Unit 3: Energy Changes and Rates of Reaction

5.1 Changes in Matter and Energy

- Thermochemistry: the study of the energy changes that accompany physical or chemical changes in matter.

- Thermal energy: energy available from a substance as a result of the motion of its molecules.

- System: The event that is being studied ex. Chemical system: a set of reactants and products, usually represented by a chemical equation.

- Surroundings: all matter around the system that is capable of absorbing or releasing thermal energy.

- Heat (q): amount of energy transferred between substances.
    - A substance does not contain heat.
    - Heat is the transfer of thermal energy.

- Exothermic: releasing thermal energy as heat flows out of the system.

- Endothermic: absorbing thermal energy as heat flows into the system.

- Temperature: average kinetic energy of the particles in a sample of matter.

- Open system: a system which both matter and energy can move in or out.

- Isolated system: a system which neither matter nor energy can move in or out.

- Closed system: a system which energy can move in or out, but not matter.

Measuring Energy Changes:

- **Calorimetry**: the technological process of measuring energy changes in a chemical system.
- Calculation of heat transferred: $q = mc\Delta T$

where, q = heat transferred ΔT = change in temperature
m = mass c = specific heat capacity

Exothermic = -q **Endothermic** = +q

(Heat energy entering a system adds energy to the system and hence its positive value. A negative value indicates a loss of heat energy by the system)
Specific Heat Capacity

- The quantity of heat required to raise the temperature of a unit mass of a substance 1°C or 1K.
  - Need to know for $H_2O_{(l)}$ c = 4.18 J/(g·°C) = 1 calorie
  - Other values – table 1 page 301, appendix page 798

- Hot Metals in water

- Burning Cheezie Demonstration (Based on "Try This" on page 297)

  mass of junk food item: _____g

  mass of 25 mL of water: use the density of water

  m = 25 mL × 1.00 g/mL = 25 g

  c = 4.18 J/(g·°C)

  ΔT = final – initial = ____ °C – ____ °C

  q = ?

  $q = mc\Delta T$

Heat Transfer and Enthalpy Change

- Chemical systems have many different forms of energy, both kinetic and potential. These include the kinetic energies of
    - moving electrons within atoms;
    - the vibration of atoms connected by chemical bonds;
    - the rotation and translation of molecules that are made up of these atoms.

- More importantly, they also include
    - nuclear potential energy of protons and neutrons in atomic nuclei; and
    - electronic potential energy of atoms connected by chemical bonds.

- The total energy value of a system is known as **enthalpy**

- You cannot measure the sum of all the kinetic and potential energies of a system so chemists study enthalpy change (ΔH).

- Enthalpy change (ΔH) = the difference in enthalpies of products compared to the reactants during after a physical, chemical or nuclear change.

    For an exothermic event, ΔH is a negative (-) value.
    For an endothermic event, ΔH is a positive (+) value

- See figure 6 on page 303 for visual representation of the flow of energy in a reaction.

- See table 2 on page 304 for types of enthalpy changes.

- Physical change: a change in the form of a substance, in which no chemical bonds are broken.

- Chemical change: a change in the chemical bonds between atoms, resulting in the rearrangement of atoms into new substances.

- Nuclear change: a change in the protons or neutrons in an atom, resulting in the formation of new atoms.

Homework

- Practice 1,2,3,4,5,8,9,10,11,12,13,14,15
- Questions 1,2,3,4,5

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