

CHEM 1411, chapter 6. Thermochemistry Exercises

- The heat capacity of 20.0 g of water is 83.7 J/°C.
A) True
B) False
- Find the heat absorbed from the surroundings when 15 g of O₂ reacts according to the equation $\text{O} + \text{O}_2 \rightarrow \text{O}_3$, $\Delta H^\circ_{\text{rxn}} = -103 \text{ kJ/mol}$.
A) $4.6 \times 10^{-3} \text{ kJ}$
B) 48 kJ
C) 96 kJ
D) 32 kJ
E) 110 kJ
- The heat of solution of calcium chloride CaCl₂ is -82.8 kJ/mol, and the combined heats of hydration of 1 mole of gaseous calcium ions and 2 mole of gaseous chloride ions is -2327 kJ. What is the lattice energy of calcium chloride?
- Given the following ΔH° values,
 $\text{H}_2(\text{g}) + \frac{1}{2} \text{O}_2(\text{g}) \rightarrow \text{H}_2\text{O}(\text{l}) \quad \Delta H^\circ_f = -285.8 \text{ kJ/mol}$
 $\text{H}_2\text{O}_2(\text{l}) \rightarrow \text{H}_2(\text{g}) + \text{O}_2(\text{g}) \quad \Delta H^\circ_{\text{rxn}} = 187.6 \text{ kJ/mol}$
calculate $\Delta H^\circ_{\text{rxn}}$ for the reaction $\text{H}_2\text{O}_2(\text{l}) \rightarrow \text{H}_2\text{O}(\text{l}) + \frac{1}{2} \text{O}_2(\text{g})$,
- Calculate the amount of work done, in joules, when 2.5 mole of H₂O vaporizes at 1.0 atm and 25 °C. Assume the volume of liquid H₂O is negligible compared to that of vapor. (1 L atm = 101.3 J)
A) 6,190 kJ
B) 6.19 kJ
C) 61.1 J
D) 5.66 kJ
E) 518 J
- The heat of solution of NH₄NO₃ is 26.2 kJ/mol. Is heat evolved or absorbed when a solution of NH₄NO₃ is diluted by addition of more water?

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

$$2\text{C}_4\text{H}_{10}(\text{g}) + 13\text{O}_2(\text{g}) \rightarrow 8\text{CO}_2(\text{g}) + 10\text{H}_2\text{O}(\text{l}) \quad \Delta H^\circ_{\text{rxn}} = -5,314 \text{ kJ/mol}$$
 How many grams of butane must be burned to release 1.00×10^4 kJ of heat?
 A) 30.9 g
 B) 61.8 g
 C) 109 g
 D) 153 g
 E) 219 g
8. Find the standard enthalpy of formation of ethylene, $\text{C}_2\text{H}_4(\text{g})$, given the following data:
 heat of combustion of $\text{C}_2\text{H}_4(\text{g}) = -1411$ kJ/mol; $\Delta H^\circ_{\text{f}}[\text{CO}_2(\text{g})] = -393.5$ kJ/mol;
 $\Delta H^\circ_{\text{f}}[\text{H}_2\text{O}(\text{l})] = -285.8$ kJ/mol.
 A) 52 kJ/mol
 B) 87 kJ/mol
 C) 731 kJ/mol
 D) 1.41×10^3 kJ/mol
 E) 2.77×10^3 kJ/mol
9. Calculate the standard enthalpy change for the reaction

$$2\text{C}_8\text{H}_{18}(\text{l}) + 21\text{O}_2(\text{g}) \rightarrow 8\text{CO}(\text{g}) + 8\text{CO}_2(\text{g}) + 18\text{H}_2\text{O}(\text{l}).$$
 Given:

$$2\text{C}_8\text{H}_{18}(\text{l}) + 25\text{O}_2(\text{g}) \rightarrow 16\text{CO}_2(\text{g}) + 18\text{H}_2\text{O}(\text{l}) \quad \Delta H^\circ = -11,020 \text{ kJ/mol}$$

$$2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) \quad \Delta H^\circ = -566.0 \text{ kJ/mol}$$
 A) 1.0454×10^4 kJ/mol
 B) -8,756 kJ/mol
 C) 1.1586×10^4 kJ/mol
 D) -6,492 kJ/mol
 E) -1.0454×10^4 kJ/mol
10. Given $2\text{Al}(\text{s}) + (3/2)\text{O}_2(\text{g}) \rightarrow \text{Al}_2\text{O}_3(\text{s})$, $\Delta H^\circ_{\text{f}} = -1,670$ kJ/mol for $\text{Al}_2\text{O}_3(\text{s})$.
 Determine ΔH° for the reaction $2\text{Al}_2\text{O}_3(\text{s}) \rightarrow 4\text{Al}(\text{s}) + 3\text{O}_2(\text{g})$.
 A) 3,340 kJ/mol
 B) 1,670 kJ/mol
 C) -3,340 kJ/mol
 D) -1,670 kJ/mol
 E) -835 kJ/mol

11. Suppose a 50.0 g block of silver (specific heat = 0.2350 J/g · °C) at 100 °C is placed in contact with a 50.0 g block of iron (specific heat = 0.4494 J/g · °C) at 0 °C, and the two blocks are insulated from the rest of the universe. The final temperature of the two blocks
- A) will be higher than 50 °C.
 - B) will be lower than 50 °C.
 - C) will be exactly 50 °C.
 - D) is unrelated to the composition of the blocks.
 - E) cannot be predicted.
12. Find $\Delta H^\circ_{\text{rxn}}$ for the reaction
 $\text{CH}_4(\text{g}) + 2\text{O}_2(\text{g}) \rightarrow \text{CO}_2(\text{g}) + 2\text{H}_2\text{O}(\text{l})$.
[$\Delta H^\circ_f(\text{CH}_4(\text{g})) = -74.8 \text{ kJ/mol}$; $\Delta H^\circ_f(\text{CO}_2(\text{g})) = -393.5 \text{ kJ/mol}$; $\Delta H^\circ_f(\text{H}_2\text{O}(\text{l})) = -285.5 \text{ kJ/mol}$]
13. At 25 °C, the standard enthalpy of formation of KCl(s) is -435.87 kJ/mol . When one mole of KCl(s) is formed by reacting potassium vapor and chlorine gas at 25 °C, the standard enthalpy of reaction is -525.86 kJ/mol . Find ΔH° for the sublimation of potassium, $\text{K}(\text{s}) \rightarrow \text{K}(\text{g})$, at 25 °C.
- A) -345.88 kJ/mol
 - B) 45.00 kJ/mol
 - C) 345.88 kJ/mol
 - D) 89.99 kJ/mol
 - E) -525.86 kJ/mol
14. A piece of copper with a mass of 218 g has a heat capacity of 83.9 J/ °C. What is the specific heat of copper?
- A) $0.385 \text{ J/g} \cdot ^\circ\text{C}$
 - B) $1.83 \times 10^4 \text{ J/g} \cdot ^\circ\text{C}$
 - C) $2.60 \text{ J/g} \cdot ^\circ\text{C}$
 - D) $1.32 \text{ J/g} \cdot ^\circ\text{C}$
 - E) $24.5 \text{ J/g} \cdot ^\circ\text{C}$
15. *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.

16. Define *specific heat*.
17. The combustion of one mole of benzene, C_6H_6 , in oxygen liberates 3268 kJ of heat. The products of the reaction are carbon dioxide and water. How much heat is given off when 183 g of oxygen are reacted with excess benzene?
18. When 0.7521 g of benzoic acid was burned in a calorimeter containing 1,000. g of water, a temperature rise of $3.60\text{ }^\circ\text{C}$ was observed. What is the heat capacity of the bomb calorimeter, excluding the water? The heat of combustion of benzoic acid is -26.42 kJ/g .
- A) $15.87\text{ kJ/}^\circ\text{C}$
B) $4.18\text{ kJ/}^\circ\text{C}$
C) $5.52\text{ kJ/}^\circ\text{C}$
D) $1.34\text{ kJ/}^\circ\text{C}$
E) $752.1\text{ kJ/}^\circ\text{C}$
19. When 0.560 g of $Na(s)$ reacts with excess $F_2(g)$ to form $NaF(s)$, 13.8 kJ of heat is evolved at standard-state conditions. What is the standard enthalpy of formation (ΔH_f°) of $NaF(s)$?
- A) 24.8 kJ/mol
B) 570 kJ/mol
C) -24.8 kJ/mol
D) -7.8 kJ/mol
E) -570 kJ/mol
20. Find ΔH_{rxn}° for the reaction
 $2Ag_2S(s) + 2H_2O(l) \rightarrow 4Ag(s) + 2H_2S(g) + O_2(g)$.
[$\Delta H_f^\circ(Ag_2S(s)) = -32.6\text{ kJ/mol}$; $\Delta H_f^\circ(H_2S(g)) = -20.5\text{ kJ/mol}$; $\Delta H_f^\circ(H_2O(l)) = -285.5\text{ kJ/mol}$]
21. The heat released when one mole of water is formed from the elements is 1,198 kJ. An experiment was conducted that permitted water to form in this manner, and the heat was contained in 2.0 liters of water. The water temperature before the reaction was $34.5\text{ }^\circ\text{C}$, and after the reaction it had risen to $52.0\text{ }^\circ\text{C}$. How many moles of water were formed? (The specific heat of water is $4.184\text{ J/g}\cdot^\circ\text{C}$.)

22. In an endothermic process, heat is absorbed by the system.
A) True
B) False
23. The specific heat of gold is $0.129 \text{ J/g} \cdot ^\circ\text{C}$. What is the molar heat capacity of gold?
A) $0.039 \text{ J/mol} \cdot ^\circ\text{C}$
B) $0.129 \text{ J/mol} \cdot ^\circ\text{C}$
C) $25.4 \text{ J/mol} \cdot ^\circ\text{C}$
D) $39.0 \text{ kJ/mol} \cdot ^\circ\text{C}$
E) $197 \text{ J/mol} \cdot ^\circ\text{C}$
24. If $2\text{Mg(s)} + \text{O}_2(\text{g}) \rightarrow 2\text{MgO(s)}$, $\Delta H^\circ = -1203.6 \text{ kJ/mol}$.
For $\text{Mg(s)} + (1/2)\text{O}_2(\text{g}) \rightarrow \text{MgO(s)}$, the enthalpy change is $\Delta H = -601.8 \text{ kJ/mol}$.
A) True
B) False
25. 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 $24.5 \text{ }^\circ\text{C}$, 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) $27.1 \text{ }^\circ\text{C}$
B) $18.6 \text{ }^\circ\text{C}$
C) $19.7 \text{ }^\circ\text{C}$
D) $21.9 \text{ }^\circ\text{C}$
E) $30.4 \text{ }^\circ\text{C}$
26. What would be the standard enthalpy change for the reaction of one mole of $\text{H}_2(\text{g})$ with one mole of $\text{Cl}_2(\text{g})$ to produce two moles of $\text{HCl}(\text{g})$ at standard state conditions?
[$\Delta H_f^\circ(\text{HCl}(\text{g})) = -92.3 \text{ kJ/mol}$]
27. Given the thermochemical equation $2\text{SO}_2(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{SO}_3(\text{g})$, $\Delta H_{\text{rxn}}^\circ = -198 \text{ kJ/mol}$, how much heat is evolved when $600. \text{ g}$ of SO_2 is burned?
A) $5.46 \times 10^{-2} \text{ kJ}$
B) 928 kJ
C) $1.85 \times 10^3 \text{ kJ}$
D) $59,400 \text{ kJ}$
E) $3.71 \times 10^3 \text{ kJ}$

28. The enthalpy of combustion of acetylene C_2H_2 is described by
 $\text{C}_2\text{H}_2(\text{g}) + (5/2)\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \quad \Delta H^\circ_{\text{rxn}} = -1299 \text{ kJ/mol}$
Calculate the enthalpy of formation of acetylene, given the following enthalpies of formation
 $\Delta H^\circ_f[\text{CO}_2(\text{g})] = -393.5 \text{ kJ/mol}$
 $\Delta H^\circ_f[\text{H}_2\text{O}(\text{l})] = -285.8 \text{ kJ/mol}$
29. Glycine, $\text{C}_2\text{H}_5\text{O}_2\text{N}$, is important for biological energy. The combustion reaction of glycine is given by the equation
 $4\text{C}_2\text{H}_5\text{O}_2\text{N}(\text{s}) + 9\text{O}_2(\text{g}) \rightarrow 8\text{CO}_2(\text{g}) + 10\text{H}_2\text{O}(\text{l}) + 2\text{N}_2(\text{g}) \quad \Delta H^\circ_{\text{rxn}} = -3857 \text{ kJ/mol}$
Given that $\Delta H^\circ_f[\text{CO}_2(\text{g})] = -393.5 \text{ kJ/mol}$ and $\Delta H^\circ_f[\text{H}_2\text{O}(\text{l})] = -285.8 \text{ kJ/mol}$, calculate the enthalpy of formation of glycine.
A) -537.2 kJ/mol
B) -268.2 kJ/mol
C) $2,149 \text{ kJ/mol}$
D) $-3,178 \text{ kJ/mol}$
E) -964 kJ/mol
30. An exothermic reaction causes the surroundings to
A) warm up.
B) become acidic.
C) expand.
D) decrease its temperature.
E) release CO_2 .
31. The heat of neutralization of HCl by NaOH is $\Delta H^\circ_{\text{rxn}} = -56.2 \text{ kJ/mol}$. How much heat is released when 125 mL of 1.750 M HCl is mixed with 195 mL of 0.667 M NaOH ?
32. The enthalpy change when a strong acid is neutralized by strong base is -56.1 kJ/mol . If 12.0 mL of 6.00 M HBr at 21.30°C is mixed with $300. \text{ mL}$ of 0.250 M NaOH , also at 21.30°C , what will the maximum temperature reached by the resulting solution? (Assume that there is no heat loss to the container, that the specific heat of the final solution is $4.18 \text{ J/g} \cdot ^\circ\text{C}$, and that the density of the final solution is that of water.)
A) 18.20°C
B) 24.53°C
C) 101.8°C
D) 24.40°C
E) 34.25°C

33. A 100. mL sample of 0.200 M aqueous hydrochloric acid is added to 100. mL of 0.200 M aqueous ammonia in a calorimeter whose heat capacity (excluding any water) is 480. J/K. The following reaction occurs when the two solutions are mixed.
- $$\text{HCl(aq)} + \text{NH}_3(\text{aq}) \rightarrow \text{NH}_4\text{Cl(aq)}$$
- The temperature increase is 2.34 °C. Calculate ΔH per mole of HCl and NH_3 reacted.
- A) 154 kJ/mol
 B) 1.96 kJ/mol
 C) 485 kJ/mol
 D) -1.96 kJ/mol
 E) -154 kJ/mol
34. To which one of the following reactions occurring at 25 °C does the symbol $\Delta H_f^\circ[\text{HNO}_3(\text{l})]$ refer?
- A) $\text{H}(\text{g}) + \text{N}(\text{g}) + \text{O}_3(\text{g}) \rightarrow \text{HNO}_3(\text{l})$
 B) $(1/2)\text{H}_2(\text{g}) + (1/2)\text{N}_2(\text{g}) + (3/2)\text{O}_2(\text{g}) \rightarrow \text{HNO}_3(\text{l})$
 C) $\text{HNO}_3(\text{l}) \rightarrow (1/2)\text{H}_2(\text{g}) + (1/2)\text{N}_2(\text{g}) + (3/2)\text{O}_2(\text{g})$
 D) $\text{HNO}_3(\text{l}) \rightarrow \text{H}(\text{g}) + \text{N}(\text{g}) + 3\text{O}(\text{g})$
 E) $\text{H}_2(\text{g}) + \text{N}_2(\text{g}) + \text{O}_3(\text{g}) \rightarrow \text{HNO}_3(\text{l})$
35. A 0.3423 g sample of pentane, C_5H_{12} , was burned in a bomb calorimeter. The temperature of the calorimeter and the 1.000 kg of water contained therein rose from 20.22 °C to 22.82 °C. The heat capacity of the calorimeter is 2.21 kJ/°C. The heat capacity of water = 4.184 J/g · °C. What is the heat of combustion, in megajoules (MJ), per mole of pentane?
36. How many grams of ethylene (C_2H_4) would have to be burned to produce 450 kJ of heat?
- $$\text{C}_2\text{H}_4(\text{g}) + 3\text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) + \text{H}_2\text{O}(\text{l}) \quad \Delta H_{\text{rxn}}^\circ = -1411 \text{ kJ/mol}$$
37. A gas is compressed in a cylinder from a volume of 20.0 L to 2.0 L by a constant pressure of 10.0 atm. Calculate the amount of work done on the system.
- A) $1.01 \times 10^4 \text{ J}$
 B) -180 J
 C) $1.81 \times 10^4 \text{ J}$
 D) $-1.81 \times 10^4 \text{ J}$
 E) 180 J

38. Octane (C_8H_{18}) undergoes combustion according to the following thermochemical equation:
 $2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(l) \quad \Delta H^\circ_{rxn} = -11,020 \text{ kJ/mol.}$
Given that $\Delta H^\circ_f[CO_2(g)] = -393.5 \text{ kJ/mol}$ and $\Delta H^\circ_f[H_2O(l)] = -285.8 \text{ kJ/mol}$, calculate the standard enthalpy of formation of octane.
- A) -210 kJ/mol
B) $-11,230 \text{ kJ/mol}$
C) $22,040 \text{ kJ/mol}$
D) -420 kJ/mol
E) 420 kJ/mol
39. For the reaction
 $C(\text{graphite}) + O_2(g) \rightarrow CO_2(g) \quad \Delta H^\circ = -393 \text{ kJ/mol}$
how many grams of C(graphite) must be burned to release 275 kJ of heat?
- A) 22.3 g
B) 0.70 g
C) 12.0 g
D) 17.1 g
E) 8.40 g
40. The heat of solution of LiCl is -37.1 kJ/mol , and the lattice energy of LiCl(s) is 828 kJ/mol. Calculate the total heat of hydration of 1 mol of gas phase Li^+ ions and Cl^- ions.
- A) 791 kJ
B) 865 kJ
C) -865 kJ
D) -791 kJ
E) None of these.
41. *Thermal 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.
42. A 26.2 g piece of copper metal is heated from 21.5°C to 201.6°C . Calculate the amount of heat absorbed by the metal. The specific heat of Cu is $0.385 \text{ J/g}\cdot^\circ\text{C}$.

43. A glass containing 200. g of H₂O at 20 °C was placed in a refrigerator. The water loses 11.7 kJ as it cools to a constant temperature. What is its new temperature? The specific heat of water is 4.184 J/g ·°C.
- A) 0.013 °C
 - B) 4 °C
 - C) 6 °C
 - D) 14 °C
 - E) 34 °C
44. The enthalpy change when a strong acid is neutralized by strong base is –56.1 kJ/mol. If 135 mL of 0.450 M HI at 23.15 °C is mixed with 145 mL of 0.500 M NaOH, also at 23.15 °C, what will the maximum temperature reached by the resulting solution? (Assume that there is no heat loss to the container, that the specific heat of the final solution is 4.18 J/g ·°C, and that the density of the final solution is that of water.)
- A) 26.06 °C
 - B) 29.19 °C
 - C) 32.35 °C
 - D) 20.24 °C
 - E) 36.57 °C
45. The heat of solution of ammonium nitrate is 26.2 kJ/mol. If a 5.368 g sample of NH₄NO₃ is added to 40.0 mL of water in a calorimeter at 23.5 °C, what is the minimum temperature reached by the solution? (The specific heat of water = 4.18 J/g ·°C; the heat capacity of the calorimeter = 650. J/°C.)
- A) 14.3 °C
 - B) 20.8 °C
 - C) –7.7 °C
 - D) 25.6 °C
 - E) 21.4 °C
46. 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) $\text{P}_4(\text{s}) + 10\text{Cl}_2(\text{g}) \rightarrow 4\text{PCl}_5(\text{s})$

47. 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
48. Which of the following processes *always* results in an increase in the energy of a system?
- A) The system loses heat and does work on the surroundings.
 B) The system gains heat and does work on the surroundings.
 C) The system loses heat and has work done on it by the surroundings.
 D) The system gains heat and has work done on it by the surroundings.
 E) None of these is always true.
49. Calculate the standard enthalpy change for the reaction
 $2\text{C}_8\text{H}_{18}(\text{l}) + 17\text{O}_2(\text{g}) \rightarrow 16\text{CO}(\text{g}) + 18\text{H}_2\text{O}(\text{l})$.
- Given:
- $$2\text{C}_8\text{H}_{18}(\text{l}) + 25\text{O}_2(\text{g}) \rightarrow 16\text{CO}_2(\text{g}) + 18\text{H}_2\text{O}(\text{l}) \quad \Delta H^\circ = -11,020 \text{ kJ/mol}$$
- $$2\text{CO}(\text{g}) + \text{O}_2(\text{g}) \rightarrow 2\text{CO}_2(\text{g}) \quad \Delta H^\circ = -566.0 \text{ kJ/mol}$$
- A) 10,450 kJ/mol
 B) 6,492 kJ/mol
 C) 15,550 kJ/mol
 D) -6,492 kJ/mol
 E) -10.450 kJ/mol
50. At 25 °C, the standard enthalpy of formation of anhydrous sodium carbonate is -1130.9 kJ/mol, whereas the standard enthalpy of formation of sodium carbonate monohydrate is -1430.1 kJ/mol. Determine ΔH° at 25 °C for the reaction
 $\text{Na}_2\text{CO}_3(\text{s}) + \text{H}_2\text{O}(\text{l}) \rightarrow \text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}(\text{s})$.
- (Given: $\Delta H_f^\circ[\text{H}_2\text{O}(\text{l})] = -285.8 \text{ kJ/mol}$)
- A) -13.4 kJ/mol
 B) -285.8 kJ/mol
 C) -585.0 kJ/mol
 D) -299.2 kJ/mol
 E) -156.3 kJ/mol

Answer Key, 1411_chapter 6. Thermochemistry exercises

1. A
2. B
3. 2,244 kJ/mol
4. -98.2 kJ/mol
5. **B**
6. Absorbed
7. E
8. A
9. B
10. **A**
11. B
12. -889.7 kJ/mol
13. D
14. A
15. **A**
16. The amount of heat required to raise the temperature of one gram of a substance by one degree Celsius.
17. 2490 kJ
18. D
19. E
20. **595.2** kJ/mol
21. 0.12 mole
22. A
23. C
24. A
25. **D**
26. -185 kJ
27. B
28. 226 kJ/mol
29. A
30. **A**
31. 7.31 kJ
32. D
33. E
34. B
35. **3.50** MJ/mol
36. 8.95 g
37. C
38. A
39. E
40. **C**
41. B
42. 1,820 J

- 43. C
- 44. A
- 45. **E**
- 46. C
- 47. E
- 48. D
- 49. D
- 50. **A**