

Page 22a

- Have weather map face-up on table
- Objective: We will describe the three types of heat transfer and explain their roles in Earth processes.
- Warm-up:
 - What heats up faster, sand or water?
 - Which one has a greater specific heat capacity?

Quick Question

1. When heating an object, the higher the specific heat capacity of an object, the _____ the temperature rises.

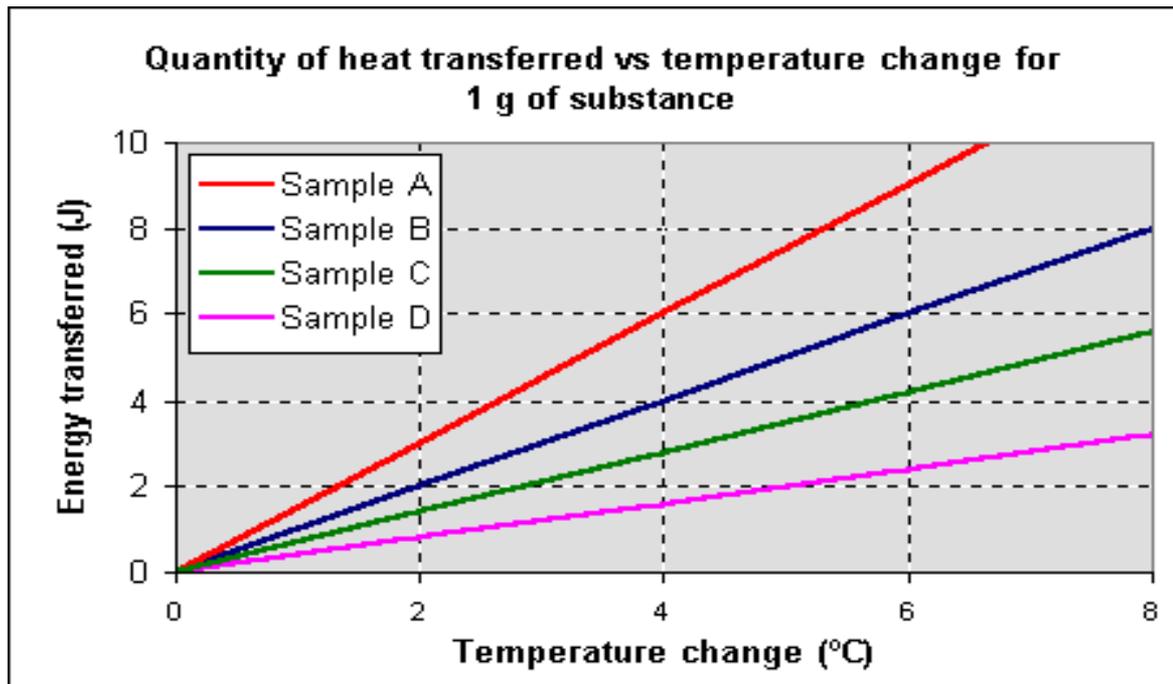
Quick Question

2. Based on the chart below, which substance will cool down the slowest?

<u>Material</u>	<u>Specific Heat (Btu/lb. °F)</u>	<u>Density (lb/cu.ft.)</u>	<u>Volumetric Heat Capacity (Btu/cu.ft. °F)</u>	<u>Thermal Conductivity (Btu/hr-ft²°F)</u>
Sand	0.19	94.6	18	0.09 - 0.14
White Pine	0.67	27	18	0.07
Gypsum	0.26	78	20	0.28
Adobe	0.24	106	25	0.30
White Oak	0.57	47	27	0.09
Concrete	0.2	140	28	1.0
Brick	0.21	140	28	0.40
Rock	0.21	180	38	1.2 - 4
Water	1.0	62.4	62.4	0.33
Air (75°F)	0.24	0.075	0.018	0.014
Hollow Concrete Block (~ 30% air)			20	
Rock bed (void fraction ~ 1/3)			25	
Copper				232

Quick Question

3. Determine from the graph below which sample has the greatest heat capacity.



Quick Question

4. Assuming town A and town B are at the same latitude, which town will be hotter during the summer?



Quick Question

5. Which city will have a greater range of temperature throughout the year?



Understanding Heat Transfer, Conduction, Convection and Radiation

Heat Transfer

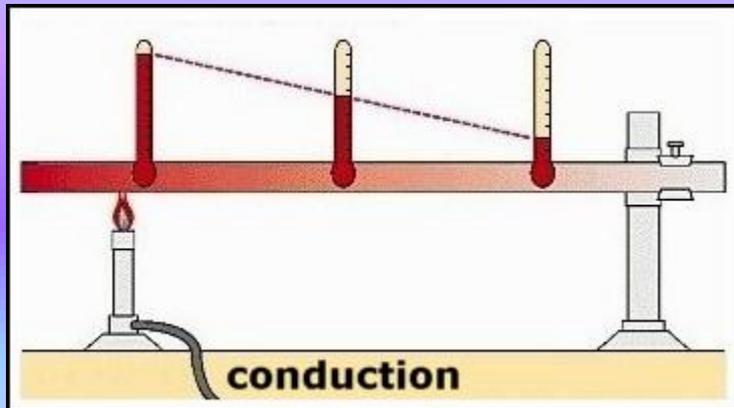
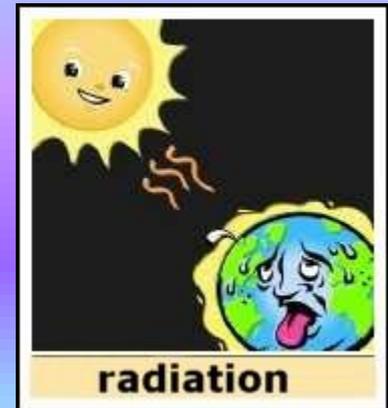
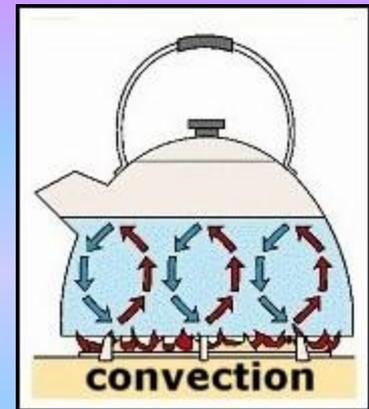
- Heat always moves from a warmer place to a cooler place.
- Hot objects in a cooler room will cool to room temperature.
- Cold objects in a warmer room will heat up to room temperature.

Question

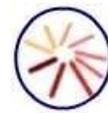
- If a cup of coffee and a red popsickle were left on the table in this room what would happen to them? Why?
- The cup of coffee will cool until it reaches room temperature. The popsickle will melt and then the liquid will warm to room temperature.

Heat Transfer Methods

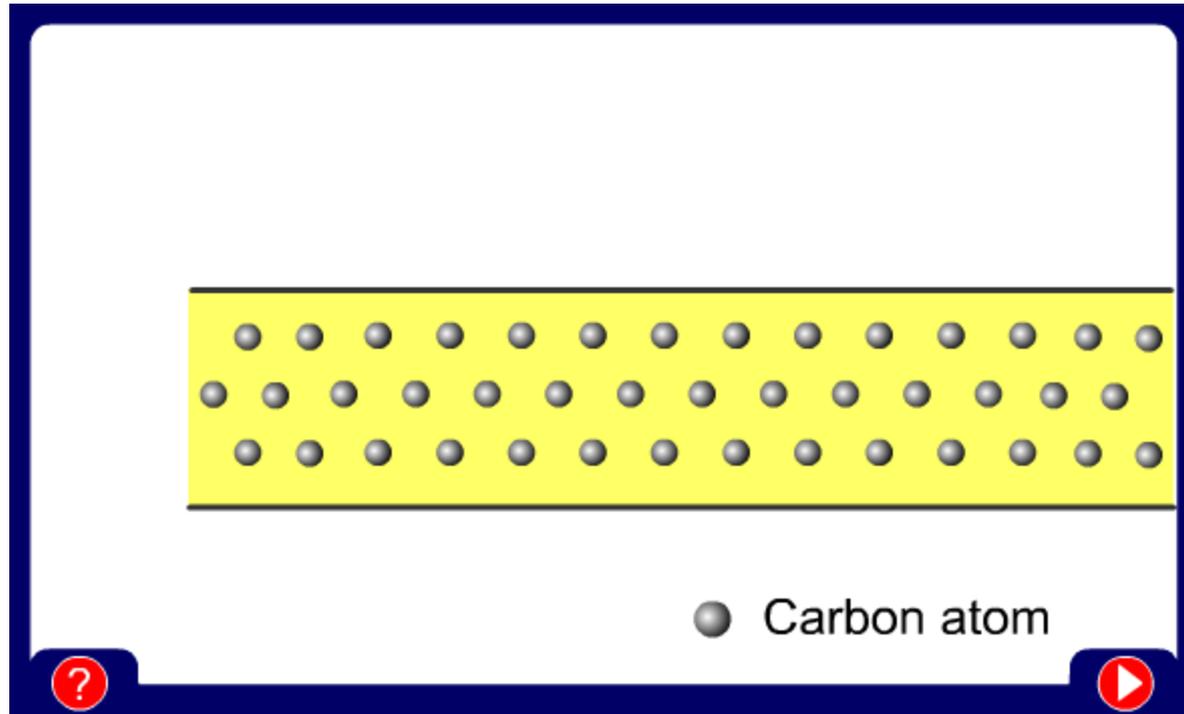
- Heat transfers in three ways:
 - Conduction
 - Convection
 - Radiation



Conduction



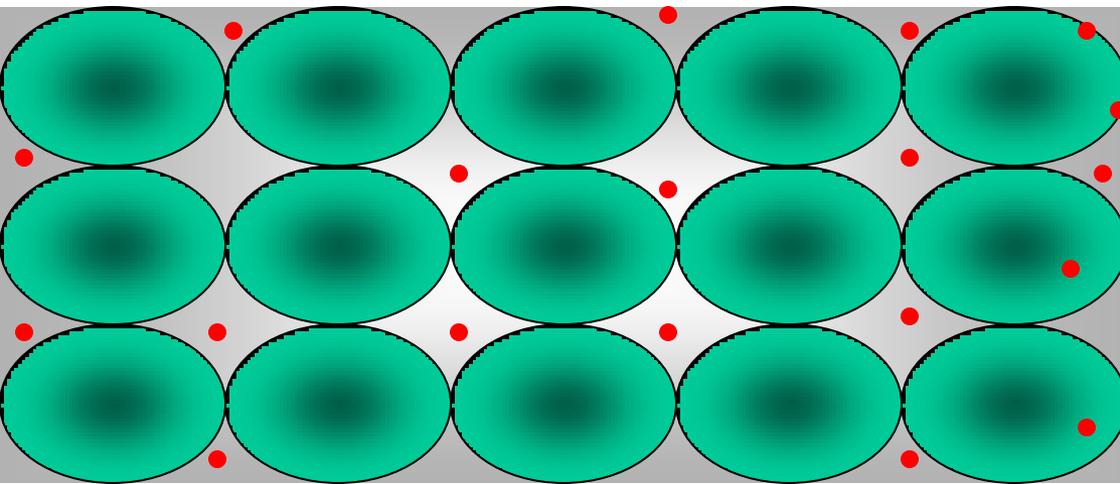
When you heat a metal strip at one end, the heat travels to the other end.



As you heat the metal, the particles vibrate, these vibrations make the adjacent particles vibrate, and so on and so on, the vibrations are passed along the metal and so is the heat. We call this? **Conduction**

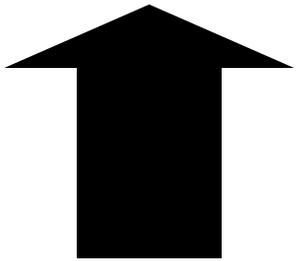
Metals are different

The outer electrons of metal atoms drift, and are free to move.



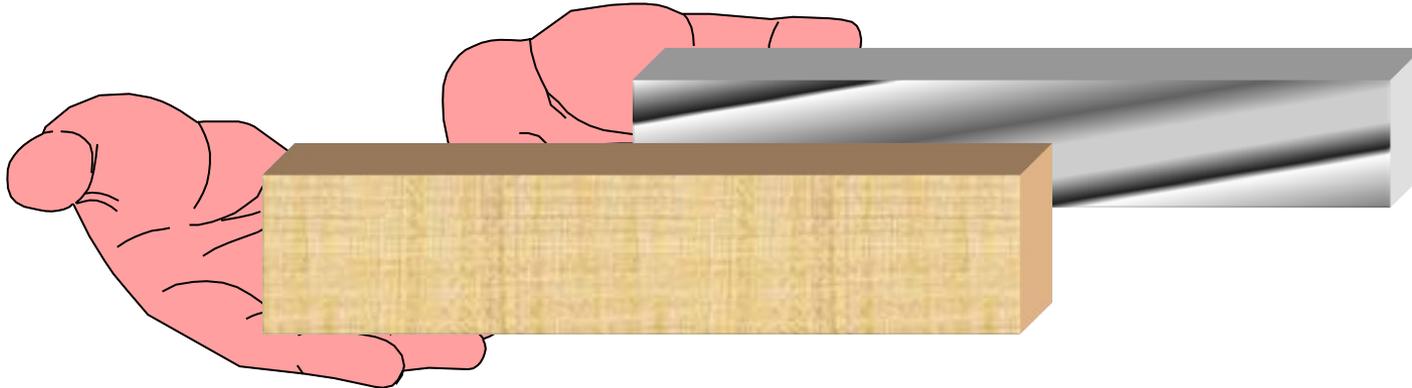
When the metal is heated, this 'sea of electrons' gain kinetic energy and transfer it throughout the metal.

Insulators, such as wood and plastic, do not have this 'sea of electrons' which is why they do not conduct heat as well as metals.



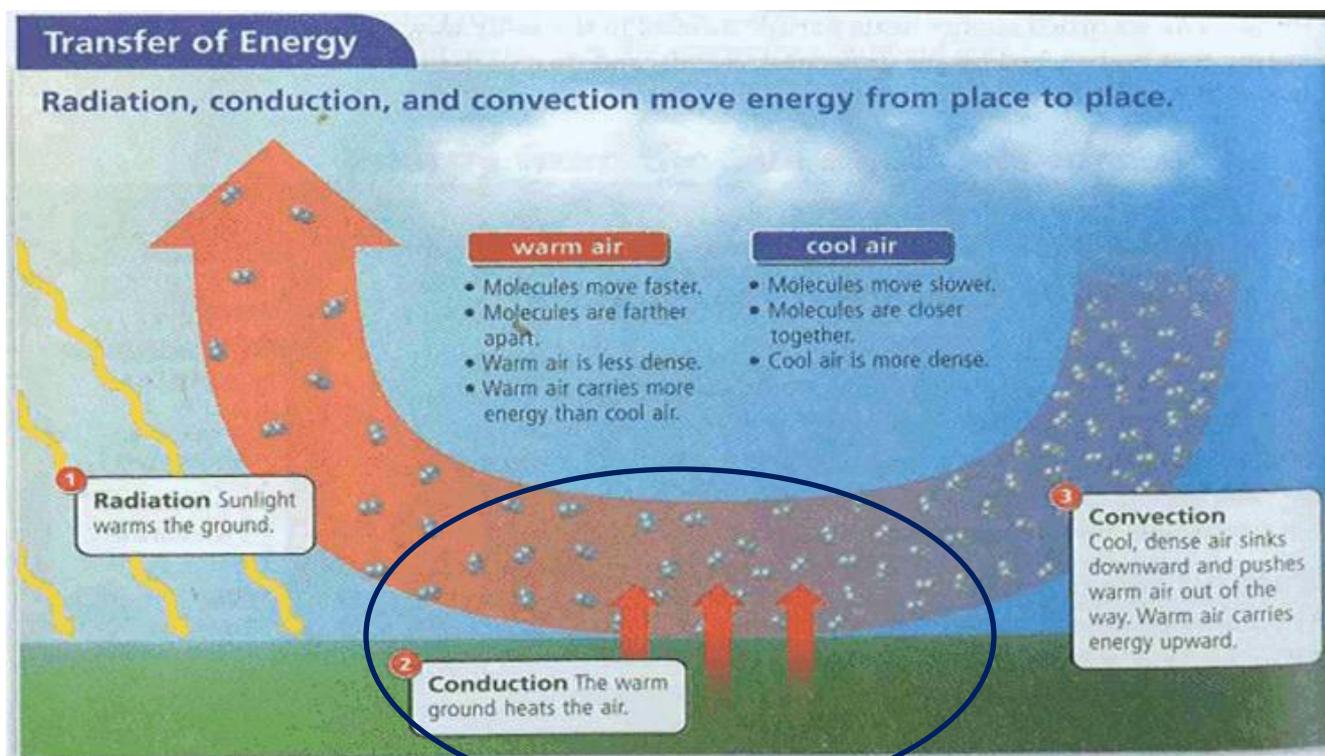
Why does metal feel colder than wood, if they are both at the same temperature?

Metal is a conductor, wood is an insulator. Metal conducts the heat away from your hands. Wood does not conduct the heat away from your hands as well as the metal, so the wood feels warmer than the metal.





Conduction in Earth processes...



- Least important in Earth processes
- Mainly present where atmosphere touches the Earth's surface.



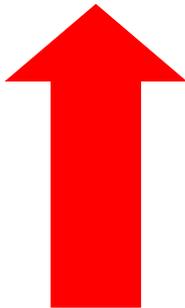
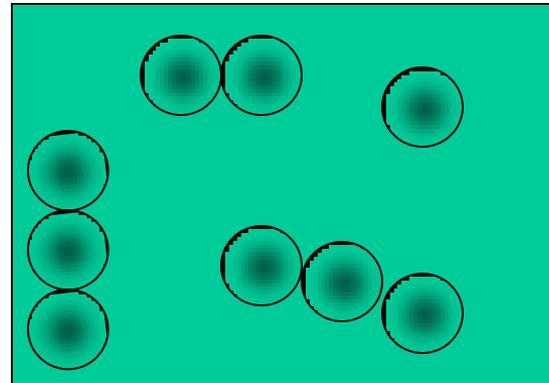
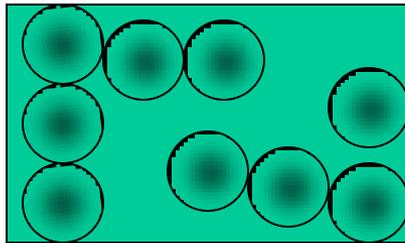
Whiteboarding:

What other examples of conduction in everyday life can you think of?

Convection

What happens to the particles in a liquid or a gas when you heat them?

The particles spread out and become less dense.



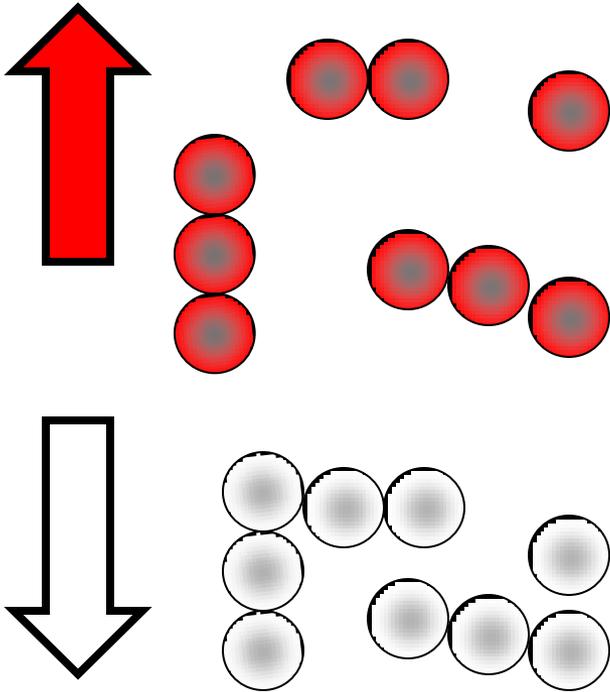
This effect is called expansion.

Fluid movement

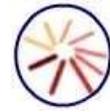
Cooler, more dense, fluids sink through warmer, less dense fluids.

In effect, warmer liquids and gases rise up.

Cooler liquids and gases sink.



Water movement

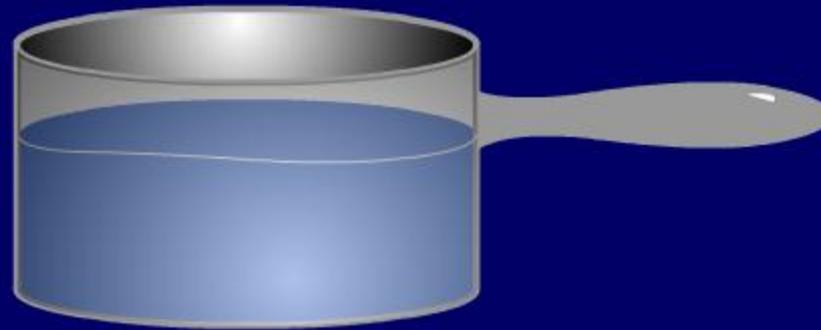


Cools at the surface

Convection current

Cooler water sinks

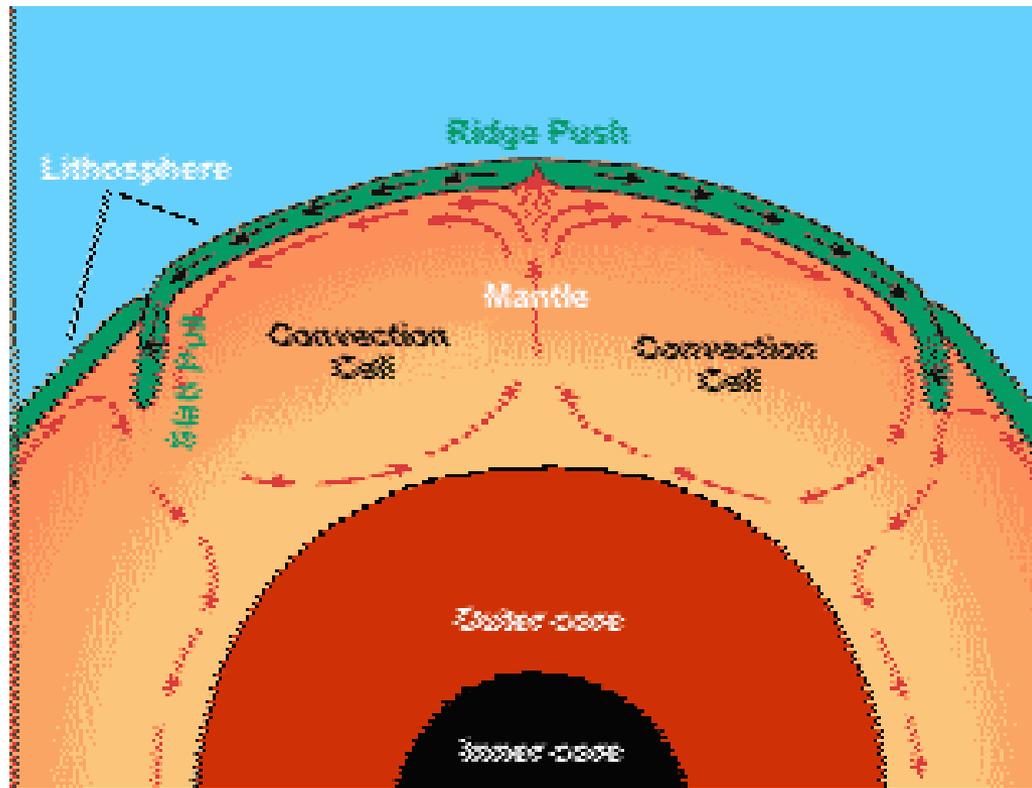
Hot water rises

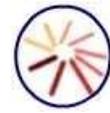


Convection

Convection in Earth processes...

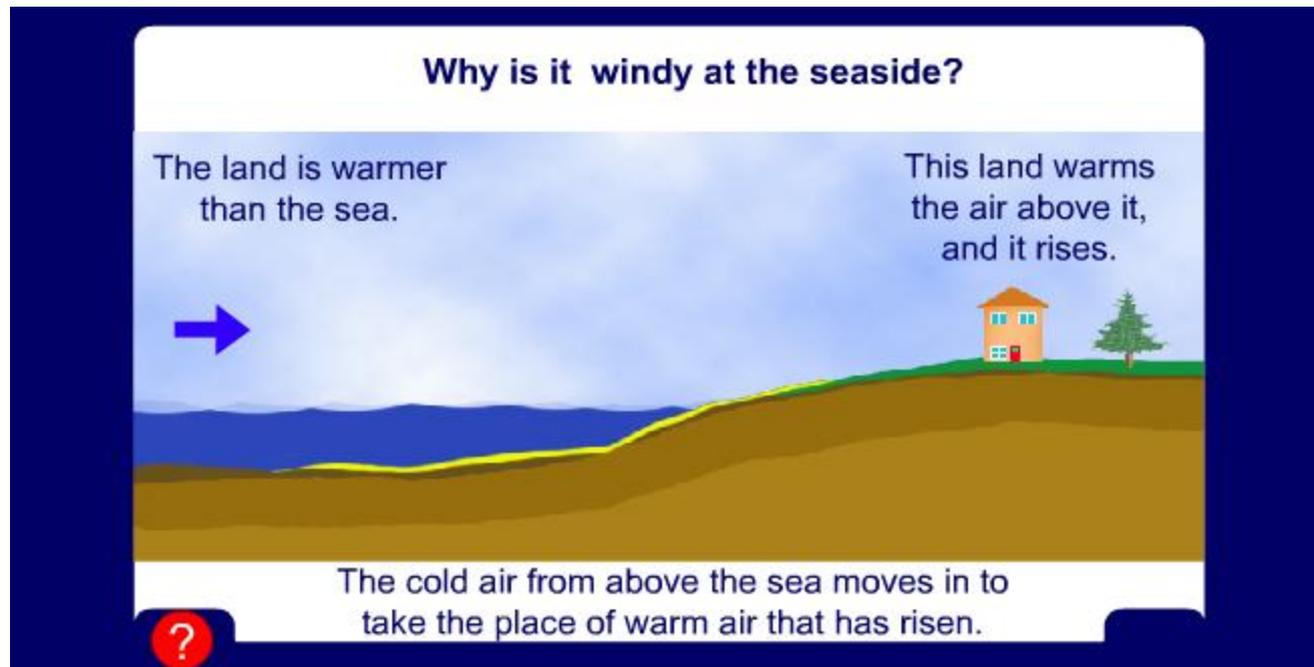
- Movement of Plate Tectonics





Convection in Earth processes...

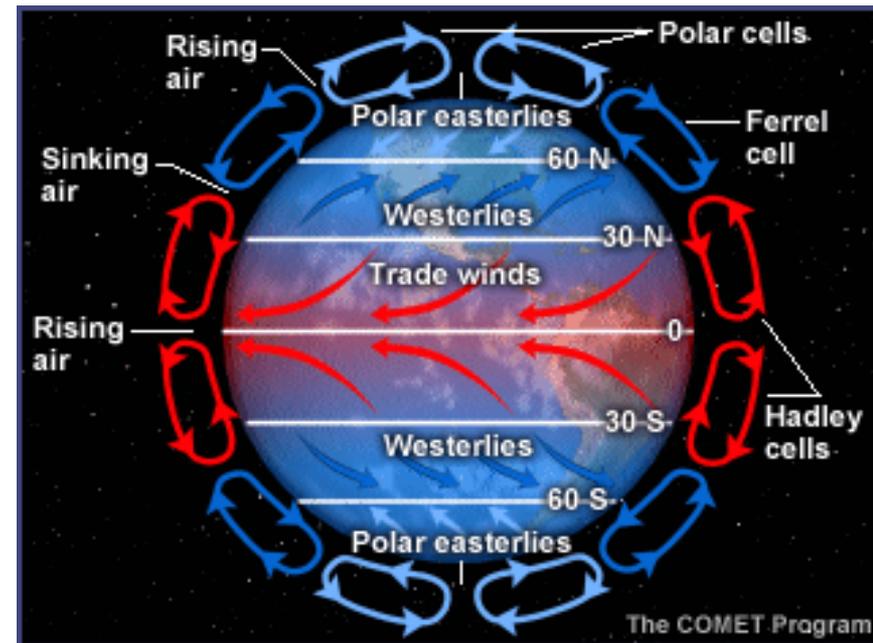
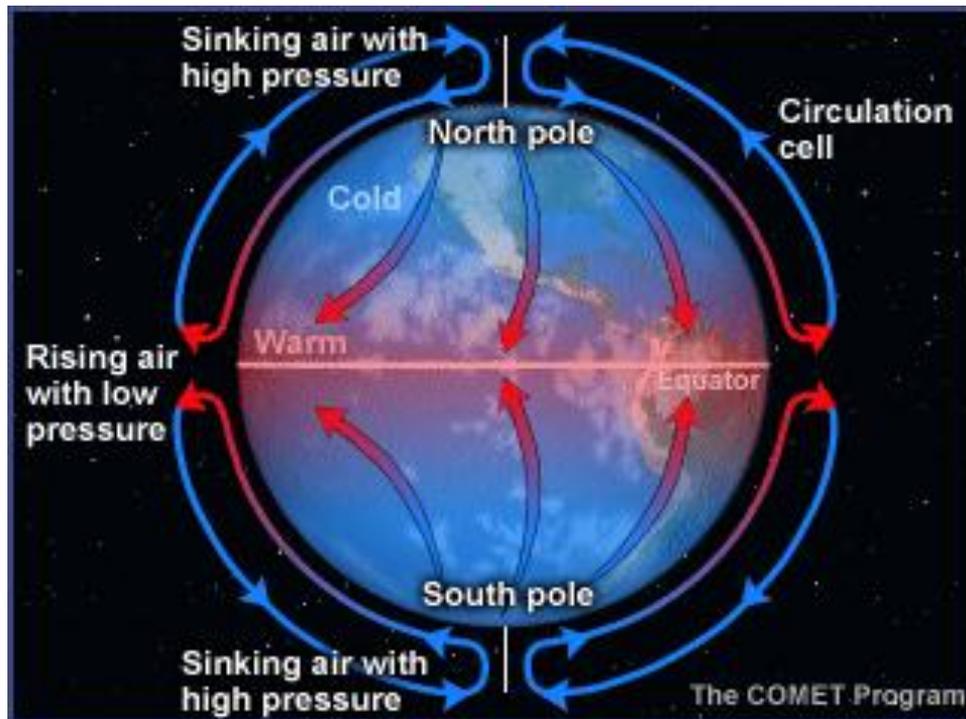
- Local Winds
 - Different Specific Heat of Land/Water



Convection

Convection in Earth processes...

- Global and Local Winds
 - Equator receives more direct sunlight than the poles



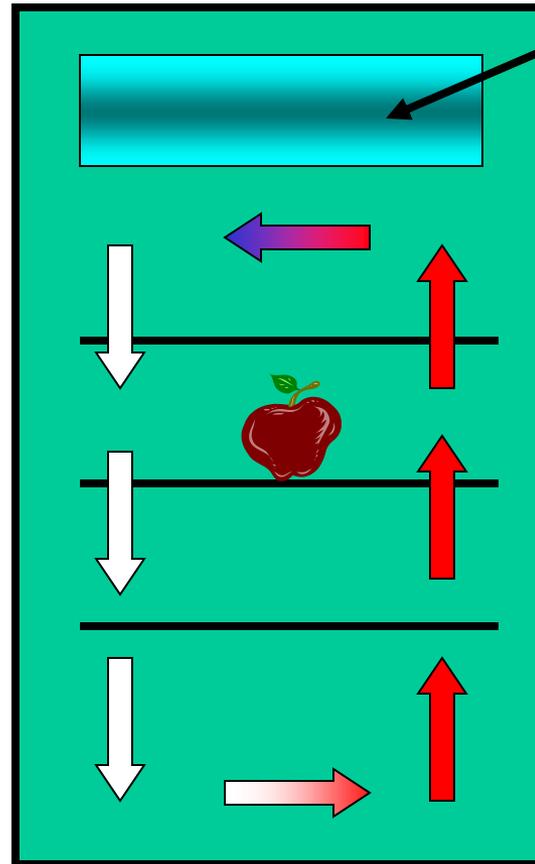
Whiteboarding:

What other examples of convection in everyday life can you think of?

Cold air sinks

Where is the freezer compartment put in a fridge?

It is put at the top, because cool air sinks, so it cools the food on the way down.

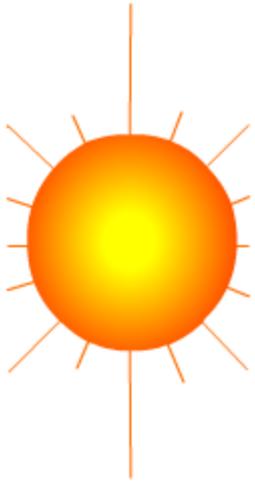


Freezer compartment

It is warmer at the bottom, so this warmer air rises and a convection current is set up.

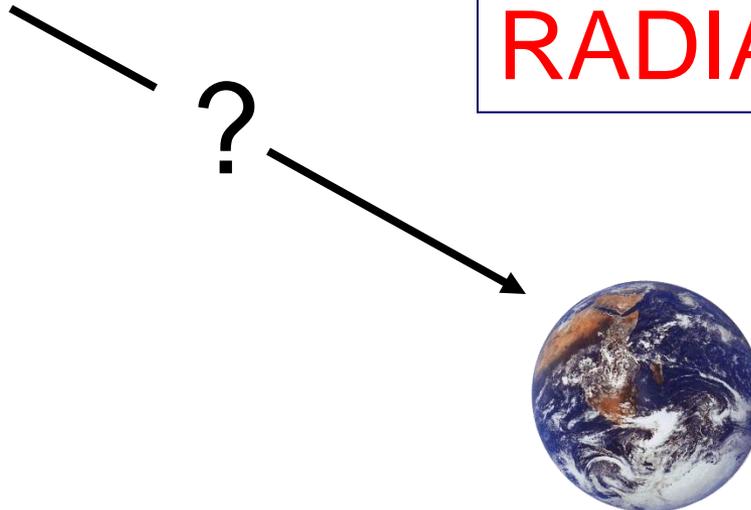
The third method of heat transfer

How does heat energy get from the Sun to the Earth?



There are no particles between the Sun and the Earth so it **CANNOT** travel by conduction or by convection.

RADIATION



Radiation

Radiation travels in straight lines

True/~~False~~

Radiation can travel through a vacuum

True/~~False~~

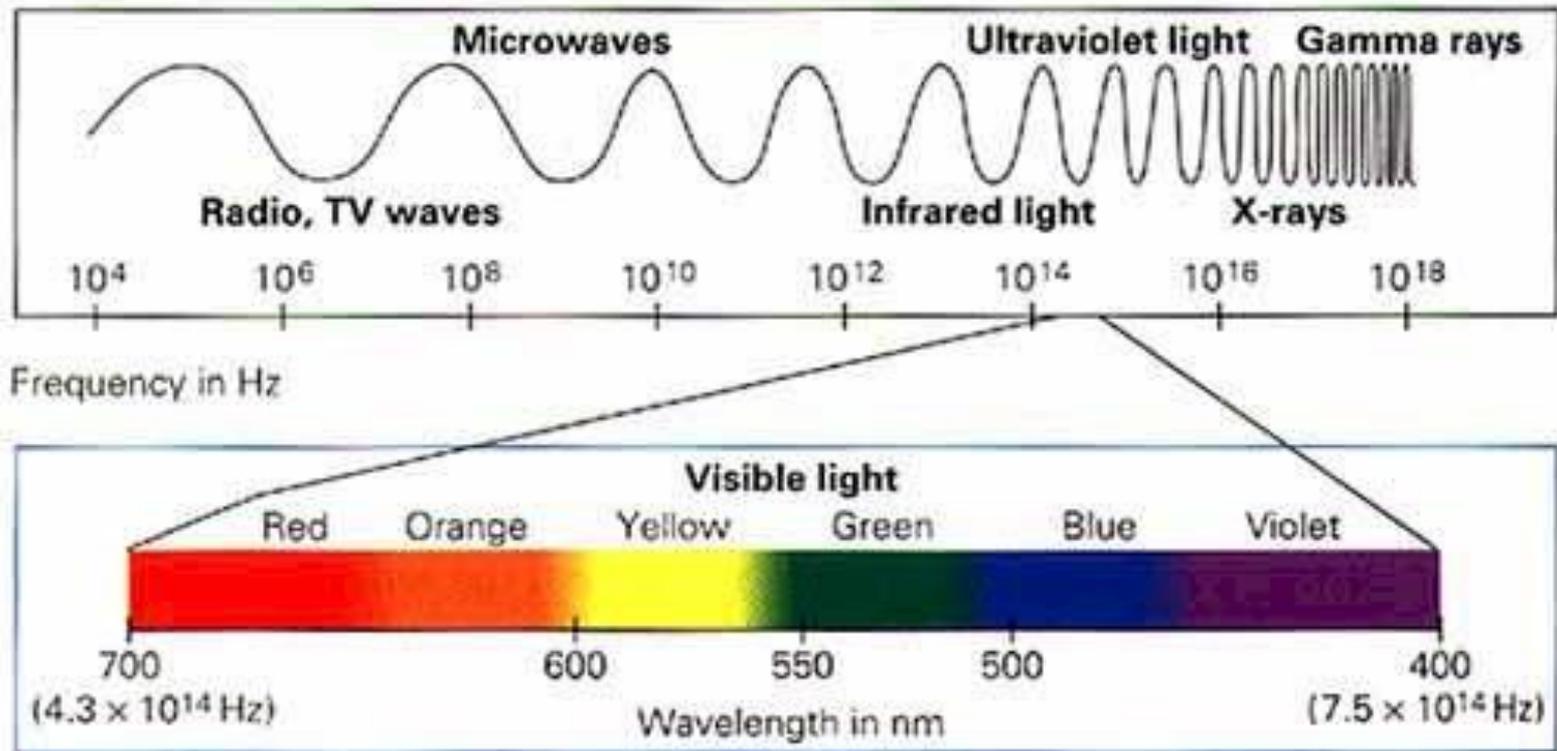
Radiation requires particles to travel

~~True~~/False

Radiation travels at the speed of light

True/~~False~~

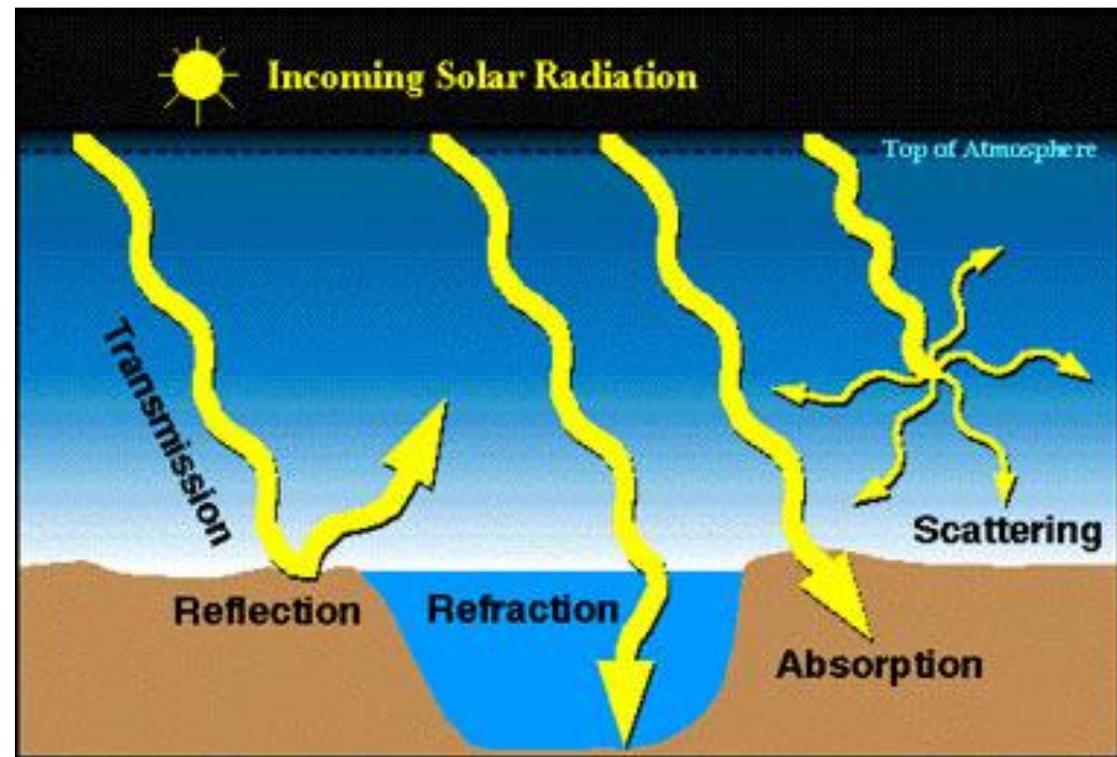
Radiation



Radiation

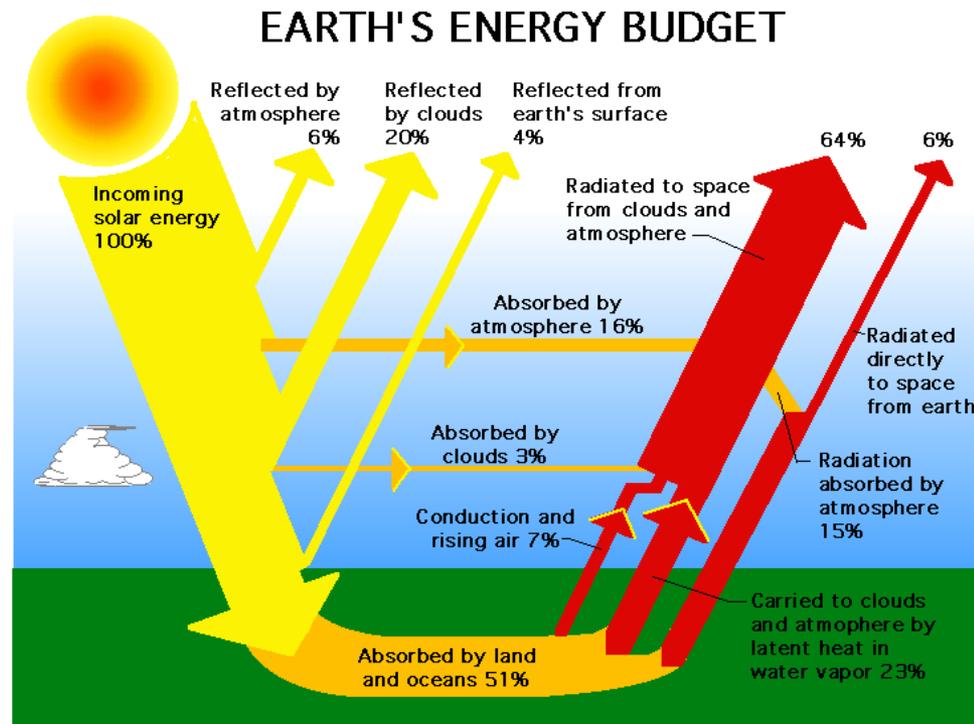
Radiation can be:

- Reflected (or scattered)
- Absorbed
- Transmitted



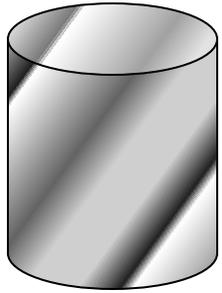
Earth Processes:

- Solar Radiation
- Earth's Reradiating Energy



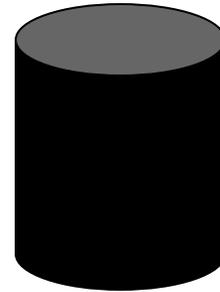
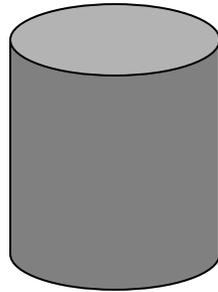
Emission experiment

Four containers were filled with warm water. Which container would have the warmest water after ten minutes?



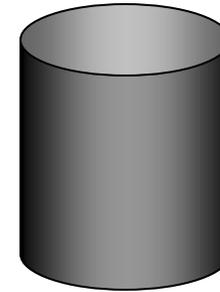
Shiny metal

Dull metal



Dull black

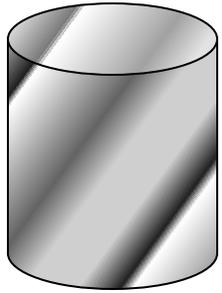
Shiny black



The shiny metal container would be the warmest after ten minutes because its shiny surface reflects heat radiation back into the container so less is lost. The dull black container would be the coolest because it is the best at emitting heat radiation.

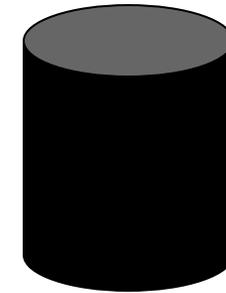
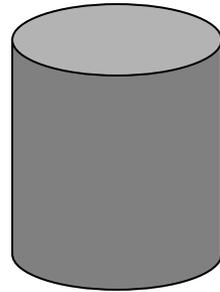
Absorption experiment

Four containers were placed equidistant from a heater. Which container would have the warmest water after ten minutes?



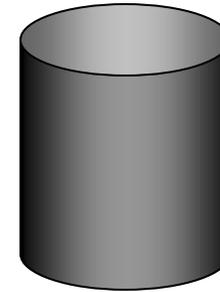
Shiny metal

Dull metal



Dull black

Shiny black



The dull black container would be the warmest after ten minutes because its surface absorbs heat radiation the best. The shiny metal container would be the coolest because it is the poorest at absorbing heat radiation.

Whiteboarding:

What other examples of radiation in everyday life can you think of?

Convection questions

Why does hot air rise and cold air sink?

Cool air is more dense than warm air, so the cool air 'falls through' the warm air.

Why are boilers placed beneath hot water tanks in people's homes?

Hot water rises.

So when the boiler heats the water, and the hot water rises, the water tank is filled with hot water.

Radiation questions

Why are houses painted white in hot countries?

White reflects heat radiation and keeps the house cooler.

Why are shiny foil blankets wrapped around marathon runners at the end of a race?

The shiny metal reflects the heat radiation from the runner back in, this stops the runner getting cold.

22a (again)

- Same objective as yesterday
- Warm-up:
 - What are the three types of heat transfer?
 - Draw a convection cell and label the areas of greatest temperature and lowest temperature.

Heat Transfer Project

- Groups of 3 or 4
- Create a poster demonstrating the three methods of heat transfer
 - Should have a theme
 - Must include definitions *in your own words*
 - Must include illustrations
 - Must include explanations of what role each plays in Earth processes
- Graded for definition and illustration accuracy, and creativity

1. Which of the following is not a method of heat transfer?

A. Radiation

B. Insulation

C. Conduction

D. Convection

2. Which method of heat transfer does not require the movement of particles?

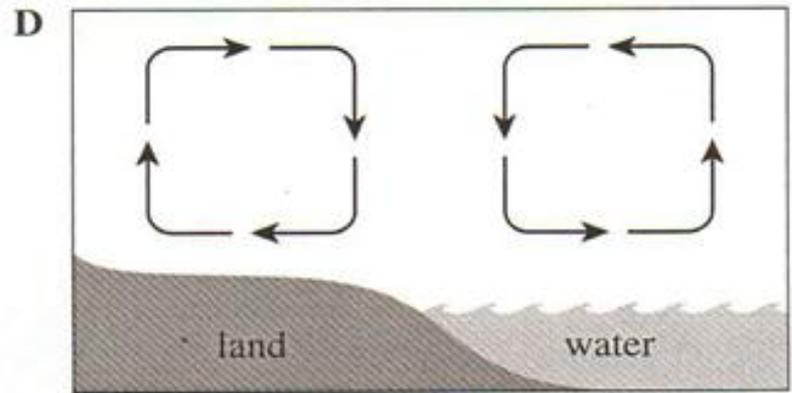
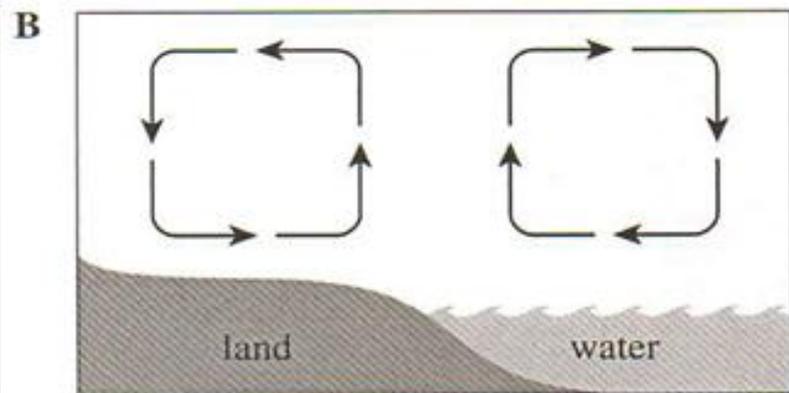
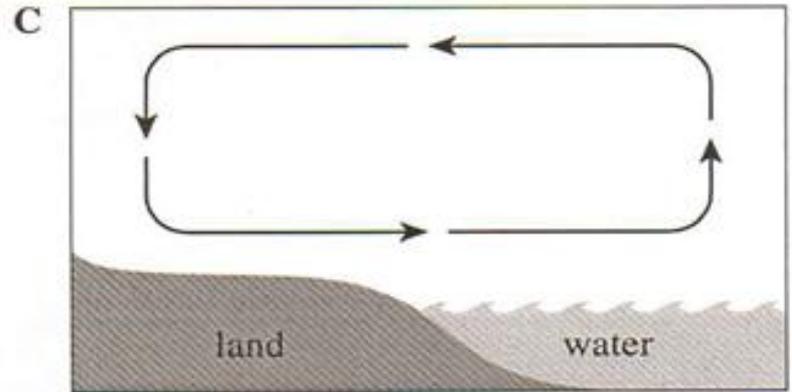
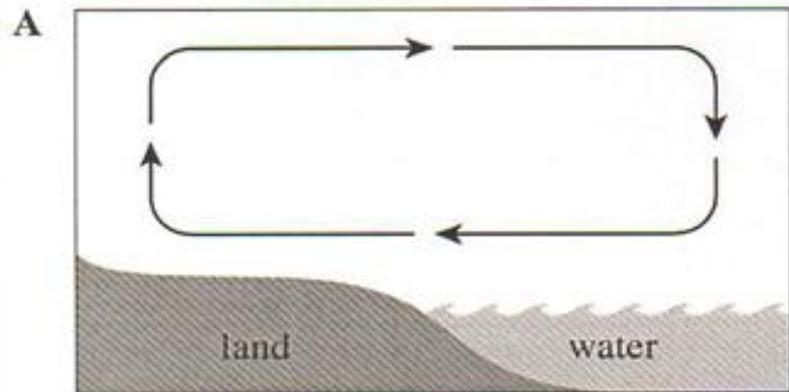
A. Convection

B. Conduction

C. Radiation

D. None of them need moving particles

3. Which of the following diagrams correctly depicts the motion of air on a cloudy early morning?



4. What type of heat transfer is primarily responsible for bringing all areas of this room to the same temperature?

5. Heat radiation can be transmitted, absorbed, scattered, or reflected. Where does the scattering of incoming solar radiation most typically occur?

- A. In the ozone layer
- B. In the atmosphere
- C. At the Earth's poles
- D. At the Earth's surface