

Exercise 16.1d

Hess's Law & Enthalpy of Formation

Name: _____

Date: _____ Per: _____

Germain Henri Hess, in 1840, discovered a very useful principle which is named for him:

The enthalpy of a given chemical reaction is constant, regardless of the reaction happening in one step or many steps.

Hess' Law is usually presented like this: $\Delta H^\circ_{\text{rxn}} = \sum \Delta H^\circ_f (\text{products}) - \sum \Delta H^\circ_f (\text{reactants})$

Or this: $\Delta H^\circ_{\text{rxn}} = \sum \Delta H^\circ_{f, \text{products}} - \sum \Delta H^\circ_{f, \text{reactants}}$

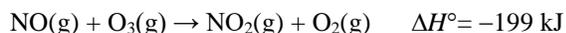
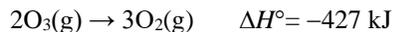
Hess' Law states that the heat evolved in a given process can be expressed as the sum of the heats of several processes that, when added, yield the process of interest. Because enthalpy is a state function, if the reactants and products remain the same, it doesn't matter how the reaction is carried out.

Some general rules relating to Hess' Law:

- The standard enthalpy of formation for an element in its standard state is zero.
- When a reaction is reversed, the sign of ΔH is changed.
- If you modify the coefficients of a reaction, multiply ΔH by the same factor.

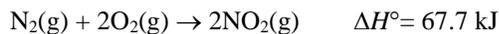
DIRECTIONS: Answer the following in the space provided.

1. Given the following data:



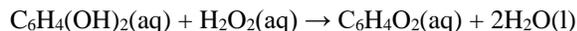
Calculate ΔH° for the reaction: $\text{NO}(\text{g}) + \text{O}(\text{g}) \rightarrow \text{NO}_2(\text{g})$

2. Given the following data:

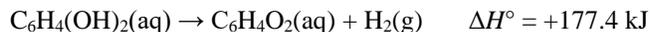


Calculate ΔH° for the dimerization of NO_2 : $2\text{NO}_2(\text{g}) \rightarrow \text{N}_2\text{O}_4(\text{g})$

3. The bombardier beetle uses an explosive discharge as a defensive measure. The chemical reaction involved is the oxidation of hydroquinone by hydrogen peroxide to produce quinone and water;



Calculate ΔH° for the reaction from the following data:



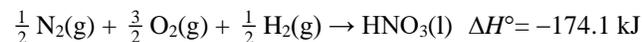
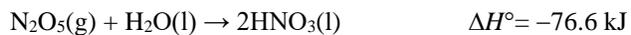
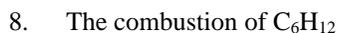
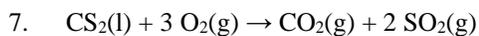
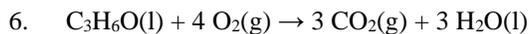
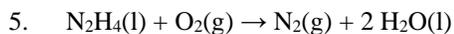
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4. Given the following data:

Calculate the ΔH° for the reaction: $2\text{N}_2(\text{g}) + 5\text{O}_2(\text{g}) \rightarrow 2\text{N}_2\text{O}_5(\text{g})$ **DIRECTIONS:** Use the data at right to calculate the ΔH for each reaction.*(N.B. Heat of formation of elements is 0.)*

Compound	Enthalpy of Formation
$\text{N}_2\text{H}_4(\text{l})$	+ 50.6 kJ/mol
$\text{H}_2\text{O}(\text{g})$	- 241.8 kJ/mol
$\text{H}_2\text{O}(\text{l})$	- 285.9 kJ/mol
$\text{CO}_2(\text{g})$	- 393.5 kJ/mol
$\text{C}_3\text{H}_6\text{O}(\text{l})$	- 249.5 kJ/mol
$\text{CS}_2(\text{l})$	+ 89.0 kJ/mol
$\text{SO}_2(\text{g})$	- 296.8 kJ/mol
$\text{C}_6\text{H}_{12}(\text{l})$	- 156.4 kJ/mol