Activity 8: Energy transfer. How far does chocolate get you?

Learning intentions

For Year 9-10 students: Students will learn that for energy to do work it needs to transform from one form to another and this is what we can measure and use to predict the behaviour of a system. Students will use their understanding of force and work to use the potential energy in a chocolate bar to calculate the work that can be done by eating that chocolate bar – it is a lot.

Materials

- Imagination – and possibly the desire to test some of the math out in real life such as eating a chocolate bar and testing the accuracy of their calculations.

Teacher Notes	Teaching Notes: Running the activity
Forms of energy The two main forms of energy are potential and kinetic and each have different types. Others energy forms include light, sound and thermal energy. See Activity 4 for an exploration of kinetic energy. For an in-depth- look at light, See FLEET Schools teacher resource, Light: reflection, refraction, diffraction Question 4. How much work in a chocolate bar? Worked example. We will use our 100g serve of dairy milk chocolate with 2250 Kilojoules (2.25×10^6 joules). Remember 1 joule = 1 Newton metre (NM) of work We know Work (W) is 2,250,000 joules and the force (F) is 400N Therefore d = 2,250,000/400 = 5625 metres (or 5.625 kilometres – a long way) But we know that all the energy from the chocolate is not being used to apply the force to the box and move it. Remember that the human body is only about 25% efficient at transferring stored energy from the chocolate (or any food) into work useful	**Method** Question 1. Activity (Year 9-10) The human body is inefficient at converting the energy in food into work. For example, if we use 100 joules of energy to swing an axe to chop firewood, only about 25% of that energy (25 joules) will be used by the muscles (kinetic energy) to do the work of chopping wood. The other 75% (75 joules) is transformed to heat energy, which in the context of the work we want to do is wasted energy because it is not being used by the body's muscles to do work of chopping wood. Let's apply this to eating a chocolate bar and calculate how much work we can do with the energy in the chocolate. Select your favourite chocolate or museli bar and find out how many kilojoules it contains (a Internet search will find the company and product with the nutrition information). For example, a 100g serve of dairy milk chocolate has 2250 Kilojoules (or 2,250,000 joules – or 2.25×10^6 joules).

to us, in this case making our muscles push the box. Therefore, only 562,500 joules will be used to actually push the box. The rest will be lost as heat. This means you only need to push that box 1,406 metres.

5625/4 = 1406 metres (still a long way)

The apple versus the lump of energy dense chocolate.
A 100 grams of apple contain about 230 kilojoules (or 230,000 Joules).

Distance = 230,000/400
= 575 metres

575 metres /4 = 143.75 metres
(Barely raise a sweat)

Discussion point
Another way of thinking about work and energy is that work is equal to the amount of energy transferred between objects (e.g., between you and your box of toys/sport gear, which moved from your floor to under your bed). This can be expressed as W(work) = ΔE, where ΔE is the change in or amount of energy transferred.

Task: Work out how far you need to push the box of toys/sport gear from Activity 2 to burn off the energy (kilojoules) in your selected chocolate bar.

To determine the distance we need to push the box, we use the equation, $W = F \times d$
And therefore, to know the distance we need to push the box: $d = W/F$

We all have different bodies that burn energy (joules) at different rates, and the amount of Force (N) that a person can apply will also differ, but let us assume we all burn energy at the same rate and a student will apply 400 Newtons of force to get the box moving. (We added more weight to this box so it requires a lot more force to move it.)

What about the healthier alternative, an apple, which contain about 230 kilojoules for 100 grams of apple? Work out how far you need to push the box to burn off the energy in an apple.

For a bit of fun
Roughly how far do you have to jog to burn off the energy in one jelly baby?
A. 3 metres B. 30 metres C. 300 metres

Check out the answer to this National Science Quiz question that FLEET was a partner in producing.

Background: Jelly babies, those small, chewy lollies in the shape of a baby, seem to have been accidentally invented in England in 1864, when the inventor was

	trying to make bear-shaped lollies. Instead of bears, he got lollies that looked like babies. Originally, they were sold under the gruesome name "Unclaimed babies", but that name apparently didn't last long and they were called "jelly babies" soon afterwards. They were the favourite lolly of George Harrison (The Beatles) and Dr. Who. **Discussion point:** Discuss what you have noticed or learned about the relationship between work and energy.