Mr. Bracken
AP Chemistry

Name _____
Period _____

Thermochemistry Notes #1

Thermochemistry: study of energy and its transformations during chemical reactions.

Kinetic Energy: Energy of Motion

Potential Energy: Energy associated with position

SI Units for Energy: Joules

Systems and Surroundings:

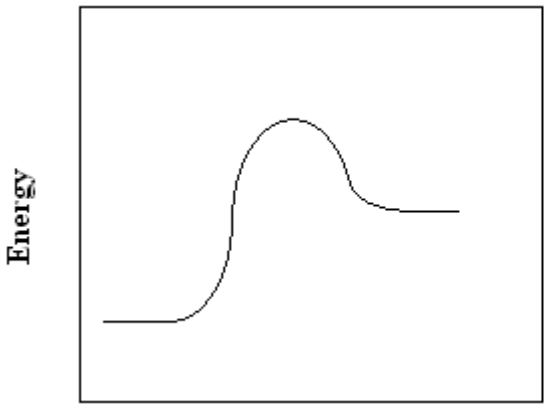
System generally refers to the chemicals
Surroundings refers to the container and everything outside the system.

Open Systems	**Closed Systems**	**Isolated Systems**
molecules can enter or exit	molecules cannot enter or exit	no molecules can enter or exit no energy can enter or exit

In chemical reactions, we are most interested in the change of internal energy of a system.

$$\Delta E = \Delta E_{final} - \Delta E_{initial}$$

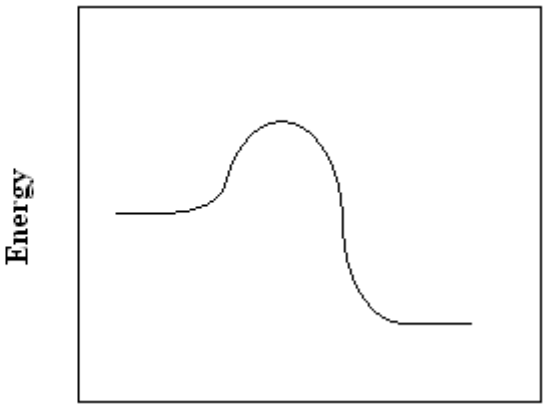
ΔE can be + or -, depending on the reaction



Endothermic

Products have more energy than reactants

$$2\,H_2O + \text{Energy} \rightarrow 2\,H_2 + O_2$$



Exothermic

Reactants have more energy than products

$$2\,H_2 + O_2 \rightarrow 2\,H_2O + \text{Energy}$$

Enthalpy: "Heat Content"

$$\Delta H = \Delta H_{products} - \Delta H_{reactants}$$

Endothermic Reactions:

- $\Delta H > 0$
- Heat absorbed by the system.
- System has more energy after reaction.

Exothermic Reactions:

- $\Delta H < 0$
- Heat released by the system.
- System has less energy after reaction.

Consider the following examples:

MELTING	$\mathbf{H_2O\ (s) \rightarrow H_2O\ (l)}$	$\Delta H = 6.01$ kJ
FREEZING	$\mathbf{H_2O\ (l) \rightarrow H_2O\ (s)}$	$\Delta H = -6.01$ kJ

Reversing a chemical equation will change the sign of the ΔH

$\mathbf{CH_4\ (g) + 2\ O_2\ (g) \rightarrow CO_2\ (g) + 2\ H_2O\ (g)}$	$\Delta H = -802.4$ kJ
$\mathbf{2\ CH_4\ (g) + 4\ O_2\ (g) \rightarrow 2\ CO_2\ (g) + 4\ H_2O\ (g)}$	$\Delta H = (2)(-802.4) = -1604.8$ kJ

If we multiply both sides of an equation, we must also multiply the ΔH value.

Using Standard Enthalpies of Formation in Chemical Equations

Key Formula: "PRODUCTS MINUS REACTANTS"

$$\Delta H^{o}_{rxn} = \Sigma \Delta H^{o}_{f}\,(\text{Products}) - \Sigma \Delta H^{o}_{f}\,(\text{Reactants})$$

Example 1: What is the standard enthalpy of reaction for the equation shown below?

$$CuO\,(s) + H_2\,(g) \rightarrow Cu\,(s) + H_2O\,(l) \qquad \Delta H^{o}_{rxn} = ?$$

Answer = -129.7 kJ

Example 2: Calculate the ΔH^{o}_{rxn} for the following chemical reaction.

$$2\,Al\,(s) + Fe_2O_3\,(s) \rightarrow Al_2O_3\,(s) + 2\,Fe\,(s) \qquad \Delta H^{o}_{rxn} = ?$$

Answer = - 847.6 kJ

Example 3: Calculate the ΔH^{o}_{rxn} for the following chemical reaction.

$$CH_4\,(g) + 2\,O_2\,(g) \rightarrow CO_2\,(g) + 2\,H_2O\,(g) \qquad \Delta H^{o}_{rxn} = ?$$

Answer = - 802.34 kJ

1. How much heat is released when 3 moles of CH_4 is burned?

2. How much heat is released when 4.0 grams of CH_4 is burned?