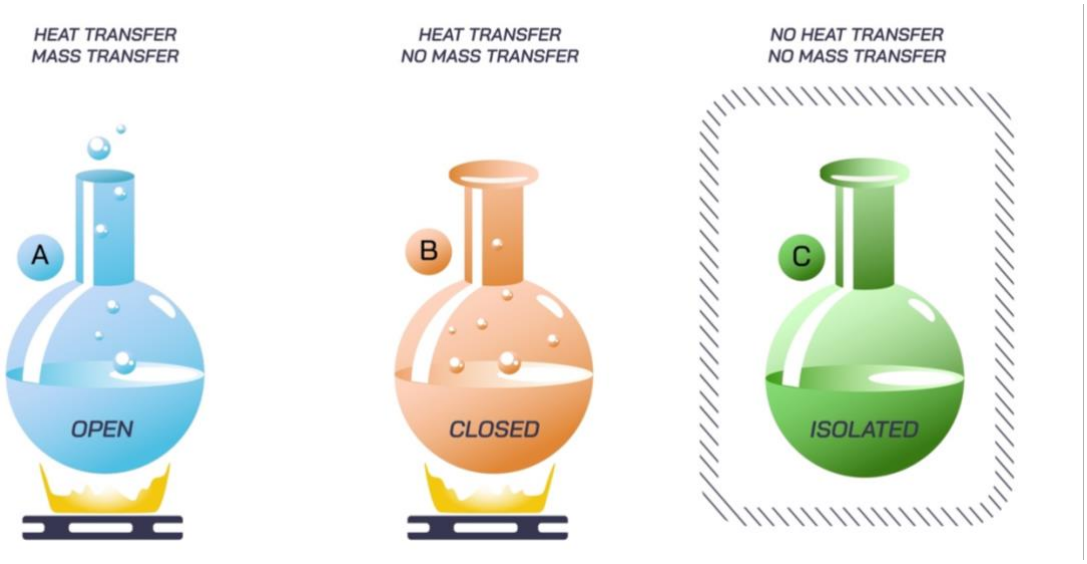
Science V13/S6 - Laws of Thermodynamics

Thermodynamics is the study of the effects of energy on a system, specifically, how energy transfer occurs in molecules. The laws of thermodynamics were not described all at once by a single scientist, but rather our understanding grew alongside advancements in physics and chemistry. The first ideas around thermodynamics were described in the early 1800s and would eventually become what we now call the second law of thermodynamics. A few decades later, scientists had described the first two laws, with the third law formulated in the early 1900s. Finally, a fourth law was added, but it would be called the zeroth law because it provided a clearer definition of temperature that added to the understanding of the first three laws.

Although the laws of thermodynamics are important, particularly in the development of engines, they can be difficult to grasp. To understand the basics of thermodynamics, you need to first understand what a "system" is. A system is the item or items that we are interested in. Everything outside of that system is called the surroundings. There are three types of systems in thermodynamics: open, closed, and isolated.

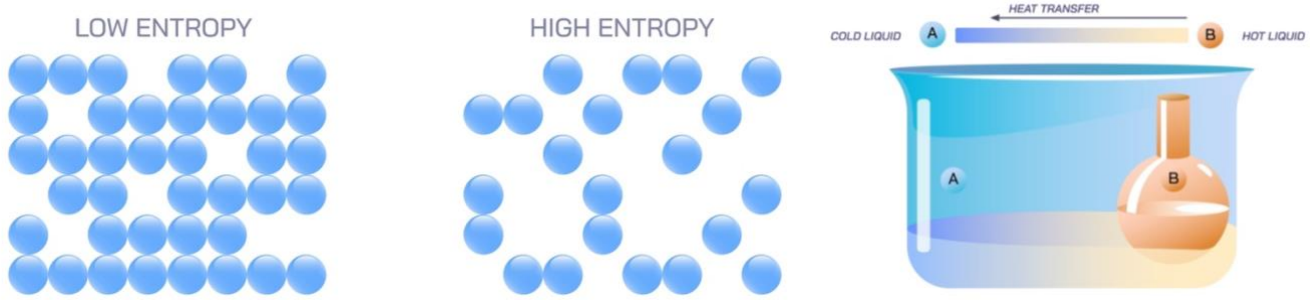
- An **open system** can exchange both energy and matter with its surroundings.
- A **closed system** can exchange only energy with its surroundings, not matter.
- An **isolated system** is one that cannot exchange either matter or energy with its surroundings.



There are complex equations and explanations for each of the four laws that physicists use to predict the operation of a physical system, but we can summarize the main point of each law in more simplistic terms.

The **first law** of thermodynamics deals with the total amount of energy in the universe. It states that energy can be converted from one form to another by heat, work, or internal energy, but it cannot be created nor destroyed. This law is also called the conservation of energy.

A simplified version of the **second law** states that energy in the universe is always moving from an ordered to a disordered form. Another word for this is **entropy**, and it is always increasing, which means more disorder. A basic example is that heat does not spontaneously pass from a colder body to a warmer body. Energy is always being transferred to try to even out the entropy, or the randomness, of a system.



The **third law** of thermodynamics states that a system's entropy only approaches a constant value (and does not change) as the temperature approaches absolute zero. At absolute zero temperatures, the system is in the state with the minimum thermal energy. This is theoretical because scientists know they can never reach this; it is impossible with our current knowledge to remove all thermal energy from a system.

The final law, actually called the **zeroth law**, has to do with defining an energy equilibrium. The zeroth law of thermodynamics states that if two systems are in thermodynamic equilibrium with a third system, the two original systems are in thermal equilibrium with each other. This may seem basic compared to the other laws, but it was important for scientists to define to make the more advanced equations of thermodynamics make sense in calculations.