

Chemistry II Calorimetry Problems:

Heat of Reaction:

ex> When 1 mole of methane is burned at constant pressure, 890 kJ of energy is released as heat. Calculate the heat of reaction (ΔH) for the process of 5.8 g of methane being burned at constant pressure. [-320 kJ]

Solution Calorimetry at Constant Pressure:

ex> Suppose we mixed 50.0 mL of 1.0 M HCl at 25.0 °C with 50.0 mL of 1.0 M NaOH (also at 25.0 °C) in a calorimeter. After the reactants were mixed by stirring, the temperature was observed to increase to 31.9 °C. (a) How much heat was evolved? [-2900 J] (b) How much kJ of heat per mole of H^+ ions? [-58 kJ/mol]

ex2> When 1.00 L of 1.00 M $Ba(NO_3)_2$ solution at 25.0 °C is mixed with 1.00 L of 1.00 M Na_2SO_4 solution at 25.0 °C in a calorimeter, the white solid barium sulfate forms, and the temperature of the mixture increases to 28.1 °C. Assuming that the calorimeter absorbs only a negligible quantity of heat, that the specific heat capacity of the solution is the same as that of water, and that the density of the final solution is 1.0 g/mL, calculate the enthalpy change per mole of barium sulfate formed. [-26 kJ/mol]

Calorimetry at Constant Volume:

ex> We want to measure the energy of combustion (in kJ/mol) of octane, a component of gasoline. A 0.5269-gram sample of octane is placed in a bomb calorimeter known to have a heat capacity of 11.3 kJ/°C (which means that 11.3 kJ of energy are required to raise the temperature of the water and other parts of the calorimeter by 1 °C). The octane is ignited in the presence of excess oxygen, and the temperature increase of the calorimeter is 2.25 °C. What is the energy of combustion of octane in kJ per mole? [-5.50 x 10³ kJ/mol]

ex2> It has been suggested that hydrogen gas obtained by the decomposition of water might be a substitute for natural gas (principally methane). To compare the energies of combustion of these fuels, the following experiment was carried out using a bomb calorimeter with a heat capacity of 11.3 kJ/°C. When a 1.50-gram sample of methane gas was burned with excess oxygen in the calorimeter, the temperature increased by 7.3 °C. When a 1.15-gram sample of hydrogen gas was burned with excess oxygen, the temperature increase was 14.3 °C. Calculate the energy of combustion per gram for hydrogen and methane. [hydrogen = 141 kJ/g, methane = 55 kJ/g]

Calorimetry Practice Problems:

- 1) The overall reaction in a commercial heat pack [hand warmer] can be represented as



- (a) How much heat is released when 4.00 moles of iron react with excess oxygen? [-1650 kJ]
(b) How much heat is released when 1.00 mole of Fe₂O₃ is produced? [-826 kJ]
(c) How much heat is released when 1.00 g of iron is reacted with excess oxygen? [-7.39 kJ]
(d) How much heat is released when 10.0 g of iron and 2.00 g of oxygen react? [-34.4 kJ]
- 2) Consider the combustion of propane. The heat of reaction for the combustion of propane is -891 kJ/mol. Calculate the heat released when
(a) 1.00 g of methane is burned in excess oxygen
(b) 1.00 x 10³ L of methane gas at 740. torr and 25.0 °C is burned in excess oxygen
- 3) In a coffee-cup calorimeter, 50.0 mL of 0.100 M AgNO₃ and 50.0 mL of 0.100 M HCl are mixed. The two solutions were initially at 22.60 °C, and the final temperature was 23.40 °C. Calculate the heat that accompanied this reaction in kJ per mole of AgCl formed. Assumed that the combined solution has a mass of 100.0 g and a specific heat capacity of 4.18 J/g·°C. [-66 kJ/mol]
- 4) Consider the dissolution of calcium chloride in water. It has a heat of reaction of -81.5 kJ per mole of calcium chloride. An 11.0 g sample of calcium chloride was dissolved in 125 g of water (with both substances at 25.0 °C). Calculate the final temperature of the solution, assuming no heat lost to the surroundings and assuming the solution has a specific heat capacity of 4.18 J/g·°C. [39.2 °C]
- 5) The heat capacity of a bomb calorimeter was determined by burning 6.79 g of methane (with an energy of combustion of -802 kJ/mole) in the bomb. The temperature changed by 10.8 °C.
(a) What is the heat capacity of the bomb? [31.5 kJ/°C]
(b) A 12.6 gram sample of ethyne produced a temperature increase of 16.9 °C in the same calorimeter. What is the energy of combustion of ethyne in kJ per mole? [-1.10 x 10³ kJ/mol]