

Option D – Practical 1

Determining the energy content of food by combustion

Safety

- Care must be taken to use foods to which no student present is allergic. Do not eat any food in the laboratory.
- Wear eye protection and laboratory aprons. Long hair should be tied back.
- If hot apparatus or open flames come in contact with skin, rinse under cold running water for 5 minutes.

Apparatus and materials

- peanuts (if no students have allergies), croutons, samples of other suitable foods
- temperature probe and interface to computer, or thermometer and stopwatch
- small can or boiling tube that will hold 50 cm³ water
- stirrer
- suitable holder for food sample (e.g. a mounted needle)
- retort stand
- matches and wooden splints
- access to weighing scales

Introduction

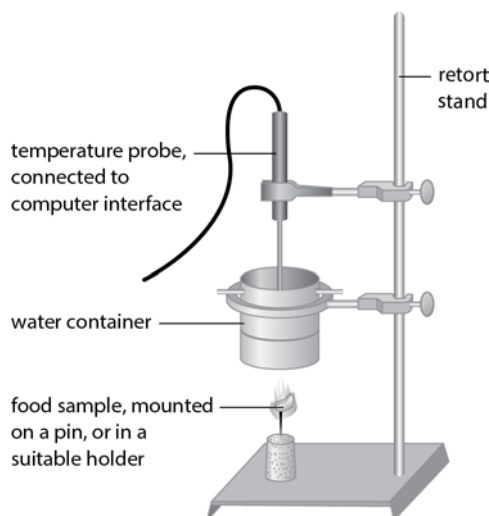
Food provides energy for life processes but the amount of energy in different foods varies. Energy content cannot be measured directly so, in this experiment, it is converted to heat by burning and the heat energy is used to raise the temperature of a known volume of water. This procedure is known as calorimetry. The amount of heat produced by the burning food can be calculated using the formula:

$$\begin{aligned} \text{heat from burned food (J)} &= \text{heat gained by water (J)} \\ &= \text{specific heat capacity of water (J/g } ^\circ\text{C)} \times \text{mass of water (g)} \times \text{change in temperature (} ^\circ\text{C)} \end{aligned}$$

We need to know the specific heat capacity of water, the mass of water used and the change in temperature of the water. The mass of food used will enable us to calculate the energy per gram in the food.

Procedure

- 1 Weigh the empty water container and record its mass. Add 50 cm³ cold water to the container and reweigh. Calculate and record the mass of water in the container.
- 2 Fix the container in a clamp stand as shown in the diagram. There should be approximately 2 cm between the bottom of the container and the location of the food sample to be burned.



- 3 Weigh the peanut (or other selected food) and record its mass.
- 4 Set up the temperature probe and connect it to the recording interface and computer. Suspend the temperature probe in the water. Alternatively, position the thermometer in the water.
- 5 Stir the water and allow the temperature to settle before proceeding.
- 6 Use a burning wooden splint to set fire to the peanut (or other food) and place it directly under the container of water.
- 7 Stir the water and take recordings for about 10 minutes (or other suitable time) until the temperature stops rising. Note the change in temperature of the water that results from the burning food.
- 8 When the burned food has cooled record the final mass that remains.

Questions and further work

- 1 Calculate the heat energy absorbed by the water using the formula. (Specific heat capacity of water = 4.18 J/g °C.) Convert your answer to kJ.

$$\text{heat gained (J)} = \text{specific heat capacity of water (J/g °C)} \times \text{mass of water (g)} \times \text{change in temperature (°C)}$$

- 2 Calculate the mass of peanut (or other food) burned.

- 3 Calculate the energy content of the peanut in kJ/g.

- 4 The published energy content for peanuts is approximately 25 kJ/g. Your answer may not be close to this due to inaccuracies in the procedure you have used. Not all the energy from the burning process is transferred to the water. List some of the factors that affect energy transfer, and suggest heat losses that would cause the experiment to be less than 100% efficient.