Mechanism of Heat in Thermodynamics

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Commentary

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ABOUT THE STUDY

Heat is defined in thermodynamics as energy transferred to or from a thermodynamic system *via* mechanisms other than thermodynamic work or matter transfer. The following section of this article discusses the various energy transfer mechanisms that define heat. Heat transfer, like thermodynamic work, is a process involving multiple systems and not a property of any single system. In thermodynamics, heat energy transfers contribute to changes in the system's cardinal energy variable of state, such as internal energy or enthalpy. This is distinct from the common understanding of heat as a property of an isolated system. The amount of energy transferred as heat in a process is the amount of energy transferred minus any thermodynamic work done and any energy contained in the matter transferred. It is necessary for the precise definition of heat that it occurs *via* a path that does not include the transfer of matter. Though not directly by definition, the quantity of energy transferred as heat can be measured by its effect on the states of interacting bodies in certain types of processes. For example, in special circumstances, heat transfer can be measured by the amount of ice melted or by the change in temperature of a body in the system's surroundings. Q or q is the conventional symbol for the amount of heat transferred in a thermodynamic process. The joule is the SI unit of heat as an amount of energy (transferred) (J).

Mechanism of heat

Conduction, through direct contact of immobile bodies, or through an impermeable to matter wall or barrier; or radiation between separated bodies; or friction due to isochoric mechanical, electrical, ferromagnetism, or gravitational work done by the surroundings on the system of interest, such as Joule heating due to an electric current driven through the system of interest by an external system, or through a wall or barrier; or radiation between separated bodies; or friction due to isochoric mechanical, electrical, magnetic, or gravitational When a suitable path exists between two systems with different temperatures, heat transfer from the hotter to the colder system occurs inexorably, immediately, and spontaneously. Thermal conduction occurs as a result of the stochastic (random) movement of microscopic particles (such as atoms or molecules). In contrast, thermodynamic work is defined by mechanisms that act macroscopically and directly on the system's whole-body state variables, such as changing the system's volume with an externally measurable force or changing the system's internal electric polarization with an externally measurable change in electric field. The definition of heat transfer does not necessitate that the process be smooth in any way. A bolt of lightning, for example, can transfer heat to a body. Convective circulation allows one body to heat another *via* an intermediate circulating fluid that transports energy from one's boundary to the other's boundary; actual heat transfer occurs *via* conduction and radiation between the fluid and the respective bodies. Convective circulation, while spontaneous, does not necessarily and immediately occur simply because of a slight temperature difference; there is a threshold that must be crossed in a given arrangement of systems for it to occur. Although heat naturally flows from a hotter to a cooler body, it is possible to build a heat pump that uses work to transfer energy from a colder to a hotter body. A heat engine, on the other hand, reduces an existing temperature difference in order to supply work to another system. An active heat spreader is another thermodynamic type of heat transfer device that works to accelerate the transfer of energy from a hotter body, such as a computer component, to colder surroundings. Heat has the International System of Units, unit Joule (J) as a form of energy (SI). However, the British Thermal Unit (BTU) and the calorie are frequently used in many applied fields of engineering. The Watt (W), defined as one joule per second, is the standard unit for the rate of heat transfer. Rudolf Clausius coined the symbol Q to represent the total amount of energy transferred as heat in 1850: "Let the amount of heat which must be imparted during the transition of the gas in a definite manner from any given state to another, in which its volume is v and its temperature t, be called Q."