Thermochemistry **Name**_____

Enthalpy

Read from **Lesson 2a Enthalpy Change in** the **Chemistry Tutorial Section, Chapter 12** of **The Physics Classroom**

Enthalpy

In chemistry, energy plays a crucial role in understanding how and why reactions occur. One key form of energy in chemical systems is **enthalpy**, denoted by **H**, which represents the total heat content of a system at constant pressure. Although absolute enthalpy cannot be measured, changes in enthalpy during a chemical reaction can be determined.

The change in enthalpy (**ΔH**) indicates whether heat is absorbed or released during a reaction:

- **If ΔH is negative**, the reaction **releases heat** to the surroundings—this is known as an **exothermic reaction** (e.g., combustion of fuels).
- **If ΔH is positive**, the reaction **absorbs heat** from the surroundings—this is an **endothermic reaction** (e.g., photosynthesis).

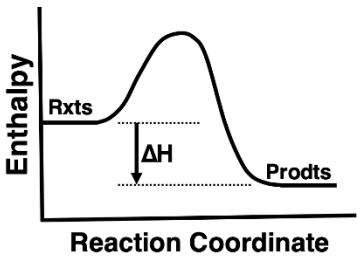
Chemists often express these energy changes using **thermochemical equations**, which are balanced chemical equations that include enthalpy changes. For example:

$$CH_4\,(g) + 2O_2\,(g) \rightarrow CO_2\,(g) + 2H_2O\,(g) \qquad \Delta H = -890\,kJ$$

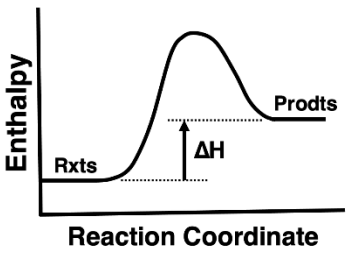
This equation shows that when methane burns in oxygen, **890 kJ of heat is released** per mole of methane combusted.

Questions

1. Label each of the following processes as either endothermic (N) or exothermic (X).
   - _____ a. Steam condensing to liquid water
   - _____ b. Ice melting into liquid water
   - _____ c. $2H_2O\,(g) + \text{energy} \rightarrow 2H_2\,(g) + 2O_2\,(g)$
   - _____ d. As salt dissolves in a glass of water, the temperature of the water increases.
   - _____ e. The potential energy of the reactants is greater than the potential energy of the products.
   - _____ f. ΔH is negative.
   - _____ g. The sublimation of dry ice.
   - _____ h. Sweat evaporating from your skin.
   - _____ i.



   - _____ i.



2. In the reaction, A + B → C + D + energy, which of the following is true?
   a. A and B have a higher potential energy than C and D, and the ΔH for the reaction is positive.
   b. A and B have a higher potential energy than C and D, and the ΔH for the reaction is negative.
   c. A and B lower a higher potential energy than C and D, and the ΔH for the reaction is negative.
   d. A and B lower a higher potential energy than C and D, and the ΔH for the reaction is positive.

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Thermochemistry

3. Compare these two enthalpy level diagrams, A and B. *(Enthalpy is measured in kJ)* Write **A**, **B**, or **none** in the space provided before each statement.

Diagram A

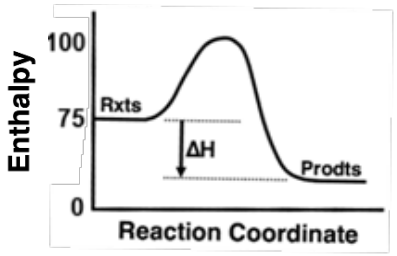
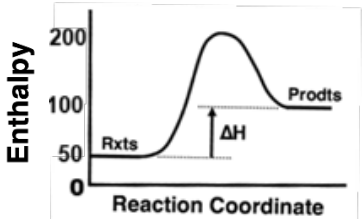


Diagram B



_____ a. Which diagram represents an endothermic reaction?

_____ b. Which diagram represents an exothermic reaction?

_____ c. Which diagram represents the reaction that releases heat to the surroundings?

_____ d. Which diagram represents a reaction that has an enthalpy change of 100 kJ??

_____ e. Which diagram represents a reaction that absorbs 50 kJ from its surroundings?

_____ f. Which diagram shows a reaction where the products have less energy than the reactants?

4. Sally Kon is camping and is roasting marshmallows. She burns a 25.0 g marshmallow which is mostly sugar or sucrose. The heat of combustion for sucrose is -5644.2 kJ/mol.

a. Write and balance a thermochemical equation for the combustion of sucrose, $C_{12}H_{22}O_{11}$.

b. How much energy is released when the marshmallow completely burns?

c. If that energy heats 1000 kg of water in a kettle that is sitting on the campfire, originally at 20.0°C, what is the final temperature of the water in the kettle? Assume that there is no heat loss.

5. Cal Kelvin works on the winter road crew that treats the roads with $CaCl_2$ before a snowstorm. When 10.0 g of $CaCl_2$ dissolves in 1000.0 g of water at 25.0°C, the temperature increases by 1.75°C.

a. Calculate the heat change during dissolving.

b. Is the process endothermic or exothermic? Explain your reasoning.

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