Heat transport

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Introduction

Heat is the transference of energy by the means of radiation, convection or conduction. The first one involves electromagnetic waves to transfer the energy and has no intervention of a medium. The two last ones involve the presence of a medium and the energy is transferred between connected atoms.

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Convection ==

Convection is the transference of heat by the movement of a fluid. This movement is designated currents of convection and has to be with the different densities that the same fluid have at different temperatures, the hotter fluid has less density than the colder fluid. The convection currents can be described has a cyclic process that occurs until the whole fluid reach the same temperature. As we can see in the following image, the cyclic currents are responsible for the heating of the fluid by the subsequent way: - The lower part of the fluid is being warmed up, starting cold, with highest density. As it is being heated, it starts to be pushed up as it gets warmer as a result of decreasing density. The upper part, where the colder fluid is, when in contact with the warmer that is going up, is pushed down because of rearrange of densities. When it gets down it warms up, and therefore they continue with this cycle until every particle is at the same temperature as the others. Convection exists in many places but one of the most important is the convections in the mantle of our planet.

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Conduction == Suppose that a person is holding a metal bar on one extremity, and that the other extremity is in close contact with a flame. The atoms of the extremity heated by the flame, acquire a bigger energy. Part of this energy is, then, transferred to the surrounding particles and, thus, the temperature increases not only in the place in contact with the flame, but also the area around it. This process continues throughout the bar, after a certain amount of time, the person holding the bar will sense the temperature elevation on his extremety. So, this transmission of heat will continue while there is still a difference of temperature between the two extremeties. This transmission was accomplished by the agitation of the atoms in the bar in a process called conduction. Most of the heat that is transferred between solid bodies, is done through this process. Depending on the atomic constitution of a substance/material, the thermic agitation can be transferred from one atom to the other with more or less ease, making that substance/material a good or a bad heat conductor. For example, metals are good heat conductors, while wood and rubber are bad conductors. The formula used to calculate the rate of heat transfer is: $dQ/dt = -\kappa A dT/dx$, where dQ/dt is the rate of heat transfer, A is the cross-sectional area, dT/dx is the temperature gradient along a chosen direction x.

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Radiation == Radiation is the emission of energy, by a source, in the form of electromagnetic waves or high energy particles. The radiation of heat is done via infrared. The heat can pass throught the vacuum, travelling at the speed of light, and it can be reflected and refracted, without affecting the medium through which it passes. So, radiation is the form in which heat propagates in vacuum. An example of this is the heat provided by the sun, this is, the heat propagates in vacuum in the form of radiation, in waves that travel at the speed of light. Another example is the oven. If an oven is working and we get near it, we can fell the heat before we even touch it. The formula used to calculate the power irradiated from a body is dQ/dt= eбAT^4, where dQ/dt is the power irradiated from the body, e is the emissivity, б corresponds to the Stefan-Boltzmann constant (б = 5.67•10-8W.m-2.k-4), T is the absolute temperature and A is the body area.

[1][2][3]

1. http://hyperphysics.phy-astr.gsu.edu/hbase/thermo/heatra.html
2. http://en.wikipedia.org/wiki/Heat_transfer
3. Vítek, František ; Lectures on biophysics with medical orientation; Ucební texty University Karlovy v Praze, Prague 2011