
Compass

BAMBOO SLIDE RULES

INSTRUCTION for General Calculation

M19
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INSTRUCTIONS

FOR THE USE OF YOUR SLIDE RULE

1. GENERAL DESCRIPTION OF SCALES

The following is a brief description of the scales:

(a) **C and D**

These are exactly alike and are the fundamental scales of the slide rule. They are used for general fundamental calculations.

(b) **DF and CF**

These are the same as the D and C scales, except that they are "folded" at π or $\sqrt{10}$. In order to avoid resetting when the answer lies beyond the end of the scale they are used together with the C and D scales.

(c) **CI**

This is an inverted C scale; it is used with the C scale in reading directly the reciprocal of numbers. It permits multiplication of three factors with just one setting of the slide.

(d) **DI**

This is an inverted D scale and is used just the same as the CI scale.

(e) **CIF**

This is an inverted CF scale and is used with the DF scale in the same relation as the CI scale to the D scale.

(f) **A and B**

These are exactly alike and are used with the C and D scales to find the square and square root.

(g) **K**

This is used in finding the cube and cube root.

(h) **S**

This scale gives the sine and cosine of an angle.

(i) **T or T₁**

This scale gives the tangent of an angle.

(j) **T₂**

This scale gives the tangent of an angle greater than 45°.

(k) **ST**

This scale gives the sine and tangent of an angle smaller than 6°.

(l) **L**

This scale is used with the D scale in finding directly the mantissa of the common logarithms of a number.

2. MULTIPLICATION AND DIVISION

(1) How to Use C and D Scales

In the following Explanation, the left hand 1 of the C or D scale is called its Left Index, the right hand 1 is called its Right Index.

(Multiplication)

The process of multiplication may be performed by using the C and D scales.

To multiply a by b :-

opposite a on D, set left or right index of C,
move hairline to b on C,
under hairline read the product on D.

Example 1. $2.4 \times 3 = 7.2$

Opposite 2.4 on D, set left index of C,
move hairline to 3 on C,
under hairline read answer as 7.2 on D.

Example 2. $4.5 \times 3.2 = 14.4$

Opposite 4.5 on D, set right index of C,
move hairline to 3.2 on C,
under hairline find 1.44 on D,
read answer as 14.4.

Note in above case that the reading would have been off scale, if the left index had been used.

(Division)

The process of division is performed by using the C and D scales.

To divide a by b ,

move hairline to a on D,
set b on C under hairline,
opposite left or right index of C read the quotient on D

Example 3. $32 \div 8 = 4$

Move hairline to 3.2 on D,
set 8 on C under hairline,
opposite right index of C read answer as 4 on D.

(Combined Multiplication and Division)

To calculate the type form of $\frac{a \times c}{b}$, first divide a by b , and then multiply the quotient by c .

Example 4. $\frac{1.57 \times 32}{44} = 1.142$

Move hairline to 1.57 on D,
set 4.4 on C under hairline,
move hairline to 3.2 on C,
under hairline read answer as 1.142 on D.

(2) How to Use CI Scale

(Multiplication)

The process of multiplication also may be performed by using the CI and D scale. By using of the CI scale, computations can be made quickly.

To multiply a by b ,
move hairline to a on D,
set b on CI under hairline,
opposite left or right index of C read the product on D.

Example 5. $2.3 \times 3.4 = 7.82$

Move hairline to 2.3 on D,
set 3.4 on CI under hairline,
opposite right index of C read answer as 7.82 on D.

To multiply three factors, first, multiply two of them, and then multiply the result by the third.

Example 6. $1.5 \times 3.2 \times 8 = 38.4$

Move hairline to 1.5 on D,
set 3.2 on CI under hairline,
move hairline to 8 on C,
under hairline find 38.4 on D,
read answer as 38.4.

(Division)

The process of division also may be performed by using the CI and D scales.

To divide a by b ,

opposite a on D, set left or right index of C,
move hairline to b on CI,
under hairline read the quotient on D.

Example 7. $1.2 \div 4 = 0.3$

Opposite 1.2 on D, set left index of C,
move hairline to 4 on CI,
under hairline find 3 on D,
read answer as 0.3.

To divide three factors, first divide two of them, and then divide the answer by the third.

Example 8. $15.7 \div 3.2 \div 4.4 = 1.115$

Move hairline to 1.57 on D,
set 3.2 on C under hairline,
move hairline 4.4 on CI,
under hairline read answer as 1.115 on D.

(Combined Multiplication and Division)

The calculation of the type form of $\frac{a \times b}{c}$ follows the procedures of multiplication and division.

Example 9. $\frac{8 \times 2}{5} = 3.2$

Move hairline to 8 on D,
set 2 on CI under hairline,
move hairline 5 on CI,
under hairline read answer as 3.2 on D.

(3) How to Use DF and CF Scales

The DF and CF scales are similar to the D and C scales folded at π or $\sqrt{10}$. These scales often can be used in calculations in order to avoid resetting when the answer runs

off the scale. When the slide is in any position with the number x on the D scale appearing opposite the number y on the C scale, then this same number x appears also on the DF scale opposite y on the CF scale. If the reading is off scale on the C-D scale it may be found on the CF-DF scale.

Moreover the π folded DF and CF scales can be used in problems requiring multiplication by π . Opposite any number on the D scale, read π times of this number on the DF scale.

These folded scales may be used to perform multiplication and division just as the C and D scales are used.

(Multiplication)

Example 10. $2.5 \times 2.4 \times 1.2 = 7.20$

Move hairline to 2.5 on D,
set 2.4 on CI under hairline,
move hairline to 1.2 on CF,
under hairline read answer as 7.20 on DF.

Example 11. $2 \times 7 \times 8 = 112$

Move hairline to 2 on D,
set 7 on CI under hairline,
move hairline to 8 on CF,
under hairline find 1.12 on DF,
read answer as 112.

(Division)

Example 12. $9 \div 6 = 1.5$

Move hairline to 9 on DF,
set 6 on CF under hairline,
opposite left index of C read answer as 1.5 on D.
(or opposite middle index of CF read answer as 1.5 on DF.)

Example 13. $9 \div 1.5 \div 4 = 1.5$

Move hairline to 9 on DF,
set 1.5 on CF under hairline
move hairline to 4 on CI,
under hairline read answer as 1.5 on D.

(Combined Multiplication and Division)

Example 14. $11.2 \div 8.4 \times 2.7 = 3.6$

Move hairline to 1.12 on DF,
set 8.4 on CF under hairline.
move hairline to 2.7 on C,
under hairline read answer as 3.6.

Example 15. $\frac{3.2 \times 1.2 \times 5.8}{8.2 \times 9.5} = 0.286$

Move hairline to 3.2 on D,
set 8.2 on C under hairline,
move hairline to 1.2 on CF.
set 9.5 on CF under hairline,
move hairline to 5.8 on C,
under hairline find 2.86 on D,
read answer as 0.286.

(Computation involving π)

By using the DF scale, which is folded to begin and end with π , if the diameter of a circle d is set on the D scale, the circumference πd is given on the DF scale, opposite d on the D scale.

Example 16. (A.) Find the circumference of a circle with its diameter of 5cm. (B) Find the diameter of a circle with its circumference of 46.8cm. Answer (A) 15.71cm (B) 14.9cm

(A) Move hairline to 5 on D,

under hairline find 1.571 on DF,
read answer as 15.71 cm.

- (B) Move hairline to 4.68 on DF,
under hairline find 1.49 on D,
read answer as 14.9 cm.

(4) How to Use CIF Scale

The CIF scale is an inverted CF scale. It may be used to perform multiplication and division just as the CI scale is used. Thus, by the use of six scales of the C, D, CI, CF, DF and this CIF, the fundamental calculations are performed very quickly and efficiently, without resetting or running off scale.

(Multiplication)

Example 17. $3.1 \times 1.6 \times 1.5 \times 8.8 = 65.5$

Move hairline to 3.1 on D,
set 1.6 on CI under hairline,
move hairline to 1.5 on CF,
set 8.8 on CIF under hairline,
opposite right index of C find 6.55 on D,
read answer as 65.5.

Example 18. $9 \times 8 \times 3 \times 7 = 1512$

Move hairline to 9 on DF,
set 8 on CIF under hairline,
move hairline to 3 on C,
set 7 on CI under hairline,
opposite left index of C find 1.512 on D,
read answer as 1512.

(Division)

Example 19. $27 \div 5 \div 7.5 = 0.72$

Move hairline to 2.7 on D,
set 5 on C under hairline,
move hairline to 7.5 on CIF,
under hairline find 7.2 on DF,
read answer as 0.72

(Combined Multiplication and Division)

Example 20. $3.8 \times 6.5 \div 2 \times 1.96 \div 1.45 = 16.7$

Move hairline to 3.8 on D,
set 6.5 on CI under hairline,
move hairline to 2 on CIF,
set 1.96 on CIF under hairline,
move hairline to 1.45 on CIF,
under hairline find 1.67 on DF,
read answer as 16.7.

Example 21. $\frac{236000 \times 0.0065 \times 188 \times 715}{0.00032 \times 7800000} = 82600$

Move hairline to 2.36 on D,
set 3.2 on C under hairline,
move hairline to 6.5 on C,
set 7.8 on C under hairline,
move hairline to 1.88 on CF,
set 7.15 on CIF under hairline,
opposite right index of C find 8.26 on D,
read answer as 82600.

The Position of the decimal point is determined by mental calculation as follows:

$$\frac{236000 \times 0.0065 \times 188 \times 715}{0.00032 \times 7800000} = \frac{2.36 \times 6.5 \times 1.88 \times 7.15}{3.2 \times 7.8} \times \frac{10^5 \cdot 3+2+2}{10^{-4+6}}$$

$$\begin{aligned} &\doteq \frac{2 \times 7 \times 2 \times 7}{3 \times 8} \times \frac{10^5}{10^2} = \frac{2 \times 7 \times 2 \times 7}{3 \times 8} \times 10^{5-2} \\ &\doteq \frac{7 \times 7}{6} \times 10^4 = \frac{50}{6} \times 10^4 = 8 \times 10^4 = 80000 \end{aligned}$$

Comparing 80000 to 8.26 which is obtained by the slide rule, it is apparent the answer is 82600.

3. PROBLEMS OF PROPORTION

Proportion is a special case of multiplication and division.

There two kinds of proportional problems: one, proportion, the other, inverse proportion.

(1) Proportion

The problems of proportion are widely applied to conversion, indexes, proportional division, percentage, etc.

Proportional calculation is performed by referring to each other scales C and D or CF and DF.

Example 22. Fill the following blanks, given 1kt=1.852 km/h.

kt	27	32.4	44
km/h	50*	60*	81.6*

*.....answer shown

Opposite 1.852 on D, set left index of C,
 move hairline to 2.7 on C,
 under hairline find 5 on D,
 read answer as 50.
 Move hairline to 3.24 on C,
 under hairline find 6 on D,

read answer as 60.

Move hairline to 4.4 on C,
 under hairline find 8.15 on C,
 read answer as 81.5.

Example 23. Find % in the following table.

	Amount	%
A	\$2,410	14.6 *
B	\$2,640	16.0 *
C	\$3,400	20.6 *
D	\$8,050	48.8 *
Total	\$16,500	100.0 *

*.....shown answer

Opposite left index of D, set 1.65 on C,
 move hairline to 2.41 on C,
 under hairline find 1.46 on D,
 read answer as 14.6.
 Move hairline to 2.64 on C,
 under hairline find 1.60 on D,
 read answer as 16.0.
 Move hairline to 3.4 on C,
 under hairline find 2.06 on D,
 read answer as 20.6.
 Move hairline to 8.05 on C,
 under hairline find 4.88 on D,
 read answer as 48.8.

(2) Inverse Proportion

Inverse proportion is calculated by referring to each other scales D and CI, or scales DF and CIF.

Example 24. A job requires 12 days for completion with 45 workmen. How many days will it take to complete it with 30 workmen? Answer: 18 days

Move hairline to 1.2 on D,
set 4.5 on CI under hairline,
move hairline to 3 on CI,
under hairline find 1.8 on D,
read answer as 18.

Example 25. A pulley with 7" diameter revolves 360 times per minute. How many revolutions per minute are there when diameter of pulley is 9"? Answer: 280 rpm

Move hairline to 3.6 on D,
set 7 on CI under hairline,
move hairline to 9 on CI,
under hairline find 2.8 on D,
read answer as 280.

4. SQUARE AND SQUARE ROOT

(1) Square

Opposite any number on the D scale, read its square on the A scale. Similarly, opposite any number on the C scale, read its square on the B scale.

Example 26. $2^2=4$, $5.63^2=31.7$

Move hairline to 2 on D,
under hairline read answer as 4 on A.

Move hairline to 5.63 on D,
under hairline read answer as 31.7 on A.

(2) Square Root

To find the square root of a number between 1 and 10, use scale A left. To find square root of a number between 10 and 100, use scale A right.

Example 27. $\sqrt{6.56}=2.56$, $\sqrt{6'56''00}=256$,
 $\sqrt{0.00'06''56}=0.0256$

Move hairline to 6.56 on A left,
under hairline find 2.56 on D.

Example 28. $\sqrt{65.6}=8.1$, $\sqrt{65'60}=81$
 $\sqrt{0.00'00''65'6}=0.0081$

Move hairline to 65.6 on A right,
under hairline find 8.1 on D.

(3) Multiplication and Division including Square

Example 29. $2 \times 4^2=32$

Move hairline to 2 on A left,
set 4 on CI (back face) under hairline,
opposite right index of C read answer as 32 on A
right.

Example 30. $1.3^2 \times 6.5^2=71.4$

Move hairline to 1.3 on D,
set 6.5 on CI (back face) under hairline,
opposite right index of C read answer as 71.4 on A
right.

Example 31. $30 \div 5^2=1.2$

Move hairline to 30 on A right,
set 5 on C under hairline,
opposite left index of C read answer as 1.2 on A left.

Example 32. $25^2 \div 50=12.5$

Move hairline to 2.5 on D,
set 50 on B right under hairline,

opposite right index of C read answer as 12.5 on A right.

Example 33. $2.4^3 \div 3.82^2 = 0.395$

Move hairline to 2.4 on D,
set 3.82 on C under hairline,
opposite right index of C find 39.5 on A right,
read answer as 0.395.

(4) Multiplication and Division including Square Root

Example 34. $\sqrt{20} \times 2 = 8.95$

Move hairline to 20 on A right,
set 2 on CI (back face) under hairline,
opposite right index of C read answer as 8.95 on D

Example 35. $\sqrt{120 \times 36} = 65.7$

Opposite 1.2 on A left, set left index of C,
move hairline to 36 on B right,
under hairline find 6.57 on D,
read answer as 65.7.

Example 36. $\sqrt{36} \div 0.5 = 12$

Move hairline to 36 on A right,
set 5 on C under hairline,
opposite left index of C find 1.2 on D,
read answer as 12.

Example 37. $6 \div \sqrt{16} = 1.5$

Move hairline to 6 on D,
set 16 on B right under hairline,
opposite left index of C read answer as 1.5 on D.

Example 38. $\sqrt{2880 \div 8.35} = 18.57$

Move hairline to 28.8 on A right,
set 8.35 on B left under hairline,

opposite left index of C find 1.857 on D,
read answer as 18.57.

5. CUBE AND CUBE ROOT

(1) Cube

Opposite any number on the D scale, read its cube on the K scale.

Example 39. $2^3 = 8$, $3^3 = 27$, $7^3 = 343$

Move hairline to 2 on D,
under hairline read answer as 8 on K.
Move hairline to 3 on D,
under hairline read answer as 27 on K.
Move hairline to 7 on D,
under hairline read answer as 343 on K.

(2) Cube Root

To find the cube root of a number between 1 and 10, use scale K left. To find the cube root of a number between 10 and 100, use scale K middle. To find the cube root of a number between 100 and 1000, use scale K right.

Example 40. $\sqrt[3]{2.62} = 1.379$, $\sqrt[3]{2'620'000} = 137.9$
 $\sqrt[3]{0.002'62} = 0.1379$

Move hairline to 2.62 on K left,
under hairline find 1.379 on D.

Example 41. $\sqrt[3]{26.2} = 2.97$, $\sqrt[3]{26'200} = 29.7$
 $\sqrt[3]{0.000'026'2} = 0.0297$

Move hairline to 26.2 on K middle,
under hairline find 2.97 on D.

Example 42. $\sqrt[3]{262} = 6.4$, $\sqrt[3]{262'000} = 64$,

$$\sqrt[3]{0.000'000'262} = 0.0064$$

Move hairline to 262 on K right,
under hairline find 6.4 on D.

6. LOGARITHMS

(1) Common Logarithms

Common Logarithms are calculated to the base 10 and include integer (characteristic) and the decimal part (mantissa).

A slide rule gives only the mantissa of common logarithms: the characteristic can be calculated by the following formula:

(the number of places exceeding decimal point of a given number—1)

viz. the characteristic of any number greater than unity is always 1 less than the number of figures at the left of decimal point.

If given number is of n places under the decimal point, the characteristic is also negative; this is indicated by placing the negative sign or bar over the figure as $-n$ or \bar{n} .

Reversing the slide and centering it, the mantissa of a given number is read directly on the L scale, opposite a given number on the D scale.

Example 43. $\log_{10} 3.14 = 0.497$

Move hairline to 3.14 on D,
under hairline read answer as 0.497 on L.

Example 44. $\log_{10} 0.000342 = \bar{4}.534$

Move hairline to 3.42 on D,
under hairline find 0.534 on L,
add characteristic $\bar{4}$, read answer as $\bar{4}.534$.

Example 45. $\log_{10} 887 = 2.948$

Move hairline to 8.87 on D,
under hairline find 0.948 on L,
add characteristic 2, read answer as 2.948.

(2) Natural Logarithms

Logarithms to the base of e (≈ 2.718) are called natural logarithms; they may be determined by multiplying by 2.3026 common logarithms according to the following formula:

$$\log_e N = 2.3026 \times \log_{10} N$$

7. TRIGONOMETRIC FUNCTIONS

These computations usually can be obtained by the co-operation of S, T ST and D scales.

S scale gives the sines of angles ranging from $5^\circ 45'$ (5.75°) to 90° .

T scale gives the tangents of angles ranging from $5^\circ 45'$ (5.7°) to 45° .

ST scale gives the sines or tangents of small angles ranging from $35'$ (0.575°) to $5^\circ 40'$ (5.7°).

T_s scale gives the tangents of angles ranging from 45° to 84.25° .

Note: S scale referred to A gives the sines of angles ranging from $35'$ to 90° .

Reversing the slide and centering it, the sines or tangents of angles are given on the D scale directly opposite an angle on the S or T scale respectively.

(1) Sin θ

Example 46. $\sin 15^\circ = 0.259$

Move hairline to 15 on S,

under hairline find 2.59 on D,
read answer as 0.259.

When using the S scale to read the value of $\sin \theta$, read the left index of D as 0.1 and the right index as 1.

Example 47. $\sin 1^\circ 30' = (\sin 1.5^\circ) = 0.0262$

Move hairline to $1^\circ 30'$ (1.5°) on ST,
under hairline find 2.62 on D,
read answer as 0.0262.

When using the ST scale to read the value of $\sin \theta$, read the left index of D as 0.01 and the right index as 0.1.

Example 48. $\sin 30^\circ \times 5 = 2.5$

Opposite 5 on D, set right index of S,
move hairline to 30 on S,
under hairline read answer as 2.5 on D.

Example 49. $3.06 \div \sin 43^\circ = 4.49$

Move hairline to 3.06 on D,
set 43 on S under hairline,
opposite right index of S, read answer as 4.49 on D

(2) Cos θ

The value of $\cos \theta$ may be found by reading the sines of the complementary angles as $\cos \theta = \sin(90^\circ - \theta)$.

Example 50. $\cos 30^\circ = 0.866$

Move hairline to $60^\circ (= 90^\circ - 30^\circ)$ on S,
under hairline find 8.66 on D,
read answer as 0.866.

(3) Tan θ

Example 51. $\tan 32^\circ 30' = \tan 32.5^\circ = 0.637$

Move hairline to $32^\circ 30'$ (32.5°) on T,
under hairline find 6.37 on D,
read answer as 0.637.

Example 52. $\tan 1^\circ 30' = \tan 1.5^\circ = 0.0262$

Move hairline to $1^\circ 30'$ (1.5°) on ST,
under hairline find 2.62 on D,
read answer as 0.0262.

When using the T scale to read the value of $\tan \theta$, read the left index of D as 0.1 and the right index as 1, and using the ST scale to read the value of $\tan \theta$, read the left index of D as 0.01 and the right index as 0.1.

Tangents of angles greater than 45° are calculated by the use of the T_2 scale.

Example 53. $\tan 62^\circ = 1.88$

Move hairline to 62 on T_2 ,
under hairline read answer as 1.88 on D.

When using the T_2 scale to read the value of $\tan \theta$, read the left index of D as 1 and right index as 10.

To find the value of the tangents of angles greater than 45° read the reciprocals of the tangents of the complementary angles as $\tan \theta = \frac{1}{\tan(90^\circ - \theta)}$

Example 54. $\tan 62^\circ = 1.88$

Move hairline to right index of D,
set $28 (= 90 - 62)$ on T under hairline,
opposite left index of T read answer as 1.88 on D.

(4) Other Trigonometric Functions

To get $\cot \theta$, $\sec \theta$ and $\operatorname{cosec} \theta$, use the following formulas:

$$\cot \theta = \frac{1}{\tan \theta}$$

$$\sec \theta = \frac{1}{\cos \theta}$$

$$\operatorname{cosec} \theta = \frac{1}{\sin \theta}$$

8. HOW TO USE GAUGE MARKS

There are the following gauge marks on our slide rules.

(1) $c \doteq 1.128$

The c mark is placed on the C and D scales at 1.128, and is used for the calculation of a circle area.

Example 55. Find the area of a circle with its diameter of 1.5cm. Answer 1.77cm^2

Move hairline to 1.5 on D,
set c on C under hairline,
opposite left index of C read answer as 1.77 on A
left.

(2) $\rho^\circ \doteq 57.2958$

The ρ° mark is placed on the C and D scales at 5.72958, and is used for converting an angle from degrees to radians.

Example 56. $2.4^\circ = 0.0419$ radians

Move hairline to right index of D,
set ρ° on C under hairline,
move hairline to 2.4 on C,
under hairline find 4.19 on D,
read answer as 0.0419 radians.

$[1^\circ \doteq 0.02$ radians (approximately)]
 $[\therefore 2.4^\circ \doteq 0.02 \times 2.4 = 0.048$ radians.]

(3) $\pi \doteq 3.1416$

The π mark is placed on the C, D, DF and CF scales at 3.1416, and shows a ratio of the circumference of a circle to its diameter.

9. HOW TO USE "ELECTRO" SLIDE RULE

"ELECTRO" slide rule is made for use by electrical engineers.

(Scales on Front Face) E, V, A, B, K, CI, C, D, S, T
(Scales on Back of Slide) LL_3, LL_2, LL_1, L

(1) Description of Scales

(a) E

This is called the efficiency scale. The black numbers ranging from 20 to 100 on the E scale give the efficiency of the dynamo in metric system and the red numbers the efficiency of the motor in metric system.

(b) V

This is called the voltage drop scale and is used for the calculation of a D.C. voltage drop in two-wire system circuit.

(c) A, B, K, CI, C, D, S, T and L

These are used for the fundamental calculations.

(d) LL_1, LL_2 and LL_3

These are used to find the values of the type form of a^n, e^x and give the natural logarithms of a number.

(2) Calculations

(a) Fundamental Calculations

The fundamental calculations by the use of the A, B, K, CI, C, D, S, T and L scales are made in the same way as in chapters 1, 2, 3, 4, 5, 6 and 7.

(b) Efficiency Calculation

By the use of the A, B and E scales, the efficiency of the dynamo or motor in metric system (1HP=0.736kW) can be obtained.

Example 57.

If the power of direct acting water turbine working in full load with 46kW dynamo is 65 HP, what is the efficiency of this dynamo? Answer 96%

the potential difference between its terminals is $30+j10$.

Answer $I=4.14-j2.70$

$$I = \frac{E}{Z} = \frac{30+j10}{4+j5} = \frac{31.6/18.4^\circ}{6.4/51.3^\circ}$$

$$\therefore I = \frac{31.6}{6.4} / 18.4^\circ - 51.3^\circ = 4.94 \angle 33.1^\circ \\ = 4.14 - j2.70$$

(e) How to Use LL Scales

LL represent that the scale is a logarithm of a logarithm and are used for the computations of the type forms of $\log N$, e^x and a^n .

($\log N$)

Example 63. $\log 5 = 1.609$

Reverse slide and center it,
move hairline to 5 on LL_3 ,
under hairline read answer as 1.609 on D.

Example 64. $\log 1.03 = 0.0296$

Move hairline to 1.03 on LL_1 ,
under hairline find 2.96 on D,
read answer as 0.0296.

(e^x)

Example 65. $e^{1.96} = 7.1$

Move hairline to 1.96 on D,
under hairline read answer as 7.1 on LL_3 .

Example 66. $e^{0.056} = 1.0576$

Move hairline to 5.6 on D,
under hairline read answer as 1.0576 on LL_1 .

(a^n)

Example 67. $4.25^{2.12} = 21.5$

Move hairline to left index of D,

set 4.25 on LL_3 under hairline,

move hairline to 2.12 on D,

under hairline read answer as 21.5 on LL_3 .

Example 68. $1.02^{24.5} = 1.625$

Move hairline to left index of D,

set 1.02 on LL_1 under hairline,

move hairline to 2.45 on D,

under hairline read answer as 1.625 on LL_2 .

(f) Decibel Calculation

Using the LL and D scales, the calculations of the decibels easily are carried out.

Example 69. Find the value of the decibel for voltage ratio, given $\frac{V_2}{V_1} = 2.4$.

Answer 7.6 db

Move hairline to 2 on D,

set 10 on LL_3 under hairline,

move hairline to 2.4 on LL_3 ,

under hairline read answer as 7.6 on D.

Example 70. Find the value of the decibel for voltage ratio, given $\frac{V_2}{V_1} = 380$.

Answer 51.6 db

Move hairline to 2 on D,

set 10 on LL_3 under hairline,

move hairline to 380 on LL_3 ,

under hairline find 51.6 on D,

read answer as 51.6.

10. HOW TO USE "DARMSTADT" SLIDE RULE

"DARMSTADT" system slide rule can be used for all

types of engineering calculation. In addition to the general scales, this rule has three LL scales (LL_1 , LL_2 and LL_3) ranging from 1.01 to 2×10^4 for numbers greater than unity, and the P scale is called "Pythagorean scale" for trigonometric calculations.

(Scales on Front Face) S, T, A, B, K, CI, C, D, P

(Scales on Back of Slide) LL_1 , LL_2 , LL_3 , L

(1) Description of Scales

(a) A, B, K, CI, C, D, S, T and L

These are used for the fundamental calculations.

(b) P

This is a special scale. When used with the S scale, it gives the value of the cosine, and used with the D, CI and A scale, it gives $\sqrt{1-x^2}$, $\sqrt{1-(1/x)^2}$ and $\sqrt{1-x}$ only by the hairline.

(c) LL_1 , LL_2 and LL_3

These are used to find the values of the type form of a^n , e^x and give the natural logarithms of a number.

(2). Calculations

(a) Fundamental Calculations

The fundamental calculations by the use of the A, B, K, CI, C, D, S, T and L scales are worked out in the same way as in chapters 1, 2, 3, 4, 5, 6 and 7.

(b) How to Use P Scale

The P scale is called "Pythagorean scale". When used with the S scale, it gives the value of the cosine by the hairline directly.

($\cos \theta$)

Against the value of $\sin \theta$ on the D scale, the value of $\cos \theta$ is shown on the P scale.

Example 71. Find $\cos \theta$, given $\sin \theta = 0.5$. Answer 0.866

Move hairline to 5 on D,

under hairline read answer as 0.866 on P.

Example 72. $\cos 15^\circ = 0.966$

Move hairline to 15 on S,

under hairline read answer as 0.966 on P.

($\sqrt{1-x^2}$)

By referring to the D and P scales, the type form $\sqrt{1-x^2}$ can be computed:

Example 73. $\sqrt{1-0.4^2} = 0.9165$

Move hairline to 4 on D,

under hairline read answer as 0.9165 on P.

(c) How to Use LL scales

LL represent that the scale is a logarithm of a logarithm and are used for the computations of the type forms of $\log_e N$, a^x and e^x .—See page 24.

—THE END—