AP Chem Name _____

Thermochemistry Practice Date _____ Block ____

Hess's Law:

1) Calculate ΔH for the reaction: C_2H_4 (g) + H_2 (g) --> C_2H_6 (g), from the following Data.

C_2H_4 (g) + 3 O_2 (g) --> 2 CO_2 (g) + 2 H_2O (l) ΔH = -1411. kJ

C_2H_6 (g) + 3½ O_2 (g) --> 2 CO_2 (g) + 3 H_2O (l) ΔH = -1560. kJ

H_2 (g) + ½ O_2 (g) --> H_2O (l) ΔH = -285.8 kJ

2) Calculate ΔH for the reaction 4 NH_3 (g) + 5 O_2 (g) --> 4 NO (g) + 6 H_2O (g), from the following Data.

N_2 (g) + O_2 (g) --> 2 NO (g) ΔH = -180.5 kJ

N_2 (g) + 3 H_2 (g) --> 2 NH_3 (g) ΔH = -91.8 kJ

2 H_2 (g) + O_2 (g) --> 2 H_2O (g) ΔH = -483.6 kJ

3) Find ΔH° for the reaction $2H_2$(g) + 2C(s) + O_2(g) --> C_2H_5OH(l), using the following thermochemical data.

C_2H_5OH (l) + 2 O_2 (g) --> 2 CO_2 (g) + 2 H_2O (l) ΔH = -875. kJ

C (s) + O_2 (g) --> CO_2 (g) ΔH = -394.51 kJ

H_2 (g) + ½ O_2 (g) --> H_2O (l) ΔH = -285.8 kJ

4) Calculate ΔH for the reaction CH_4 (g) + NH_3 (g) --> HCN (g) + 3 H_2 (g), given:

N_2 (g) + 3 H_2 (g) --> 2 NH_3 (g) ΔH = -91.8 kJ

C (s) + 2 H_2 (g) --> CH_4 (g) ΔH = -74.9 kJ

H_2 (g) + 2 C (s) + N_2 (g) --> 2 HCN (g) ΔH = +270.3 kJ

5) Calculate ΔH for the reaction 2 Al (s) + 3 Cl_2 (g) --> 2 $AlCl_3$ (s) from the data.

2 Al (s) + 6 HCl (aq) --> 2 $AlCl_3$ (aq) + 3 H_2 (g) ΔH = -1049. kJ

HCl (g) --> HCl (aq) ΔH = -74.8 kJ

H_2 (g) + Cl_2 (g) --> 2 HCl (g) ΔH = -1845. kJ

$AlCl_3$ (s) --> $AlCl_3$ (aq) ΔH = -323. kJ

Endothermic vs. Exothermic

1. What is the sign for ΔH for the following reactions? Which of these changes are endothermic? Which are exothermic?
   a) Melting of ice

   b) CH_4 (g) + 2 O_2 (g) → CO_2 (g) + 2 H_2O (g) + 882 kJ

   c) Deposition of iodine

   d) NH_4Cl (s) → NH_4Cl (aq) ΔH° = + 14.7 kJ/mol

   e) Calcium oxide solid dissolving in water causes a temperature increase

Enthalpy of Formation and Reaction: Use the standard enthalpies of formation table to determine the ΔH_{rxn} for each of these reactions.

1) $NaOH(s) + HCl(g) \text{----> } NaCl(s) + H_2O(g)$

2) $2\ H_2S(g) + 3\ O_2(g) \text{---> } 2\ H_2O(l) + 2\ SO_2(g)$

3) $2\ NO(g) + O_2(g) \text{---> } 2\ NO_2(g)$

Compound	ΔH_f (kJ/mol)	Compound	ΔH_f (kJ/mol)
$CH_4(g)$	-74.8	HCl(g)	-92.3
$CO_2(g)$	-393.5	$H_2O(g)$	-241.8
CO(g)	-110.5	$SO_2(g)$	-296.1
$H_2O(l)$	-285.8	$NH_4Cl(s)$	-315.4
$H_2S(g)$	-20.1	NO(g)	+90.4
$H_2SO_4(l)$	-811.3	$NO_2(g)$	+33.9
$MgSO_4(s)$	-1278.2	$SnCl_4(l)$	-545.2
MnO(s)	-384.9	SnO(s)	-286.2
$MnO_2(s)$	-519.7	$SnO_2(s)$	-580.7
NaCl(s)	-411.0	$SO_2(g)$	-296.1
NaF(s)	-569.0	$SO_3(g)$	-395.2
NaOH(s)	-426.7	ZnO(s)	-348.0
$NH_3(g)$	-46.2	ZnS(s)	-202.9

Other:

1) For the reaction: $2\ C_4H_{10}(g) + 13\ O_2(g) \rightarrow 8\ CO_2\ (g) + 10\ H_2O(l)$, the $\Delta H°_{comb}$ is – 2877.4 kJ.

   a) What is the $\Delta H_{comb}°$ for the combustion of 1 mole of C_4H_{10}?

   b) What is the $\Delta H_{comb}°$ for the production of 5 moles of H_2O?

   c) What is the $\Delta H_{rxn}°$ for the production of 1 mole of C_4H_{10}?

2) Calculate the mass of a sample of lead (C_{Pb} = 0.160 J/g.°C) when it loses 200. J cooling from 75.0°C to 42.0°C.

3) Calculate the energy required to take 450.0 g of water from 27.5°C to 102.0°C. (C_{H2O} = 4.184 J/g°C, C_{steam} = 2.006 J/g, H_{vap} = 2260 J/g)

4) A 28.4 g sample of aluminum is heated to 39.4 °C, and placed in a calorimeter containing 50.0 g of water. The temperature of water increases from 21.00 °C to 23.00 °C. What is the specific heat capacity, C, of aluminum? (for $H_2O(l)$, C = 4.184 J/g°C)

5) Calculate the heat of formation of ethane, C_2H_6 (g), if its heat of combustion, $\Delta H°_{comb}$, is -3120. kJ as described by the equation is $2\ C_2H_6\ (g) + 7\ O_2\ (g) \rightarrow 6\ H_2O\ (l) + 4\ CO_2\ (g)$.

Answers:
1) -136.8 kJ
2) -1628.2 kJ
3) -485.62 kJ
4) 255.95 kJ
5) -6386.8 kJ

1a) endo
1b) exo
1c) exo
1d) endo
1e) exo

1) -133.8 kJ
2) -1123.6 kJ
3) -113 kJ

1a) -1438.7 kJ
1b) -1438.7 kJ
1c) +1438.7 kJ
2) 37.9 g
3) 1,155,308 J = 1155 kJ
4) 0.898 J/gC
5) -84.4 kJ