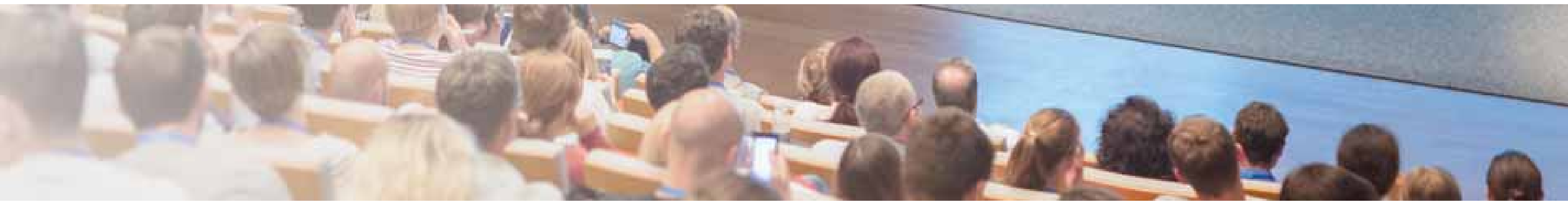


Basic knowledge

Material-bound / non-material-bound heat transport

Material-bound heat transport

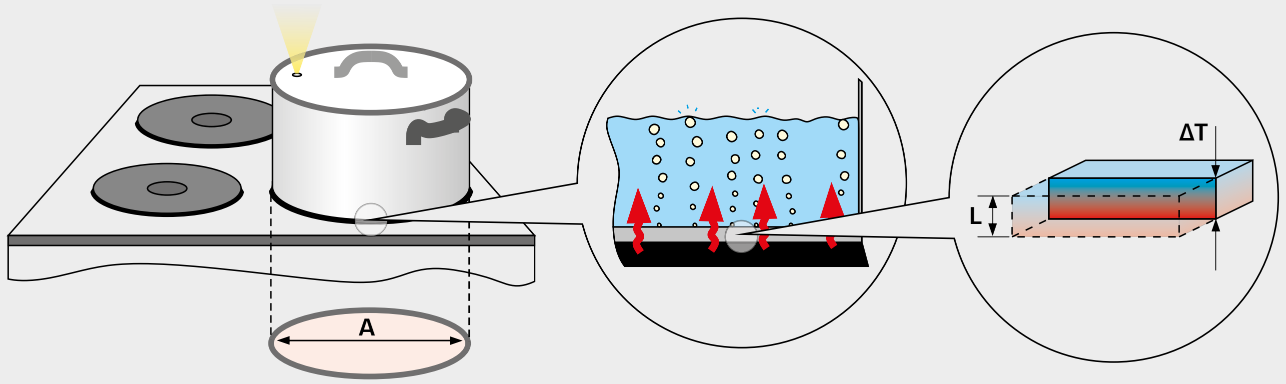
by conduction and convection

Conduction

In the case of thermal conduction, heat transport takes place through direct interaction between the molecules (e.g. molecule collisions) within a solid or a fluid at rest. A prerequisite for this is that there is a temperature difference within the substance or that substances of different temperatures come into direct contact with each other. All aggregate states allow this transfer mechanism.

The amount of heat transported depends on:

- the thermal conductivity **λ** of the material,
- the heat conducting length **L**,
- the heat transferring area **A**,
- the dwell time **t** and
- the temperature difference **ΔT** between the beginning and end of the thermal conductor



The hot stove transfers the heat to the water through the bottom of the saucepan with the cross-sectional area **A**.

The red arrows indicate the direction of the heat flux.

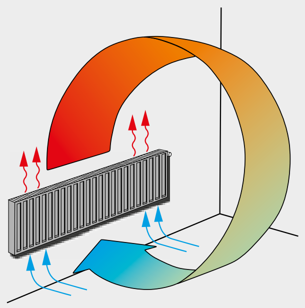
The heat is transferred from the hot to the cold material along the heat-conducting length **L** due to the interaction of the molecules via the temperature difference **ΔT**.

Convection

Heat transport takes place in flowing liquids or gases by means of material movement, i.e. material transport. Where **forced convection** occurs, the flow is forced by external forces. Examples: a pump in a warm water heater, fans in a power pack or PC.

If the flow is caused by differences in density due to different temperatures within the fluid this is called **free or natural convection.** Examples: water movement when heated in a pot, by a foehn wind, the gulf stream, or a vent in a chimney.

Cold air is sucked in by the fan, cools the internal components and flows out again as heated air.



The air molecules warmed by the heater rise due to differences in density.

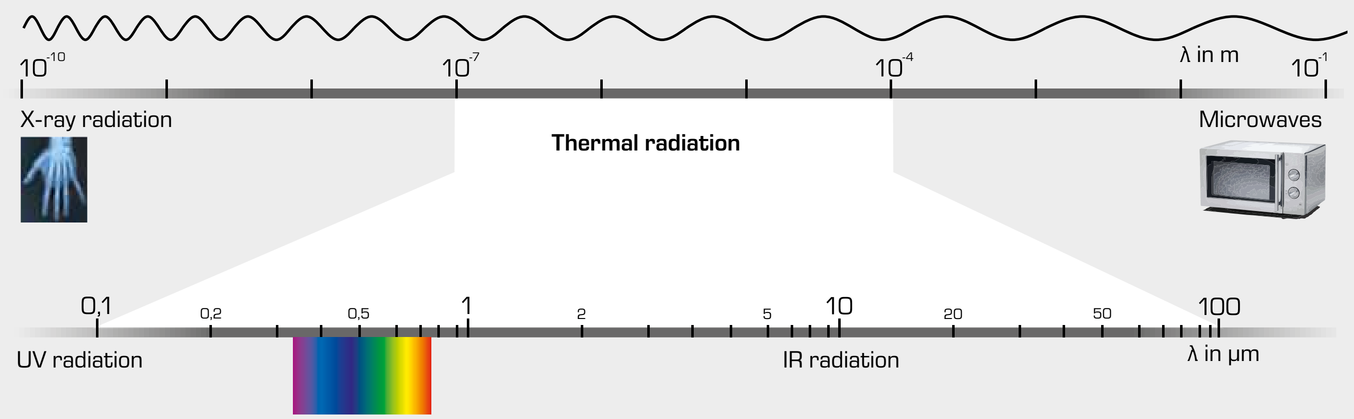
Non-material-bound heat transport

by thermal radiation

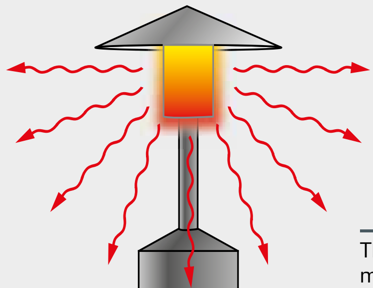
Radiation

Energy transport through electromagnetic oscillation in a specific wavelength range. Any body with a temperature above zero Kelvin emits radiation known as thermal radiation.

Thermal radiation includes UV radiation, light radiation and infrared radiation. Light radiation covers the wavelength range visible to the human eye.



Using a thermal imaging camera, it is possible to make thermal radiation visible: the thermal camera converts long-wave infrared radiation into visible radiation.



The best example of thermal radiation is the sun. One example of a technical application is a patio heater: electromagnetic oscillations are emitted by the heat source as thermal radiation in all directions. The portion of the thermal radiation directed upwards is reflected by the canopy.

Material characteristics

Heat transfer coefficient α: a measure of how much heat is transferred from a solid to a fluid or vice versa (convection)

Thermal conductivity λ: a measure of how well heat is transferred into a solid (conduction)

Overall heat transfer coefficient k: describes the overall heat transfer between fluids separated by solids (convection and conduction)

Reflectance, absorbance and transmittance: a measure of the proportion of thermal radiation reflected, absorbed or transmitted to a body (radiation)