**Heat transfer**

Heat transfer is defined as energy-in-transit due to temperature difference. Heat transfer takes place whenever there is a temperature gradient within a system or whenever two systems at different temperatures are brought into thermal contact. Heat, which is energy-in-transit cannot be measured or observed directly, but the effects produced by it can be observed and measured. Since heat transfer involves transfer and/or conversion of energy, all heat transfer processes must obey the first and second laws of thermodynamics.

**Conduction heat transfer**

Conduction heat transfer takes place whenever a temperature gradient exists in a stationary medium. Conduction is one of the basic modes of heat transfer. On a microscopic level, conduction heat transfer is due to the elastic impact of molecules in fluids, due to molecular vibration and rotation about their lattice positions and due to free electron migration in solids.

The fundamental law that governs conduction heat transfer is called **Fourier’s law of heat conduction**, it is an empirical statement based on experimental observations and is

 In the above equation, Qx is the rate of heat transfer by conduction in x-direction, (dT/dx) is the temperature gradient in x-direction, A is the cross-sectional area normal to the x-direction and k is a proportionality constant and is a property of the conduction medium, called **thermal conductivity**. The ‘-‘ sign in the above equation is a consequence of 2nd law of thermodynamics, which states that in spontaneous process heat must always flow from a high temperature to a low temperature (i.e., dT/dx must be negative). The thermal conductivity is an important property of the medium as it is equal to the conduction heat transfer per unit cross-sectional area per unit temperature gradient. Thermal conductivity of materials varies significantly. Generally it is very high for pure metals and low for non-metals. Thermal conductivity of solids is generally greater than that of fluids.

Convection Heat Transfer: Convection heat transfer takes place between a surface and a moving fluid, when they are at different temperatures. In a strict sense, convection is not a basic mode of heat transfer as the heat transfer from the surface to the fluid consists of two mechanisms operating simultaneously. The first one is energy transfer due to molecular motion (conduction) through a fluid layer adjacent to the surface, which remains stationary with respect to the solid surface due to no-slip condition. Superimposed upon this conductive mode is energy transfer by the macroscopic motion of fluid particles by virtue of an external force, which could be generated by a pump or fan (forced convection) or generated due to buoyancy, caused by density gradients.

## Newton's Law of Cooling

Newton's Law of Cooling states that the rate of change of the temperature of an object is proportional to the difference between its own temperature and the ambient temperature (i.e. the temperature of its surroundings).

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Radiation heat transfer: Radiation is another fundamental mode of heat transfer. Unlike conduction and convection, radiation heat transfer does not require a medium for transmission as energy transfer occurs due to the propagation of electromagnetic waves. A body due to its temperature emits electromagnetic radiation, and it is emitted at all temperatures. It is propagated with the speed of light in a straight line in vacuum. Its speed decreases in a medium but it travels in a straight line in homogenous medium.

**Stefan-Boltzman’s Law:**

This law states that the intensity of radiation emitted by a radiating body is proportional to the fourth power of the absolute temperature of that body.

Radiation flux = ƐσT4

σ = Stefan-Boltzman’s constant = 5.67 x 10-5 ergs cm-2 sec-1K-4

Ɛ = Emissivity of a body (0 <  s > 1.0)

T = Absolute temperature of the surface in °K

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T = Absolute temperature of the surface in °K

####  Kirchoff’s Law:

Any grey object (other than a perfect black body) which receives radiation, disposes off a part of it in reflection and transmission. The absorptivity, reflectivity and transmissivity are each less than or equal to unity.

Kirchoffs law states that the absorptivity (a) of a substance for radiation of a specific wavelength is equal to its emissivity for the same wavelength and is given by the following equation:

 a (λ) = e(λ)

**Black-body radiation** is the [thermal](https://en.wikipedia.org/wiki/Thermal_radiation) [electromagnetic radiation](https://en.wikipedia.org/wiki/Electromagnetic_radiation) within or surrounding a body in [thermodynamic equilibrium](https://en.wikipedia.org/wiki/Thermodynamic_equilibrium) with its environment, emitted by a [black body](https://en.wikipedia.org/wiki/Black_body) (an idealized opaque, non-reflective body). It has a specific spectrum of wavelengths, inversely related to intensity that depend only on the body's temperature, which is assumed for the sake of calculations and theory to be uniform and constant.

## Absorptivity

The fraction of irradiation absorbed by the surface is called the absorptivity (α). It is the ratio of absorbed radiation (G abs) to incident radiation (G).

Its value: 0 ≤ α ≤ 1

## Reflectivity

The fraction of radiation reflected by the surface is called the reflectivity (ρ). It is the ratio of reflected radiation (G ref) to incident radiation (G).

Its value: 0 ≤ ρ ≤ 1

## Transmissivity

The fraction of radiation transmitted is called the transmissivity (τ). It is the ratio of transmitted radiation (G tr) to incident radiation (G)

Its value: 0 ≤ τ ≤ 1

The [first law of thermodynamics](https://clubtechnical.com/first-law-of-thermodynamics) requires that the sum of the absorbed, reflected, and transmitted radiation energy be equal to the incident radiation. That is,

G abs + G ref + G tr = G