

Thermal Energy Transfer

- Heat is the transfer of thermal energy from warmer objects to cooler ones.
- How does this happen?
- Depends on state of matter

STATES OF MATTER

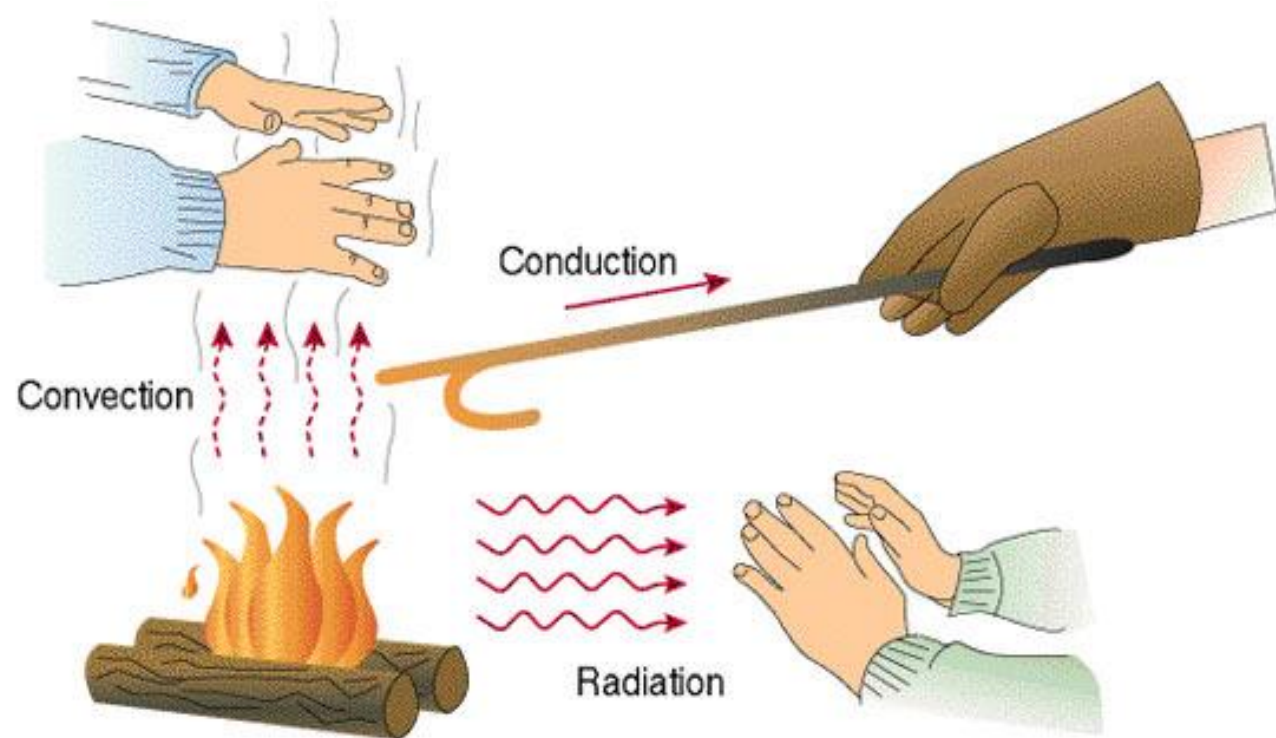


THREE ways thermal energy can move.

– Conduction

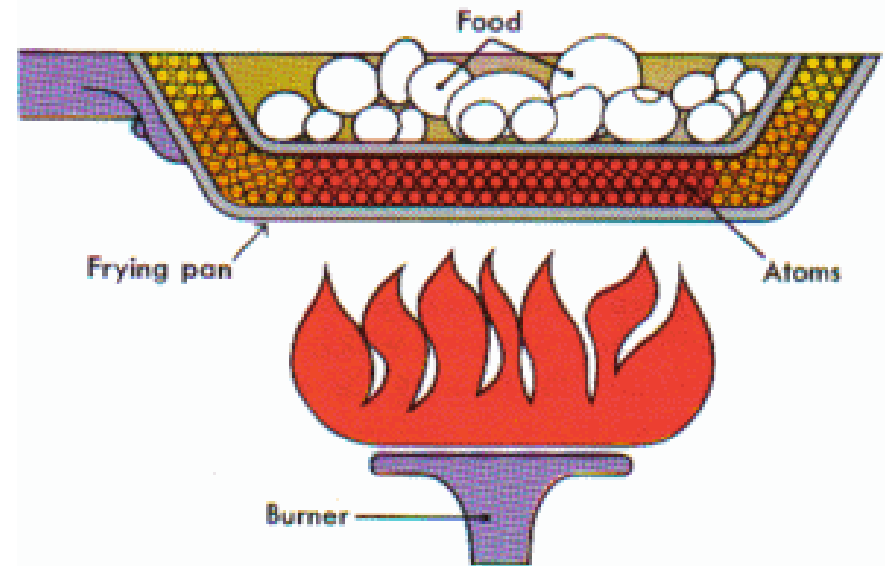
– Convection

– Radiation



CONDUCTION - Solids

- Heat is transferred from one particle of matter to another in an object without change of position.
- As KE increases, particles vibrate faster
- Transfer of KE by collision
- Conduction = CONTACT



Thermal Conductivity

- Factors that control **rate** of heat transfer in solids

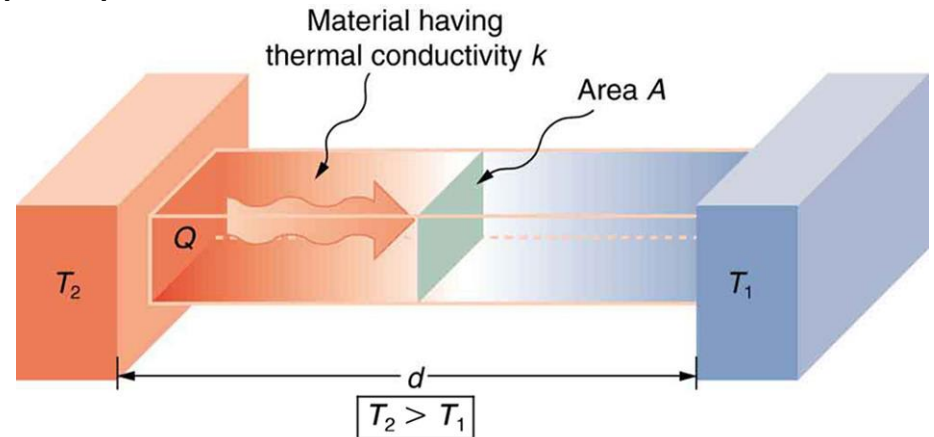
Temperature Difference $|\Delta T|$

Surface Area A

Distance Travelled d

Thermal Conductivity k

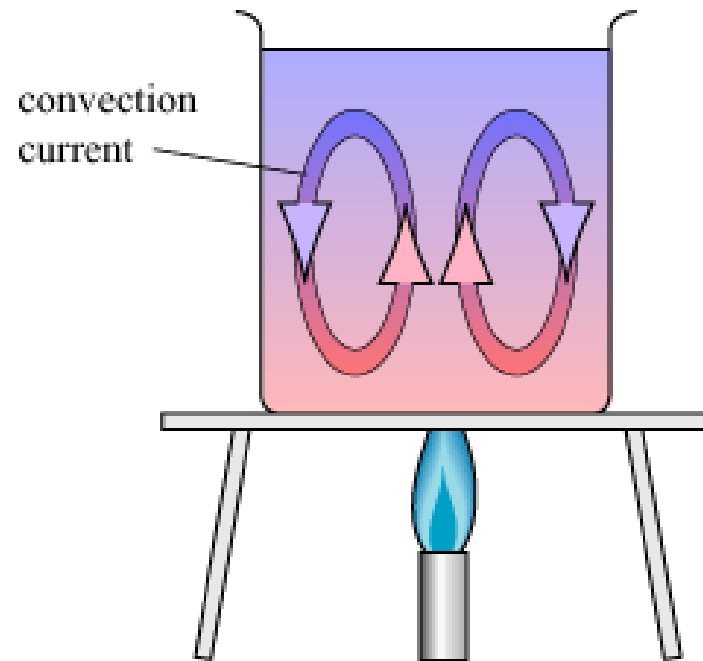
$$\frac{Q}{t} = \frac{|\Delta T|Ak}{d}$$



Example: A 4.0 mm thick glass window is 2.0 m wide and 1.5 m high. The outside temperature is -10°C and the inside temperature is 21°C . How much heat moves through the window in 1.0 h?

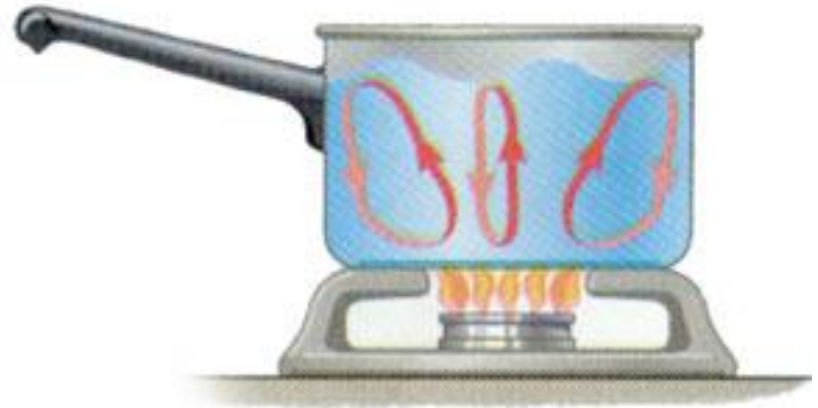
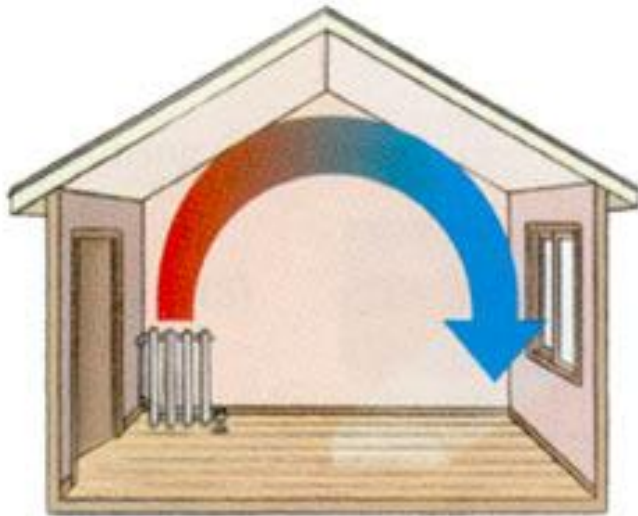
CONVECTION - Fluids

- Convection is the movement that transfers heat within fluids (liquids and gases)
- Heat is transferred by currents within the fluid
- Particles
 - gain KE
 - Collide and transfer KE
 - Change positions

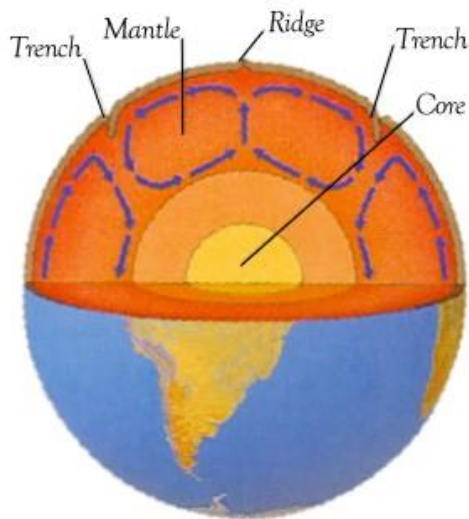
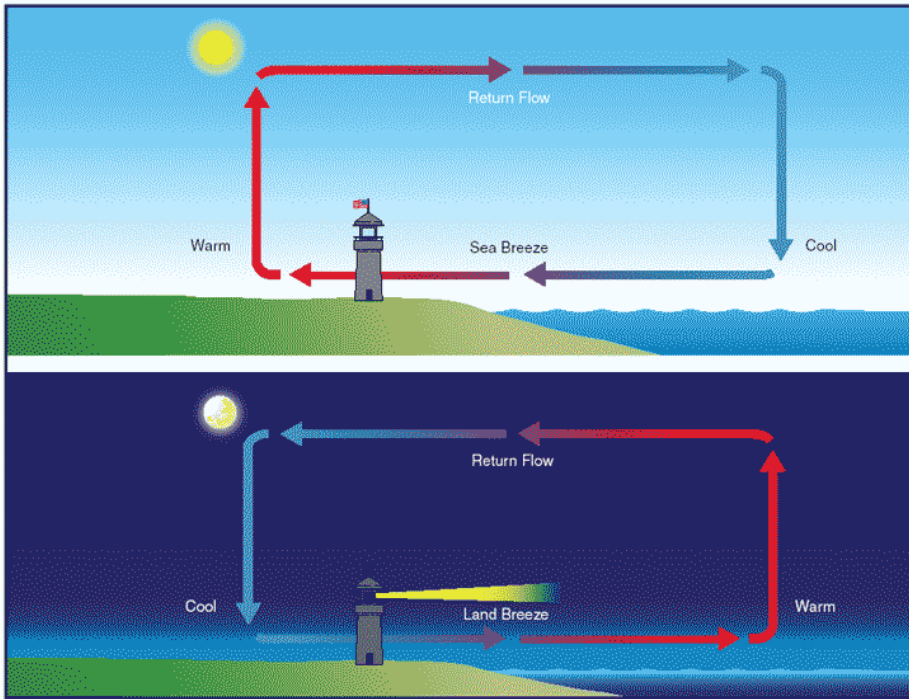


Examples of Convection

- Have you ever noticed that the air near the ceiling is warmer than the air near the floor? Or that water in a pool is cooler at the deep end?
- What is happening inside fireproof balloon?



Explaining Convection

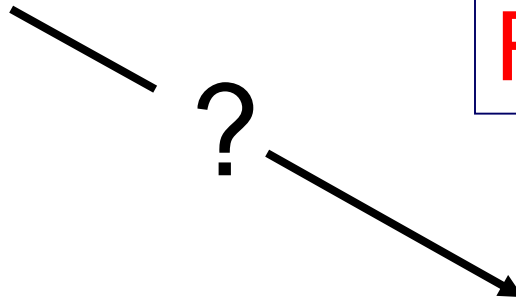
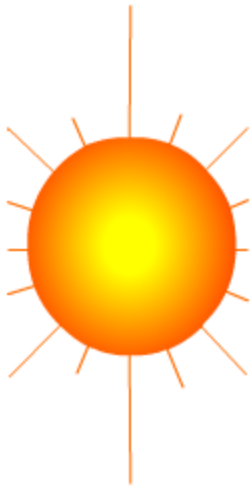


- Convection currents cause the cooler breezes you experience by a large body of water.
- These currents also cause the movement of magma within the earth.

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

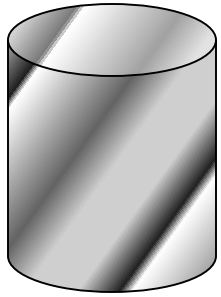


RADIATION

- Radiation is the transfer of energy by electromagnetic waves (gamma, UV, visible...)
- Radiation does NOT require matter to transfer thermal energy
- **Radiation = Radiates** (heat escaping the sun and warming the Earth)

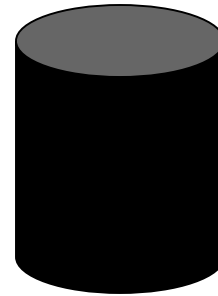
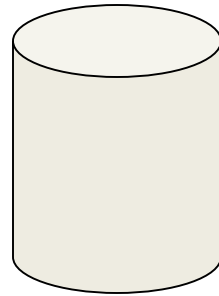
Emission experiment

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



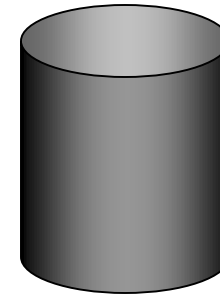
Shiny metal

Dull metal



Dull black

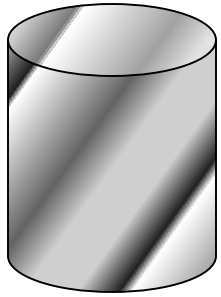
Shiny black



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.

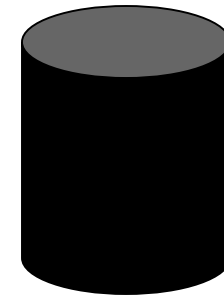
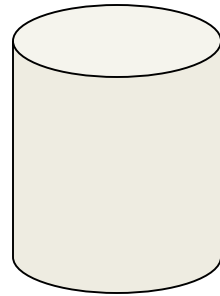
Absorption experiment

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



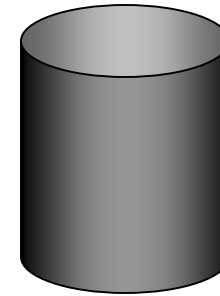
Shiny metal

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

Conduction

Radiation

Radiation

