

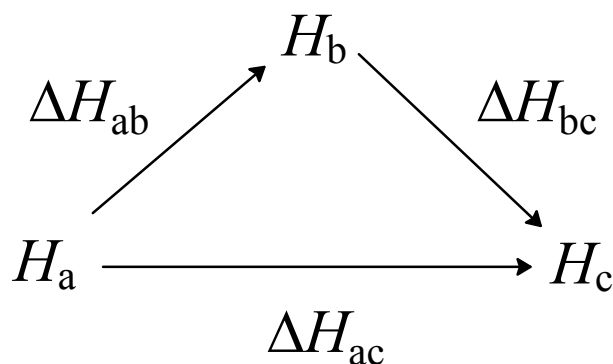
State Functions

✎ A **state function** (or function of state) only depends upon current conditions (the state of the system) for its value, not on how the current state was reached.

⇒ **Enthalpy, H** , is a state function.

☞ The value of the enthalpy change, ΔH , for any process depends only on the difference between the final and initial states, not on the path chosen.



$$\Delta H = H_{\text{final}} - H_{\text{initial}}$$



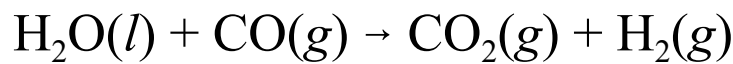
$A \rightarrow B$	ΔH_{ab}
$B \rightarrow C$	ΔH_{bc}
<hr/>	
$A \rightarrow C$	$\Delta H_{ac} = \Delta H_{ab} + \Delta H_{bc}$

Hess's Law of Constant Heat Summation

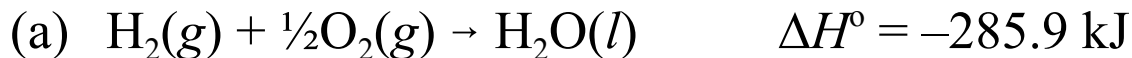
G. H. Hess - 1840

-  The enthalpy change for any reaction is independent of its path.
-  The sum of the enthalpies of any set of reactions that add together to give an overall reaction of interest is the same as would be measured for the reaction directly.

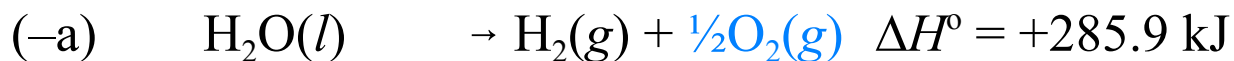
Example: Calculate ΔH° for the reaction,





Given:



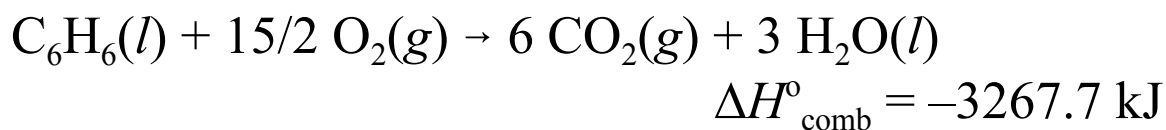
If we flip (a) and keep (b) as given, we can add to get the overall reaction:



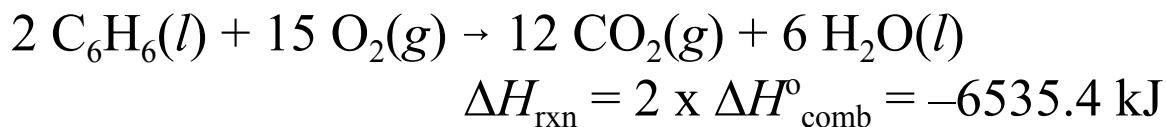
Heat of Combustion

-  The **heat of combustion** for a compound that is composed of C and H, possibly with either or both O and N, is the heat liberated when one mole of the substance is burned with the stoichiometric amount of $O_2(g)$ to produce, $CO_2(g)$, $H_2O(l)$, and $N_2(g)$, as may be appropriate.
-  The heat of combustion under standard conditions is the standard heat of combustion, $\Delta H^\circ_{\text{comb}}$.


Standard heat of combustion of benzene:




NOT the standard heat of combustion of benzene:

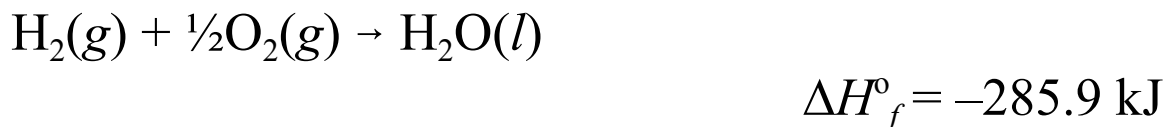


Standard Enthalpies of Formation

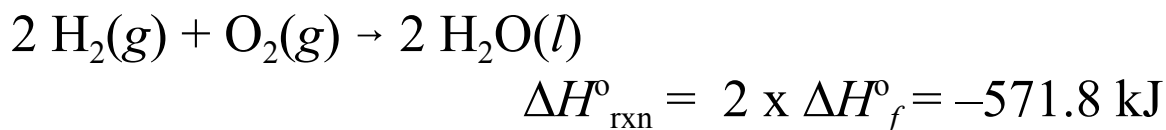
 The **standard enthalpy of formation**, ΔH_f° , of a compound is the enthalpy change for the reaction in which one mole of the compound in its standard state is made from the stoichiometric amounts of its elements in their standard states.

 For all elements in their standard states,
$$\Delta H_f^\circ \equiv 0,$$
by definition.

Standard enthalpy of formation of water:




NOT the standard enthalpy of formation of water:



 Source for standard enthalpy of formation data:
National Institute of Standards and Technology Web-
book, <http://webbook.nist.gov/>


Using ΔH_f° Values to Calculate Heats of Reactions

-  ΔH° for a reaction is the sum of the enthalpies of formation for the products multiplied by their stoichiometric coefficients minus the sum of the enthalpies of formation of the reactants multiplied by their stoichiometric coefficients:

$$\Delta H_{\text{rxn}}^\circ = \sum n_p \Delta H_p^\circ - \sum n_r \Delta H_r^\circ$$

where n_p and n_r are the stoichiometric coefficients of each of the products and each of the reactants, respectively.

 **Note that this relationship can only be used if all the data are enthalpies of formation.**

-  For a reaction $aA + bB \rightarrow cC + dD$, we would have

$$\Delta H_{\text{rxn}}^\circ = [c\Delta H_f^\circ(\text{C}) + d\Delta H_f^\circ(\text{D})] \\ - [a\Delta H_f^\circ(\text{A}) + b\Delta H_f^\circ(\text{B})]$$