Thermal energy meaning in physics

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The term "thermal energy" is often used ambiguously in physics and engineering.[1] It can denote several different physical concepts, including:

Mark Zemansky (1970) has argued that the term "thermal energy" is best avoided due to its ambiguity. He suggests using more precise terms like "internal energy" and "heat" to avoid confusion.[1] The term is, however, used in some textbooks.[2]

In thermodynamics, heat is energy in transfer to or from a thermodynamic system by mechanisms other than thermodynamic work or transfer of matter, such as conduction, radiation, and friction.[3][4] Heat refers to a quantity in transfer between systems, not to a property of any one system, or "contained" within it; on the other hand, internal energy and enthalpy are properties of a single system. Heat and work depend on the way in which an energy transfer occurs. In contrast, internal energy is a property of the state of a system and can thus be understood without knowing how the energy got there.[5]

In addition to the microscopic kinetic energies of its molecules, the internal energy of a body includes chemical energy belonging to distinct molecules, and the global joint potential energy involved in the interactions between molecules and suchlike.[6] Thermal energy may be viewed as contributing to internal energy or to enthalpy.

The internal energy of a body can change in a process in which chemical potential energy is converted into non-chemical energy. In such a process, the thermodynamic system can change its internal energy by doing work on its surroundings, or by gaining or losing energy as heat. It is not quite lucid to merely say that "the converted chemical potential energy has simply become internal energy". It is, however, sometimes convenient to say that "the chemical potential energy has been converted into thermal energy". This is expressed in ordinary traditional language by talking of "heat of reaction".[7]

In a body of material, especially in condensed matter, such as a liquid or a solid, in which the constituent particles, such as molecules or ions, interact strongly with one another, the energies of such interactions contribute strongly to the internal energy of the body. Still, they are not immediately apparent in the kinetic energies of molecules, as manifest in temperature. Such energies of interaction may be thought of as contributions to the global internal microscopic potential energies of the body.[8]

In a statistical mechanical account of an ideal gas, in which the molecules move independently between instantaneous collisions, the internal energy is just the sum total of the gas"s independent particles" kinetic

energies, and it is this kinetic motion that is the source and the effect of the transfer of heat across a system"s boundary. For a gas that does not have particle interactions except for instantaneous collisions, the term "thermal energy" is effectively synonymous with "internal energy".[9]

When there is no accompanying flow of matter, the term "thermal energy" is also applied to the energy carried by a heat flow.[14]

All objects are made up of atoms and molecules-- so many that it would take longer than the Universe"s estimated lifetime to count. The constant and random motion of an object"s atoms or molecules is what determines its Thermal Energy. Thermal Energy is a component of internal energy, but is unrelated to the vibrational and rotational energy of a solid"s atoms. Instead, Thermal Energy occurs from atoms" translational motion.

When we say "change of thermal energy," we mean that it is the part of the internal energy that is associated with a Temperature change. Thermal Energy is quantified using temperature. This quantification describes the approximate average Thermal Kinetic Energy present in all of the atoms or molecules in the object/sample/system. In the real world, it is often impossible to accurately state how much of an object"s internal energy is Thermal. However, if the Heat Capacity and mass of am object is known, we can measure its temperature using a thermometer and calculate its Thermal Energy.

A change in Thermal Energy can be calculated by using the following equation: