

# Investigation

## Buffon's Needle Experiment



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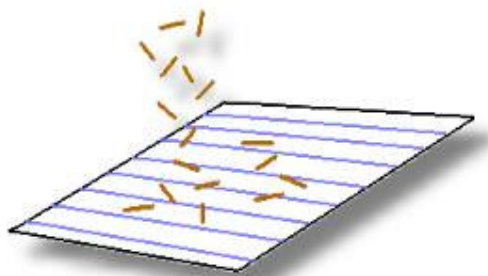
**Born:** 7 Sept 1707 in Montbard, Côte d'Or, France

**Died:** 16 April 1788 in Paris, France

He is remembered most in mathematics for a probability experiment which he carried out calculating  $\pi$  by throwing sticks over his shoulder onto a tiled floor and counting the number of times the sticks fell across the lines between the tiles. This experiment caused much discussion among mathematicians which helped towards an understanding of probability.

The value of  $\pi$  is approximately  $\pi = 3.14159\dots$ ; the number of decimal places is infinite, and there is no repeating pattern.

One way to calculate for yourself the value of  $\pi$  is to drop a lot of toothpicks onto a large piece of paper that has lines drawn on it!



**Here's how it works. You'll need several toothpicks.**

1. Measure the length of the toothpicks.
2. Get a large piece paper (A3 or larger), and draw parallel lines on it, from one side to the other. The lines should be separated by a distance just slightly larger than the length of a toothpick. For example, if the length of the toothpicks is 65 mm, the lines could be separated 70 mm.
3. From a height of about one metre, drop the toothpicks onto the paper, so that they all fall randomly somewhere on the paper.
4. Count how many toothpicks are touching a line (or would be, if they weren't resting on another toothpick).

When you're done, write the value for each of the following quantities:

**c** = toothpick length (in mm): \_\_\_\_\_

**a** = line separation (in mm): \_\_\_\_\_

**N** = total number of toothpicks dropped: \_\_\_\_\_

**M** = total number of intersections: \_\_\_\_\_

You now have all the numbers you need to calculate  $\pi$

Here's the formula you need to calculate  $\pi$ :

$$\pi = \frac{2cN}{aM}$$

You know the values for **c** (the length of a toothpick) and **a** (the distance between the lines). These must be measured in the same units.

You also have **M** (the total number of toothpicks that were touching a line), and **N** (the total number of toothpicks dropped).

Fill them in the formula, and work out your own value of  $\pi$ : \_\_\_\_\_

Repeat this process as many times as you can. **Twenty times** could probably be enough for this experiment. All that's important is that, each time you drop the toothpicks, you write down how many you dropped, and how many of those ended up touching a line.

Now you need to calculate the average of the values of  $\pi$  that you found. To average, add the values and divide by the number of values you have.

Write your average value of  $\pi$  here:  $\pi =$  \_\_\_\_\_

How many decimal places did you get to agree with the real value 3.14159...?

### Websites for further investigation

<http://www.ship.edu/~deensl/mathdl/stats/Buffon.html>

<http://www-groups.dcs.st-and.ac.uk/~history/Mathematicians/Buffon.html>

<http://stud4.tuwien.ac.at/~e9527412/buffon.html>

<http://www.ms.uky.edu/~mai/java/stat/buff.html>