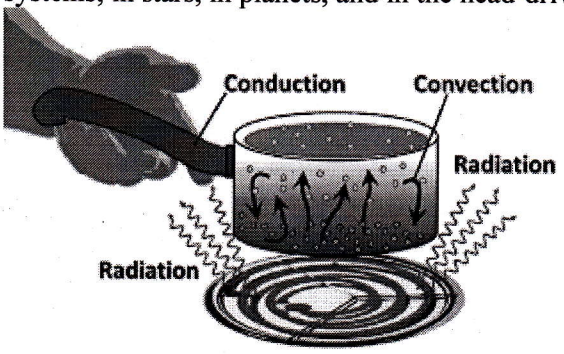
Energy in Motion: Convection, Radiation, Conduction, Insulation

Thermal (heat) energy is transferred from place to place as heat by three different mechanisms: conduction, convection, and radiation. All three can be demonstrated with a candle flame. If one holds the end of a steel nail against a candle flame you will begin to feel heat slowly seeping through the nail. Thermal energy is being transferred by ***conduction***. If one places a hand a safe distance above the flame one can feel the currents of heated air moving upward. These currents carry thermal energy by ***convection***. If you place the back of your hand along side the candle flame you will feel heat emanating from the flame via ***radiation***. Heat transfer plays an important role in virtually all energy-transforming-systems; in stars, in planets, and in the head-driven machinery (heat-engines) that power much of modern society.



Conduction – thermal conduction is the transfer of random kinetic energy within a substance without any net motion of the constituent particles of the substance.

- Conduction is important in solids because the particles (atoms/molecules) of a solid can not move from place to place, but they do vibrate. If one part of a solid is heated to a higher temperature the increased vibrations of the particles at the hot-spot interact with neighboring particles causing them to vibrate more vigorously thereby transferring heat energy.
    - Materials that allow heat (and electricity) to travel through them are referred to as **conductors**.
    - Materials that inhibit the flow of heat (and electricity) **insulators**.

Convection – is the transfer of thermal energy by large-scale movements within a fluid (liquid, gas, plasma).

- Connective movement (convection) commonly takes place in fluids whenever there is a difference in temperature across the fluid and the fluid is acted on by gravity. Virtually all fluids expand and become less dense with increasing temperature. The warmer, expanded regions rise against gravity; and the cooler, denser regions sink. This action creates convection currents in the fluid which transfer energy.
- Convection is the basis of most weather phenomena. Warm regions of air in the atmosphere expand and rise, and cool regions of air sink. Winds arise when air rushes in to replace regions of air that have risen.

Radiation – is the transfer of energy by means of electromagnetic waves.

- Electromagnetic waves can also be thought of as streams of particle-like entities called photons.
- Radiant energy travels at the speed of light when traversing empty space.
- All bodies emit radiant energy of various kinds (radio, infrared, visible light, ultraviolet, x-rays, and gamma rays).

Heat Transfer: Thermal energy is also called "heat" energy. Thermal energy will always move from an area with a higher amount of thermal energy to an area where there is less thermal energy. We call this process an energy transfer.

- Use the above definitions of conduction, convection, and radiation to complete the sentences.

Conduction	Convection	Radiation
Definition: When two objects _____ each other.	Definition: When heat energy moves through the air or another _____	Definition: When heat energy moves through _____waves (hint: think light)
Explanation: When two objects touch, heat is always transferred from the _____ object to the _____ object	Explanation: Only happens in liquids and gasses: causes circulation and movement of the _____	Explanation: Heat is transferred through _____ or electromagnetic waves, not by touch or fluids.
Examples: Cooking on a grill; touching a hot piece of metal and _____	Examples: Boiling water in a pot; currents in the ocean; and _____	Examples: The sun gives you a sunburn; using an electric heater; and _____

For the following scenarios, state the type of heat transfer (conduction, convection, radiation) that is evident in the following descriptions.

- Solids conduct heat better than liquids or gasses; however not all solids are good at conducting energy. A substance that is good at conducting energy (heat/electric) is called a **conductor** (steel, aluminum, copper are examples of conductors). A substance that is not good at conducting energy (heat/electricity) is called an **insulator** (wood, Styrofoam, cloth, plastic, oven mitts are examples of insulators).

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 due to _____.
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 transferred to his hand by _____.
6. A heater is placed under one corner of a water bed mattress. Warm water moves in 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 heart 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 park gets so hot during the day that you can't sit on it because of _____.
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. This is due to the fact that heat rises in a fluid by _____.
18. The reason heating vents are placed on the floor of houses is _____.
19. This type of heat transfer is trapped by greenhouses (and greenhouse gasses) _____.
20. Why you would use potholders when getting the cookie sheet out of the oven _____.

How Heat Travels Content Organizer

How Are They Alike?		
Conduction	Convection	Radiation

How Are They Different?		
Conduction	Convection	Radiation

Everyday Examples		
Conduction	Convection	Radiation

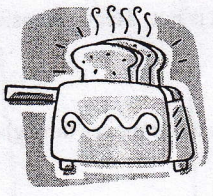
Worksheet: Methods of Heat Transfer
(conduction, convection, and radiation)

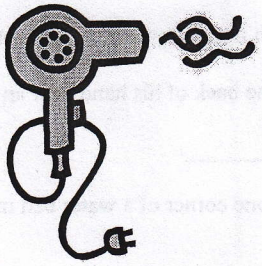
Define conduction:

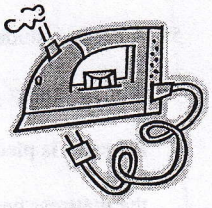
Define convection:

Define radiation:

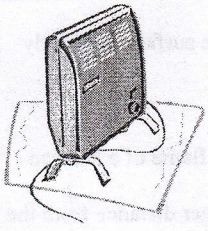
Identify the method of heat transfer that takes place in each illustration. Some illustrations may show more than one form of heat transfer.

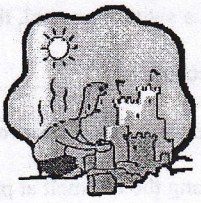
1. 

2. 

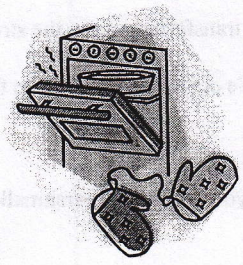
3. 

4. 

5. 

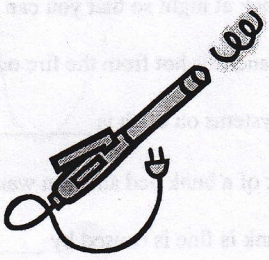
6. 

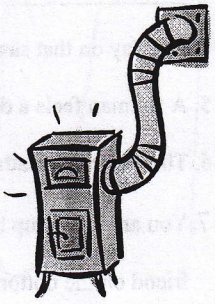
7. 

8. 

9. 

10. 

11. 

12. 

Thermal Energy Transfer Lab

Wax Dot Demonstration

- With forceps, tongs, or gloves hold the end of the metal knitting needle that does not have wax on it.
- Heat the other end of the needle using a candle.
    - Record your observations and describe how the heat got from the source (the flame) to the wax. Use a labeled diagram in your explanation including the source of the heat and the direction of heat transfer.
    - What kind of heat transfer is this an example of? Explain your answer.

Incandescent Light Bulb Demonstration

- Turn on the light bulb and let it glow for a few minutes.
- Without touching the bulb, place your hand near the bulb and feel the heat from the bulb.
    - Record your observations and describe how the heat got from the bulb to your hand. Use a labeled diagram in your explanation including the source of the heat and the direction of heat transfer.
    - What kind of heat transfer is this an example of? Explain your answer.

Paper Spiral Demonstration

- Hang the spiral using the thread and place a lit candle under the spiral.
    - Record your observations and describe why the spiral motion of the paper occurs. Use a labeled diagram in your explanation including the source of the heat and the direction of heat transfer.
    - What kind heat transfer is this? Explain your answer.

USE THE BACK SIDE OF THIS PAPER TO RECORD YOUR OBSERVATIONS AND DRAW YOUR DIAGRAMS!