

CHM 110 EXPERIMENT 6
SAMPLE CALCULATIONS

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Let's say we test a reaction in an identical setup to experiment 6:



We pour 25.0 mL of 1.50 M A and 25.0 mL of 1.50 M B - both initially at a temperature of 25°C - into the calorimeter. We then record the temperature every 30 seconds for 4 minutes. The recorded temperatures are given below.

Time (sec)	Temp (°C)
30	41.3
60	41.2
90	41.1
120	41.0
150	40.9
180	40.8
210	40.7
240	40.6

To find the heat of reaction, we need to take advantage of the first law of thermodynamics:

$$Q_{\text{system}} + Q_{\text{water}} + Q_{\text{cup}} = 0$$

We can calculate both Q_{cup} and Q_{water} - and then use them to find the heat of reaction - Q_{system} .

$$Q_{\text{water}} = M_{\text{water}} \times S_{\text{water}} \times (t_f - t_i)$$

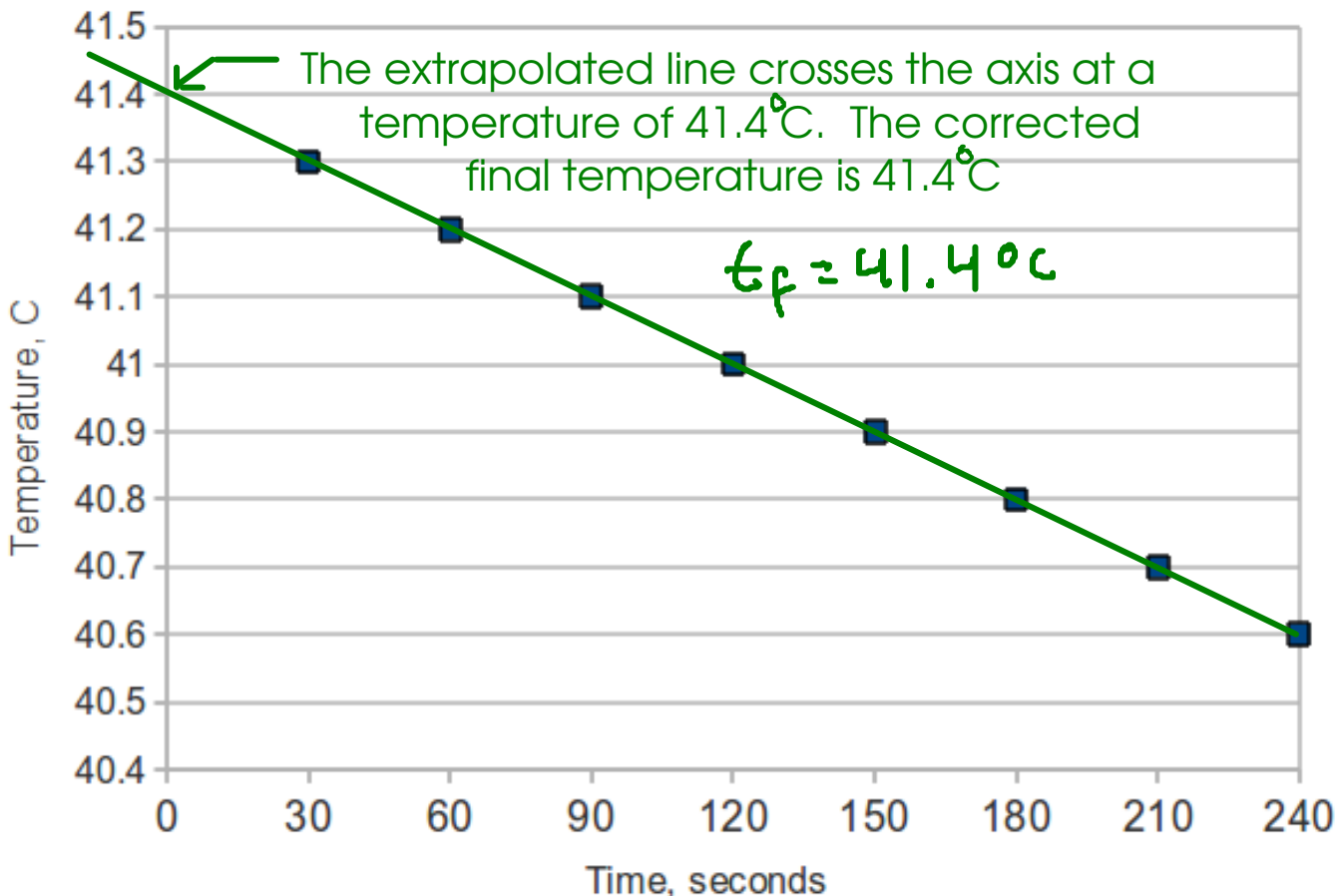
$$Q_{\text{cup}} = C_{\text{cup}} \times (t_f - t_i)$$

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To find the mass of water (M_{water}), assume the 1.50 M solutions you added are almost all water - with a density of 1.00 g/mL. The mass of water in the calorimeter, then, is $25.0 + 25.0 = 50$ grams.

The specific heat of water (S_{water}) and the heat capacity of the calorimeter (C_{cup}) are also known. t_i is the initial temperature of 25.0°C . That leaves the final temperature t_f ...

To determine the final temperature of the calorimeter corrected for heat loss to the environment, we plot the temperature inside the calorimeter versus time, then extrapolate back to time=0.



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Now we can calculate Q_{water} and Q_{cup}

$$Q_{\text{water}} = 50.0 \text{ g} \times 4.184 \text{ J/g}^\circ\text{C} \times (41.4^\circ\text{C} - 25.0^\circ\text{C})$$

$$= 3430.88 \text{ J}$$

$$Q_{\text{cup}} = 10.0 \text{ J/g}^\circ\text{C} \times (41.4^\circ\text{C} - 25.0^\circ\text{C})$$

$$= 164 \text{ J}$$

And finally, Q_{system} ...

$$Q_{\text{system}} + 3430.88 \text{ J} + 164 \text{ J} = 0$$

$$Q_{\text{system}} = -3594.88 \text{ J}$$

Since the Q_{system} above depends on the amount of material reacted, we'd rather report the final answer per mole of reactant. Since we added stoichiometric amounts of each reactant to the calorimeter, it doesn't matter which reactant we use for the calculation. Let's use A.

$$\text{mol A} = 25.0 \text{ mL} \times \frac{10^{-3} \text{ L}}{\text{mL}} \times 1.50 \frac{\text{mol A}}{\text{L}} = 0.0375 \text{ mol A}$$

$$\Delta H = \frac{Q_{\text{system}}}{\text{mol A}} = \frac{-3594.88 \text{ J}}{0.0375 \text{ mol A}} = -95900 \text{ J/mol A}$$

... or in kilojoules...

$$\Delta H = -95.9 \text{ kJ/mol A}$$