

The Calorimetry Detective

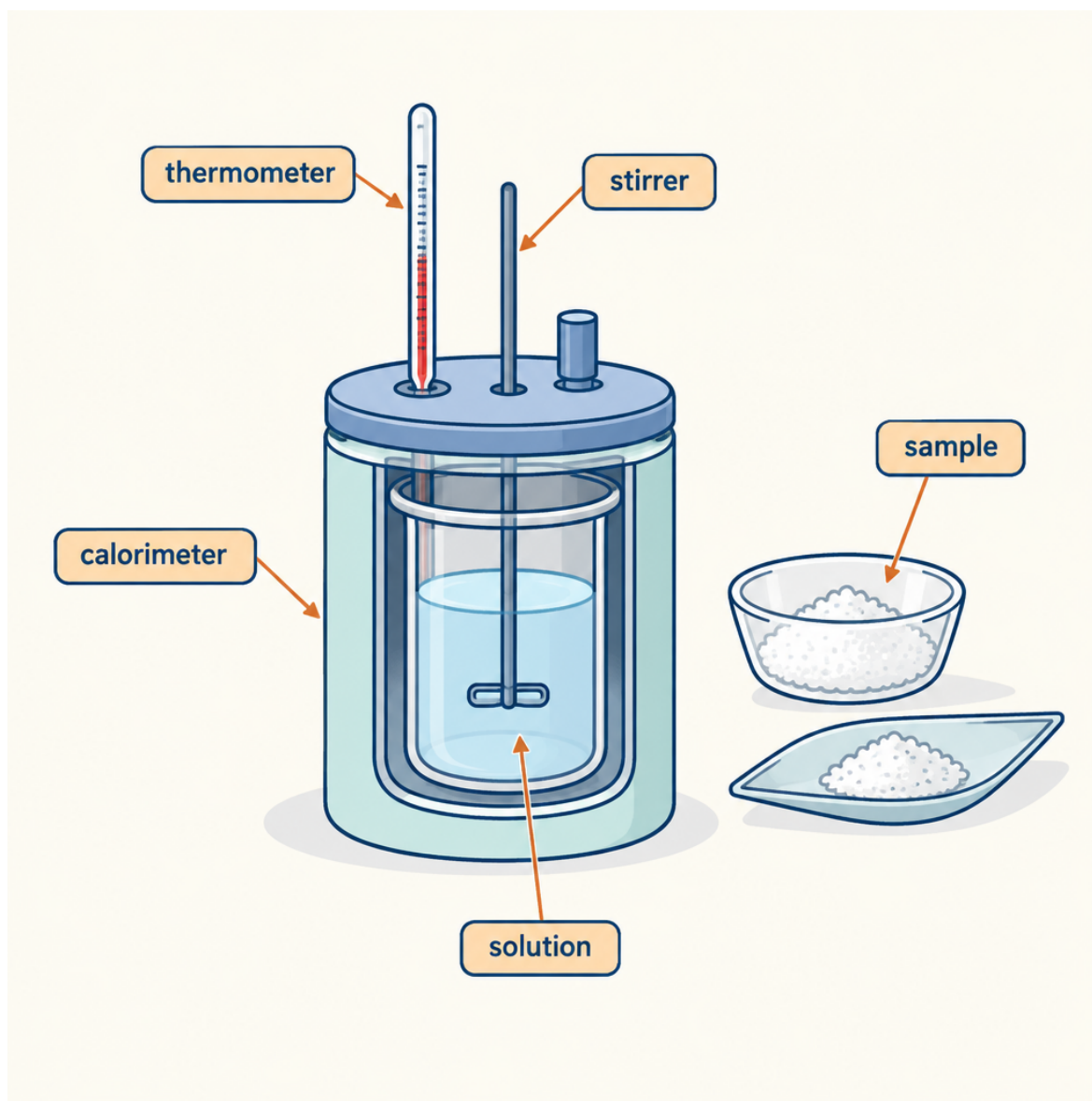


Figure 1: Clean labelled diagram in the style of a textbook figure illustrating Enthalpy changes and calorimetry: the equipment, materials and key

This puzzle challenges you to apply the heat transfer equation $Q = mc\Delta T$ and enthalpy data from a calorimetry experiment ([Outcome](#), [Outcome](#)). You will determine energy changes in chemical reactions by working backwards from thermal measurements ([Topic](#)).

The puzzle

A student burns a food sample in a calorimeter. The calorimeter contains 200 grams of water. Before the reaction, the water temperature is 22°C. After the reaction, the water temperature rises to 38°C.

The student then repeats the experiment with a different food sample of the same mass. This time the water temperature rises from 22°C to 45°C.

The specific heat capacity of water is 4.18 J/(g·°C).

Your task: Calculate the heat released by each food sample. Then determine which sample released more energy per gram of food burned, and by how much (in joules).

Hints

Hint 1: Use the equation $Q = mc\Delta T$ for each trial. Remember that ΔT is the change in temperature, not the final temperature.

Hint 2: The mass of water is the same in both trials. The specific heat capacity is the same. Only the temperature change differs between the two experiments.

Hint 3: Once you have calculated Q for each sample, compare the two values. The difference between them is the additional energy released by the second sample.

Answer key

First sample:

$m = 2.0 \text{ kg}$

$$Q = mc\Delta T = (2.0 \text{ kg})(4.18 \text{ J/g}^\circ\text{C})(10^\circ\text{C}) = 8360 \text{ J}$$

Second sample:

$m = 2.0 \text{ kg}$

$$Q = mc\Delta T = (2.0 \text{ kg})(4.18 \text{ J/g}^\circ\text{C})(20^\circ\text{C}) = 16720 \text{ J}$$

Difference:

$$16720 \text{ J} - 8360 \text{ J} = 8360 \text{ J}$$

The second food sample released 8360 joules more energy than the first sample.

Reasoning: Calorimetry measures the heat transferred from a chemical reaction to the surroundings (the water). The larger the temperature change in the water, the more heat was released by the reaction. By applying $Q = mc\Delta T$, calculating the heat released and comparing the results, you determine that the second food sample is a more energy-dense fuel ([Outcome](#), [Outcome](#)). This type of calculation is central to determining enthalpy changes from experimental data ([Outcome](#)).