**W/S Bond Enthalpy**

1. \(2 \text{C}_2\text{H}_6(\text{g}) + 7 \text{O}_2(\text{g}) \rightarrow 4 \text{CO}_2(\text{g}) + 6\text{H}_2\text{O}(\text{g})\)

2. \[\begin{array}{c}
\text{H} - & \text{C} - & \text{C} - & \text{H} & \cdot & \cdot & \cdot & \cdot & \cdot & \cdot \\
& & & & & \cdot & \cdot & \cdot & \cdot & \cdot \\
& & & & & \cdot & \cdot & \cdot & \cdot & \cdot \\
& & & & & \cdot & \cdot & \cdot & \cdot & \cdot \\
\text{H} & & & & & & & & & \text{H}
\end{array}\]

3. **Reactants**
   - 12 C-H @ 413 kJ/mol = 4,956 kJ/mol
   - 2 C-C @ 346 kJ/mol = 692 kJ/mol
   - 7 O=O @ 498 kJ/mol = 3,486 kJ/mol
   - \(9134\) kJ/mol

4. **Products**
   - 8 C=O @ 799 kJ/mol = 6,392 kJ/mol
   - 12 O-H @ 463 kJ/mol = 5,556 kJ/mol
   - \(11,948\) kJ/mol

5. **\(\Delta H_{\text{rxn}} = \Sigma \Delta H_{\text{f}}^{\text{prod}} - \Sigma \Delta H_{\text{f}}^{\text{react}}\)**
   
   \[
   \Delta H_{\text{comb}} = -2814 \text{ KJ/mol}
   \]

   *negative value makes sense, combustion is an exothermic process*

6. **\(\Delta H_{\text{rxn}} = \Sigma \Delta H_{\text{f}}^{\text{prod}} - \Sigma \Delta H_{\text{f}}^{\text{react}}\)**
   
   \[
   \Delta H_{\text{comb}} = [4(-393.5) + 6(-241.8)] - [2(-84.7)]
   \]
   
   \[
   = -2855.4 \text{ KJ/mol}
   \]

7. **\(\Delta H_{\text{comb}}(\text{KJ/mol})\)**

<table>
<thead>
<tr>
<th></th>
<th>(\Delta H_{\text{comb}}(\text{KJ/mol}))</th>
</tr>
</thead>
<tbody>
<tr>
<td>BE</td>
<td>-2814</td>
</tr>
<tr>
<td>(\Delta H_{\text{f}}^{\text{O}_2})</td>
<td>-2855</td>
</tr>
</tbody>
</table>
a) BE's are averages that vary from molecule to molecule.

b) When using heats of formation, you are assuming bonds are being formed (or using values from bond formation) which takes place in the products. The reactants must be subtracted to change the value since they are not being formed, but broken (the reverse process). Therefore the formula is products - reactants.

c) Bond energies come from the breaking of bonds which takes place in the reactants. Products are not being broken but formed (reverse process) so we must subtract them, because all values being used are associated with bond breaking. Therefore the formula is reactants - products.

\[ \text{H}_2(\text{g}) + \text{F}_2(\text{g}) \rightarrow 2\text{HF}(\text{g}) \]

\[ \text{H-H} \quad :\text{F}=-\text{F}: \quad \text{H-F} \quad \text{use table} \quad \text{P9} \]

\[ \Delta H_{\text{rxn}} = \Sigma \text{BE reactants} - \Sigma \text{BE products} \]

\[ \Delta H_{\text{rxn}} = \left[ 436.4 + 156.9 \right] - \left[ 2(568.2) \right] \]

\[ = -543.1 \text{ kJ/mol} \]
8. \[ \text{H}_2(g) + \text{C}_2\text{H}_4(g) \rightarrow \text{C}_2\text{H}_6(g) \]

\[
\begin{align*}
\text{H} & \quad \text{H} \\
\text{C} & \quad \text{C} \\
\text{H} & \quad \text{H} \\
\text{H} & \quad \text{H} \\
\end{align*}
\]

\[ \Delta H_{\text{rxn}} = \Sigma B\!E_{\text{react}} - \Sigma B\!E_{\text{prod}} \]

\[
\Delta H_{\text{rxn}} = \left[ 430.4 + 4(414) + 620 \right] - \left[ 6(414) + 347 \right]
\]

\[ = -119 \text{ kJ/mol} \]

9. \[ \text{H}_2(g) + \text{I}_2(g) \rightarrow 2 \text{HI}(g) \]

\[
\begin{align*}
\text{H} & \quad \text{H} \\
\text{I} & \quad \text{I} \\
\text{H} & \quad \text{I} \\
\end{align*}
\]

\[
\Delta H_{\text{rxn}} = \left[ 430.4 + 151.0 \right] - \left[ 2(298.3) \right]
\]

\[ = -9.2 \text{ kJ/mol} \]