AP Chemistry Practice Test, Ch. 6: Thermochemistry

Name_____

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) A chemical reaction that absorbs heat from the surroundings is said to be _____ and has a _____ ΔH at constant pressure.
   A) endothermic, positive
   B) endothermic, negative
   C) exothermic, negative
   D) exothermic, positive
   E) exothermic, neutral

2) The reaction

   $4Al\ (s) + 3O_2\ (g) \rightarrow 2Al_2O_3\ (s) \qquad \Delta H^\circ = -3351\ kJ$

   is _____, and therefore heat is _____ by the reaction.
   A) exothermic, released
   B) exothermic, absorbed
   C) endothermic, released
   D) endothermic, absorbed
   E) thermoneutral, neither released nor absorbed

3) The value of ΔH° for the reaction below is –126 kJ. How much heat (in kJ) is released when 2.00 mol of NaOH is formed in the reaction?

   $2Na_2O_2\ (s) + 2H_2O\ (l) \rightarrow 4NaOH\ (s) + O_2\ (g)$

   A) 252 B) –126 C) 7.8 D) 63 E) 3.9

4) The value of ΔH° for the reaction below is –790 kJ. The enthalpy change accompanying the reaction of 0.95 g of S is _____ kJ.

   $2S\ (s) + 3O_2\ (g) \rightarrow 2SO_3\ (g)$

   A) –23 B) 12 C) –12 D) 23 E) –790

5) The value of ΔH° for the reaction below is –6535 kJ. How many kJ of heat are released in the combustion of 16.0 g of C_6H_6 (l)?

   $2C_6H_6\ (l) + 15O_2\ (g) \rightarrow 12CO_2\ (g) + 6H_2O\ (l)$

   A) 673 B) 2.68×10^3 C) 5.23×10^4 D) –6535 E) 1.34×10^3

6) The value of ΔH° for the reaction below is –336 kJ. Calculate the heat (kJ) released to the surroundings when 23.0 g of HCl is formed.

$$CH_4\,(g) + 3Cl_2\,(g) \rightarrow CHCl_3\,(l) + 3HCl\,(g)$$

A) 211 B) 177 C) 70.7 D) –336 E) 2.57×10^3

7) The specific heat capacity of lead is 0.13 J/g–K. How much heat (in J) is required to raise the temperature of 15 g of lead from 22°C to 37°C?

A) 29 B) 5.8×10^{-4} C) –0.13 D) 2.0 E) 0.13

8) The specific heat of liquid bromine is 0.226 J/g–K. How much heat (J) is required to raise the temperature of 10.0 mL of bromine from 25.00°C to 27.30°C? The density of liquid bromine: 3.12 g/mL.

A) 16.2 B) 10.4 C) 32.4 D) 5.20 E) 300

9) The specific heat capacity of methane gas is 2.20 J/g–K. How many joules of heat are needed to raise the temperature of 5.00 g of methane from 36.0°C to 75.0°C?

A) 22.9 B) 88.6 C) 429 D) 0.0113 E) 1221

10) The ΔH for the solution process when solid sodium hydroxide dissolves in water is –44.4 kJ/mol. When a 13.9–g sample of NaOH dissolves in 250.0 g of water in a coffee–cup calorimeter, the temperature increases from 23.0°C to _____°C. Assume that the solution has the same specific heat as liquid water, i.e., 4.18 J/g–K.

A) 14.0°C B) 37.8°C C) 40.2°C D) 37.0°C E) 35.2°C

11) Given the following reactions

$$Fe_2O_3\,(s) + 3CO\,(s) \rightarrow 2Fe\,(s) + 3CO_2\,(g) \qquad \triangle H = -28.0\ kJ$$

$$3Fe\,(s) + 4CO_2\,(s) \rightarrow 4CO\,(g) + Fe_3O_4\,(s) \qquad \triangle H = +12.5\ kJ$$

the enthalpy of the reaction of Fe_2O_3 with CO

$$3Fe_2O_3\,(s) + CO\,(g) \rightarrow CO_2\,(g) + 2Fe_3O_4\,(s)$$

is _____ kJ.

A) 40.5 B) +109 C) –15.5 D) –109 E) –59.0

12) Given the following reactions

$N_2(g) + 2O_2(g) \rightarrow 2NO_2(g)$ $\Delta H = 66.4$ kJ

$2NO(g) + O_2(g) \rightarrow 2NO_2(g)$ $\Delta H = -114.2$ kJ

the enthalpy of the reaction of the nitrogen to produce nitric oxide

$N_2(g) + O_2(g) \rightarrow 2NO(g)$

is _____ kJ.

A) –47.8 B) 47.8 C) 180.6 D) –180.6 E) 90.3

13) Calculate ΔH° (in kJ) for reaction 3.

$2S(s) + 3O_2(g) \rightarrow 2SO_3(g)$ $\triangle H = -790$ kJ
$S(s) + O_2(g) \rightarrow SO_2(g)$ $\triangle H = -297$ kJ

the enthalpy of the reaction in which sulfur dioxide is oxidized to sulfur trioxide

$2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

is _____ kJ.

A) –196 B) –543 C) 1087 D) 196 E) –1384

14) The value of ΔH° for the following reaction is –3351 kJ:

$2Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$

The value of ΔH_f° for $Al_2O_3(s)$ is _____ kJ.

A) –3351 B) –1676 C) +3351 D) –16.43 E) –32.86

15) Given the data in the table below, ΔH°_{rxn} for the reaction

$Ca(OH)_2 + 2H_3AsO_4 \rightarrow Ca(H_2AsO_4)_2 + 2H_2O$

is _____ kJ.

Substance	ΔH_f° (kJ/mol)
$Ca(OH)_2$	–986.6
H_3AsO_4	–900.4
$Ca(H_2AsO_4)_2$	–2346.0
H_2O	–285.9

A) –4219 B) –130.4 C) –4519 D) –76.4 E) –744.9

16) Given the data in the table below, ΔH°_{rxn} for the reaction

$$IF_7\,(g) + I_2\,(g) \rightarrow IF_5\,(g) + 2IF\,(g)$$

is _____ kJ.

Substance	ΔH_f° (kJ/mol)
IF (g)	–95
IF_5 (g)	–840
IF_7 (g)	–941

A) 311 kJ

B) 69 kJ

C) –1991 kJ

D) –69 kJ

E) The ΔH_f° of I_2 (g) is needed for the calculation.

Answer Key
Testname: CH_06_PRAC_TEST.TST

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question.

1) A
ID: chem9b 5.1–32

2) A
ID: chem9b 5.1–33

3) D
ID: chem9b 5.1–35

4) C
ID: chem9b 5.1–37

5) A
ID: chem9b 5.1–38

6) C
ID: chem9b 5.1–40

7) A
ID: chem9b 5.1–54

8) A
ID: chem9b 5.1–57

9) C
ID: chem9b 5.2–5

10) D
ID: chem9b 5.1–58

11) E
ID: chem9b 5.1–63

12) C
ID: chem9b 5.1–64

13) A
ID: chem9b 5.1–66

14) B
ID: chem9b 5.1–74

15) B
ID: chem9b 5.1–81

16) E
ID: chem9b 5.1–83

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(3) $2.00 \text{ mol NaOH} \times \frac{-126 \text{ kJ}}{4 \text{ mol NaOH}} = -63 \text{ kJ}$

$\Delta H = -63.0 \text{ kJ}$

63 kJ released (D)

(4) $0.95 \text{ g S} \times \frac{1 \text{ mol S}}{32.06 \text{ g S}} \times \frac{-790 \text{ kJ}}{2 \text{ mol S}} = -12 \text{ kJ}$

$\Delta H = -12 \text{ kJ}$ (C)

(5) $16.0 \text{ g } C_6H_6 \times \frac{1 \text{ mol } C_6H_6}{78.12 \text{ g } C_6H_6} \times \frac{-6535 \text{ kJ}}{2 \text{ mol } C_6H_6} = -669 \text{ kJ}$

$12.01 \times 6 = 72.06$

$1.01 \times 6 = 6.06$

78.12 g/mol

$\Delta H = -669 \text{ kJ}$

669 kJ are released (A)

(6) $23.0 \text{ g HCl} \times \frac{1 \text{ mol HCl}}{36.46 \text{ g HCl}} \times \frac{-336 \text{ kJ}}{3 \text{ mol HCl}} = -70.7 \text{ kJ}$

35.45

1.01

36.46 g/mol

$\Delta H = -70.7 \text{ kJ}$

70.7 kJ are released (C)

(7) $q = mC\Delta T$

$= (15 \text{ g})\left(0.13 \frac{\text{J}}{\text{g K}}\right)(15 \text{ K})$

$= 29 \text{ J}$ (A)

$37 - 22 = 15^\circ\text{C}$

$310 \text{ K} - 295 \text{ K} = 15 \text{ K}$

(8) $q = mC\Delta T = (31.2 \text{ g})\left(2.226 \frac{\text{J}}{\text{g K}}\right)(2.30 \text{ K})$

$= 16.2 \text{ J}$ (A)

$m = 10.0 \text{ mL} \times \frac{3.12 \text{ g}}{\text{mL}} = 31.2 \text{ g}$

$27.30 - 25.00 = 2.30^\circ\text{C}$

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(9) $q = MC\Delta T$

$= (5.00\,g)\left(\frac{2.20\,J}{g\,K}\right)(39.0\,K)$

$= 429\,J$ (c)

$75.0 - 36.0 = 39°C$ $\quad 39.0\,K$

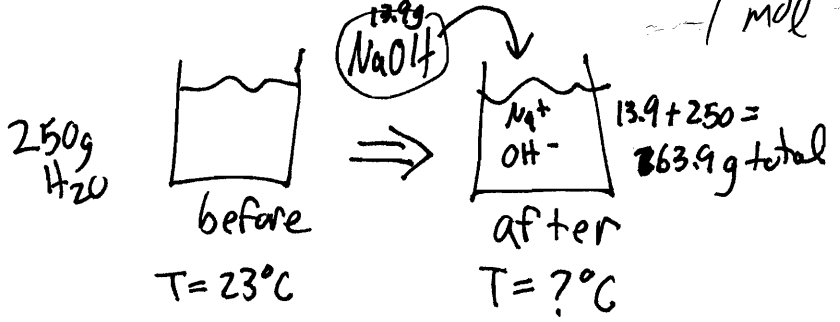
(10) $NaOH_{(s)} \xrightarrow{H_2O} Na^+_{(aq)} + OH^-_{(aq)}$ $\quad \Delta H = -44.4\,kJ$

~~stated value is incorrect.~~ → updated and fixed.

23.0 + 16.0 + 1.0 = 40 g/mol

$13.9\,g \times \frac{1\,mol}{40.0\,g} = 0.348\,mol\,NaOH$

$0.348\,mol\,NaOH \times \frac{-44.4\,kJ}{1\,mol} = -15.5\,kJ$



ΔH for NaOH dissolving = $-15.5\,kJ$

thus ΔH for water = $+15.5\,kJ$

water's C ≈ solution's C

$q = MC\Delta T$

$15500\,J = (13.9\,g + 250.0\,g)\left(4.18\,\frac{J}{g\,K}\right)(\Delta T)$

$\frac{15500\,J}{(263.9\,g)\left(4.18\,\frac{J}{g\,K}\right)} = 14.0\,K = \Delta T = T_f - T_i$

$23.0°C + 14.0°C = 37.0°C$

$T_i + \Delta T = T_f$

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(11) GOAL: $3Fe_2O_{3(s)} + CO_{(g)} \rightarrow CO_{2(g)} + 2Fe_3O_{4(s)}$

$3(Fe_2O_3 + 3CO \rightarrow 2Fe + 3(O_2))$ $\quad 3(-28\ kJ)$

$2(3Fe + 4CO_2 \rightarrow 4CO + Fe_3O_4)$ $\quad 2(+12.5\ kJ)$

$3Fe_2O_{3(s)} + 9CO_{(g)} \rightarrow 6Fe_{(s)} + 9CO_{2(g)}$ $\quad \Delta H = -84.0\ kJ$

$+ \quad 6Fe_{(s)} + 8CO_{2(g)} \rightarrow 8CO_{(g)} + 2Fe_3O_{4(s)}$ $\quad \Delta H = +25.0\ kJ$

$3Fe_2O_3 + CO \rightarrow CO_{2(g)} + 2Fe_3O_{4(s)}$ $\quad \Delta H = -59\ kJ$

$\Delta H = -59.0\ kJ$

(12) GOAL: $N_2 + O_2 \rightarrow 2NO$

$N_2 + 2O_2 \rightarrow 2NO_2$ $\quad \Delta H = 66.4\ kJ$

reverse $\quad 2NO + O_2 \rightarrow 2NO_2$ $\quad \Delta H = -114.2\ kJ$

$+ \quad 2NO_2 \rightarrow 2NO + O_2$ $\quad \Delta H = +114.2\ kJ$

$N_2 + 2O_2 + 2NO_2 \rightarrow 2NO_2 + 2NO + O_2$

$N_2 + O_2 \rightarrow 2NO$ $\quad \Delta H = +180.6\ kJ$

(C)

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(13) GOAL: $2SO_2 + O_2 \rightarrow 2SO_3$

$2S + 2O_2 \rightarrow 2SO_3 \quad \Delta H = -790\ kJ$

double and reverse → ~~$S + O_2 \rightarrow SO_2 \quad \Delta H = -297\ kJ$~~

$+ \quad 2SO_2 \rightarrow 2S + 2O_2 \quad \Delta H = +594\ kJ$

(A) $2SO_2 + O_2 \rightarrow 2SO_3 \quad \Delta H = -196\ kJ$

(14) Because this reaction shows the formation of Al_2O_3 from its elements, the ΔH° for the formation of only one mole would be ½ of the given ΔH°.

$$1\ mol\ Al_2O_3 \times \frac{-3351\ kJ}{2\ mol\ Al_2O_3} = \underline{-1676}\ kJ$$ (B)

(15) $\Delta H^\circ_{rxn} = [(1)(-2346) + (2)(-285.9)] - [(-986.6) + (2)(-900.4)]$

$= [-2346 + -571.8] - [(-986.6) + (-1800.8)]$

$= -2917.8 - -2787.4$

$= -130.4\ kJ$ (B)

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(16) E, because

I_2 is a solid in its standard state

(I would have told you, "I_2 is a solid at 25°C and 1 atm" if I were to have put this on a test.)