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Chapter 5: Thermochemistry

Joule (J): a unit for energy

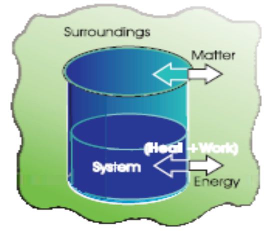
- *In chemistry, we use kilojoules (kJ)*

calorie (cal): measurement of energy change accompanying chemical reactions

- 1 cal = 4.184 J

System vs Surroundings

- SYSTEM is what we're studying. Usually the chemicals in a chemical reaction
- SURROUNDINGS are everything else. Usually the container in which the reaction is occurring
  - Closed system: usually what we study; can exchange energy, but not matter, with its surroundings



First Law of Thermodynamics: Energy is conserved

- $\Delta E = E_{final} - E_{initial}$
  - $+\Delta E$ ➔ $E_{final} > E_{initial}$ ➔ System gained energy
  - $-\Delta E$ ➔ $E_{final} < E_{initial}$ ➔ System lost energy
- (delta) E = q + w
  - q is heat, w is work

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

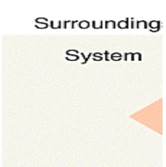
- **Endothermic:** system absorbs heat; heat flows *into* the system *from* the surrounding
- **Exothermic:** the system releases heat; heat flows *from* the system *to* the surrounding
- Energy is a **state function**
  - ΔE depends only on the initial and final states of the system, not on how the change occurs

Enthalpy: heat absorbed or released under constant pressure

- Enthalpy is a state function
- $\Delta H = \Delta H_{final} - \Delta H_{initial} = q_p$ (heat at constant pressure)
  - $+\Delta H$ = endothermic reaction
  - $-\Delta H$ = exothermic reaction

Enthalpy of reaction (or heat of reaction)

- $\Delta H_{rxn} = H_{products} - H_{reactants}$
- Enthalpy is an *extensive* property: the magnitude of ΔH is directly proportional to the amount of reactant and product consumed in the process
- If you reverse the direction of the reaction, ΔH is the same magnitude, but w/ reversed sign
  - Ex: CH4 + 2O2 → CO2 + H20 ΔH = -890 kJ
    CO2 + 2H2O → 2O2 =CH4 ΔH = 890 kJ
- Enthaply change depends on the state of the reactants and products



Practice Problem!

How much heat has been released when 4.50 g of methane gas is burned in a constant pressure system? Is the reaction endothermic or exothermic?

CH4 + 2O2 → CO2 + H20 ΔH = -890 kJ

Heat = (4.50 g CH4)(1 mol CH4/16.0 g CH4)(-890 kJ/1 mol CH4) = -250 kJ

The negative sign in front of our answer tells us that the reaction is exothermic