Estimating energy transferred from food

Student activity • practical and reasoning

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The question

How much energy reaches the water per gram of food burned?

Measure actual temperatures and masses, then evaluate the limits of open-flame calorimetry.

Equipment

- Clamped metal calorimeter, 25 cm^3 measure and thermometer
- Heatproof mat, supported food holder, balance and selected dry food
- Eye protection and supervised ignition source

Wear eye protection; tie back hair and secure loose clothing. Check ingredient allergies, avoid nuts and do not eat laboratory food. Keep flames away from combustibles, ventilate the room, avoid smoke exposure and let metal cool before touching or weighing. Staff supervise ignition and select samples that do not drip burning material.

Course coverage: Biology only: 2.33B. Energy content of food.

Plan, model or apparatus sketch

Draw and label the apparatus or biological model; identify one limitation.

Method and reasoning

Read the whole sequence before starting

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1. Wear eye protection and use the staff-approved clamped calorimeter over a heatproof mat. Measure 25 cm^3 water and record its initial temperature.

2. Weigh the cool food holder with a small selected sample. Record the combined mass and the fixed gap below the calorimeter.

3. Under supervision ignite the sample, remove the ignition source and position the burning food below the water container. Do not leave another flame heating the water.

4. When burning ends, stir carefully and record the highest water temperature. Let the holder and residue cool fully before reweighing.

5. Use fresh water and a cooled setup for repeats. Keep the container, water volume and gap constant; compare class repeats for two foods.

6. Calculate $q = m \times 4.2 \times \Delta T$ in joules, using water mass m in grams and temperature rise ΔT in °C. Divide q by food mass lost, then by 1000 for kJ g^{-1}. Explain why this is energy captured by water rather than the full food energy.

Cleanup

- Allow all equipment and residues to cool before disposal or washing.
- Staff isolate ignition sources; clear cooled solid residues and wash hands.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Use measured masses and temperatures. Practice only: 25 g water warming by 12 °C gains 1260 J. If 0.40 g food is lost, the captured energy is 3.15 kJ g^{-1}. Heat loss and incomplete combustion usually give low estimates; food label energy is not an expected experimental answer.

Run / food	Mass lost / g	Initial / °C	Final / °C
A1			
A2			
A3			
B1			
B2			
B3			

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Which mass belongs in q = mcΔT?

2. Why weigh the cooled residue?

3. Calculate q for the example.

4. Calculate captured energy per gram.

5. Why keep the ignition flame away from the calorimeter?

6. Give two important limitations.