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University of Oregon; Spring 2008

Physics 353: The Laws of Thermodynamics

It's worth noting the "Laws of Thermodynamics." They were formulated based on empirical understandings of thermodynamics before the invention of statistical mechanics, and so were quite a remarkable intellectual feat. However, since they don't contain the clarity of statistical mechanics, they are, in my opinion, confusing and opaque. I don't like them. But here they are:

Zeroth Law

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

First Law

In any process, the total energy of the universe remains constant.
i.e. Energy is conserved
i.e. $đQ = dU + đW$

Second Law

In an isolated system, a process can occur only if it increases the total entropy of the system. *or*
Heat cannot spontaneously flow from a material at lower temperature to a material at higher temperature. *or*
It is impossible to convert heat completely into work. *or*
There is no process that, operating in a cycle, produces no other effect than the subtraction of a positive amount of heat from a reservoir and the production of an equal amount of work.

As you can see, there are many possible formulations of the second law, all of which are equivalent (though not always obviously so). The second law is the hardest law to express without the benefit of statistical mechanics. The above formulations were developed by Rudolf Clausius and Lord Kelvin; I've taken the phrasing from Wikipedia's article on the second law.

Third Law

As temperature approaches absolute zero, the entropy of a system approaches a constant.
i.e. The number of available states is just the ground state (or multiple degenerate ground states).
This is equivalent to saying that one can't exactly reach absolute zero temperature. I won't go into this; you can think about it.

As phrased by the poet Allen Ginsburg:

First law: "You can't win." (Energy is conserved.)
Second law: "You can't break even." (Entropy increases, so can't turn energy completely into mechanical work.)
Third law: "You can't quit." (I'm not sure what this means, but it sounds good. Perhaps it refers to the fact that you can't get to zero temperature; if you could, you could "break even.")