Name _____ Date _____ Class _____

CHAPTER 16 STUDY GUIDE FOR CONTENT MASTERY

Section 16.4 Calculating Enthalpy Change

In your textbook, read about Hess's law and standard enthalpy (heat) of formation.

In the space at the left, write *true* if the statement is true; if the statement is false, change the italicized word or phrase to make it true.

true — **1.** Hess's law states that if two or more thermochemical equations can be added to produce a final equation for a reaction, then the sum of all the enthalpy changes for the individual reactions is the enthalpy change for the *final reaction*.

one mole — **2.** The standard enthalpy of formation is the change in enthalpy that accompanies the formation of *one gram* of a compound in its standard state from its constituent elements in their standard states.

true — **3.** The standard state of iron is *solid*.

true — **4.** For a pure gas, the standard state is the gas at a pressure of *one atmosphere*.

true — **5.** The symbol used to represent standard enthalpy of formation is ΔH_f°.

298K — **6.** The standard state of a substance is the normal state of the substance at *0 K* and one atmosphere pressure.

true — **7.** The standard enthalpy of formation of a free element in its standard state is *0.0 kJ*.

positive — **8.** A standard enthalpy of formation that has a *negative* value means that energy is absorbed during the reaction.

true — **9.** The standard state of oxygen is *gas*.

true — **10.** Standard enthalpies of formation provide data for calculating the enthalpies of reactions under standard conditions using *Hess's law*.

liquid — **11.** The standard state of mercury is *solid*.

Name _____ Date _____ Class _____

CHAPTER 16 STUDY GUIDE FOR CONTENT MASTERY

Section 16.4 *continued*

Use the table to answer the following questions.

Compound	Formation Equation	ΔH_f° (kJ/mol)
$CH_4(g)$	$C(graphite) + 2H_2(g) \rightarrow CH_4(g)$	−75
$CH_3OH(g)$	$C(graphite) + 2H_2(g) + \frac{1}{2}O_2(g) \rightarrow CH_3OH(g)$	−239
$H_2O(g)$	$\frac{1}{2}O_2(g) + H_2(g) \rightarrow H_2O(g)$	−242

12. What does a formation equation show?

A formation equation shows how a compound is formed from the component elements. The enthalpy of formation for the elements is 0.0 kJ/mol. Therefore, the enthalpy change for the formation reaction is the enthalpy of formation for the compound.

13. What does the negative sign on the value of an enthalpy of formation indicate?

The negative sign indicates that the formation of the compound from the elements is an exothermic process.

14. Using the formation equations for $CH_4(g)$, $CH_3OH(g)$, and $H_2O(g)$, calculate ΔH_{rxn} for the following equation. Show and explain all your work.

$$CH_4(g) + H_2O(g) \rightarrow CH_3OH(g) + H_2(g)$$

$CH_4(g)$ and $H_2O(g)$ are the reactants and $CH_3OH(g)$ and $H_2(g)$ are the products in the final equation. Rearrange the three thermochemical equations in the table to obtain this relationship.

	ΔH_f° (kJ/mol)
$CH_4(g) \rightarrow C(graphite) + 2H_2(g)$	75
$C(graphite) + 2H_2(g) + \frac{1}{2}O_2(g) \rightarrow CH_3OH(g)$	−239
$H_2O(g) \rightarrow \frac{1}{2}O_2(g) + H_2(g)$	242

Add all the equations.

$CH_4(g) + \cancel{C(graphite)} + \cancel{2H_2(g)} + \frac{1}{2}\cancel{O_2(g)} + H_2O(g) \rightarrow$

$\cancel{C(graphite)} + \cancel{2H_2(g)} + CH_3OH(g) + \frac{1}{2}\cancel{O_2(g)} + H_2(g)$

Remove all terms that are on both sides of the equation.

$CH_4(g) + H_2O(g) \rightarrow CH_3OH(g) + H_2(g)$

Determine ΔH_{rxn} by adding the enthalpies of the reactions.

$\Delta H_{rxn} = 75\ kJ - 239\ kJ + 242\ kJ = 78\ kJ$