SOLVING BOMB CALORIMETER PROBLEMS

A 1.000 g sample of octane (C_8H_{18}) is burned in a bomb calorimeter containing 1200 grams of water at an initial temperature of 25.00ºC. After the reaction, the final temperature of the water is 33.20ºC. The heat capacity of the calorimeter (also known as the "calorimeter constant") is 837 J/ºC. The specific heat of water is 4.184 J/g ºC. **Calculate the heat of combustion of octane in kJ/mol.**

Since this is a combustion reaction, heat flows from the system to the surroundings… thus, it is exothermic. The heat released by the reaction will be absorbed by two things: (a) the water in the calorimeter and (b) the calorimeter itself.

a. Calculate the heat absorbed by the water (q_{water})

   m = 1200 grams
   c_{water} = 4.184 J/gºC
   ΔT = 33.20 – 25.00 = 8.20ºC

   $q_{water} = (m)(c)(\Delta T)$, so
   $q_{water} = (1200\text{ g})(4.184\ {}^{J}\!/_{g\cdot{}^\circ C})(8.20^\circ\text{C}) = 41170.56\text{ J} = \mathbf{41.2\ kJ}$

b. Calculate the heat absorbed by the calorimeter (q_{cal})

   The temperature change of the calorimeter is the same as the temperature change for water. In this step, however, we must use the **heat capacity** of the calorimeter, which is already known. When using heat capacity, the mass of the calorimeter is not required for the calculation. (It's already incorporated into the heat capacity).

   C_{cal} = 837 J/ºC
   ΔT = 33.20 – 25.00 = 8.20ºC

   $q_{cal} = (C_{cal})(\Delta T)$, so
   so, $q_{cal} = (837\ {}^{J}\!/_{{}^\circ C})(8.20^\circ\text{C}) = 6863.4\text{ J} = \mathbf{6.86\ kJ}$

The TOTAL heat absorbed by the water and the calorimeter is the sum of (a) and (b): 41.2 + 6.86 = **+ 48.1 kJ.** (Remember, q is positive because the heat is being absorbed).

The amount of heat released by the reaction is equal to the amount of heat absorbed by the water and the calorimeter. We just need to change the sign. So,

$$\boxed{\mathbf{q_{reaction} = -\ 48.1\ kJ}}$$

Since 1.000 gram of octane was burned, the **heat of combustion** for octane is equal to – 48.1 kJ/gram. In other words, when one mole of octane is burned, 48.1 kJ of heat is released from the reaction. *What is the heat of combustion in kJ/mol?*

1 mol of octane weighs 114 grams, so (-48.1 kJ/g)(114 g/mol) = **– 5483 kJ/mol.**