Slide Rule Guide

Authors
Mario G. Salvadori and Jerome H. Weiner
Colombia University

Editor
Joseph L. Leon
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Preface

This is a reformatted version of a document which was copyrighted in 1956. There is no record in the U.S. Copyright Office of this copyright being updated. The original company’s phone number is disconnected, and the original editor and owner of the company has passed away. So far as we can tell, this document is now in the public domain.

This reformatted version is based on a low resolution scan. Image processing enhancements were performed to ready the image for optical character recognition software. Sections at a time were isolated and fed to the OCR software. The resulting text was assembled into one document. OCR mistakes were then located and corrected. Original text was preserved in almost every instance.

The layout has been changed to a much more readable format. Mathematics were typeset with small modifications to improve clarity, such as the use of powers of ten notation. A few typographic flaws in the original were corrected, such as square-root symbols which did not always extend as far as necessary. Finally, two transposed digits were found and corrected in the answers in the log-log section.

For a list of abbreviations, see Appendix A.

For a grayscale version of the original document, see Appendix B.
Chapter I

READING THE SLIDE RULE SCALES

I-A THE DECIMAL POINT (d.p.)

There is no way of indicating the position of the d.p. in a number read on a slide rule scale. Only the sequence of significant digits is indicated.

I-B SIGNIFICANT DIGITS (s.d.’s)

in a number are the first non-zero digit and those following it, up to and including the last non-zero digit.

Ex: s.d.’s in italics: 600, 450, 40500, 0.0600, 0.06020, 0.00160060.

Thus the numbers 10,500, 1,050, and .00105 are treated as the same number consisting only of the three s.d.’s 1-0-5. Likewise .002, .02, 2, 200, 2,000, etc. are treated as a number with the single s.d. “2”.

NOTE: Numbers may be expressed to three places using zeros when necessary since slide rule scales can usually be read accurately to just three places.

Ex: 2 may be written 2-0-0; 69 as 6-9-0; etc.

For the location of the d.p. in the answer see Section II on page 5.
I-C PRIMARY MARKS

PRIMARY MARKS AND THE FIRST SIGNIFICANT DIGIT

The ten primary marks on each of the scales in Fig. 1 are labeled with the largest numbers (1, 2, 3, 4, 5, 6, 7, 8, 9, 1) and divide the length of a scale into nine primary spaces. The scale may run the length of the rule (C scale) or may be repeated several times (A and K scales) as seen on your slide rule.

A NUMBER WITH ONE SIGNIFICANT DIGIT

A number with one significant digit is located at the corresponding primary mark.

Ex: No. s 1-0-0, 2-0-0, 3-0-0, etc. are located at primary marks 1, 2, 3, etc.

I-D SECONDARY MARKS

SECONDARY MARKS AND THE SECOND SIGNIFICANT DIGIT

Secondary marks (the heavy lines in Fig. 1) form the major divisions of the space between two consecutive primary marks and may vary in number. Note in Fig. 1 and on your slide rule that nine secondary marks form ten secondary spaces. Each space is then equal to one unit in the second place of a number and s.d.’s 1 to 9 can be located on secondary marks. Four marks form only five secondary spaces, each space representing two units in the second place. This means that even digits (2, 4, 6, 8) are located on marks and odd digits (1, 3, 5, 7, 9) are located midway between marks.

A NUMBER WITH TWO SIGNIFICANT DIGITS

A number with two significant digits is located at the secondary mark or in the secondary space representing the second digit following the primary mark that represents the first digit.

Ex: 1. No. 1-8-0 is located on each scale at the eighth secondary mark following primary mark 1.

Ex: 2. No. 2-3-0 is located on each scale at the third secondary mark after primary mark 2.

Ex: 3. No. 6-2-0 on scale K is located at the first secondary mark after primary mark 6.
4. 7-5-0 on scale K is located halfway between second secondary mark (7-4-0) and third secondary mark (7-6-0).

I-E TERTIARY MARKS

TERTIARY MARKS AND THE THIRD DIGIT

Tertiary marks (the thin lines in Fig. 1) divide the space between two consecutive secondary marks.

A NUMBER WITH THREE SIGNIFICANT DIGITS

A number with three significant digits is located at the corresponding tertiary mark or in the tertiary space following the second digit position.

Ex: 5. No. 1-3-2. On scale C it is located at the second tertiary mark following position 1-3-0. On scale A it is located at the first tertiary mark following position 1-3-0, since each space is valued two units. On scale K, 1-3-2 is estimated two-fifths of the way between 1-3-0 and the next tertiary mark 1-3-5.

Ex: 6. No. 8-5-7. On scale C it is located two-fifths of the way between the center tertiary mark 8-5-5 and mark 8-6-0. On scale A, 8-5-7 is estimated at a point seven-tenths of the way between 8-5-0 and 8-6-0 since the entire space is equivalent to 10 units in the third place. On scale K first locate 8-5-0 midway between marks 8-4-0 and 8-6-0. Then estimate a point seven-tenths of the way between 8-5-0 and 8-6-0 to locate 8-5-7.

Ex: 7. No. 9-0-3. NOTE: When the second digit is zero the number is always located in the space between the appropriate primary mark and first secondary mark following it. No. 9-0-3. On scale C, located three-fifths of the way between primary mark 9 (9-0-0) and the first tertiary mark (9-0-5). On scale A, since there are no tertiary marks, it is located three-tenths of the way between primary mark 9 (9-0-0) and the first secondary mark (9-1-0). On scale K, first estimate 9-1-0; then estimate 9-0-3 at a point three-tenths of the distance between 9-0-0 and 9-1-0.

I-F THE FOURTH DIGIT OF A NUMBER

can be located only on that portion of a scale containing ten tertiary spaces.

Ex: 8. No. 1-5-5-8 is located on scale C eight-tenths of the way between 1-5-5-0 and 1-5-6-0.
I-G  IF A NUMBER HAS MORE SIGNIFICANT DIGITS THAN CAN BE LOCATED ACCURATELY ON A GIVEN SCALE

it is first rounded off. See Section II on page 5.

Table I.1: SUMMARY OF VARIATIONS IN SLIDE RULE SCALE DIVISIONS

<table>
<thead>
<tr>
<th>MARKS</th>
<th>SPACES</th>
<th>SPACE / VALUE</th>
<th>DIGIT LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>10</td>
<td>1 unit</td>
<td>All digits located on marks.</td>
</tr>
<tr>
<td>4</td>
<td>5</td>
<td>2 units</td>
<td>2, 4, 6, 8 on marks; 1, 3, 5, 7, 9 half-way between marks.</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
<td>5 units</td>
<td>5 on the mark; 1 to 4 and 6 to 9 estimated in space left or right of the mark.</td>
</tr>
<tr>
<td>0</td>
<td>1</td>
<td>10 units</td>
<td>All digits estimated by approximate division of the space into ten parts.</td>
</tr>
</tbody>
</table>
Chapter II

LOCATION OF THE DECIMAL POINT IN THE ANSWER

Found by obtaining an approximate answer (AA) as follows:

1. ROUND OFF. Set all s.d.’s but the first equal to “0”.

   Ex: 1340 becomes 1000; .0609→.06; 53.65→50; .003006→.003

   NOTE: Increase the first s.d. by one unit if the second is five or more.

   Ex: 4.62→5; .987→1.0

2. CONVERT TO POWERS OF TEN.

   POWERS OF TEN:
   \(10^0 = 1; 10^1 = 10; 10^2 = 100; 10^3 = 1000; 10^{-1} = 0.1; 10^{-2} = 0.01; 10^{-3} = 0.001\); etc.
   NOTE: Negative powers of ten are the reciprocals of the corresponding powers of ten.

   Ex: \(10^{-2} = \frac{1}{10^2} = \frac{1}{100} = .01\)

   CONVERSION FORM:
   Numbers are written with one (or two) s.d.’s to the left of the d.p.

   Ex: \(300 = 3 \times 10 \times 10 = 3 \times 10^2\)

   The integer is called the multiplier. The exponent of ten is the power.

   Numbers > 10: Shift the d.p. “m” places left, multiply by 10.

   Ex: \(500 = 5 \times 10^2, 6000 = 6 \times 10^3\)

   Numbers < 1: Shift the d.p. “m” places right and multiply by \(10^{-m}\).

   Ex: \(0.06 = 6 \times 10^{-2}, 0.0030 = 3 \times 10^{-3}\)

3. PERFORM INDICATED OPERATIONS.

   MULTIPLICATION:
   \((N_1 \times 10^x)(N_2 \times 10^y) = (N_1 \times N_2)(10^{x+y})\).
   Exponents are added algebraically.
**DIVISION:**

\[(N_1 \times 10^x) \div (N_2 \times 10^y) = (N_1 \div N_2)(10^{x-y}).\]

Exponents are subtracted algebraically.

- Ex: \((6 \times 10^5) \div (3 \times 10^2) = (2 \times 10^3)\)
- Ex: \((8 \times 10^4) \div (4 \times 10^4) = (2 \times 10^0) = 2\)
- Ex: \((9 \times 10^1) \div (3 \times 10^{-5}) = (3 \times 10^6)\)

**POWERS:**

\[(N \times 10^x)^y = (N^y)(10^{xy}).\]

Exponents are multiplied algebraically.

- Ex: \((2 \times 10^3)^2 = (2^2 \times 10^{3\times2}) = (4 \times 10^6)\)
- Ex: \((2 \times 10^{-3})^3 = (8 \times 10^{-9})\)

**ROOTS:**

\[\sqrt[\chi]{(N \times 10^x)} = (\sqrt[\chi]{N} \times 10^{x/y}).\]

Exponents are divided algebraically.

- Ex: \(\sqrt{400} = \sqrt{4 \times 10^2} = \sqrt{4} \times 10^{2/2} = 2 \times 10^1\)
- Ex: \(\sqrt{.0004} = \sqrt{(4 \times 10^{-4})} = (2 \times 10^{-2})\)
- Ex: \(\sqrt[3]{27,000} = \sqrt[3]{27 \times 10^3} = (3 \times 10^1)\)

4. **CONVERT ANSWERS BACK TO DECIMAL NOTATION.**

\((N \times 10^m)\): Shift the decimal point “m” places right.

- Ex: \((6 \times 10^3) = 6000\)
- Ex: \((5.4 \times 10^1) = 54\)

\((N \times 10^{-m})\): Shift decimal point “m” places left.

- Ex: \((7.14 \times 10^{-2}) = 0.0714\)
- Ex: \(.0600 \times 10^{-1} = .006\)

**COMBINED OPERATIONS:**
Ex:

\[
\frac{3.02 \times 120 \times \sqrt{392}}{1.15 \times (30.6)^2}
\]

AA:

\[
\frac{(3 \times 10^0)(1 \times 10^2)(\sqrt{4 \times 10^2})}{(1 \times 10^0)(3 \times 10^1)^2} = \frac{3 \times 1 \times 2}{1 \times 9} \times 10^{0+2+\frac{2}{2}-0-(1 \times 2)} = \frac{2}{3} \times 10^1 = 6.67
\]
Chapter III

MULTIPLICATION

III-A  SCALES USED

The C on the slide and the D on the body extend the length of the rule. The left and right "1" marks are called the left and right C and D indices. (LC1, RC1; LD1, RD1)

III-B  SLIDE RULE OPERATION (SRO)

\( N_1 \times N_2 = P \): Set the left C index over the first number \( N_1 \) on the D scale. Move the hairline (HLN) to the second number \( N_2 \) on the C scale. Read the product P under the hairline on the D scale.

<table>
<thead>
<tr>
<th>Ex: ( 2 \times 3 )</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SRO:</strong> Set LC1 over D2. Move HLN to C3. Read product under the HLN at D6.</td>
<td></td>
</tr>
<tr>
<td><strong>ANS:</strong> 6.</td>
<td></td>
</tr>
<tr>
<td><strong>NOTE:</strong> If in the second step, ( N_2 ) cannot be positioned on the C scale, set the right C index over ( N_1 ) instead.</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex: ( 2 \times 9 )</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SRO:</strong> If LC1 is set over D2, C9 is off scale; therefore, set RC1 over D2. Move HLN to C9. Read product under HLN at D1-8.</td>
<td></td>
</tr>
<tr>
<td><strong>ANS:</strong> 18</td>
<td></td>
</tr>
</tbody>
</table>
III-C  COMPLETE OPERATION

Ex: 21 × 320

AA: Round off and express as powers of ten; 21 → 20 = (2 × 10^1); 320 → 300 = (3 × 10^2). Perform the indicated operation; multiply: (2 × 10^1) × (3 × 10^2) = (6 × 10^3) = 6000.

SRO: Set LC1 on D2-1. Move HLN to C3-2. Read the product under the HLN at D6-7-2.

ANS: Since AA = 6000, the true answer is 6,720.

Ex: 0.0855 × 4120

AA: (9 × 10^{-2}) × (4 × 10^3) = (36 × 10^1) = 360

SRO: RC1 on D8-5-5, HLN to C4-1-2. Product under HLN at D3-5-2.

ANS: 352

Ex: 0.442 × 11.6

AA: (4 × 10^{-1}) × (1 × 10^1) = (4 × 10^0) = 4

SRO: LC1 on D4-4-2, HLN to C1-1-6. Product under HLN at D5-1-2.

ANS: 5.12

III-D  PERCENTAGES

x% of N = (x) × (N) × (10^{-2}).

Ex: 50% of 12 = 50 × 12 × 10^{-2} = 600 × 10^{-2} = 6

Ex: 6.4% of .036

AA: 6 × (4 × 10^{-2}) × 10^{-2} = (24 × 10^{-4}) = .0024

SRO: Set RC1 over D6-4. Move HLN to C3-6. Read under HLN, D2-3.

ANS: 0.0023
III-E CONTINUED PRODUCTS

\[ N_1 \times N_2 \times N_3 = P. \]

**SRO:** Multiply the first two factors \((N_1 \times N_2 = P_a)\). Multiply this partial product by the next factor \((P_a \times N_3 = P_b)\). Continue multiplying each partial product by the next factor until the final product is obtained.

<table>
<thead>
<tr>
<th>Ex: 6.4 \times .088 \times 12.3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AA:</strong> (6 \times (9 \times 10^{-2}) \times (1 \times 10^1)) = 5.4)</td>
</tr>
<tr>
<td><strong>SRO:</strong> It is not necessary to read any of the partial products. Set (RCI) over (D6-4). Move (HLN) to (C8-8). Bring (LC1) under the (HLN). Move (HLN) to (C1-2-3). The final product is under (HLN) at (D6-9).</td>
</tr>
<tr>
<td><strong>ANS:</strong> 6.9</td>
</tr>
</tbody>
</table>


Chapter IV

DIVISION

IV-A SCALES USED

are C and D.

IV-B SRO

\( N_1 \div N_2 = Q \). Set hairline over the numerator \( N_1 \) on D scale. Bring the denominator \( N_2 \) on the C scale under the hairline. Read quotient Q under whichever C index falls on the D scale.

<table>
<thead>
<tr>
<th>Ex: 6 ( \div ) 3</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SRO:</strong> Set HLN on D6. Bring C3 under HLN. Read quotient under LC1 at D2.</td>
</tr>
<tr>
<td><strong>ANS:</strong> 2</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex: 62 ( \div ) 305</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AA:</strong> ((6 \times 10^1) \div (3 \times 10^2) = (2 \times 10^{-1}) = 0.2)</td>
</tr>
<tr>
<td><strong>SRO:</strong> Set HLN on 05.2. Bring C3-0-5 under HLN. Read quotient under LC1 at D2-0-3.</td>
</tr>
<tr>
<td><strong>ANS:</strong> 0.203</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex: 17.55 ( \div ) 0.00203</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AA:</strong> ((2 \times 10^1) \div (2 \times 10^{-3}) = (1 \times 10^4) = 10,000)</td>
</tr>
<tr>
<td><strong>SRO:</strong> HLN on D1-7-5-5. Bring C2-0-3 under HLN. Under RC1 read D8-6-4.</td>
</tr>
<tr>
<td><strong>ANS:</strong> 8,640</td>
</tr>
</tbody>
</table>
Chapter V

COMBINED_MULTIPLICATION_AND_DIVISION

V-A ONE FACTOR IN NUMERATOR OR DENOMINATOR

Perform sequence multiplication then division.

Form: \(N_1 \times N_2 \times N_3 \times \cdots \div N_d\)
Or: \((N_n \div N_1) \times N_2 \times N_3 \ldots\)

V-B SEVERAL FACTORS IN NUMERATOR AND DENOMINATOR

Perform multiplication and division operations alternately whenever possible since the least number of slide rule motions will then be required.

Form:

\[
\begin{array}{c}
\frac{N_1 \times N_2}{N_3 \times N_4}
\end{array}
\]

Perform as: \(N_1 \div N_3 \times N_2 \div N_4\)

Form:

\[
\begin{array}{c}
\frac{N_1 \times N_2 \times N_3 \times N_4}{N_5 \times N_6}
\end{array}
\]

Perform as: \(N_1 \times N_2 \div N_5 \times N_3 \div N_6 \times N_4\)

Form:

\[
\begin{array}{c}
\frac{N_1 \times N_2}{N_3 \times N_4 \times N_5}
\end{array}
\]

Perform as: \(N_1 \div N_3 \times N_2 \div N_4 \div N_5\)
Ex: \[
\frac{2.02 \times 120 \times 0.0925}{1.15 \times 0.81}
\]

AA:
\[
\frac{2 \times (1 \times 10^2) \times (9 \times 10^{-2})}{1 \times (8 \times 10^{-1})} = 18 \div 8 \times 10^1 \approx 20
\]

SRO: It is not necessary to read any intermediate results. Perform as 2-0-2 ÷ 1-1-5 × 1-2-0 ÷ 8-1 × 9-2-5.

1. Divide: Set HLN on D2-0-2. Bring C1-1-5 under HLN.
2. Multiply: Move HLN to C1-2-0.
3. Divide: Bring C8-1-0 under HLN.
5. Read under HLN, D2-4-1.

ANS: 24.1

(See also Section VII on page 16.)
Chapter VI

PROPORTIONS ON THE SLIDE RULE

VI-A  PRINCIPLE

Any pair of numbers set opposite each other on the C and D (or CF and DF) scales are in the same proportion as any other pair of numbers found opposite each other along the entire length of the scales.

Ex: Set C1 over D2; the proportion is 1 to 2 (written also 1/2 or 1:2); read on the scales C2 opposite D4, C3 opposite D6, etc.

VI-B  FORMATION OF PROPORTIONS

A whole number may be divided by 1.

Ex: 6 = 2.6/x solve as 6/1 = 2.6/x

Any factor in the numerator (denominator) of one ratio may be transferred to the denominator (numerator) of the other.

Ex: 6 = $\frac{2.4 \times 9.4}{x}$ solve as $\frac{6}{9.4} = \frac{2.4}{x}$ or $\frac{x}{2.4} = \frac{9.4}{6}$; etc.
### VI-C  MULTIPLE PROPORTIONS

**Ex:**

\[
\frac{.0202}{.182} = \frac{x}{.3} = \frac{4.5}{y}
\]

(Set numerators on C)

(Set denominators on D)

**AA:**

\[
x = \frac{(2 \times 10^{-2}) \times (3 \times 10^{-1})}{(2 \times 10^{-1})} = \frac{(3 \times 10^{-2})}{.03}
\]

\[
y = \frac{(5) \times (2 \times 10^{-1})}{(2 \times 10^{-2})} = \frac{(5 \times 10^1)}{50}
\]

**SRO:** Set C2-0-2 over D1-8-2. Move HLN to D3; read C3-3-3. Move HLN to C4-5; read D4-0-5.

**ANS:** \(x = .0333; y = 40.5\)
Chapter VII

FOLDED SCALES

VII-A SCALES

The CF, a folded C scale is on the slide; the DF, a folded D scale, is on the body. Both scales have a single index in the center. Their extreme right and left ends are labeled π.

VII-B PRINCIPLE

Operations performed on the C and D scales are simultaneously being performed on the CF and DF scales.

VII-C APPLICATIONS

When numbers cannot be conveniently matched because of their position on the C and D scales: the operation can be transferred to the folded scales. The calculation can either be completed on the folded scales or returned to the C and D scales at will.

NOTE: When the answer is to be found under an index, it can be read under either the CF or C indices; but when the answer is to be found under the hairline, it must be read on the scale concerned.

<table>
<thead>
<tr>
<th>Ex: $(18 \div 4) \times 11$</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA: $(20 \div 4) \times 10 = 50$</td>
</tr>
<tr>
<td>SRO:</td>
</tr>
<tr>
<td>1. Divide: Over D1-8 set C4; quotient is then under RC1 at D4-5.</td>
</tr>
<tr>
<td>2. Multiply: Move hairline to C1-1; since 1-1 is off scale, it would be necessary to switch LC1 over 4-5 to bring 1-1 back on scale. Instead, note that DF4-5 is over CF1. Then, merely move HLN to CF1-1 and read under HLN, DF4-9-5.</td>
</tr>
<tr>
<td>ANS: 49.5</td>
</tr>
</tbody>
</table>
Multiplication by $\pi$:

SRO: Set N on D under HLN, read $\pi \times N$ on DF.

Ex: Opposite 3 on D read $3\pi = 9.42$ on DF.

Division by $\pi$:

SRO: Set N on DF under HLN, read $N \div \pi$ on D.

Ex: Opposite 4 on DF read $4 \div \pi = 1.273$ on D.

NOTE: Circumference (on DF) = $\pi \times$ diameter (on D); diameter (on D) = circumference (on DF)/$\pi$
Chapter VIII

RECIROCAL (or INVERSE) SCALES

VIII-A SCALES

The CI, on the slide, is an inverted C scale, and reads from right to left. The CIF (above the CI) is a folded CI scale having a single index in the center of the scale.

VIII-B RECIPROCALS

Definition:

The reciprocal of the number N equals 1/N; also written as \(N^{-1}\).

Ex: \(5^{-1} = 1/5 = .200\)

Properties:

Division by N can be replaced by multiplication by 1/N, \(a \div N = a \times 1/N\).

Ex: \(6 \div 3 = 6 \times 1/3 = 2\)

Multiplication by N can be replaced by division by 1/N, \(a \times N = a \div 1/N\).

Ex: \(4 \times 2 = 4 \div 1/2 = 8\)

VIII-C USING THE RECIPROCAL SCALES

To obtain a reciprocal:

SRO: Set N on scale C under the hairline, read 1/N on the scale CI. If N is on the CF, 1/N is read from the CIF scale.
Ex: Find 1/246

AA: 1/246 \rightarrow 1/200 = (1/2 \times 10^{-2}) = (.5 \times 10^{-2}) = .005
SRO: Set C2-4-6 under HLN and read CI4-0-6
ANS: 0.00406

To reduce slide motions in multiply and divide when factors are widely separated:

Remember: When using the CI answers are read on D; with the CIF, answers are read on the DF.

Ex: 12 \div 7.5 \text{ — Perform as } 12 \times 7.5^{-1}

SRO: Set LC1 over D1-2. Move HLN to CI7-5. Read under HLN, D1-6.
ANS: 1.6

Ex: 12 \times 9.1 \text{ — Perform as } 12 \div 9.1^{-1}

SRO: Set HLN over D1-2. Bring CI9-1 under HLN. Read under RC1, D1-0-9-2.
ANS: 109.2
NOTE: 12 \times 9.1 could also have been calculated with the CF and DF.

To simplify combined operations by permitting complete alternation of multiply and divide operations:

NOTE: The proficient use of the CI and CIF scales is of fundamental importance in fast computation.

Ex: 2.1 \times 14 \times 6.6 \div 0.073

AA: (2 \times 10 \times 7) \div (7 \times 10^{-2}) = 140 \div (7 \times 10^{-2}) = (20 \times 10^{2}) = 2000
SRO: Perform as 2.1 \times 1.4 \div 6.6^{-1} \times 7.3^{-1}
    1. Multiply: Set LC1 over D2-1, move HLN to CI4-4.
    2. Divide: Bring CI6-6 under HLN.
    3. Multiply: Set HLN on CI7-3. Read under HLN, D2-6-6.
ANS: 2660
Chapter IX

COMBINED OPERATIONS — FOLDED AND INVERSE SCALES

NOTE: With the combined use of folded and inverse scales, a minimum number of slide and HLN shifts is required.

### Ex: $2 \times 1.4 \times 6.2 \times 7 \times 0.51$

**AA:*** $2 \times 1 \times 6 \times 7 \times (5 \times 10^{-1}) = 42$

**SRO:** Perform as $2 \times 1.4 \div 6.2^{-1} \times 7 \div 0.51^{-1}$

1. Multiply: Set $LC1$ on $D2$, $HLN$ on $C1-4$.
2. Divide: Bring $CI6-2$ under $HLN$.
3. Multiply. Since $C7$ is off scale, set $HLN$ on $CF7$.
4. Divide: Bring $CIF5-1$ under $HLN$. Read under $CF$ index, $DF6-2$.

**ANS:** 62

### Ex: $6.04 \times .051 \times 86 \div 2.64$

**AA:** $6 \times (5 \times 10^{-2}) \times 8 \times 10 \div 2 = 12$

**SRO:** Perform as $6.04 \times .051 \div 86^{-1} \times 2.64^{-1}$

1. Multiply. Set $LC1$ at $D6-0-4$, $HLN$ on $C5-1$.
2. Divide: Bring $CI8-6$ under $HLN$.

**ANS:** 10.02
Chapter X

SQUARES

X-A SCALES USED

$D$ and $C$ with the $A$ and $B$ (or $\sqrt{}$) scales. The $A$ on the body and $B$ on the slide each contain two scales, similar to, but $1/2$ the length of the $D$. (Two full-length scales may replace the $A$ and $B$.)

X-B SRO

$N \rightarrow N^2$. Set hairline over $N$ on $D$ scale and read $N^2$ under hairline on $A$ scale (or set hairline over $N$ on $C$ scale and read $N^2$ under hairline on $B$ scale).

<table>
<thead>
<tr>
<th>Ex: $3^2$</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>SRO: Set him over $D3$, read under $HLN$, $A9$.</td>
<td></td>
</tr>
<tr>
<td>ANS: 9</td>
<td></td>
</tr>
</tbody>
</table>

Ex: $(41)^2$

|  |
|---|---|
| AA: $(4 \times 10^1)^2 = (16 \times 10^2) = 1600$ |  |
| SRO: $HLN$ on $D4-1$, read under $HLN$, $A1-6-8$. |  |
| ANS: 1680 |  |
Ex: $(.15)^2$

**AA:** $(1 \times 10^{-1})^2 = (1 \times 10^{-2}) = .01$

**SRO:** *HLN* on *D1-1-5:* read under *HLN,* *A1-3-2.*

**ANS:** 0.0132

Ex: $(613)^2$

**AA:** $(6 \times 10^2)^2 = (36 \times 10^4) = 360,000$

**SRO:** *HLN* on *D6-1-3;* read under *HLN,* *A3-7-6.*

**ANS:** 376,000

**X-C SRO**

Set hairline on *N* on √ scale. Read *N* on √ scale.

Ex: $(6.1)^2$

**SRO:** Set *HLN* on 6-1 on √ scale; read *D3-7-2.*

**ANS:** 37.2
Chapter XI

CUBES

XI-A SCALES USED

The $D$ with $K$ (or $\sqrt[3]{\cdot}$) scales. The $K$ on the body is composed of three scales, similar to, but each 1/3 the length of the $D$. (Three full-length scales may replace the $K$.)

XI-B SRO

$N \rightarrow N^3$. Set hairline over $N$ on $D$ scale; read $N^3$ under hairline on $K$ scale.

<table>
<thead>
<tr>
<th>Ex: $2^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRO: Set $HLN$ over $D2$; read under $HLN$, $K8$.</td>
</tr>
<tr>
<td>ANS: 8</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex: $(0.117)^3$</th>
</tr>
</thead>
<tbody>
<tr>
<td>AA: $(0.117)^3 \approx (1 \times 10^{-1})^3 = .001$</td>
</tr>
<tr>
<td>SRO: $HLN$ on $D1-1-7$, read under $HLN$, $K1-6-1$</td>
</tr>
<tr>
<td>ANS: .00161</td>
</tr>
</tbody>
</table>
Chapter XII

SQUARE ROOTS

XII-A SCALES USED

Same as for squares.

XII-B FORM OF N

Must have either one or two digits left of the d.p. Otherwise, re-write N with an even power of ten

\[ \ldots, 10^{-4}, 10^{-2}, 10^0, 10^2, 10^4, \ldots \]

such that one or two digits are placed left of the d.p. in the multiplier. Then, take the square root of this power of ten.

Ex: \[ \sqrt{400} = \sqrt{(4 \times 10^2)} = 4 \times 10^1 \]

Ex: \[ \sqrt{0.00225} = \sqrt{(22.5 \times 10^{-4})} = (\sqrt{22.5} \times 10^{-2}) \]

The square root of the multiplier is found on the slide rule as follows:

XII-C SRO

\[ N \rightarrow \sqrt{N} \rightarrow \] Set the hairline over N located on the proper section of the A or B scales as shown:

<table>
<thead>
<tr>
<th>No. of digits left of the d.p. in the multiplier</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root location on section of A or B scale</td>
<td>left (1st)</td>
<td>right (2nd)</td>
</tr>
</tbody>
</table>

Read \[ \sqrt{N} \] under the hairline on the D scale if N is set on A (or on the C scale is N is set on B).
XII-D  SRO

Set hairline on N on D.

Read $\sqrt{N}$ on upper or lower $\sqrt{-}$ scale if N has one or two digits left of the d.p.

XII-E  DECIMAL POINT LOCATION

Always place the d.p. after the first digit of the number read from the slide rule. When the square root is multiplied by a power of ten, move the d.p. the indicated number of places.

<table>
<thead>
<tr>
<th>Ex: $\sqrt{900}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Form:</strong> $\sqrt{900} = \sqrt{(9 \times 10^2)} = (\sqrt{9} \times 10^1)$</td>
</tr>
<tr>
<td><strong>SRO:</strong> HLN on A9 (left section). Read under HLN D3-0-0.</td>
</tr>
<tr>
<td><strong>D.P.:</strong> $(3.0 \times 10^1)$</td>
</tr>
<tr>
<td><strong>ANS:</strong> 30</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex: $\sqrt{25}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Form:</strong> $\sqrt{25}$ is already in the proper form.</td>
</tr>
<tr>
<td><strong>SRO:</strong> Set HLN on A2-5 (right section). Read under HLN, D5-0-0.</td>
</tr>
<tr>
<td><strong>D.P.:</strong> 5.0</td>
</tr>
<tr>
<td><strong>ANS:</strong> 5.0</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex: $\sqrt{415} = \sqrt{(4.15 \times 10^2)} = (\sqrt{4.15} \times 10^1)$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SRO:</strong> Set HLN on A4-1-5 (left section). Read under HLN, D2-0-4.</td>
</tr>
<tr>
<td><strong>D.P.:</strong> $(2.04 \times 10^1)$</td>
</tr>
<tr>
<td><strong>ANS:</strong> 20.4</td>
</tr>
</tbody>
</table>
### Ex: \( \sqrt{0.00365} = \sqrt{(36.5 \times 10^{-4})} = (\sqrt{36.5} \times 10^{-2}) \)

<table>
<thead>
<tr>
<th><strong>SRO:</strong></th>
<th>Set HLN on A3-6-5 (right section). Read under HLN, D6-0-4.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>D.P.:</strong></td>
<td>((6.04 \times 10^{-2}))</td>
</tr>
<tr>
<td><strong>ANS:</strong></td>
<td>0.0604</td>
</tr>
</tbody>
</table>

### Ex: \( \sqrt{52.4} \)

<table>
<thead>
<tr>
<th><strong>SRO:</strong></th>
<th>Set HLN on D5-2-4; read 7 2-4 on lower ( \sqrt{\ } ) scale.</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>ANS:</strong></td>
<td>7.24</td>
</tr>
</tbody>
</table>
Chapter XIII

CUBE ROOTS

XIII-A SCALES USED

Same as for cubes.

XIII-B FORM OF N

Must have either one, two, or three digits to the left of the d.p. Otherwise, rewrite N with a power of ten that is a multiple of three

\[ \ldots, 10^{-6}, 10^{-3}, 10^0, 10^3, 10^6, \ldots \]

such that one, two, or three digits are placed to the left of the d.p. in the multiplier. Then, take the cube root of this power of ten.

Example:

\[ 3\sqrt{27000} = 3\sqrt{(27 \times 10^3)} = (3\sqrt{27} \times 10^1) \]

Example:

\[ 3\sqrt{.0000157} = 3\sqrt{(15.7 \times 10^{-6})} = (3\sqrt{15.7} \times 10^{-2}) \]

The cube root of the multiplier is found on the slide rule as follows:

XIII-C SRO

\( N \rightarrow N^3 \) — Set the hairline over \( N \) on the proper section of the \( K \) scale as shown:

<table>
<thead>
<tr>
<th>No. of digits left of the d.p. in the multiplier</th>
<th>1</th>
<th>2</th>
<th>3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Root location on section of L scale</td>
<td>left (1st)</td>
<td>middle (2nd)</td>
<td>right (3rd)</td>
</tr>
</tbody>
</table>

Read \( \sqrt[3]{N} \) under the hairline on the \( D \) scale.
XIII-D  SRO

Set N on D.
Read $\sqrt[3]{N}$ on upper, middle or lower $\sqrt[3]{N}$ scale if N has one, two, or three digits left of the d.p.

XIII-E  THE LOCATION OF THE DECIMAL POINT

Always place the d.p. after the first digit of the number read from the slide rule.
When the cube root is multiplied by a power of ten, move the d.p. the indicated number of places.

Ex: $\sqrt[3]{4150}$

Form: $\sqrt[3]{4150} = \sqrt[3]{(4.15 \times 10^3)} = (\sqrt[3]{4.15} \times 10^1)$
SRO: Set hairline on K4-1-5 (left section). Read under hlm, D1-6-0-5.
D.P.: (1.605 \times 10^1)
ANS: 16.05

Ex: $\sqrt[3]{0.000068}$

Form: $\sqrt[3]{0.000068} = \sqrt[3]{(68.0 \times 10^{-6})} = (\sqrt[3]{68.0} \times 10^{-2})$.
SRO: Set HLN on K6-8-0 (middle section). Read under HLN, D4-0-8.
D.P.: (4.08 \times 10^{-2}) = 0.0408

Ex: $\sqrt[3]{47.3}$

SRO: Set HLN on D4-7-3; read 3-6-1-5 on middle $\sqrt[3]{N}$ scale.
ANS: 3.615
Chapter XIV

COMBINED OPERATIONS: SQUARES OR SQUARE ROOTS

These problems can be solved without first finding the required roots or powers using the following methods.

XIV-A SQUARE ROOTS

Write all roots in the proper form (see Section XII on page 24). Perform the multiply and divide operations in the usual manner on the scales previously described but when the square root of a number N is needed: on the C (moving) scale, set the hairline over N on the proper section of the B (moving) scale; on the D (fixed) scale, set the hairline over N on the proper section of the A (fixed) scale.

<table>
<thead>
<tr>
<th>Ex: $2 \times \sqrt{9}$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SRO:</strong> Set $LC1$ at $D2$. Since the root is required on the C scale set $HLN$ on $B9$ (left section). Read under $HLN$, $D6$.</td>
</tr>
<tr>
<td><strong>ANS:</strong> 6</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex: $\sqrt{16} \div 2$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SRO:</strong> Since root is required on the D scale set $HLN$ on A1-6 (right section). Bring $C2$ under $HLN$. Read under $LC1$, $D2$.</td>
</tr>
<tr>
<td><strong>ANS:</strong> 2</td>
</tr>
</tbody>
</table>
Ex: $2.06 \times \sqrt{.062} \div \sqrt{916}$

Form: $2.06 \times \sqrt{(6.2 \times 10^{-2})} \div \sqrt{(9.16 \times 10^2)}$

AA: $2 \times (2 \times 10^{-1}) \div (3 \times 10^1) \approx .01$

SRO: Set LC1 at D2-0-6. Set HLN over B6-2 (left section). Bring B9-1-6 (left section) under HLN. Read under LC1, D1-6-9-5.

ANS: 0.01695

XIV-B  SQUARES

Multiply and divide may be performed on the A and B scales exactly as on the C and D scales. When the square of a number N is needed: on the B (moving) scale, set the hairline over N on the C (moving) scale; on the A (fixed) scale, set the hairline over N on the D (fixed) scale.

Ex: $2 \times 3^2$


ANS: 18

Ex: $6^2 \div 4$


ANS: 9

Ex: $(4.1)^2 \div (6.8)^2 \times 2$

AA: $20 \div 50 \times 2 = 0.800$

SRO: Set HLN on D4-1. Bring C6-8 under HLN. Set HLN on B2 and read under HLN A7-2-7.

ANS: 0.727
XIV-C  MIXED SQUARE ROOTS AND SQUARES

For the roots, use the rules in Section XIV-A, but compute the squares as a repeated product (see Section III-E on page 10).

Ex: $6 \times \sqrt{9} \times 2^2$, performed as $6 \times \sqrt{9} \times 2 \times 2$
Chapter XV

LOGARITHMS

XV-A SCALES USED

The L and D both on the body. The L scale has eleven primary marks labeled, 0, 0.1, 0.2, 0.3, etc. to 1 forming 10 equal primary spaces. The value of secondary and tertiary divisions is similar to the other scales.

XV-B COMPUTING LOGS

To determine the characteristic, C: Write N in powers of ten placing one digit to the left of the d.p. of the multiplier. C = the value of the exponent.

To determine the mantissa, M: Set the hairline over N on D scale, read M under the hairline on L scale.

Ex: log 36
C: 36 = \((3.6 \times 10^1)\); C = +1
M: Set hairline on D3-6: read M = 0.556 on L.
ANS: \(\log 36 = 1 + .556 = 1.556\)

Ex: log 0.0622
C: .0622 = \((6.22 \times 10^{-2})\); C = −2
M: Set hairline on D6-2-2; read M = 0.794 on L.
ANS: \(\log 0.0622 = -2 + 0.794\) written as 8. 794 − 10 or 7.794
XV-C ANTI-LOGS

Given the logarithm of N, find N.

SRO: Set the mantissa on L, read N on D.

D.P. location: Place the d.p. to the right of the first digit read from the slide rule. Convert the characteristic to a power of ten then move the d.p. the indicated number of places.

<table>
<thead>
<tr>
<th>Ex: Given log ( N = 9.583 - 10 ), find ( N ).</th>
</tr>
</thead>
<tbody>
<tr>
<td>SRO: Set .583 on ( L ), read under ( HLN ) D3-8.3.</td>
</tr>
<tr>
<td>D.P.: Write 3.83. Since ( C = 9 - 10 = -1 ); ( N = (3.83 \times 10^{-1}) = 0.383 )</td>
</tr>
</tbody>
</table>
Chapter XVI

TRIGONOMETRIC FUNCTIONS

XVI-A SCALES

The $S$ scale for sines and cosines; the $T$ scale for tangents (or cotangents) and the $ST$ scale for the sine or tangent of small angles.

XVI-B READING THE SCALES

Angles (θ) measured in degrees, are indicated by the numbered marks. On many slide rules, the $S$ and $T$ scales have two angles associated with the numbered marks: $θ$ (values of $θ$ increase from left to right) and $(90° − θ)$; values of $(90° − θ)$ increase from right to left and are sometimes printed in red.

Ex: On the $S$ scale, mark: 70|20 represents both $θ = 20°$ and $(90° − θ) = 70°$.

Angles not numbered on the scale are positioned by counting the number of primary marks in the space between labeled angles.

Ex: $24°$ is located on the fourth primary mark between labeled angles $20°$ and $25°$.

Fractions of angles are located between primary marks and may be expressed either in tenths of degrees or minutes (60 min. = 1 deg.) depending upon the make of the slide rule.

<table>
<thead>
<tr>
<th>Number of marks</th>
<th>DEGREES</th>
<th>MINUTES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of spaces</td>
<td>2 5 10</td>
<td>2 3 6</td>
</tr>
<tr>
<td>Value of space</td>
<td>0.5 0.2</td>
<td>30' 20'</td>
</tr>
</tbody>
</table>
XVI-C  SLIDE RULE OPERATIONS

SIN θ

<table>
<thead>
<tr>
<th>θ</th>
<th>0.57° to 5.7°</th>
<th>ST</th>
</tr>
</thead>
<tbody>
<tr>
<td>sinθ</td>
<td>0.01 to 0.1</td>
<td>C</td>
</tr>
</tbody>
</table>

SRO: Set HLN on θ on scale ST, read the value of sin θ under HLN on scale C.

D.P.: Place 1 zero between the d.p. and the first digit.

Ex: sin 1.62°
SRO: Set HLN on 1.62° on ST; read D2-8-2.
ANS: 0.0282

Ex: sin 3°14′
SRO: Set HLN on 3°14′ on ST; read C5-6-4.
ANS: 0.0564

NOTE: Use the numbers on the S scale which represent θ (usually to the right of the numbered marks). The scale reads from 5.7° on the left, to 90° on the right. The single mark between 80° and 90° represents 85°.

SRO: Set HLN on θ on S, read value of sinθ under HLN on C.

D.P.: Place to the left of the first digit.

Ex: sin 20°
SRO: Set 20 on S at 70|20, read C3-4-2.
ANS: 0.342
Ex: \( \sin 22.3^\circ (22^\circ 20') \)

**SRO:** Set HLN on \( 22.3^\circ (22^\circ 20') \) on \( S \), read C3-8-0.

**ANS:** 0.380

**NOTE:** \( \sin 81^\circ \) is 0.988; \( \sin 85^\circ \) is 0.996; \( \sin 89^\circ \) is 0.999.

---

**COS \( \theta \)**

<table>
<thead>
<tr>
<th>( \theta )</th>
<th>( 84.3^\circ ) to ( 0^\circ )</th>
<th>( S )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \cos \theta )</td>
<td>( 0.1 ) to ( 1.0 )</td>
<td>( C )</td>
</tr>
</tbody>
</table>

**NOTE:** Since \( \sin \theta = \cos(90^\circ - \theta) \), the graduations on the \( S \) scale to the left of the numbered marks, representing \((90^\circ - \theta)\), are used for the cosines of the angles. The cosine scale reads from \( 0^\circ \) on the right to \( 84.3^\circ \) on the left. The single mark between \( 0^\circ \) and \( 10^\circ \) represents \( 5^\circ \) for the cosine (and also \( 90^\circ - 5^\circ = 85^\circ \) for the sine).

**SRO:** Set HLN on \( \theta \) on \( S \), read value of the cos under HLN on \( C \).

**D.P.:** Place to the left of first digit.

---

Ex: \( \cos 65^\circ \)

**SRO:** Set HLN on \( 65^\circ \) on \( S \) at 65|25; read C4-2-2.

**ANS:** 0.422

---

Ex: \( \cos 66.4^\circ \)

**SRO:** Set HLN on \( 66.4^\circ \) on \( S \), read C4-0-1.

**ANS:** 0.401

---

Ex: \( \cos 4^\circ \)

**SRO:** Set HLN on \( 4^\circ \) on \( S \) by dividing the space between \( 0^\circ \) and \( 5^\circ \) by eye, read C9-9-7.

**ANS:** 0.997

---

<table>
<thead>
<tr>
<th>( \theta )</th>
<th>( 89.4^\circ ) to ( 84.3^\circ )</th>
<th>( ST )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \cos \theta )</td>
<td>( 0.01 ) to ( 0.1 )</td>
<td>( C )</td>
</tr>
</tbody>
</table>
SRO: Using the relationship $\sin \theta = \cos (90^\circ - \theta)$, set $(90^\circ - \theta)$ on scale ST; read cos value on C.

D.P.: Place one zero between the d.p. and the first digit.

<table>
<thead>
<tr>
<th>Ex: $\cos 86^\circ$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SRO:</strong> Set $(90^\circ - 86^\circ)$ or $4^\circ$ on ST, read C6-9-7.</td>
</tr>
<tr>
<td><strong>ANS:</strong> 0.0697</td>
</tr>
</tbody>
</table>

**TAN $\theta$**

<table>
<thead>
<tr>
<th>$\theta$</th>
<th>0.57$^\circ$ to 5.7$^\circ$</th>
<th>ST</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\tan \theta$</td>
<td>.01 to 0.1</td>
<td>C</td>
</tr>
</tbody>
</table>

SRO: Set $\theta$ on ST, read value of $\tan \theta$ from the C scale.

D.P.: Place one zero between the d.p. and the first digit.

<table>
<thead>
<tr>
<th>Ex: $\tan 3.5^\circ$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SRO:</strong> Set 3.5$^\circ$ on ST, read C6-1-1.</td>
</tr>
<tr>
<td><strong>ANS:</strong> 0.0611</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>$\theta$</th>
<th>5.7$^\circ$ to 45$^\circ$</th>
<th>T</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\tan \theta$</td>
<td>0.1 to 1.0</td>
<td>C</td>
</tr>
</tbody>
</table>

NOTE: Use the graduation on the T scale to the right of the numbered marks, which represent $\theta$. The scale reads from 5.7$^\circ$ on the left, to 45$^\circ$ on the right.

SRO: Set $\theta$ on T, read the value of $\tan \theta$ on scale C.

D.P.: Place to the left of the first digit.

<table>
<thead>
<tr>
<th>Ex: $\tan 11^\circ$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>SRO:</strong> Set 11$^\circ$ on T at 79</td>
</tr>
<tr>
<td><strong>ANS:</strong> 0.194</td>
</tr>
</tbody>
</table>
Ex: \( \tan 11.7^\circ (11^\circ 40') \)

**SRO:** Set 11.7\(^\circ\) (11\(^\circ\)40\(\prime\)) on \( T \), read C2-0-7.

**ANS:** 0.207

<table>
<thead>
<tr>
<th>( \theta )</th>
<th>45(^\circ) to 84.3(^\circ)</th>
<th>( T )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \tan \theta )</td>
<td>1.0 to 10</td>
<td>( CI )</td>
</tr>
</tbody>
</table>

**NOTE:** Use the graduations on the \( T \) scale to the left of the numbered marks, which represent \((90^\circ - \theta)\). This scale reads from 45\(^\circ\) on the right, to 84.3\(^\circ\) on the left.

**SRO:** Using the relationship \( \tan \theta = 1 \div \tan(90^\circ - \theta) \), set \( \theta \) on \( T \) and read the value of \( \tan \theta \) from the \( CI \) scale. If there is no \( CI \) scale, use \( \tan \theta = 1 \div \tan(90^\circ - \theta) \).

**D.P.:** Place after the first digit.

Ex: \( \tan 55^\circ \)

**SRO:** Set 55\(^\circ\) on \( T \) at 55\(|35\), read CI1-4-3.

**ANS:** 1.43

<table>
<thead>
<tr>
<th>( \theta )</th>
<th>84.3(^\circ) to 89.4(^\circ)</th>
<th>( ST )</th>
</tr>
</thead>
<tbody>
<tr>
<td>( \tan \theta )</td>
<td>10 to 100</td>
<td>( CI )</td>
</tr>
</tbody>
</table>

**SRO:** Using relationship \( \tan \theta = 1 \div \tan(90^\circ - \theta) \), set \((90^\circ - \theta)\) on \( ST \) scale and read the value of \( \tan \theta \) from the \( CI \) scale.

**D.P.:** Place after the second digit.

Ex: \( \tan 86^\circ \)

**SRO:** Set \((90^\circ - 86^\circ)\) or 4\(\circ\) on \( ST \); read CI1-4-3.

**ANS:** 14.3
XVI-D  COMBINED TRIGONOMETRIC OPERATIONS

Multiplication and division involving trigonometric functions may be performed without recording the value of these functions by using the S, T, and ST scales exactly as the C scale. This is possible since the angles on the S, T, and ST scales are in line with the corresponding trigonometric functions of these angles on the C scale and the right and left indices on the trigonometric scales are in line with the indices on the C scale.

<table>
<thead>
<tr>
<th>Ex: $2.3 \times \sin 8^\circ$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AA:</strong> $\sin 8^\circ \approx 0.1, \ 2 \times \sin 8^\circ \approx 0.2$</td>
</tr>
<tr>
<td><strong>SRO:</strong> Set LC1 on D2-3. Set HLN on S8°. Read D3-2 under HLN.</td>
</tr>
<tr>
<td><strong>ANS:</strong> 0.32</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex: $0.315 \div \tan 39^\circ$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AA:</strong> $\tan 39^\circ \approx 1; 0.3 \div \tan 39^\circ \approx 0.3$</td>
</tr>
<tr>
<td><strong>SRO:</strong> Set HLN on D3-1-5. Bring T39° under HLN. Read D3-8-9 under RT1.</td>
</tr>
<tr>
<td><strong>ANS:</strong> 0.389</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Ex: $6.38 \times (\cos 58^\circ)^2 \div 0.132$</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AA:</strong> $\cos 58^\circ \approx 0.5; 6 \times (0.5)^2 \div .1 \approx 15$</td>
</tr>
<tr>
<td><strong>SRO:</strong> Use A and B scales. (See Section XIV-B on page 30) Set RB1 at A6-3-8. Set HLN on S58° (cosine marking). Bring B1-3-2 under HLN. Read A1-3-6 on B index.</td>
</tr>
<tr>
<td><strong>ANS:</strong> 13.6</td>
</tr>
</tbody>
</table>
Chapter XVII

LOG LOG SCALES

XVII-A  DESCRIPTIONS

The scales labeled $LL_1$, $LL_2$, $LL_3$ cover numbers $>1$. Numbers $<1$ are on the reciprocal scales which may be labeled $LL_{01}$, $LL_{02}$, etc.; or $LL_1$, $LL_2$, etc.; $LL_{1/1}$, $LL_{1/2}$, etc.; or $LL_0$ and $LL_{00}$. All scales are read with the d.p. in the printed position.

XVII-B  APPLICATIONS

To find natural logarithms ($\log_e N$ or $\ln N$):

**SRO:** Set hairline on $N$ on appropriate $LL$ scale. Read $\log_e$ under hairline on $D$ (or $DF/M$ scale).

**D.P.:** Located by the exponent range (or first digit position) of the $LL$ scale used: $N$ on $LL_1$, $\log_e N$ on $D$ has two decimal places (.01→.1 or 0.0D); on $LL_2$, one decimal place; on $LL_3$, one digit left of the d.p. in $\log_e N$.

**Ex:** $\log_e 12.2$

<table>
<thead>
<tr>
<th>SRO: Set $HLN$ on 12.2 on $LL_3$. Read under $HLN D$ (or $DF/M$) 2-5-0.</th>
</tr>
</thead>
<tbody>
<tr>
<td>ANS: 2.50</td>
</tr>
</tbody>
</table>
Ex: \( \log_e 0.98 \)

**SRO:** Set HLN on 0.98 on LL01 (or LL1-). Read under HLN D (or DF/M) 2-0-2.

**ANS:** Since exponent range on LL01 is -0.01 to -0.1 (or on LL1-, first digit position is -0.0D) answer is -0.0202

**NOTE:** On slide rules having only the LL0 and LL00, read \( \log_e N \) on the A instead of the D scale.

**D.P.:** N on LL0, use AA = N-1; N on LL00, left half of A scale is -0.D: right half is -D.0

Ex: \( \log_e 0.97 \)

**SRO:** Set HLN on 0.97 on LL0. Read under HLN A3-0-5.

**AA:** \( 0.97 - 1 = -0.03 \)

**ANS:** -0.0305

Ex: \( \log_e 0.50 \)

**SRO:** Set HLN on 0.50 on LL00. Read under HLN 6-9-5 on left half of A.

**ANS:** -0.695

---

**To find non-integer powers and roots:**

**SRO:** \( N^x = P \) or \( \sqrt[n]{N} = Q \). Calculate AA. Set hairline on N on appropriate LL scale, then set a C index under the hairline. Move hairline to \( x \) on C scale for powers, to \( x \) on CI scale for roots. Read under hairline on appropriate LL scale as indicated by the AA.

Ex: \( 4^2 \)

**SRO:** Set HLN on 4 on LL3. Set LC1 under HLN. Set HLN on C2. Read 16 on LL3.

Ex: \( 6.2^{-2.1} \)

**AA:** \( 6^{-2} = \frac{1}{36} = 0.03 \)

**SRO:** Set HLN on 6.2 on LL3. Set LC1 under HLN. Move HLN to C2-1; read 0.0217 under HLN on LL03, (or LL/3, or LL3-).
Ex: $\sqrt[4]{30}$

**AA:** $\sqrt[4]{30} = 2.3$.

**SRO:** Set HLN on 3 on LL3. Set LC1 under HLN. Move HLN to CI4-1.

**ANS:** Read 2.29 under HLN on LL2.

**NOTE:** On rules having only two reciprocal scales (LL0, LL00), use instead of scale C, scale B (or A) with the correct half to employ determined by the AA. Furthermore, negative powers of N can only be solved by first evaluating the positive reciprocal.

---

Ex: $6.2^{-2.1} = 1/(6.2)^{2.1} = (0.162)^{2.1}$

**AA:** $(0.16)^2 = 0.026$

**SRO:** Set HLN on 0.162 on LL0. Set central B1 under HLN. Set HLN on 2-1 on right half of B scale.

**ANS:** Read 0.0217 under HLN on LL00.
Appendix A

GLOSSARY

Notations in this document include:

**Ex:** An example.

**Form:** How to re-arrange the question in order to facilitate slide rule operations.

**AA:** An approximate answer. This is the rough estimate used to determine the final order of magnitude of a calculation.

**SRO:** Slide rule operations. What steps are done to arrive at the answer.

**D.P.:** Where to set the decimal point.

**M:, C:** The mantissa and characteristic of a power-of-ten notation number. \((M \times 10^C)\)

**ANS:** The final answer.

**Scales** Slide rule scales are italicized, such as scale “C”.

**Markings** Slide rule readings are indicated such as “C4-3” for primary mark 4 and secondary mark 3 on scale C.

**HLN** The slide rule’s hairline, also italicized as HLN.
Appendix B

ORIGINAL DOCUMENT

The following pages are a grayscale version of the original document. The original colors were as shown on the title page.
VIII. RECIPROCAL (or INVERSE) SCALES
A. Concept: The inverse of a slide, in the same sense, is a reversed scale, and reads from right to left. The CIP (above the CIP) is a folded CIP scale showing the top half of the scale.

1. DEFINITION: The reciprocal of the number N on an ordinary scale is 1/N. If any scale be multiplied by 1/N, the result is the reciprocal scale.

2. PROPERTIES: The reciprocal of a reciprocal is the original scale. Any scale can be represented by a reciprocal scale.

3. USING THE RECIPROCAL SCALE:

(a) Flow diagram and associated data:

- Set N on the scale and read the reciprocal on the same digit as N.
- Place N on the CIP and read the reciprocal on the right side of the scale.
- To convert readings, use the reciprocal scale.

(b) Calculations:

- For addition and subtraction, use the reciprocal scale.
- For multiplication and division, use the reciprocal scale.
- For exponentiation and logarithms, use the reciprocal scale.

IX. COMBINED OPERATIONS: FOLDED AND INVERSE SCALES

1. Concept: Combined operations involve the use of both the folded and the inverse scales, along with other scales, to obtain a desired result.

2. Example:

- Given: 45°, 30°, 15°, and 7.5° angles.
- Use the inverse scale to find the reciprocal of each angle.
- Use the folded scale to add the reciprocal angles.
- Use the inverse scale again to find the desired result.

3. Steps:

(a) Use the inverse scale to find the reciprocal of each angle.
(b) Use the folded scale to add the reciprocal angles.
(c) Use the inverse scale again to find the desired result.

X. MULTIPLE OPERATIONS

1. Concept: Multiple operations involve the use of several scales simultaneously to obtain a desired result.

2. Example:

- Given: 45°, 30°, 15°, and 7.5° angles.
- Use the inverse scale to find the reciprocal of each angle.
- Use the folded scale to add the reciprocal angles.
- Use the inverse scale again to find the desired result.

3. Steps:

(a) Use the inverse scale to find the reciprocal of each angle.
(b) Use the folded scale to add the reciprocal angles.
(c) Use the inverse scale again to find the desired result.

XI. LOGARITHMIC SCALES: USB AND THE DOUBLE SCALE

1. Concept: Logarithmic scales, such as the USB and the double scale, are used to represent large data sets in a more manageable way.

2. Example:

- Given: 10, 100, 1,000, and 10,000 values.
- Use the USB scale to represent the data set.
- Use the double scale to amplify the representation.

3. Steps:

(a) Use the USB scale to represent the data set.
(b) Use the double scale to amplify the representation.
(c) Use both scales to understand the data set.

XII. SQUARE ROOTS, CUBE ROOTS, ETC.

1. Concept: Square roots, cube roots, and other roots can be calculated using logarithmic scales.

2. Example:

- Given: 16, 81, and 256.
- Use the square root scale to calculate the square root of each number.
- Use the cube root scale to calculate the cube root of each number.

3. Steps:

(a) Use the square root scale to calculate the square root of each number.
(b) Use the cube root scale to calculate the cube root of each number.
(c) Use both scales to obtain the desired results.

XIII. TRIGONOMETRIC FUNCTIONS

1. Concept: Trigonometric functions, such as sine, cosine, and tangent, can be calculated using logarithmic scales.

2. Example:

- Given: 30°, 45°, and 60° angles.
- Use the sine scale to calculate the sine of each angle.
- Use the cosine scale to calculate the cosine of each angle.
- Use the tangent scale to calculate the tangent of each angle.

3. Steps:

(a) Use the sine scale to calculate the sine of each angle.
(b) Use the cosine scale to calculate the cosine of each angle.
(c) Use the tangent scale to calculate the tangent of each angle.

XIV. COMBINED OPERATIONS: SQUARES OR SQUARE ROOTS

1. Concept: Combined operations involving squares or square roots can be performed using logarithmic scales.

2. Example:

- Given: 4, 16, and 25.
- Use the square scale to calculate the square of each number.
- Use the square root scale to calculate the square root of each number.

3. Steps:

(a) Use the square scale to calculate the square of each number.
(b) Use the square root scale to calculate the square root of each number.
(c) Use both scales to obtain the desired results.

XV. COMBINED OPERATIONS: SQUARES, CUBE ROOTS, ETC.

1. Concept: Combined operations involving squares, cube roots, and other roots can be performed using logarithmic scales.

2. Example:

- Given: 8, 27, and 64.
- Use the square scale to calculate the square of each number.
- Use the cube root scale to calculate the cube root of each number.

3. Steps:

(a) Use the square scale to calculate the square of each number.
(b) Use the cube root scale to calculate the cube root of each number.
(c) Use both scales to obtain the desired results.

XVI. LOG SCALING SCALES: USB, T, B, and the Double Scale

1. Concept: Logarithmic scales, such as the USB, T, B, and the double scale, are used to represent large data sets in a more manageable way.

2. Example:

- Given: 10,000, 100,000, and 1,000,000.
- Use the USB scale to represent the data set.
- Use the T scale to amplify the representation.
- Use the B scale to further amplify the representation.

3. Steps:

(a) Use the USB scale to represent the data set.
(b) Use the T scale to amplify the representation.
(c) Use the B scale to further amplify the representation.

XVII. SQUARE ROOT SCALE, USB Scale. Same as for squares.

1. Concept: The square root scale is used to calculate the square root of a number.

2. Example:

- Given: 16, 25, and 36.
- Use the square root scale to calculate the square root of each number.

3. Steps:

(a) Use the square root scale to calculate the square root of each number.

XVIII. TRIGONOMETRIC FUNCTIONS

1. Concept: Trigonometric functions, such as sine, cosine, and tangent, can be calculated using logarithmic scales.

2. Example:

- Given: 30°, 45°, and 60° angles.
- Use the sine scale to calculate the sine of each angle.
- Use the cosine scale to calculate the cosine of each angle.
- Use the tangent scale to calculate the tangent of each angle.

3. Steps:

(a) Use the sine scale to calculate the sine of each angle.
(b) Use the cosine scale to calculate the cosine of each angle.
(c) Use the tangent scale to calculate the tangent of each angle.

XIX. LOGARITHMIC SCALES: USB, T, B, and the Double Scale

1. Concept: Logarithmic scales, such as the USB, T, B, and the double scale, are used to represent large data sets in a more manageable way.

2. Example:

- Given: 10,000, 100,000, and 1,000,000.
- Use the USB scale to represent the data set.
- Use the T scale to amplify the representation.
- Use the B scale to further amplify the representation.

3. Steps:

(a) Use the USB scale to represent the data set.
(b) Use the T scale to amplify the representation.
(c) Use the B scale to further amplify the representation.

XX. TRIGONOMETRIC FUNCTIONS

1. Concept: Trigonometric functions, such as sine, cosine, and tangent, can be calculated using logarithmic scales.

2. Example:

- Given: 30°, 45°, and 60° angles.
- Use the sine scale to calculate the sine of each angle.
- Use the cosine scale to calculate the cosine of each angle.
- Use the tangent scale to calculate the tangent of each angle.

3. Steps:

(a) Use the sine scale to calculate the sine of each angle.
(b) Use the cosine scale to calculate the cosine of each angle.
(c) Use the tangent scale to calculate the tangent of each angle.