Chapter 6: Thermochemisty

6.1 The Nature of Energy

* energy (E) : the capacity to do work or produce heat. It can be classified as either potential or kinetic energy.
    - potential energy : energy due to position or composition.
        - attractive and repulsive forces can also lead to potential energy
    - kinetic energy : the energy of an object due to its motion.
      $KE = \frac{1}{2}mv^2$
    - m is the mass, v is the velocity

* Energy can be converted from one form to another. (Potential energy is converted into kinetic energy and vice versa.)
    - frictional heating : kinetic energy transferred into an object's surroundings as heat

* the Law of Conservation of Energy : states that energy can be converted from one form to another but can be neither created nor destroyed.

* heat: involves the transfer of energy between two objects because of temperature difference

* work: force acting over a distance

* pathway: the way energy transfer is divided between work and heat depending on specific conditions.

* state function/state property - refers to a property of the system that depends only on its present state.

* system - the part of the universe being focused on

* surroundings - everything else in the universe

* exothermic - when a reaction results in the evolution of heat, that is, where energy flows
  out of the system.
    - In any exothermic reaction, some of the potential energy stored in the chemical is being converted to thermal energy (random kinetic energy) via heat.

* endothermic - when a reaction absorbs heat from its surroundings, and heat flows into the system.

* thermodynamics - the study of energy and its interconversions.

* the First Law of Thermodynamics - states that the energy of the universe is constant.
    - The energy gained by the surroundings must be equal to the energy lost by the system.

* internal energy - the sum of an objects kinetic and potential energies
    Work = $-P\Delta V$
    $\Delta E = q + w$
    ΔE is the change in the system's internal energy, q is the heat, and w is the work

6.2 Enthalpy and Calorimetry

* Enthalpy:
    (H) = E + PV
        ΔH = q(where pressure is constant)
            = heat
    $\Delta H = H_{prod} - H_{reactants}$
  - exothermic: ΔH is negative
  - endothermic: ΔH is posative

* Calorimetry: the science of measuring temperature changes
    - Substances respond differently to being heated.

* constant pressure calorimetry
    - heat of reaction = $c \times m \times \Delta T = q$
    - c = specific heat, m = mass

* enthalpy per mole = heat released / mol of substance
        = KJ/mol

* extensive property: depends directly on the amount of substance
    - ex. : heat of a reaction

* intensive property: not related to the amount of a substance
    - ex : temperature

6.3 Hess's Law

* Hess's Law - states that in going from a particular set of reactants to a particular set of products, the change in enthalpy is the same whether the reaction takes place in one step or in a series of steps.

* Characteristics of Enthalpy Changes
    1. If a reaction is reversed the sign of ΔH is also reversed.
    2. The magnitude of ΔH is directionally proportional to the quantities of reactants and products in a reaction. If the coefficients in a balanced reaction are multiplied by an integer, the value of ΔH is multiplied by the same integer.

6.4 Standard Enthalpies of Formation

* standard enthalpy of formation ($\Delta H_f°$) - change in enthalpy that accompanies the formation of one mole of a compound from its elements with all substances in their standard state.
    - A degree symbol on a thermodynamic function, for example, $\Delta H°$, indicates that the corresponding process has been carried out under standard conditions.

* standard state - a precisely defined reference state (for example 1atm, 25°C)

* The enthalpy change for a given reaction can be calculated by subtracting the enthalpies of formation of the reactants from the enthalpies of formation of the products.

$$\Delta H°_{reaction} = \Sigma n_p \Delta H_f°(_{products}) - \Sigma n_r \Delta H_f°(_{reactants})$$

    - Elements are not included in the calculation because elements require no change in form.

6.5 Present Sources of Energy

* fossil fuels: created over processes of millions of years involving the conversion of photosynthetic plants or their decay products.
    - petroleum : a thick, dark liquid composed of hydrocarbons. It originated from marine organisms that existed over 500 million years ago.
    - natural gas: associated with petroleum. Includes: methane, ethane, propane, ect.
    - coal: formed from the remains of plants that were buried and subjected to high pressures until it “matured”

* greenhouse effect: when the atmosphere disallows infrared radiation to return to space, thus producing a net increase in the temperature on earth. It is caused by an excess of carbon dioxide concentration in the atmosphere, a result of the burning of fossil fuels.

6.6 New Energy Sources

* coal conversion: through the process of coal gasification, the coal structure is broken down to make gaseous coal from the solid substance. The desired product is a mixture of carbon monoxide and hydrogen, which can react with oxygen to combust and release heat.
    - syngas: a synthetic gas.

* hydrogen as a fuel:
    - The heat of combustion of H_2 gas per gram is 2.5 that of natural gas.
    - Hydrogen gas to be used for fuel can be obtained through such methods as the treating of methane or the electrolysis of water.