Answer on the question #65789, Chemistry / Other

Question:

The combustion of sugar, in a bomb calorimeter is similar to the oxidation of sugar in the body. A student ate three sugar cubes, with the masses of 6.84g, 6.75g and 6.79g.

A) calculate the overall molar enthalpy of oxidation of sugar in the body.

B) using these three sugar cubes as representative of regular-sized cubes, determine the amount of energy released by an average-sized cube.

Solution:

A) The reaction of combustion of sugar is:

$$C_{12}H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O$$

According to Hess's law, molar enthalpy of combustion of sugar is:

$$\Delta H_c^0(C_{12}H_{22}O_{11}) = 12\Delta H_f^0(CO_2) + 11\Delta H_f^0(H_2O) - \Delta H_f^0(C_{12}H_{22}O_{11})$$

Enthalpy of formation for sugar, carbon dioxide and water are -2221.2 kJ/mol, -393.51 kJ/mol and -285.830 kJ/mol, respectively. Then, molar enthalpy of oxidation of sugar in the body is:

$$\Delta H_c^0(C_{12}H_{22}O_{11}) = 12 \cdot (-393.51) + 11 \cdot (-285.830) + 2221.2$$
$$= -5645.05\ kJ/mol$$

B) Average mass of the sugar cube is:

$$m = \frac{6.84 + 6.75 + 6.79}{3} = 6.79\ (g)$$

Molar mass of sugar is 342.2965 g/mol. Then average sugar cube contains the following number of the moles of sugar:

$$n = \frac{m}{M} = \frac{6.79(g)}{342.2965\ (g\ mol^{-1})} = 0.01985\ mol$$

So, the amount of energy, released by an average-sized cube is:

$$Q = n \cdot \Delta H_c^0(C_{12}H_{22}O_{11}) = 0.01985(mol) \cdot 5645.05(kJ\ mol^{-1})$$
$$= 112\ kJ, or\ 26.8\ kcal.$$

Answer: A) $-5645.05\ kJ/mol$; B) $112\ kJ, or\ 26.8\ kcal$
Thermochemistry data was taken from http://webbook.nist.gov/chemistry/ website.