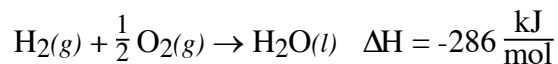


During Class Invention

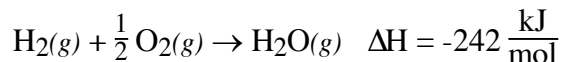
Name(s) with Lab section in Group

Enthalpy

1. The enthalpy for the formation of liquid water is shown below,



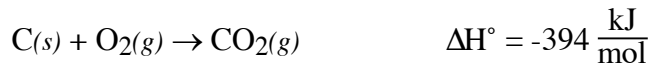
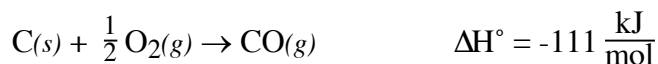
The enthalpy change for the formation of gaseous water is shown below,



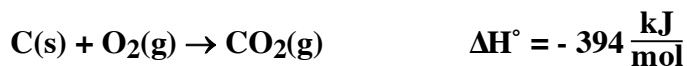
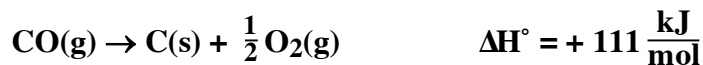
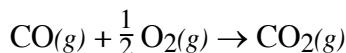
Why is the enthalpy change different?

**The water formed in the first equation is in the liquid phase, while the water formed in the second equation is in the gas phase. Energy is required to convert the water in the liquid phase to water in the gas phase, therefore the enthalpy is less negative in the second equation compared to the first.**

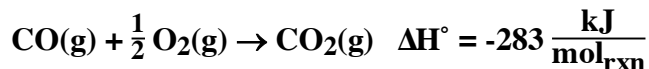
2. Given the enthalpy change for the two reactions below,



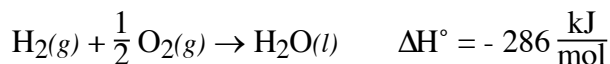
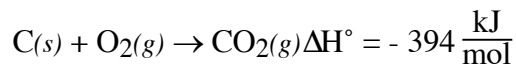
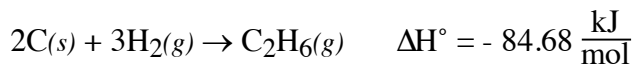
Calculate the enthalpy change for the reaction,



**Adding the two equations**

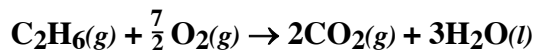


3. Using the following standard enthalpy of reaction data,

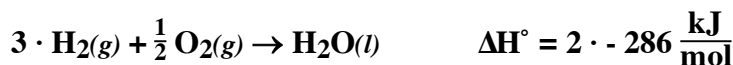
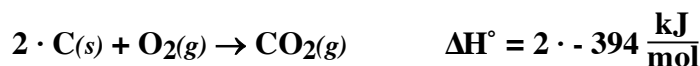
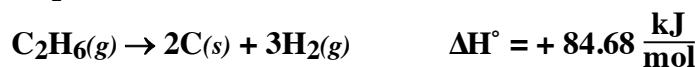


Calculate the heat of reaction for the combustion of 1 mol of ethane ( $\text{C}_2\text{H}_6$ ).

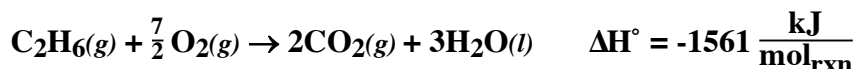
The equation which describes the combustion of ethane is,



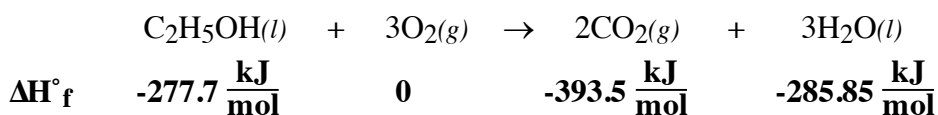
Rearranging the equations provided



Adding the equations



4a. Using standard heats of formation, calculate the  $\Delta H^\circ$  for the following reaction,



$$\Delta H^\circ_{\text{rxn}} = \Sigma \Delta H^\circ_f (\text{products}) - \Sigma \Delta H^\circ_f (\text{reactants})$$

$$\Delta H^\circ_{\text{rxn}} = \frac{3 \text{ mol}_{\text{H}_2\text{O}}}{\text{mol}_{\text{rxn}}} \left( -285.85 \frac{\text{kJ}}{\text{mol}_{\text{H}_2\text{O}}} \right) + \frac{2 \text{ mol}_{\text{CO}_2}}{\text{mol}_{\text{rxn}}} \left( -393.5 \frac{\text{kJ}}{\text{mol}_{\text{CO}_2}} \right) -$$

$$\left( \frac{1 \text{ mol}_{\text{C}_2\text{H}_5\text{OH}}}{1 \text{ mol}_{\text{rxn}}} \left( -277.7 \frac{\text{kJ}}{\text{mol}_{\text{C}_2\text{H}_5\text{OH}}} \right) \right)$$

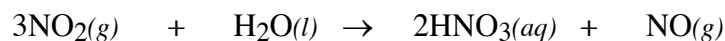
$$\Delta H^\circ_{\text{rxn}} = -1366.8 \frac{\text{kJ}}{\text{mol}_{\text{rxn}}}$$

b) Determine the amount of heat released at constant pressure when 1.00 gram of ethanol,  $\text{C}_2\text{H}_5\text{OH}$ , is combusted in excess oxygen.

From part a, -1366.8 kJ are produced when 1 mol of ethanol is combusted. The amount of heat produced when 1.00 g is combusted is,

$$1.0 \text{ g } \text{C}_2\text{H}_5\text{OH} \left( \frac{1 \text{ mol } \text{C}_2\text{H}_5\text{OH}}{46.0 \text{ g}} \right) \left( \frac{-1366.8 \text{ kJ}}{1 \text{ mol}} \right) = -29.7 \text{ kJ}$$

5. Calculate the  $\Delta H^\circ$  for the following reaction,



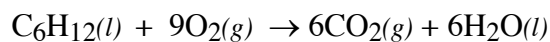
$$\Delta H^\circ_f \quad +33.84 \frac{\text{kJ}}{\text{mol}} \quad -285.85 \frac{\text{kJ}}{\text{mol}} \quad -206.6 \frac{\text{kJ}}{\text{mol}} \quad +90.37 \frac{\text{kJ}}{\text{mol}}$$

$$\Delta H^\circ_{\text{rxn}} = \Sigma \Delta H^\circ_f (\text{products}) - \Sigma \Delta H^\circ_f (\text{reactants})$$

$$\Delta H^\circ_{\text{rxn}} = \frac{2 \text{ mol HNO}_3}{\text{mol}_{\text{rxn}}} \left( -285.85 \frac{\text{kJ}}{\text{mol HNO}_3} \right) + \frac{1 \text{ mol NO}}{\text{mol}_{\text{rxn}}} \left( +90.37 \frac{\text{kJ}}{\text{mol NO}} \right) - \left( \frac{3 \text{ mol NO}_2}{1 \text{ mol}_{\text{rxn}}} \left( +33.84 \frac{\text{kJ}}{\text{mol NO}_2} \right) + \frac{1 \text{ mol H}_2\text{O}}{1 \text{ mol}_{\text{rxn}}} \left( -285.85 \frac{\text{kJ}}{\text{mol H}_2\text{O}} \right) \right)$$

$$\Delta H^\circ_{\text{rxn}} = -138.5 \frac{\text{kJ}}{\text{mol}_{\text{rxn}}}$$

6. The standard enthalpy of combustion to  $\text{CO}_2(\text{g})$  and  $\text{H}_2\text{O}(\text{l})$  at  $25^\circ\text{C}$  of cyclohexane,  $\text{C}_6\text{H}_{12}(\text{l})$ , is  $-3924 \frac{\text{kJ}}{\text{mol}}$ . Calculate the standard heat of formation,  $\Delta H_f^\circ$ , of cyclohexane



$$\Delta H_f^\circ \quad ? \quad 0 \quad -393.5 \frac{\text{kJ}}{\text{mol}} \quad -285.85 \frac{\text{kJ}}{\text{mol}}$$

$$\Delta H_{\text{rxn}}^\circ = \Sigma \Delta H_f^\circ (\text{products}) - \Sigma \Delta H_f^\circ (\text{reactants})$$

$$\Delta H_{\text{rxn}}^\circ = 6\Delta H_f^\circ (\text{CO}_2) + 6\Delta H_f^\circ (\text{H}_2\text{O}) - \Delta H_f^\circ (\text{C}_6\text{H}_{12})$$

$$\Delta H_f^\circ (\text{C}_6\text{H}_{12}) = 6\Delta H_f^\circ (\text{CO}_2) + 6\Delta H_f^\circ (\text{H}_2\text{O}) - \Delta H_{\text{rxn}}^\circ$$

$$\Delta H_f^\circ (\text{C}_6\text{H}_{12}) = \frac{6 \text{ mol CO}_2}{\text{mol}_{\text{rxn}}} \left( -393.5 \frac{\text{kJ}}{\text{mol}_{\text{CO}_2}} \right) + \frac{6 \text{ mol H}_2\text{O}}{\text{mol}_{\text{rxn}}} \left( -285.85 \frac{\text{kJ}}{\text{mol}_{\text{H}_2\text{O}}} \right) - \left( -3924 \frac{\text{kJ}}{\text{mol}_{\text{rxn}}} \right)$$

$$\Delta H_f^\circ (\text{C}_6\text{H}_{12}) = -152.1 \frac{\text{kJ}}{\text{mol}}$$