Chapter 6: Thermodynamics Worksheet

1. Define the following terms:
   a) enthalpy – heat given off or absorbed at constant pressure.
   b) exothermic – energy, in the form of heat given off to surroundings.
   c) First Law of Thermodynamics – energy can neither be created nor destroyed.
   d) system – the part of the Universe we are interested in.
   e) calorimetry – measuring the heat of a process.
   f) standard enthalpy of formation – heat associated with the formation of one mole of a compound from its elements in their standard state (way they occur at 1 atm and 25 °C).

2. For the reaction:

\[ S_8(s) + 8 \text{O}_2(g) \rightarrow 8 \text{SO}_2(g) \quad \Delta H = -2368 \text{ kJ} \]

a) How much heat is evolved when 25.0 moles of sulfur is burned in excess oxygen?

\[ -59,000 \text{ kJ (} -5.9 \times 10^4 \text{ kJ) } \]

b) How much heat is evolved when 275 grams of sulfur is burned in excess oxygen?

\[ -2540 \text{ kJ (} -2.54 \times 10^3 \text{ kJ) } \]

c) How much heat is evolved when 150.0 grams of sulfur dioxide is produced?

\[ -693.1 \text{ kJ} \]

3. It takes 78.2 J to raise the temperature of 45.6 grams of lead by 13.3 °C. Calculate the specific heat capacity and molar heat capacity of lead.

\[ 0.129 \text{ J/g } \cdot \text{°C} \]

4. A 15.0 gram sample of nickel metal is heated to 100.0 °C and dropped into 55.0 grams of water, initially at 23.0 °C. Assuming that all the heat lost by the nickel is absorbed by the water, calculate the final temperature of the nickel and water. (The specific heat of nickel is 0.444 J/g °C)

\[ 25.2 \text{ °C} \]
5. Using the standard enthalpies of formation listed in Table 6.2, calculate the standard enthalpy change for the overall reaction that occurs when ammonia is burned in air to form nitrogen dioxide gas and liquid water.

\[ \Delta H = -1396 \text{ kJ} \]

6. Two forms of carbon are graphite, the soft, black, slippery material used in "lead" pencils and as a lubricant for locks, and diamond, the brilliant, hard gemstone. Using the enthalpies of combustion for graphite (\(-394 \text{ kJ/mole C}\)) and diamond (\(-396 \text{ kJ/mole C}\)), calculate the \(\Delta H\) for the conversion of graphite to diamond.

\[ C_{\text{graphite(s)}} \rightarrow C_{\text{diamond(s)}} \]

\[ +2 \text{ kJ} \]

7. Diborane (\(B_2H_6\)) is a highly reactive boron hydride, which was once considered as a possible rocket fuel for the U.S. space program. Calculate \(\Delta H\) for the synthesis of diborane from its elements, according to the equation:

\[ 2B(s) + 3H_2(g) \rightarrow B_2H_6(g) \]

using the following data:

<table>
<thead>
<tr>
<th>Reaction</th>
<th>(\Delta H) (kJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) (2B(s) + \frac{3}{2}O_2(g) \rightarrow B_2O_3(s))</td>
<td>(-1273)</td>
</tr>
<tr>
<td>(b) (B_2H_6(g) + 3O_2(g) \rightarrow B_2O_3(s) + 3H_2O(g))</td>
<td>(-2035)</td>
</tr>
<tr>
<td>(c) (H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l))</td>
<td>(-286)</td>
</tr>
<tr>
<td>(d) (H_2O(l) \rightarrow H_2O(g))</td>
<td>(44)</td>
</tr>
</tbody>
</table>

\[ 36 \text{ kJ} \]

8. Given the following data:

<table>
<thead>
<tr>
<th>Reaction</th>
<th>(\Delta H) (kJ)</th>
</tr>
</thead>
<tbody>
<tr>
<td>(H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l))</td>
<td>(-285.5)</td>
</tr>
<tr>
<td>(N_2O_4(g) + H_2O(l) \rightarrow 2HNO_3(l))</td>
<td>(-76.6)</td>
</tr>
<tr>
<td>(\frac{1}{2}N_2(g) + \frac{3}{2}O_2(g) + \frac{1}{2}H_2(g) \rightarrow HNO_3(l))</td>
<td>(-174.1)</td>
</tr>
</tbody>
</table>

calculate the \(\Delta H\) for the reaction

\[ 2N_2(g) + 5O_2(g) \rightarrow 2N_2O_5(g) \]

\[ 27.8 \text{ kJ} \]