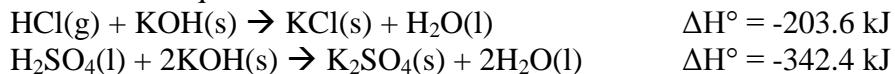


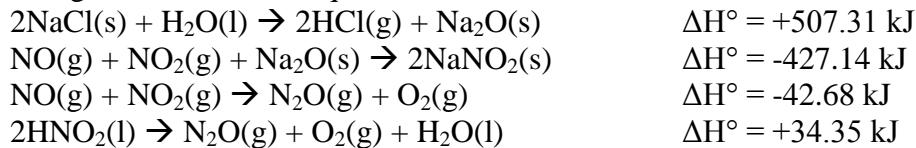
ΔH ASSIGNMENT

1. The reaction of 2 mol of gaseous hydrogen with 1 mol of gaseous oxygen to form 2 mol of liquid water releases 517.8 kJ, provided that all reactants and products are brought to 25°C and 1 atm. Write a thermochemical equation for the formation of 1 mol of liquid water.
2. Ethanol, C₂H₅OH, is made industrially by the reaction of water with ethylene, C₂H₄. Calculate the value of ΔH° for the reaction C₂H₄(g) + H₂O(l) → C₂H₅OH(l) given the following thermochemical equations:
$$\text{C}_2\text{H}_4(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \quad \Delta\text{H}^\circ = -1411 \text{ kJ}$$
$$\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l}) \quad \Delta\text{H}^\circ = -1367.1 \text{ kJ}$$
3. Calculate the ΔH° for the following reactions:
 - a. 2NO(g) + O₂(g) → 2NO₂(g)
 - b. NaOH(s) + HCl(g) → NaCl(s) + H₂O(g)
4. Write out the thermochemical equation for the combustion of 1 mol of sucrose, C₁₂H₂₂O₁₁, which released 5640.9 kJ of energy. Calculate the *standard heat of formation* of sucrose.
5. Nitric acid reacts with potassium hydroxide as follows: HNO₃(aq) + KOH(aq) → KNO₃(aq) + H₂O(l). In one experiment a student placed 55.0 mL of 1.3 mol/L nitric acid in a coffee cup calorimeter and noted that the temperature was 23.5°C. The student added 55.0 mL of 1.3 mol/L KOH also at 23.5°C. After quickly stirring the mixture with a thermometer, its temperature was seen to rise to 31.8°C. Calculate the heat of this reaction. Assume that the specific heats of all solutions were 4.184 J/g°C and that the densities of all solutions were 1 g/mL. Calculate the heat of reaction per mole of acid.
6. Aluminum and iron (III) oxide react and form aluminum oxide and iron. For each mole of aluminum used, 426.9 kJ of energy is released under standard conditions. Write the thermochemical equation that shows the consumption of 4 mol of Al. (All substances are solids).
7. The following equation represents the dehydration of calcium hydroxide to make quick lime, CaO, a substance present in cement: Ca(OH)₂(s) → CaO(s) + H₂O(l) ΔH° = +65.3 kJ. One of the reactions when cement is mixed with water is the reverse of this reaction. Write the thermochemical equation for the reaction of 10 mol of quick lime with water under standard conditions.
8. Show how the equations: N₂O₄(g) → 2NO₂(g) ΔH° = +57.93 kJ and 2NO(g) + O₂(g) → 2NO₂(g) ΔH° = -113.14 kJ can be manipulated to give the value of ΔH° for the following reaction: 2NO(g) + O₂(g) → N₂O₄(g).

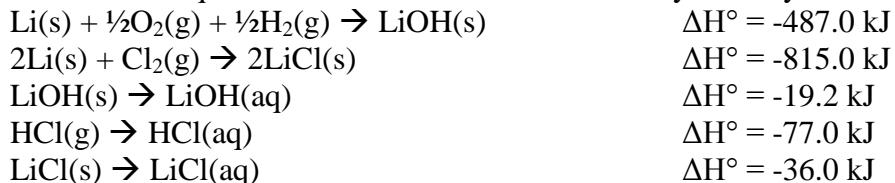
9. We can generate hydrogen chloride by heating a mixture of sulfuric acid and potassium chloride according to the reaction: $2\text{KCl(s)} + \text{H}_2\text{SO}_4\text{(l)} \rightarrow 2\text{HCl(g)} + \text{K}_2\text{SO}_4\text{(s)}$. Calculate the ΔH° for this reaction from the following thermochemical equations.



10. Calculate ΔH° for the following reaction, which describes the preparation of an unstable nitrous acid. $\text{HCl(g)} + \text{NaNO}_2\text{(s)} \rightarrow \text{HNO}_2\text{(l)} + \text{NaCl(s)}$. Use the following thermochemical equations.



11. What is the value for ΔH° for the neutralization of lithium hydroxide by hydrochloric acid? $\text{LiOH(aq)} + \text{HCl(aq)} \rightarrow \text{LiCl(aq)} + \text{H}_2\text{O(l)}$. The following thermochemical equations can be used in addition to any others you make up.



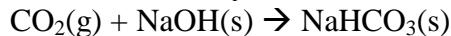
12. Write the thermochemical equations that would be used in connection with values of ΔH_f° for each of the following compounds. Obtain values for ΔH° from your data table.

- Acetic acid
- Sodium bicarbonate (sodium hydrogen carbonate)
- Gypsum ($\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$)
- Plaster of Paris ($\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$)
- Methanol

13. Nitrogen dioxide, an air pollutant, combines with water to make nitric acid, a corrosive acid, and nitrogen monoxide (NO). What is the ΔH° for the following reaction:



14. We can remove carbon dioxide from air by passing the air through solid granules of sodium hydroxide. What is the ΔH° for the following reaction:



15. From ΔH_f° data for the formation of carbon dioxide and water and the thermochemical equation for the combustion of glucose, $\text{C}_6\text{H}_{12}\text{O}_6\text{(s)} + 6\text{O}_2\text{(g)} \rightarrow 6\text{CO}_2\text{(g)} + 6\text{H}_2\text{O(g)}$, $\Delta H_{\text{combustion}}^\circ = -2820 \text{ kJ/mol}$, calculate the ΔH_f° for glucose.

16. Phosphorus burns in air to give tetraphosphorus decaoxide: $4P(s) + 5O_2(g) \rightarrow P_4O_{10}(s)$ $\Delta H^\circ = -3062$ kJ. The product combines with water to give phosphoric acid: $P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(l)$ $\Delta H^\circ = -257.2$ kJ. Using these equations and some others from this unit as needed, write the thermochemical equation for the formation of 1 mol of phosphoric acid from its elements, including the value for ΔH°_f .
17. Calculate the ΔH° for: $CO(g) + Fe_3O_4(s) \rightarrow CO_2(g) + Fe(s)$