Chapter 06
Thermochemistry

Multiple Choice Questions

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.

Bloom's Level: 2. Understand
Difficulty: Easy
Gradable: automatic
Section: 06.01
Subtopic: Units of Energy
Topic: Thermochemistry

2. *Thermal energy* is 4
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.

Bloom's Level: 2. Understand
Difficulty: Easy
Gradable: automatic
Section: 06.01
Subtopic: Units of Energy
Topic: Thermochemistry

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.

Bloom's Level: 2. Understand
Difficulty: Easy
Gradable: automatic
Section: 06.01
Subtopic: Units of Energy
Topic: Thermochemistry

4. *Potential 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.

Bloom's Level: 2. Understand
Difficulty: Easy
Gradable: automatic
Section: 06.01
Subtopic: Units of Energy
Topic: Thermochemistry

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.

Bloom's Level: 2. Understand
Difficulty: Medium
Gradable: automatic
Section: 06.02
Subtopic: System/Surroundings and Heat/work
Subtopic: Units of Energy
Topic: Thermochemistry

6. An endothermic reaction causes the surroundings to
A. warm up.
B. decrease in temperature.
C. become acidic.
D. release CO_2.
E. condense.

Bloom's Level: 2. Understand
Difficulty: Easy
Gradable: automatic
Section: 06.02
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

7. An exothermic reaction causes the surroundings to
A. increase in temperature
B. decrease in temperature.
C. become acidic.
D. release CO_2.
E. expand.

Bloom's Level: 2. Understand
Difficulty: Easy
Gradable: automatic
Section: 06.02
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

8. Aluminum metal has a specific heat of 0.900 J/g·°C. Calculate the amount of heat required to raise the temperature of 10.5 moles of Al from 30.5 °C to 225°C.
A. 1.84 kJ
B. 2.41 kJ
C. 65.1 kJ
D. 49.6 kJ
E. 57.3 kJ

Bloom's Level: 3. Apply
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

9. Given the specific heat for aluminum is 0.900 J/g·°C, how much heat is released when a 3.8 g sample of Al cools from 450.0°C to 25°C?
A. 54 J
B. 60 J
C. 86 J
D. 1.5 kJ
E. 1.7 kJ

Bloom's Level: 3. Apply
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

10. Calculate the amount of heat necessary to raise the temperature of 135.0 g of water from 50.4°F to 85.0°F. The specific heat of water = 4.184 J/g·°C.
A. 1.1 kJ
B. 10.9 kJ
C. 16.6 kJ
D. 19.5 kJ
E. 48.0 kJ

Bloom's Level: 3. Apply
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

11. How much heat is required to raise the temperature of 1.5×10^3 g of water from 45°F to 130.°F? The specific heat of water is 4.184 J/g·°C.
A. 3.0×10^1 kJ
B. 3.0×10^2 kJ
C. 3.4×10^2 kJ
D. 5.3×10^2 kJ
E. 8.2×10^2 kJ

Bloom's Level: 3. Apply
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

12. Three separate 3.5g blocks of Al, Cu, and Fe at 25°C each absorb 0.505 kJ of heat. Which block reaches the highest temperature? The specific heats of Al, Cu, and Fe are 0.900 J/g·°C, 0.385J/g·°C, and 0.444 J/g·°C, respectively.
A. Al
B. Cu
C. Fe
D. Al and Cu
E. Fe and Cu

Bloom's Level: 5. Evaluate
Difficulty: Easy
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

13. 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

Bloom's Level: 3. Apply
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

14. A 22.0 g block of copper at 45°C absorbs 2.50 kJ of heat. Given the specific heat of Cu is 0.385 J/g·°C what will be the final temperature of the Cu?
A. 45°C
B. 340.°C
C. 295°C
D. 30.°C
E. 250.°C

Bloom's Level: 3. Apply
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

15. If 10.6 moles of water at 35°C absorbs 12.30 kJ, what is the final temperature of the water? The specific heat of water is 4.184 J/g·°C.
A. 15°C
B. 20°C
C. 35°C
D. 50.°C
E. 312°C

Bloom's Level: 3. Apply
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

16. A 135 g sample of H_2O at 85°C is cooled. The water loses a total of 15 kJ of energy in the cooling process. What is the final temperature of the water? The specific heat of water is 4.184 J/g·°C.

A. 27°C
B. 58°C
C. 70°C
D. 84°C
E. 112°C

Bloom's Level: 3. Apply
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

17. 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 J/g·°C
B. 1.32 J/g·°C
C. 2.60 J/g·°C
D. 24.5 J/g·°C
E. 1.83×10^4 J/g·°C

Bloom's Level: 3. Apply
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

18. The specific heat of gold is 0.129 J/g·°C. What is the molar heat capacity of gold?
A. 0.039 J/mol·°C
B. 0.129 J/mol·°C
C. 25.4 J/mol·°C
D. 39.0 kJ/mol·°C
E. 197 J/mol·°C

Bloom's Level: 3. Apply
Difficulty: Easy
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

19. 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.

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

20. When 0.7521 g of benzoic acid was burned in a calorimeter containing 1,000. g of water, a temperature rise of 3.60°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. 1.34 kJ/°C
B. 4.18 kJ/°C
C. 5.52 kJ/°C
D. 15.87 kJ/°C
E. 752.1 kJ/°C

Bloom's Level: 3. Apply
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

21. Naphthalene combustion can be used to calibrate the heat capacity of a bomb calorimeter. The heat of combustion of naphthalene is –40.1 kJ/g. When 0.8210 g of naphthalene was burned in a calorimeter containing 1,000. g of water, a temperature rise of 4.21°C was observed. What is the heat capacity of the bomb calorimeter excluding the water?
A. 1.76 kJ/°C
B. 3.64 kJ/°C
C. 7.8 kJ/°C
D. 15.3 kJ/°C
E. 32.9 kJ/°

Bloom's Level: 3. Apply
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: First Law of Thermodynamics
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

22. Which of the following processes is exothermic?
A. $CH_4(g) + 2\ O_2(g) \rightarrow CO_2(g) + 2\ H_2O(l)$
B. $CO_2(g) + 2\ H_2O(l) \rightarrow CH_4(g) + 2\ O_2(g)$
C. $CO_2(s) \rightarrow CO_2(g)$
D. $H_2O(l) \rightarrow H_2O(g)$
E. $6\ H_2O(g) + 4\ CO_2(g) \rightarrow 2\ C_2H_6(g) + 7\ O_2(g)$

Bloom's Level: 5. Evaluate
Difficulty: Easy
Gradable: automatic
Section: 06.02
Subtopic: Enthalpy (Heats of Reaction)
Topic: Thermochemistry

23.

Which of the following processes is *exothermic*, given the following:
$N_2(g) + 2\ O_2(g) \rightarrow N_2O_4(l)\ \Delta H^\circ = 9.67$ kJ/mol
$N_2(g) + 2\ O_2(g) \rightarrow 2\ NO_2(g)\ \Delta H^\circ = 67.70$ kJ/mol

A. $2\ N_2(g) + 4\ O_2(g) \rightarrow 2\ N_2O_4(l)$
B. $\frac{1}{2}\ N_2(g) + O_2(g) \rightarrow \frac{1}{2}\ N_2O_4(l)$
C. $N_2O_4(l) \rightarrow N_2(g) + 2\ O_2(g)$
D. $2\ N_2(g) + 4\ O_2(g) \rightarrow 2\ NO_2(g) + N_2O_4(l)$
E. $2\ N_2(g) + 4\ O_2(g) \rightarrow 4\ NO_2(g)$

Bloom's Level: 5. Evaluate
Difficulty: Easy
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Topic: Thermochemistry

24.

Which of the following processes is *endothermic*, given the following:
$S(s) + O_2(g) \rightarrow SO_2(g)$ $\Delta H = -299$ kJ/mol
$S(s) + 3/2\ O_2(g) \rightarrow SO_3(g)$ $\Delta H = -395$ kJ/mol

A. $2\ S(s) + 2\ O_2(g) \rightarrow 2\ SO_2(g)$
B. $½\ S(s) + ½\ O_2(g) \rightarrow ½\ SO_2(g)$
C. $2\ S(s) + 5/2\ O_2(g) \rightarrow SO_2(g) + SO_3(g)$
D. $SO_3(g) \rightarrow S(s) + 3/2\ O_2(g)$
E. $2\ S(s) + 3\ O_2(g) \rightarrow 2\ SO_3(g)$

Bloom's Level: 5. Evaluate
Difficulty: Easy
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Topic: Thermochemistry

25. Which of the following processes is *endothermic*?
A. $O_2(g) + 2H_2(g) \rightarrow 2H_2O(g)$
B. $H_2O(g) \rightarrow H_2O(l)$
C. $3O_2(g) + 2CH_3OH(g) \rightarrow 2CO_2(g) + 2H_2O(g)$
D. $H_2O(s) \rightarrow H_2O(l)$

Bloom's Level: 5. Evaluate
Difficulty: Easy
Gradable: automatic
Section: 06.04
Subtopic: Enthalpy (Heats of Reaction)
Topic: Thermochemistry

26.

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.
$HCl(aq) + NH_3(aq) \rightarrow NH_4Cl(aq)$
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. 1.96 kJ/mol
D. 154 kJ/mol
E. 485 kJ/mol

Bloom's Level: 5. Evaluate
Difficulty: Difficult
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: Enthalpy (Heats of Reaction)
Topic: Thermochemistry

27. A 0.1326 g sample of magnesium was burned in an oxygen bomb calorimeter. The total heat capacity of the calorimeter plus water was 5,760 J/°C. If the temperature rise of the calorimeter with water was 0.570°C, calculate the enthalpy of combustion of magnesium.
$Mg(s) + 1/2O_2(g) \rightarrow MgO(s)$
A. –3280 kJ/mol
B. –602 kJ/mol
C. –24.8 kJ/mol
D. 106 kJ/mol
E. 435 kJ/mol

Bloom's Level: 5. Evaluate
Difficulty: Difficult
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: Enthalpy (Heats of Reaction)
Topic: Thermochemistry

28. The reaction that represents the standard enthalpy of formation for acetone (CH_3COCH_3), a common ingredient in nail polish remover is:
A. 3 C(graphite) + 3 $H_2(g)$ + ½ $O_2(g)$ → $CH_3COCH_3(l)$
B. 6 C(diamond) + 6 $H_2(g)$ + $O_2(g)$ → 2 $CH_3COCH_3(l)$
C. 3 C(diamond) + 3 $H_2(g)$ + ½ $O_2(g)$ → $CH_3COCH_3(l)$
D. $CH_3COCH_3(l)$ →3 C(graphite) + 3 $H_2(g)$ + ½ $O_2(g)$
E. $CH_3COCH_3(l)$ + 4 $O_2(g)$ → 3 $CO_2(g)$ + 3 $H_2O(g)$

Bloom's Level: 5. Evaluate
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions (ΔH°_f and ΔH°_{rxn})
Topic: Thermochemistry

29. The reaction that represents the standard enthalpy of formation for sucrose ($C_{12}H_{22}O_{11}$) is:
A. $C_{12}H_{22}O_{11}(s)$ + 12 O_2 → 12 $CO_2(g)$ + 11 $H_2O(g)$
B. 12 C(diamond) + 11 $H_2(g)$ + 11/2 $O_2(g)$ → $C_{12}H_{22}O_{11}(s)$
C. 12 C(graphite) + 11 $H_2(g)$ + 11/2 $O_2(g)$ →$C_{12}H_{22}O_{11}(s)$
D. 24 C(diamond) + 22 $H_2(g)$ + 11 $O_2(g)$ → 2 $C_{12}H_{22}O_{11}(s)$
E. $C_{12}H_{22}O_{11}(s)$ →12 C(graphite) + 11 $H_2(g)$ + 11/2 $O_2(g)$

Bloom's Level: 5. Evaluate
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions (ΔH°_f and ΔH°_{rxn})
Topic: Thermochemistry

30. The reaction that represents the standard enthalpy of formation for benzene (C_6H_6) is:
A. 6 C(diamond) + 3 H_2(g) $\rightarrow$ C_6H_6(l)
B. 6 C(graphite) + 6 H(g) $\rightarrow$ C_6H_6(l)
C. C_6H_6(l) + 15/2 O_2(g) $\rightarrow$ 6 CO_2(g) + 3 H_2O(g)
D. 6 C(graphite) + 3 H_2(g) $\rightarrow$ C_6H_6(l)
E. C_6H_6(l) $\rightarrow$6 C(graphite) + 3 H_2(g)

Bloom's Level: 5. Evaluate
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

31.

Which of the following has a $\Delta H°_f$= 0 kJ/mol?

A. $CO_2(g)$
B. $O_3(g)$
C. $Cl^-(aq)$
D. $NH_3(aq)$
E. $I_2(s)$

Bloom's Level: 5. Evaluate
Difficulty: Easy
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

32.

Which of the following has a $\Delta H°_f$= 0 kJ/mol?

A. $NO(g)$
B. $CS_2(l)$
C. $Fe^{2+}(aq)$
D. $H_2O(l)$
E. $N_2(g)$

Bloom's Level: 5. Evaluate
Difficulty: Easy
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

33.

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 ($\Delta H°_f$) of NaF(s)?

A. -570 kJ/mol
B. –24.8 kJ/mol
C. –7.8 kJ/mol
D. 24.8 kJ/mol
E. 570 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

34.

When 18.5 g of HgO(s) is decomposed to form Hg(l) and $O_2(g)$, 7.75 kJ of heat is absorbed at standard-state conditions. What is the standard enthalpy of formation ($\Delta H°_f$) of HgO(s)?

A. –90.7 kJ/mol
B. –7.75 kJ/mol
C. 0.419 kJ/mol
D. 27.9 kJ/mol
E. 143 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

35.

Ethanol undergoes combustion in oxygen to produce carbon dioxide gas and liquid water. The standard heat of combustion of ethanol, $C_2H_5OH(l)$, is –1366.8 kJ/mol. Given that $\Delta H°_f[CO_2(g)]$ = –393.5 kJ/mol and $\Delta H°_f[H_2O(l)]$ = –285.8 kJ/mol, what is the standard enthalpy of formation of ethanol?

A. –687.6 kJ/mol
B. –277.6 kJ/mol
C. 687.6 kJ/mol
D. 1,367 kJ/mol
E. 3,010 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

36.

Find the standard enthalpy of formation of ethylene, $C_2H_4(g)$, given the following data: heat of combustion of $C_2H_4(g)$= –1411 kJ/mol; $\Delta H°_f[CO_2(g)]$ = –393.5 kJ/mol; $\Delta H°_f[H_2O(l)]$ = –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

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

37.

Octane (C_8H_{18}) undergoes combustion according to the following thermochemical equation:
$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(l)$, $\Delta H°_{rxn} = -11{,}020$ kJ/mol.
Given that $\Delta H°_f[CO_2(g)] = -393.5$ kJ/mol and $\Delta H°_f[H_2O(l)] = -285.8$ kJ/mol, calculate the standard enthalpy of formation of octane.

A. –210 kJ/mol
B. –11,230 kJ/mol
C. 22,040 kJ/mol
D. –420 kJ/mol
E. 420 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

38.

Acetylene (C_2H_2) undergoes combustion in excess oxygen to generate gaseous carbon dioxide and water. Given $\Delta H°_f[CO_2(g)] = -393.5$ kJ/mol, $\Delta H°_f[H_2O(g)] = -241.8$ kJ/mol, and $\Delta H°_f[C_2H_2(g)] = 226.6$ kJ/mol, how much energy is released (kJ) when 10.5 moles of acetylene is burned?

A. 2,510.8 kJ
B. 26,400 kJ
C. 13,200 kJ
D. 52,700 kJ
E. 9,050 kJ

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

39.

Butane (C_4H_{10}) undergoes combustion in excess oxygen to generate gaseous carbon dioxide and water. Given $\Delta H°_f[C_4H_{10}(g)] = –124.7$ kJ/mol, $\Delta H°_f[CO_2(g)] = –393.5$ kJ/mol, $\Delta H°_f[H_2O(g)] = –241.8$ kJ/mol, how much energy is released (kJ) when 8.30 g of butane is burned?

A. 22,100 kJ
B. 2,658.3 kJ
C. 379 kJ
D. 759 kJ
E. 2,910 kJ

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

40.

Glycine, $C_2H_5O_2N$, is important for biological energy. The combustion reaction of glycine is given by the equation
$4C_2H_5O_2N(s) + 9O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l) + 2N_2(g)$ $\Delta H°_{rxn} = –3857$ kJ/mol
Given that $\Delta H°_f[CO_2(g)] = –393.5$ kJ/mol and $\Delta H°_f[H_2O(l)] = –285.8$ kJ/mol, calculate the enthalpy of formation of glycine.

A. –3,178 kJ/mol
B. –964 kJ/mol
C. –537.2 kJ/mol
D. –268.2 kJ/mol
E. 2,149 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

41.

Styrene, C_8H_8, is one of the substances used in the production of synthetic rubber. When styrene burns in oxygen to form carbon dioxide and liquid water under standard-state conditions at 25°C, 42.62 kJ are released per gram of styrene. Find the standard enthalpy of formation of styrene at 25°C.
(Given: $\Delta H°_f[CO_2(g)] = –393.5$ kJ/mol, $\Delta H°_f[H_2O(l)] = –285.8$ kJ/mol, $\Delta H°_f[H_2O(g)] = –241.8$ kJ/mol)

A. 147.8 kJ/mol
B. 323.8 kJ/mol
C. ~636.7 kJ/mol
D. ~4249 kJ/mol
E. ~8730 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

42.

Given $2Al(s) + (3/2)O_2(g) \rightarrow Al_2O_3(s)$, $\Delta H°_f = –1{,}670$ kJ/mol for Al_2O_3 (s).
Determine $\Delta H°$ for the reaction $2Al_2O_3(s) \rightarrow 4Al(s) + 3O_2(g)$.

A. –3,340 kJ/mol
B. –1,670 kJ/mol
C. –835 kJ/mol
D. 1,670 kJ/mol
E. 3,340 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Easy
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

43.

Calculate the standard enthalpy of formation of liquid methanol, $CH_3OH(l)$, using the following information:

$$C(graph) + O_2 \rightarrow CO_2(g) \qquad \Delta H° = -393.5 \text{ kJ/mol}$$
$$H_2(g) + (1/2)O_2 \rightarrow H_2O(l) \qquad \Delta H° = -285.8 \text{ kJ/mol}$$
$$CH_3OH(l) + (3/2)O_2(g) \rightarrow CO_2(g) + 2H_2O(l) \qquad \Delta H° = -726.4 \text{ kJ/mol}$$

A. –1,691.5 kJ/mol
B. –238.7 kJ/mol
C. –47.1 kJ/mol
D. 47.1 kJ/mol
E. 1691.5 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Hess's Law
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

44.

Calculate the standard enthalpy change for the reaction
$2C_8H_{18}(l) + 17O_2(g) \rightarrow 16CO(g) + 18H_2O(l)$.
Given

$$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(l) \quad \Delta H° = -11{,}020\ kJ/mol$$
$$2CO(g) + O_2(g) \rightarrow 2CO_2(g) \quad \Delta H° = -566.0\ kJ/mol$$

A. –10.450 kJ/mol
B. –6,492 kJ/mol
C. 6,492 kJ/mol
D. 10,450 kJ/mol
E. 15,550 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Hess's Law
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

45.

During volcanic eruptions, hydrogen sulfide gas is given off and oxidized by air according to the following chemical equation:
$2H_2S(g) + 3O_2(g) \rightarrow 2SO_2(g) + 2H_2O(g)$
Calculate the standard enthalpy change for the above reaction given:

$3S(s) + 2H_2O(g) \rightarrow 2H_2S(g) + SO_2(g)$ $\quad \Delta H° = 146.9\ kJ/mol$
$S(s) + O_2(g) \rightarrow SO_2(g)$ $\quad \Delta H° = -296.4\ kJ/mol$

A. –1036.1 kJ/mol
B. –742.3 kJ/mol
C. –149.5 kJ/mol
D. 443.3 kJ/mol
E. 742.3 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Hess's Law
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

46.

Calculate the standard enthalpy change for the reaction
$2C_8H_{18}(l) + 21O_2(g) \rightarrow 8CO(g) + 8CO_2(g) + 18H_2O(l)$.
Given:
$2C_8H_{18}(l) + 25O_2(g) \rightarrow 16CO_2(g) + 18H_2O(l)\ \Delta H° = -11{,}020\ kJ/mol$
$2CO(g) + O_2(g) \rightarrow 2CO_2(g)\ \Delta H° = -566.0\ kJ/mol$

A. -1.0454×10^4 kJ/mol
B. –8,756 kJ/mol
C. –6,492 kJ/mol
D. 1.0454×10^4 kJ/mol
E. 1.1586×10^4 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Hess's Law
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

47.

Calculate the standard enthalpy change for the reaction
$2A + 2A_2 + 4AB + B \rightarrow 5A_2B$
Given:

$2A + B \rightarrow A_2B$ $\quad \Delta H° = -25.0$ kJ/mol

$2A_2B \rightarrow 2AB + A_2$ $\quad \Delta H° = 35.0$ kJ/mol

A. – 95.0 kJ/mol
B. – 60.0 kJ/mol
C. – 15.0 kJ/mol
D. 10.0 kJ/mol
E. 45.0 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Hess's Law
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

48.

Calculate the standard enthalpy change for the reaction
$4A + 2B \rightarrow 2AB + A_2$
Given:

$2A + B \rightarrow A_2B$ $\quad \Delta H° = -25.0$ kJ/mol
$2A_2B \rightarrow 2AB + A_2$ $\quad \Delta H° = 35.0$ kJ/mol

A. – 95.0 kJ/mol
B. – 60.0 kJ/mol
C. – 15.0 kJ/mol
D. 10.0 kJ/mol
E. 45.0 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Hess's Law
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

49.

Calculate the heat required when 2.50 mol of A reacts with excess B and A_2B according to the reaction:
$2A + B + A_2B \rightarrow 2AB + A_2$
Given:

$2A + B \rightarrow A_2B$ $\quad\quad \Delta H° = -25.0$ kJ/mol
$2A_2B \rightarrow 2AB + A_2$ $\quad\quad \Delta H° = 35.0$ kJ/mol

A. 10.0 kJ
B. 12.5 kJ
C. 25.0 kJ
D. 35.0 kJ
E. 62.5 kJ

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Hess's Law
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

50.

How much heat (kJ) is evolved when 4.50 g of Fe_2O_3 is reacted with excess carbon monoxide using the equation below?
$Fe_2O_3(s) + 3CO(g) \rightarrow 2\ Fe(s) + 3\ CO_2(g)\ \Delta H°_{rxn} = -24.8$ kJ/mol,

A. 0.699 kJ
B. 2.10 kJ
C. 17.9 kJ
D. 24.8 kJ
E. 112 kJ

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

51.

Given $H_2(g) + (1/2)O_2(g) \rightarrow H_2O(l)$, $\Delta H° = –286$ kJ/mol, determine the standard enthalpy change for the reaction $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$.

A.
$\Delta H° = –286$ kJ/mol

B.
$\Delta H° = +286$ kJ/mol

C.
$\Delta H° = –572$ kJ/mol

D.
$\Delta H° = +572$ kJ/mol

E.
$\Delta H° = –143$ kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Easy
Gradable: automatic
Section: 06.06
Topic: Thermochemistry

52.

Pentaborane $B_5H_9(s)$ burns vigorously in O_2 to give $B_2O_3(s)$ and $H_2O(l)$. Calculate ΔH_{rxn} for the combustion of 5.00 mol of B_5H_9.
$\Delta H°_f[B_2O_3(s)] = –1{,}273.5$ kJ/mol
$\Delta H°_f[B_5H_9(s)] = 73.2$ kJ/mol
$\Delta H°_f[H_2O(l)] = –285.8$ kJ/mol

A. – 45,400 kJ
B. 45,400 kJ
C. – 22,700 kJ
D. – 9,090 kJ
E. – 8,790 kJ

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

53.

Concerning the reaction

$$C(\text{graphite}) + O_2(g) \rightarrow CO_2(g) \qquad \Delta H° = -393 \text{ kJ/mol}$$

how many grams of C(graphite) must be burned to release 275 kJ of heat?

A. 0.70 g
B. 8.40 g
C. 12.0 g
D. 17.1 g
E. 22.3 g

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

54.

The combustion of butane produces heat according to the equation
$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$, $\Delta H°_{rxn} = -5{,}314$ 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

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

55.

The combustion of butane produces heat according to the equation
$2C_4H_{10}(g) + 13O_2(g) \rightarrow 8CO_2(g) + 10H_2O(l)$, $\Delta H°_{rxn} = -5{,}314$ kJ/mol.
How many grams of CO_2 are produced per 1.00×10^4 kJ of heat released?

A. 23.4 g
B. 44.0 g
C. 82.3 g
D. 187 g
E. 662 g

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

56.

Given that $CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$, $\Delta H°_{rxn} = –64.8$ 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. 3.40×10^4 g

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

57.

The combustion of pentane produces heat according to the equation
$C_5H_{12}(l) + 8O_2(g) \rightarrow 5CO_2(g) + 6H_2O(l)$, $\Delta H°_{rxn} = –3{,}510$ kJ/mol.
How many grams of CO_2 are produced per 2.50×10^3 kJ of heat released?

A. 0.0809 g
B. 3.56 g
C. 31.3 g
D. 157 g
E. 309 g

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

58.

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?
$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$ $\Delta H°_{rxn} = -890.4$ kJ/mol

A. 7.1×10^{-4} g
B. 1.4×10^{3} g
C. 1.4×10^{4} g
D. 2.2×10^{4} g
E. 3.6×10^{5} g

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

59.

Given the thermochemical equation $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$, $\Delta H°_{rxn} = -198$ kJ/mol, how much heat is evolved when 600. g of SO_2 is burned?

A. 5.46×10^{-2} kJ
B. 928 kJ
C. 1.85×10^{3} kJ
D. 3.71×10^{3} kJ
E. 59,400 kJ

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

60.

Determine the heat given off to the surroundings when 9.0 g of aluminum reacts according to the equation $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$, $\Delta H°_{rxn} = -849$ kJ/mol.

A. 1.4×10^2 kJ
B. 2.8×10^2 kJ
C. 5.6×10^2 kJ
D. 2.5×10^3 kJ
E. 7.6×10^3 kJ

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

61.

Find the heat absorbed from the surroundings when 15 g of O_2 reacts according to the equation $O + O_2 \rightarrow O_3$, $\Delta H°_{rxn} = -103$ kJ/mol.

A. 4.6×10^{-3} kJ
B. 32 kJ
C. 48 kJ
D. 96 kJ
E. 110 kJ

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

62.

Ethanol (C_2H_5OH) burns according to the equation
$C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$, $\Delta H°_{rxn} = -1367$ kJ/mol.
How much heat is released when 35.0 g of ethanol is burned?

A. 9.61×10^{-4} kJ
B. 1,040 kJ
C. 1,367 kJ
D. 1,797 kJ
E. 4.78×10^{4} kJ

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

63.

Methanol (CH_3OH) burns according to the equation
$2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(l)$, $\Delta H°_{rxn} = -1454$ kJ/mol.
How much heat, in kilojoules, is given off when 75.0 g of methanol is burned?

A. 727 kJ
B. 3.22×10^{3} kJ
C. 1.45×10^{3} kJ
D. 1.70×10^{3} kJ
E. 3.41×10^{3} kJ

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Topic: Thermochemistry

64.

Calcium oxide and water react in an exothermic reaction:
$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$, $\Delta H°_{rxn} = –64.8$ kJ/mol.
How much heat would be liberated when 7.15 g CaO(s) is dropped into a beaker containing 152g H_2O?

A. 1.97×10^{-3} kJ
B. 8.26 kJ
C. 508 kJ
D. 547 kJ
E. 555 kJ

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Subtopic: Calorimetry (Measuring Heats of Reaction)
Topic: Thermochemistry

65.

Solid sodium peroxide (Na_2O_2) reacts with liquid water yielding aqueous sodium hydroxide and oxygen gas. How much heat is released when 250.0 L of oxygen gas is produced from the reaction of sodium peroxide and water if the reaction is carried out in an open container at 1.000 atm pressure and 25°C?
(Given: $\Delta H°_f[Na_2O_2(s)] = –510.9$ kJ/mol; $\Delta H°_f[NaOH(aq)] = –469.2$ kJ/mol; $\Delta H°_f[H_2O(l)] = –285.8$ kJ/mol)

A. 141.7 kJ
B. 1740 kJ
C. 2900 kJ
D. 3330 kJ
E. 35,400 kJ

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.06
Subtopic: The Ideal Gas Law
Topic: Gases
Topic: Thermochemistry

66.

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 $\Delta H°$ at 25°C for the reaction $Na_2CO_3(s) + H_2O(l) \rightarrow Na_2CO_3 \cdot H_2O(s)$.
(Given: $\Delta H°_f[H_2O(l)] = –285.8$ kJ/mol)

A. –585.0 kJ/mol
B. –156.3 kJ/mol
C. –299.2 kJ/mol
D. –13.4 kJ/mol
E. –285.8 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

67. According to the first law of thermodynamics:
A. Energy is neither lost nor gained in any energy transformations.
B. Perpetual motion is possible.
C. Energy is conserved in quality but not in quantity.
D. Energy is being created as time passes. We have more energy in the universe now than when time began.

Bloom's Level: 2. Understand
Difficulty: Easy
Gradable: automatic
Section: 06.03
Topic: Thermochemistry

68. The heat of solution of KCl is 17.2 kJ/mol and the lattice energy of KCl(s) is 701.2 kJ/mol. Calculate the total heat of hydration of 1.00 mol of gas phase K^+ ions and Cl^- ions.
A. –718 kJ
B. –684 kJ
C. 684 kJ
D. 718 kJ
E. None of these.

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.07
Topic: Thermochemistry

69. 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 1.00 mol of gas phase Li^+ ions and Cl^- ions.
A. –865 kJ
B. –791 kJ
C. 791 kJ
D. 865 kJ
E. None of these.

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.07
Topic: Thermochemistry

70. The total heat of hydration of 1.00 mol of gas phase Li^+ ions and Cl^- ions is –865 kJ. The lattice energy of LiCl(s) is 828 kJ/mol. Calculate the heat of solution of LiCl.
A. –1,693 kJ/mol
B. –37 kJ/mol
C. 37 kJ/mol
D. 1,693 kJ/mol

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.07
Topic: Thermochemistry

71.

10.1 g CaO is dropped into a styrofoam coffee cup containing 157 g H_2O at 18.0°C.
If the following reaction occurs, what temperature will the water reach, assuming that the cup is a perfect insulator and that the cup absorbs only a negligible amount of heat? (The specific heat of water = 4.18 J/g·°C)
$CaO(s) + H_2O(l) \rightarrow Ca(OH)_2(s)$ $\Delta H°_{rxn} = -64.8$ kJ/mol

A. 18.02°C
B. 35.8°C
C. 42.2°C
D. 117°C
E. 311°C

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: First Law of Thermodynamics (Conservation of Energy)
Topic: Thermochemistry

72. 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 is 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. 20.24°C
B. 26.06°C
C. 29.19°C
D. 32.35°C
E. 36.57°C

Bloom's Level: 3. Apply
Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.05
Subtopic: Acid-Base Definitions
Subtopic: First Law of Thermodynamics (Conservation of Energy)
Topic: Acids and Bases
Topic: Thermochemistry

73. 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. mL of 0.250 M NaOH, also at 21.30°C, what is 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. 18.20°C
B. 24.40°C
C. 24.53°C
D. 34.25°C
E. 101.8°C

Bloom's Level: 3. Apply
Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.05
Subtopic: Acid-Base Definitions
Subtopic: First Law of Thermodynamics (Conservation of Energy)
Topic: Acids and Bases
Topic: Thermochemistry

74. Calculate the amount of work done, in joules, when 2.5 mole of H_2O vaporizes at 1.0 atm and 25°C. Assume the volume of liquid H_2O is negligible compared to that of vapor. (1 L·atm = 101.3 J)

A. 61.1 J
B. 518 J
C. 5.66 kJ
D. 6.19 kJ
E. 6,190 kJ

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.03
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

75. 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. -1.81×10^4 J
B. –180 J
C. 180 J
D. 1.01×10^4 J
E. 1.81×10^4 J

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.03
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

76. Calculate the amount of work done against an atmospheric pressure of 1.00 atm when 500.0 g of zinc dissolves in excess acid at 30.0°C.
$Zn(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2(g)$
A. w = +22.4 kJ
B. w = +24.9 kJ
C. w = 0
D. w = –2.52 kJ
E. w = –19.3 kJ

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.03
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

77.

A gas is allowed to expand, at constant temperature, from a volume of 1.0 L to 10.1 L against an external pressure of 0.50 atm. If the gas absorbs 250 J of heat from the surroundings, what are the values of q, w, and ΔE?

	q	w	ΔE
A.	250 J	−460 J	−210 J
B.	−250 J	−460 J	−710 J
C.	250 J	460 J	710 J
D.	−250 J	460 J	210 J
E.	250 J	−4.55 J	245 J

A. A
B. B
C. C
D. D
E. E

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.03
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

78. 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.

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.03
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

79.

For which of these reactions will the difference between ΔH° and ΔE° be the greatest?

A. $2H_2O_2(l) \rightarrow 2H_2O(l) + O_2(g)$
B. $CaCO_3(s) \rightarrow CaO(s) + CO_2(g)$
C. $NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$
D. $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(l)$
E. $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

Bloom's Level: 5. Evaluate
Difficulty: Medium
Gradable: automatic
Section: 06.04
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

80.

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

A. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
B. $4PH_3(g) \rightarrow P_4(g) + 6H_2(g)$
C. $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$
D. $CO_2(g) + 2H_2O(l) \rightarrow CH_4(g) + 2O_2(g)$
E. $P_4(s) + 10Cl_2(g) \rightarrow 4PCl_5(s)$

Bloom's Level: 5. Evaluate
Difficulty: Medium
Gradable: automatic
Section: 06.04
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

81.

At 25°C, the following heats of reaction are known:

$2ClF(g) + O_2(g) \rightarrow Cl_2O(g) + F_2O(g)$ $\quad \Delta H°_{rxn} = 167.4\ kJ/mol$

$2ClF_3(g) + 2O_2(g) \rightarrow Cl_2O(g) + 3F_2O(g)$ $\quad \Delta H°_{rxn} = 341.4\ kJ/mol$

$2F_2(g) + O_2(g) \rightarrow 2F_2O(g)$ $\quad \Delta H°_{rxn} = -43.4\ kJ/mol$

At the same temperature, use the above data to calculate the heat released (kJ) when 3.40 moles of ClF(g) reacts with excess F_2:

$ClF(g) + F_2(g) \rightarrow ClF_3(g)$

A. 109 kJ
B. 233 kJ
C. 370. kJ
D. 465 kJ
E. 1,580 kJ

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Hess's Law
Topic: Thermochemistry

82.

The *bond enthalpy* of the Br–Cl bond is equal to ΔH° for the reaction
$BrCl(g) \rightarrow Br(g) + Cl(g)$.
Use the following data to find the bond enthalpy of the Br–Cl bond.

$Br_2(l) \rightarrow Br_2(g)$	$\Delta H° = 30.91$ kJ/mol
$Br_2(g) \rightarrow 2Br(g)$	$\Delta H° = 192.9$ kJ/mol
$Cl_2(g) \rightarrow 2Cl(g)$	$\Delta H° = 243.4$ kJ/mol
$Br_2(l) + Cl_2(g) \rightarrow 2BrCl(g)$	$\Delta H° = 29.2$ kJ/mol

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

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Hess's Law
Topic: Thermochemistry

83. The heat of solution of ammonium nitrate is 26.2 kJ/mol. If a 5.368 g sample of NH_4NO_3 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. –7.7°C
B. 14.3°C
C. 20.8°C
D. 21.4°C
E. 25.6°C

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.05
Subtopic: Calorimeter (Measuring Heats of Reactions)
Subtopic: Enthalpy (Heats of Reaction)
Topic: Thermochemistry

84. 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 J/g·°C; the heat capacity of the calorimeter = 365. J/°C.)

A. 18.6°C
B. 19.7°C
C. 21.9°C
D. 27.1°C
E. 30.4°C

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.05
Subtopic: Calorimeter (Measuring Heats of Reactions)
Subtopic: Enthalpy (Heats of Reaction)
Topic: Thermochemistry

85.

Aluminum oxide can be reduced to aluminum metal using carbon, the other reaction product being carbon monoxide. Determine the enthalpy change when 12.5 g of aluminum is produced by this method. [$\Delta H°_f$(carbon monoxide) = –110.5 kJ/mol; $\Delta H°_f$(aluminum oxide) = –1669.8 kJ/mol]

A. 310 kJ
B. 361 kJ
C. 697 kJ
D. 725 kJ
E. 1504 kJ

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

86.

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? [$\Delta H°_f(NO) = 90.4$ kJ/mol; $\Delta H°_f(NO_2) = 33.85$ kJ/mol; $\Delta H°_f(O_3) = 142.2$ kJ/mol]

A. –1690 kJ
B. –167 kJ
C. –97.6 kJ
D. –69.2 kJ
E. –19.7 kJ

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Gas Stoichiometry
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Gases
Topic: Thermochemistry

True / False Questions

87. Select True or False: Specific heat is defined as the amount of heat required to raise the temperature of one gram of a substance by one degree Celsius.
TRUE

Bloom's Level: 1. Remember
Difficulty: Easy
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Topic: Thermochemistry

Multiple Choice Questions

88.

How many grams of ethylene (C_2H_4) would have to be burned to produce 450 kJ of heat?
$C_2H_4(g) + 3O_2(g) \rightarrow 2CO_2(g) + H_2O(l)$ $\Delta H°_{rxn} = –1411$ kJ/mol

A. 5.95 g
B. 695 g
C. 7.95 g
D. 8.95 g
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Subtopic: Enthalpy (Heats of Reaction)
Topic: Thermochemistry

89.

Calculate the enthalpy of reaction for $H_2(g) + C_2H_4(g) \rightarrow C_2H_6(g)$.
[$\Delta H°_f(C_2H_4(g)) = 52.3$ kJ/mol; $\Delta H°_f(C_2H_6(g)) = –84.7$ kJ/mol]

A. –117 kJ/mol
B. –127 kJ/mol
C. –137 kJ/mol
D. –147 kJ/mol
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

90.

The enthalpy of combustion of acetylene C_2H_2 is described by
$C_2H_2(g) + (5/2)O_2(g) \rightarrow 2CO_2(g) + H_2O(l)$, $\Delta H°_{rxn} = -1299$ kJ/mol.
Calculate the enthalpy of formation of acetylene, given the following enthalpies of formation
$\Delta H°_f[CO_2(g)] = -393.5$ kJ/mol
$\Delta H°_f[H_2O(l)] = -285.8$ kJ/mol

A. 216 kJ/mol
B. 226 kJ/mol
C. 236 kJ/mol
D. 246 kJ/mol
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

91.

Given the following $\Delta H°$ values,

$H_2(g) + \frac{1}{2} O_2(g) \rightarrow H_2O(l)$ $\Delta H°_f = -285.8$ kJ/mol
$H_2O_2(l) \rightarrow H_2(g) + O_2(g)$ $\Delta H°_{rxn} = 187.6$ kJ/mol

calculate $\Delta H°_{rxn}$ for the reaction $H_2O_2(l) \rightarrow H_2O(l) + \frac{1}{2} O_2(g)$.

A. –98.2 kJ/mol
B. –88.2 kJ/mol
C. –78.2 kJ/mol
D. –68.2 kJ/mol
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Hess's Law
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

92. The heat of solution of calcium chloride $CaCl_2$ is –82.8 kJ/mol, and the combined heats of hydration of 1.00 mole of gaseous calcium ions and 2.00 mole of gaseous chloride ions is –2327 kJ. What is the lattice energy of calcium chloride?
A. 2,144 kJ/mol
B. 2,244 kJ/mol
C. 2,344 kJ/mol
D. 2,444 kJ/mol
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.07
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Hess's Law
Topic: Thermochemistry

True / False Questions

93. Select True or False: The heat of solution of NH_4NO_3 is 26.2 kJ/mol. Heat is evolved when a solution of NH_4NO_3 is diluted by addition of more water.
FALSE

Bloom's Level: 4. Analyze
Difficulty: Easy
Gradable: automatic
Section: 06.07
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

Multiple Choice Questions

94. 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 J/g·°C.
A. 1,620 J
B. 1,720 J
C. 1,820 J
D. 1,920 J
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

95. A 0.1946 g piece of magnesium metal is burned in a constant-volume calorimeter that has a heat capacity of 1349 J/°C. The calorimeter contains 500. g of water and the temperature rise is 1.40°C. Calculate the heat of combustion of magnesium metal in kJ/g, given that the specific heat of water = 4.184 J/g·°C.
A. 21.8 kJ/g
B. 22.8 kJ/g
C. 23.8 kJ/g
D. 24.8 kJ/g
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

96. 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. How much heat was given off during combustion of the sample of pentane?
A. 18.6 kJ
B. 17.6 kJ
C. 16.6 kJ
D. 15.6 kJ
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

97. 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 kilojoules, per gram of pentane?
A. 48.6 kJ/g
B. 47.6 kJ/g
C. 46.6 kJ/g
D. 45.6 kJ/g
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

98. The heat of combustion of propane, C_3H_8, is 2220 kJ/mol. The specific heat of copper is 0.385 J/g×°C. How many grams of propane must be burned to raise the temperature of a 10.0 kg block of copper from 25.0°C to 65.0°C, assuming none of the heat is lost to the surroundings?
A. 3.36 g
B. 3.26 g
C. 3.16 g
D. 3.06 g
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

99. The residential rate for natural gas is about $15 per thousand cubic foot. Burning one cubic foot of natural gas releases about 1080 kJ of heat. How much would it cost to heat the water in a 25,000 gallon swimming pool from 52°F to 78°F, assuming all of the heat from burning the natural gas went towards warming the water? (1 gal = 3.785 L; the specific heat of water = 4.184 J/g·°C)
A. $69
B. $79
C. $89
D. $99
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

100.

The heat of neutralization of HCl by NaOH is $\Delta H°_{rxn} = -56.2$ 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?

A. 7.11 kJ
B. 7.21 kJ
C. 7.31 kJ
D. 7.41 kJ
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.04
Subtopic: Acid-Base Definitions
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Acids and Bases
Topic: Analyze
Topic: Thermochemistry

101. 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°C, and after the reaction it had risen to 52.0°C. How many moles of water were formed? (The specific heat of water is 4.184 J/g·°C.)
A. 0.42 mole
B. 0.32 mole
C. 0.22 mole
D. 0.12 mole
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

102. When an automobile engine starts, the metal parts immediately begin to absorb heat released during the combustion of gasoline. How much heat will be absorbed by a 165 kg iron engine block as the temperature rises from 15.7°C to 95.7°C? (The specific heat of iron is 0.489 J/g·°C.)
A. 6,450 kJ
B. 6,350 kJ
C. 6,250 kJ
D. 6,150 kJ
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

103.

The value of $\Delta H°_{rxn}$ for the following reaction is –6535 kJ/mol.
$2C_6H_6(l) + 15O_2(g) \rightarrow 12CO_2(g) + 6H_2O(g)$
How many kilojoules of heat will be evolved during the combustion of 16.0 g of $C_6H_6(l)$?

A. 689 kJ
B. 679 kJ
C. 669 kJ
D. 659 kJ
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

104.

What would be the standard enthalpy change for the reaction of 1.00 mole of $H_2(g)$ with 1.00 mole of $Cl_2(g)$ to produce 2.00 moles of HCl(g) at standard state conditions?
[$\Delta H°_f$ (HCl(g))= –92.3 kJ/mol)]

A. –155 kJ
B. –165 kJ
C. –175 kJ
D. –185 kJ
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

105.

Calculate the heat released (kJ) in the reaction of 3.50 g of acetylene (C_2H_2) and excess hydrogen gas to form ethane gas:
$C_2H_2(g) + 2H_2(g) \rightarrow C_2H_6(g)$
Given:
$2C_2H_2(g) + 5O_2(g) \rightarrow 4CO_2(g) + 2H_2O(g)$ $\Delta H = –2320$ kJ/mol
$2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$ $\Delta H = –3040$ kJ/mol
$2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$ $\Delta H = –572$ kJ/mol

A. 27.5 kJ
B. 28.5 kJ
C. 29.5 kJ
D. 30.5 kJ
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Hess's Law
Topic: Thermochemistry

106.

Calculate the heat released (kJ) in the reaction of 2.20 g of sulfur dioxide gas and excess oxygen gas to form sulfur trioxide gas:
$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$
Given:
$S(s) + O_2(g) \rightarrow SO_2(g)\ \Delta H = -299$ kJ/mol
$S(s) + 3/2O_2(g) \rightarrow SO_3(g)\ \Delta H = -395$ kJ/mol

A. 3.10 kJ
B. 3.20 kJ
C. 3.30 kJ
D. 3.40 kJ
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Hess's Law
Topic: Thermochemistry

107.

Find $\Delta H°_{rxn}$ for the reaction
$CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(l)$.
[$\Delta H°_f\ (CH_4(g)) = -74.8$ kJ/mol; $\Delta H°_f\ (CO_2(g)) = -393.5$ kJ/mol; $\Delta H°_f\ (H_2O(l)) = -285.5$ kJ/mol]

A. -879.7 kJ/mol
B. -889.7 kJ/mol
C. -899.7 kJ/mol
D. -909.7 kJ/mol
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

108.

Find $\Delta H°_{rxn}$ for the reaction
$2Ag_2S(s) + 2H_2O(l) \rightarrow 4Ag(s) + 2H_2S(g) + O_2(g)$.
[$\Delta H°_f$ ($Ag_2S(s)$) = –32.6 kJ/mol; $\Delta H°_f$ ($H_2S(g)$) = –20.5 kJ/mol; $\Delta H°_f$ ($H_2O(l)$) = –285.5 kJ/mol]

A. 595.2 kJ/mol
B. 585.2 kJ/mol
C. 575.2 kJ/mol
D. 565.2 kJ/mol
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

109.

Find $\Delta H°_{rxn}$ for the reaction
$2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + 2H_2(g)$.
[$\Delta H°_f$ ($NaOH(aq)$) = –426.8 kJ/mol; $\Delta H°_f$ ($H_2O(l)$) = –285.5 kJ/mol]

A. –284.6 kJ
B. –282.6 kJ
C. –280.6 kJ
D. –278.6 kJ
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Subtopic: Standard Enthalpies of Formation and Reactions ($\Delta H°_f$ and $\Delta H°_{rxn}$)
Topic: Thermochemistry

110. The specific heat of silver is 0.235 J/g·°C. How many joules of heat are required to heat a 75 g silver spoon from 20°C to 35°C?
A. 240 J
B. 250 J
C. 260 J
D. 270 J
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Easy
Gradable: automatic
Section: 06.05
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

111. At body temperature 2,404 joules of energy are required to evaporate 1.00 g of water. After vigorous exercise, a person feels chilly because the body is giving up heat to evaporate the perspiration. A typical person perspires 25 mL of water after 20. minutes of exercise. How much body heat is this person using to evaporate this water?
A. 6.0×10^4 J
B. 6.3×10^4 J
C. 6.5×10^4 J
D. 6.7×10^4 J
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.04
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

112. 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?
A. 2290 kJ
B. 2490 kJ
C. 2690 kJ
D. 2890 kJ
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.04
Subtopic: Enthalpy (Heats of Reaction)
Topic: Thermochemistry

113. A feverish student weighing 75 kilograms was immersed in 400. kg of water at 4.0°C to try to reduce the fever. The student's body temperature dropped from 40.0°C to 37.0°C. Assuming the specific heat of the student to be 3.77 J/g·°C, what was the final temperature of the water?
A. 2.5°C
B. 3.5°C
C. 4.5°C
D. 55°C
E. None of the above

Bloom's Level: 4. Analyze
Difficulty: Difficult
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

True / False Questions

114. Select True or False: The specific heats of water and iron are 4.184 and 0.444 J/g°C, respectively. When equal masses of water and iron both absorb the same amount of heat, the temperature increase of the water will be 2.42 times greater than that of the iron.
FALSE

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

115. Select True or False: Chemical reactions in a bomb calorimeter occur at constant pressure.
TRUE

Bloom's Level: 4. Analyze
Difficulty: Easy
Gradable: automatic
Section: 06.05
Subtopic: Calorimetry (Measuring Heats of Reaction)
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

116.

Select True or False: If $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$, $\Delta H° = –1203.6$ kJ/mol, then for $Mg(s) + (1/2)O_2(g) \rightarrow MgO(s)$, the enthalpy change is $\Delta H = –601.8$ kJ/mol.

TRUE

Bloom's Level: 4. Analyze
Difficulty: Easy
Gradable: automatic
Section: 06.06
Subtopic: Enthalpy (Heats of Reaction)
Topic: Thermochemistry

117. Select True or False: The heat capacity of 10.0 g of water is 83.7 J/°C.
FALSE

Bloom's Level: 4. Analyze
Difficulty: Medium
Gradable: automatic
Section: 06.05
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

118. Select True or False: The work done on the surroundings by the expansion of a gas is w = –PDV.
TRUE

Bloom's Level: 4. Analyze
Difficulty: Easy
Gradable: automatic
Section: 06.03
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry

119. Select True or False: The heat absorbed by a system at constant pressure is equal to DE - PDV.
FALSE

Bloom's Level: 4. Analyze
Difficulty: Easy
Gradable: automatic
Section: 06.04
Subtopic: System/Surroundings and Heat/work
Topic: Thermochemistry