Enthalpy and Internal Energy

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Introduction to Enthalpy

When a reaction occurs under constant pressure (which is the usual situation), the energy changes in the reaction are described using Enthalpy (H) instead of the Internal Energy (U).

Enthalpy

- Enthalpy (H) is the sum of the Internal Energy (U) plus a PV term. The equation used in chemistry is

$$\Delta H_{rxn} = \Delta U_{rxn} + P\Delta V_{rxn}$$

Change in internal energy of the system (reaction)

Pressure-volume work

Enthalpy

- The big difference between ΔH and ΔU is the little bit of PV work that the reaction does to expand against atmospheric pressure.

$$\Delta H = \Delta U + P\Delta V$$

Enthalpy is a state function.

Constant P versus Constant V Conditions

- **ΔH is the heat** (of reaction) under **constant pressure** conditions.
(This means the volume can change).

$$\Delta H = \Delta U + P\Delta V$$

$$\Delta H = q_p$$

Constant P versus Constant V Conditions

- **ΔU is the heat** under **constant volume** conditions. The volume can't change, so **no PV work** is done during the reaction. ($\Delta V = 0$)

$$\Delta H = \Delta U + P\Delta V$$

$$= \Delta U + P(0) = \Delta U$$

$$\Delta U = q_v$$

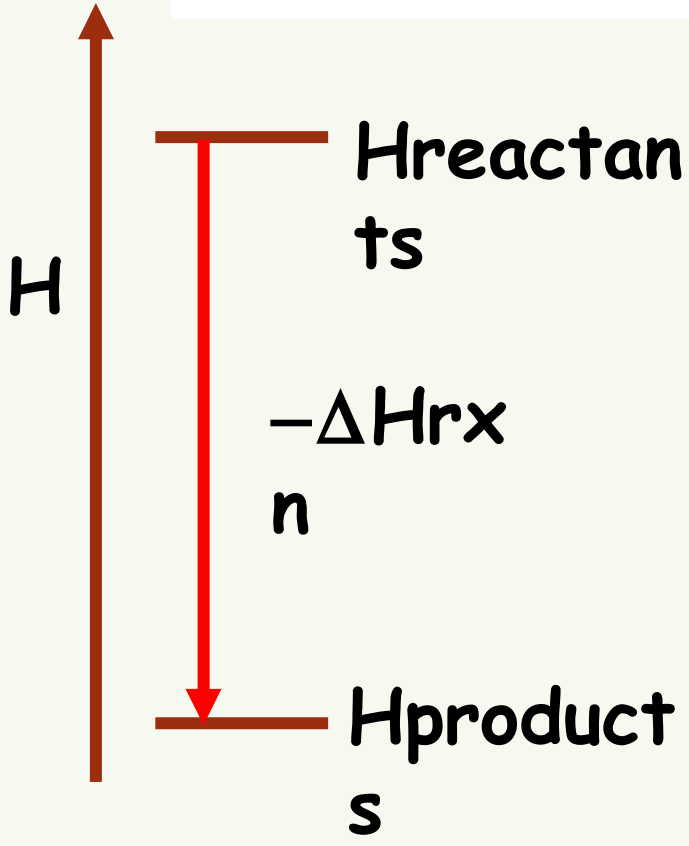
Thermochemistry and Enthalpy

- Thermochemistry is the study of heat (q) given off or absorbed during the course of a chemical reaction.

Under constant pressure (the usual situation in a lab)…

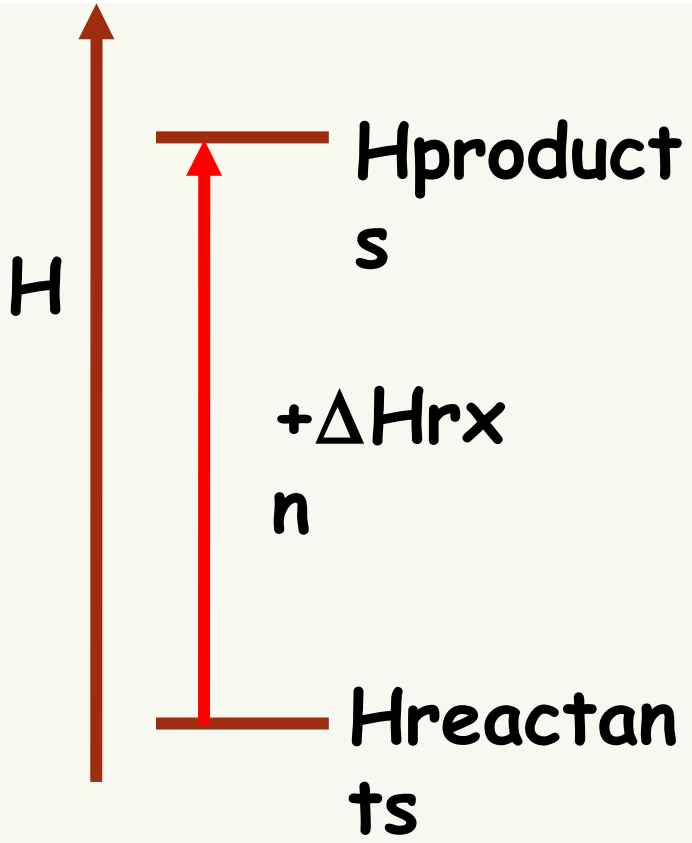
$$\Delta H_{rxn} = \Delta U_{rxn} + P\Delta V_{rxn} = q_p$$

Enthalpy of Reaction (ΔH_{rxn})



When ΔHrxn is negative, heat is released in the reaction.

This is an <u>exothermic</u> reaction.



When ΔHrxn is positive, heat is absorbed in the reaction.

This is an <u>endothermic</u> reaction.

Is the Reaction Exothermic or Endothermic?

Is this reaction endo or exothermic?

$$2\ C_{16}H_{34}(l) + 49\ O_2(g) \rightarrow 32\ CO_2(g) + 34\ H_2O(l)$$

Is the Reaction Exothermic or Endothermic?

Is this reaction endo or exothermic?

$$2\ C_{16}H_{34}(l) + 49\ O_2(g) \rightarrow 32\ CO_2(g) + 34\ H_2O(l)$$

What type of reaction is it? ***A combustion reaction!***

$$\Delta H_{rxn} = -10700\ kJ/mol$$

Endo or exothermic?

Combustion Reactions are Exothermic Reactions

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What You Should Be Able to Do (so far)

Define Enthalpy and use the equation in calculations.

Define the heat at constant volume (ΔU).

Define the heat at constant pressure (ΔH).

Determine whether a reaction is exo- or endothermic from the sign of ΔH.