Essential Question:

How does heat energy move from one object to another?

Standard:

S8P2d. Plan and carry out an investigations on the effects of heat transfer on molecular motion as it related to the collision of atoms (conduction), through space (radiation), or in currents in a liquid or a gas (convection).

What is thermal energy?

*Thermal Energy is the sum of the kinetic and potential energy of the particles that make up a material. (It describes the energy of the particles that make up a solid, liquid, or a gas).

*Depends on…

1) temperature of substance (thermal energy increases as temperature increases because as temperature increases, atoms move faster - have more kinetic energy)
2) amount of substance (ex: a cup of tea has less energy than a kettle of tea)

What is temperature?

*Temperature is the average kinetic energy of the particles that make up a material. NOT dependent on the amount.

*The greater the average kinetic energy of particles, the greater the temperature.

(ex: the particles in the air in a warm house-lower temp- move faster and have more kinetic energy than those outside on a cold evening-higher temp)

Thermal Energy vs. Temperature

*Thermal energy and temperature are related, but not the same.

(ex: As a frozen pond melts, both ice and water are present and they have the same temperature. So the particles that make up the ice and water have the same average kinetic energy, or speed. However, the particles do not have the same thermal energy. This is because the average distance of the particles that make up the liquid water and ice are different. *The particles that make up the liquid and the solid water have different potential energies and, therefore, different thermal energies*)

What is heat?

* Heat is the movement of thermal energy from a warmer object to a cooler object.

*Heat is transferred only when two objects are at different temperatures.

(ex: holding a cup of hot chocolate- thermal energy from the cup heats your hands, or the cup is heating your hands)

*All objects have thermal energy. However, you *heat* something when thermal energy *transfers* from one object to another.

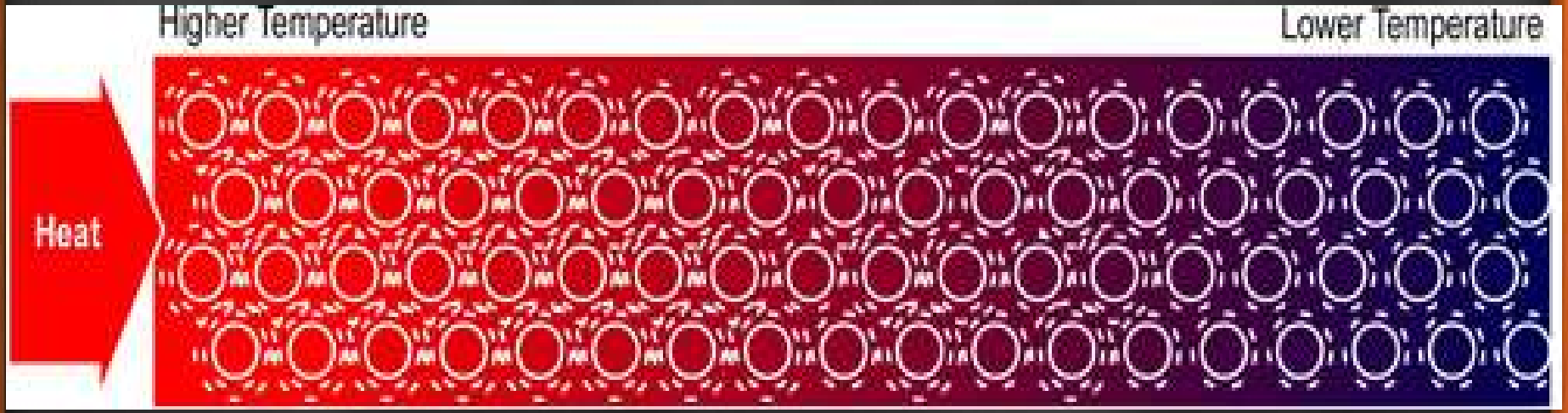
*Heat is transferred among molecules/atoms.

*the rate at which heating occurs depends on the difference in temperatures between the two objects.

*The warmer object loses thermal energy and becomes cooler as the cooler object gains thermal energy and becomes warmer.

*Heat will continue to move until all materials are at the same temperature.

Applying HEAT increases KINETIC ENERGY in a substance. Notice the "energy" in the molecules in the diagram below. The higher the temperature the more the molecules expand and begin to move away from each other.



http://www.middleschoolchemistry.com/multimedia/chapter1/lesson2#heating_and_cooling

Heat Transfer can occur in three ways:

Conduction

Convection

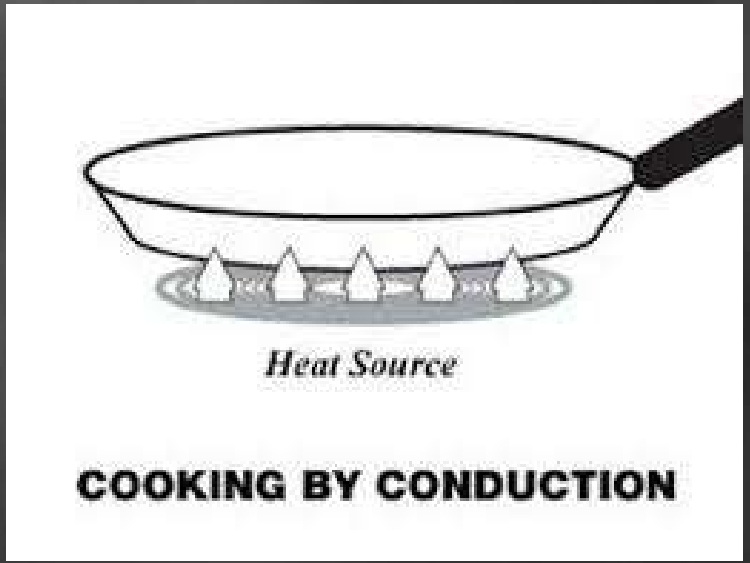
Radiation

Conduction

- Heat is transferred through solids and liquids by direct contact-collision of particles- NOT EMPTY SPACE----but can occur in solids, liquids, & gas.

(thermal energy is transferred via colliding molecules/atoms)

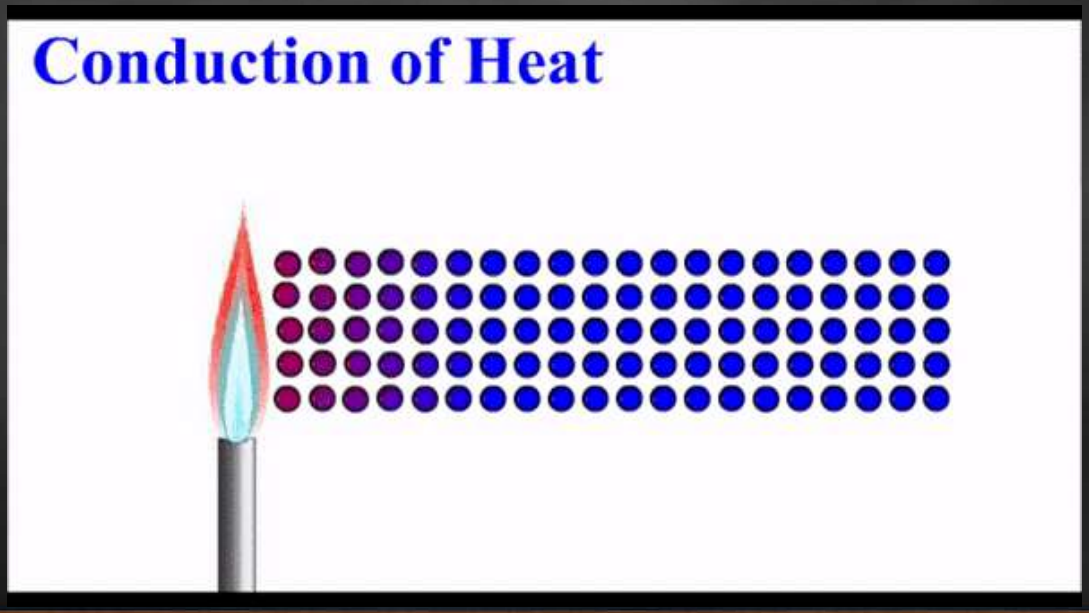
DRAW THIS!!



Conduction

Why is conduction easier in solids and liquids?

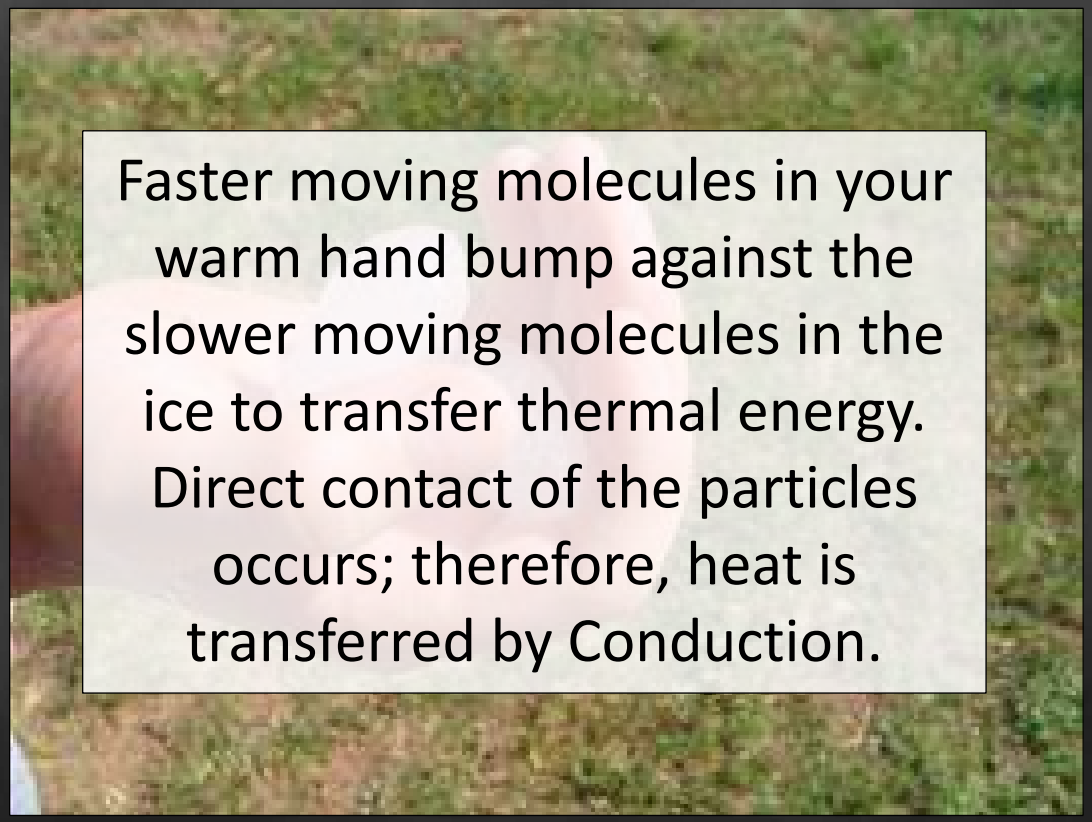
Atoms and molecules are closer together in solids and liquids. So, the particles need to move only a short distance before they bump into one another and transfer energy.



Explain the movement of thermal energy in the picture below.

Faster moving molecules in your warm hand bump against the slower moving molecules in the ice. Thermal energy moves from your warmer hand to the colder ice. The slow moving molecules in the ice move faster.

How is this an example of Conduction?



Conduction

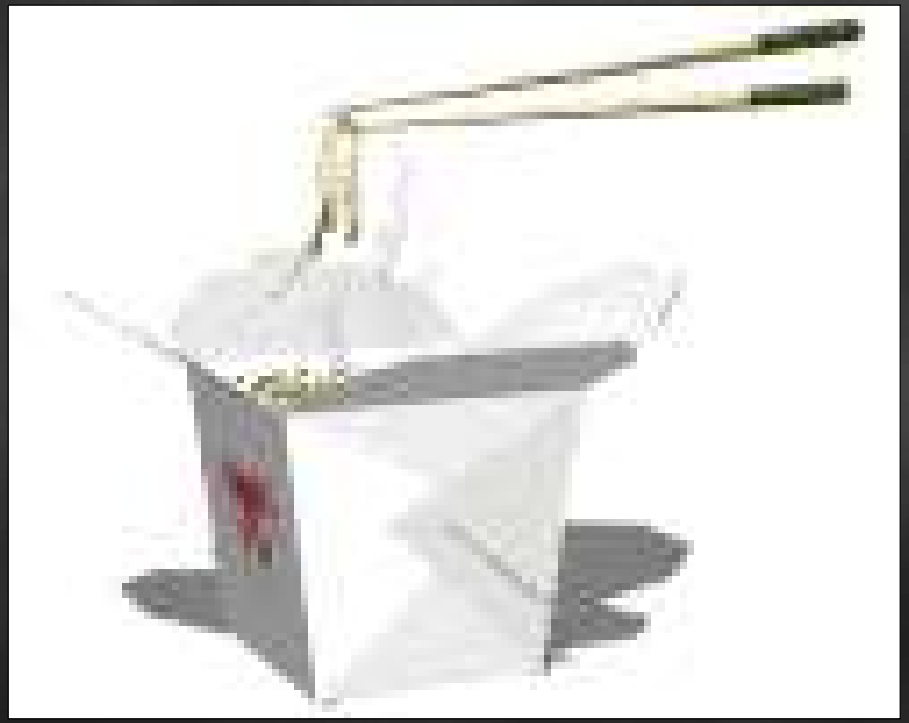
Animation:

http://www.passmyexams.co.uk/GCSE/physics/conduction-heat-transfer.html

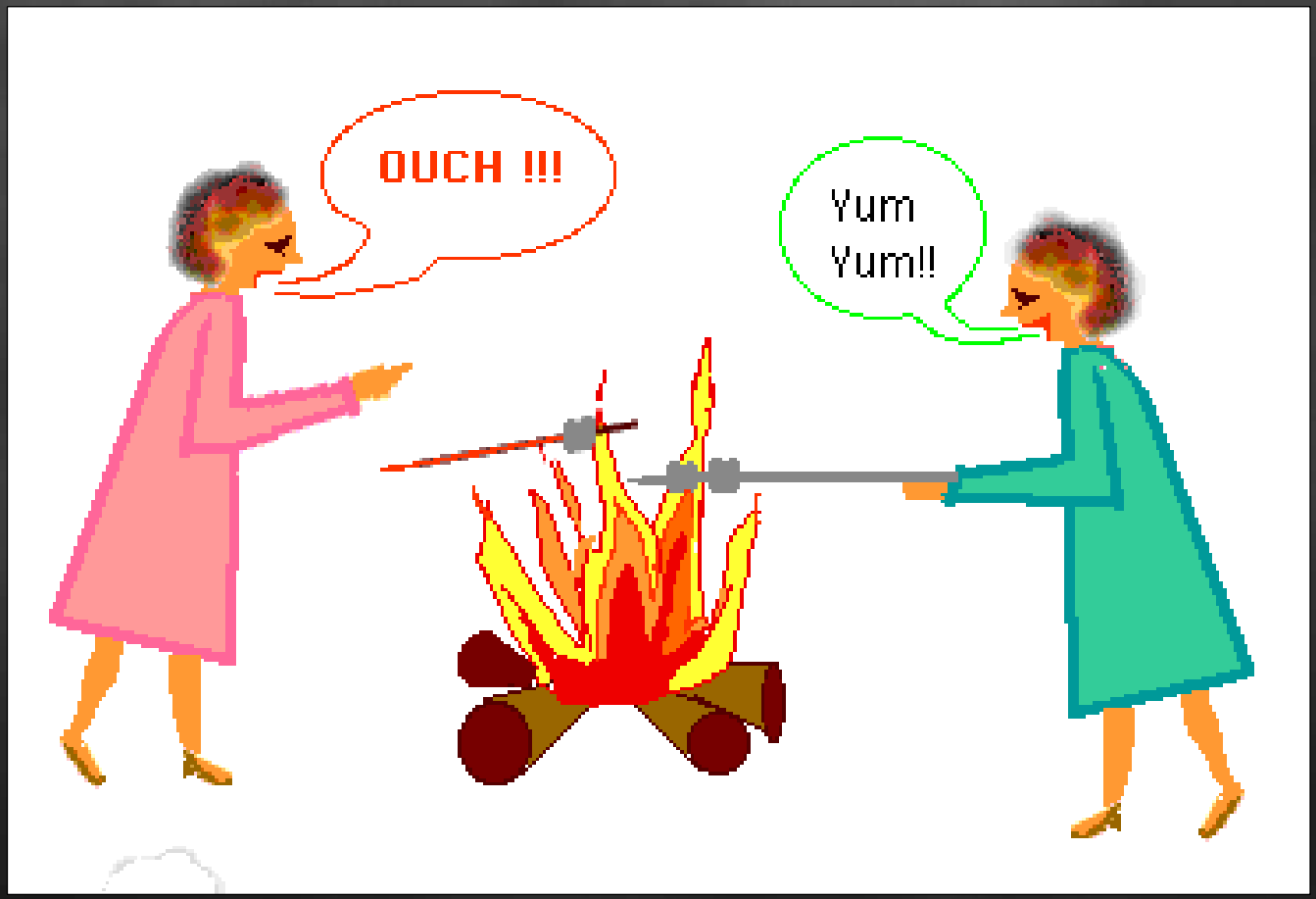
Eureka Video clip:

http://www.youtube.com/watch?v=Yitiw6Y7xZg

Your turn…Explain the movement of thermal energy if you were about to eat the Chinese food below. How is this an example of Conduction?



Why does the lady in the pink dress drop her roasting stick before the lady in the green dress?



Conductors and Insulators

*A thermal conductor is a material through which thermal energy flows easily.

*A thermal insulator is a material through which thermal energy does not flow easily.

Conductors and Insulators

Table 1 Common Conductors

Good conductors	Fair conductors
silver	graphite (carbon)
copper	nichrome
gold	the human body
aluminum	damp skin
magnesium	acid solutions
tungsten	salt water
nickel	Earth
mercury	water vapour in air
platinum	silicon
iron	germanium

Table 2 Common Insulators

Good insulators	
oil	plastic
fur	wood
silk	paper
wool	wax
rubber	ebonite
porcelain, glass	pure water

Convection

*Note: molecules collide in a liquid or gas-this is an energy transfer of conduction-which leads to **convection** currents.

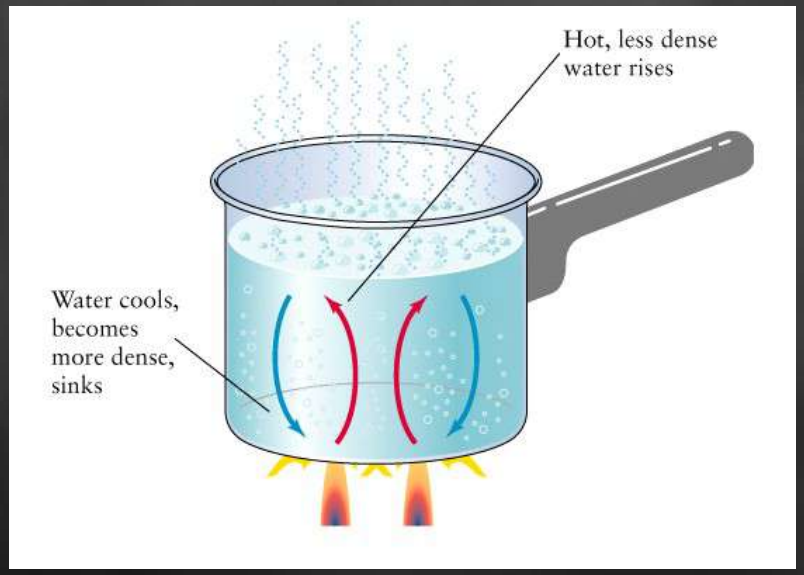
*Convection is the flow of currents in a liquid or gas.

*The transfer of thermal energy by the movement of particles from one part of a material to another.

*As liquids or gases warm up at the bottom, the molecules rise to the top (expand-become less dense)

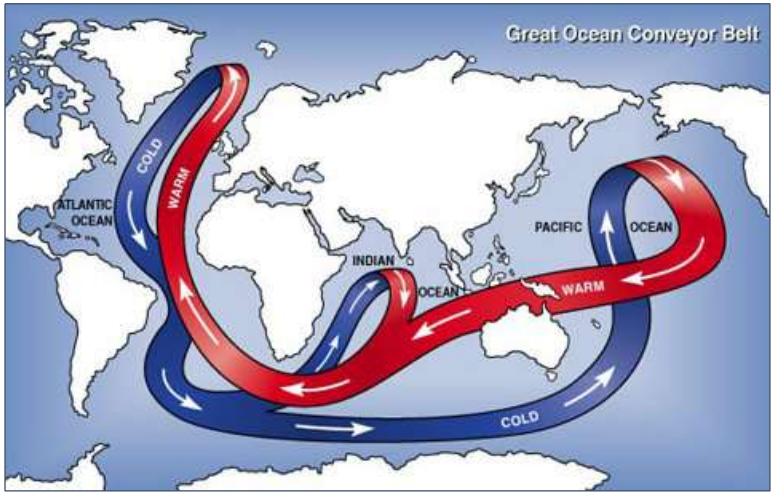
*The cooling process at the top causes the denser liquid or gas to sink.

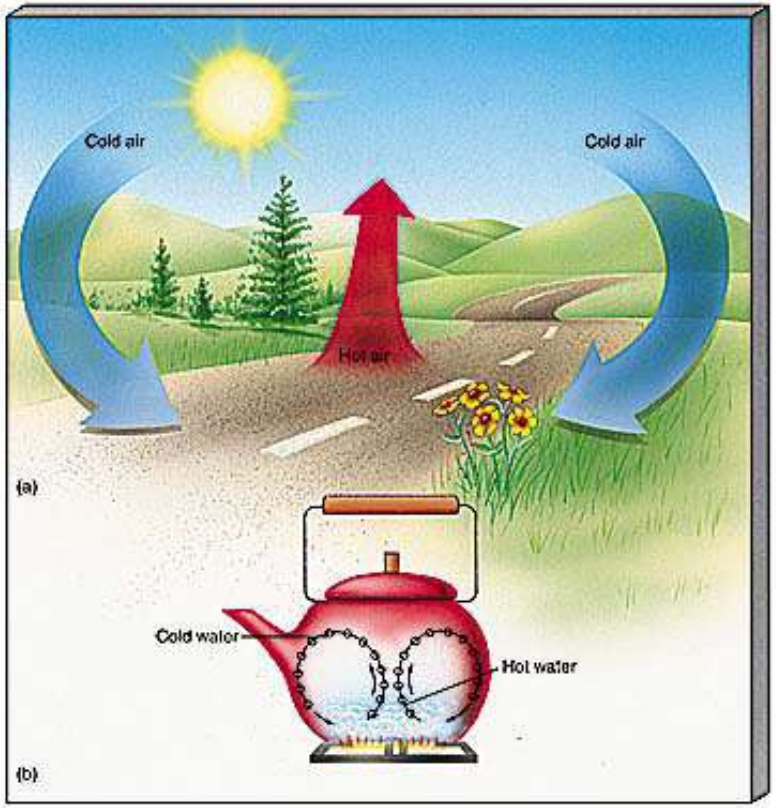
*The cycle repeats until all the water is at the same temperature.

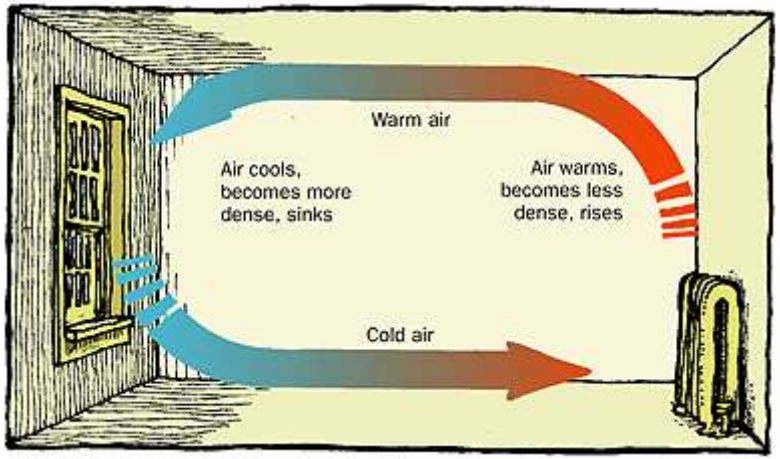


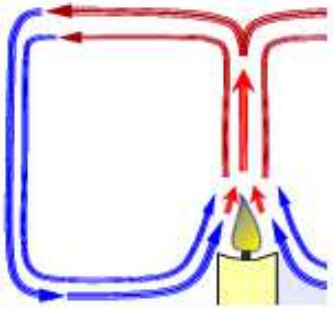
DRAW THIS!!

Everyday Examples of Convection Currents









http://www.healthyheating.com/Definitions/heat-transfer-convection.htm#.VD7SIfmjOSo

Pan handle is an insulator and doesn't conduct heat very well.

Soup is heated in the pan by convection. The hot soup rises. Cool soup falls to take the hot soup's place.

Heat energy from the stove is transferred to the pan by conduction.

Convection

Animations and Video Clips

http://www.passmyexams.co.uk/GCSE/physics/convection-heat-transfer.html

Eureka Video clip:

http://www.youtube.com/watch?v=ON2Y3FEk_UI

Convection

Describe an example of convection that you have experienced recently at home, at school, or outside.

How Hot was it?

Dashboard Oven Hot

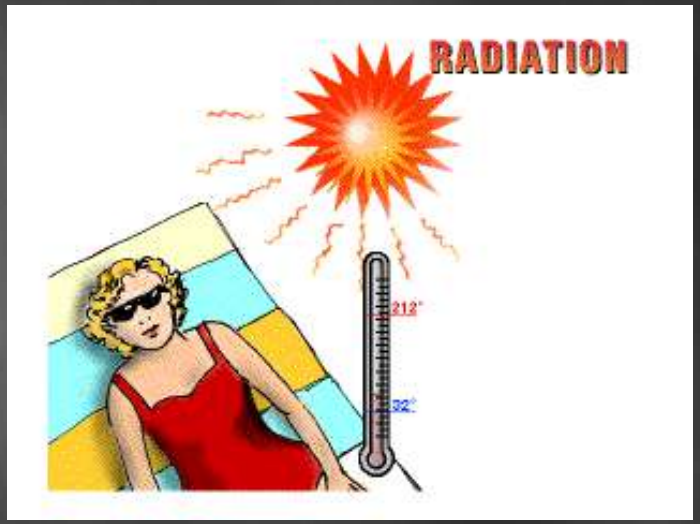
What cooked the cookies?

Radiation

* Radiation is heat transfer through space

(not matter)

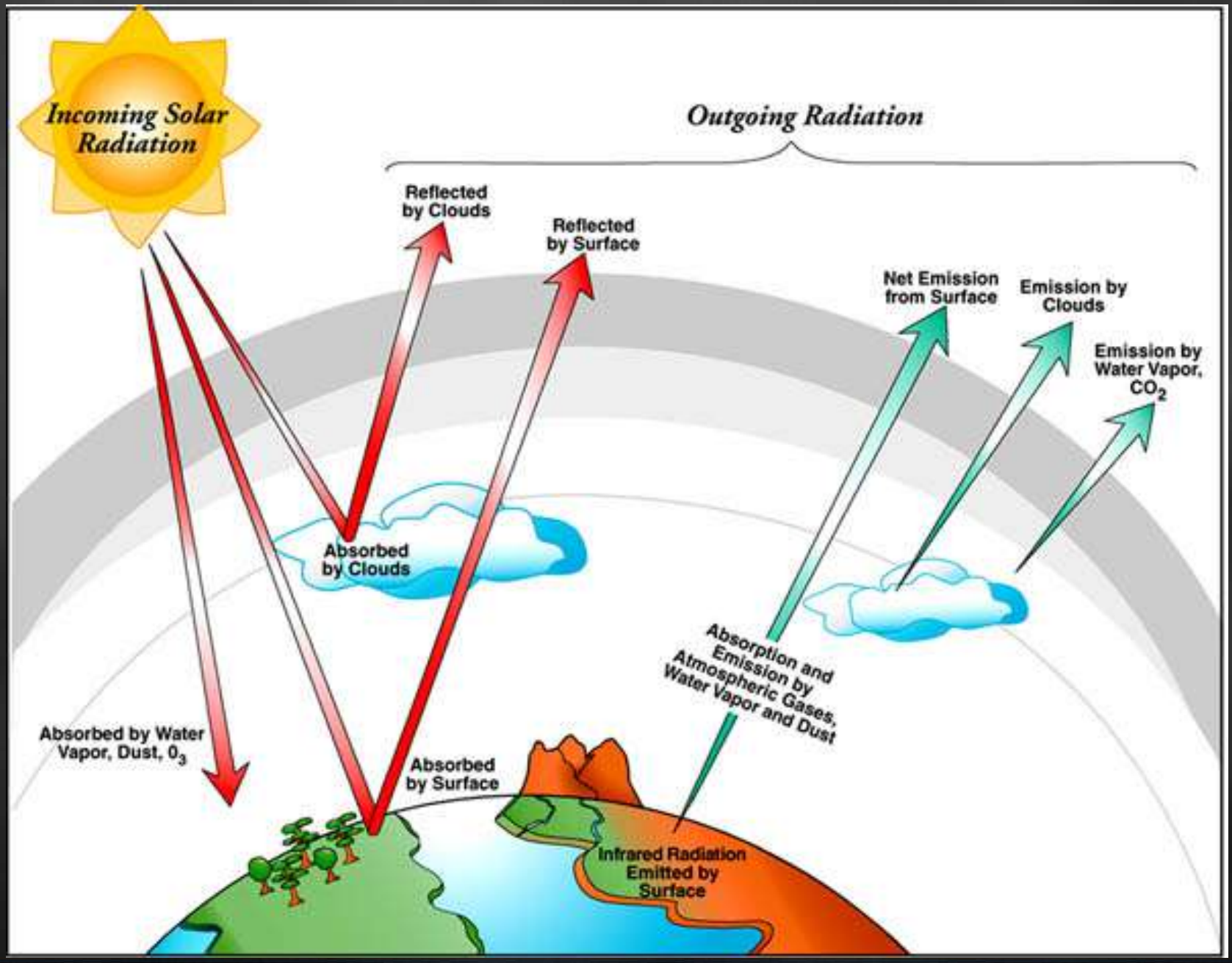
by electromagnetic waves



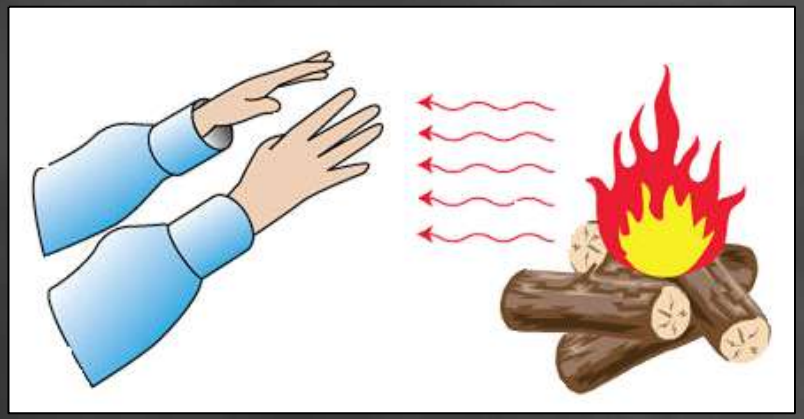
DRAW THIS

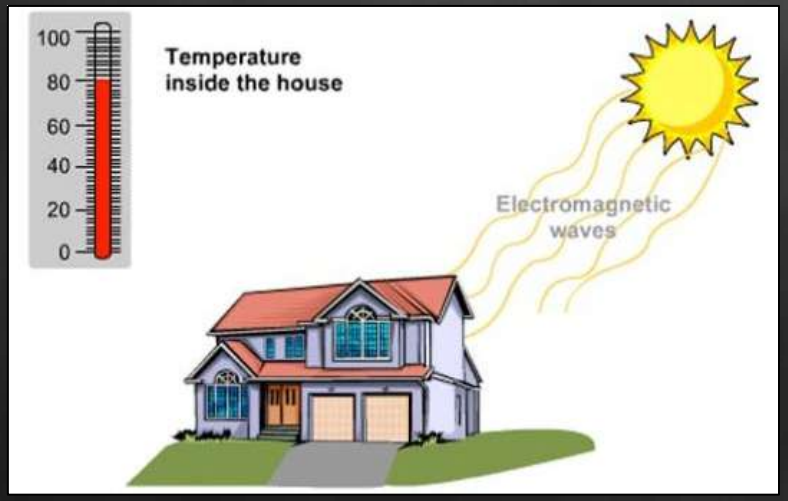
*Unlike Conduction and Convection, Radiation can occur in empty space (a vacuum), as well as in solids, liquids, and gases.

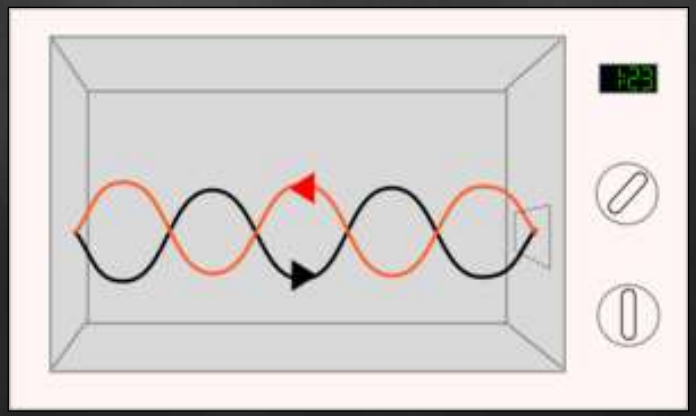
*Waves such as visible light, infrared, and ultraviolet light are examples of radiation


Incoming Solar Radiation
Outgoing Radiation
Reflected by Clouds
Reflected by Surface
Net Emission from Surface
Emission by Clouds
Emission by Water Vapor, CO_2
Absorbed by Clouds
Absorption and Emission by Atmospheric Gases, Water Vapor and Dust
Absorbed by Water Vapor, Dust, 0_3
Absorbed by Surface
Infrared Radiation Emitted by Surface

Radiation







Radiation

Eureka video clip:

http://www.youtube.com/watch?v=2JZciWtK6vc

Animations of Heat Transfer

http://www.pbslearningmedia.org/asset/lsps07_int_heattransfer/

https://www.e-education.psu.edu/egee102/node/2053

Scroll down for animations

Look at the examples of Heat Transfer in the Image below

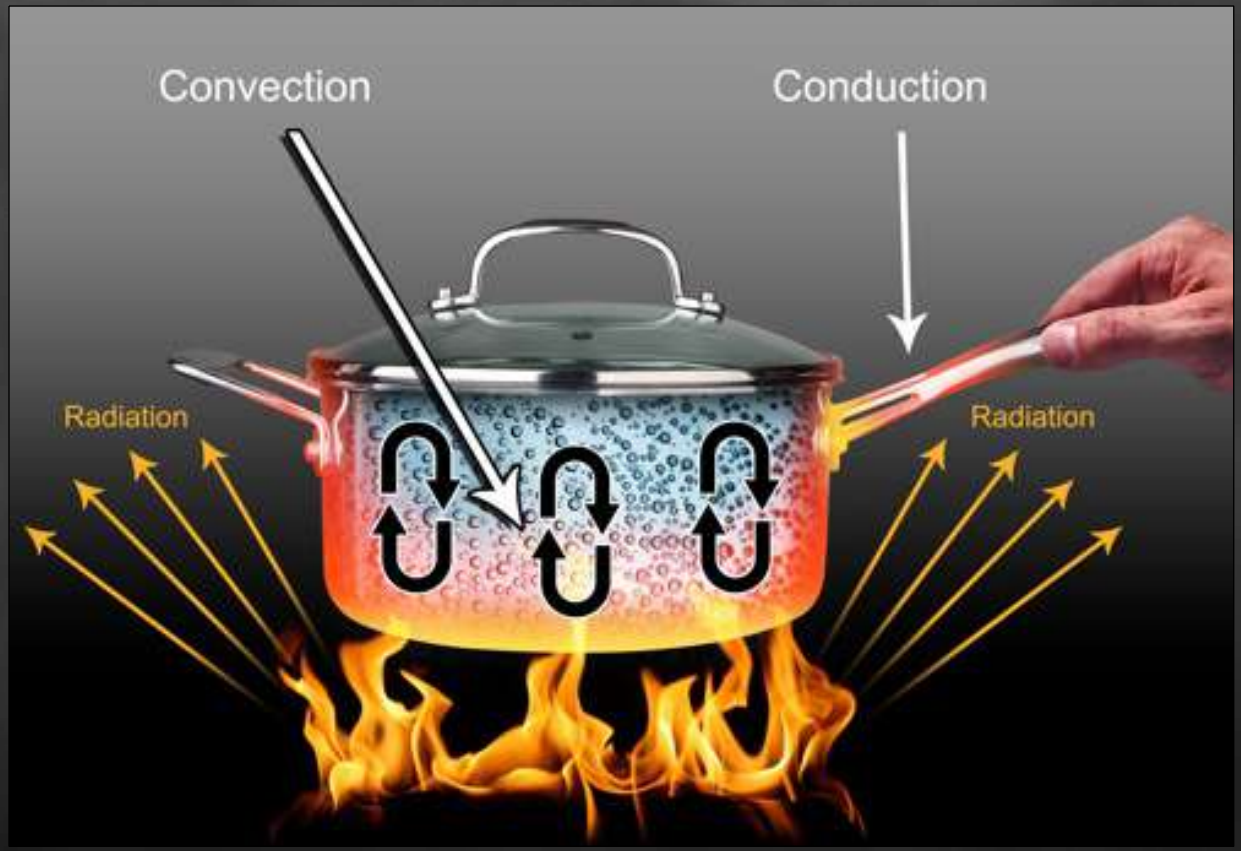


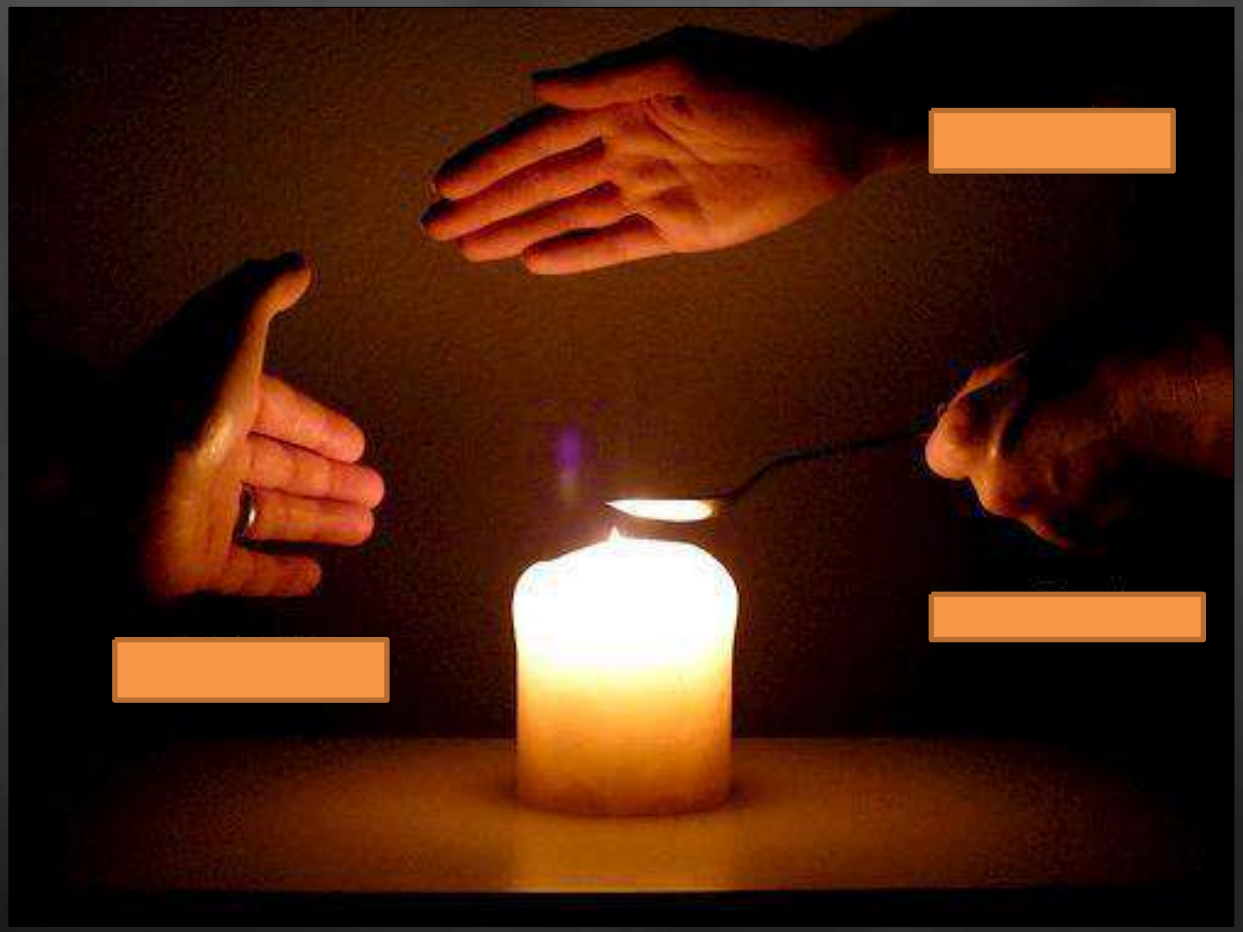
Figure 2--Conduction, Convection, and Radiation

Energy is transferred by direct contact.

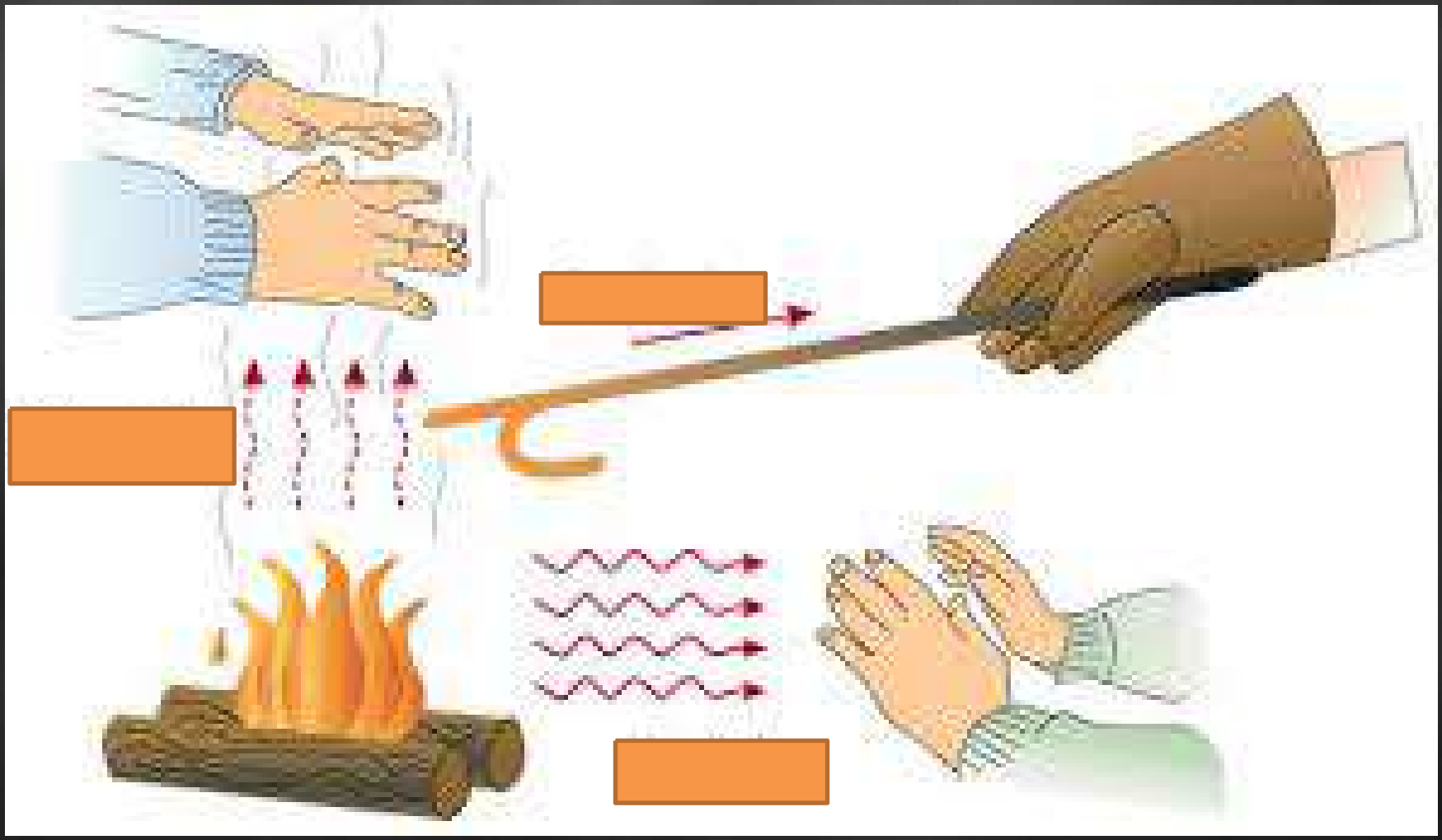
Energy is transferred by the mass motion of molecules.

Energy is transferred by electromagnetic radiation.

Which type of heat transfer?



Which type of heat transfer?



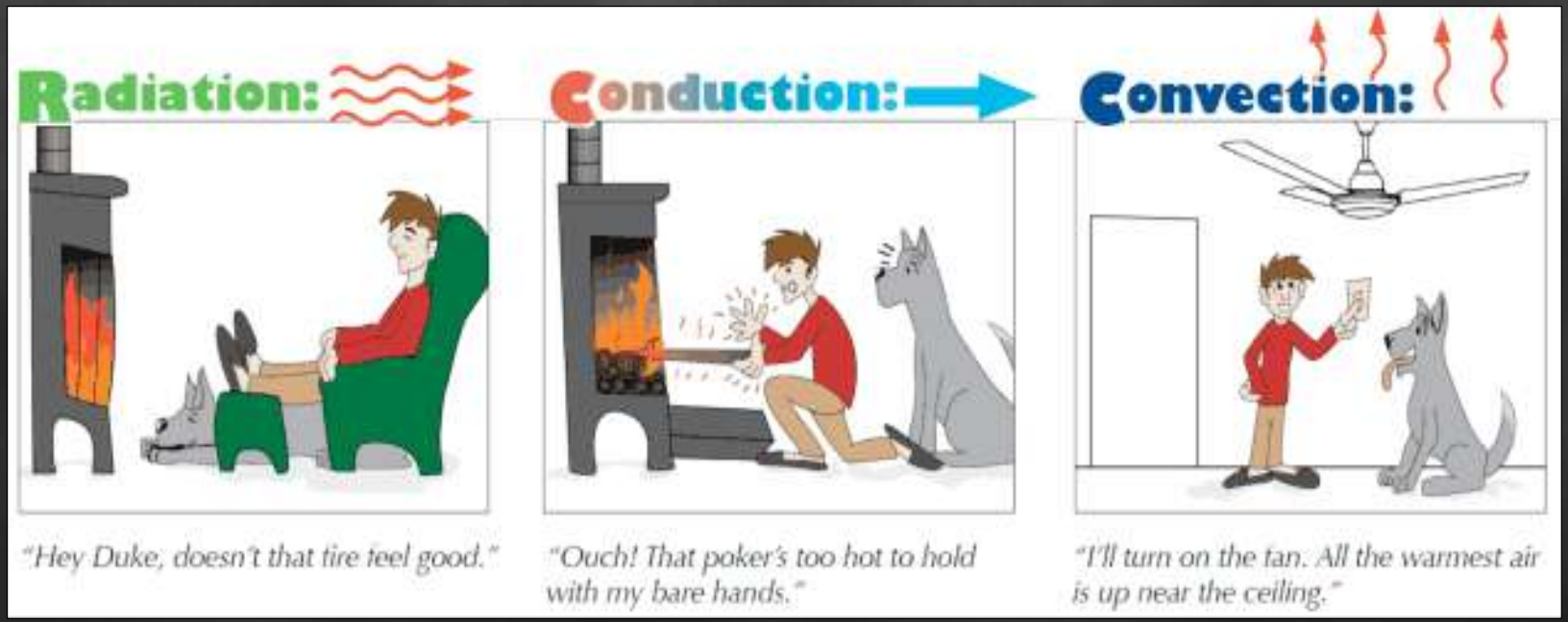
Heat Transfer Song

http://www.youtube.com/watch?v=wr8Z4SCETPs

Look at the three images below. Identify which is an example of conduction, convection, and radiation.

A. **B.** **C.**

Look at the three images below. Identify which is an example of conduction, convection, and radiation.



When water boils in a pan on a hot burner, heat gets to the water mainly by…

a) radiation of heat through the pan
b) reflection of heat from the burner
c) conduction of heat through the pan
d) absorption of heat from the air in the room

Alex’s mother asked him to use a spoon to stir the stew that was cooking on the stove. Which spoon will stay the coolest while he stirs?

a) an iron spoon
b) a silver spoon
c) a wooden spoon
d) an aluminum spoon

Patti used a steel wrench to work on her bicycle on a hot, sunny day. She left the wrench on the hot concrete surface for an hour while she had lunch. When she returned, the wrench was very hot to touch. What is the BEST explanation for how the wrench got so hot?

A. Heat transferred from the wrench to the air.

B. Heat transferred from the bicycle to the wrench.

C. Heat transferred from the wrench to the concrete.

D. Heat transferred from the concrete to the wrench.

Which statement is an example of heat transfer by convection?

A. Jane's feet burned as she walked across the hot beach sand.
B. Hot air from the sand rose and was replaced by cool air blowing in from the ocean.
C. The black asphalt of the parking lot was much warmer than the green grass surrounding the lot.
D. People were scattered across the beach, sitting on chairs and towels, warming themselves in the bright sunshine.

Heat Transfer Summarizer

Heat Transfer Summarizer Name _____ Date ____ Period __

Label the example of conduction, convection, and radiation in the diagram below.