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Chapter 10 Practice Worksheet:
Thermochemistry: Chemical Energy

1) Describe the difference between potential energy and kinetic energy.

2) What is the difference between heat and temperature?

3) Describe what we mean by conservation of energy. Give an example.

4) Draw a picture showing the direction of heat flow in an endothermic reaction versus an exothermic reaction. Define the system and the surroundings in each case.

5) Explain why boiling water is an endothermic process. (Hint: Think about what is happening to the attractive forces between water molecules.)

6) Hydrogen gas and oxygen gas release 482.6 kJ of heat when they combine to form steam. Is this reaction endothermic or exothermic? In which direction does heat transfer (between system and the surroundings) for this reaction? Is ΔH for this reaction positive or negative?

7) ___ H_2 (g) + ___ O_2 (g) → ___ H_2O (g) $\Delta H = -482.6$ kJ

a. Interpret this thermochemical equation (i.e., how much heat is given off per amount of each substance?).

b. How much heat is released if we begin with 2.0087 g of O_2 gas?

c. How much heat is released if we begin with 1.5021 g of H_2 gas?

8) Which substance in each pair below has a higher specific heat? Circle your answer.

a)	aluminum foil	water
b)	wood	metal
c)	ethanol (C_p = 2460 J/kg·^{o}C)	gold (C_p = 129 J/kg·^{o}C)
d)	mercury	copper

9) How much heat is lost when a 640 g piece of copper cools from 375^{o}C to 26^{o}C? (The specific heat of copper is 0.385 J/g·^{o}C)

10) The specific heat of iron is 0.4494 J/g·^{o}C. How much heat is transferred when a 24.7 kg iron bar is cooled from 880^{o}C to 13^{o}C?

11) 8750 J of heat are applied to a 170 g sample of metal, causing a 56^{o}C increase in its temperature. What is the specific heat of the metal? Which metal is it?

12) Use the following enthalpies of reaction to determine the enthalpy for the reaction of ethylene with fluorine.

C_2H_4 (g) + 6F_2 (g) → 2CF_4 (g) + 4HF (g) ΔH = ?

H_2 (g) + F_2 (g) → 2HF (g) ΔH = -537 kJ

C (s) + 2F_2 (g) → CF_4 (g) ΔH = -680 kJ

2C (s) + 2H_2 (g) → C_2H_4 (g) ΔH = 52.3 kJ

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13) Using the thermochemical equations below, what combination of the following numbered ΔH's (1-4) will determine the ΔH_{rxn}? If a reaction needs to be reversed, write it as –ΔH. If a reaction needs to be multiplied by a factor (x), write it as xΔH.

$Mg_3N_2 + 3H_2O \rightarrow 3MgO + 2NH_3$ $\Delta H_{rxn} = ?$

$3Mg + N_2 \rightarrow Mg_3N_2$ ΔH_1

$H_2 + ½\ O_2 \rightarrow H_2O$ ΔH_2

$Mg + ½\ O_2 \rightarrow MgO$ ΔH_3

$½\ N_2 + 3/2\ H_2 \rightarrow NH_3$ ΔH_4

14) Which of the following substances do **NOT** have $\Delta H^o_f = 0$?

Cl_2 (g) Na (l) K (s) O (g) S_8 (s) Br_2 (l)

15) Calculate the standard enthalpy of formation of solid $Mg(OH)_2$ given the data shown below. (Hint: Write the equation for the standard enthalpy of formation of $Mg(OH)_2$ (starting from elements and forming 1 mol of product) first.)

$2Mg\ (s) + O_2\ (g) \rightarrow 2\ MgO\ (s)$ $\Delta H^o = -1203.6$ kJ

$Mg(OH)_2\ (s) \rightarrow MgO\ (s) + H_2O\ (l)$ $\Delta H^o = +37.1$ kJ

$2H_2\ (g) + O_2\ (g) \rightarrow 2H_2O\ (l)$ $\Delta H^o = -571.7$ kJ

16) Write the equation that represents the standard enthalpy of formation of:

a) MgO (s):

b) H_2O (l):

c) $BaCl_2$ (s):

17) Calculate the ΔH^o of reaction for:

$BaO\ (s) + SO_3\ (g) \rightarrow BaSO_4\ (s)$

The values of ΔH^o_f are as follows: BaO (s) = -548 kJ/mol; SO_3 (g) = -395.7 kJ/mol; $BaSO_4$ (s) = -1473 kJ/mol.

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18) Calculate the ΔH^o of reaction for:

C_3H_8 (g) + $5O_2$ (g) → $3CO_2$ (g) + $4H_2O$ (l)

The values of ΔH^o_f are as follows: C_3H_8 (g) = -103.95 kJ/mol; CO_2 (g) = -393.5 kJ/mol; H_2O (l) = -285.8 kJ/mol

19) Determine the enthalpies of the following reactions using average bond enthalpies.

a. CH_4 (g) + Cl_2 (g) → CH_3Cl (g) + HCl (g) **(BE_{C-Cl} = 328 kJ/mol)**

b. N_2H_4 (g) → N_2 (g) + $2H_2$ (g) **(N_2H_4 = $H_2N – NH_2$)**

c. $4NH_3$ (g) + $5O_2$ (g) → 4NO (g) + $6H_2O$ (g) **($BE_{N=O}$ = 631 kJ/mol)**