South Pasadena • AP Chemistry

Name ________________________________
Period ___ Date ___/___/___

6 • Energy and Chemical Reactions

HESS'S LAW CALCULATIONS

The enthalpy of the reactants, $H_{reactants}$ and the enthalpy of the products, $H_{products}$ depend on the bonding of the reactants and products… nothing else. So, the $\Delta H_{reaction}$ only depends on the initial and final state of the reaction, not how you got from one state to another state. It is called a "state function".

Practically speaking, if we can find several equations that "add up" to the equation we want, the $\Delta H_{reactions}$ will add up to the overall ΔH. This is called Hess's Law.

Heats of Formation: Write the formation equations for the following. [See Table 6.2 on page 270 of text.]

Compound	Formation Equation	ΔH_f ($kJ \cdot mol^{-1}$)
$CH_4(g)$	$C(s) + 2H_2(g) \rightarrow CH_4(g)$	-74.8
$H_2O(l)$		-285.8
$H_2O(g)$		-241.8
$CO_2(g)$		-393.5
$C_2H_6(g)$		-84.7
$C_3H_8(g)$		???
$C_4H_{10}(g)$		-125.6

Example in class:
Calculate the $\Delta H_{combustion}$ for CH_4:

$$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$$

a) Calculate the heat of combustion, $\Delta H_{combustion}$, for ethane, $C_2H_6(g)$

b) Calculate the energy for the reaction between nitrogen and oxygen to form nitrogen dioxide:

$$2NO(g) + O_2(g) \rightarrow 2NO_2(g) \ldots\ldots\ldots\ldots \Delta H = ?$$

Use these two reactions:

$N_2(g) + O_2(g) \rightarrow 2NO(g)$ .... $\Delta H = 180$ kJ

$N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$ .... $\Delta H = 68$ kJ

c) Notice that we do the same thing each time.

If a compound is a **reactant**…
what do you do to the equation? _________________ What do you do to the ΔH_f? _____

If a compound has a **coefficient of 3**…
what do you do to the equation? _________________ What do you do to the ΔH_f? _____

Write the "shortcut version" of Hess's Law (when using H_f's):

$$\Delta H_{rxn} = \Sigma$$

Compound	ΔH_f ($kJ \cdot mol^{-1}$)
$H_2O(l)$	-285.8
$CO_2(g)$	-393.5
$C_4H_{10}(g)$	-125.6

c) Use this shortcut to calculate the $\Delta H_{combustion}$ of butane, $C_4H_{10}(g)$.

d) The heat of combustion of propane, C_3H_8 , is –2220.0 $kJ \cdot mol^{-1}$.
Set up the shortcut for the calculation of the $\Delta H_{combustion}$ of propane.
Use this information to calculate the ΔH_f of C_3H_8.