VCL 5-5: Heat of Combustion: Chicken Fat

The heat of combustion ($\Delta H_{\text{comb}}$) is the heat of reaction for the complete burning (reacting with $O_2$) of one mole of a substance to form $CO_2$ and $H_2O$. Calorimetry experiments that measure the heat of combustion can be performed at constant volume using a device called a bomb calorimeter. In a bomb calorimeter a sample is burned in a constant-volume chamber in the presence of oxygen at high pressure. The heat that is released warms the water surrounding the chamber. By measuring the temperature increase of the water, it is possible to calculate the quantity of heat released during the combustion reaction. In this assignment you will calculate the heat of combustion of chicken fat. The calorimeter has already been calibrated by combusting benzoic acid.

1. Start Virtual ChemLab and select Heat of Combustion: Chicken Fat from the list of assignments. The lab will open in the Calorimetry laboratory with the bomb calorimeter out and disassembled and with a sample of chicken fat in the calorimeter cup on the balance. The balance has already been tared.

2. Click on the Lab Book to open it.

3. Record the mass of the chicken fat sample from the balance. If you cannot read it click on the Balance area to zoom in, record the mass in the data table below and return to the laboratory.

4. Double-click the following (in numerical order) to assemble the calorimeter: (1) the cup on the balance pan, (2) the bomb head, (3) the screw cap, and (4) the bomb. Click the calorimeter lid to close it. Combustion experiments can take a considerable length of time. Click the clock on the wall labeled Accelerate to accelerate the laboratory time.

5. Click the bomb control panel and the plot window to bring them to the front. Click on the Save button to save data to the lab book. Allow the graph to proceed for 20-30 seconds to establish a baseline temperature.

6. Click Ignite and observe the graph. When the temperature has leveled off (up to 5 minutes of laboratory time), click Stop. A blue data link will appear in the lab book. Click the blue data link to view the collected data. Record the temperature before and after ignition of the chicken fat sample in the data table.

<table>
<thead>
<tr>
<th>Data Table</th>
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</thead>
<tbody>
<tr>
<td>chicken fat</td>
</tr>
<tr>
<td>mass of sample (g)</td>
</tr>
<tr>
<td>initial temperature (°C)</td>
</tr>
<tr>
<td>final temperature (°C)</td>
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</tbody>
</table>

7. Calculate $\Delta T$ for the water using $\Delta T = |T_f - T_i|$.

8. Calculate the moles of chicken fat in the sample ($MW_{\text{fat}} = 797.7 \text{ g/mol}$).
9. \( \Delta H_{\text{comb}} \) for chicken fat can be calculated using \( \Delta H_{\text{comb}} = \left( C_{\text{system}} \Delta T \right)/n \), where \( n \) is the moles of chicken fat in the sample and \( C_{\text{system}} \) is the heat capacity of the calorimetric system.

Use 10.310 kJ/K for \( C_{\text{system}} \) and calculate the heat of combustion, in kJ/mol, for chicken fat.

10. If the accepted value for the heat of combustion for chicken fat is 30,038 kJ/mol calculate the percent error.

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\% \text{ Error} = \frac{|\text{your answer} - \text{accepted answer}|}{\text{accepted answer}} \times 100
\]

This experiment does not consider that all of the conditions are standard state conditions; therefore, you are calculating \( \Delta H_{\text{comb}} \) not \( \Delta H^\circ_{\text{comb}} \).

11. The “calorie” used to measure the caloric content of foods is actually a kilocalorie (kcal) or 4184 kJ.

If the heat of combustion for sugar is 5639 kJ/mol, why are people who are on limited calorie diets advised to limit their fat intake?

12. The food that we ingest is certainly not “combusted” in the same manner as is done in a bomb calorimeter.

Why can we compare the heats of combustion of sugar or chicken fat measured in a bomb calorimeter with the caloric content of those foods?