

Make Your Own Slide Rule!

You will need: a scientific or graphing calculator; scissors.

A slide rule is a tool that math students used to multiply and divide before there were calculators. (Your parents or grandparents may have used them.) Here you will learn how to make your own!

Making a Slide Rule

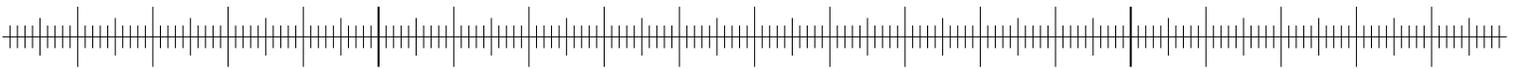
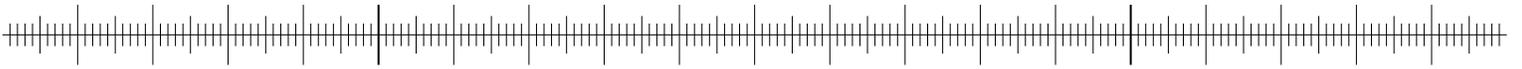
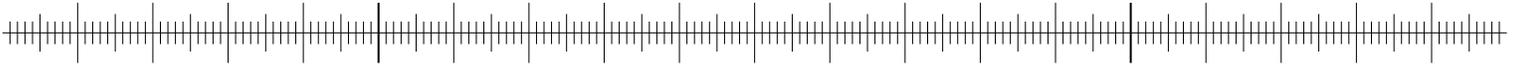
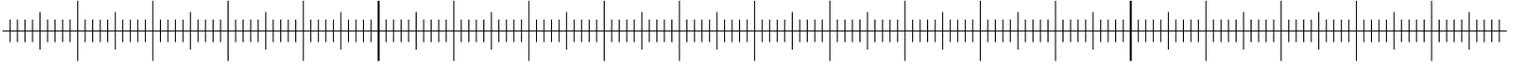
You have been given a piece of paper with tick-marked lines on it. The longer tick marks are 1 cm apart, and the shorter are 1 mm apart. Between the two thicker tick marks, there are 10 cm, which we will consider to be 1 unit. Consider the thick tick mark on the left to be 0, and the one on the right 1. So the longer tick marks are at 0.1, 0.2, 0.3 units, etc. from the origin. Do not write these numbers on the paper! Just be aware of them.

1. Label the thick tick mark on the left '1', both above and below the line. This is because $\log(1) = 0$. Using your calculator, check that $\log(2) = .301\dots$, and label the point at approximately 3.01 cm (0.301 units) with a '2', both above and below the line.
2. a. Continue to do this for the remaining integers 3–9. For 10, just write 1, like you did for 0.
b. What do you notice about the distances between successive numbers?
3. After checking that the numbers are labeled both above and below the line, cut your paper carefully along the ruler line, all the way across, so you can *slide* the top along the bottom.

Using the Slide Rule

You have created a logarithmic scale. You can use it to multiply and divide:

4. What is $2 \cdot 4$? Look at the '2' on the bottom piece of your slide rule. Slide the top of the paper along until the '1' on the top lines up with the '2' on the bottom. Look at where the 4 on the top is now. What number is below it? That number is the product.
5. a. Repeat, but switch the role of the top and bottom. Does it still work?
b. Try it with $3 \cdot 2$ and $2 \cdot 5$.
6. What is $9/3$? Look at the '9' on the bottom of your slide rule. Match it up with the '3' on top. Look at where the '1' on top is now. What number is below it? That number is the answer.
7. Try it with $8/2$ and $6/3$.
8. Explain why this works. Hint: what operations were you doing physically with the slide rule? How are they related to the operations you intended?
9. **Challenge:** Try to figure out how students handled a multiplication like $3 \cdot 4$, where the result is "too big". Hint: figure it out by experimenting! The explanation depends on understanding how reciprocals show up on your slide rule, and on seeing that 12 shows up as 1.2.



Teacher Notes

On a slide rule, the '2' represents 2, 20, 200, etc. as well as 0.2, 0.02, etc. The user of the slide rule must keep track of the order of magnitude.

If you have access to one or more real slide rules show them to your students. They are sure to find them fascinating.

The key concept for this lesson, of course, is that to multiply two numbers, you add their logs, and to divide them you subtract their logs. It is important to have students respond to question 8, otherwise the whole activity will have been in vain.

You can follow this up by searching for a slide rule applet on the Internet. One good one is at the online Computer Museum: <http://www.syssrc.com/html/museum/html/sims/javaslide/>. You may be tempted to just do this activity on the computer, but in my experience most students will benefit from doing the work on paper first, as it will help develop their number sense about what a log scale looks and feels like.

Question 9 is very difficult. If you decide to do it with your whole class, you will probably have to do a fair amount of explaining.

- How to do it: put the right-hand '1' of the top over the '4' on the bottom, and find the answer below the '3'. Of course, for this to work well, you'd need to indicate where 1.1, 1.2, etc can be found between the 1 and the 2! Real slide rules (or their online models) make that easier than the paper model.
- Why it works: the reciprocal of 3 is the number by which you multiply 3 to get 1. Its log is the log you add to the log of 3 to get the log of 1. On the slide rule, that log is the distance from the point marked '3' to the right-hand '1'. Subtracting that log from the log of 4 is the same as dividing by the reciprocal of 3, which is the same as multiplying by 3! (In reality, most slide rule users probably did not understand this explanation, but they learned to do this almost automatically, just like they learned methods for long division and square root extraction without understanding them, and just like today's students need not know how the calculator works to use it.)