

Chapter 06: Energy Relationships in Chemical Reactions

1. *Radiant energy* is
 - A) the energy stored within the structural units of chemical substances.
 - B) the energy associated with the random motion of atoms and molecules.
 - C) solar energy, i.e. energy that comes from the sun.
 - D) energy available by virtue of an object's position.

3. *Chemical energy* is
 - A) the energy stored within the structural units of chemical substances.
 - B) the energy associated with the random motion of atoms and molecules.
 - C) solar energy, i.e. energy that comes from the sun.
 - D) energy available by virtue of an object's position.

5. *Heat* is
 - A) a measure of temperature.
 - B) a measure of the change in temperature.
 - C) a measure of thermal energy.
 - D) a measure of thermal energy transferred between two bodies at different temperature.

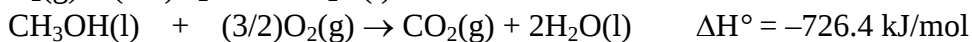
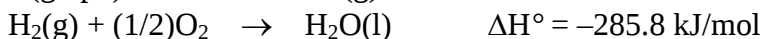
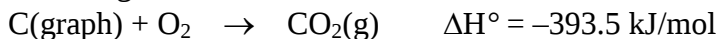
7. An exothermic reaction causes the surroundings to
 - A) warm up.
 - B) become acidic.
 - C) expand.
 - D) decrease its temperature.
 - E) release CO₂.

9. Calculate the amount of heat necessary to raise the temperature of 12.0 g of water from 15.4°C to 93.0°C. The specific heat of water = 4.18 J/g·°C.
A) 0.027 J B) 324 J C) 389 J D) 931 J E) 3,890 J

11. A beaker contains 115 g of ethanol at 18.2°C. If the ethanol absorbs 1125 J of heat without losing heat to the surroundings, what will be the final temperature of the ethanol? The specific heat of ethanol is 2.46 J/g·°C.
A) 4.08°C B) 14.1°C C) 18.4°C D) 22.2°C E) 36.4°C

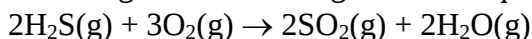
13. If 325 g of water at 4.2°C absorbs 12.28 kJ, what is the final temperature of the water? The specific heat of water is 4.184 J/g·°C.
A) 4.21°C B) 4.8°C C) 9.0°C D) 13.2°C E) 2,938°C

33. Calculate the standard enthalpy of formation of liquid methanol, $\text{CH}_3\text{OH}(\text{l})$, using the following information:

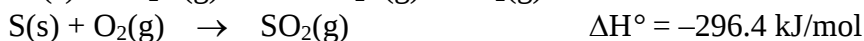
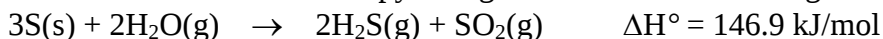


- A) $-1,691.5 \text{ kJ/mol}$ D) 47.1 kJ/mol
 B) -238.7 kJ/mol E) -47.1 kJ/mol
 C) 1691.5 kJ/mol

35. During volcanic eruptions, hydrogen sulfide gas is given off and oxidized by air according to the following chemical equation:



Calculate the standard enthalpy change for the above reaction given:

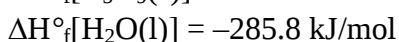
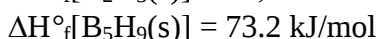
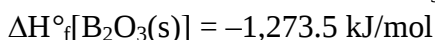


- A) -1036.1 kJ/mol D) 443.3 kJ/mol
 B) -742.3 kJ/mol E) 742.3 kJ/mol
 C) -149.5 kJ/mol

37. Given the thermochemical equation $2\text{SO}_2 + \text{O}_2 \rightarrow 2\text{SO}_3$, $\Delta H^\circ_{\text{rxn}} = -198 \text{ kJ/mol}$, what is the standard enthalpy change for the decomposition of one mole of SO_3 ?

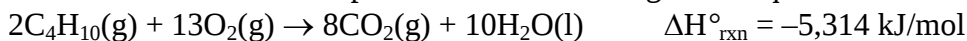
- A) 198 kJ/mol D) 396 kJ/mol
 B) -99 kJ/mol E) -198 kJ/mol
 C) 99 kJ/mol

39. Pentaborane $\text{B}_5\text{H}_9(\text{s})$ burns vigorously in O_2 to give $\text{B}_2\text{O}_3(\text{s})$ and $\text{H}_2\text{O}(\text{l})$. Calculate $\Delta H^\circ_{\text{rxn}}$ for the combustion of 1 mol of B_5H_9 .



- A) $-1,2735 \text{ kJ/mol}$ D) $-9,086 \text{ kJ/mol}$
 B) $-4,543 \text{ kJ/mol}$ E) $-8,448 \text{ kJ/mol}$
 C) $-18,170 \text{ kJ/mol}$

41. The combustion of butane produces heat according to the equation



What is the heat of combustion per gram of butane?

- A) -32.5 kJ/g D) $-2,656 \text{ kJ/g}$
 B) -45.7 kJ/g E) $-15,440 \text{ kJ/g}$
 C) -91.5 kJ/g

43. The combustion of butane produces heat according to the equation
 $2\text{C}_4\text{H}_{10}(\text{g}) + 13\text{O}_2(\text{g}) \rightarrow 8\text{CO}_2(\text{g}) + 10\text{H}_2\text{O}(\text{l})$ $\Delta H^\circ_{\text{rxn}} = -5,314 \text{ kJ/mol}$
 How many grams of butane must be burned to release $1.00 \times 10^4 \text{ kJ}$ of heat?
 A) 30.9 g B) 61.8 g C) 109 g D) 153 g E) 219 g
45. Given that $\text{CaO}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Ca}(\text{OH})_2(\text{s})$, $\Delta H^\circ_{\text{rxn}} = -64.8 \text{ kJ/mol}$, how many grams of CaO must react in order to liberate 525 kJ of heat?
 A) 6.92 g B) 56.1 g C) 455 g D) 606 g E) $3.40 \times 10^4 \text{ g}$
47. An average home in Colorado requires 20. GJ of heat per month. How many grams of natural gas (methane) must be burned to supply this energy?
 $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$ $\Delta H^\circ_{\text{rxn}} = -890.4 \text{ kJ/mol}$
 A) $1.4 \times 10^3 \text{ g}$ D) $2.2 \times 10^4 \text{ g}$
 B) $3.6 \times 10^5 \text{ g}$ E) $1.4 \times 10^4 \text{ g}$
 C) $7.1 \times 10^{-4} \text{ g}$
49. Determine the heat given off to the surroundings when 9.0 g of aluminum reacts according to the equation $2\text{Al} + \text{Fe}_2\text{O}_3 \rightarrow \text{Al}_2\text{O}_3 + 2\text{Fe}$, $\Delta H^\circ_{\text{rxn}} = -849 \text{ kJ/mol}$.
 A) $7.6 \times 10^3 \text{ kJ}$ D) $5.6 \times 10^2 \text{ kJ}$
 B) $2.8 \times 10^2 \text{ kJ}$ E) $2.5 \times 10^3 \text{ kJ}$
 C) $1.4 \times 10^2 \text{ kJ}$
51. Ethanol ($\text{C}_2\text{H}_5\text{OH}$) burns according to the equation
 $\text{C}_2\text{H}_5\text{OH}(\text{l}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + 3\text{H}_2\text{O}(\text{l})$, $\Delta H^\circ_{\text{rxn}} = -1367 \text{ kJ/mol}$.
 How much heat is released when 35.0 g of ethanol is burned?
 A) 1,797 kJ B) 1,367 kJ C) $9.61 \times 10^{-4} \text{ kJ}$ D) $4.78 \times 10^4 \text{ kJ}$ E) 1,040 kJ
53. Calcium oxide and water react in an exothermic reaction:
 $\text{CaO}(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Ca}(\text{OH})_2(\text{s})$ $\Delta H^\circ_{\text{rxn}} = -64.8 \text{ kJ/mol}$
 How much heat would be liberated when 7.15 g CaO(s) is dropped into a beaker containing 152g H_2O ?
 A) $1.97 \times 10^{-3} \text{ kJ}$ B) 8.26 kJ C) 508 kJ D) 547 kJ E) 555 kJ

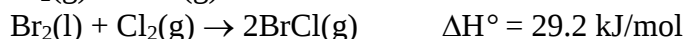
67. For which of these reactions will the difference between ΔH° and ΔE° be the smallest?

- A) $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightarrow 2\text{NH}_3(\text{g})$
- B) $4\text{PH}_3(\text{g}) \rightarrow \text{P}_4(\text{g}) + 6\text{H}_2(\text{g})$
- C) $\text{H}_2(\text{g}) + \text{Cl}_2(\text{g}) \rightarrow 2\text{HCl}(\text{g})$
- D) $\text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l}) \rightarrow \text{CH}_4(\text{g}) + 2\text{O}_2(\text{g})$
- E) $\text{P}_4(\text{s}) + 10\text{Cl}_2(\text{g}) \rightarrow 4\text{PCl}_5(\text{s})$

69. The *bond enthalpy* of the Br–Cl bond is equal to ΔH° for the reaction



Use the following data to find the bond enthalpy of the Br–Cl bond.



- A) 219.0 kJ/mol
- B) 203.5 kJ/mol
- C) 14.6 kJ/mol
- D) 438.0 kJ/mol
- E) 407.0 kJ/mol

71. The heat of solution of ammonium chloride is 15.2 kJ/mol. If a 6.134 g sample of NH_4Cl is added to 65.0 mL of water in a calorimeter at 24.5°C , what is the minimum temperature reached by the solution? (The specific heat of water = $4.18 \text{ J/g} \cdot ^\circ\text{C}$; the heat capacity of the calorimeter = $365. \text{ J/}^\circ\text{C}$.)

- A) 27.1°C
- B) 18.6°C
- C) 19.7°C
- D) 21.9°C
- E) 30.4°C

73. Ozone (O_3) in the atmosphere can be converted to oxygen gas by reaction with nitric oxide (NO). Nitrogen dioxide is also produced in the reaction. What is the enthalpy change when 8.50L of ozone at a pressure of 1.00 atm and 25°C reacts with 12.00 L of nitric oxide at the same initial pressure and temperature? [$\Delta H^\circ_f(\text{NO}) = 90.4 \text{ kJ/mol}$; $\Delta H^\circ_f(\text{NO}_2) = 33.85 \text{ kJ/mol}$; $\Delta H^\circ_f(\text{O}_3) = 142.2 \text{ kJ/mol}$]

- A) -69.2 kJ
- B) -19.7 kJ
- C) -1690 kJ
- D) -97.6 kJ
- E) -167 kJ