Answer on Question #52881 – Chemistry – General chemistry

Question:

A 1.148 gram sample of benzoic acid is burned in an excess of oxygen gas in a bomb calorimeter. The temperature of the calorimeter rises from 24.96 to 30.25 degrees Celsius. The heat of combustion of benzoic acid is -26.42 kJ/g. In a second experiment, a 0.895 gram powdered coal sample is burned in the same calorimeter assembly. The temperature rises from 24.98 to 29.73 degrees Celsius. How many kilograms of this coal would have burned to liberate 1.00E^9 kJ of heat.

Solution:

Heat released after combustion of benzoic acid is: $q_1 = m_1 \times \Delta H_1 = 1.148\ g \times (-26.42\ kJ/mol) = 30.33\ kJ$,

where ΔH_1 – the enthalpy of combustion of benzoic acid.

If ΔT_1 is the first change of the temperature, the calorimeter constant is:

$K = q_1/\Delta T_1 = 30330\ J/5.29\ K = 5733\ J/K$

Burned coal gives: $\Delta T_2 = 29.73\ K - 24.98\ K = 4.75\ K$, thus $q_2 = \Delta T_2 \times K$ and $\Delta H_2 = \Delta T_2 \times K / m_2$,

where ΔH_2 – the enthalpy of combustion of the coal.

$\Delta H_2 = 4.75\ K \times 5733\ J/K / 0.895\ g = 30\ 426.54\ J/g$

The mass of the coal needed to liberate 10^9 kJ is: $m = q/\Delta H_2 = 10^{12}\ J / 30\ 426.54\ J/g = 32870\ kg$

Answer: 32870 kg