Chapter 7 Answers

Practice Examples

1a. 32.7 kJ

1b. 4.89 kJ

2a. 3.0×10^{2} g

2b. 37.9°C

3a. -3.83×10^{3} kJ/mol

3b. 6.26 kJ/° C

4a. –65. kJ/mol

4b. 33.4°C

5a. 114 J

5b. +14.6 kJ

6a. $+1.70 \times 10^{2}$ J

6b. 179 J of work is done by the system to the surroundings.

7a. 60.6 g $C_{12}H_{22}O_{11}$

7b. 0.15 kJ heat evolved

8a. +3.31 kJ

8b. 1.72 kg H_2O

9a. –124 kJ

9b. –2006 kJ

10a. $6\ \mathrm{C}(\text{graphite}) + \frac{13}{2}\mathrm{H}_2(\mathrm{g}) + \mathrm{O}_2(\mathrm{g}) + \frac{1}{2}\mathrm{N}_2(\mathrm{g}) \rightarrow \mathrm{C}_6\mathrm{H}_{13}\mathrm{O}_2\mathrm{N}(\mathrm{s})$

10b. The specified reaction is twice the reverse of the formation reaction, and its enthalpy change is minus two times the enthalpy of formation of $\mathrm{NH}_3(\mathrm{g})$: $-2 \times (-46.11\ \mathrm{kJ}) = +92.22\ \mathrm{kJ}$

11a. -1367 kJ

11b. -2.5×10^{3} kJ/mole of mixture

12a. -1273 kJ/mol $C_6H_{12}O_6$(s)

12b. -184 kJ/mol $CH_3OCH_3(g)$

13a. -112.3 kJ/mol AgI(s) formed

13b. -505.8 kJ/mol $Ag_2CO_3(s)$ formed.

Integrative Example

A. -125.5 kJ/mol

B. The contents of the vessel after completion of the reaction are 74.1 g of $Ca(OH)_2$ and 66.3 g of H_2O.

Exercises

1a. $+2.9\times10^{2}$ kJ

1b. -177 kJ

3a. $0.385\ \text{J g}^{-1}\ {}^{\circ}\text{C}^{-1}$ for Zn

3b. $0.13\ \text{J g}^{-1}\ {}^{\circ}\text{C}^{-1}$ for Pt

3c. $0.905\ \text{J g}^{-1}\ {}^{\circ}\text{C}^{-1}$ for Al

5. 545 °C

7. $24.0\,^{\circ}\text{C}$

9. $2.3\times10^{2}\ \text{J mol}^{-1}\,{}^{\circ}\text{C}^{-1}$

11. 1.21 J/K

13. 2.49×10^{5} kJ of heat evolved.

15a. 65.59 kJ

15b. 3.65×10^{3} kJ

15c. 1.45×10^{3} kJ

17a. 504 kg CH_4

17b. -6.20×10^{5} kJ of heat energy

17c. 2.90×10^{3} L H_2O

19. 1.36×10^{3} kJ heat

21a. -5×10^{1} kJ/mol

21b. The ΔT here is known to just one significant figure (0.9 °C). Doubling the amount of KOH should give a temperature change known to two significant figures (1.6 °C) and using twenty times the mass of KOH should give a temperature change known to three significant figures (16.0 °C).

23. 4.2×10^{2} g NH_4Cl

25. -56 kJ/mol

27. 2.7×10^{2} kJ heat evolved .

29. 39.6 g

31. 1.$\underline{83}$ g H_2O

33. 0.111 L

35. 4.98 kJ /° C

37a. -2.34×10^{3} kJ/mol $C_5H_{10}O_5$

37b. $C_5H_{10}O_5(g) + 5O_2(g) \rightarrow 5CO_2(g) + 5H_2O(l) \qquad \Delta H = -2.34\times10^{3}$ kJ

39a. Endothermic

39b. +18 kJ/mol

41. 7.72 kJ/°C

43. 5.23°C

45. 15 g

47a. -3.4 L atm

47b. -3.5×10^{2} J

47c. -83 cal

49. When the Ne(g) sample expands into an evacuated vessel it does not push aside any matter, hence no work is done.

51a. Work is done on the system by the surroundings (compression).

51b. No pressure-volume work is done.

51c. Work is done on the system by the surroundings (compression).

53. 3.21 L

55a. 0

55b. -562 J

55c. 0.08 kJ

57a. Yes

57b. Yes

57c. The temperature of the gas stays the same if the process is isothermal.

57d. ΔU for the gas must equal zero by definition (temperature is not changing).

59. This situation is impossible. An ideal gas expanding isothermally means that $\Delta U = 0 = q + w$, or $w = -q$, not $w = -2q$.

61. -545 J

63. According to the First Law of Thermodynamics, the answer is (c).

65a. -2008 kJ/mol

65b. -2012 kJ/mol

67. +30.74 kJ

69. $\Delta H^\circ = -290.$ kJ

71. $\Delta H^\circ = -217.5$ kJ

73. $\Delta H^\circ = -747.5$ kJ

75. $\Delta H^\circ = -35.8$ kJ

77. $\Delta H^\circ = -120.$ kJ

79a. –55.7 kJ

79b. –1124 kJ

81. –206.0 kJ/mol

83. +202.4 kJ

85. –1366.7 kJ

87. –102.9 kJ/mol

89. –55 kJ

91. 2.40×10^{6} kJ

93. $-424\ \text{kJ} = \Delta H_f^\circ\left[\text{HCOOH}(s)\right]$

Integrative and Advanced Exercises

96. 3.5 °C. This large a temperature rise is unlikely, as some of the kinetic energy will be converted into forms other than heat, such as sound and the fracturing of the object along with the surface it strikes. In addition, some heat energy would be transferred to the surface.

97. -1.95×10^{3} kJ/mol $C_6H_8O_7$

103. The sewage gas.

107. 303 g $C_6H_{12}O_6$

109. The gas mixture contains 87.0% CH_4 and 13.0% C_2H_6, both by volume.

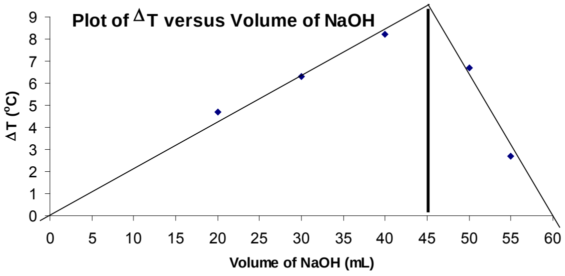
112. $\Delta H = -1.45\times10^{3}\text{kJ/mol},\ 3\ O_2(g)\ +\ C_2H_6O(g) \rightarrow 2\ CO_2(g) +\ 3\ H_2O(l)$.

113. 69 seconds

114. -12 J

Feature Problems

122a. The equivalence point occurs with 45.0 mL of 1.00 M NaOH(aq) [45.0 mmol NaOH] added and 15.0 mL of 1.00 M citric acid [15.0 mmol citric acid].

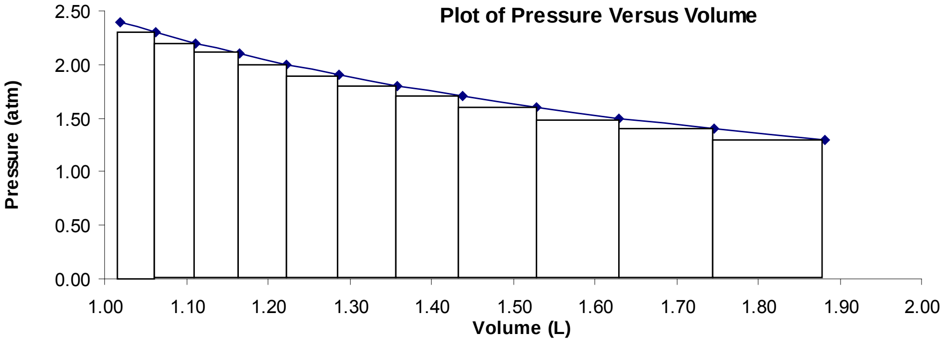


122b. Heat is a product of the reaction, as are chemical species (products). Products are maximized at the exact stoichiometric proportions. Since each reaction mixture has the same volume, and thus about the same mass to heat, the temperature also is a maximum at this point.

122c. $H_3C_6H_5O_7(s) + 3OH^-(aq) \rightarrow 3H_2O(l) + C_6H_5O_7^{3-}(aq)$

125a. $-14\underline{7}$ J

125b.



125c. $w = -152$ J

125d. The maximum work is 209 J. The minimum work would be +152 J.

125e. $\Delta U = 0$. Because $\Delta U = q + w = 0$, $q = -w$. This means that –209 J corresponds to the maximum work of compression, and –152 J corresponds to the minimum work of compression.

125f. $q/T = nR \ln V_f / V_i$. Yes, q/T is a state function.

Self-Assessment Exercises

130. The answer is (b).

131. The answer is (c).

132. The answer is (d).

133. The answer is (a).

134. The answer is (b).

135. The answer is (a).

136. 52.7 °C

137a. $2\ N_2 + O_2 \rightarrow 2\ N_2O$

137b. $S + O_2 + Cl_2 \rightarrow SO_2Cl_2$

137c. $2\ CH_3CH_2COOH + 7\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$

138. -218 kJ/mol

139. Enthalpy of formation for elements (even molecular ones, such as O_2 or Cl_2) is by convention set to 0. While it is possible for the enthalpy of formation of a compound to be near zero, it is unlikely.

140. From a theoretical standpoint, one can have a situation where the $\Delta U < 0$, but there is enough work done on the system that makes $\Delta H > 0$.

141. A gas stove works by combustion of a flammable fuel. Once shut off, the heat source instantly disappears. An electric stove works by the principle of heat conduction. Even after the electricity is shut off to the heating coil, it takes time for the coil to cool because of its heat capacity, and therefore it continues to supply heat to the pot.

142. The answer is (a).

143. The answer is (b).