HOW IS HEAT TRANSFERRED?

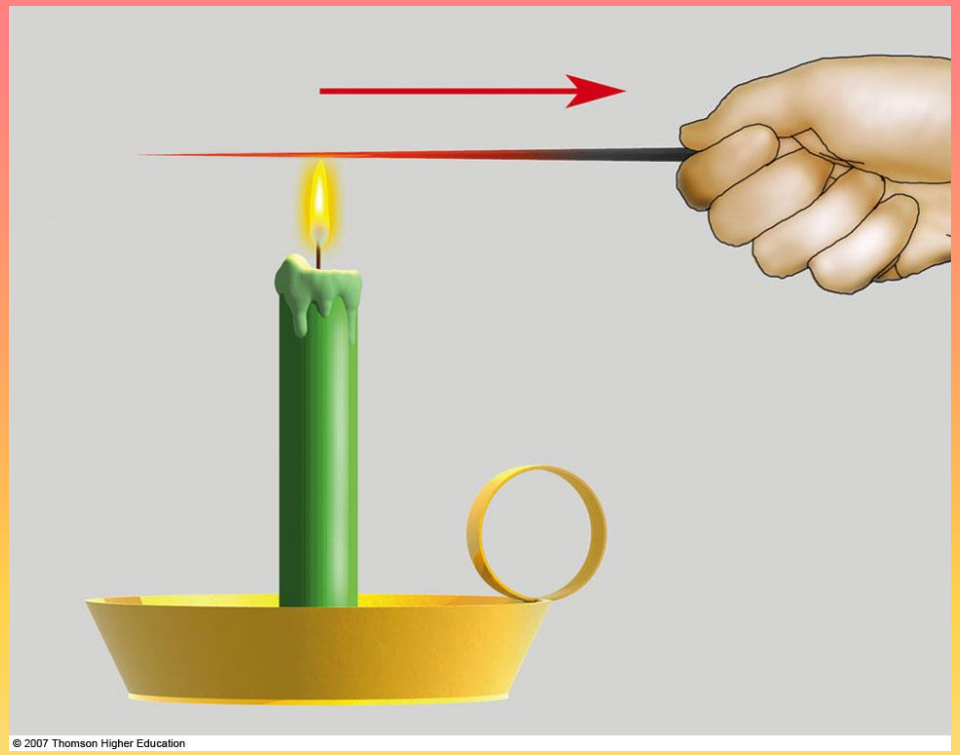
- Conduction
- Convection
- Radiation

AN INTRODUCTORY VIDEO

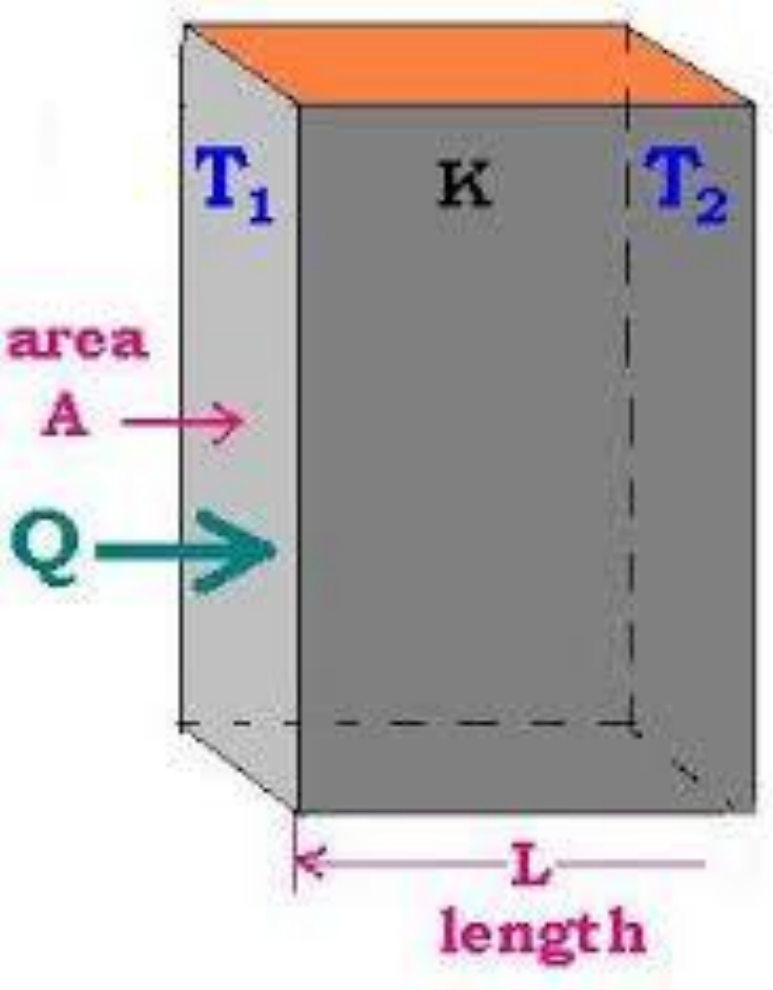
CONDUCTION

Conduction occurs when there is a difference in temperature between two extremities of an object, without a displacement of matter.

At one end of the object, the particles have more energy and vibrate more. These particles bump into each other and tranfer them their energy throughout the object. This process continues until the end of the substance.



With conduction in a bar we can obtain the Fourier's law:



$$Q = k \frac{\Delta T \cdot A}{d} \cdot \Delta t$$

Q: heat capacity

ΔT: difference of temperature between two ends

A: area of the bar

d (length): is the distance between two ends

Δt: range of time

k: thermal conductivity (a measure of the ability of a material to allow the flow of heat from its warmer surface through the material to its colder surface)

K is inversely proportional to T so:

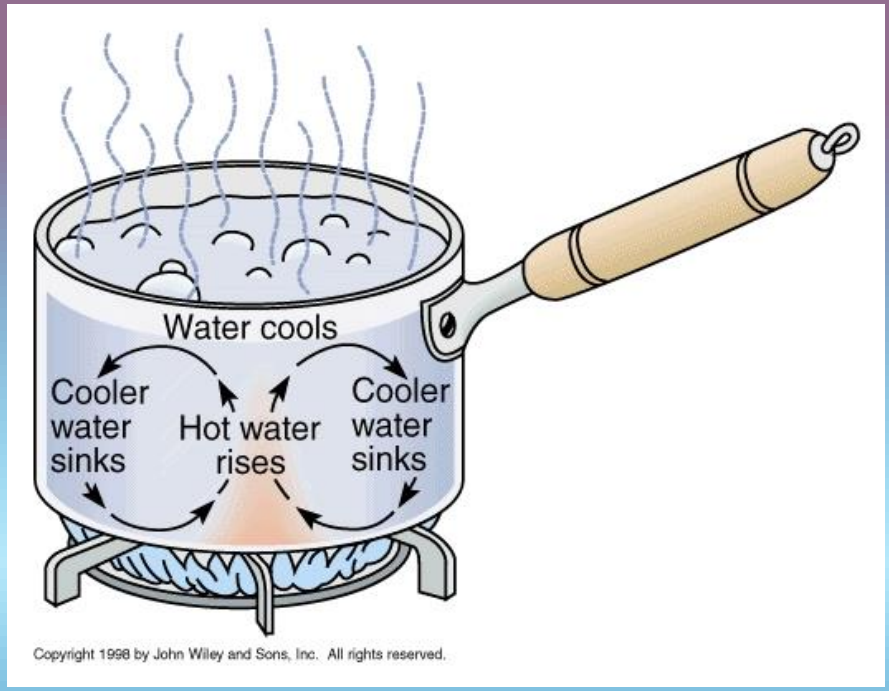
If k is big T is small, heat is transferred very quickly: the material is a good conductor.

If k is small T is big, heat is transferred slowly: the material is an insulator.

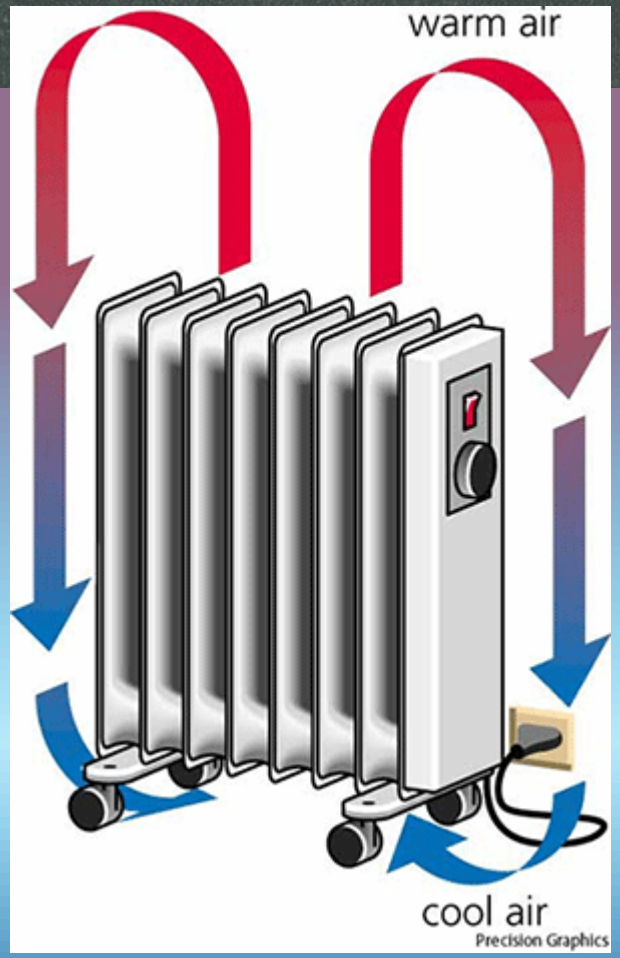
If the material is a good conductor of heat it is also a good conductor of electricity due to metallic bonds.

CONVECTION

As with conduction, convection happens when there is a difference in temperature between a fluid or gas in motion and a surface. This fluid motion consists of a large number of molecules moving as aggregates, like in a bulk motion.

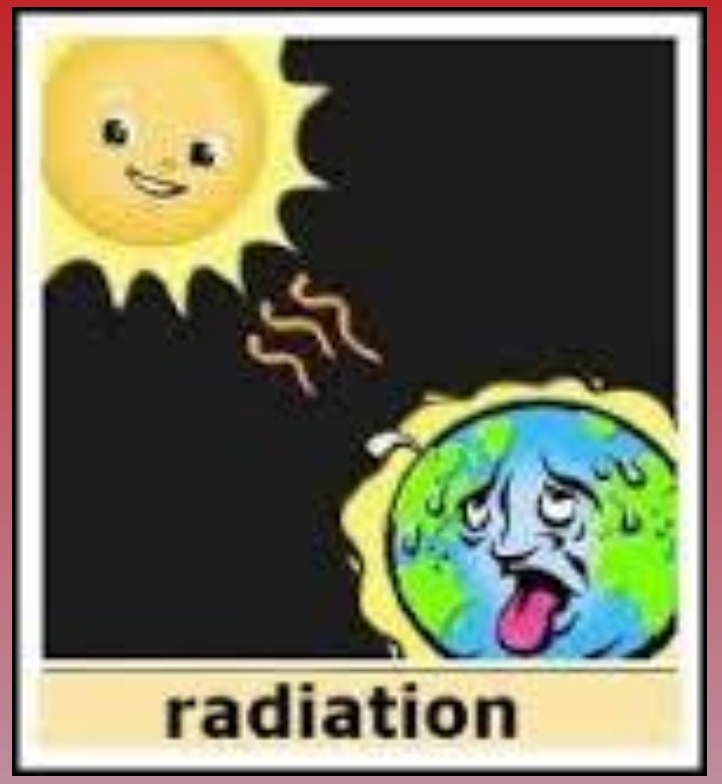


There are two types of convection:
Forced convection occurs when the fluid motion is caused by external means; an example is the fan.
Instead free or natural convection occurs when the fluid comes in contact with a hot component that increases its temperature and consequently there is a reduction in density.



RADIATION

Radiation is energy emitted by matter at a finite temperature and transerred by electromagnetic waves.
While the transfer of energy by convection or conduction requires the presence of a material medium, radiation transfer occurs most efficiently in a vacuum.



Stefan-Boltzmann Law

$$(P) = \varepsilon \cdot \sigma \cdot A \cdot T^4$$

Where:

ε- emissivity $0 \leq \varepsilon \leq 1$

σ – Stefan-Boltzmann's constant (5.67 x 10-8 $W/m^{-2}K^{-4}$)

P - Radiation Energy

A - Surface Area

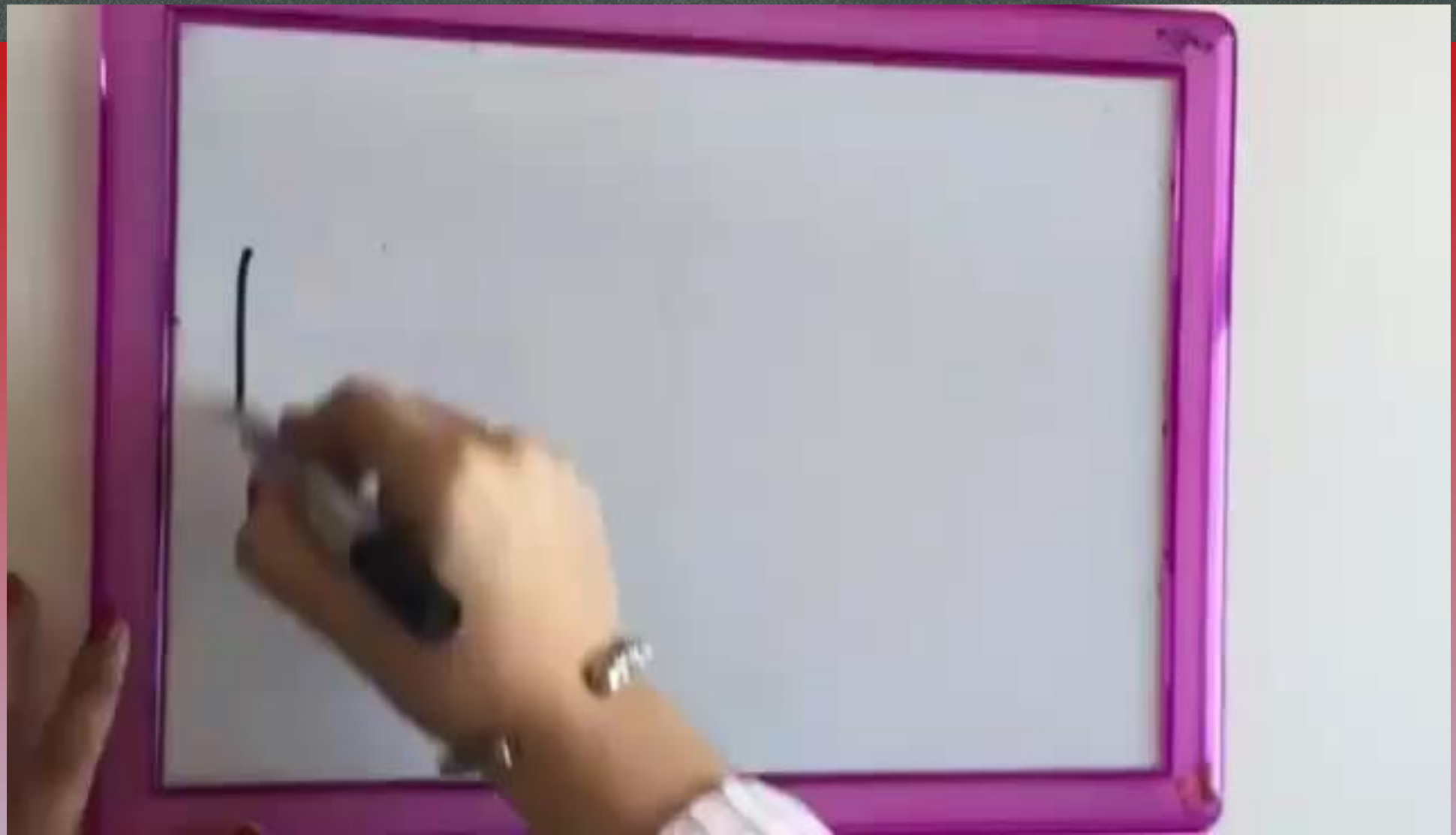
T - Temperature

The emissivity of a black body is approximately equal to 1.

A black body is an idealized physical body that absorbs all electromagnetic radiations.

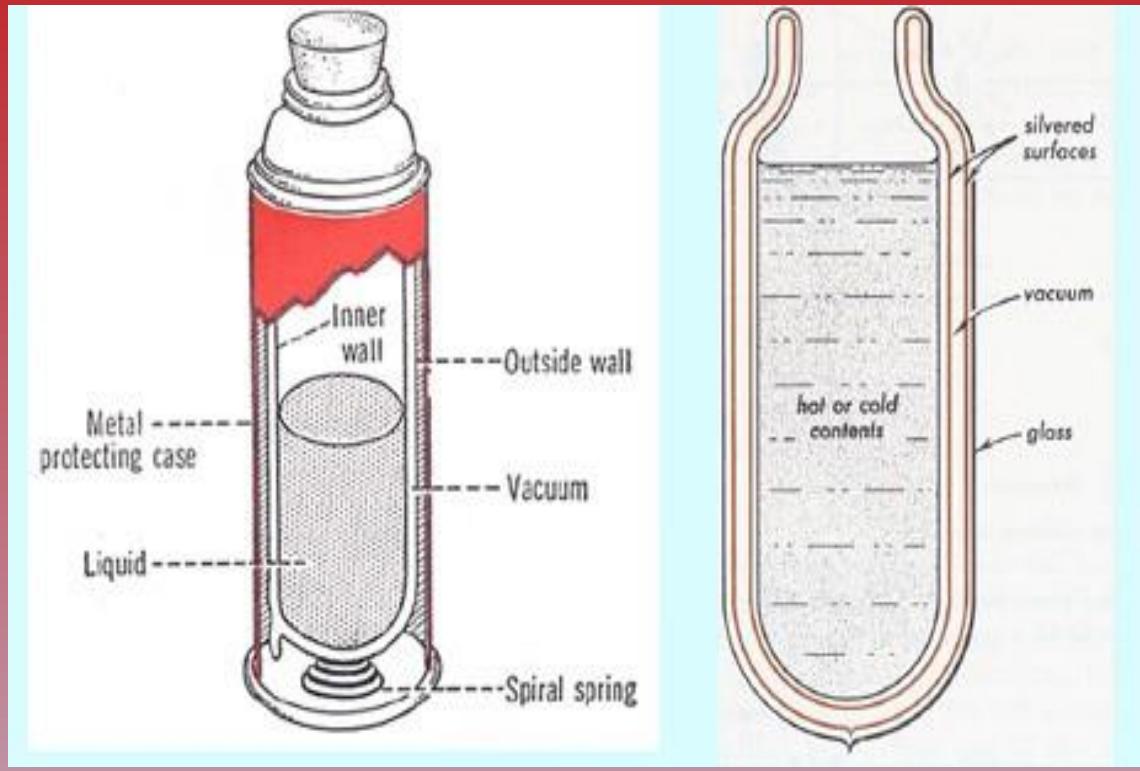
A white body reflects all incident rays completely and uniformly in all directions.

Why during summer is better wear white clothes?
Watch this VIDEO



How a thermos flask works:

Thermos is a container that allows to mantain its contenents hotter or colder than the sorrounding thanks to the vacuum between the internal side and the outside. The heat through the vacuum isn’t transferred by conduction or convection but only by radiation, that is played down thanks to reflective cover on the surface.



Exercises:

- A piece of wood has the area equal to $1.8m^2$ and a thickness of 8.0 mm (=0.008m). His thermal conductivity (K) is equal to $0.80\ \frac{W}{m°C}$. The difference in temperature between internal and external surface in 20°C. Calculate the heat transferred in 1 hour.

- The surface of the Sun has a temperature of about 5778 K, his area is $6.088 \cdot 10^{-18}\ m^2$.
Calculate the energy radiated by the Sun.
The emissivity (Ɛ) of the sun is 0.965

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