

Lecture 6 b

Spring 2022

General Chemistry II

Chem 102

Thermochemistry

Cont.

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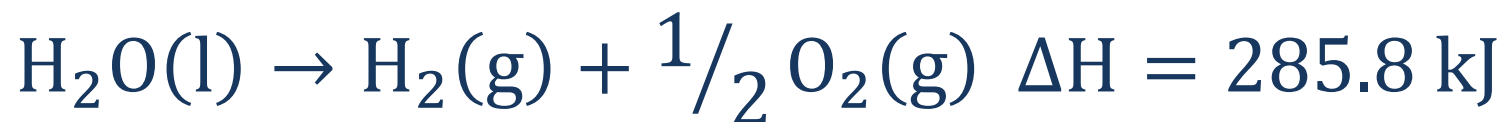
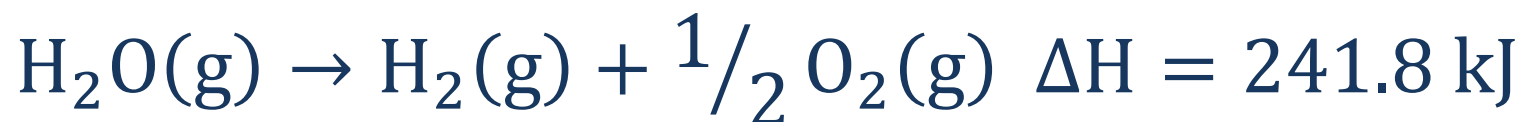
Hess's Law

On going from a particular set of reactants to a particular set of products, **the change in enthalpy** is the **same** whether the reaction takes place in **one step** or in **a series of steps**.



Factors affecting $\Delta_r H^\circ$

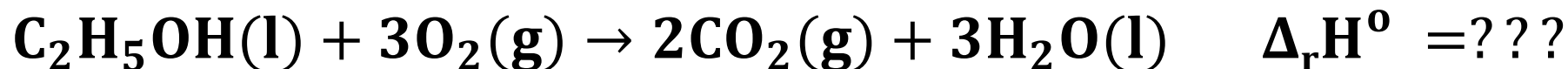
- quantities of reactants and products.
- physical state of reactants and products



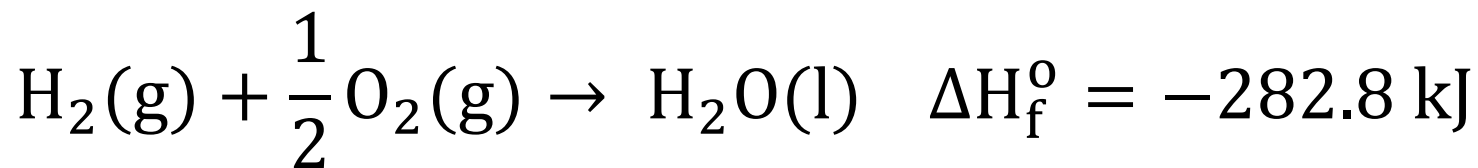
- If a reaction is reversed, the sign of ΔH is also reversed.
- If the coefficients in a balanced reaction are multiplied by a factor, the value of ΔH is multiplied by the same factor.

Exercise

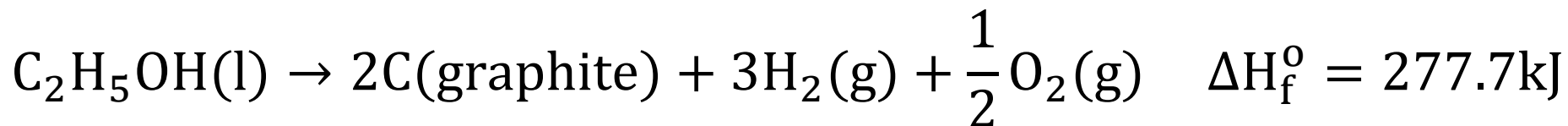
Consider the complete combustion of ethanol:

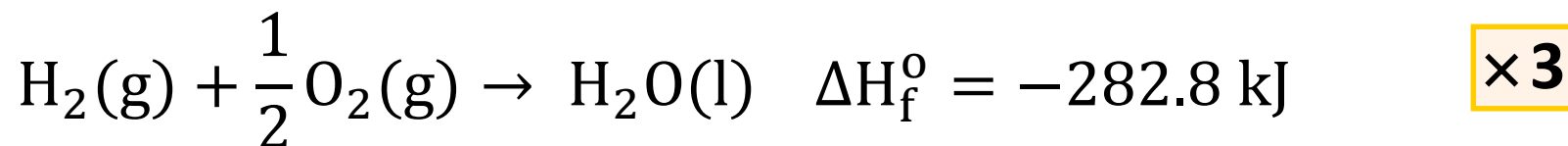
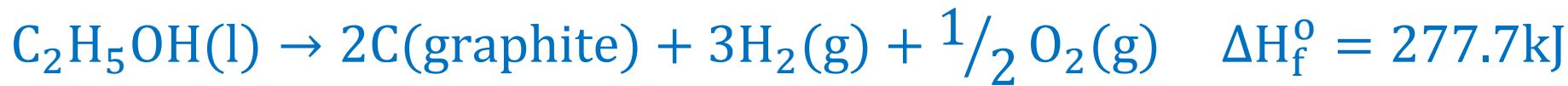


Knowing that



Reverse the first equation and the sign of ΔH





$$\begin{aligned}\Delta_\text{r}\text{H}^\circ &= (1)277.7 - (2)393.5 - (3)282.8 \\ &= -21357.7 \text{ kJ}\end{aligned}$$

Exercise

How much heat is required to decompose calcium carbonate to calcium oxide and carbon dioxide?

Knowing that ΔH°_f (kJ/mol) of $\text{CaCO}_3(s) = -1207.1$, $\text{CaO}(s) = -635.5$, $\text{CO}_2(g) = -393.5$

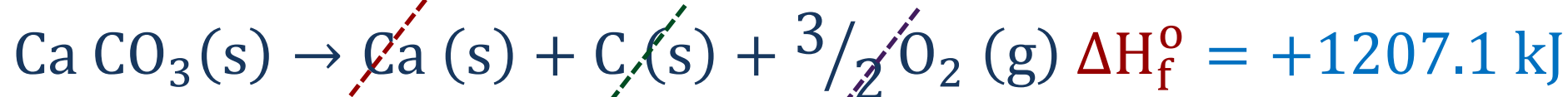
Solution



$$\Delta_r H^\circ = \sum_{\text{products}} \nu \Delta_f H^\circ_m - \sum_{\text{reactants}} \nu \Delta_f H^\circ_m$$

$$\Delta_r H^\circ = (-635.5 - 393.5) - (-1207.1) = +178.1 \text{ kJ}$$

Alternatively



$$\Delta_r H^\circ = (1207.1) + (-635.5) + (-393.5) = +178.1 \text{ kJ}$$

Exercise

Calculate the enthalpy change of formation of methane from solid carbon and hydrogen gas using



Solution





$$\Delta_r H^\circ = (-393.5) + (-571.6) + (890.3) = -74.8 \text{ kJ}$$

Significance of knowing $\Delta_r H^\circ$

- 🍏 Identifying the **direction** of heat transfer.
 - 🍏 At room temperature, **most exothermic reactions are product-favored.**
- 🍏 The **heat of combustion** of fuels can be calculated
- 🍏 **Taking precautions** to prevent exothermic reactions from over-heating and possible damages when reactions are carried out on a large scale.