PROBLEM 24

a) \( \text{CaCO}_3(s) \rightarrow \text{CaO}(s) + \text{CO}_2(g) \) \( \Delta H = 178.1 \text{ kJ} \)

b) \[
\begin{align*}
\text{CaO}(s) & \rightarrow \text{CO}_2(g) \\
178.1 \text{ kJ} & \rightarrow \\
\text{CaCO}_3(s)
\end{align*}
\]

PROBLEM 28

a) \( \Delta H \) is positive \( \rightarrow \) Run is Endothermic

b) \[
45.0 \text{ g CH}_2\text{OH}(g) \times \frac{1 \text{ mol CH}_2\text{OH}}{32.04 \text{ g CH}_2\text{OH}} \times \frac{+90.7 \text{ kJ}}{1 \text{ mol CH}_2\text{OH}} = +127 \text{ kJ}
\]

c) \[
16.5 \text{ kJ} \times \frac{2 \text{ mol H}_2}{90.7 \text{ kJ}} \times \frac{2.016 \text{ g H}_2}{1 \text{ mol H}_2} = 0.733 \text{ g H}_2
\]

d) Since the reaction is in the reverse direction we work with the following thermochemical equation

\[
\text{CO}(g) + 2 \text{ H}_2(g) \rightarrow \text{CH}_3\text{OH}(g) \quad \Delta H = -90.7 \text{ kJ}
\]

\[
10.0 \text{ g CO} \times \frac{1 \text{ mol CO}}{28.01 \text{ g CO}} \times \frac{-90.7 \text{ kJ}}{1 \text{ mol CO}} = -32.4 \text{ kJ}
\]

The negative sign tells us the heat is released.

PROBLEM 35

a) \( \Delta H = +726.5 \text{ kJ} \) for the reverse reaction

b) \( 2\text{CH}_3\text{OH}(l) + 3\text{O}_2(g) \rightarrow 2\text{CO}_2(g) + 4\text{H}_2\text{O}(l) \) \( \Delta H = -1453 \text{ kJ} \)

c) Exothermic reactions are usually thermodynamically favored (products more stable than reactants), so I would think that the forward reaction is more likely to be favored.

d) It takes energy to convert water from the liquid state to the gaseous state. Therefore we can say that liquid water is more stable (enthalpically) than gaseous water. Therefore the \( \Delta H_{\text{rxn}} \) will be less exothermic (the magnitude will decrease) if the product is \( \text{H}_2\text{O}(g) \) than it would be for \( \text{H}_2\text{O}(l) \).