed on the floor of a home.
   a. Why?

9. ____________ Insulation is used to prevent this type of heat transfer.
   a. Why?

10. ____________ This type of heat transfer is trapped by green houses.
    a. Why?

11. ____________ Why the dog lays down next to the wood stove.
    a. Why?

12. ____________ Why the cat sits on a stove above the stove.
    a. Why?

13. ____________ Why the kettle on the stove gets hot.
    a. Why?

14. ____________ Why you use a pot holder when getting the cookie sheet out of the oven.
    a. Why?

15. ____________ Heat you feel when you sit next to a campfire.
    a. Why?

16. ____________ Heat you feel from your electric blanket.
    a. Why?
Target: Classify heat transfer as conduction, convection or radiation. (knowledge)

**Energy Worksheet 2: Conduction, Convection and Radiation**

In each of the following examples, identify whether heat is being transferred through conduction, convection or radiation. Some may have two possible answers. Choose the answer that best fits the situation.

1) Warming hand over a radiator.
2) Eggs cooking in a frying pan.
3) Snowman melting in the sun.
4) Water boiling in a kettle.
5) Warmth from the fireplace circulating through the house.
6) Tongue freezing to a metal pole.
7) Newt boiling in a hot caldron.
8) Ice melting on a hotplate.
9) Freezing outside on a cold day.

10) Steam piping out of a teapot.

11) Burning your hand on a hot pan

12) Ice cubes keeping lemonade cold.

13) Laying out in the sun.

14) Roasting marshmallows over a fire.

15) Making toast in a toaster.

16) Heating a kettle on a hot furnace.
Section 1: Temperature (p. 150)

4. Usually when you turn on the hot-water knob, the water that comes out of the faucet isn't hot at first. Can you think of another time when something is labeled “hot” or “cold” and really isn’t?

What Is Temperature? (p. 150)

5. Temperature is a measure of the average _______ of the particles in an object.
   a. potential energy   c. kinetic energy
   b. mechanical energy  d. size

6. The faster the particles of an object are moving, the _______ the temperature of the object.
   (higher or lower)

7. All of the particles of a substance at a certain temperature move at the same speed and in the same direction. True or False? (Circle one.)

8. The temperature of a substance depends on how much of the substance you have. True or False? (Circle one.)

Measuring Temperature (p. 152)

9. When a substance undergoes thermal expansion (Circle all that apply.)
   a. its particles expand.
   b. its particles spread out.
   c. its particles get colder.
   d. its volume increases.

10. All substances will expand equally with the same change in temperature. True or False? (Circle one.)

11. According to the Brain Food on page 152, the hottest temperature ever recorded was taken in the Libyan desert. It was 58°C in the shade! What is this temperature on the Fahrenheit scale?
   a. 192°F   c. 136°F
   b. 89°F    d. 104°F

12. At what temperature does water boil? Write your answer using all three of the temperature scales on page 152.

13. It is incorrect to say the temperature of an object is 23°K. Why?
14. What temperature scale do weather reporters in the United States use to tell you how hot it is outside?
   a. Kelvin   c. Celsius
   b. Fahrenheit   d. SI

15. If you are given a temperature in degrees Fahrenheit and asked to convert it to degrees Celsius, which equation would you use?
   a. \( \^\circ F = \left( \frac{9}{5} \times \^\circ C \right) + 32 \)
   b. \( K = \^\circ C + 273 \)
   c. \( \^\circ C = \frac{5}{9} \times (\^\circ F - 32) \)
   d. \( \^\circ C = K - 273 \)

More About Thermal Expansion (p. 154)

16. Expansion joints are used in bridges in order to prevent the bridge from
   a. swaying.   c. buckling.
   b. getting too hot.   d. making noise.

17. The thermostat in your home has a ____________ strip that coils or uncoils with changes in
   ____________.

18. Figure 4, on page 154, shows how a thermostat works. When room temperature falls below the desired temperature, the strip in your thermostat _______________ and an electric circuit is _______________. (coils or uncoils, opened or closed)

Section 2: What Is Heat? (p. 155)

1. A stethoscope feels colder than a tongue depressor when it touches your skin. Why?

__________________________

Heat Is a Transfer of Energy (p. 155)

2. Under what condition can heat occur between two objects?
   a. The objects must be hot.
   b. The objects must be large.
   c. The objects must be at different temperatures.
   d. The objects must have a lot of energy.
3. If two objects come in contact with each other, and one object is warmer than the other object, what happens?
   a. Both objects get colder.
   b. Both objects get warmer.
   c. Energy is transferred from the colder object to the warmer object.
   d. Energy is transferred from the warmer object to the colder object.

4. If two objects have the same temperature, but the larger object has more moving particles than the smaller object, what do you know about the thermal energy of the two objects?
   a. The larger object has more thermal energy.
   b. The smaller object has more thermal energy.
   c. They have the same thermal energy.
   d. None of the above

5. The temperature of an object ________ as its particles slow down. (decreases or increases)

6. You place a warm bottle of juice in ice water like in Figure 7 on page 156. After the bottle and the ice water have reached thermal equilibrium
   a. the juice is cooler than the water.
   b. the water is cooler than the juice.
   c. the water and the juice have the same temperature.
   d. the water is cooler than it was before.

**Conduction, Convection, and Radiation** (p. 157)

7. In conduction, when faster-moving particles collide with slower-moving particles, the faster-moving particles ______________ kinetic energy to the slower-moving particles.

8. In the table of conductors and insulators on page 158, what do all of the objects named as conductors have in common?
   a. They are all used for cooking.
   b. They are all made of metal.
   c. They have the same shape.
   d. They have the same size.

9. In a convection current, warmer particles ______________ because they are ______________ than cooler particles.
   (rise or sink, denser or less dense)

10. You can feel the warmth of a portable heater like the one in Figure 10, on page 159, when you are standing near it because of ______________. (conduction or radiation)
“FEEL THE HEAT”
Co-Teach

Problem: How is heat transferred?

Research: Heat is transferred in three ways: conduction, convection and radiation.

Conduction -
Convection -
Radiation -

Hypothesis: If heat is transferred, then it will

Procedure:
Observe teacher demonstrations.

Analysis and Conclusions:

Station 1 - HOT vs COLD WATER
a. Describe what happened to the food coloring when it was placed in hot water. Why is this happening?

b. Describe what happened to the food coloring when it was placed in cold water. Why is this happening?

Station 2: DENSITY TANK
a. Describe what happened when the divider was lifted. Why did this occur?

b. Over time, what can you predict will happen to the colored water?

Station 3 - BALL AND RING
a. Step 1: Was there a lot of room between the ball and ring or was it a tight fit?

b. Step 3: Did the ball fit through the ring after being heated?

c. Step 5: Did the ball fit through the ring after being cooled?

d. Explain what was happening in this experiment using the vocabulary words from your notes.

e. Give an example where we might find a similar situation happening in our every day lives.

**Station 4 - CONDUCTOMETER**

a. Label the picture of the conductometer.

b. When the center was placed in the flame, what kind of process of heat transfer happened to make the conductometer grow hotter?

c. By what process did heat flow from the center of the conductometer to the tines?

d. In what order did the wax melt?

e. Why do you think this apparatus is called a conductometer?

**Station 5 - EEK! A SNAKE**

a. Describe what happens to the snake after the heat lamp has been turned on for several minutes.
b. What type of heat transfer caused this to happen?

Station 6 - SAVE THE CUBES

<table>
<thead>
<tr>
<th>Observation/Prediction</th>
<th>BLOCK A</th>
<th>BLOCK B</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temp. Observation</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melt First Prediction</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Melt First Actual</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Material Block Made Of</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

b. Describe why you think the ice melted as it did. What type of heat transfer is occurring?

c. Remove the ice and dry the blocks. Turn over the blocks to find out of what substance each block is made and record on the table.

Station 7 - HANDBOILER

a. Describe what happens when you hold the apparatus.

b. What type of heat transfer is occurring?
The Nature of Heat

Heat is the movement of thermal energy from a substance at a higher temperature to another at lower temperature. Matter does not contain heat but has thermal energy. Only when thermal energy is transferred is it called heat. **Heat is thermal energy moving from a warmer object to a cooler object.** Heat is measured in joules.

**Heat is transferred by conduction, convection, and radiation.**

In the process of conduction, heat is transferred from one particle of matter to another without the movement of matter itself. A metal spoon sitting in a pot of boiling water is heated by conduction.

**Convection** transfers heat within a fluid (a liquid or a gas) by the movement of currents. Heated fluids are less dense than cooler fluids. So heated fluids rise. As warmer fluid moves away, cooler fluid takes its place. This flow creates a circular motion known as a convection current.

**Radiation** is the transfer of energy by electromagnetic waves. Unlike conduction and convection, radiation does not require matter to transfer thermal energy. For example, all of the sun’s energy that reaches Earth travels through millions of kilometers of empty space.

If two substances have different temperatures, heat will flow from the warmer object to the colder one. Heat will flow from one substance to the other until the two substances have the same temperature.

A material that conducts heat well is called a conductor. Metals such as silver or stainless steel are good conductors. A material that does not conduct heat well is called an insulator. Wood, wool, straw, paper, cork, and gases, such as air, are good insulators.

When an object is heated, its temperature rises. But the temperature does not rise at the same rate for all objects. Different materials need more or less heat to change their temperature by the same amount. The amount of energy required to raise the temperature of 1 kilogram of a substance by 1 kelvin is called its specific heat. The unit measure for specific heat is joules per kilogram-kelvin (J/(kg·K)).

The energy gained or lost by an object is related to the mass, change in temperature, and specific heat of the material. You can calculate thermal energy changes with the following formula.

**Change in energy = Mass × Specific heat × Change in temperature**
**The Nature of Heat**

**Understanding Main Ideas**

Fill in the spaces in the table below by writing whether the heat is transferred by convection, radiation, or conduction.

<table>
<thead>
<tr>
<th>Heat Transfer Example</th>
<th>Method of Heat Transfer</th>
</tr>
</thead>
<tbody>
<tr>
<td>An entire lake is heated by water from a hot spring at the bottom of the lake.</td>
<td></td>
</tr>
<tr>
<td>Sunlight melts a wax crayon left outside.</td>
<td></td>
</tr>
<tr>
<td>A burner on a stove heats the bottom of a pot.</td>
<td></td>
</tr>
<tr>
<td>The inside frame of your front door feels cold during winter.</td>
<td></td>
</tr>
<tr>
<td>A kite rises high above a hot, sandy beach.</td>
<td></td>
</tr>
<tr>
<td>You feel the warm glow of a bonfire.</td>
<td></td>
</tr>
</tbody>
</table>

**Building Vocabulary**

Fill in the space to complete each sentence.

7. Heat is transferred directly from one particle of matter to another by the process of ____________

8. A(n) ____________ is a material that transfers heat well.

9. ____________ is a transfer of thermal energy from a warmer object to a cooler object.

10. A circular flow of warmer fluid and cooler fluid is called a(n) ____________

11. The amount of energy required to raise the temperature of 1 kilogram of a substance by 1 kelvin is called its ____________

12. A(n) ____________ is a material that does not conduct heat well.

13. ____________ is the transfer of energy by electromagnetic waves.

14. Heat is transferred by the movement of currents within a fluid by a process called ____________

© Prentice-Hall, Inc.