In-Class Examples

1. 9.0 grams of charcoal (C) were completely consumed in a bomb calorimeter. If we assume that the 2.0 L of water absorbed all of the heat released by the charcoal, and if the temperature of the water increased from 20.25 to 56.04^{o}C, what is the ***molar enthalpy*** of carbon?

$Q = mc\,\Delta T$
$= 2000g(4.18\ J/(g\ C))(56.04-20.25)$
$= 299\ 920\ J$
$\Delta H = -\ Q = -\ 299\ 920\ J = -299.92\ kJ$

$n = 9.0g / 12.01\ g/mole = 0.7493\ mole$

$\Delta H/n = -299.92\ kJ/\ 0.7493\ mole =$ $-400.27 kJ/mole\ of\ C$

2. CS_2, a very flammable liquid, has a molar enthalpy of -1028 kJ/mole. What do you expect aluminum's final temperature to be if 1.0 kg of Al is initially at 20.0 C, and it absorbs all the heat from the following sample of CS_2:

   mass of CS_2 before burning: 22.6 g
   mass of CS_2 after burning: 11.6 g

   specific heat capacity of Al: 0.900 J/[g C]

$mass = 22.6 - 11.6 = 11.0\ g$

$11.0g/\ 76g/mole = 0.1447\ moles$

$n(\Delta Hx) = \Delta H = 0.1447 moles\ (-1028\ kJ/mole) = -148.79\ kJ = -148\ 790\ J$

$Q = -\Delta H = 148790\ J$
$Q = mc\,\Delta T$
$148790\ J = 1000g(0.900)(T_f - 20)$

$T_f = 185.3\ ^{0}C$

3. 300 mL of 0.2 M aqueous KOH neutralizes 150 mL of aqueous 0.2 M H_2SO_4. We go from an average initial temperature of 22.3 ^oC to a maximum of 29.2 C. Calculate the molar heat(enthalpy) of neutralization of KOH.

$$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2\ H_2O$$

$Q = mc\ \Delta T$
$= (300g + 150g)(4.18)(29.2\text{-}22.3)$
$=13009.95\ J$

$\Delta H = - Q = - 13009.95\ J = -13.01\ kJ$

$n = CV = 0.2 mole/L(0.300\ L) = 0.06\ moles$

$\Delta H/n = -13.10\ kJ/0.06\ moles = -217\ kJ/mole\ of\ KOH$

Very important: When plugging in V, make sure by looking at the stoichiometry that you consider only the volume of the KOH (since they asked for its enthalpy)that actually reacted.

4. Find the final temperature of the following mixture:

400. g of Cu initially at 99.0 ^oC
25 L of water initially at 10.0 ^oC

c for Cu = 0.39 J/[g C]

$Q_{H2O} = - Q_{Cu}$ (because the heat lost by Cu will be gained by the water)
$m_{H2O}c_{H2O} (T_f - T_{H2O}) = -m_{Cu}c_{Cu} (T_f - T_{Cu})$; Note that they reach the same final temperature.

$$25000g\ (4.18)(\ T_f\text{-}10) = -400\ (\ 0.39)(\ T_f\ \text{-}99)$$

$$T_f = 10.1\ ^oC$$

The temperature change is insignificant (especially if we pay attention to significant figures) because the amount of water is much greater than the amount of Cu, and because water has a higher specific heat than Cu.

Calorimetry :

1) A student mixed 100.0 ml of 1.50 **mol/l** sulfuric acid with 200.0 ml of 1.50 mol/l sodium hydroxide. Both solutions were at 19.67 C initially and the highest temperature reached by the reaction mixture was 34.06 C.
a) Calculate the **number of moles** (n) of sulfuric acid (volume in **Liters** times molarity in **mol/l**).

b) Calculate the total volume of the two solutions (both sulfuric acid **and** sodium hydroxide).

c) Calculate the mass of the two solutions combined. (m). Assuming 1 ml = 1 g

d) Using the information in the question, calculate the molar enthalpy of sulfuric acid, using the formula .

$$\Delta H_x = \frac{m(c)\,\Delta t}{n}$$

A = -120 kJ/mol

2) Calculate the molar enthalpy for the solidification of gallium metal (Ga) if 10.0 g of gallium causes 50 ml of water to change temperature from 24.0 to 27.8 C when it solidifies.

A = -5.68 kJ/mol

3) The molar enthalpy of methane (Hr = -803 KJ/mol). What is the minimum mass of methane that must be burned to warm 4.00 L of water from 22.4 to 87.6 C, assuming no heat losses? (Assume that 1L of water = 1Kg).

m = 21.8 g

4) Find the temperature increase expected for 1.00 L of water when it absorbs all of the energy from the combustion of 1.00 g of acetylene, C_2H_2 (g). The molar enthalpy of combustion for acetylene is -1,290 KJ/mol.

Δt = 11.69 C

5) In a chemistry experiment 10 g of urea NH_2COHN_2 is added to 150 ml of water in a simple coffee cup calorimeter. A temperature decrease of 3.7 C is noticed. Calculate the molar enthalpy of urea.

A = 16.7 kJ/mol

6) A laboratory technician initially adds 43.1 ml of concentrated 11.6 mol/l hydrochloric acid to water to form a 500 ml solution. The temperature of the solution rises 2.6 C. .

Calculate the number of moles of hydrochloric acid added (c x v)
(molarity=concentration = mol/l times volume in liters)

Convert the final volume of the mixture to mass(1ml = 1g). This value is **m** in the formula**.**

Calculate the molar enthalpy, using the remaining information.

A = -10.9 kJ/mo