The internal energy of a system is identified with the random, disordered motion of molecules; the total (internal) energy in a system includes potential and kinetic energy. This is contrast to external energy which is a function of the sample with respect to the outside environment (e.g. kinetic energy if the sample is moving or potential energy if the sample is at a height from the ground etc). The symbol for Internal Energy Change is \( \Delta U \).

Energy on a smaller scale

- Internal energy includes energy on a microscopic scale
- It is the sum of all the microscopic energies such as:
  1. translational kinetic energy
  2. vibrational and rotational kinetic energy
  3. potential energy from intermolecular forces

Example

One gram of water at zero °Celsius compared with one gram of copper at zero °Celsius do NOT have the same internal energy because even though their kinetic energies are equal, water has a much higher potential energy causing its internal energy to be much greater than the copper's internal energy.

**Internal Energy Change Equations**

The first law of thermodynamics states:

\[ \Delta U = dq + dw \]

where \( dq \) is heat and \( dw \) is work.

An isolated system cannot exchange heat or work with its surroundings making the change in internal energy equal to zero:

\[ \Delta U_{\text{isolated system}} = 0 \]

Therefore, in an isolated system:

\[ dq = -dw \]
Energy is Conserved

\[dU_{\text{isolated system}} = dU_{\text{system}} + dU_{\text{surroundings}}\]
\[dU_{\text{system}} = -dU_{\text{surroundings}}\]

The signs of internal energy

- Energy entering the system is **POSITIVE** (+), meaning heat is absorbed, \(q>0\). Work is thus done on the system, \(w>0\).
- Energy leaving the system is **NEGATIVE** (-), meaning heat is given off by the system, \(q<0\) and work is done by the system, \(w<0\).

Quick Notes

- A system contains **ONLY** Internal Energy
- A system does NOT contain energy in the form of heat or work
- Heat and work only exist during a change in the system; they are path functions
- Internal energy is a state function

Outside Links


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