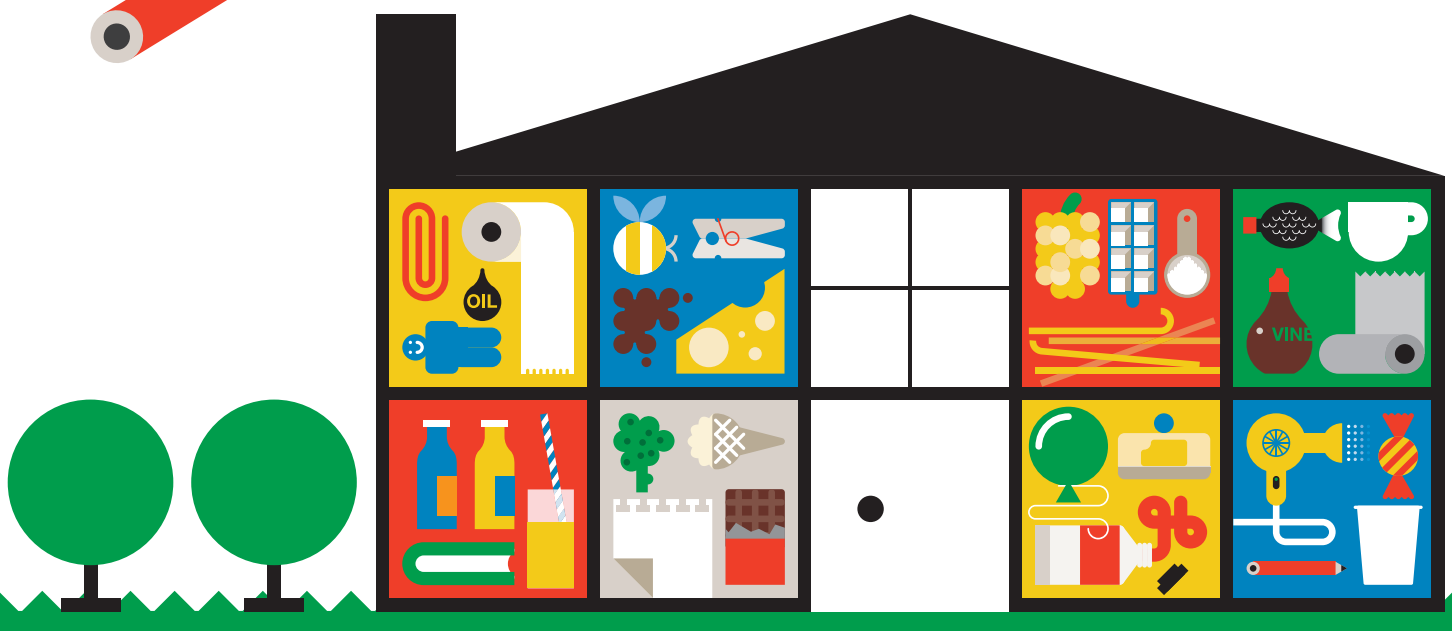
Balancing sculptures

The activity

Make a balancing toy.

ExpeRiment with the design of your toy to find out what affects whether or not it balances.

Learn about the centre of mass of an object and how it relates to whether or not something balances.



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What you'll need

- A carrot or similar vegetable
- Kebab skewers
- Marshmallows and/or other jelly type sweets, or small pieces of carrot or similar hard vegetables.
- Plasticine or blu-tac
- 500ml soft drink bottle or washing up liquid bottle

What to do

Being safe:

Take care using the kebab skewers, particularly when inserting them into hard vegetables. Avoid poking them into hands and make sure you always keep them away from eyes.

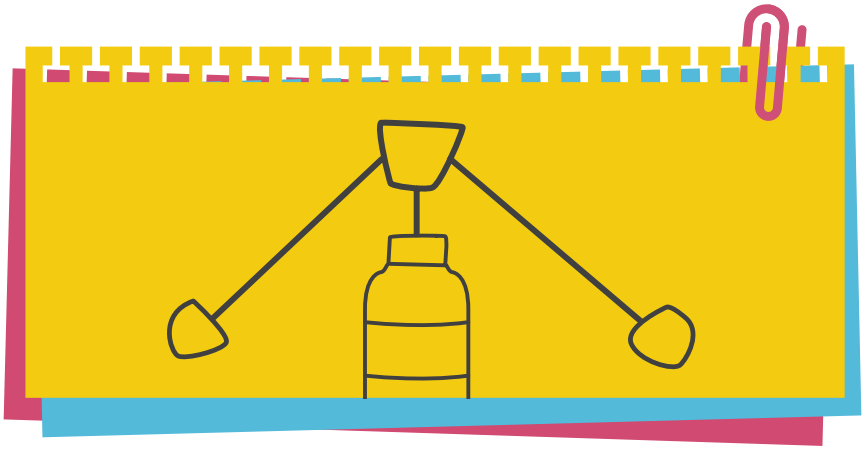
Stage 1: Cut a piece of carrot about 3 cm long. Stick a kebab skewer into one end of the piece of carrot and break the skewer so that you have only 2 or 3 cm of it sticking out. Try to stand the carrot piece up on the end of the kebab skewer – you should find this very difficult, if not impossible to do.

Stage 2: Stick a kebab skewer into each side of the carrot so that they point downwards at about 45 degrees. Then stick a marshmallow or other jelly sweet onto the ends of the skewers, as shown in the picture below.

Place this on top of a bottle and you should find that it balances.

Get children to investigate what happens when you slide the marshmallows up and down the 'arms' of the sculpture and if you add more marshmallows.

Stick an additional two or more kebab skewers into the carrot and challenge children to add at least one item to each skewer and still keep the sculpture balanced.



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Questions to ask children

With just central part of the sculpture: why doesn't this stay balanced?

Before showing them stage 2: do you think we can use more kebab skewers and anything else to help it balance?

Why do you think it balances like this?

What can we change? (position of skewers, items pushed onto the skewers, position of things on skewers)

What do you think will happen if we change these things?

What do you think we need to do to make sure our sculpture balances?

The science

To understand how these sculptures balance, it's helpful to know about something called the "centre of mass" of an object.

When you try to balance something on your finger, you find that there's a particular point below which it will balance. This point is sometimes called the centre of mass or centre of gravity of an object. You can think of it as the point around which the mass or weight of an object is evenly distributed.

In the case of something like a pencil, the centre of mass is roughly in the centre of the object, but with something like a hammer, which is heavier at one end, the centre of mass is closer to the heavier end.

If you try to balance an object and the centre of mass is not in the same vertical line as the point at which the object is pivoted, it will start to turn. If the centre of mass is higher than the pivot this turning will make the object fall over, but if it's below the pivot then it will bring the centre of mass closer to that vertical line. An object will be balanced if its centre of mass remains in the same vertical line as the point at which it is pivoted.

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The science

It might seem strange, but the centre of mass doesn't have to be part of the object itself – for example, for something like a roll of masking tape or a doughnut, the centre of mass is in the middle of the hole.

It's quite hard to balance a roll of masking tape on top of your finger because it has a tendency to roll to one side or the other – it's hard to keep the centre of mass directly above your finger. But if you put your finger inside the roll, as Gail does in the video, the roll will remain stable as long as the centre of mass is below your finger. If you push the roll of tape to the side, the masking tape always rolls in such a way that the centre of mass ends up below the pivot point. In other words, it always returns to its stationary position. This is the secret to building a successful balancing toy – it needs to be made in such a way that its centre of mass is below the point at which it is supported.

You can change the centre of mass of a balancing sculpture by adjusting the position of the various bits and pieces you use to make it. The heaviest parts of the sculpture need to be located below the pivot point and you can slide objects along the length of kebab sticks until the turning effect they have on the sculpture is balanced out.

Going Further

Learn more about the centre of mass and stability: http://bit.ly/StabilitySci

Learn more about the turning effect of forces: http://bit.ly/TurningSci

Try making some animal-shaped balancing toys: http://bit.ly/AniBalance

Make a balancing butterfly: http://bit.ly/BalanceButterfly

Watch this short video of an amazing demonstration of balancing: http://bit.ly/BalanceVid