THE FIRST LAW OF THERMODYNAMICS

$$\Delta U = Q - W$$

Change in system's internal energy = energy transferred to or from system as heat – energy transferred to or from system as work

When this equation is used, all quantities must have the same energy units. Throughout this chapter, the SI unit for energy, the joule, will be used.

According to the first law of thermodynamics, a system's internal energy can be changed by transferring energy as either work, heat, or a combination of the two. The thermodynamic processes discussed in Section 1 can therefore be expressed using the equation for the first law of thermodynamics, as shown in **Table 2.**

Table 2 First Law of Thermodynamics for Special Processes

Process	Conditions	First law of thermodynamics	Interpretation
Isovolumetric	no work done	$\Delta V = 0$, so $P\Delta V = 0$ and $W = 0$; therefore, $\Delta U = Q$	Energy added to the system as heat ($Q > 0$) increases the system's internal energy. Energy removed from the system as heat ($Q < 0$) decreases the system's internal energy.
Isothermal	no change in temperature or internal energy	$\Delta T = 0$, so $\Delta U = 0$; therefore, $\Delta U = Q - W = 0$, or $Q = W$	Energy added to the system as heat is removed from the system as work done by the system. Energy added to the system by work done on it is removed from the system as heat.
Adiabatic	no energy transferred as heat	$Q = 0$, so $\Delta U = -W$	Work done on the system ($W < 0$) increases the system's internal energy. Work done by the system ($W > 0$) decreases the system's internal energy.
Isolated system	no energy transferred as heat and no work done on or by the system	$Q = 0$ and $W = 0$, so $\Delta U = 0$ and $U_i = U_f$	There is no change in the system's internal energy.