



Analog Scientific Calculator



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Summary

You can do most of the functions of a scientific calculator with just paper, pencil & this model!



2.64 hrs



1 pcs



0.10 mm



0.40 mm



PLA



16 g



Prusa MINI /
MINI+

[Learning](#) > [Math](#)

Tags: [parametric](#) [calculator](#) [openscad](#) [log](#) [analog](#) [cosine](#)
[division](#) [multiplication](#) [sine](#) [addition](#) [substraction](#)
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Apart from the basic functions that you can expect from a quarter circle protractor:

- **Measure angles**
- **Draw straight lines and right angles**
- **Find the center of small circles**

You can do most of the functions of a scientific calculator with just paper, pencil & this model!

- **Addition / Subtraction**
- **Product / Division**
- $\sqrt{x}$ / $\sqrt[3]{x}$ / ...
- **Log10 / 10x**
- **Sin / Cos / Tan / Asin / Acos / Atan**

And, if you print the model at 1:1 scale, you can also:

- **Measure distances in mm**

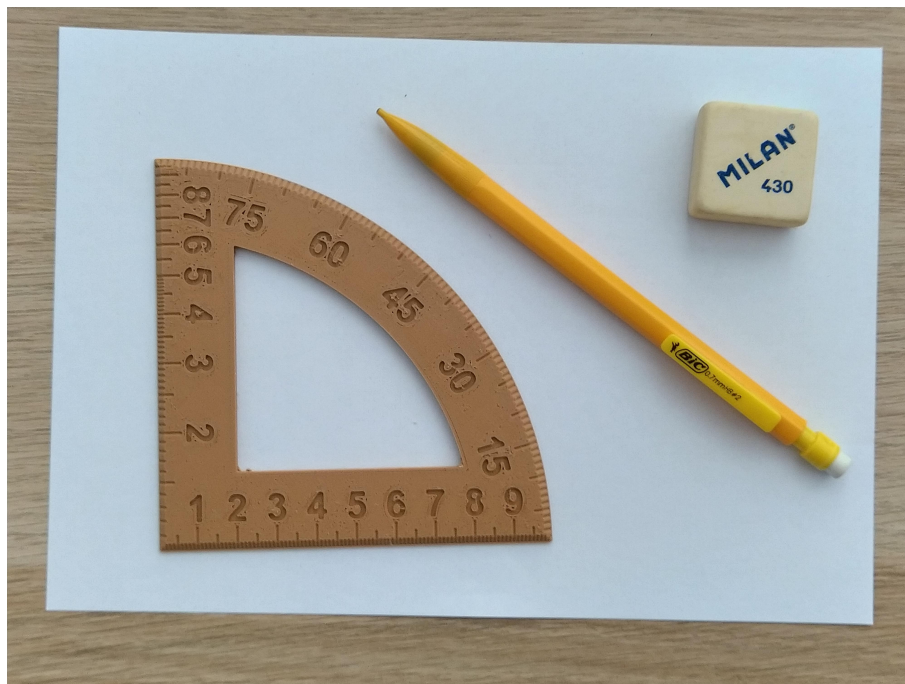
Find out how to do all these operations with this simple analog tool!

Specifications

The model is just a quarter of a circle (of 10 cm radius) with 3 different scales marked:

- **The linear scale:** on the lower side, you can find a linear scale with 1 mm ticks.
- **The logarithmic scale:** on the left side, you can find a base-10 logarithmic scale.
- **The angular scale:** on the circular side, you can find an angular scale with 10 ticks.

This simple analog tool is able to perform many operations with enough precision (usually, **2 or 3 significant digits**). Of course, you will be better off by doing additions, subtractions, multiplications, and divisions “by hand” using the standard procedures you learned at school. But the logarithmic and trigonometric operations are **transcendental functions** and can only be performed with the aid of an electronic calculator nowadays.



In addition to this model, you will need a sheet of paper (that will perform the role of RAM memory) and a pencil (to write in the RAM!).

This material has been designed as a teaching aid to help the students to better understand the meaning and properties of the logarithmic and trigonometric functions.

Measure distances in mm

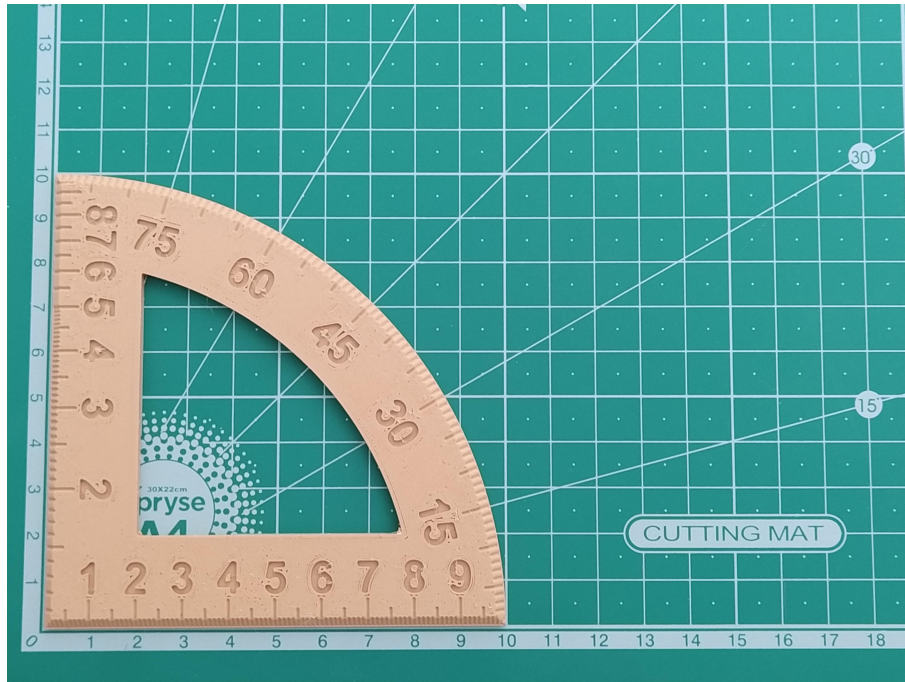
The linear scale is calibrated in 1 mm increments and can be used to measure distances of up to 100 mm. **Example:** the standard A7 paper is 74 mm wide.



Measuring longer distances can be done by breaking them in 10 cm fragments + a remainder.

Measure angles

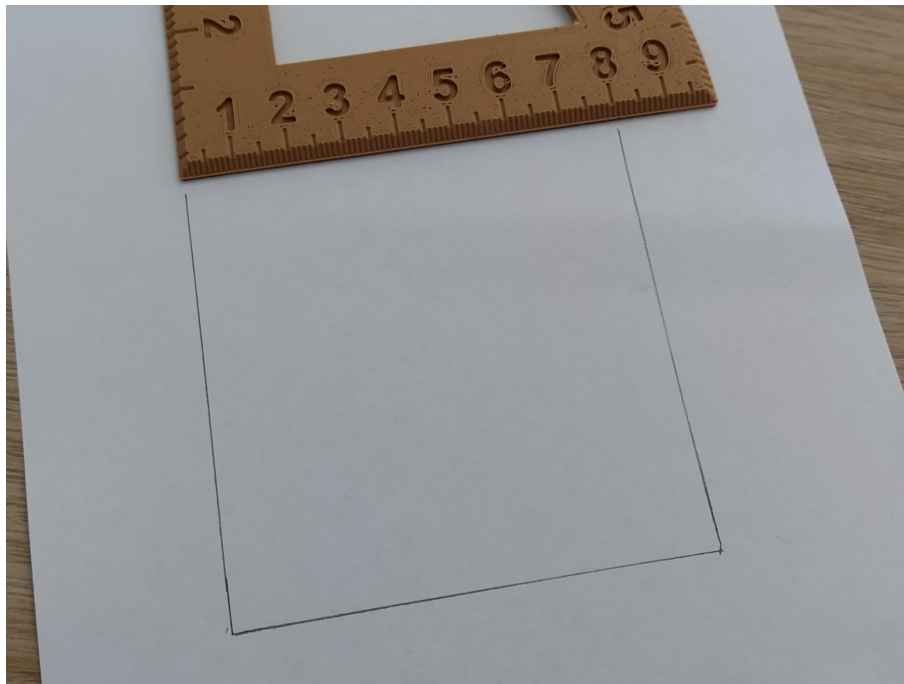
The angular scale is calibrated in 10 increments and can be used to measure angles of up to 90°:



Measuring larger angles can also be done by breaking them in 90° fragments + a remainder.

Draw straight lines and right angles

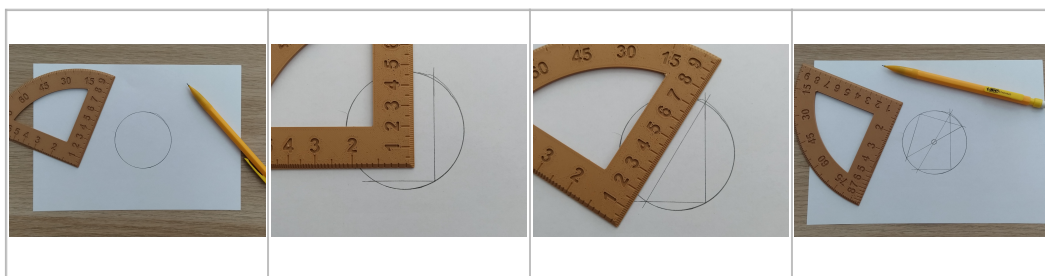
The border of the Analog Scientific Calculator can be used to draw lines of up to 10 cm. **Example:** A pretty decent 8 cm square drawn with the aid of the Analog Scientific Calculator.



The 90° angle of the Analog Scientific Calculator can be used to draw perpendicular lines.

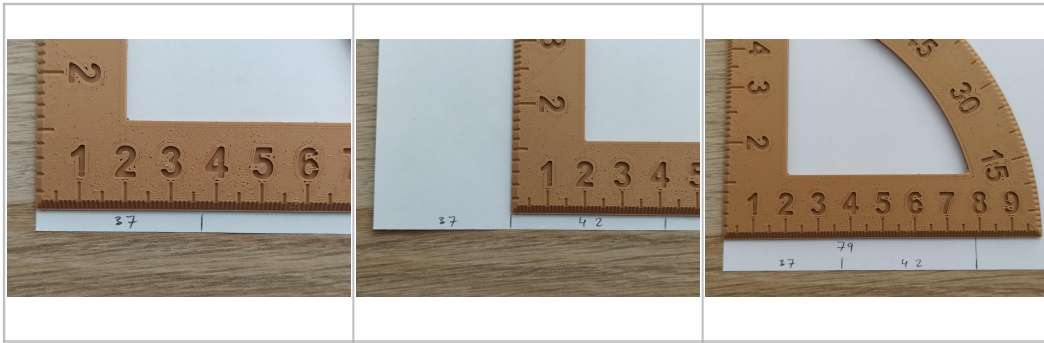
Find the center of small circles

To find the center of a small circle (up to 10 cm in diameter), inscribe the right angle of the Analog Scientific Calculator in the circle and mark the 2 crossing points. The line that joins these two points is always a diameter of the circle. The center of the circle is the point where 2 or more diameters cross each other. **Example:**

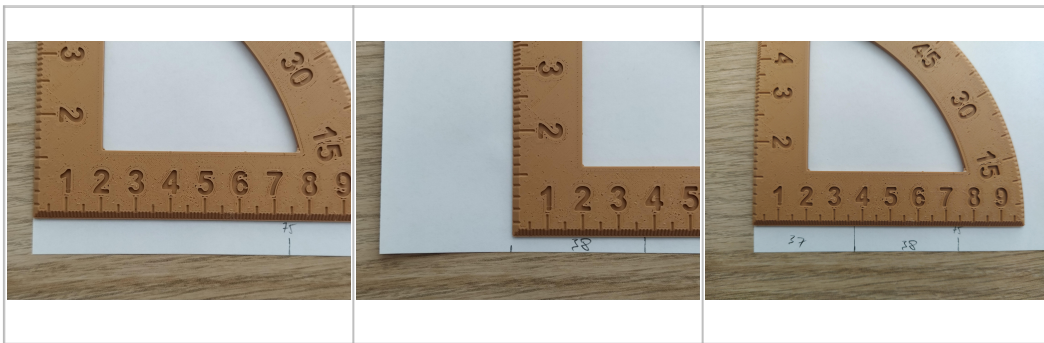


Addition / Subtraction

To add two numbers, use the linear scale to mark both distances, one after the other on the border of the paper. Then use the linear scale to measure the combined length. **Example:** $37 + 42 = 79$

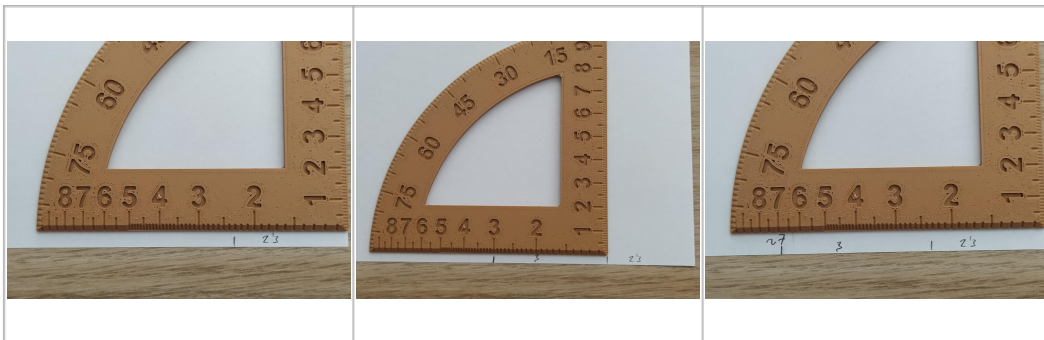


For subtracting numbers, do the same procedure backwards. **Example:** $75 - 38 = 37$

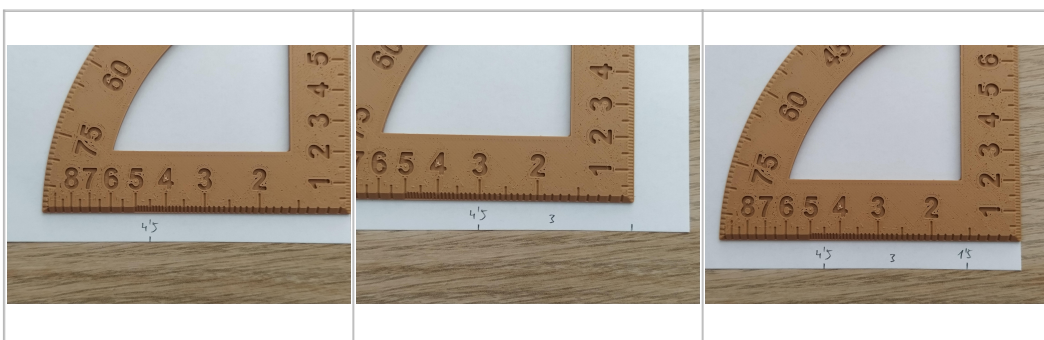


Product / Division

To multiply two numbers, use the logarithmic scale to mark both distances, one after the other, on the border of the paper. Then use the logarithmic scale to measure the combined length. **Example:** $2.3 \cdot 3 \approx 7$

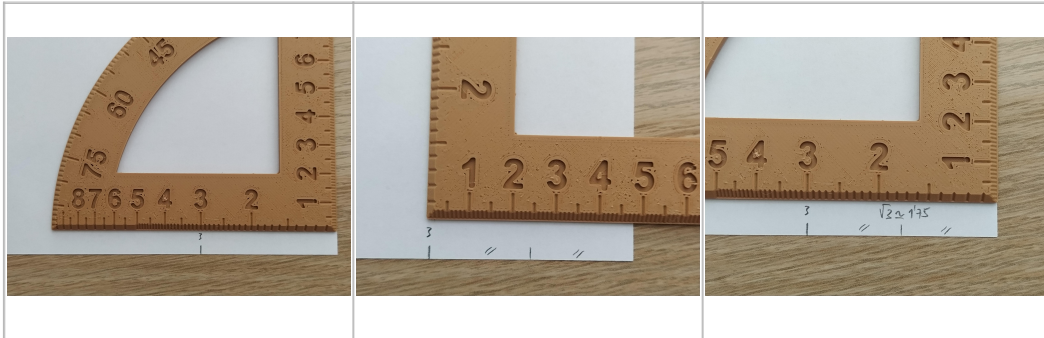


For dividing two numbers, do the same procedure backwards. **Example:** $4.5 / 3 = 1.5$



$$\sqrt{x} / \sqrt[3]{x} / \dots$$

To compute the square root of a number, use the logarithmic scale to mark that distance on the border of the paper. Then measure this distance using the linear scale, and mark half this distance on the border of the paper. Finally, measure that halved length with the logarithmic scale. **Example:** $\sqrt{3} \approx 1.75$



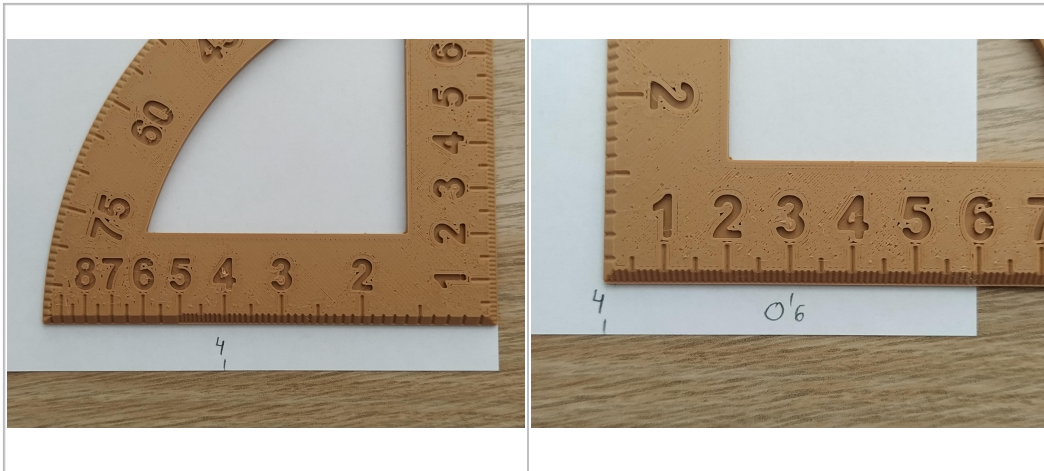
To compute the cubic root of a number, do the same procedure, but dividing the length by 3 instead of halving it. **Example:** $\sqrt[3]{8} = 2$



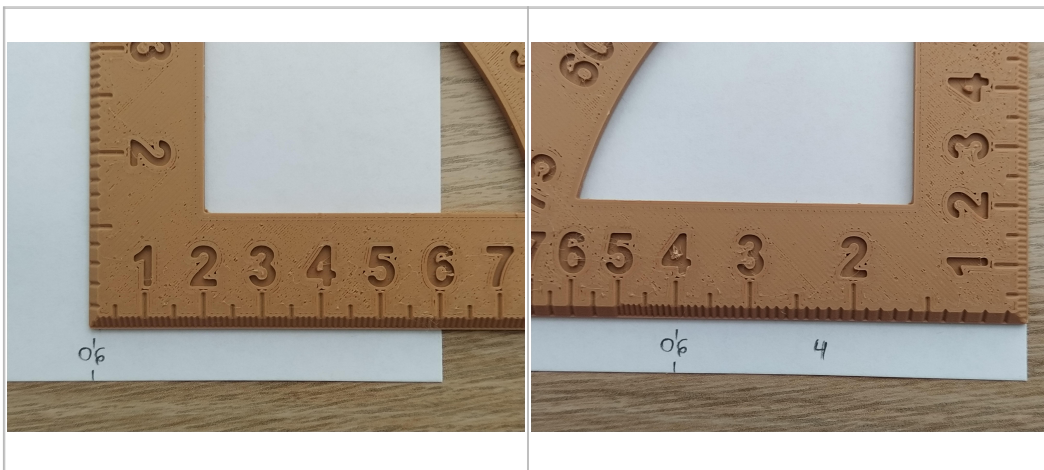
In general, you can compute the Nth root by dividing the length by N.

Log10 / 10x

To compute the Log10 of a number, mark the number in the lower side of the paper using the logarithmic scale and then read the result using the linear scale. **Example:** $\text{Log}_{10}(4) \approx 0.6$ (which also means that $\text{Log}_{10}(40) \approx 1.6$, $\text{Log}_{10}(400) \approx 2.6$, $\text{Log}_{10}(4000) \approx 3.6$, $\text{Log}_{10}(0.4) \approx -0.4$, etc.)

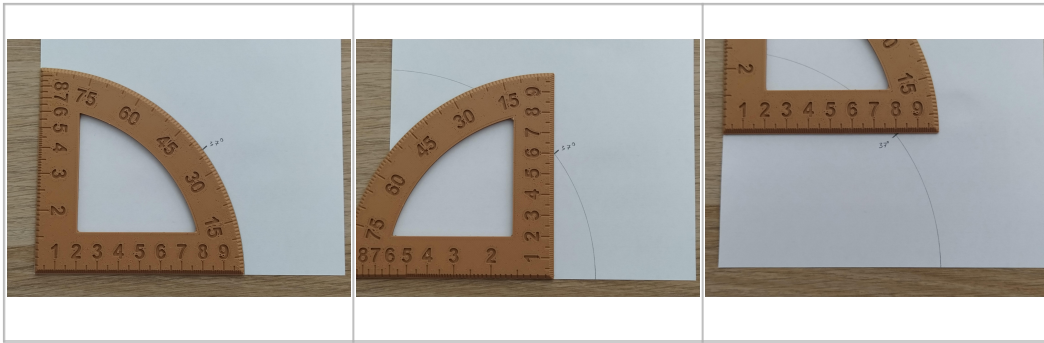


To compute 10 to the power of a number, mark the number in the lower side of the paper using the linear scale and then read the result using the logarithmic scale. **Example:** $10^{0.6} \approx 4$ (which also means that $10^{1.6} \approx 40$, $10^{2.6} \approx 400$, $10^{3.6} \approx 4000$, $10^{-0.4} \approx 0.4$, etc.)

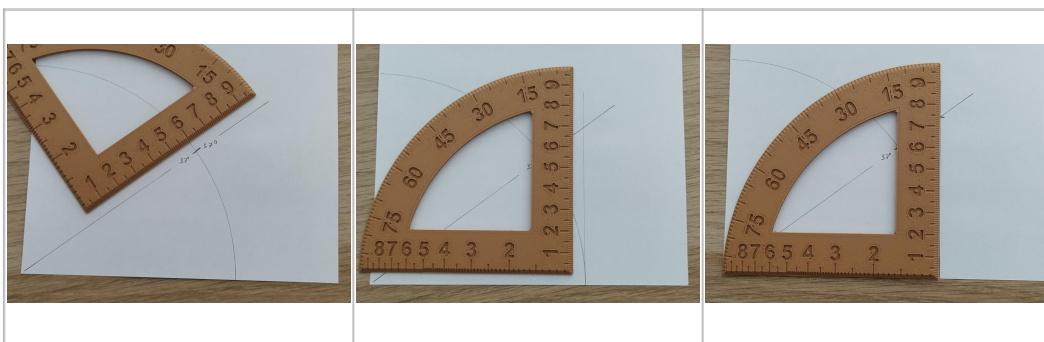


Sin / Cos / Tan

To compute the Sin of an angle, place the corner of the Analog Scientific Calculator in the corner of the paper and then mark a dot in the desired angle using the angular scale. The sin of that angle is just the vertical distance from that dot to the lower edge of the paper. You can measure it with the linear scale (take advantage of the right angle to ensure that you are measuring the angle correctly). To compute the Cos of an angle, do the same procedure, but measure the horizontal distance from the dot to the left edge of the paper. **Example:** $\sin(37^\circ) \approx 0.6$ and $\cos(37^\circ) \approx 0.8$

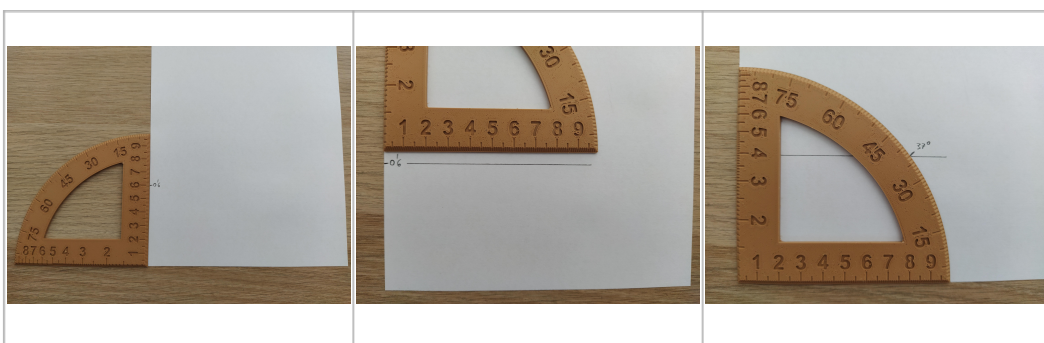


To compute the Tan of an angle, extend the radius until it meets the vertical line drawn from the bottom point of the circular arc. Then measure the vertical distance from the edge of the paper to the intersection using the linear scale. **Example:** $\text{Tan}(37^\circ) \approx 0.75$

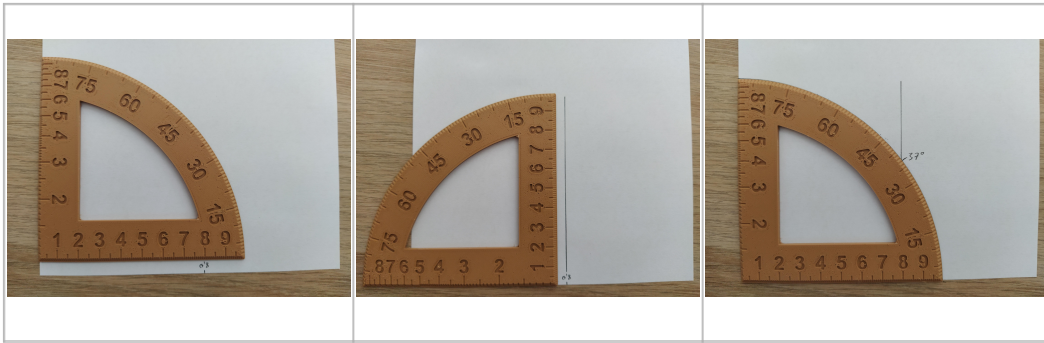


Asin / Acos / Atan

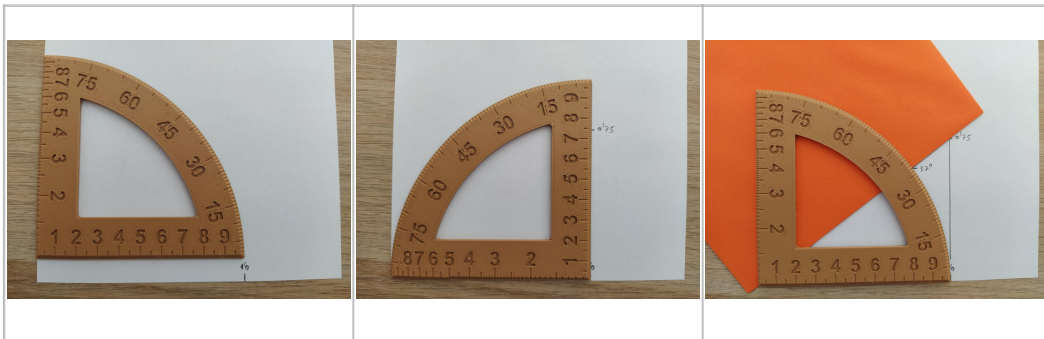
To find the Asin of a length, use the linear scale to mark that distance on the left side of the paper (starting in the lower left corner). Then draw a perpendicular line. Finally, place the Analog Scientific Calculator in the corner of the paper and read the corresponding angle in the angular scale. **Example:** $\text{Asin}(0.6) \approx 37^\circ$



To find the Acos of a length, do the same procedure on the lower side of the paper. **Example:** $\text{Acos}(0.8) \approx 37^\circ$



To find the Atan of a length, draw a vertical line at 10 cm from the lower left corner. Then use the linear scale to mark that distance on the line (from the paper border). Then join that point with the paper corner (using another sheet of paper) and use the angular scale to measure the corresponding angle. **Example:** $\text{Atan}(0.75) \approx 37^\circ$



Recommended Print Settings:

- The model works well with a **0.1 mm layer height** and a **0.4 mm nozzle**, but it can probably be printed with a different configuration.
- I printed it in **PLA**, but you can use pretty much any material of your choice.

Model files



analog-scientific-calculator.stl

☐ A piece of plastic to compute them all!

analog-scientific-calculator.scad

☐ The parametric OpenScad script used to generate this model.

Print files



analog-scientific-calculator_04n_01mm_pla_mini_2h38m .bgcode

⚙️ PLA 📏 0.40 mm ≡ 0.10 mm ⌚ 2.64 hrs ⚖️ 16 g 🖨️ Prusa MINI / MINI+

📄 A piece of plastic to compute them all!

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