

# Introduction to Probability

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## Before You Watch

This topic provides a brief introduction to probability and one of the common methods used to solve probability problems. You don't need any previous knowledge in probability, but you do need to be familiar with the 4-step problem-solving method. So if you haven't already watched [Introduction to Problem-Solving](#), do that first. Also, because it will help to be comfortable with some of the fundamental ideas from algebra, it's a good idea to watch [Introduction to Algebra](#) to refresh your memory, then come back.

## The Video Content

This video introduces the concept of probability and how to calculate the probability of a particular outcome.

Here's a simple example: let's calculate the probability of flipping 2 heads in 2 tosses of a coin.

### Step 1 Understand the question

What do we mean by the probability of 2 heads?

Let's say that we have a certain number of possible outcomes, or results. For example, rolling a die has 6 possible outcomes, 1 through to 6. And let's say they are all equally likely. This is because when rolling a die, each possible result is just as likely as any other.

Usually we are only interested in some of the possible outcomes: for instance, to roll a 6 or, in our example question, to flip 2 heads.

Then the probability ( $p$ ) of the outcome we want is equal to:

$$p = \frac{\text{number of desirable outcomes}}{\text{total number of possible outcomes}}$$

We need to determine:

- how many ways there are of flipping 2 heads and
- how many possible outcomes in total there are.

### Step 2 Develop a plan

In probability, it is often helpful to visualise the situation. Here we will use a visualisation technique known as a probability tree to do this. That's the plan.

### Step 3 Carry out the plan

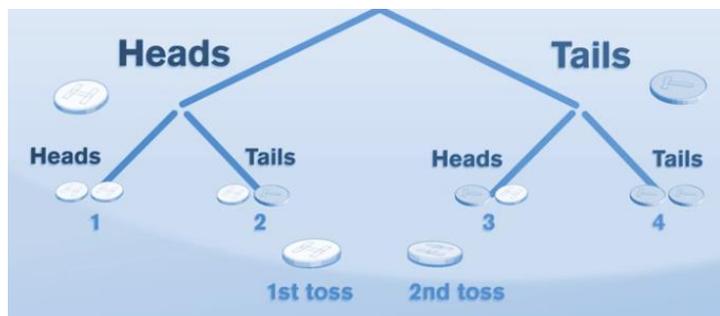
A probability tree starts at a single point, and for each event, it branches out into a number of equally likely possible outcomes. In this case, we can consider the coins being flipped separately, because flipping one coin has no effect on the other coin.

When we flip the first coin, there are 2 equally likely options: heads and tails. Therefore our tree goes into 2 branches, 1 for heads and 1 for tails.



(It is possible to create a probability tree where the branches are not of equal likelihood; however, in this example we have chosen a tree where all branches are equally likely.)

Now we flip the second coin. It also has 2 equally likely outcomes, so each of our 2 branches now branches into 2 more. We have 4 total branches.



Now we can see that there are a total of 4 possible outcomes. Each outcome is equally likely, and only one of the branches has two heads.

Therefore, our probability is equal to the number of desirable outcomes, which is 1, over the total number of outcomes, which is 4:

$$p = 1 / 4$$

So our answer is one quarter, or 25%.

#### **Step 4 Reality check**

It can be difficult to know if a probability answer is correct or not, but we can catch obvious mistakes.

If the answer is bigger than one, or 100%, or if the sum of different probabilities is bigger than one, or 100%, then something went wrong.

For example, the probability of 2 heads plus the probability of 2 tails must be less than 100%.

Since we know that the chance of getting 2 tails has to be the same as 2 heads, then the probability of 2 heads must be less than 50%. We know this because there are also other outcomes for the 2 coin tosses to consider, namely a head and a tail.

Similarly, if the answer is negative, we know that it's wrong. Taking all those things into consideration, 25% seems a reasonable answer.

If we wanted to expand our reality check, we could consider other things:

- If an event has no chance of occurring it has a probability of 0.
- If an event will definitely occur then it has a probability 1 (or 100%).

This tells us we must check that the answer is in the range of 0 to 1 (0 to 100%) – if it isn't, we've made an error.

We also know that including additional criteria will reduce (or at least cannot increase) the probability.

For instance, if the probability of 1 head appearing on a single coin toss is 0.5, and we add the criterion of considering a second coin toss and also getting a head, then the probability of 2 heads will be *less than or equal to 0.5* – it cannot be greater than 0.5.

## A Practice Question

What is the probability of rolling a 7 when rolling 2 standard 6-sided dice?

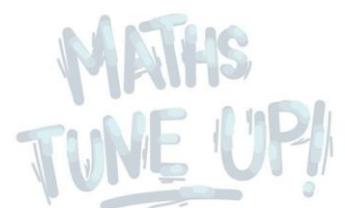
Answer

$$6 / 36 = 1 / 6 = 16.67\%$$

Take a look at the working out for the answer [here](#).

## Now What?

Now that you're familiar with the fundamental concepts of probability, take a look at **Introduction to Statistics**. You will see that statistics builds on some of the concepts of probability. Alternatively, you could continue to develop your skills within probability by looking at some of the Other Links and exploring harder problems in probability.



## *But When Am I Going To Use This?*

Probability is widely used in situations where there are a number of unpredictable events. The most obvious example is that of gambling; casinos and poker machine operators study the probability of people winning and then adjust the returns for those winnings such that they have an extremely high probability of making money. Probability is also used in insurance to determine the premiums that must be set in order for the insurance company to make money.

Another application of probability is in quantum physics. At the very small scale, movements of particles becomes unpredictable; we therefore must use probability to determine the likelihood of a particular event happening, such as, for instance, the probability that an atom will split and trigger the atomic bomb.

## *Other Links*

**Maths is Fun** provides a summary of the fundamental concepts in probability and explains the meanings of common terms. It also offers a selection of questions to practise on, and explores more complex probability problems.

- <https://www.mathsisfun.com/data/probability.html>

**Online Math Learning** features a series of lessons and videos covering a wide range of concepts in probability. The link below gives you access to a number of sections. The best place to start is “Samples in Probability”.

- <http://www.onlinemathlearning.com/math-probability.html>

The **Khan Academy** has a comprehensive set of video tutorials covering a large range of mathematical and other concepts, as well as questions to test your knowledge. This link takes you to a large chapter dedicated to calculating probability.

- [https://www.khanacademy.org/math/precalculus/prob\\_comb](https://www.khanacademy.org/math/precalculus/prob_comb)

**Patrick JMT** (Just Maths Tutorials) has many video tutorials covering lots of mathematical concepts. This content investigates simple probability. The site also has numerous videos covering more complex probability concepts.

- <http://patrickjmt.com/calculating-the-probability-of-simple-events/>

