General Chemistry

Chapter 5 • Enthalpy

Review

Definitions:

- **Energy:** the capacity to do work or transfer heat.
- **Work:** the energy used to cause an object to move against a force. $w = Fd$
- **Heat:** the energy used to cause the temperature of an object to increase.
- **Kinetic energy:** the energy of motion. $E_k = \frac{1}{2}mv^2$
- **Potential energy:** the energy possessed by an object by virtue of its position relative to others, stresses within itself, electric charge, and other factors.
- **System:** the portion that single out for study.
- **Surroundings:** everything except the system.
- **Internal energy:** the sum of all the kinetic and potential energies of the components of the system. $\Delta E = E_{final} - E_{initial} = q + w$
- **Endothermic:** the process occurs in which the system absorbs heat.
- **Exothermic:** the process in which the system loses heat.

Table 5.1 Sign Conventions for q, w, and ΔE

For q	+ means system *gains* heat	− means system *loses* heat
For w	+ means work done *on* system	− means work done *by* system
For ΔE	+ means *net gain* of energy by system	− means *net loss* of energy by system

- **State function:** a function defined for a system relating several state variables or state quantities that depends only on the current equilibrium state of the system, not on the path the system took to reach that state.
- **Enthalpy:** the internal energy plus the product of the pressure and volume of the system.

$$H = E + PV$$

- **Pressure-volume work (P-V work):** the work involved in the expansion or compression of gases.
- **Enthalpy change in constant pressure:**

$$\Delta H = \Delta(E + PV) = \Delta E + P\Delta V = (q_p + w) - w = q_p$$

- **Enthalpy of reaction (heat of reaction):** the enthalpy change that accompanies a reaction.

$$\Delta H_{rxn} = H_{product} - H_{reactant}$$

- **Thermochemical equation:** balanced chemical equations that show the associated enthalpy change.
- **Heat capacity (C):** the amount of heat required to raise its temperature by 1 K(or 1℃). (unit: J/K, J/°C)

- **Molar heat capacity (C_m):** the heat capacity of one mole of a substance. (unit: J/mol-K, J/mol-^oC)
- **Specific heat capacity (C_s):** the heat capacity of one gram of a substance, or merely named as specific heat. (unit: J/g-K, J/g-^oC)

- **Hess's Law:** If a reaction is carried out in a series of steps, ΔH for the overall reaction equals the sum of the enthalpy changes for the individual steps.
- **Enthalpies of formation (ΔH_f):** the enthalpy change associated with the process of the formation of a compound from its constituent elements.
- **Standard state:** 1atm, 298 K (25℃)
- **Standard enthalpy change of a reaction (ΔH^0):** the enthalpy change when all reactants and products are in their standard states.
- **Standard enthalpy of formation of a compound (ΔH_f^0):** the enthalpy change for the reaction that forms one mole of the compound from its element with all substance in their standard states.
  Note: the standard enthalpy of formation of the most stable form of any element is zero.

Basic knowledge points:

- **The first law of thermodynamics:** the energy can be transferred back and forth between a system and its surroundings in the forms of work and heat, and that energy is conserved**.**

- **The guidelines of the enthalpy of reactions:**

1) Enthalpy is an extensive property.
2) The enthalpy change for a reaction is equal in magnitude, but opposite in sign, to ΔH for the reverse reaction.
3) The enthalpy change for a reaction depends on the states of the reactants and products.

- **Quantity of heat transferred:** $q = C_s \times m \times \Delta T$

- $\Delta H_{rxn}^0 = \sum n\Delta H_f^0(products) - \sum m\Delta H_f^0(reactants)$