Key

1. $q = ms\Delta t$

a. $q = (8.50\times10^2\ g)(.900\ J/g°C)(71.8°C)$

$\boxed{= 54{,}900\ J}$

b. $\frac{.900\ \cancel{J}}{\cancel{g}°C} \times \frac{1\ kJ}{1000\ \cancel{J}} \times \frac{27.0\ \cancel{g}}{1\ mol} = \boxed{.0243\ \frac{kJ}{mol\ °C}}$

2. a) $q = (12.0g)(.71\ J/g°C)(1.0°C) = \boxed{8.5\ J}$

b) $q = (850.g)(.71\ J/g°C)(150.°C) = \boxed{91{,}000\ J}$

c) $q = (75{,}000g)(.71\ J/g°C)(54.0°C) = \boxed{2{,}900{,}000\ J}$

3. a) $782\ J = 45.6g \cdot s \cdot 13.3°C$

$s = .129\ J/g°C$

$\frac{.129\ \cancel{J}}{\cancel{g}°C} \times \frac{1\ kJ}{1000\ \cancel{J}} \times \frac{207.2\ \cancel{g}}{1\ mol} = -\frac{.0267\ kJ}{mol}$

(negative because heat is released)

4. $535\ J = 125.6g \times s \times 35.3°C$

$s = .132\ J/g°C$

$\frac{.132\ J}{g°C} \times \frac{1\ kJ}{1000\ J} \times \frac{200.6\ g}{1\ mol} = -.0256\ kJ/mol$

(again negative because heat is released)

5.

$q = (150.g)(4.184 J/g°C)(1.50°C)$

$= 941 J$

$941 J = (28.2g)(s)(74.80°C)$

$\boxed{= .446 J/g°C}$

6.

$q = (70.0g)(4.184 J/g°C)(2.20°C)$

$= 644 J$

$644 J = (46.2g)(s)(73.6°C)$

$\boxed{= .189 J/g°C}$

7.

$q = (125 + 10.5g)(4.184 J/g°C)(3.10°C)$

$= 1760 J$

$\Delta H = \frac{1760 J}{10.5 g} = \boxed{168 J/g}$

$\frac{168 J}{g} \times \frac{1 kJ}{1000 J} \times \frac{119 g}{1 mol} = \boxed{19.99 \ kJ/mol}$

8.

$q = (200 g)(4.184 J/g°C)(6.70°C)$

$= 5610 J$

$-5.61 kJ$

$1.0M = \frac{x}{.100 L} \quad x = .100 \ mol$

$\Delta H = \frac{-5.61 kJ}{.100 mol} = \boxed{-56.1 \ kJ/mol}$

$q = C \Delta t$

$\Delta t = 2.28°C$

$\boxed{[illegible] /°C}$

$.1204 g \times \frac{1 mol}{152 g} \times \frac{5903.6 kJ}{1 mol} =$

$4.68 kJ$

$\frac{4.99 kJ}{.1964 g} \times \frac{108 g}{1 mol} = \boxed{2743 kJ/mol}$

11. $q = (100.\text{g})(4.184\,\text{J/g°C})(.80\text{°C})$

$= 335\,\text{J}$

$\frac{.100 = x}{.050\,\text{L}} \quad x = .005\,\text{mol}$

$\frac{335\,\cancel{\text{J}}}{.005\,\text{mol}} \times \frac{1\,\text{kJ}}{1000\,\cancel{\text{J}}} = \boxed{-67\,\text{kJ/mol}}$

Key

AP CHEMISTRY WORKSHEET ON CALORIMETRY

NAME:________________________DATE:__________PERIOD:________

SHOW YOUR WORK!!!!!! SHOW YOUR WORK!!!!!! SHOW YOUR WORK!!!!!!

(1) The following substances undergo complete combustion in a bomb calorimeter. The bomb calorimeter assembly (including the water) has a heat capacity of 4.881 kJ/ ^{0}C. In each case, what is the final water temperature if the initial water temperature is 24.62 ^{0}C?

a. 0.5187 grams of cyclohexanol ($C_6H_{12}O_{(l)}$); heat of combustion = – 3727 kJ/mol

$q = C\Delta t$

$.5187 g\ C_6H_{12}O \times \frac{1 mol}{100.} = .005187 mol \times -\frac{3727 kJ}{1 mol} = -19.33 kJ$

$-19.33 kJ = -4.881 kJ/°C \cdot \Delta t$ $\Delta t = 3.96 °C$

$T_f = 24.62 + 3.96 °C = 28.58 °C$

b. 1.75 mL of ethyl acetate ($C_4H_8O_{2(l)}$, density = 0.901 g/mL); heat of combustion = –2246 kJ/mol.

$m = (1.75 mL)(.901 g/mL) = 1.58 g\ C_4H_8O_2 \times \frac{1 mol}{88.0} = .0180 mol$

$-2246 \frac{kJ}{mol} \times .0180 mol = -40.4 kJ$

$-40.4 kJ = -4.881 kJ/°C\ \Delta t$ $\Delta t = 8.28 °C$

$T_f = 24.62 + 8.28 = 32.9 °C$

(2) A 0.50 gram sample of NH_4NO_3 is added to 35.0 grams of water in a "coffee cup" (constant pressure) calorimeter and stirred until it dissolves. The temperature of the solution drops from 22.7 ^{0}C to 21.6 ^{0}C. What is the HEAT OF SOLUTION of NH_4NO_3 expressed in kJ/mol NH_4NO_3?

$s = 4.184 J/g°C$

$q = ms\Delta t$
$= (35.5 g)(4.184 J/g°C)(1.10 °C)$
$= 163 J \rightarrow .163 kJ$

$.50 g\ NH_4NO_3 \times \frac{1 mol}{80.0 g} = .00625 mol$

$\Delta H = \frac{.163 kJ}{.00625 mol} = 26.1 kJ/mol$

(3) 0.5060 grams of liquid cyclohexanol undergo complete combustion in a bomb calorimeter. The calorimeter assembly has a heat capacity of 827.0 J/^{0}C and contains exactly 1000 grams of water. What is the final temperature if the initial water temperature is 24.98 ^{0}C? The heat of combustion of the cyclohexanol is –3727 kJ/mol.

$.5060 g \times \frac{1 mol}{100 g} = .005060 mol \times \frac{-3727 kJ}{mol} = -18.86 kJ$ total

$q_{total} = q_{cal} + q_{water}$

$18860 J = C\Delta t + ms\Delta t$

$18860 = (827 J/°C)\Delta t + (1000. g)(4.184)\Delta t$

$827\Delta t + 4184\Delta t$

$18860 = 5011\Delta t$ $\Delta t = 3.76 °C$

$T_f = 24.98 + 3.76 = 28.74$

(4) A coffee-cup calorimeter having a heat capacity of 472 J/^{0}C is used to measure the heat evolved when the following aqueous solutions, both initially at 22.6 ^{0}C, are mixed: 100 g of a solution containing 6.62 g of lead (II) nitrate, and 100 g of solution containing 6.00 g of sodium iodide. The final temperature is 24.2 ^{0}C. Assume that the specific heat of the mixture is the same as that for water (4.184 J/g·^{0}C).

a. Write a balanced equation for the reaction that occurs

$Pb(NO_3)_2 + 2\ NaI \longrightarrow PbI_2 + 2\ NaNO_3$

b. Calculate the heat evolved in the reaction

$q_{tot} = q_{cal} + q_{rxn}$

$q = msΔt$

$= 200.g \cdot 4.184J/g°C \cdot 1.6°C + (472J/°C)(1.6°C) = 2094 J$ or $2.09 kJ$

c. Calculate the ΔH for the reaction (per mole of lead (II) nitrate consumed) under the conditions of the experiment.

$6.62g \times \frac{1 mol}{331.2} = .0200$ $\quad ΔH = \frac{-2.094 kJ}{.0200 mol} = -104.5 kJ/mol$

(5) The combustion of 1.048 g of benzene, $C_6H_{6\,(l)}$, in a bomb calorimeter compartment surrounded by 945 g of water raised the temperature of the water from 23.640 ^{0}C to 32.692 ^{0}C. The heat capacity of the calorimeter is 891 J/^{0}C.

a. Write a balanced equation for the combustion reaction that occurs, assuming that $CO_{2\,(g)}$ and $H_2O_{\,(l)}$ are the only products

$2\ C_6H_6 + 15\ O_2 \rightarrow 12\ CO_2 + 6\ H_2O$

$1.048g\ C_6H_6 \times \frac{1 mol}{78.0} = .0134 mol$

b. Use the calorimetric data to calculate ΔE for benzene in kJ/g and kJ/mol.

$q_{total} = q_{cal} + q_{water}$

$= (891J/°C)(9.052°C) + (946g)(4.184)(9.052°C)$

$= 43,894\ J$

$ΔH = \frac{43.894 kJ}{1.048g} = -41.88 kJ/g$ $\quad ΔH = \frac{43.894 kJ}{.0134 mol} = -3275 kJ/mol$

(6) A 1.567 g sample of naphthalene, $C_{10}H_{8\,(s)}$, is completely combusted in a bomb calorimeter assembly and a temperature increase of 8.37 ^{0}C is observed. When a 1.227 g sample of thymol, $C_{10}H_{14}O_{\,(s)}$ (a preservative and a mold and mildew preventative), is burned in the same calorimeter assembly, the temperature increase is 6.12 ^{0}C. If the heat of combustion of naphthalene is 5153.9 kJ/mol $C_{10}H_8$, what is the heat of combustion of thymol, expressed in kJ/mol $C_{10}H_{14}O$?

$1.567g \times \frac{1}{128} = .0123 mol$

$5153.9 \frac{kJ}{mol} \times .0123 mol = 63.39 kJ$

① Find C of Calorimeter

$q = CΔt$

$63.39 kJ = C\ (8.37°C)$

$C = 7.57 kJ/°C$

$1.227g \times \frac{1 mol}{150} = .00818 mol$

② Calc q for thymol

$q = (7.57)(6.12°C)$

$= 46.3 kJ$

$ΔH = -46.3 kJ / 1.227g = -37.7 kJ/g$

$ΔH = -46.3 kJ / .00818 mol = -5660 kJ/mol$