

PHY 157

The Slide Rule

(Experiment 10)

Name: _____

1 Introduction

Before electronic calculators became available around 1975, students, engineers, and scientists performed mathematical calculations using an instrument called a *slide rule*. With this simple device, you will be able to multiply, divide, and calculate reciprocals, squares, square roots, cubes, cube roots, logarithms, sines, cosines, tangents, cotangents, and inverse trigonometric functions.

In this lab you will construct a slide rule and learn how to use it to perform some basic calculations. Your slide rule will be very similar to the type used decades ago, and provides good practice in using analog devices. You will do the exercises (last page) and hand in only this last page as your lab report.

You may keep your slide rule.

2 Apparatus

- Slide Rule Kit (from May 2006 issue of *Scientific American*)

This experiment does not have a separate analysis section. You will perform calculations using your slide rule and write the answers in the spaces provided.

3 Instructions

The slide rule can perform calculations to three significant digits. It does not, however, keep track of the decimal point. You locate the decimal point by estimating the answer in your head.

The slide rule consists of three parts: (1) the *body* (or *stock*); (2) the *slide*; and (3) the *cursor* (the transparent sliding window with a hairline). Inscribed on the body and slide are sets of scales. This slide rule has nine scales; some more advanced models have 25, 30 or more. Scales are generally labeled with one or two letters, and these names are standard on most rules.

On your slide rule, the T, K and A scales are on the upper part of the body; the B, CI, and C scales are on the slide; and the D, L, and S scales are on the lower part of the body.

1. **The C and D Scales.** The C and D scales are the scales that are used most often: they are used to perform multiplication and division.

Multiplication. Set the left *index* (the left 1) on the C scale over the first number (the multiplicand) on the D scale. Find the second number (the multiplier) on the D scale; move the cursor so that the hairline is over this second number. You then read the product on the D scale. If the second number is beyond the right-hand side of the scales, then move the slide to the left and use the right index (the right 1) instead of the left index on C.

Division. Division is actually a bit easier than multiplication. Set the hairline in the cursor over the dividend (the numerator) on the D scale. Then move the slide so that the divisor (the denominator) is under the hairline. The quotient will then be found on the D scale, under either the left or right index of the C scale.

2. **The CI Scale.** The CI scale is a reversed C scale; it shows the reciprocals of numbers on the C scale. To find the reciprocal of a number, just set the hairline over the number on the C scale, and read its reciprocal on the CI scale. (Notice that numbers on the CI scale run backwards, increasing from right to left.)

3. **The A and B Scales.** These scales are used to find squares and square roots.

Squares. To square a number, place the hairline over the number on the D scale, and find its square on the A scale. (You could also place the hairline over the number on the C scale, and find its square on the B scale.)

Square roots. To find the square root of a number, place the hairline over the number on the A scale, and read its square root on the D scale. Since the A scale has two scales on it, you have to know which half of the scale to use. You can use this rule: write the number in scientific notation. If the exponent of 10 is even, use the left half of A; if it is odd, use the right half.

You can also multiply and divide using the A and B scales, but with reduced accuracy (due to the smaller scales).

4. **The K Scale.** The K scale is used to find cubes and cube roots.

Cubes. To find the cube of a number, place the hairline over the number on the D scale, and read its cube on the K scale.

Cube roots. To find the cube root of a number, place the hairline over the number on the K scale, and read its cube root on the D scale. Since the K scale is divided into three parts, you will have to take care to use the correct third of the K scale when doing this. Write the number in scientific notation; if the exponent of 10 is a multiple of 3, then use the left third; if it is 1 more than a multiple of 3, use the middle third; if it is 2 more than a multiple of 3, then use the right third.

5. **The L Scale.** The L scale is used to calculate common (base 10) logarithms. The L scale will only show the part of the logarithm to the right of the decimal point. You must provide the part to the left of the decimal point from knowing the magnitude of the number.

Place the hairline over a number on the D scale, and read the logarithm (the part to the right of the decimal point) on the L scale.

To find natural logarithms, use $\ln x = \log x / \log e = 2.30 \log x$. In other words, multiply the base 10 logarithm by 2.30.

6. **The S Scale.** The S scale is used to find sines and cosines of angles.

Sine of an angle between 0° and $5^\circ.74$. the sine of an angle in this range is approximately the angle converted to radians, so just multiply the degrees by $\pi/180 = 0.0175$.

Sine of an angle between $5^\circ.74$ and 90° . Find the angle (in degrees) on the S scale (using the black numbers), and read its sine on the D scale.

Cosine of an angle between 0° and $84^\circ.3$. Find the angle (in degrees) on the S scale (using the grey numbers), and read its cosine on the D scale.

7. **The T Scale.** The T scale is used to find tangents and cotangents of angles.

Tangent of an angle between 0° and $5^\circ.74$. The tangent of an angle in this range is approximately the angle converted to radians, so just multiply the degrees by $\pi/180 = 0.0175$.

Tangent of an angle between $5^\circ.74$ and 45° . Set the hairline over the angle (in degrees) on the T scale (black numbers), and find its tangent on the D scale.

Tangent of an angle between 45° and $84^\circ.3$. First, align the C and D scales (so that the slide is centered). Set the hairline over the angle (in degrees) on the T scale (grey numbers), and find its tangent on the CI scale.

Cotangent of an angle between $5^\circ.74$ and 45° . First, align the C and D scales (so that the slide is centered). Set the hairline over the angle (in degrees) on the T scale (black numbers), and find its cotangent on the CI scale.

Cotangent of an angle between 45° and $84^\circ.3$. Set the hairline over the angle (in degrees) on the T scale (grey numbers), and find its cotangent on the D scale.

Lab 10 Exercises

Name: _____

Use the slide rule to calculate the following:

$$15 \times 17 = \underline{\hspace{2cm}}$$

$$27 \times 45 = \underline{\hspace{2cm}}$$

$$6/4.5 = \underline{\hspace{2cm}}$$

$$4.3^2 = \underline{\hspace{2cm}}$$

$$\sqrt{45} = \underline{\hspace{2cm}}$$

$$2.3^3 = \underline{\hspace{2cm}}$$

$$\log 3.70 = \underline{\hspace{2cm}}$$

$$\sin 22^\circ = \underline{\hspace{2cm}}$$

$$\cos 52^\circ = \underline{\hspace{2cm}}$$

$$\tan 23^\circ = \underline{\hspace{2cm}}$$