STEM in the lab

Inspiring Idaho's future STEM workforce

Pi Day: Buffon's Needle

GRADE LEVELS

This activity is appropriate for grades 7-12.

MISSION

Find Pi (3.14) using Buffon's needle problem.

VOCABULARY

AREA: the size of a surface (area= length x width)

CIRCUMFERENCE: the distance around the edge of a circle

DIAMETER: the distance from one point on a circle through the center to another point on the circle. It is also the longest distance across the circle. The diameter is twice the radius.

IRRATIONAL NUMBER: a number with a decimal that goes on forever without repeating.

MATERIALS

» toothpicks
» paper
» pencil
» calculator
» ruler

ABOUT THIS ACTIVITY

When we think of Pi (π), most of us think of an irrational number that is achieved when you divide the ircumference of a circle by its diameter. No matter the size of the circle, your answer will always be 3.14. A circle is always a little more than three times its width around.

Even though most of us learned to find Pi through the above method, back in 1777, a man by the name of Georges-Louis Leclerc, the Count of Buffon, found another way to find Pi. His method doesn't even involve measuring a circle. Instead, it uses probability to find Pi, and it is considered one of the oldest problems in the field of geometrical probability. Back in Leclerc's day, lines would be drawn on the floor and people would bet based on where a coin tossed on the floor would land. Would it cross a line or not? A philosopher, Leclerc was also interested in math. He wanted to generalize the game, so he started dropping a needle on a lined sheet of paper. He would record if the needle crossed the line on the paper. He repeated this experiment several times. His results found that the probability was directly related to the never-ending number Pi value. This was because two times the number of needles he dropped divided by the number of needles crossing a line was almost equal to Pi all the time. His results became the formula: $P=2n/c$. P is the probability, n is the number of needles, and c is the number of needles crossing a line. The probability is directly related to the value of Pi.

In this activity, you will repeat "Buffon's needle problem" (named after Georges-Louis Leclerc) and see how close you can come to 3.14.

INSTRUCTIONS

Make the following graph on a piece of paper to write your information.

TOOTHPICK	TALLY	TOTAL
Crosses Line		
Not Touching Line		

1. Measure your toothpick in centimeters. The length of your toothpick will determine how far apart your lines are on the paper.
2. On a piece of paper, starting at the top, draw parallel lines across the paper until you fill the page. The distance between the lines should be equal to the length of the toothpick.
3. Place the piece of paper on a flat surface. Drop the toothpick onto the paper from a height of 10 to 15 cm. Record where it lands.
4. Repeat Step 4 several times. The more times you drop the toothpick, and record the results, the more accurate your results.
5. After you have finished step 5, solve the following problem: (number of tosses)/(number of intersections).
6. Take your answer and multiply by 2. This is your approximation of π. Your answer should be close to 3.14.
7. Complete extension activities.

EXTENSIONS

» Try this experiment with different shapes with a computer simulation at: *https://mste.illinois.edu/activity/buffon/*

» Use Integral geometry to write a proof for the Buffon needle: *https://medium.com/however-mathematics/a-beautiful-way-to-calculate-%CF%80-buffons-needle-problem-51d41029f287*

RESOURCES

» https://mste.illinois.edu/activity/buffon/
» https://www.mathsisfun.com/activity/buffons-needle.html
» https://medium.com/however-mathematics/a-beautiful-way-to-calculate-%CF%80-buffons-needle-problem-51d41029f287

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For information on grants, training and student opportunities, curriculum ideas, and resources, please visit ***stem.inl.gov.***