

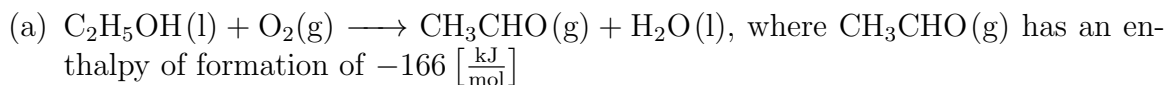
## Problem Set Chapter 8 Part 2

Michael Brodskiy

Instructor: Mr. Morgan

January 11, 2020

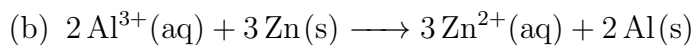
1. Using the enthalpies of formation, calculate the enthalpy change in the following:



$$\begin{array}{rcl} \text{C}_2\text{H}_5\text{OH}(\text{l}) & \longrightarrow & -277.7 \left[ \frac{\text{kJ}}{\text{mol}} \right] \\ \text{O}_2(\text{g}) & \longrightarrow & 0 \left[ \frac{\text{kJ}}{\text{mol}} \right] \\ \text{H}_2\text{O}(\text{l}) & \longrightarrow & -285.8 \left[ \frac{\text{kJ}}{\text{mol}} \right] \end{array} \quad (1)$$

---

$$-285.8 - 166 - (-277.7) = -174.1[\text{kJ}]$$

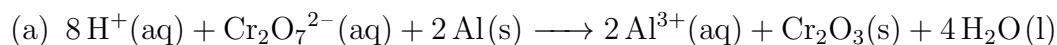


$$\begin{array}{rcl} 2 \text{Al}^{3+}(\text{aq}) & \longrightarrow & 2(-531) \left[ \frac{\text{kJ}}{\text{mol}} \right] \\ 3 \text{Zn}(\text{s}) & \longrightarrow & 0 \left[ \frac{\text{kJ}}{\text{mol}} \right] \\ 3 \text{Zn}^{2+}(\text{aq}) & \longrightarrow & 3(-153.9) \left[ \frac{\text{kJ}}{\text{mol}} \right] \\ 2 \text{Al}(\text{s}) & \longrightarrow & 0 \left[ \frac{\text{kJ}}{\text{mol}} \right] \end{array} \quad (2)$$

---

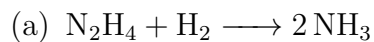
$$3(-153.9) - 2(-531) = 600.3[\text{kJ}]$$

2. Using enthalpies of formation the enthalpy of the reaction, calculate the enthalpy of formation for  $\text{Cr}_2\text{O}_7^{2-}$ ;  $\Delta H = -1855[\text{kJ}]$

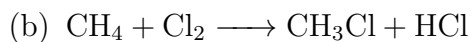


$$\begin{array}{rcl}
 8 \text{H}^+(\text{aq}) & \longrightarrow & 8(0) \left[ \frac{\text{kJ}}{\text{mol}} \right] \\
 2 \text{Al}(\text{s}) & \longrightarrow & 2(0) \left[ \frac{\text{kJ}}{\text{mol}} \right] \\
 2 \text{Al}^{3+}(\text{aq}) & \longrightarrow & 2(-531) \left[ \frac{\text{kJ}}{\text{mol}} \right] \\
 \text{Cr}_2\text{O}_3(\text{s}) & \longrightarrow & -1139.7 \left[ \frac{\text{kJ}}{\text{mol}} \right] \\
 4 \text{H}_2\text{O}(\text{l}) & \longrightarrow & 4(-285.8) \left[ \frac{\text{kJ}}{\text{mol}} \right] \\
 \text{Cr}_2\text{O}_7^{2-}(\text{aq}) & \longrightarrow & ? \left[ \frac{\text{kJ}}{\text{mol}} \right] \\
 \hline
 2(-531) + (-1139.7) + 4(-285.8) - x & = & -1855 \\
 x & = & -1489.9[\text{kJ}]
 \end{array} \tag{3}$$

3. Using bond energies, calculate the enthalpy of the following reactions:



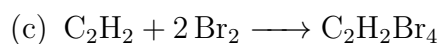
$$\begin{array}{rcl}
 & \text{Broken:} & \\
 \text{N} \text{ --- } \text{N} & = & 159[\text{kJ}] \\
 4 \cdot \text{N} \text{ --- } \text{H} & = & 4(389)[\text{kJ}] \\
 \text{H} \text{ --- } \text{H} & = & 436[\text{kJ}] \\
 & \text{Made:} & \\
 6 \cdot \text{N} \text{ --- } \text{H} & = & 6(389)[\text{kJ}] \\
 \hline
 159 + 4(389) + 436 - 6(389) & = & 183[\text{kJ}]
 \end{array} \tag{4}$$



$$\begin{array}{rcl}
& & \text{Broken:} \\
4 \cdot \text{C} \text{---} \text{H} & = & 4(414)[\text{kJ}] \\
\text{Cl} \text{---} \text{Cl} & = & 243[\text{kJ}] \\
& & \text{Made:} \\
3 \cdot \text{C} \text{---} \text{H} & = & 3(414)[\text{kJ}] \\
\text{C} \text{---} \text{Cl} & = & 331[\text{kJ}] \\
\text{H} \text{---} \text{Cl} & = & 431[\text{kJ}]
\end{array} \tag{5}$$

---


$$4(414) + 243 - 3(414) - 331 - 431 = -105[\text{kJ}]$$

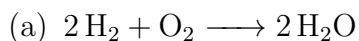


$$\begin{array}{rcl}
& & \text{Broken:} \\
\text{C} \equiv \text{C} & = & 820[\text{kJ}] \\
2 \cdot \text{C} \text{---} \text{H} & = & 2(414)[\text{kJ}] \\
2 \cdot \text{Br} \text{---} \text{Br} & = & 2(193)[\text{kJ}] \\
& & \text{Made:} \\
4 \cdot \text{C} \text{---} \text{Br} & = & 4(276)[\text{kJ}] \\
2 \cdot \text{C} \text{---} \text{H} & = & 2(414)[\text{kJ}] \\
\text{C} \text{---} \text{C} & = & 347[\text{kJ}]
\end{array} \tag{6}$$

---

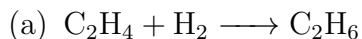

$$820 + 2(414) + 2(193) - 4(276) - 2(414) - 347 = -245[\text{kJ}]$$

4. Calculate the  $\Delta H$  for the formation of 45.7[g] of oxygen in the following;  $\Delta H = 286[\text{kJ}]$



$$\begin{aligned}
\frac{45.7}{32} &= 1.425[\text{mol}] \\
1.425 \cdot 286 &= 408[\text{kJ}]
\end{aligned} \tag{7}$$

5. The heat evolved on combustion of  $\text{C}_2\text{H}_6$  is  $3120[\text{kJ}]$  and  $\text{C}_2\text{H}_4$  is  $1411[\text{kJ}]$ . If the heat of formation of  $\text{CO}_2$  is  $-394[\text{kJ}]$  and  $\text{H}_2\text{O}$  is  $-286[\text{kJ}]$ , calculate the  $\Delta H$  for the following reaction:



$$\begin{array}{rcl}
2 \text{ C}_2\text{H}_4 + 6 \text{ O}_2 & \longrightarrow & 4 \text{ CO}_2 + 4 \text{ H}_2\text{O} \\
4(-394) + 4(-286) - 2(1411) & = & -5542[\text{kJ}] \\
2 \text{ C}_2\text{H}_6 + 7 \text{ O}_2 & \longrightarrow & 4 \text{ CO}_2 + 6 \text{ H}_2\text{O} \\
4(-394) + 6(-286) - 2(3120) & = & -9532[\text{kJ}] \\
4 \text{ CO}_2 + 6 \text{ H}_2\text{O} & \longrightarrow & 2 \text{ C}_2\text{H}_6 + 7 \text{ O}_2 \\
- [4(-394) + 6(-286) - 2(3120)] & = & 9532[\text{kJ}] \\
\hline
& & (8)
\end{array}$$
  

$$\begin{array}{rcl}
2 \text{ C}_2\text{H}_4 + 6 \text{ O}_2 & \longrightarrow & 4 \text{ CO}_2 + 4 \text{ H}_2\text{O} \\
4 \text{ CO}_2 + 6 \text{ H}_2\text{O} & \longrightarrow & 2 \text{ C}_2\text{H}_6 + 7 \text{ O}_2 \\
\hline
2 \text{ C}_2\text{H}_4 + 2 \text{ H}_2\text{O} & \longrightarrow & 2 \text{ C}_2\text{H}_6 + \text{O}_2 \\
\Delta H = 9532 - 5542 & = & 3990[\text{kJ}] \\
2 \text{ H}_2 + \text{O}_2 & \longrightarrow & 2 \text{ H}_2\text{O} 2(-286) = -572[\text{J}]
\end{array}$$