

Understanding Heat Transfer, Conduction, Convection and Radiation

PFE-2.4.5

By:

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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.

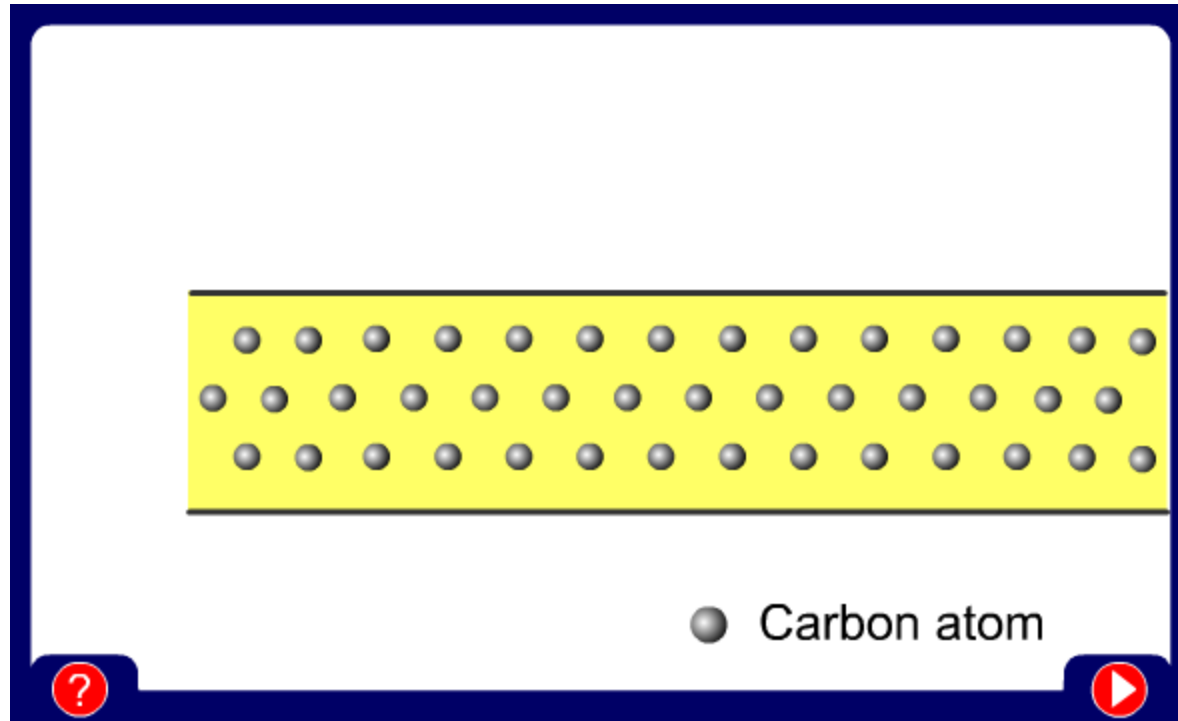
Heat Transfer Methods

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

Conduction



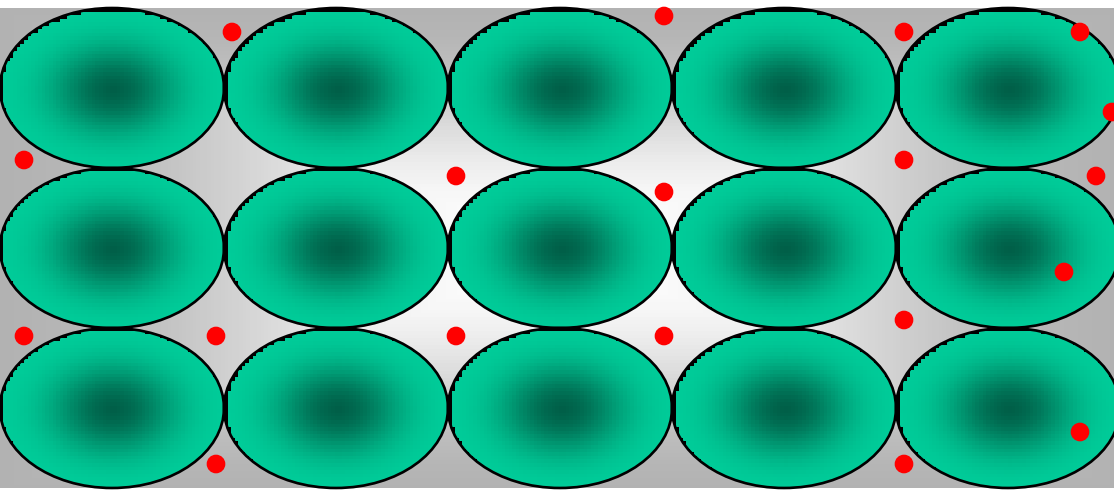
When you heat a metal strip at one end, the heat travels to the other end.



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**

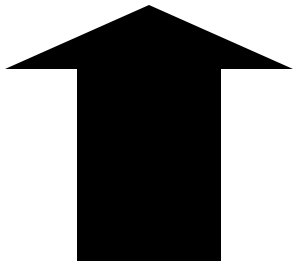
Metals are different

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



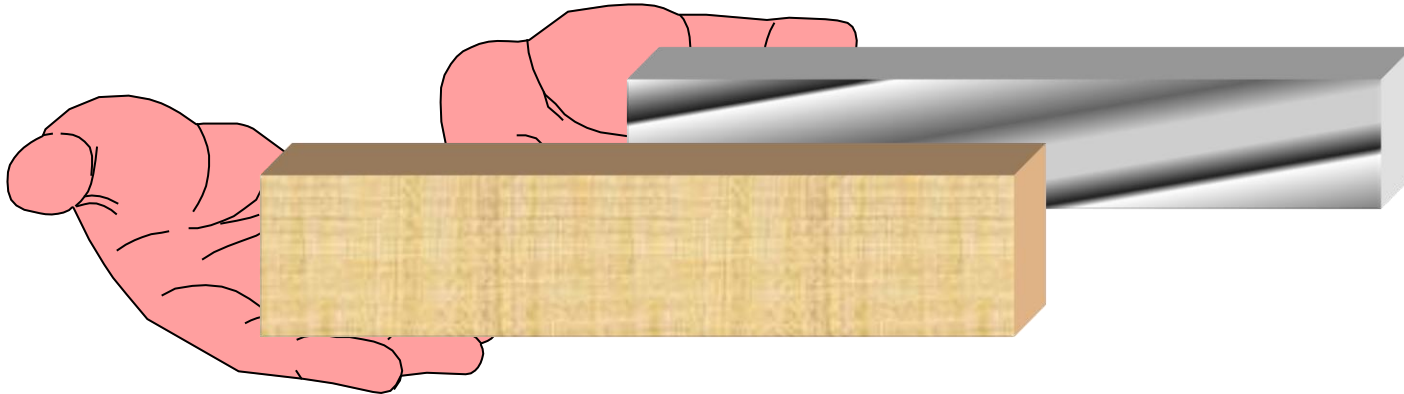
When the metal is heated, this 'sea of electrons' gain kinetic energy and transfer it throughout the metal.

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?

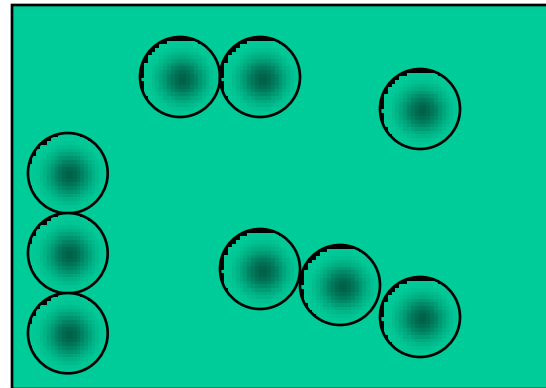
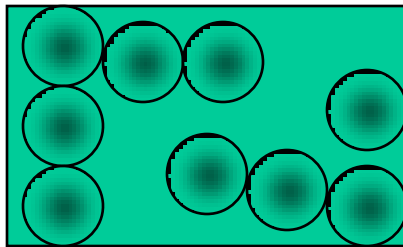
Metal is a conductor, wood is an insulator. Metal conducts the heat away from your hands. Wood does not conduct the heat away from your hands as well as the metal, so the wood feels warmer than the metal.



Convection

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

The particles spread out and become less dense.



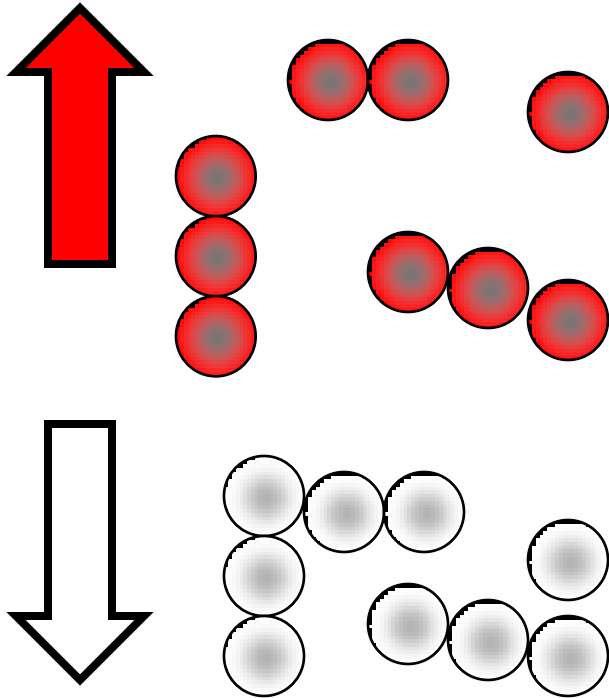
This effect is called expansion.

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

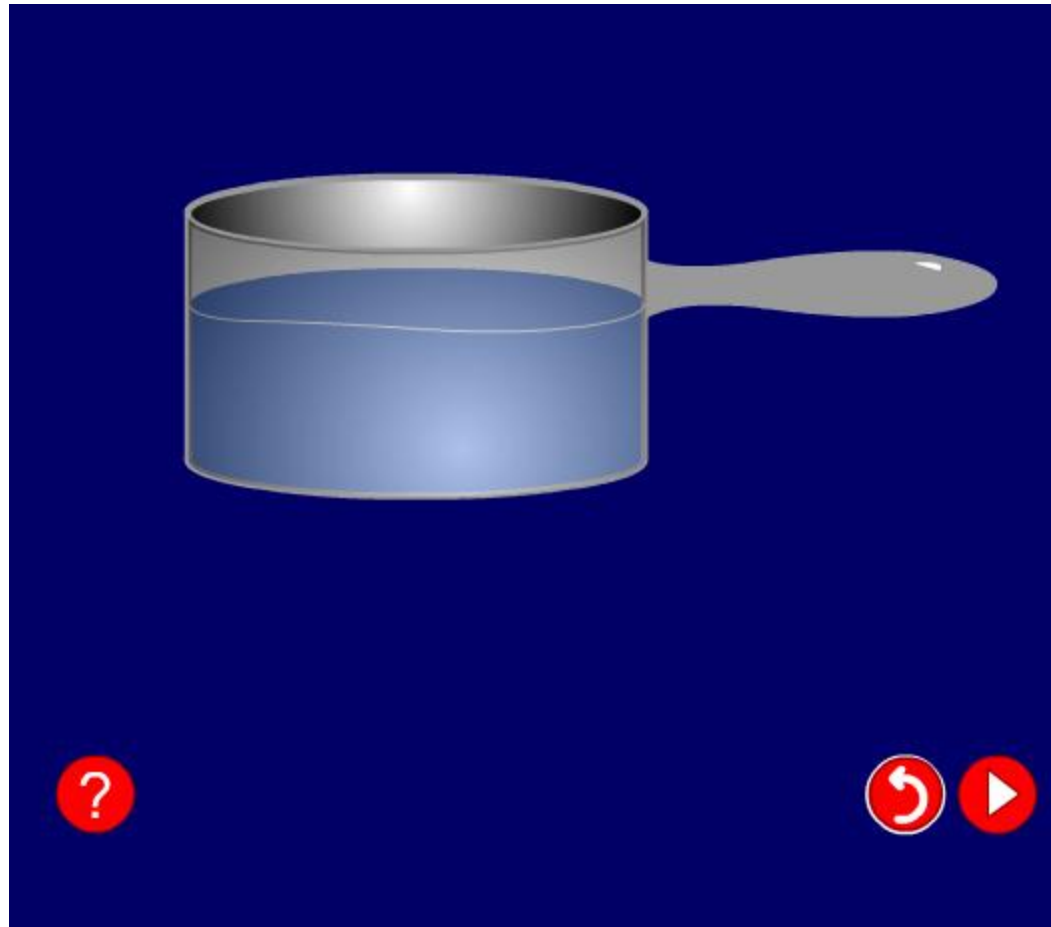


Cools at the surface

Convection current

Cooler water sinks

Hot water rises



Why is it windy at the seaside?



Why is it windy at the seaside?

The land is warmer than the sea.



This land warms the air above it, and it rises.



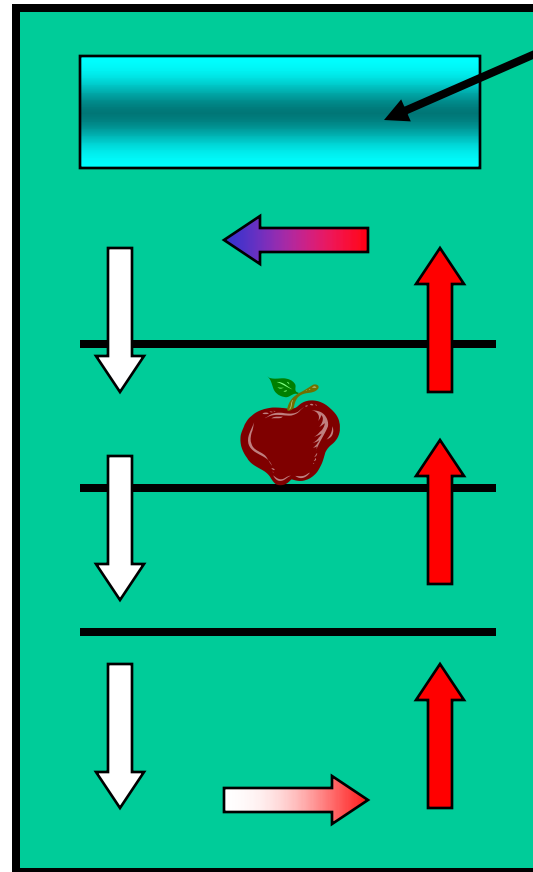
The cold air from above the sea moves in to take the place of warm air that has risen.



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.

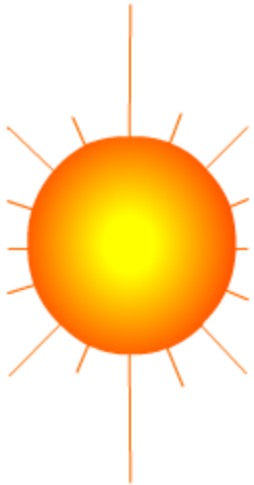


Freezer compartment

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

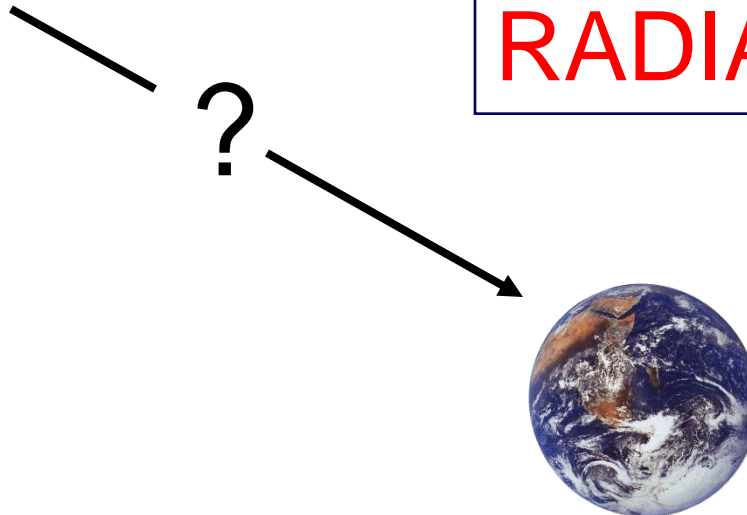
The third method of heat transfer

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

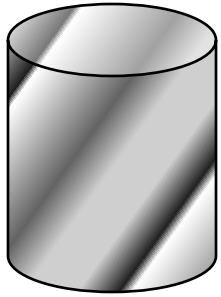
~~True~~/False

Radiation travels at the speed of light

True/~~False~~

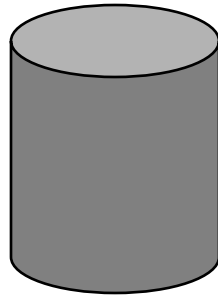
Emission experiment

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

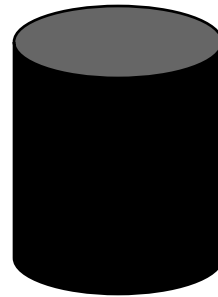


Shiny metal

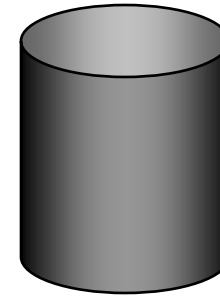
Dull metal



Dull black



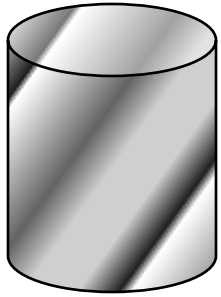
Shiny black



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.

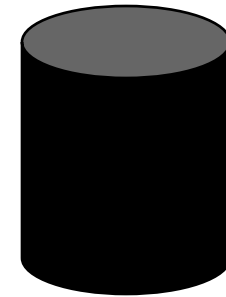
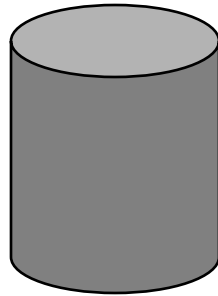
Absorption experiment

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



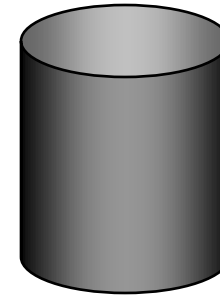
Shiny metal

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.

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.

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

A. Radiation

B. Insulation

C. Conduction

D. Convection

2. In which of the following are the particles closest together?

- A. Solid
- B. Liquid
- C. Gas
- D. Fluid

3. How does heat energy reach the Earth from the Sun?

- A. Radiation
- B. Conduction
- C. Convection
- D. Insulation

4. Which is the best surface for reflecting heat radiation?

- A. Shiny white
- B. Dull white
- C. Shiny black
- D. Dull black

5. Which is the best surface for absorbing heat radiation?

A. Shiny white

B. Dull white

C. Shiny black

D. Dull black