Practice – Heats of Formation

1. Calculate ΔH°_f (kJ) for the following reaction from the listed standard enthalpies of formation:

$$CO(g) + NH_3(g) \rightarrow HCN(g) + H_2O(g)$$

$\Delta H^\circ_f\, CO(g) = -110.5$ kJ
$\Delta H^\circ_f\, NH_3(g) = -46.1$ kJ
$\Delta H^\circ_f\, HCN(g) = +135.1$ kJ
$\Delta H^\circ_f\, H_2O(g) = -241.8$ kJ

$\Delta H = [\Delta H_f^\circ(HCN) + \Delta H_f^\circ(H_2O)] - [\Delta H_f^\circ(CO) + \Delta H_f^\circ(NH_3)]$

$= +135.1 + (-241.8) - [-110.5 + (-46.1)]$

$\Delta H = +49.9$ kJ

2. Use the given standard enthalpies of formation to determine the heat of reaction of the following reaction:

$$2\ Cl_2(g) + 2\ H_2O(l) \rightarrow 4\ HCl(g) + O_2(g)$$

$\Delta H^\circ_f\, H_2O(l) = -285.8$ kJ/mole
$\Delta H^\circ_f\, HCl(g) = -92.3$ kJ/mole

$\Delta H = 4\Delta H_f^\circ(HCl) + \Delta H_f^\circ(O_2) - [2\Delta H_f^\circ(Cl_2) + 2\Delta H_f^\circ(H_2O)]$

$= 4(-92.3) + 0 - [2(0) + 2(-285.8)]$

$\Delta H = +202.4$ kJ

3. Use the given standard enthalpies of formation to determine the heat of reaction of the following reaction:

$$2\ Ag_2S(s) + 2\ H_2O(l) \rightarrow 4\ Ag(s) + 2\ H_2S(g) + O_2(g)$$

$\Delta H^\circ_f\, Ag_2S(s) = -32.6$ kJ/mole
$\Delta H^\circ_f\, H_2S(g) = -20.6$ kJ/mole
$\Delta H^\circ_f\, H_2O(l) = -285.8$ kJ/mole

$\Delta H = 4\Delta H_f^\circ(Ag) + 2\Delta H_f^\circ(H_2S) + \Delta H_f^\circ(O_2) - [2\Delta H_f^\circ(Ag_2S) + 2\Delta H_f^\circ(H_2O)]$

$= 4(0) + 2(-20.6) + 0 - [2(-32.6) + 2(-285.8)]$

$\Delta H = +595.6$ kJ

4. The heats of formation of $CO_2(g)$ and $H_2O(l)$ are -394 kJ/mole and -285.8 kJ/mole respectively. Using the data for the following combustion reaction, calculate the heat of formation of $C_6H_5CO_2H(s)$.

$$2\ C_6H_5CO_2(s) + 15\ O_2(g) \rightarrow 14\ CO_2(g) + 6\ H_2O(l)$$

$\Delta H^\circ_{rxn} = -6454$ kJ

$\Delta H = [14\Delta H_f^\circ(CO_2) + 6\Delta H_f^\circ(H_2O)] - [2\Delta H_f^\circ(C_6H_5CO_2)]$

$-6454 = [14(-394) + 6(-285.8)] - 2X$

$X = -388.4$ kJ/mol

5. The heats of formation of $CO_2(g)$ and $H_2O(l)$ are -394 kJ/mole and -285.8 kJ/mole respectively. Using the data for the following combustion reaction, calculate the heat of formation of $C_4H_{10}(g)$.

$$2\ C_4H_{10}(g) + 13\ O_2(g) \rightarrow 8\ CO_2(g) + 10\ H_2O(l)$$

$\Delta H^\circ_{rxn} = -5756.1$ kJ

$\Delta H = [8\Delta H_f^\circ(CO_2) + 10\Delta H_f^\circ(H_2O)] - [2\Delta H_f^\circ(C_4H_{10})]$

$-5756.1\ kJ = [(8)(-394) + (10)(-285.8)] - 2X$

$X = -126.95$ kJ/mol

6. The heats of formation of $CO_2(g)$ and $H_2O(l)$ are -394 kJ/mole and -285.8 kJ/mole respectively. Using the data for the following combustion reaction, calculate the heat of formation of $C_3H_4(g)$.

$$C_3H_4(g) + 4\ O_2(g) \rightarrow 3\ CO_2(g) + 2\ H_2O(l)$$

$\Delta H^\circ_{rxn} = -1939.1$ kJ

$\Delta H = 3\Delta H_f^\circ(CO_2) + 2\Delta H_f^\circ(H_2O) - \Delta H_f^\circ(C_3H_4)$

$-1939.1 = 3(-394) + 2(-285.8) - X$

$X = +185.5$ kJ/mol