Thermochemistry

. . . is the study of energy changes that occur during chemical reactions and physical changes.

LESSON 1: Terminology

Primary Learning Goals

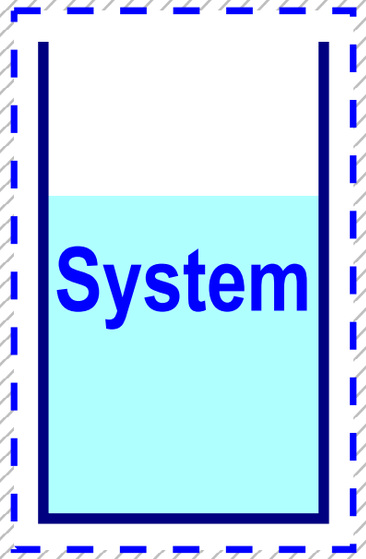
I can describe and recognise open, closed, and isolated systems.

I can differentiate between exothermic and endothermic reactions.

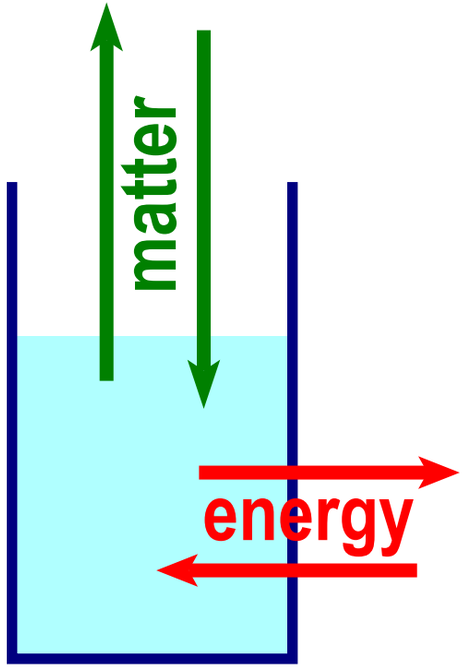
I can contrast physical changes, chemical reactions, and nuclear reactions, and the resulting energy changes.

I can differentiate among temperature, thermal energy, and heat.

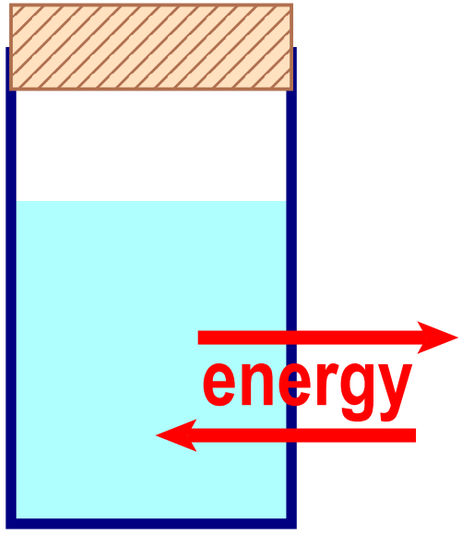
Surroundings



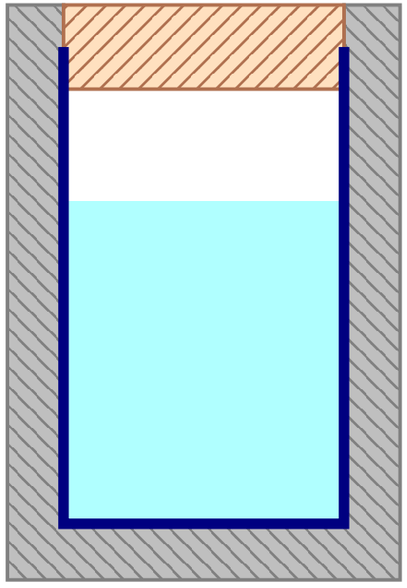
Open System



Closed System



Isolated System



System and Surroundings

system
- the part of the universe chosen for study

surroundings
- the part of the universe outside the system

open system
- can exchange energy and matter with its surroundings

closed system
- can exchange energy with its surroundings, but not matter

isolated system
- cannot exchange energy or matter with its surroundings

Exothermic and Endothermic Reactions

exothermic reaction

- gives off heat to the surroundings, or . . .
- produces a temperature increase in an isolated system

example

$CaCl_2(s) \rightarrow Ca^{2+}(aq) + 2\ Cl^-(aq) + 83\ kJ$

endothermic reaction

- absorbs heat from the surroundings, or . . .
- produces a temperature decrease in an isolated system

example

$KNO_3(s) + 35\ kJ \rightarrow K^+(aq) + NO_3^-(aq)$

Physical, Chemical, and Nuclear Changes

physical change

- does not produce new substances
- involves relatively low energy change (10^0 to 10^2 kJ/mol)

<u>example</u>

$H_2O(l) \rightarrow H_2O(s) + 6\ kJ$

chemical change

- produces new substances without changing atoms
- typically involves higher energy change (10^2 to 10^4 kJ/mol)

<u>example</u>

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(g) + 242\ kJ$

nuclear change

- produces new atoms
- involves very high energy change (10^{10} to 10^{12} kJ/mol)

example

$$^{235}U \rightarrow {}^{140}Cs + {}^{93}Rb + 2\,{}^{1}n + 20\,000\,000\,000\ kJ$$

Temperature, Thermal Energy, and Heat

Particles (molecules, atoms, ions) are in random motion (translational, rotational, vibrational).

The energy associated with motion is kinetic energy.

Temperature is a measure of the average kinetic energy of the particles in a substance.

Thermal energy is the total kinetic energy of the particles in a substance.

Heat is a transfer of thermal energy.