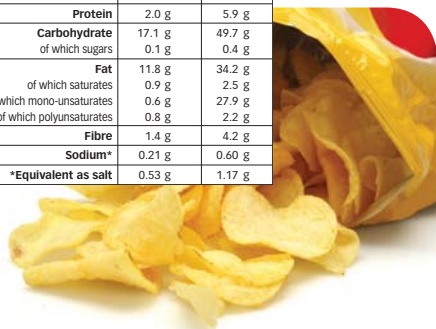


Learning objectives

After studying this topic, you should be able to:

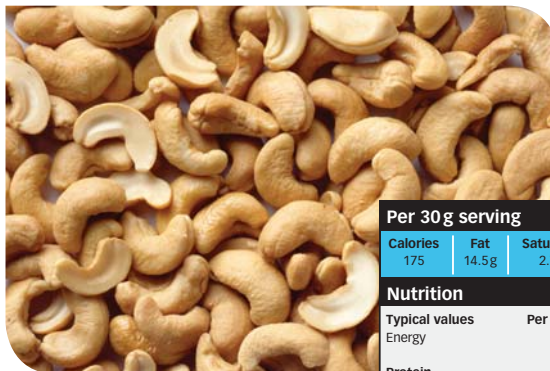
- ✓ describe how to measure the energy transferred when foods and fuels burn

TYPICAL NUTRITIONAL VALUES		
	Per 34.5 g pack	Per 100 g
Energy	761 kJ 163 kcal	2207 kJ 529 kcal
Protein	2.0 g	5.9 g
Carbohydrate of which sugars	17.1 g 0.1 g	49.7 g 0.4 g
Fat of which saturates of which mono-unsaturates of which polyunsaturates	11.8 g 0.9 g 0.6 g 0.8 g	34.2 g 2.5 g 27.9 g 2.2 g
Fibre	1.4 g	4.2 g
Sodium*	0.21 g	0.60 g
*Equivalent as salt	0.53 g	1.17 g



Behind the label

Which do you prefer – crisps or cashew nuts? Which provide more energy?



Per 30 g serving					
Calories	Fat	Saturates	Salt	Sugars	
175	14.5 g	2.7 g	0.0 g	1.7 g	
Nutrition					
Typical values	Per 30 g serving	Per 100 g			
Energy	725 kJ	2410 kJ			
	175 kcal	585 kcal			
Protein	5.7 g	19.0 g			
Carbohydrate	5.3 g	17.8 g			
of which sugars	1.7 g	5.8 g			
Fat	14.5 g	48.2 g			
of which saturates	2.7 g	8.9 g			
Fibre	2.7 g	8.9 g			
Sodium	0.0 g	trace			

Food labels tell us how much energy foods provide. Eating 100 g of cashew nuts provides 2410 kJ of energy, and 100 g of crisps provides 2207 kJ.

Of course, energy values are not the full story. Cashew nuts and crisps provide similar amounts of energy, but the nuts are more nutritious.

How do food companies know what numbers to write on the labels? Today, they use data tables to work out the energy values of processed foods. Before these data were available, scientists compared food energy values by using burning foods to heat water. The energy transferred on burning is similar to that available to the person eating the food.

Measuring food energy

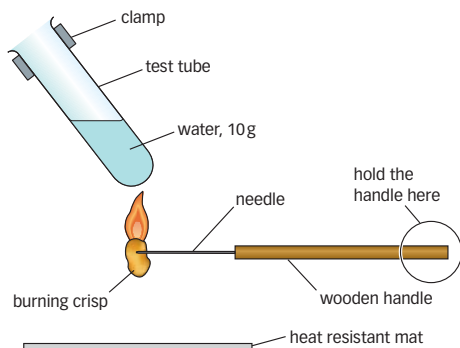
Freya pours 100 g of water into a metal container. She measures its temperature. She heats the water with a burning crisp. She measures the temperature again.

Here is a summary of Freya's results.

Mass of crisp (g)	1
Increase in water temperature (°C)	40

A A joule is the unit of energy. Give the number of joules in one kilojoule, 1 kJ.

B Which stores more energy – 100 g of crisps or 100 g of cashews?



▲ Measuring the energy in food

Freya uses an equation to calculate the heat energy, Q , transferred to the water:

$$Q = mc\Delta T$$

- m is the mass of water, in grams.
- c is the **specific heat capacity** of the water. It is the energy needed to make 1 g of water 1°C hotter. Its value is 4.2 J/g°C.
- ΔT is the temperature change of the water, in °C.

So for Freya's experiment, the heat, Q , transferred to 100 g of water by 1 g of crisps:

$$\begin{aligned} &= 100 \text{ g} \times 4.2 \text{ J/g}^\circ\text{C} \times 40^\circ\text{C} \\ &= 16800 \text{ J} \\ &= 16.8 \text{ kJ} \end{aligned}$$

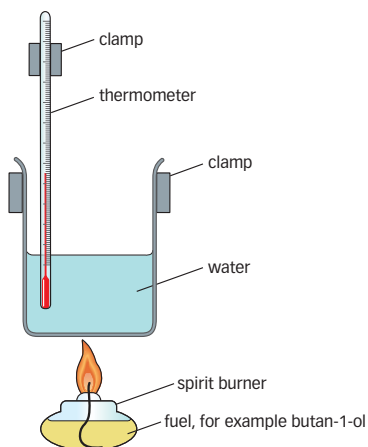
This gives a value of -1680 kJ for burning 100 g of crisps. The negative sign shows that the burning reaction is exothermic. It transfers energy to the surroundings. In other words, it gives out energy.

Freya's value is different from that on the crisp packet. There are two reasons for this:

- Not all the heat from the burning crisp was transferred to the water – some was transferred to the surroundings and the apparatus.
- Some of the energy in crisps – that in the fibre – cannot be absorbed by the body. This energy is not included in the energy value on the crisp packet.

Comparing fuels

You can use a similar experiment to compare the heat produced by burning fuels. The diagram shows how.



◀ Measuring the energy in a fuel

Key words

joule, kilojoule, specific heat capacity

Did you know...?

100 g of crisps provides 10 times more energy than an apple of the same mass, but the apple is much richer in vitamins and minerals.

Exam tip

AQA

- ✓ Take care with units, and note whether energy values are given in joules (J) or kilojoules (kJ). You may even be given energy data in calories.

Questions

1 Give the symbol for the scientific unit of energy. **S**

2 Eva burns 1 g of butan-1-ol fuel in the apparatus shown. It makes 100 g of water 55°C hotter. Calculate the amount of heat energy transferred to the water from the butan-1-ol. The specific heat capacity of water is 4.2 J/g°C. **M**

3 Eva checks her result in a data book. This states that burning 1 g of butan-1-ol releases 36 122 J of heat energy. Suggest why Eva's value is different from that in the data book. **H**