Thermodynamics

Thermodynamics is the branch of physics that studies relationships between thermal energy, work, entropy, temperature, chemical potential, pressure, volume and related physical quantities of macroscopic systems. Thermodynamics plays a role in a wide variety of such systems. The changes in the above quantities in response to a change in the environment are governed by the four laws of thermodynamics.

Zeroth Law: If two systems are each in thermal equilibrium with a third, they are also in thermal equilibrium with each other.

First Law: In a process without transfer of matter, the change in internal energy, ΔU of a thermodynamic system is equal to the energy gained as heat, ΔQ less the thermodynamic work, ΔW done by the system on its surroundings.

Second Law:

The second law of thermodynamics expresses the common wisdom that
not flow uphill". It is stated more precisely by Clausius:

> There does not exist a thermodynamic transformation whose sole
> deliver heat from a reservoir of lower temperature to a reservoir
> temperature.

An equivalent statement is due to Kelvin:

> There does not exist a thermodynamic transformation whose sole
> extract heat from a reservoir and convert it entirely into work.

The above is an extracted from the book on Statistical Physics by Kerson Huang.

Third Law:

The entropy of a system approaches a constant value as the temperature approaches zero. The earliest statement of this law, due to Nernst, is that at absolute zero the entropy difference disappears between all those configurations of a system which are in internal thermal equilibrium. Except for glasses, there would not be any objection to affirming that the multiplicity of available states is a small number and hence entropy is essentially zero. Glasses have a frozen-in disorder, and for them entropy can be substantial, of the order of the number of atoms N. What the third law tells us is that curves of many reasonable physical quantities plotted against absolute temperature T must come in flat as T approaches 0.

The above is an extracted from the book on Thermal Physics by Kittel & Kroemer.

Statistical Mechanics

Statistical Mechanics is the mathematical theory of combining laws of quantum or classical mechanics of individual physical entities with statistics to derive macroscopic behavior of thermodynamic systems. It provides a connection between the microstates of a large system of particles or quanta to predict its macroscopic behavior.