Calorimetry Lab Report

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Heat capacity of the system

Mass of wire = 0.0185 g

Mass of wire left = 0.0079 g

Mass of wire combusted = 0.0106 g

Mass of wire + pellet = 1.0126 g

Mass of pellet = 0.9941 g

$\Delta H_c(BA) = 0.9941g \ * \ -26435.8 \ J/g = -2.6279829 \times 10^4$ J

$\Delta U(wire)$ = 0.0106 g * -5858 J/g = -62.0948 J

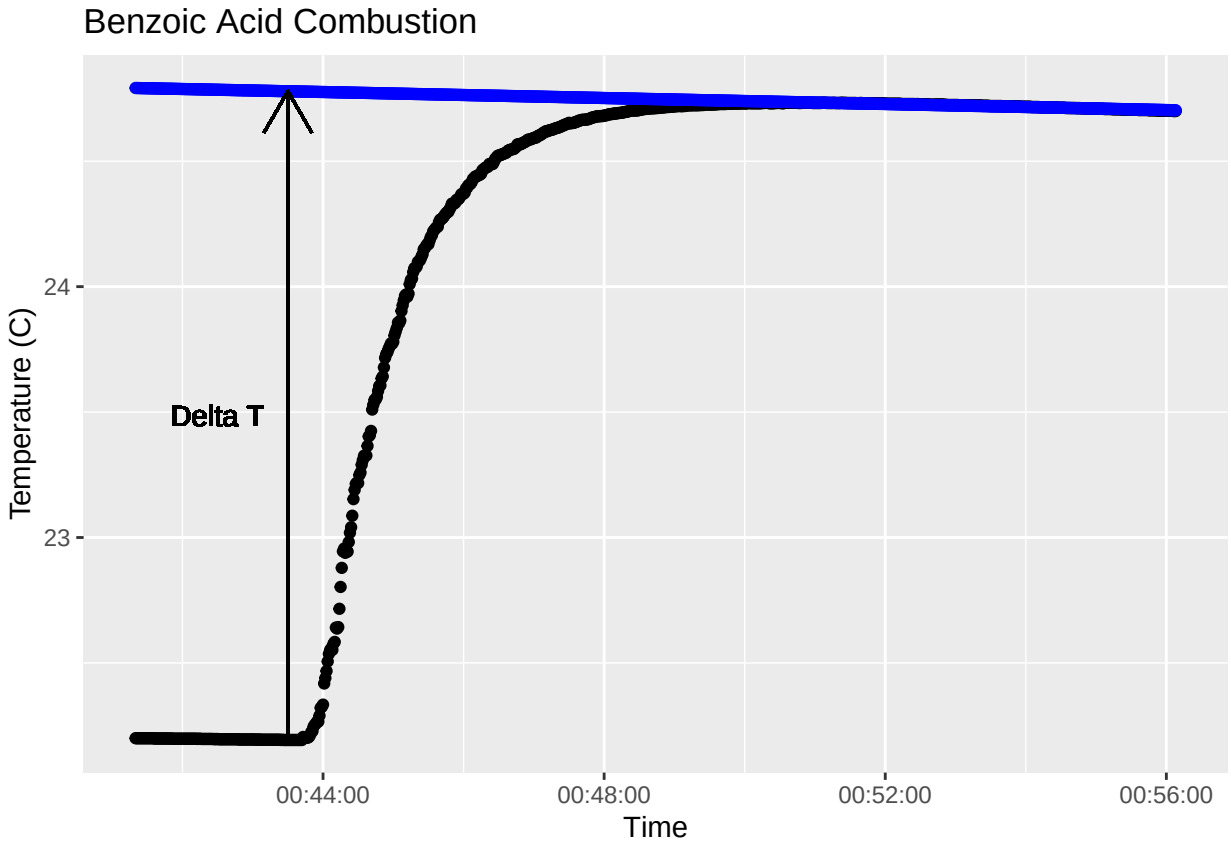
$C_6H_5COOH(s) + 7.5O_2(g) \rightarrow 7CO_2(g) + 3H_2O(g)$

Moles of benzoic acid = 0.0081484

Moles of net gas produced per mole of benzoic acid = 2.5

Δn = 2.5 * Moles of benzoic acid = 0.0203709

$\Delta U(BA) = \Delta H(BA) - RT\Delta \ n = -2.6330336 \times 10^4$ J



$$C_v = -\frac{\Delta H(BA) - RT\Delta n + \Delta U(Wire)}{\Delta T}$$

$\Delta T = 2.5858321$ K

$C_v = 1.0207 \times 10^4 \pm 8$ J/K

Naphthalene

Mass of wire = 0.0153 g

Mass of wire left = 0.0136 g

Mass of wire combusted = 0.0017 g

Mass of wire + pellet = 0.5748 g

Mass of pellet = 0.5595 g

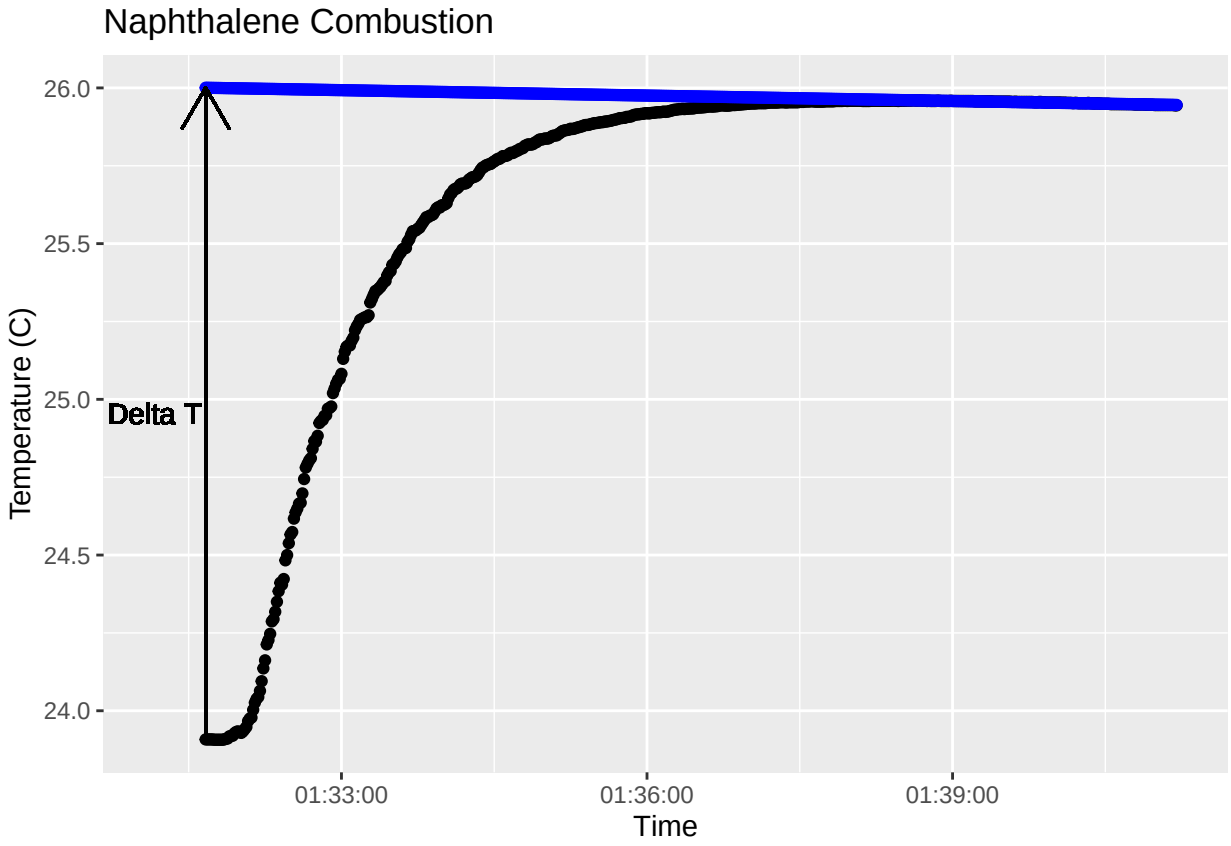
$\Delta U(wire)$ = 0.0017 g * -5858 J/g = -9.9586 J

$C_{10}H_8(s) + 12O_2(g) \rightarrow 10CO_2(g) + 4H_2O(g)$

Moles of naphthalene = 0.0081484

Moles of net gas produced per mole of naphthalene = 2

Δn = 2 * Moles of naphthalene = 0.0162967



$\Delta H(N) = -\Delta T C_v + RT\Delta n - \Delta U(wire)$

ΔT = 2.0925538 K

$\Delta H(N) = -2.1307396 \times 10^4$ J

$\Delta \tilde{H}(N) = \frac{\Delta H(N)}{moles\ naphthalene}$

$\Delta \tilde{H}(N)$ = -4881 ± 4 kJ/mol

Gummy Bear

Mass of wire = 0.0162 g

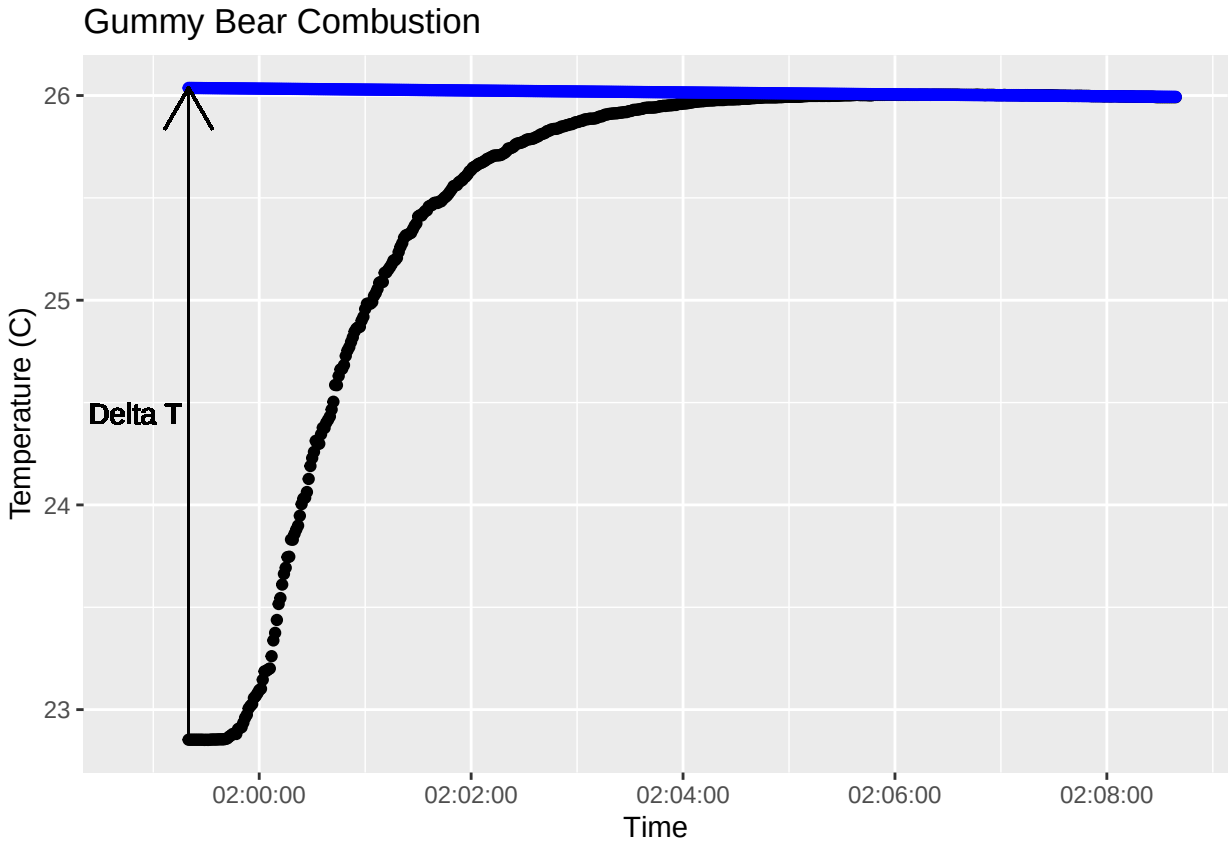
Mass of wire left = 0.008 g

Mass of wire combusted = 0.0082 g

Mass of wire + gummy bear = 2.2202 g

Mass of gummy bear = 2.204 g

$\Delta U(wire)$ = 0.0082 g * -5858 J/g = -48.0356 J



$\Delta U(bear) = -\Delta T C_v - \Delta U(wire)$

ΔT = 3.1840326 K

$\Delta U(bear)$ = -32.4 ± 0.030 kJ = -7.76 ± 0.01 kcal

Discussion

Our obtained value of -4881 kJ/mol for ΔH of naphthalene was close to the literature value of -5651 kJ/mol, but still off by -769.9 kJ/mol (13.6%). This is outside the uncertainty range ($\pm$ 4 kJ/mol) of our result. It may have been that some of the naphthalene flaked off of our pellet as we were loading it in, leading to a smaller total enthalpy but higher calculated amount of naphthalene. Alternatively, there was inadequate oxygenation of the combustion chamber, or inconsistent oxygenation between the two runs; or, inconsistent amounts of water in the bomb, leading to different heat capacities.

For the gummy bear, we measured a change in energy of -7.76 kcal. Our nutritional information gave us 140 kcal / 17 gummy bears = -8.24 kcal. This matches our result quite nicely, with a difference of 0.48 kcal (1.942%). Some of this difference may have been due to the energy lost in expanding the system, due to the conversion of solid to gas; since we do not know the formulas for combustion of the gummy bear, we could not account for this, and thus the value we obtained is expected to be lower than the true chemical energy contained in the gummy bear. We also do not know the method used to calculate the calories in the bear. It is possible the measurement on the bag is inexact (no uncertainty is reported) and thus our uncertainty ranges actually overlap nicely.