Teacher notes for the Three-Sided Coin Experiment

Equipment

To take part in this experiment you will need a set of coins. You could:

- Create your own out of household materials - for example sticking several normal coins together, or using chopped up cylindrical dowel or broom handle.
- 3D print your own, using the downloadable models here: bit.ly/3Dcoinfiles
- Buy a set of 3D printed coins. You can buy a set of coins with your one favourite ratio here: bit.ly/3Dcoinshop
  Or you can buy a set with various ratios here: bit.ly/3Dcoinset
- Borrow the set of coins used by Hugh in the video! If you'd like to be put on our list of potential recipients of Hugh's three-sided coins, please fill in the form here: bit.ly/coinrequest. We can't guarantee that everyone who completes this form will be sent the coins - we'll email within two weeks to let you know whether you'll be sent coins or not.

Your students will also need a cup each to shake their coins in - disposable plastic party cups will do.

Method & Results

The student results sheet outlines the method they should use. It's important that everyone doing the experiment throws them in the same way – shaking the coins in a cup and letting them fall on to a hard surface, as Hugh and Matt did in the video. The students can any number of coins in the cup in each throw, as long as the coins are free to move.

The marks on the two faces of the students' coins do not need to be H and T – Matt and Hugh used O and X. You should take care to make sure marking the faces doesn't bias the coin – adding a sticker, or etching the face, may change the weight distribution. You may also wish for the students to put their result straight into a spreadsheet rather than the table, but we've provided a results table for them to use if they're working on paper.

Please give us your class data by filling in this form: bit.ly/coinsubmit so we can include it in our experiment! The more data we have the better. On this form we will request a photo of your coins – so please take one. There is also the opportunity to share with us a short video clip (less than 30 seconds) or photos of your class conducting the experiment, if you wish.

You may wish to statistically evaluate your own results in addition to this. In order to officially conclude from your results whether the probability that your coin lands on its side is one third, you can use hypothesis testing. Jen Rogers from the video has created a guide to doing this, which is on the download page.

Alternatively, Jen has also put together for us a quick reference table so that you conclude if the probability of your coin landing on its edge is one third.

For particular values of n (total number of coin throws) this table shows you the range of edge-landing throws that you could expect to see if the probability is one third. If your number of throws is outside of this range you cannot statistically conclude that the probability for your coin is one third.

Number of rolls	Number of edges
100	25-42
500	147-187
1000	305-362
5000	1602-1732

You may also find it helps to have a look at the download of Matt's spreadsheets with the results from his and Hugh's experiment.

The additional worksheets

The worksheets 'Method 1: the coin & the sphere' and 'Method 2: the coin & the circle' lead the students through the methods that Hugh and Matt used for theoretically calculating the correct ratio. To check your students' answers to these worksheets, we've included as a download some screengrabs of Hugh's working out from the video. Please note Matt and Hugh have called diameter of the coin D, and we have called it h (for height of coin). This is so it doesn't get confused with the diameter of the sphere/circle.

It's worth noting that neither of these methods yielded a ratio that was supported by Hugh and Matt's experimental evidence - so we think these methods are both incorrect!

Some extension questions for your students:

Can your students come up with an alternative calculation? Does the ratio they get match their experimental results?

Can students deduce for themselves the formula **2πrt** that has been given to them for the surface area of the middle band in 'Method 1: The coin & the sphere'.