

Lesson 26: Thermochemistry I

text: 411-430, ask in class if we don't do it: Heating curve for water (16)

what to know:

- principles of heat flow and related terms, §10-1 and calorimetry, specific heat and heat capacity, §1-2
- concept of enthalpy and changes in enthalpy, §10-3
- thermochemical equations, Hess' law, -enthalpies of phase changes, enthalpies of formation, §10-3
- standard molar enthalpies, §10-4

questions:

1. Given the specific heats of $\text{H}_2\text{O}(\text{l})$ and $\text{Hg}(\text{l})$ as 4.184 and 0.139 $\text{J/g}^\circ\text{C}$, respectively, which liquid would require the greatest time to heat from 20 $^\circ\text{C}$ to 85 $^\circ\text{C}$ given identical heating conditions?
2. If 43.0 g of a substance at 98.0 $^\circ\text{C}$ is placed into a calorimeter containing 100.0 g of water at 25.0 $^\circ\text{C}$, the temperature rises to 29.5 $^\circ\text{C}$. If the heat capacity of the calorimeter is 35.0 J°C , what is the specific heat of the substance?
3. Upon which of the following factors does the heat capacity of a substance depend? T, mass, compos.
4. When 1.34 g of KBr (119 g/mole) dissolves in 74.0 g of water in a coffee-cup calorimeter, the temperature drops from 18.000 $^\circ\text{C}$ to 17.279 $^\circ\text{C}$. Assume that all the heat absorbed in the solution comes from the water. The specific heat for water is 4.184 $\text{J/g}^\circ\text{C}$. What is q for the dissolving of one mole of KBr in water?
5. A process occurring in a bomb calorimeter causes the change in the temperature of a calorimeter from 19.75 $^\circ\text{C}$ to 28.67 $^\circ\text{C}$. The heat capacity of the calorimeter is 13.24 kJ°C . What was q for the process involved?
6. Ten(10) g of water at 32 $^\circ\text{C}$ is heated to 100 $^\circ\text{C}$, then cooled and frozen at 0 $^\circ\text{C}$. The 10 g of ice is then melted and heated to 32 $^\circ\text{C}$. Calculate ΔH for the process. The heat of fusion for water is 6.00 kJ/mole and the specific heat of water is 4.184 $\text{J/g}^\circ\text{C}$. The processes are:
 - a. $\text{H}_2\text{O}(\text{l})(32^\circ\text{C}) \implies \text{H}_2\text{O}(\text{l})(100^\circ\text{C})$
 - b. $\text{H}_2\text{O}(\text{l})(100^\circ\text{C}) \implies \text{H}_2\text{O}(\text{l})(0^\circ\text{C})$
 - c. $\text{H}_2\text{O}(\text{l})(0^\circ\text{C}) \implies \text{H}_2\text{O}(\text{s})(0^\circ\text{C})$
 - d. $\text{H}_2\text{O}(\text{s})(0^\circ\text{C}) \implies \text{H}_2\text{O}(\text{l})(0^\circ\text{C})$
 - e. $\text{H}_2\text{O}(\text{l})(0^\circ\text{C}) \implies \text{H}_2\text{O}(\text{l})(32^\circ\text{C})$
7. How much heat is given off when 1.26×10^4 g of ammonia is produced according to the equation, and under standard conditions? Ammonia is 17 g/mole. $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \implies 2\text{NH}_3(\text{g})$ $\Delta H^\circ = -92.6 \text{ kJ}$
8. Which of the following are exothermic, and what is the sign on ΔH ?
 - a. $\text{H}_2\text{O}(\text{g}) \implies \text{H}_2\text{O}(\text{l})$
 - b. $2\text{Na}(\text{s}) + 2\text{H}_2\text{O}(\text{l}) \implies 2\text{Na}^+(\text{aq}) + 2\text{OH}^-(\text{aq}) + \text{H}_2(\text{g})$
 - c. $\text{H}^+(\text{aq}) + \text{OH}^-(\text{aq}) \implies \text{H}_2\text{O}(\text{l})$
 - d. $\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \implies \text{CH}_4(\text{g}) + 2\text{O}_2(\text{g})$
9. Acetylene burns in air according to the equation: $2\text{C}_2\text{H}_2(\text{g}) + 5\text{O}_2(\text{g}) \implies 4\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$ $\Delta H^\circ = -2598.9 \text{ kJ}$. Would you expect the change in enthalpy to more or less negative if the water formed were a gas rather than a liquid?
10. The ΔH_f° for $\text{NO}_2(\text{g})$ is given as 33.9 kJ/mole . Write the thermochemical equation for which this is the standard change in enthalpy.
11. Which has the most positive ΔH_f° ? $\text{Cl}_2(\text{g})$, $\text{Cl}_2(\text{l})$, $\text{Br}_2(\text{g})$, $\text{Br}_2(\text{l})$?
12. If the heat of combustion for hydrogen gas is given by the equation, $2\text{H}_2(\text{g}) + \text{O}_2(\text{g}) \implies 2\text{H}_2\text{O}(\text{l})$ $\Delta H^\circ = -572 \text{ kJ}$, what is the ΔH_f° for liquid water?
13. What is the standard heat of reaction (ΔH°) for the following reaction,
 $2\text{C}_2\text{H}_2(\text{g}) + 5\text{O}_2(\text{g}) \implies 4\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$,
given standard heats of formation as follows: $\text{C}_2\text{H}_2(\text{g}) = +227 \text{ kJ/mole}$,
 $\text{CO}_2(\text{g}) = -394 \text{ kJ/mole}$, $\text{H}_2\text{O}(\text{l}) = -286 \text{ kJ/mole}$
14. Calculate the standard enthalpy of formation of carbon disulfide (CS_2) from its elements, given that:
 $\text{C}(\text{graphite}) + \text{O}_2(\text{g}) \implies \text{CO}_2(\text{g})$ $\Delta H^\circ = -394 \text{ kJ}$
 $\text{S}(\text{s}) + \text{O}_2(\text{g}) \implies \text{SO}_2(\text{g})$ $\Delta H^\circ = -296 \text{ kJ}$
 $\text{CS}_2(\text{l}) + 3\text{O}_2(\text{g}) \implies \text{CO}_2(\text{g}) + 2\text{SO}_2(\text{g})$ $\Delta H^\circ = -1072 \text{ kJ}$
15. Given the thermochemical equation: $2\text{Al}_2\text{O}_3(\text{s}) \implies 4\text{Al}(\text{s}) + 3\text{O}_2(\text{g})$ $\Delta H^\circ = +3352 \text{ kJ}$
What is the standard heat of formation of aluminum oxide per mole?