5.5: Standard Enthalpy of Formation

Table 1 Standard Enthalpies of Formation for Several Compounds

Compound	ΔH_f° (kJ/mol)
$AlCl_3(s)$	−704.2
$Al_2O_3(s)$	−1675.7
$CaSO_4(s)$	−1434.1
$Ca_3(PO_4)_2(s)$	−4120.8
$CH_3OH(l)$	−239.1
$CH_4(g)$	−74.4
$C_2H_2(g)$	+228.2
$C_2H_5OH(l)$	−235.2
$C_2H_6(g)$	−83.8
$C_3H_8(g)$	−104.7
$C_6H_{12}O_6(s)$	−1273.1
$C_8H_{18}(l)$	−250.1
$C_{12}H_{22}O_{11}(s)$	−2225.5
$CO(g)$	−110.5
$CO_2(g)$	−393.5
$Fe_2O_3(s)$	−824.2
$HCN(g)$	+135.1
$HCl(g)$	−92.3
$HF(g)$	−273.3
$H_2O(g)$	−241.8
$H_2O(l)$	−285.8
$H_2SO_4(l)$	−814.0
$H_3PO_4(l)$	−1271.7
$MgO(s)$	−601.6
$Mg(OH)_2(s)$	−924.5
$NH_3(g)$	−45.9
$NH_4Cl(s)$	−314.4
$NH_4ClO_4(s)$	−295.8
$NO(g)$	+90.2
$NO_2(g)$	+33.2
$SiCl_4(l)$	−687.0
$SiO_2(s)$	−910.7

ΔH_f° -- the change in enthalpy that accompanies the formulation of 1 mole of a compound from its elements in their standard states. And standard state is the most stable form of a substance under standard conditions, 25 degree Celsius and 100 kPa.

$$\Delta H_r^\circ = \Sigma n_{products} \Delta H_{products}^\circ - \Sigma n_{reactants} \Delta H_{reactants}^\circ$$

Example 1:

Using standard enthalpies of formation in Table 1, calculate the standard change in enthalpy for the thermite reaction represented by the balanced equation

$$2\ Al(s) + Fe_2O_3(s) \rightarrow Al_2O_3(s) + 2\ Fe(s)$$

Example 2:

Until recently, liquid methanol was used to fuel high-performance engines in race cars. Gasoline is a mixture of hydrocarbons, but assume for this problem that gasoline is pure liquid octane, $C_8H_{18}(l)$. Using the data in Table 1, determine the standard enthalpy of combustion per gram of (a) methanol and (b) octane. Then (c) determine which fuel has the greater standard enthalpy per gram. The balanced chemical equation for the combustion of methanol is

$$2\ CH_3OH(l) + 3\ O_2(g) \rightarrow 2\ CO_2(g) + 4\ H_2O(l)$$

The balanced chemical equation for the combustion of octane is

$$2\ C_8H_{18}(l) + 25\ O_2(g) \rightarrow 16\ CO_2(g) + 18\ H_2O(l)$$