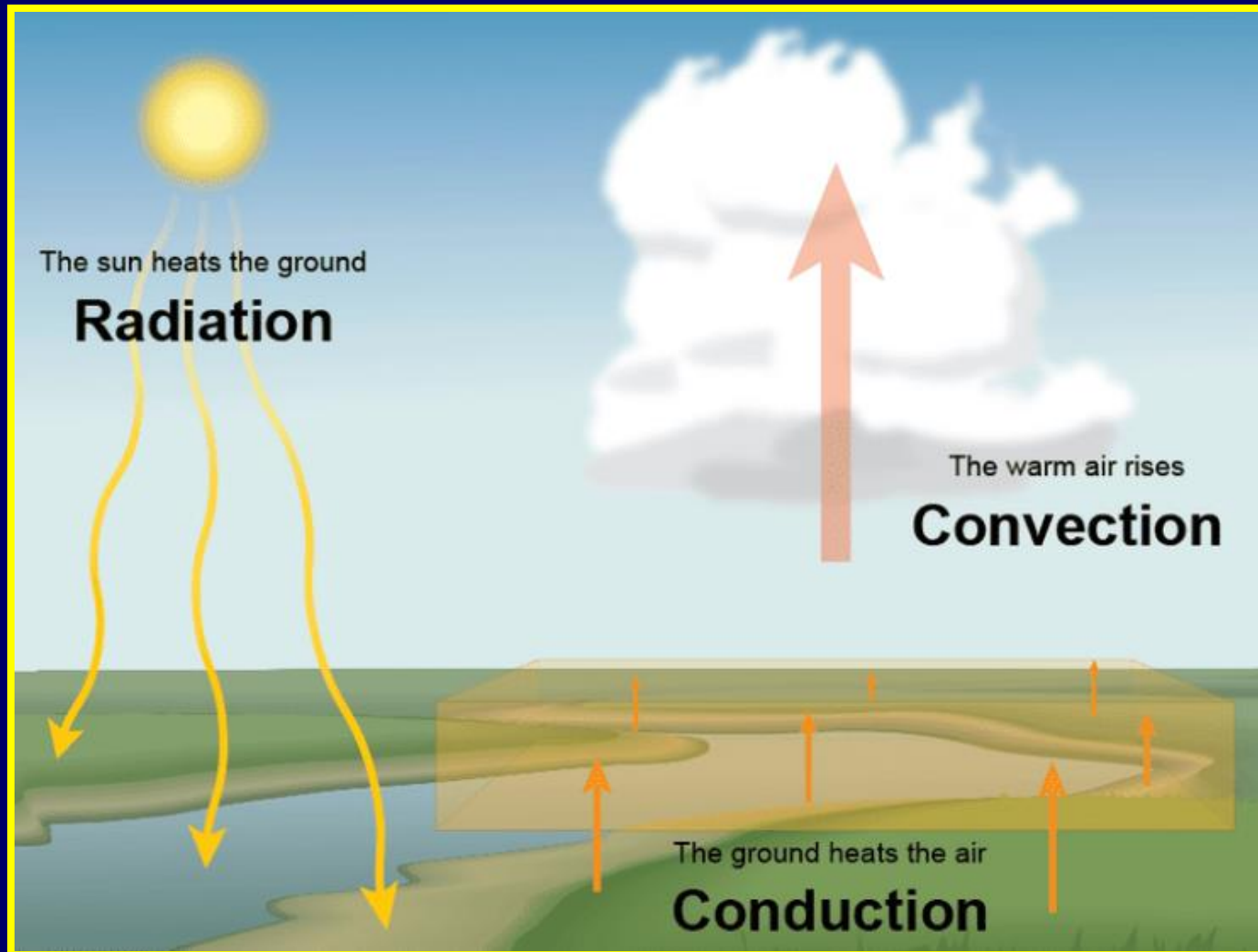


Transfer of Thermal Energy



Essential Standard 2.5

Understand the structure of and processes within our atmosphere.

Learning Objective 2.5.2

Explain the formation of typical air masses and the weather systems that result from air mass interactions.

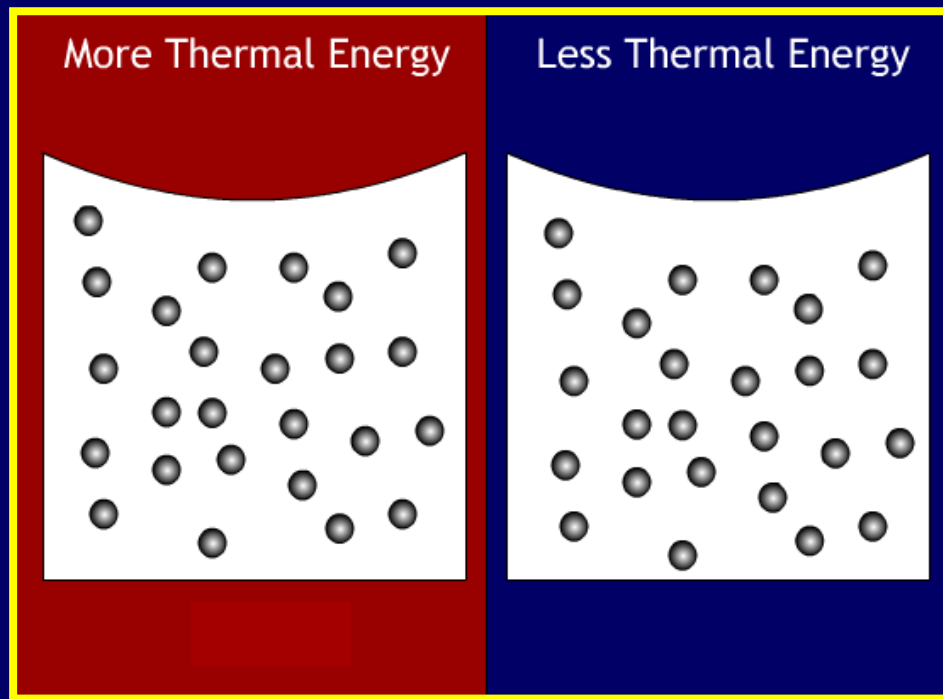
I Can Statements

At the end of this lesson, you should be able to say, with confidence:

- I can explain how electromagnetic waves can be transmitted, reflected, or absorbed.
- I can explain how light waves can change into infrared waves.
- I can explain how thermal energy can be transferred through radiation, convection, and conduction.

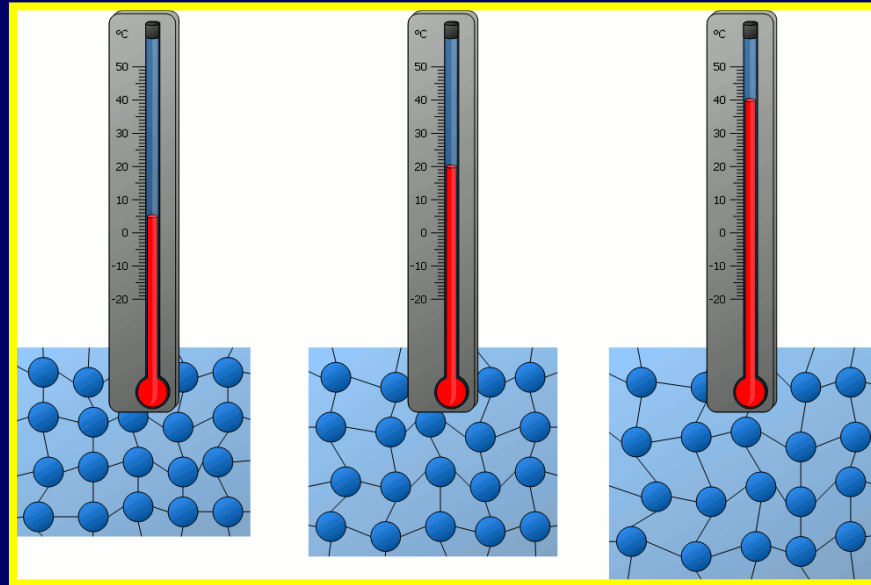
Thermal Energy

Thermal energy refers to the amount of energy there is in a substance based on the motion of its particles.



Temperature

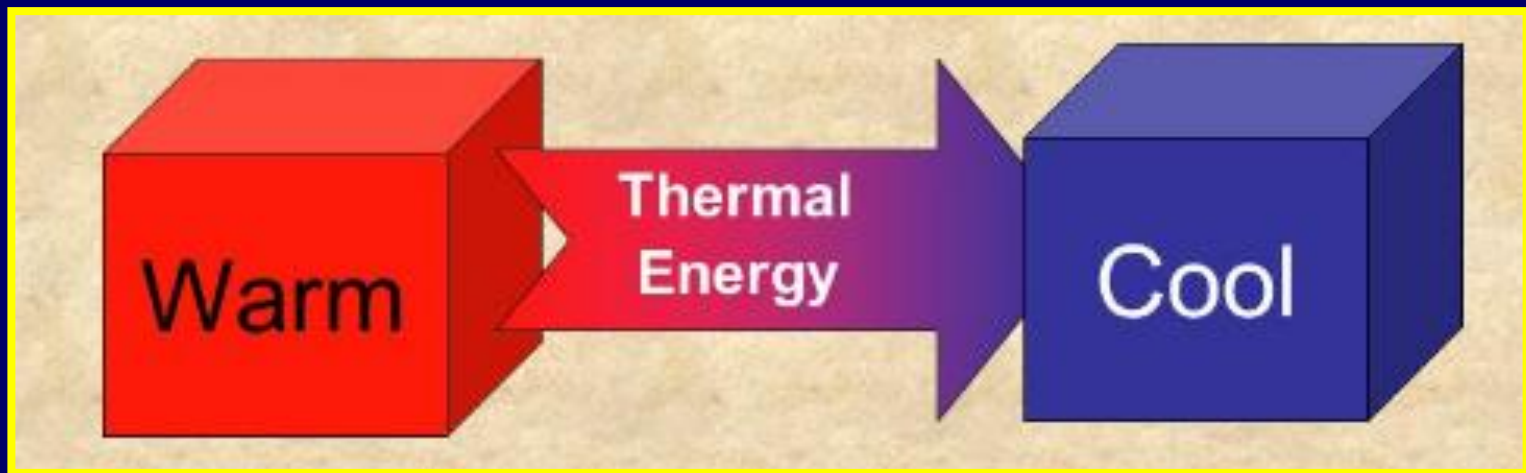
Temperature is a measurement of the amount of thermal energy in a substance.



Substances with faster moving atoms have more thermal energy and a higher temperature.

Heat

Heat is the flow or transfer of thermal energy.



Heat always flows from warmer objects to cooler objects.

Heat

Think of heat like pool balls, only with atoms.

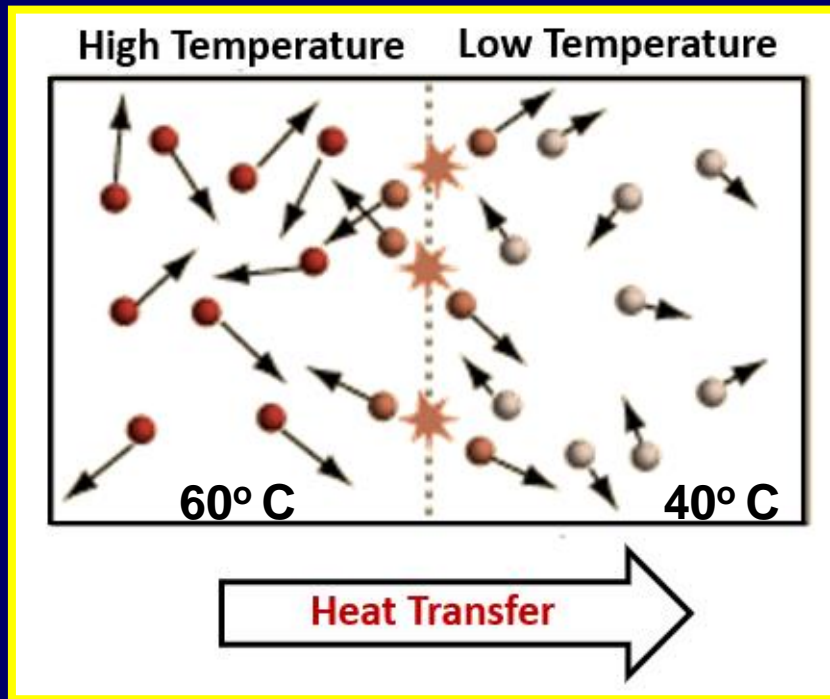


When the faster moving cue ball collides with the stationary pool balls, energy is transferred from the cue ball to the stationary pool balls.

Due to the transfer of energy, the cue ball slows down, but the pool balls begin to move.

Heat

When faster moving atoms collide with slower moving atoms, energy is transferred.

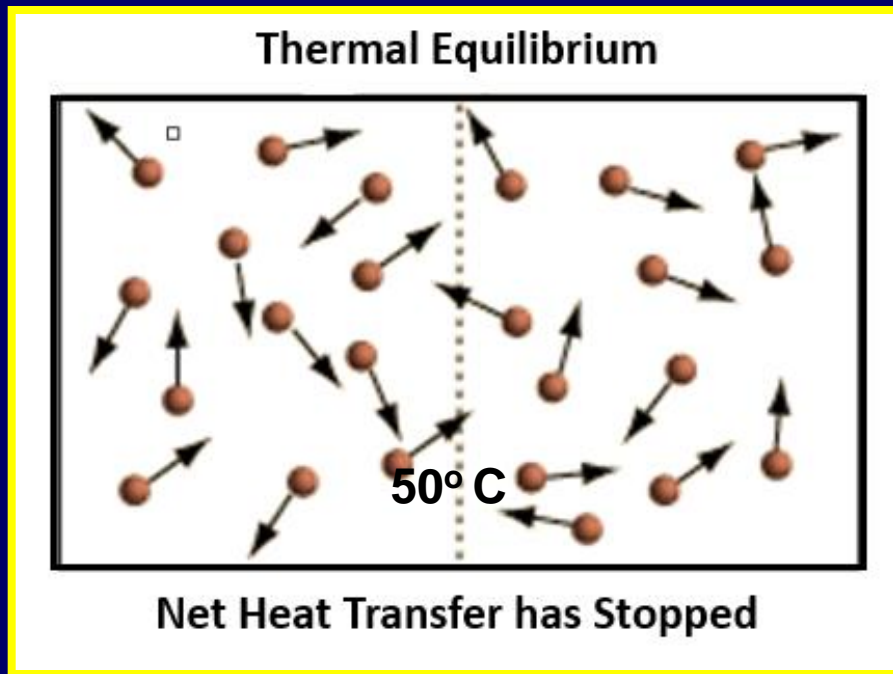


Due to the transfer of energy, the faster moving atoms slow down and decrease in temperature.

Meanwhile, the slower moving atoms speed up and increase in temperature.

Equilibrium

After all of the thermal energy has been transferred, thermal equilibrium will be reached.



Thermal equilibrium occurs when all the atoms are moving at the same speed and the temperature is equal throughout the substance.

Transfer of Thermal Energy

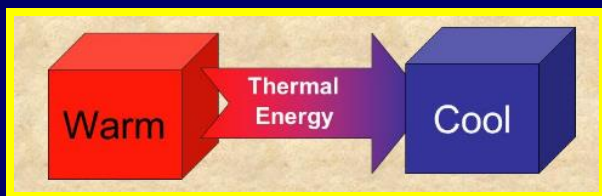
When you place an ice cube in a glass of tea, the faster moving molecules in the tea collide with the slower moving molecules in the ice.



During the collisions, thermal energy is transferred from the tea to the ice cube.

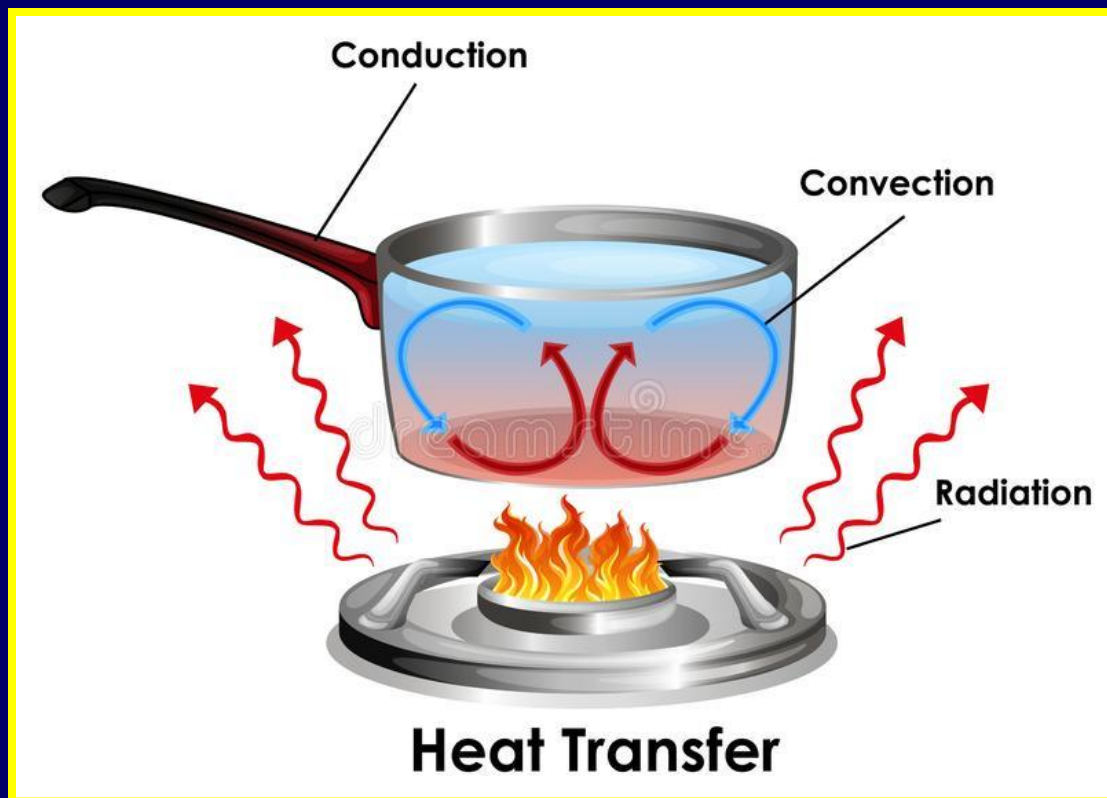
The loss of thermal energy in the tea molecules, results in a cooling effect on the tea.

At the same time, the ice warms up and begins to melt.



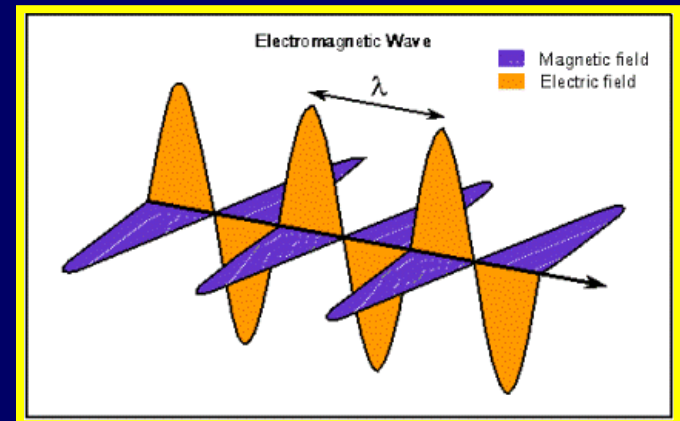
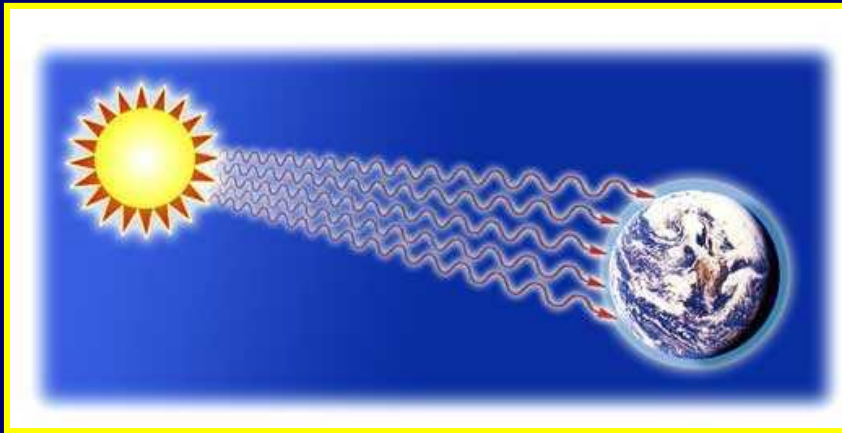
Methods of Heat Transfer

There are three basic methods by which heat can be transferred: Radiation, Conduction, and Convection.



Radiation

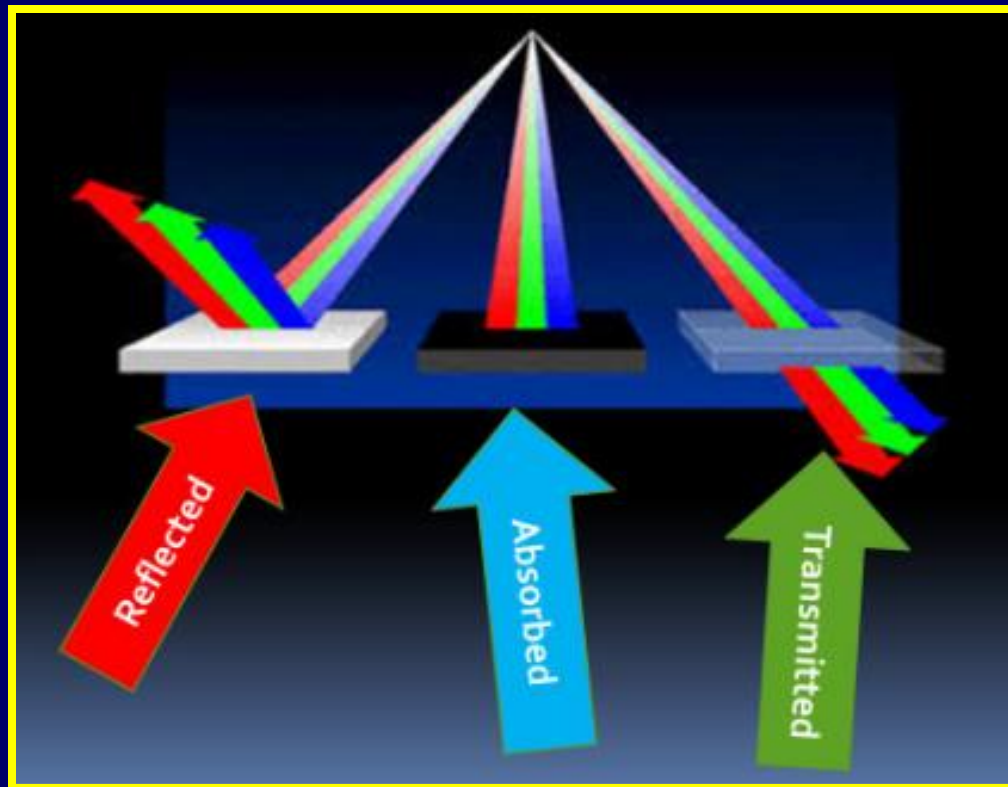
Radiation is the transfer of heat energy through electromagnetic waves and does not require atoms for it to occur.



Since no atoms are required, radiation can transfer heat through the vacuum of space, where no atoms exist.

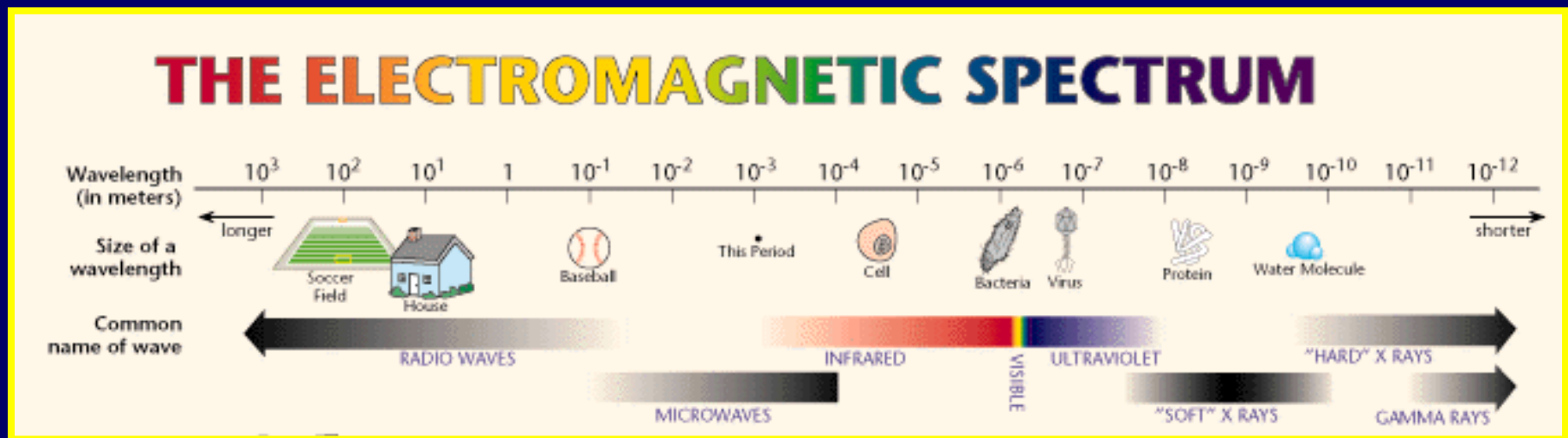
Wave Behavior

When electromagnetic waves strike an object, they can be reflected, absorbed, or transmitted completely through the material.



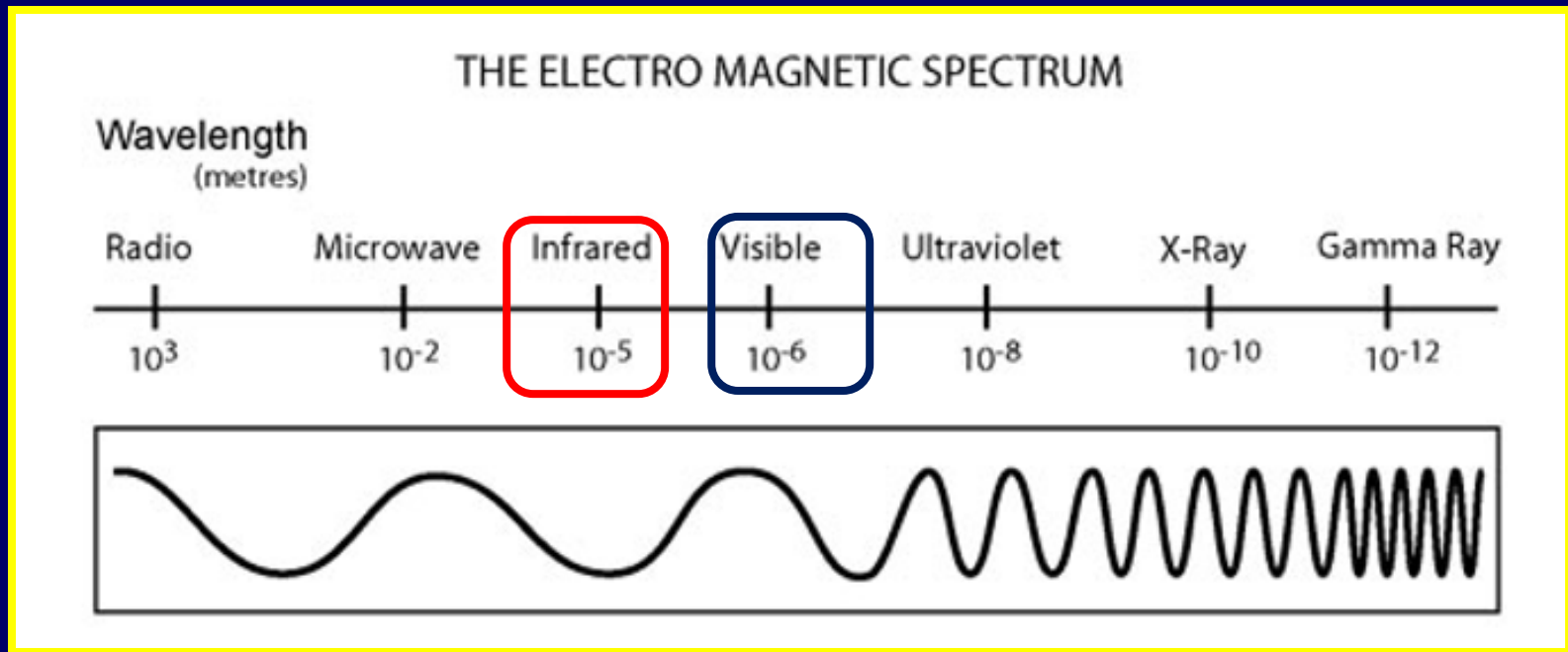
Light Waves → Infrared Waves

When light waves are absorbed by an object, they are turned into infrared waves, often called heat waves.



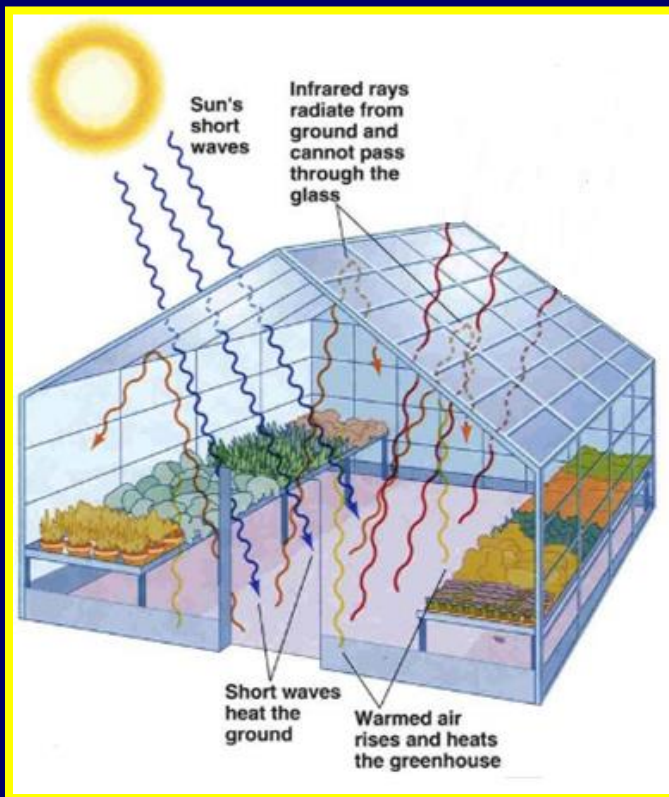
Light Waves → Infrared Waves

Infrared waves have longer wavelengths than light waves.



Infrared (Heat) Waves

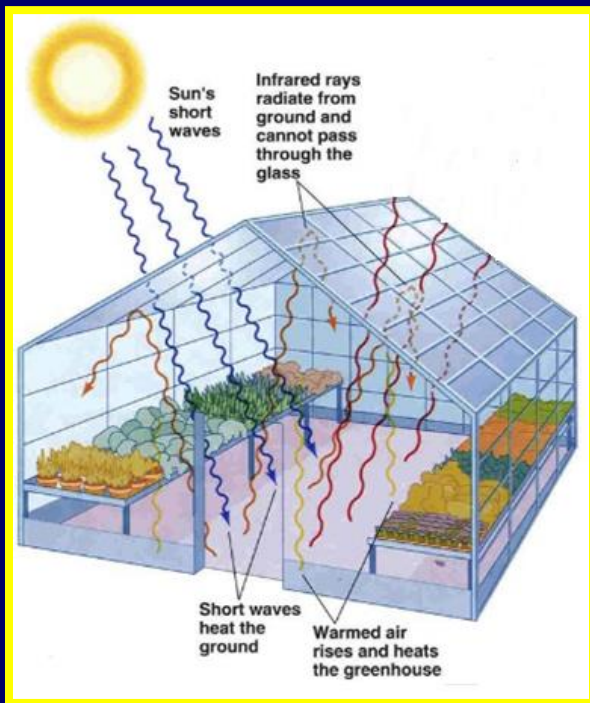
Because of their longer wavelengths, infrared waves cannot travel through solids like glass that light waves can travel through.



In a greenhouse, the shorter light waves travel through the glass and strike ground and are turned into infrared waves.

Infrared (Heat) Waves

The hot ground surface emits the infrared waves that are too long to escape through the glass, so they become trapped and warm the air in the greenhouse, even on cold days.



The conversion of light waves into infrared (heat) waves that become trapped, thereby warming the environment, is called the Greenhouse Effect.

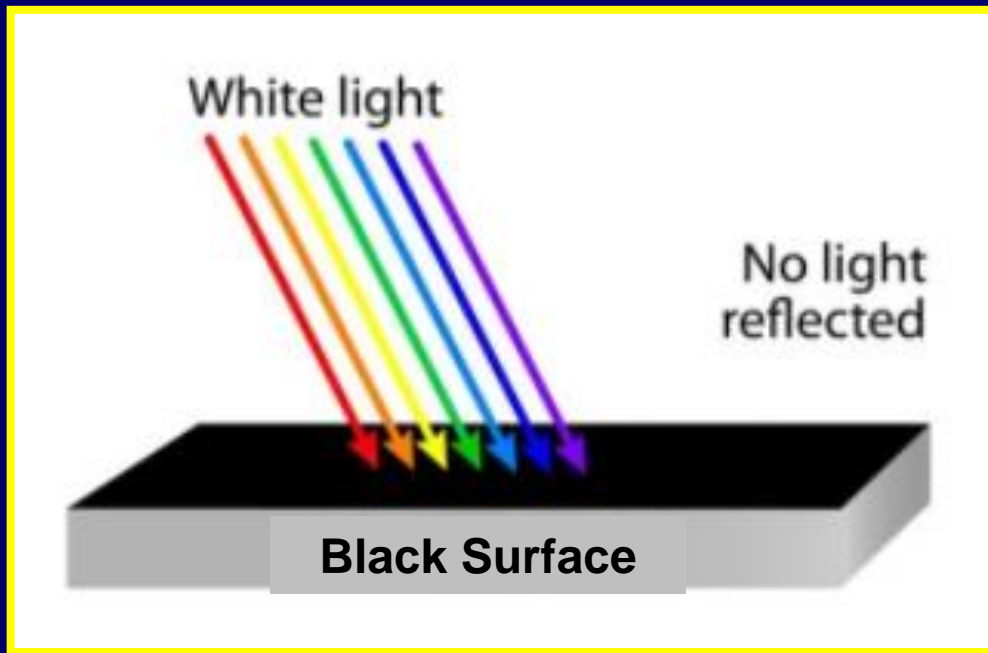
Infrared (Heat) Waves

The same process of light waves turning into infrared waves and becoming trapped happens in your car, especially during hot summer days.



Black Objects

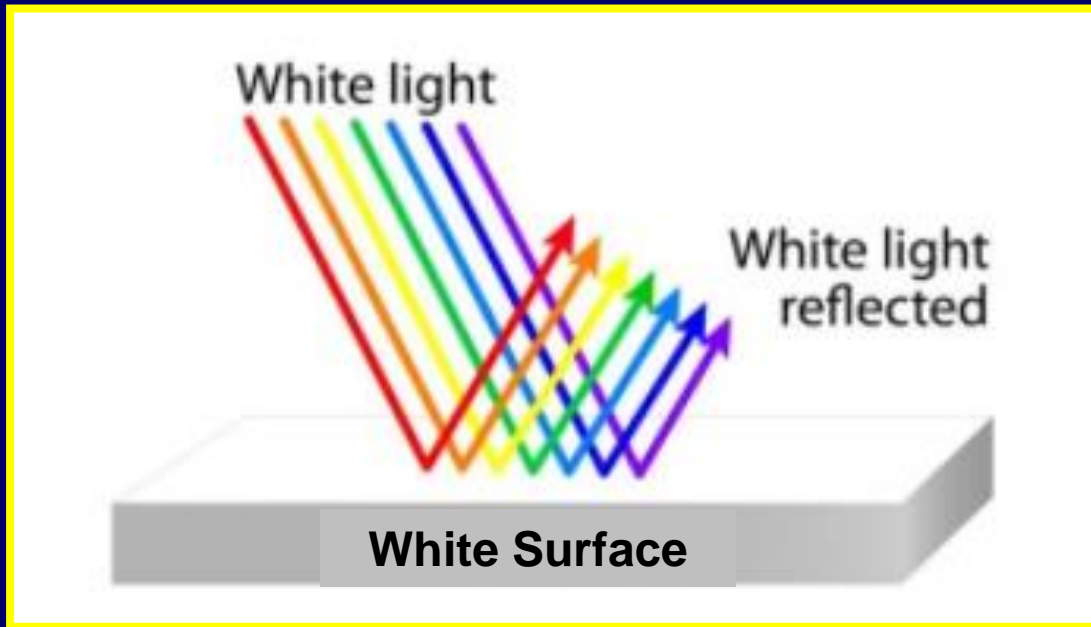
When light strikes black objects, all the colors of light are absorbed and not reflected, so we see the objects as black.



Since all or most of the light is absorbed, the objects can become very hot.

White Objects

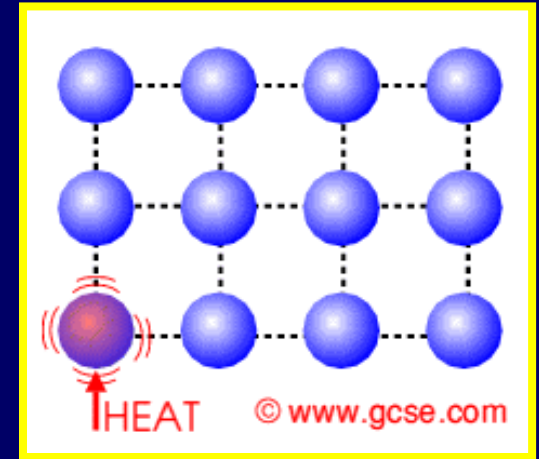
When light strikes white objects, all the different colors of light are reflected, so the objects appear white.



Also, since all or most light is reflected and not absorbed, the objects do not get that hot.

Conduction

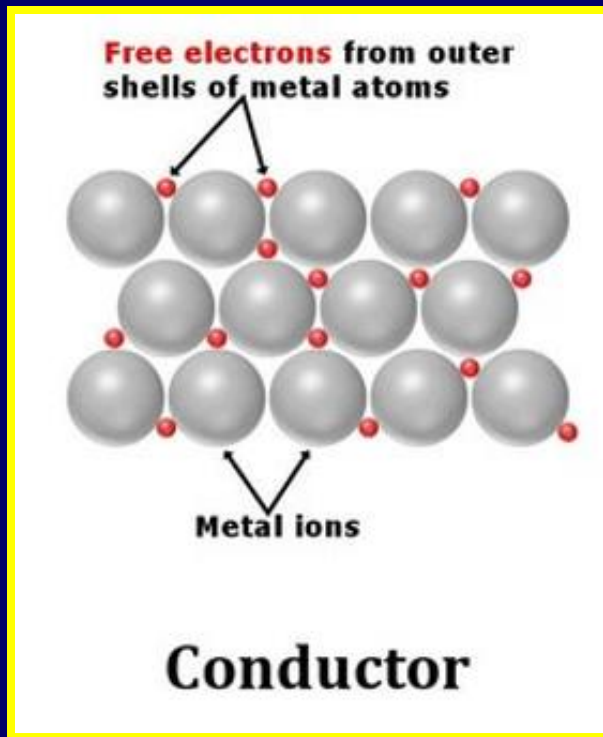
Conduction is the transfer of energy when molecules come in contact and collide.



Once radiant energy strikes Earth's surface, it is changed into heat energy and is transferred across the ground surface and into the above air molecules through conduction.

Conductors

The chemical structure of metals enable the atoms to remain very mobile.

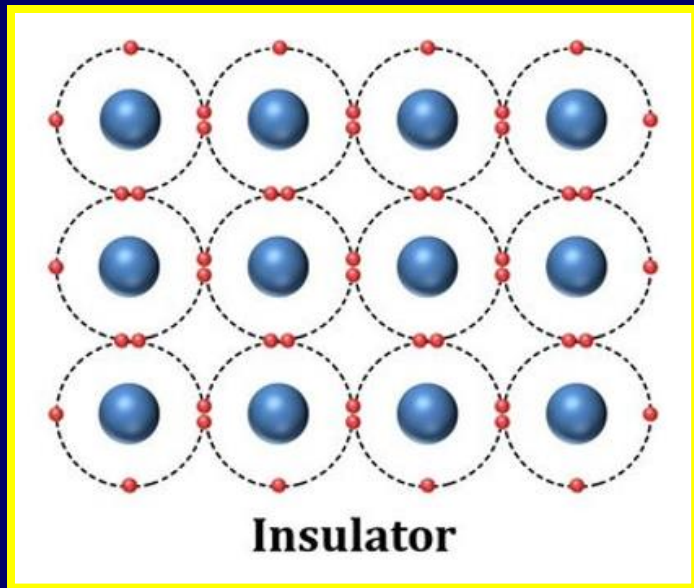


Because the atoms are so mobile in metals, the atoms can collide and transfer thermal energy very easily.

Metals make good heat conductors.

Insulators

In non-metal materials, like wood, rubber, or plastic, the atoms are not very mobile.

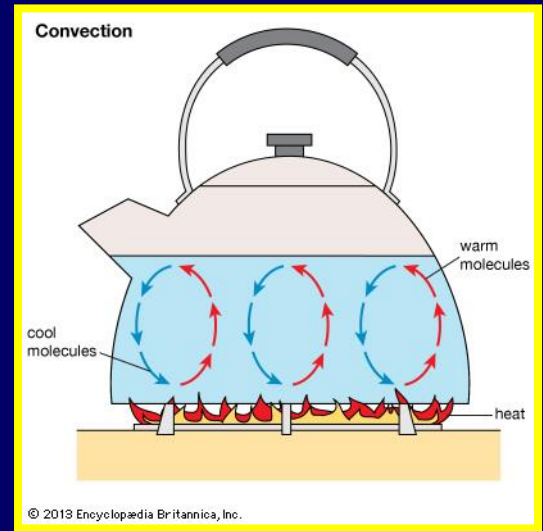


Because the atoms in non-metals are not mobile, they do not conduct heat easily.

Non-metals, like wood, rubber, and plastic, make good insulators of heat.

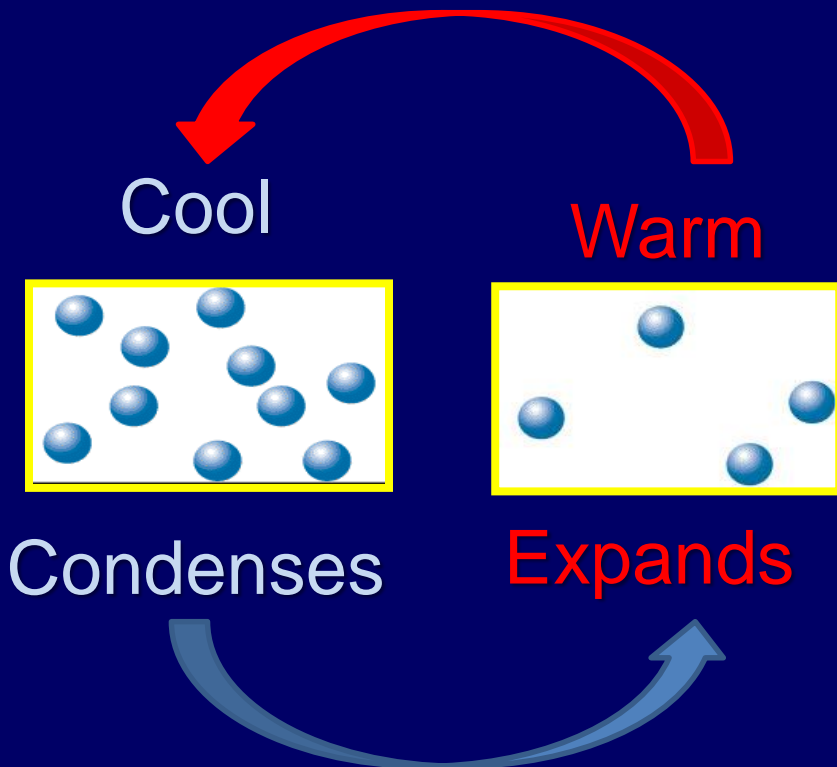
Convection

Convection is the transfer of energy by the flow of a heated fluid, which can be a liquid or a gas.



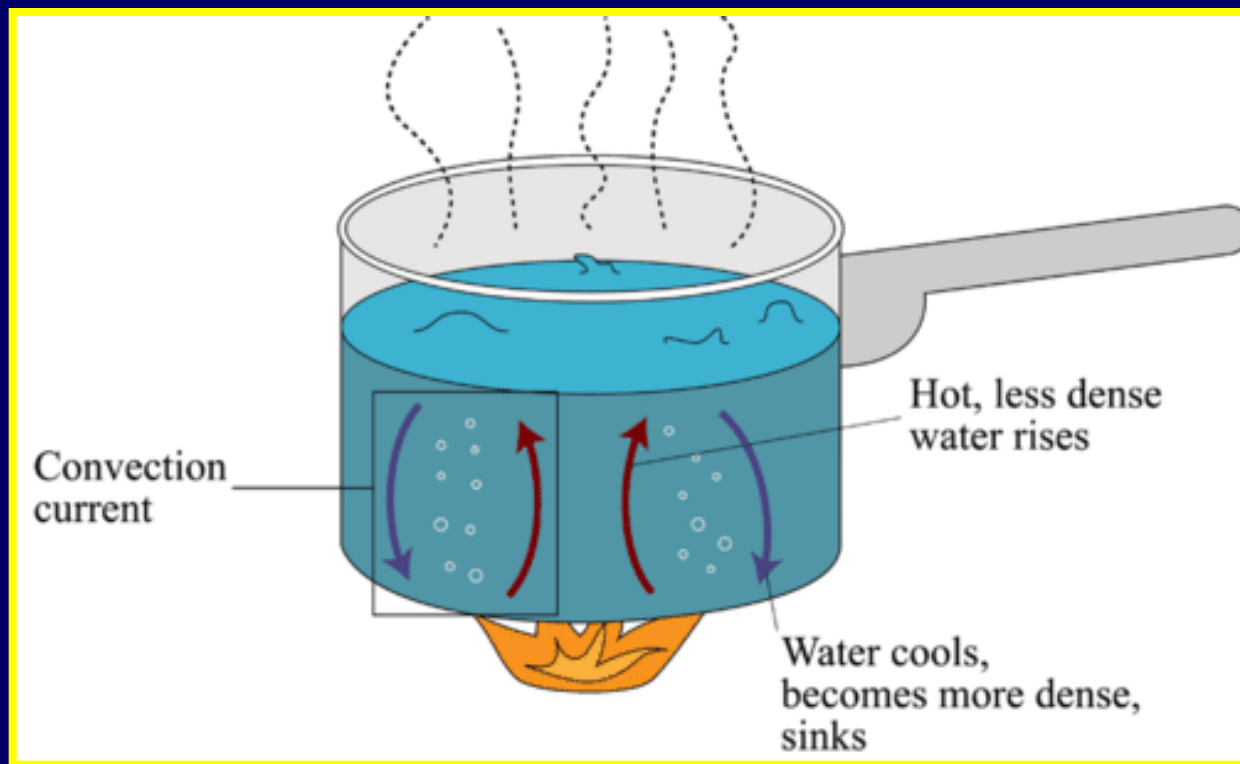
When a fluid warms up, the molecules expand and the warm fluid rises.

When a fluid cools, the molecules condense and the cool fluid sinks.



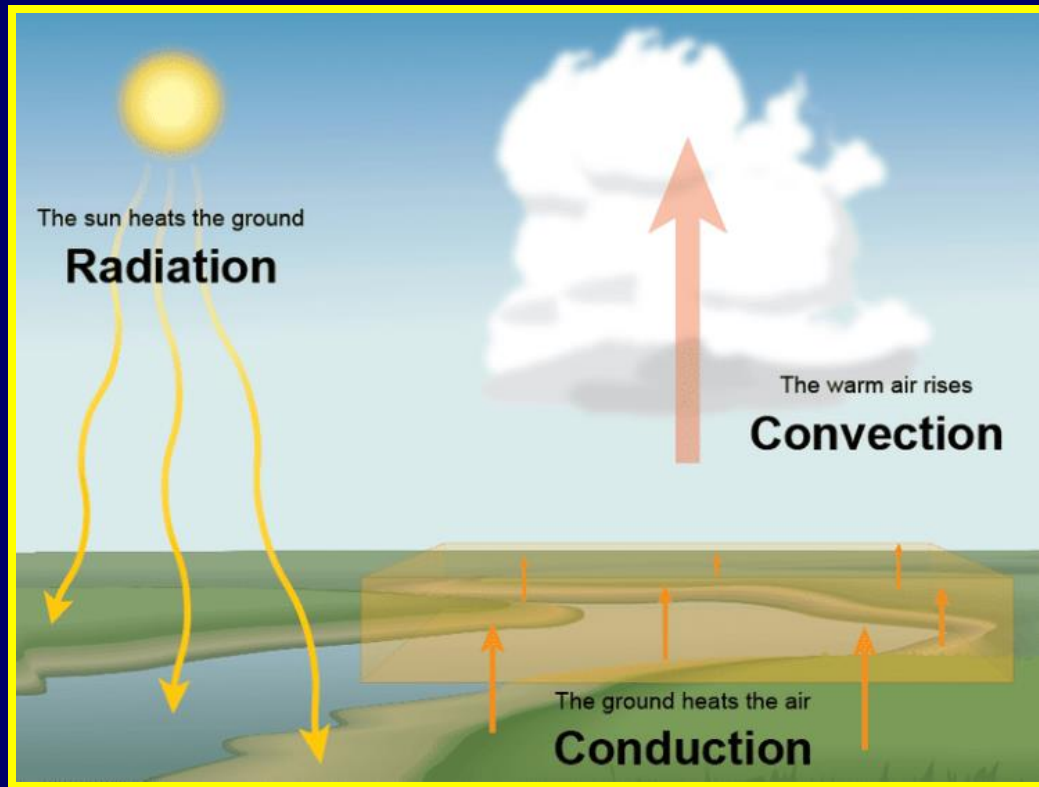
Convection Currents

Convection currents are created by the continual flow of hot fluids rising and cool fluids sinking, as thermal energy is transferred throughout the fluid.



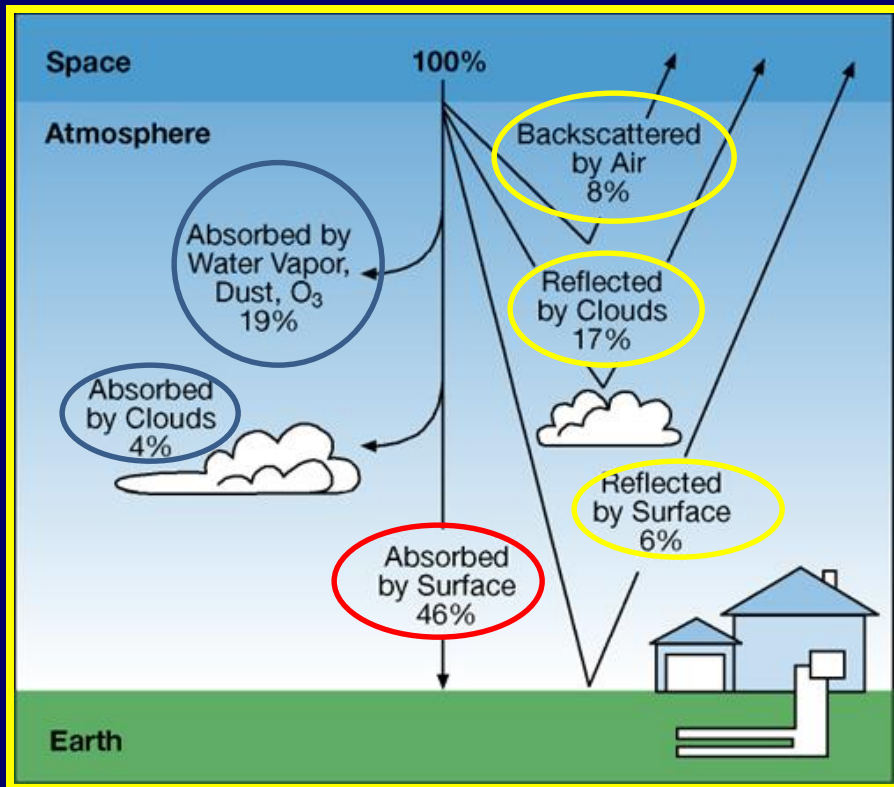
Solar Fundamentals

The Sun is the source of all thermal energy in the atmosphere and is transferred throughout the atmosphere by radiation, conduction, and convection.



Radiation

As radiation enters Earth's atmosphere, about 25% of the energy is absorbed by the clouds and gas molecules in the atmosphere. ●

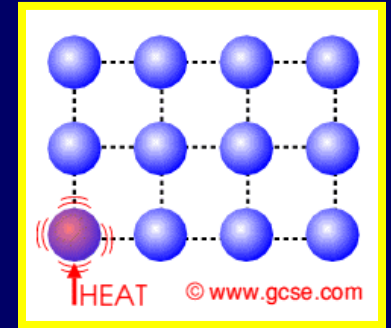


25% of solar radiation is reflected back into space. ●

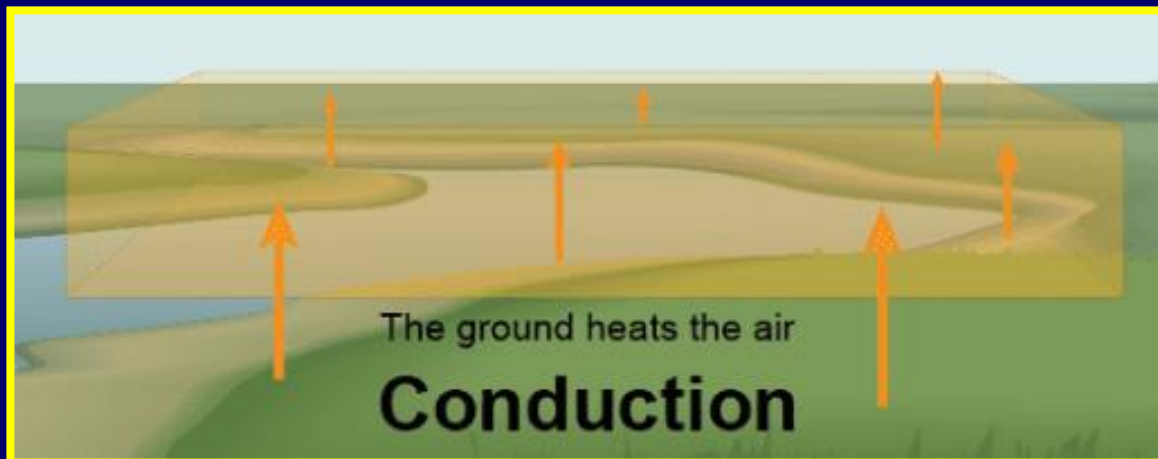
About 50% of solar radiation is absorbed by Earth's surface. ●

Conduction

The radiant energy that is absorbed by Earth's surface is converted into thermal (heat) energy.

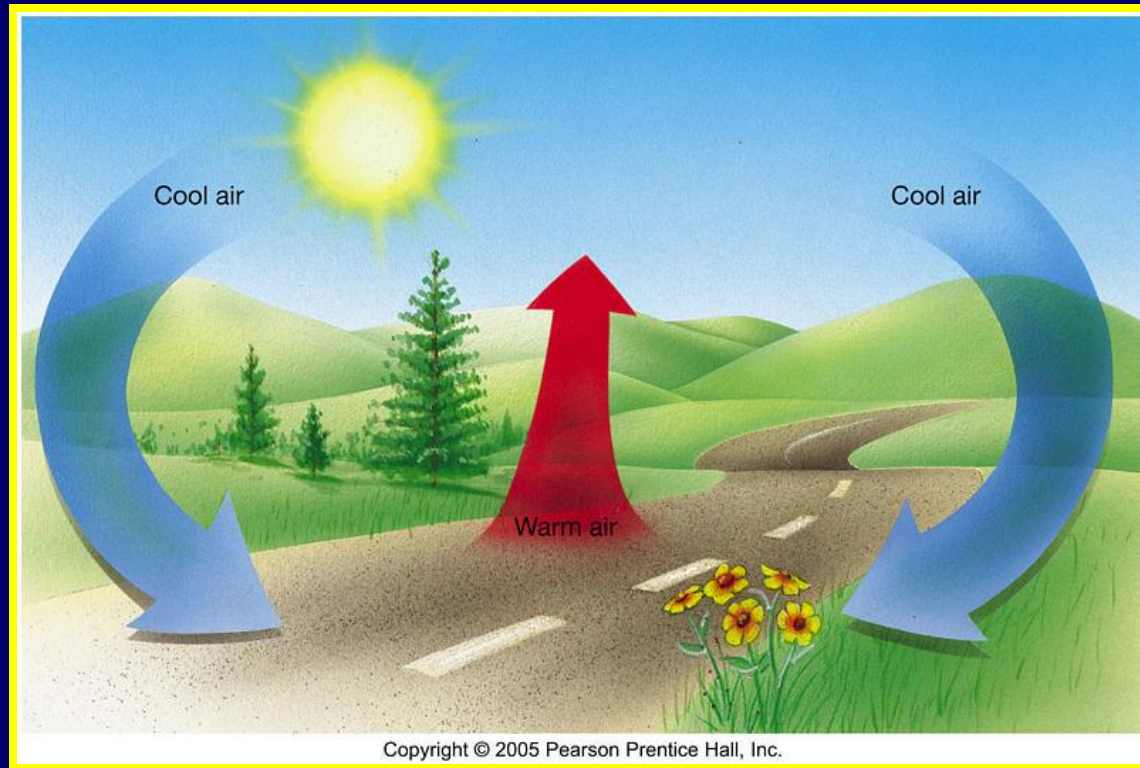


The heat energy is then transferred through conduction across the ground surface and into the air molecules directly above the surface.



Convection

Convection occurs in the atmosphere when the warm air, above the surface of Earth, rises, cools, and sinks creating convection currents.



The End

