

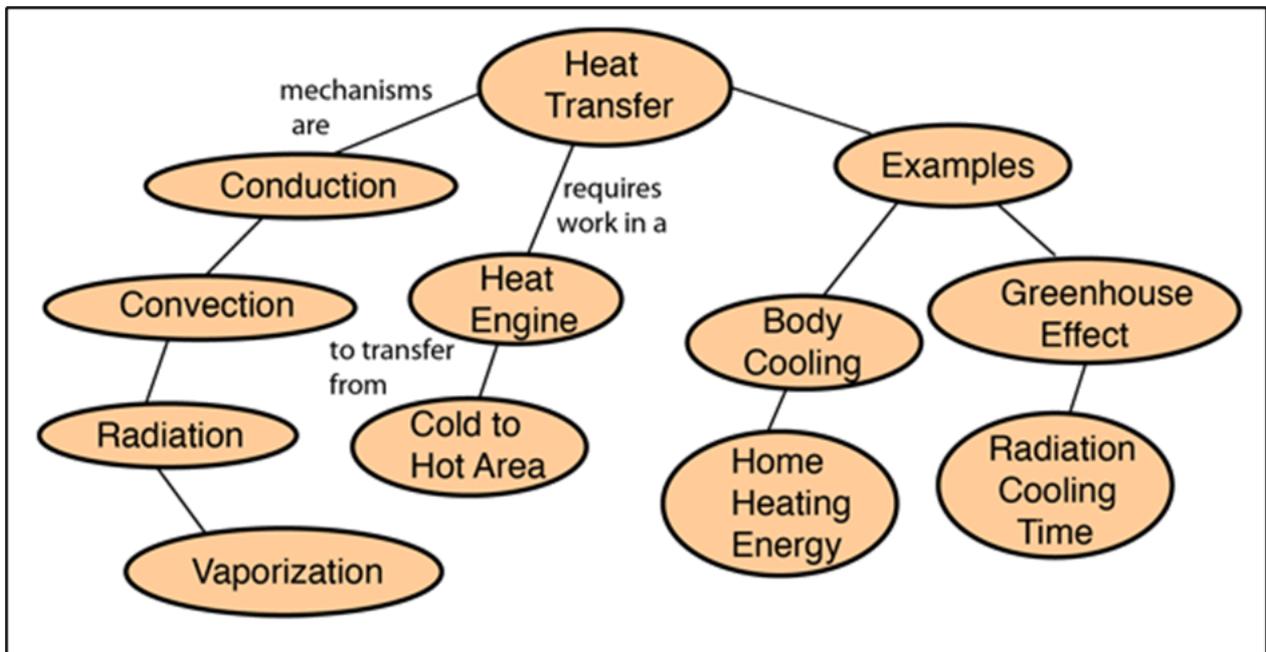
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Heat Transfer by Convection, Heat Transfer, Heat Transferred through Convection (For CBSE, ICSE, IAS, NET, NRA 2022)

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Heat Transfer by Convection

Heat Transfer



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- Heat transfer is the transfer of heat or thermal energy between physical systems.
- So, when there is a temperature difference between two bodies, heat is transferred from the hot body to the colder body.
- There are three common modes of heat transfer – conduction, convection, and radiation.
- Convection is either the heat transfer due to bulk movement.
- The process of heat transfer between a surface and a fluid flowing in contact with it is called convective heat transfer.

About Convection

Mechanisms of Heat Transfer - Convection

$$q = h\Delta T$$

where

q is the local heat flux density [$\text{W}\cdot\text{m}^{-2}$]

h is the heat transfer coefficient [$\text{W}\cdot\text{m}^{-2}\cdot\text{K}$]

ΔT is the temperature difference [K]

$$q = -k\nabla T$$

where

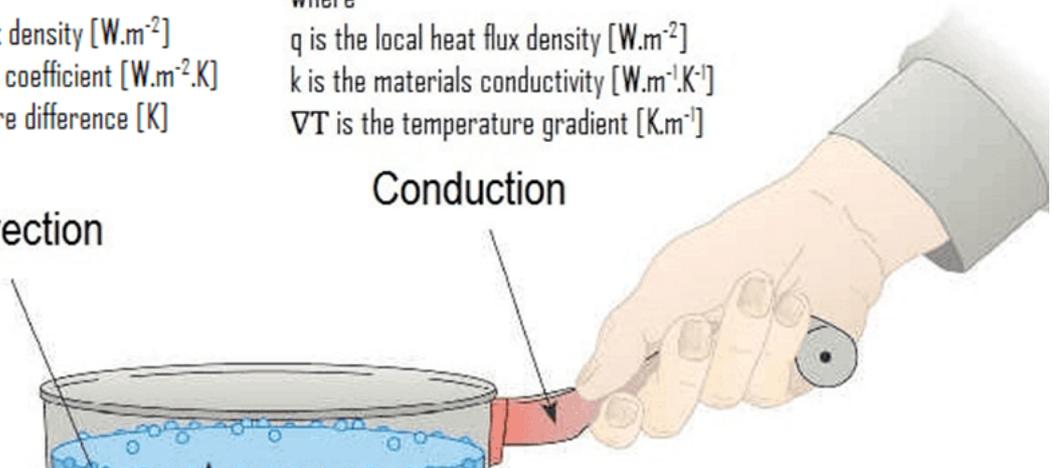
q is the local heat flux density [$\text{W}\cdot\text{m}^{-2}$]

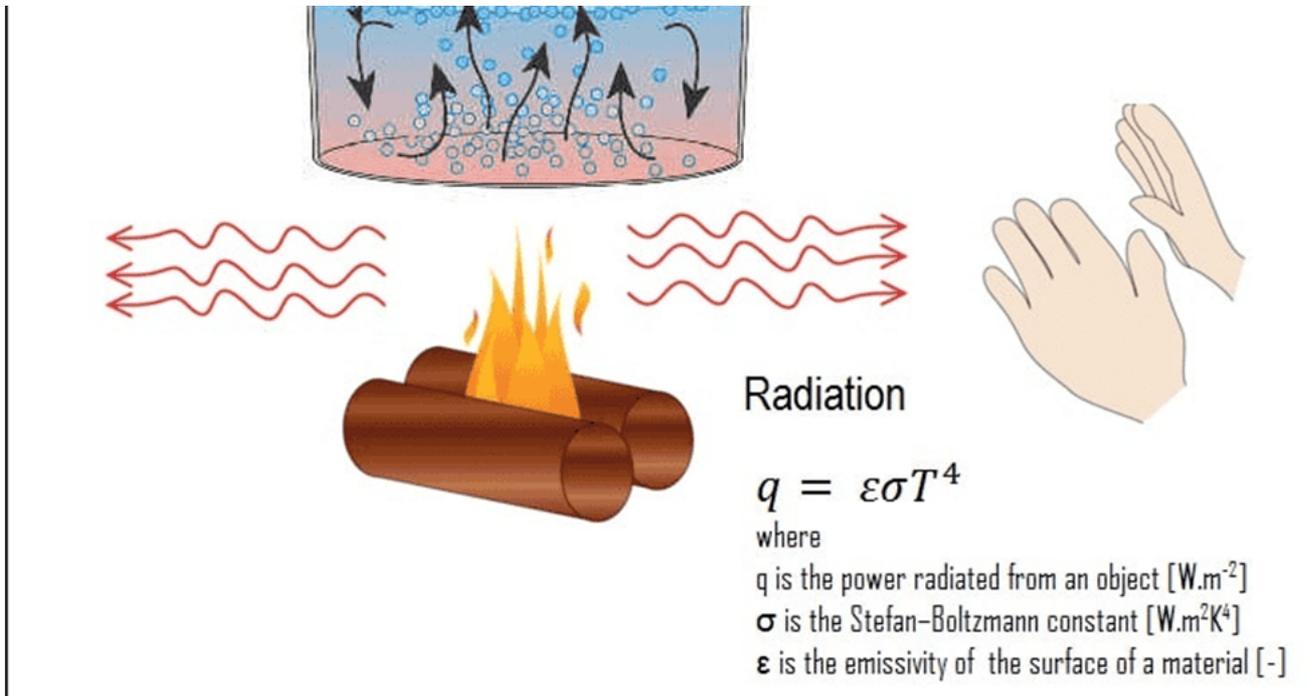
k is the materials conductivity [$\text{W}\cdot\text{m}^{-1}\cdot\text{K}^{-1}$]

∇T is the temperature gradient [$\text{K}\cdot\text{m}^{-1}$]

Convection

Conduction





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- It is the process of heat transfer by the bulk movement of molecules within fluids such as gases and liquids.
- The initial heat transfer between the object and the fluid takes place through conduction, but the bulk heat transfer happens due to the motion of the fluid.
- Convection is the process of heat transfer in fluids by the actual motion of matter.
 - happens in liquids and gases
 - may be natural or forced
 - involves a bulk transfer of portions of the fluid

Heat Transferred through Convection

- Energy is transferred as heat either due to the migration of free electrons or lattice vibration waves (phonons), in thermal conduction.
- There is no movement of mass in the direction of energy flow. Heat transfer by conduction is dependent upon the driving “force” of temperature difference.
- Convection and Conduction are similar in that both mechanisms require the presence of a material medium
- Rather they are different in that convection requires the presence of fluid motion.
- It must be emphasized, at the surface, energy flow occurs purely by conduction, even in convection.
- It is because of the fact, there is always a thin stagnant fluid film layer on the heat transfer surface.
- But in the next layers both conduction and diffusion-mass movement in the molecular level or macroscopic level occurs.
- Though the mass movement the rate of energy transfer is higher. Higher the rate of mass movement, thinner the stagnant fluid film layer will be and higher will be the heat flow rate.
- Nucleate boiling at the surface effectively disrupts this stagnant layer and therefore nucleate boiling significantly increases the ability of a surface to transfer thermal energy to bulk fluid.
- Heat transfer through a fluid is by convection in the presence of mass movement and by conduction in the absence of it.
- So, thermal conduction in a fluid can be viewed as the limiting case of convection, corresponding to the case of quiescent fluid.
- When a fluid is heated from below, thermal expansion takes place. The lower layers of the fluid, which are hotter, become less dense. We know that colder fluid is denser.
- Because of buoyancy, the less dense, hotter part of the fluid rises. And the colder, denser fluid replaces it.
- So, this process is repeated when this part also gets heated and rises to be replaced by the colder upper layer. This is how the heat is transferred through convection.