1. Basic Terminology
   1. [Thermodynamics](https://en.wikipedia.org/wiki/Thermodynamics)

The term *Thermodynamics* stems from the two Greek words *therme* and *dynamikos* which respectively translate to English as *heat* and *power*. Put together, these two words define a, **“branch of *physics* dealing with the *transformation* of heat into or from other forms of energy such as mechanical, magnetic, electrical etc. as well as the laws which govern such transformations”** (Laughlin, 2018). The addition of *chemical work* by Gibbs has allows for thermodynamics to apply to chemical reactions.

In studying thermodynamics, it is important to note how it differs from traditional Newtonian mechanics as that *Equilibrium Thermodynamics* deal with the same quantities with the exception of time. In Newtonian mechanics we have to deal with specific units such as *mass* (kg), *distance* (m), *volume* (m3), *time* (s), *velocity* (m/s), and *momentum* (kg m/s). These variables can be put together into formulas for:

In equilibrium thermodynamics, time is not used as a running variable, rather the states of systems are defined in two different periods: *Now* (t = 0, the state of a system) and *Future* (t = ∞, equilibrium state of a system). In addition to these quantities of mechanics three other quantities are also used in thermodynamics: *temperature* (T), *thermal energy* (Q), and *entropy* (S). The central focus of applied thermodynamics is to determine the effect that the *surroundings* have on the *equilibrium state* of a given *system*. The other focus is the, “establishment of relationships which exist between the equilibrium state of a given system and the influences which have been brought to bear on it” (Gaskell & Laughlin, 2017, p.4). Or in other words, is to look at the relationships that exist between the system’s equilibrium state and its influences.

* 1. [Systems](https://en.wikipedia.org/wiki/Thermodynamic_system)

A *System* simply defined is the, **“part of the universe with which we are interested in investigating”** (Laughlin, 2018). The surrounding areas which may interact with the system through either energy or matter exchange are denoted as either the *surroundings* or *environment*. A system is allowed to perform work on the surroundings or have work performed on it from the surrounding. In the context of materials science, the system is typically a material and the interactions between the system and surrounds depends of the *boundary* or *wall* of the system. All of this is encapsulated in what is called the *universe* which in the context of thermodynamics is defined as everything.

Boundary

Surroundings

(Universe)

System

Figure 1: Diagram of a system’s relationship with its surroundings

Examples of systems can range from simple heat engines to devices such as transducers, however in the study of thermodynamics a system is usually composed of matter which can be anything that contains mass and occupies space. *Matter* in the context of thermodynamics, “has a given temperature, pressure, and chemical composition, as well as physical properties such as thermal expansion, compressibility, heat capacity, viscosity, and so on” (Gaskell & Laughlin, 2017, p.4).

* + 1. Isolated Systems

An *isolated system* is a system where energy and overall composition remain constant. In this system, energy and matter cannot enter or leave and also no work is done on or by the system. Thus, changes in the surroundings will not have an effect on the system.

* + 1. Closed Systems

A *closed system* is a system which may give or receive energy to or from its surroundings, respectively. It has boundaries which are *diathermal* in that the transfer of thermal energy between the system and surroundings are not prohibited but the transfer of matter is prohibited. This causes the amount of matter within the system to remain constant.

* + 1. Open Systems

An *open system* is a system that allows for the both energy and matter to be exchanged between the system and its surroundings. With this neither the energy nor the composition of these systems will need to remain constant as the boundaries are both permeable and diathermal.

* 1. [Boundaries (Walls)](https://en.wikipedia.org/wiki/Thermodynamic_system#Walls)

**The boundaries or walls of a system is the barrier in which selectively determine which interactions may take place between a system and its surrounding.** With this there are several different types of walls, each of which allow for selective types of interactions.

* + 1. Adiabatic

An *adiabatic* wall does not allow for thermal energy to pass through

* + 1. Diathermal

A *diathermal* wall does allows of thermal energy to pass through

* + 1. Permeable

A *permeable* wall allows for matter to pass through

* + 1. Impermeable

An *impermeable* wall does not allow for matter to pass through

* + 1. Semipermeable

A *semipermeable* wall allows for some component to pass through which prohibiting others.