SLIDE RULE CALCULATIONS BY EXAMPLE

Introduction

This isn't really a tutorial, it's more of a self-guided demo. This page gives numeric examples of the basic calculations that a slide rule can do. Just follow the step-by-step instructions and you will be amazed by the power and versatility of the venerable slipstick. Just start up a virtual slide rule (opens in new window) and start calculating.

Contents

Multiplication

Simple Multiplication (uses C and D scales)

Example: calculate 2.3 × 3.4

- Move the cursor to 2.3 in the D scale.
- Slide the leftmost '1' on C to the cursor.
- Move the cursor to 3.4 on the C scale.
- The cursor is on the D scale at 7.8. This is the answer.

'Wrap-Around' Multiplication (uses C and D scales)

Example: calculate 2.3 × 4.5

- Move the cursor to 2.3 on the D scale.
- Slide the rightmost '1' on C to the cursor.
- Move the cursor to 4.5 on the C scale.
- The cursor is now at 1.04 on the D scale.
- We know the correct answer is near 2 × 5 = 10, so we adjust the decimal place to get 10.4.

Folded-Scale Multiplication (uses C, D, CF and DF scales)

Example: calculate 2.3 × 4.5

- Move the cursor to 2.3 on the D scale.
- Slide the leftmost '1' on C to the cursor.
- We can't move the cursor to 4.5 on the C scale; it's out of range. We can use the folded scales to get this answer.
- Move the cursor to 4.5 on the CF scale.
- The cursor is now at 1.4 on the DF scale.
- We know the correct answer is near 2 × 5 = 10, so we adjust the decimal place to get 10.4.

Multiplication by π (uses D and DF scales)

Example: calculate 123 × π

- Move the cursor to 1.23 on the D scale.
- The cursor is now at 3.86 on the DF scale.
- We know that the correct answer is near 100 × 3 = 300, so we adjust the decimal place to get 386.

Division

Simple Division (uses C and D scales)

Example: calculate 4.5 / 7.8

- Move the cursor to 4.5 on the D scale.
- Slide 7.8 on the C scale to the cursor.
- Move the cursor to either the leftmost or rightmost '1' on the C scale, whichever is in range. In this case, you would move it to the rightmost '1'.
- The cursor is now at 5.8 on the D scale.
- We know that the correct answer is near 4/8 = 0.5, so we adjust the decimal place to get 0.58.

Reciprocal (uses C and CI scales)

Example: calculate the reciprocal of 7.8, or 1/7.8

- Move the cursor to 7.8 on the CI scale. Note that the CI scale increases from right to left, as indicated by the '<' symbols before the numbers.
- The cursor is now at 1.28 on the C scale.
- We know that the correct answer is near 1/10 = 0.1, so we adjust the decimal place to get 0.128.

Trigonometry

Sin(x) for angles between 5.7° and 90° (uses S and C scales)

Example: calculate sin(33°)

- Move the cursor to 33 on the S scale.
- The cursor is at 5.45 on the C scale.
- We know that the correct answer for a sin in this range is between 0.1 and 1, so we adjust the decimal place to get 0.545.

Cos(x) for angles between 5.7° and 90° (uses S and C scales)

Example: calculate cos(33°).

- The cos scale shares the sin S scale. Instead of increasing from left to right like the sin scale, cos increases from right to left. This is indicated on the slide rule by '<' characters which remind you that the number in increasing 'backwards'.
- Move the cursor to <33 on the S scale.
- The cursor is now at 8.4 on the C scale.
- We know that the correct answer for a cos in this range is between 0.1 and 1, so we adjust the decimal place to get 0.84.

Tan(x) for angles between between 5.7° and 45° (uses T and C scales)

Example: calculate tan(33°).

- Move the cursor to 33 on the T scale.
- The cursor is now at 6.5 on the C scale.
- We know that the correct answer for a tan in this range is between 0.1 and 1, so we adjust the decimal place to get 0.65.

Tan(x) for angles between between 45° and 84° (uses backward T and CI scale)

Example: calculate tan(63°).

- Move the cursor to <63 on the T scale. Note that this range increases from right to left, as indicated by the '<' before the numbers.
- The cursor is now at <1.96 on the CI scale.
- We know that the correct answer for a tan in this range is between 1 and 10, so we don't need to adjust the decimal place.

Tan(x) for angles between between 45° and 84° (uses forward T and C scale)

Example: calculate tan(63°).

- Move the cursor to 63 on the forward T scale. This scale increases from left to right.
- The cursor is now at 1.96 on the C scale.
- We know that the correct answer for a tan in this range is between 1 and 10, so we don't need to adjust the decimal place.

Sin(x) and tan(x) for angles between 0.6° and 5.7° (using the ST and C scales)

In this range, the sin and tan functions are very close in value, so a single scale can be used to calculate both.

Example: calculate sin(1.5°)

- Move the cursor to 1.5 on the ST scale.
- The cursor is now at 2.62 on the C scale.
- We know that the correct answer for a sin in this range is between 0.01 and 0.1, so we adjust the decimal place to get 0.0262.

Sin(x) and tan(x) for other small angles (using C and D scales)

For small angles, the sin or tan function can be approximated closely by the equation:
$\sin(x) = \tan(x) = x / (180/\pi) = x / 57.3$.
Knowing this, the calculation becomes a simple division. This technique can also be used on rules without an ST scale.

Example: calculate sin(0.3°)

- Move the cursor to 3 on the D scale.
- Slide 5.73 on the C scale to the cursor. Most rules have a tick labeled 'R' at this point.
- Move the cursor to either the leftmost or rightmost '1' on the C scale, whichever is in range.
- The cursor is now at 5.24 on the D scale.
- We know that the correct answer is near 0.3 / 60 = 0.005, so we adjust the decimal place to get 0.00524.

Squares and Square Roots

Square (uses C and B scales)

Example: calculate 4.7^2

- Move the cursor to 4.7 on the C scale.
- The cursor is now at 2.2 on the B scale.
- We know that the correct answer is near 5^2 = 25, so we adjust the decimal place to get 22.

Square Root (uses C and B scales)

Example: calculate $\sqrt{4500}$

- You will notice that the B scale has two similar halves. The first step is to decide which half to use to find a square root.
- The left half is used to find the square root of numbers with odd numbers of digits or leading zeros after the decimal point. The right half is used for numbers with even numbers of digits or leading zeros. Since 4500 has an even number of digits, then we'll use the right half of the scale.
- Move the cursor to 4.5 on the right half of the B scale.
- The cursor is now at 6.7 on the C scale.
- We know that 70^2 = 3600, which is in the ballpark of 4500. Therefore we adjust the decimal point to get a result of 67.

Cubes and Cube Roots

Cube (uses D and K scales)

Example: calculate 4.7^3

- Move the cursor to 4.7 on the D scale.
- The cursor is now at 1.04 on the K scale.
- We know that the correct answer is near 5 x 5 x 5, which, to further approximate, is near 5 x 5 x 4 = 5 x 20 = 100. Therefore we adjust the decimal point to get a result of 104.

Cube Root (uses D and K scales)

Example: calculate $\sqrt[3]{4500}$

- You will notice that the K scale has three similar thirds. The first step is to determine which third to use to find the cube root.
- The first third is used to find the cube root is numbers with one digit. You can cycle through the thirds, increasing the number of digits by one for each third, to find which part to use.
- For the value of 4500, which has 4 digits, we cycle through the thirds and find that we would use the first third.
- Move the cursor to 4.5 on the third third of the K scale.
- The cursor is now at 1.65 on the D scale.
- We can take a guess that the correct answer is around 10. The cube of 10 is 1000 and the cube of 20 is 8000. Thus we know that the correct answer is between 10 and 20, therefore we can move the decimal place and get the correct result of 16.5.

Log-Log Scales

Log-log scales are used to raise numbers to powers. Unlike many of the other scales, log-log scales can't be learned simply be memorizing a few rules. It is necessary to actually understand how they work. These examples are intended to gradually introduce you to the concepts of log-log scales, so you gain that understanding. Hopefully, the power of 10 examples don't bore you, as they lay the foundation for later examples.

Since there are many slight variations of log-log scales on different slide rules, I'll refer only to the scales found on the Pickett N3, Pickett N600 and Pickett N803 slide rules (among others). If you want to view a virtual N3, click here, if you want a virtual N600, click here (opens in a new window.)

Another interesting aspect of LL scales is that the decimal point is "placed." That is, you don't have to figure out afterwards where the decimal point belongs in your result. The disadvantage to this is that LL scales are limited in the numbers they can calculate. Typically, the highest result you can get is about 20,000, and the lowest is 1/20,000 or 0.00005. One exception to this is the Picket N4 (virtual here), which goes up to 10^{10}.

Raising a Number to Powers of 10 (N>1)

To raise a number to the power of 10, simply move the cursor to the number and look at the next highest LL scale. (These examples are for numbers greater than 1.)

Example: calculate 1.35^{10} (uses LL2 and LL3 scales)

- Move the cursor to 1.35 on the LL2 scale.
- The cursor is at 20.1 on the LL3 scale. This is the correct answer.

Example: calculate 1.04^{100} (uses LL1 and LL3 scales)

- Move the cursor to 1.04 on the LL1 scale.
- The cursor is at 50.5 on the LL3 scale.

Example: calculate 1.002^{1000} (uses LL0 and LL3 scales)

- Move the cursor to 1.002 on the LL0 scale.
- The cursor is at 7.4 on the LL3 scale. This is the correct answer.

Example: calculate sequential powers of ten of 1.002 (uses LL0 to LL3 scales)

- Move the cursor to 1.002 on the LL0 scale.
- On LL1, the cursor is at 1.002^{10}, or 1.02.
- On LL2, the cursor is at 1.002^{100}, or 1.22.
- On LL3, the cursor is at 1.002^{1000}, or 7.4.

Raising a Number to Powers of 10 (N<1)

The reciprocals of the LL scales are the -LL scales. They work the same way, but you have to make sure that you look for the answer on a -LL scale.

Example: calculate 0.75^{10} (uses -LL2 and -LL3 scales)

- Move the cursor to 0.75 on the -LL2 scale.
- The cursor is at 0.056 on the -LL3 scale. This is the correct answer.

Finding the 10th Root

As you've seen in the previous examples, to raise a number to the 10th power, you simply look at the adjacent number on the next highest LL scale. To find a tenth root, you look at the adjacent number on the next lowest LL scale. Remember also that finding the tenth root is the same as raising a number to the power of 0.1.

Example: calculate $\sqrt[10]{5}$, or $5^{0.1}$ (uses LL2 and LL3 scales)

- Move the cursor to 5 on the LL3 scale.
- The cursor is now at 1.175 on the LL2 scale. This is the correct answer.

Example: calculate $\sqrt[100]{0.15}$, or $0.15^{0.01}$ (uses -LL3 and -LL1 scale)

- Move the cursor to 0.15 on the -LL3 scale.
- The cursor is now at 0.9812 on the -LL1 scale. This is the correct answer.

Arbitrary Powers (Staying on Same LL Scale)

Occasionally, depending on the numbers, it is possible to calculate a power without switching scales.

Example: calculate $9.1^{2.3}$ (uses LL3 scale)

- Move the cursor to 9.1 on the LL3 scale.
- Slide the leftmost '1' on C to the cursor.
- Move the cursor to 2.3 on the C scale.
- The cursor is now at about 160 on the LL3. This is very close to the correct answer of 160.6. One of the problems with LL scales is that their accuracy diminishes as the numbers increase in value.

Example: calculate $230^{0.45}$ (uses LL3 scale)

- Move the cursor to 230 on the LL3 scale.
- Since we're raising to a power that's less than 1, we have to go left on the LL scale.
- Slide the rightmost '1' on the C scale to the cursor.
- Move the cursor to 4.5 on the C scale.
- The cursor is now at 11.6 on the LL3 scale. This is close to the correct answer of 11.56.

Example: calculate $0.78^{3.4}$ (uses -LL2 scale)

- Move the cursor to 0.78 on the -LL2 scale.
- Slide the leftmost '1' on the C scale to the cursor.
- Move the cursor to 3.4 on the C scale.
- The cursor is now at 0.43 on the -LL2 scale. This is the correct answer.

Example: calculate $0.78^{0.45}$ (uses -LL2 scale)

- Move the cursor to 0.78 on the -LL2 scale.
- Since we're raising to a power that's less than 1, we have to go left on the LL scale.
- Slide the rightmost '1' on the C scale to the cursor.
- Move the cursor to 4.5 on the C scale.
- The cursor is now at 0.894 on the -LL2 scale. This is the correct answer.

Arbitrary Powers (Switching LL Scales)

One of the rules of exponents is that $(A^B)^C$ is equal to $A^{B \times C}$. We can use this fact, along with our knowledge of powers of ten, to calculate arbitrary powers.

Example: calculate $1.9^{2.5}$ (uses LL2 and LL3 scales)

- If we try to calculate this the easy way, the power 2.5 is out of range for the scale.
- We can reinterpret the problem as:
  Calculate $(1.9^{0.25})^{10}$
  Because 0.25 x 10 is 2.5.
- Move the cursor to 1.9 on the LL2 scale.
- Slide the rightmost '1' on the C scale to the cursor.

- Move the cursor to 2.5 on the C scale.
- The cursor is now at $1.9^{0.25}$ on the LL2 scale. Since we want to also raise this to the power of 10, we look "one scale higher" at the LL3 scale.
- The cursor is at 4.97 on the LL3 scale. This is the correct answer.

Example: calculate $12^{0.34}$ (uses LL3 and LL2 scales)

- Like the previous example, if we try to calculate this the easy way, the power 0.34 is out of range for the scale.
- We can reinterpret the problem as:
  Calculate $(12^{3.4})^{0.1}$
  Because 3.4 x 0.1 is 0.34.
- Move the cursor to 12 on the LL3 scale.
- Slide the leftmost '1' on the C scale to the cursor.
- Move the cursor to 3.4 on the C scale.
- The cursor is now at $12^{3.4}$ on the LL3 scale, which is about 5000 (which is not the number we're looking for). Since we also want to raise this to the power of 0.1, we look at the LL2 scale.
- The cursor is now at 2.33 on the LL2 scale. This is the correct answer.

Example: calculate 0.99^{560} (uses -LL1 and -LL3 scales)

- We can reinterpret this problem as:
  Calculate $(0.99^{5.6})^{100}$
  Because 5.6 x 100 = 560
- Move the cursor to 0.99 on the -LL1 scale.
- Slide the leftmost '1' on the C scale to the cursor.
- Move the cursor to 5.6 on the C scale.
- The cursor is now at $0.99^{5.6}$ on the -LL1 scale. Since we also want to raise this to the power of 100, we look "two scales higher", or the -LL3 scale.
- The cursor is now at 0.0036 on the -LL3 scale. This is the correct answer.

Log-Log Approximations

In general, LL scales don't handle numbers extremely close to 1, such as 1.001 or 0.999. This is not a problem because there is an accurate approximation for numbers in this range. In general, if you have a very small number 'd', then:

$$(1 + d)^p = 1 + d\,p$$

Example: calculate 1.00012^{34} (uses C and D scales)

- In this case, if we use the approximation $(1 + d)^p = 1 + d\,p$, then:
  d = 0.00012, and
  p = 34
- We must calculate 0.00012 * 34.

- Move the cursor to 1.2 on the D scale.
- Slide the leftmost '1' on the C scale to the cursor.
- Move the cursor to 3.4 on the C scale.
- The cursor is now at 4.08 on the D scale.
- We know that the correct answer would be near 0.0001 * 30, or 0.003. Therefore we adjust the decimal point to get a value of 0.00408.
- Add 1 to 0.00408. The result is 1.00408, which is very close to the correct answer of 1.004088.

Example: calculate 0.99943^{21} (uses C and D scales)

- Like before, we'll use the approximation $(1 + d)^{p} = 1 + d\ p$. In this case:
  d = (0.99943 - 1) = -0.00057, and
  p = 21
- We must calculate -0.00057 * 21.
- Move the cursor to 5.7 on the D scale.
- Slide the rightmost '1' on the C scale to the cursor.
- Move the cursor to 2.1 on the C scale.
- The cursor is at 1.195 on the D scale.
- We know that the correct answer would be near -0.0006 * 20, or -0.0120. Therefore we adjust the decimal point to get a value of -0.01195.
- Subtract 0.01195 from 1. The result is (1 - 0.01195) = 0.98803. This is very close to the correct answer of 0.98809.