Heat

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Key Concepts

- Heat is energy that transfers between a source and a sink because of a difference in temperature between them.
- Heat always moves from the higher-temperature object or system to the lower-temperature object or system. In general, the temperature of the former decreases as the temperature of the latter increases.
- It is inaccurate to consider heat as energy inherent within an object while the energy is not flowing.
- Heat differs from work, the other type of energy in transit, in that the conversion of heat to work is limited by the second law of thermodynamics.

Energy that is in transit, but unassociated with matter, and that results from a temperature difference between the source from which the energy is coming and the sink toward which the energy is going. When two objects or systems with differing temperatures, or amounts of inherent energy, are in contact, heat transfers from the higher-temperature to the lower-temperature object or system. In general, the temperature of the former (the source), decreases as the temperature in the latter (the sink) increases (see **illustration**). The matter in the objects can undergo a phase transition, for instance from solid to liquid, due to the flow of heat energy and not experience a change in temperature. *See also:* AMORPHOUS SOLID; CRYSTAL; ENERGY; HEAT TRANSFER; LIQUID; MATTER (PHYSICS); PHASE TRANSITIONS; TEMPERATURE.

In common usage, "heat" is thought of as energy within an object or system relating directly to the object's or system's temperature. While it is accurate that objects or systems with higher temperatures will tend to contain more energy, the correct consideration of heat is only as the energy being transferred; that is, energy is not called "heat" before it starts to flow, nor after it has ceased to flow. *See also:* INTERNAL ENERGY.

For the purposes of thermodynamics, it is convenient to define all energy while in transit as either heat or work. Heat flow is a result of a potential temperature difference between the source and sink. Work is energy in transit as a result of a difference in any other potential, such as height. Work may be thought of as that energy which can be completely used for the examples of lifting weights or stretching a spring. Heat differs from work, the other type of energy in transit, in that its conversion to work is limited by the fundamental second law of thermodynamics, or Carnot efficiency. This natural law is that the fraction of the heat Q convertible to work is

Hot, molten lava flows into the comparatively cold water of the ocean. Energy in the form of heat transfers from the lava to the water, raising the temperature of the latter and causing evaporation. At the same time, the temperature of the lava lowers, and the material begins to darken and solidify. (Credit: Shutterstock / Claudio Rossol)

determined by the relation $dW = Q(dT/T)$ for processes where the source and sink are differentially different in temperature, or by the relation $dW = dQ(T_1 - T_2)/T_1$ where the source (at T_1) and the sink (at T_2) differ by a finite temperature interval. *See also:* CARNOT CYCLE; THERMODYNAMIC PROCESSES; TRANSPORT PROCESSES; WORK; WORK FUNCTION (THERMODYNAMICS).

For the above relations to be valid, temperature must be expressed on a thermodynamic temperature scale. Conversely, any temperature scale for which the above relations are valid, irrespective of the substance or material under investigation, is a thermodynamic temperature scale. The perfect gas law defines a scale in which the temperature is proportional to the thermodynamic temperature. In order to make the two scales be identical, the triple point of water (temperature and pressure at which ice, water, and vapor are in equilibrium) is defined to be at 273.16 kelvins on both the ideal-gas and the thermodynamic scales. *See also:* GAS; THERMODYNAMIC PRINCIPLES; TRIPLE POINT; WATER.

The unit of work or energy (as heat) in the International System of Units is the joule, symbolized J. Calorimetry is the measurement of the quantity of heat transferred to or from an object. The measure of the heat required to raise the temperature of a substance is known as specific heat. *See also:* CALORIMETRY; SPECIFIC HEAT; SPECIFIC HEAT OF SOLIDS; UNITS OF MEASUREMENT.

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Keywords

Heat; temperature; hotness; coldness; heat transfer; heat energy; heat flow; energy flow; energy transfer; temperature gradient

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