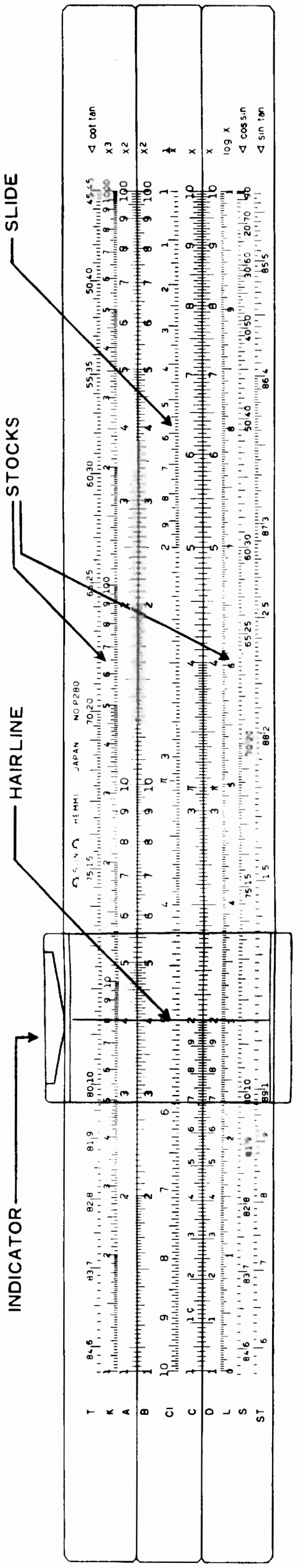
AN INSTRUCTION MANUAL FOR HEMMI SLIDE RULES P280 AND P281



CONSTRUCTION OF SLIDE RULE

The Hemmi Slide Rules P280 and P281, known as the Mannheim Type, have the three components: two stocks, the slide, and the indicator which slides along the top surface of the rule. These stocks are connected together by the end plates.

HANDLING OF SLIDE RULE

The slide rule is an instrument to perform some certain kinds of calculation, and it is operated in the following manners. The slide rule is preferably set on top of a desk when it is being used.

OPERATION OF INDICATOR

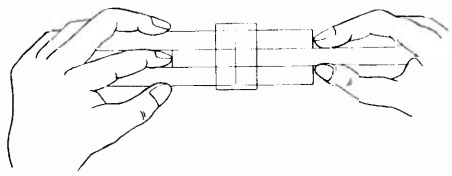
(1) The cursor is pushed in either direction with the tip of the thumb. Through this entire operation, the thumb should move along the edge of the stock and should not come away from the rule.

(2) When the hairline comes close to the required position, its movement is slowed by using the tip of the other thumb.

(3) "FINE" setting of the hairline is gently made by slowly moving the indicator.

OPERATION OF SLIDE

(1) Push one end of the slide with either the forefinger or the middle finger. At the same time, the other hand grips the slide with the forefinger and the thumb pressing against stocks.



(2) When the slide comes close to the required position, it is gently moved by the aforementioned fingeres to set the final position.

SUN HEMMI **HEMMI SLIDE RULE CO.,LTD.**

TOKYO, JAPAN

CHAPTER 1. READING THE SCALES.

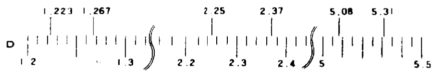
In order to master the slide rule, you must first practice reading the scales quickly and accurately. This chapter explains how to read the D scale which is the fundamental scale and is most often used.

(1) SCALE DIVISIONS

Divisions of the D scale are not uniform and differ as follows:

Between 1 – 2 one division is 0.01
Between 2 – 4 one division is 0.02
Between 4 – 10 one division is 0.05

Values between lines can be read by visual approximation.
An actual example is given below.



(2) SIGNIFICANT FIGURES

The D scale is read without regard to decimal point location. For example, 0.237, 2.37, and 237 are read 237 (two three seven) on the D scale. When reading the D scale, the decimal point can be generally ignored and the numbers are directly read as "2 3 7 (two three seven), the 2 (two) is called the "first significant figure".

(3) INDEX LINES

The lines at the left and right ends of the D scale and labelled 1 and 10 respectively are called the "fixed index lines."

The corresponding lines on the C scale are called the "slide index lines"

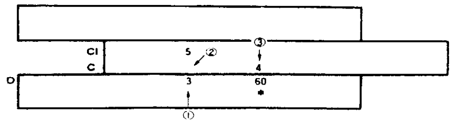
SLIDE RULE DIAGRAM

For the reader's convenience, calculating procedure will be explained in diagram form in this instruction manual. The symbols used in the diagrams are:

Slide Operation — Moving the slide to the position of the arrow with respect to the body of the rule.
Indicator Operation — Setting the hairline of the indicator to the arrow positions on the body and slide.
* The position at which the answer is read.

The numeral in the small circle indicates the procedure order. The below diagram shows the slide rule operation required to calculate $3\times5\times4=60$ using the C, D and CI scales.

(1) Set the hairline over 3 on the D scale.
(2) Move 5 on the CI scale under the hairline.
(3) Reset the hairline over 4 on the C scale and read the answer 60 on the D scale under the hairline.



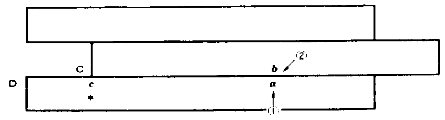
(Note) The vertical lines at both right and left ends of the diagram do not indicate the actual end lines of the slide rule, but only serve to indicate the location of the indices.

CHAPTER 2. MULTIPLICATION AND DIVISION. (1) (CI, C, D SCALES)

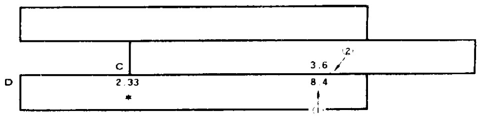
§1. DIVISION

FUNDAMENTAL OPERATION (1) $a\div b=c$

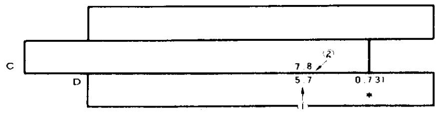
(1) Set the hairline over a on the D scale.
(2) Move b on the C scale under the hairline,
read the answer c on the D scale opposite the index of the C scale.



Ex. 2.1 $8.4\div3.6=2.33$



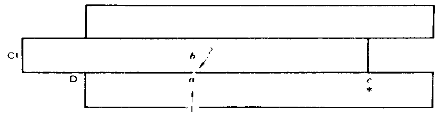
Ex. 2.2 $5.7\div7.8=0.731$



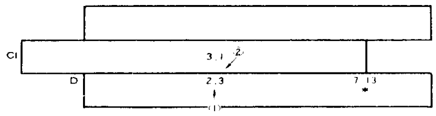
§2. MULTIPLICATION

FUNDAMENTAL OPERATION (2) $a\times b=c$

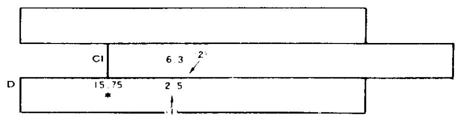
(1) Set the hairline over a on the D scale.
(2) Move b on the CI scale under the hairline,
read the answer c on the D scale opposite the index of the CI scale.



Ex. 2.3 $2.3\times3.1=7.13$



Ex. 2.4 $2.5\times6.3=15.75$



CHAPTER 3. MULTIPLICATION AND DIVISION (2) (CI, C, D SCALES)

§1. MULTIPLICATION AND DIVISION OF THREE NUMBERS

Multiplication and division of three numbers are given in the forms of $(a\times b)\times c$, $(a\times b)\div c$, $(a\div b)\times c$ and $(a\div b)\div c$. The part in parentheses is calculated in the manner previously explained and the additional multiplication or division is, usually, performed with one additional indicator operation.

FUNDAMENTAL OPERATION (3) Multiplication and division of three numbers.

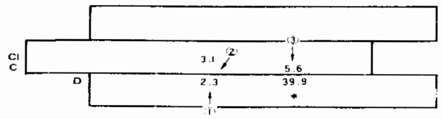
(1) $(a\times b)\times c=d$, $(a\div b)\times c=d$

For additional multiplication to follow the calculation $(a\times b)$ or $(a\div b)$, set the hairline over c on the C scale and read the answer d on the D scale under the hairline.

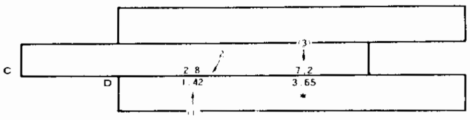
(2) $(a\times b)\div c=d$, $(a\div b)\div c=d$
For additional division to follow the calculation $(a\div b)$ or $(a\times b)$, set the hairline over c on the CI scale and read the answer d on the D scale under the hairline.

In multiplication and division of two numbers, you use the CI scale for multiplication and the C scale for division. However, in multiplication and division of three numbers, you must use the C scale for the additional multiplication and the CI scale for the additional division.

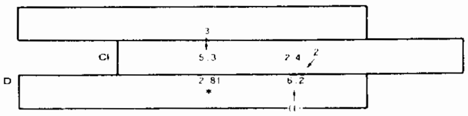
Ex. 3.1 $2.3\times3.1\times5.6=39.9$



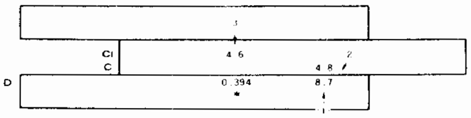
Ex. 3.2 $1.42\div2.8\times7.2=3.65$



Ex. 3.3 $6.2\times2.4\div5.3=2.81$



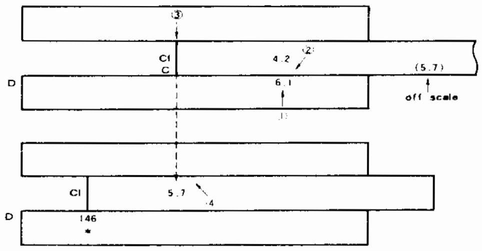
Ex. 3.4 $8.7\div4.8\div4.6=0.394$



§ 2. OFF SCALE

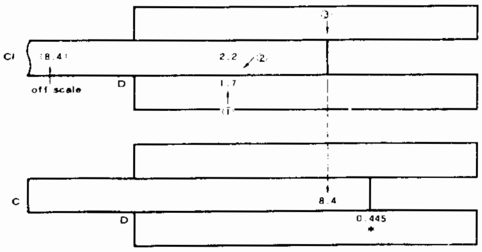
When multiplications and divisions of three numbers are performed by an indicator operation, a position on the C or CI scale over which the hairline is to be set may occasionally run off scale. In this case you once set the hairline over the position on which you read the answer of the first two numbers (opposite the index of the C scale). Then, accomplish the remaining multiplication or division by a slide operation.

Ex. 3.5 $6.1\times4.2\times5.7=146$



The above operations mean that the problem of $a\times b\times c=x$ is solved in such a manner as $a\times b=y$ and $y\times c=x$. Therefore, the third number 5.7 is to be set on the CI scale based on the principle of multiplication and division of two numbers. If the third operation is a division as the problem of Ex. 3.6, set the third number on the C scale.

Ex. 3.6 $1.7\times2.2\div8.4=0.445$

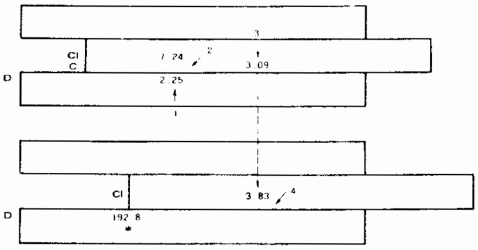


§ 3. MULTIPLICATION AND DIVISION OF MORE THAN THREE NUMBERS.

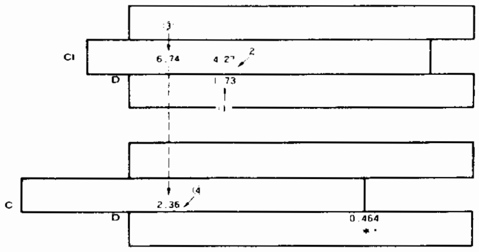
When the multiplication and division of three numbers, such as $a\times b\times c=d$ is completed, the answer (d) is found under the hairline on the D scale.

Using this value of d on the D scale you can start for further multiplications or divisions by slide operation and indicator operation. Multiplications and divisions of four or more numbers are calculated by alternative operations of slide-indicator. When a problem of multiplication or division of four or more numbers is given, you will select a better procedure order of calculations to minimize the distance the slide must be moved as well as to avoid the off scale.

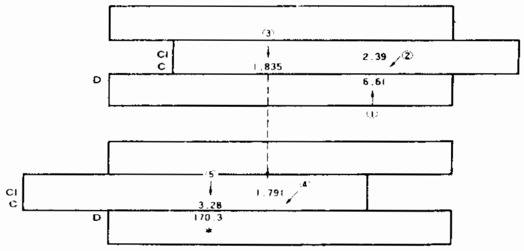
Ex. 3.7 $2.25\times7.24\times3.09\times3.83=192.8$



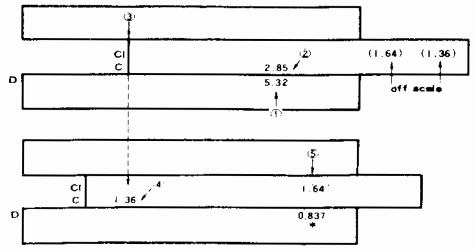
Ex. 3.8 $\dfrac{1.73\times4.27}{6.74\times2.36}=0.464$



Ex. 3.9 $6.61\times2.39\times1.835\times1.791\times3.28=170.3$



Ex. 3.10 $\dfrac{5.32}{1.36\times1.64\times2.85}=0.837$



§4. PLACING THE DECIMAL POINT

Since slide rule calculations of multiplication and division problems yield only the significant figures of the answer, it is necessary to determine the proper location of the decimal point before the problem is completed. There are many methods used to properly place the decimal point. Several of the most polular will be described here.

(a) Approximation

The location of the decimal point can be determined by comparing the significant figures given by the slide rule and the product calculated mentally by rounding off.

Ex. $25.3 \times 7.15 = 180.9$

To get an approximate value $25.3 \times 7.15 \rightarrow 30 \times 7 = 210$. Since the significant figures are read 1809 (one · eight · zero · nine) given by the slide rule, the correct answer must be 180.9.

To get an approximate value from multiplication and division of three and more factors may be difficult. In this case, the following method can be employed.

(i) Moving the decimal point

Ex. $\dfrac{285 \times 0.00875}{13.75} = 0.1814$

Divide 285 by 100 to obtain 2.85 and, at the same time, multiply 0.00875 by 100 to obtain 0.875. In other words, the decimal point of 285 is moved two places to the left and that of 0.00875 is moved two places to the right, therefore, the product of 285 times 0.00875 is not affected.

$\dfrac{285 \times 0.00875}{13.75}$ is rewritten to $\dfrac{2.85 \times 0.875}{13.75}$ and approximated to $\dfrac{3 \times 0.9}{10} = 0.27$.

Since you read 1814 (one eight one four) on the slide rule, the answer must be 0.1814.

Ex. $\dfrac{1.346}{0.00265} = 508$

$$\frac{1.346}{0.00265} \rightarrow \frac{1346}{2.65} \rightarrow \frac{1000}{3} \rightarrow 300$$

(ii) Reducing fractions

If a number in the numerater has a value close to that of a number in the denominator, they can be cancelled out and an approximate figure is obtained.

Ex. $\dfrac{1.472 \times 9.68 \times 4.76}{1.509 \times 2.87} = 15.66$

$$\frac{\cancel{1.472} \times \overset{3}{\cancel{9.68}} \times 4.76}{\cancel{1.509} \times \cancel{2.87}} \rightarrow 3 \times 5 = 15$$

1.472 in the numerator can be considered to be equal to 1.509 in the denominator and they can therefore be cancelled out. 9.68 in the numerator is approximately 9 and 2.87 in the denominator is approximately 3. 4.76 in the numerator is approximately 5. Using the slide rule, you read 1566 on the D scale, therefore, the answer must be 15.66

(iii) Combination of (i) and (ii)

Ex. $\dfrac{7.66 \times 0.423 \times 12.70}{0.641 \times 3.89} = 16.50$

$$\frac{7.66 \times 0.423 \times 12.70}{0.641 \times 3.89} \rightarrow \frac{\cancel{7.66} \times \cancel{4.23} \times 12.70}{\cancel{6.41} \times \cancel{3.89}} \rightarrow 13$$

The decimal point of 0.423 and 0.641 in the numerator is shifted one place to the right. The approximate numbers in the denominator and numerator are cancelled and the answer, which is approximately 13, is found.

(b) Exponent

Any number can be expressed as $N \times 10^P$ where $1 \leqq N < 10$.

This method of writing numbers is useful in determining the location of the decimal point in difficult problems involving combined operations.

Ex. $\dfrac{1587 \times 0.0503 \times 0.381}{0.00815} = 3730$

$$\frac{1587 \times 0.0503 \times 0.381}{0.00815} = \frac{1.587 \times 10^3 \times 5.03 \times 10^{-2} \times 3.81 \times 10^{-1}}{8.15 \times 10^{-3}}$$

$$= \frac{1.587 \times 5.03 \times 3.81}{8.15} \times 10^{3-2-1-(-3)}$$

$$= \frac{2 \times 5 \times 4}{8} \times 10^{3-2-1-(-3)} = 5 \times 10^3 = 5000$$

CHAPTER 4. PROPORTION AND INVERSE PROPORTION (CI, C, D SCALE)

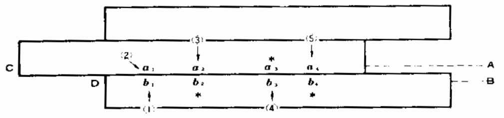
§1. PROPORTION

When the slide is set in any position, the ratio of any number on the D scale to its opposite on the C scale is the same as the ratio of any other number on the D scale to its opposite on the C scale. In other words, the D scale is directly proportional to the C scale. This relationship is used to calculate percentages, indices of numbers, conversion of measurements to their equivalents in other systems, etc.

FUNDAMENTAL OPERATIDN (4) $A \propto B$

A	a_1	a_2	(a_3)	a_4
B	b_1	(b_2)	b_3	(b_4)

( ) indicates an unknown quantity.

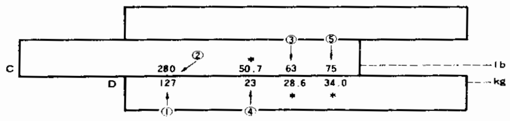


As illustrated in the above figure, when a_1 on the C scale is set opposite b_1 on the D scale the unknown quantities are all found on the C or D scales by moving the hairline.

Ex. 4.1 Conversion.

Given 127 kg = 280 lb. Find the values corresponding to the given values.

Pounds	280	63	(50.7)	75
kg	127	(28.6)	23	(34.0)



(Note) In calculating proportion, the C scale must be used for one measurement and the D scale for the other. Interchanging the scales is not permitted until the calculation is completed. In Ex.4.1., the C scale is used for the measurement of pounds and the D scale for that of kilo-grams.

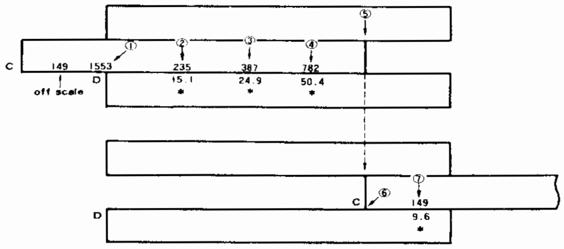
Ex. 4.2 Percentages.

Complete the table below.

Product	A	B	C	D	Total
Sales	235	387	782	149	1553
Percentage	(15.1)%	(24.9)	(50.4)	(9.6)	100

(UNIT: $10,000)

149 is on the part of the C scale which projects from the slide rule and its opposite on the D scale cannot be read. This is called "off scale". In the case of an "off scale", move the hairline to the right index of the C scale and move the slide to bring the left index of the C scale under the hairline. The answer 9.6 can then be read on the D scale opposite 149 on the C scale which is now inside the rule. This operation is called "interchanging the indices".



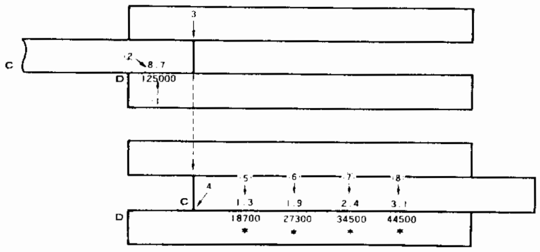
Ex. 4.3 Proportional Distribution.

Distribute a sum of $ 125,000 in proportion to each rate specified below.

Rate	1.3	1.9	2.4	3.1	Total (8.7)
Amount	(18,700)	(27,300)	(34,500)	(44,500)	125,000

(UNIT: $)

When 8.7 on the C scale is set opposite 125000 on the D scale, 1.3, 1.9, 2.4, and 3.1 on the C scale run "off scale". Therefore interchanging the indices is immediately required.



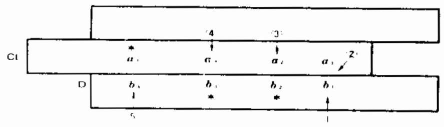
§ 2. INVERSE PROPORTION

When the slide is set in any position, the product of any number on the D scale and its opposite on the CI scale is the same as the product of any other number on the D scale and its opposite on the CI scale. In other words, the D scale is inversely proportional to the CI scale. This relationship is used to calculate inverse proportion problems.

FUNDAMENTAL OPERATION (5) $A \propto \frac{1}{B}$ $A \times B$ = Constant

A	a_1	a_2	a_3	(a_4)
B	b_1	(b_2)	(b_3)	b_4

( ) indicates an unknown quantity.

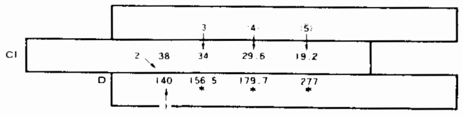


When a_1 on the CI scale is set opposite b_1 on the D scale, the product of $a_1 \times b_1$ is equal to that of $a_2 \times b_2$, that of $a_3 \times b_3$, and also equal to that of $a_4 \times b_4$. Therefore, b_2, b_3, a can be found by merely moving the hairline of the indicator.

Ex. 4.4

A bicycle runs at 38 km per hour, and takes 140 minutes to go from one town to another. Calculate how many minutes it will take if the bicycle is travelling at 34 km per hour, 29.6 km per hour or 19.2 km per hour.

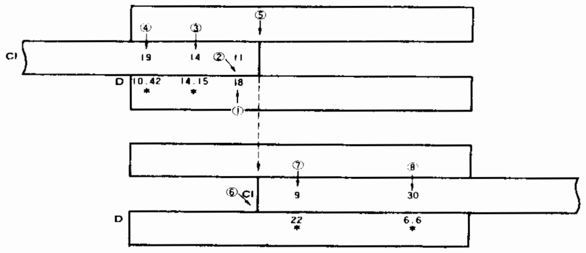
Speed	38 km	34	29.6	19.2
Time required	140 min.	(156.5)	(179.7)	(277)



In solving inverse proportion problems, unlike proportional problems, you can freely switch the scales from one to another, but it is preferable to select and use the scales so that the answer is always read on the D scale. In Ex. 3.1 the answer is always read on the D scale since the given figures are all set on the slide.

Ex. 4.5 A job which requires 11 men 18 days to complete. How many days will it take if the job is done by 9 men, 30 men, 19 men and 14 men?

No. of men	11	9	30	19	14
Time required	18	(22)	(6.6)	(10.42)	(14.15)



In this example 9 and 30 run "off scale". In this case it is more efficient to calculate the figures (19 and 14) which are inside the rule before interchanging the indices.

CHAPTER 5. SQUARES AND SQUARE ROOTS (A, B, SCALE)

The "place number" is used to find squares and square roots as well as placing the decimal point of squares and square roots.

When the given number is greater than 1, the place number is the number of digits to the left of the decimal point. When the given number is smaller than 1, the place number is the number of zeros between the decimal point and the first significant digit but the sign is minus.

For example, the place number of 2.97 is 1, of 29.7 is 2, of 2970 is 4, and of 0.0297 is - 1. The place number of 0.297 is 0.

§ 1. SQUARES AND SQUARE ROOTS

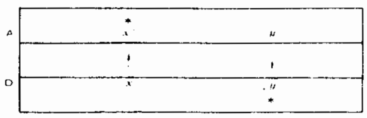
The A scale, which is identical to the B scale, consists of two D scales connected together and reduced to exactly 1/2 of their original length. The A scale is used with the C, D or CI scale to perform the calculations of the square and square root of numbers.

Since they consist of two D scales, the A and B scales are called "two cycle scales" whereas the fundamental C, D and CI scales are called "one cycle scales"

FUNDAMENTAL OPERATION (6) x^2, $\sqrt{y}$

(1) When the hairline is set over x on the D scale, x^2 is read on the A scale under the hairline.

(2) When the hairline is set over y on the A scale, $\sqrt{y}$ is read on the D scale under the hairline.



The location of the decimal point of the square read on the A scale is determined using the place number as follows:

a) When the answer is read on the left half section of the A scale (1 ~ 10), the "place number" of x^2 = 2 ("place number" of x) − 1

b) When the answer is read on the right half section of the A scale (10 ~ 100), the "place number" of x^2 = 2 ("place number" of x)

Ex. 5.1 $172^2 = 29600$ ·············· (Hence, the place number in the answer is $2 \times 3 - 1 = 5$)

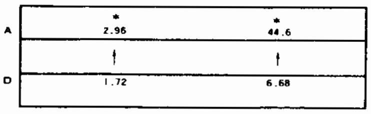
$17.2^2 = 296$ ················ (Hence, the place number in the answer is $2 \times 2 - 1 = 3$)

$0.172^2 = 0.0296$ ·········· (Hence, the place number in the answer is $2 \times 0 - 1 = -1$)

Ex. 5.2 $668^2 = 446000$ ············· (Hence, the place number in the answer is $2 \times 3 = 6$)
$= 4.46 \times 10^5$

$0.668^2 = 0.446$ ············· (Hence, the place number in the answer is $2 \times 0 = 0$)

$0.0668^2 = 0.00446$ ········ (Hence, the place number in the answer is $2 \times (-1) = -2$)



When the hairline is set over x on the A scale, $\sqrt{x}$ appears under the hairline on the D scale. Since the A scale consists of two identical sections, only the correct section can be used. Set off the number whose square root is to be found into two digits groups from the decimal point toward the first significant figure of the number. If the group in which the first significant figure appears has only one digit (the first significant digit only), use the left half of the A scale. If it has two digits (the first significant digit and one more digit), use the right half of the A scale.

Ex. 5.3 21|80|00 (right half) Place number······3 $\sqrt{218000} = 467$

2|18|00 (left half) Place number······3 $\sqrt{21800} = 147.7$

21|80 (right half) Place number······2 $\sqrt{2180} = 46.7$

2|18 (left half) Place number······2 $\sqrt{218} = 14.77$

0.21|8 (right half) Place number······0 $\sqrt{0.218} = 0.467$

0.02|18 (left half) Place number······0 $\sqrt{0.0218} = 0.1477$

0.00|21|8 (right half) Place number···-1 $\sqrt{0.00218} = 0.0467$

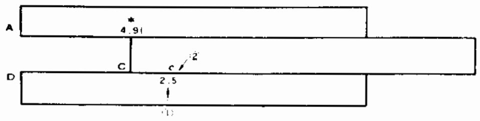
0.00|02|18 (left half) Place number···-1 $\sqrt{0.000218} = 0.01477$

§ 2. THE AREA OF A CIRCLE

A gauge mark "c" is imprinted on the C scale at the 1.128 position. This is used with the D scale to find the area of a circle.

When you set the gauge mark "c" on the C scale opposite the diameter set on the D scale, the area of the circle is read on the A scale opposite the index of the C scale.

Ex. 5.4 Find the area of a circle having a diameter of 2.5cm.



Answer 4.91cm²

CHAPTER 6. CUBES AND CUBE ROOTS (K SCALE)

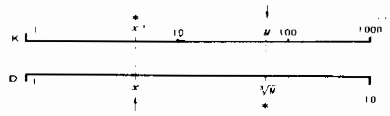
The K scale consists of three D scales connected together and reduced to exactly 1/3 of its original length. The K scale is called " three cycle scale" and is used with the C, D and CI scales to perform the calculations of the cubes and cube roots of numbers.

§ 1. CUBES AND CUBE ROOTS

FUNDAMENTAL OPERATION (7) $x^3, \sqrt[3]{y}$

(1) When the hairline is set over x on the D scale, x^3 is read under the hairline on the K scale.

(2) When the hairline is set over y on the K scale, $\sqrt[3]{y}$ is read under the hairline on the D scale.



The location of the decimal point in the cubes read on the K scale is determined by using the place number as follows:

a. When the answer is read on the left section of the K scale ($1 \sim 10$), "place number" of $x^3 = 3$·("place number" of x) $- 2$.

b. When the answer is read on the center section of the K scale ($10 \sim 100$), "place number" of $x^3 = 3$ ("place number" of x) $- 1$.

c. When the answer is read on the right section of the K scale ($100 \sim 1000$), "place number" of $x^3 = 3$ ("place number" of x).

Ex. 6.1 $16.3^3 = 4330$ ("place number" of answer $= 3 \times 2 - 2 = 4$)

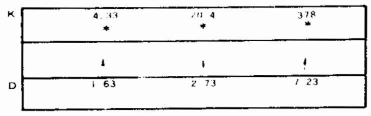
$0.163^3 = 0.00433$ ("place number" of answer $= 3 \times 0 - 2 = -2$)

$273^3 = 20400000$ ("place number" of answer $= 3 \times 3 - 1 = 8$)
$= 2.04 \times 10^7$

$0.0273^3 = 0.0000204$ ("place number" of answer $= 3 \times (-1) - 1 = -4$)
$= 2.04 \times 10^{-5}$

$72.3^3 = 378000$ ("place number" of answer $= 3 \times 2 = 6$)
$= 3.78 \times 10^5$

$0.00723^3 = 0.000000378$ ("place number" of answer $= 3 \times (-2) = -6$)
$= 3.78 \times 10^{-7}$



When the hairline is set over x on the K scale $\sqrt[3]{x}$ is found under the hairline on the D scale. Since the K scale consists of three identical sections, only the correct section can be used.

Set off the number into groups of three (3) digits from the decimal point to the first significant figure. If the group in which the first significant figure appears has only one digit, use the left section of the K scale. If the group has two digits, use the center section of the K scale, and if three, the right section of the K scale.

The location of the decimal point in the cube roots read on the D scale is determined in the manner previously described.

Ex. 6.2 Find the cube roots of the following numbers.

673|000 (right) $\sqrt[3]{673000} = 87.7$

67|300 (center) $\sqrt[3]{67300} = 40.7$

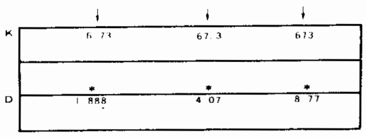
6|730 (left) $\sqrt[3]{6730} = 18.88$

0.673 (right) $\sqrt[3]{0.673} = 0.877$

0.067|3 (center) $\sqrt[3]{0.0673} = 0.407$

0.006|73 (left) $\sqrt[3]{0.00673} = 0.1888$

0.000|673 (right) $\sqrt[3]{0.000673} = 0.0877$



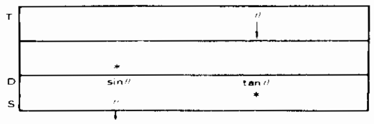
CHAPTER 7. TRIGONOMETRIC FUNCTIONS (T. S. ST SCALES)

The S scale is used to find the sine of an angle. The T scale is used to find the tangent of an angle. These scales are graduated in degrees and decimals of degrees and read from left to right using the black numbers and from right to left using the red numbers.

§ 1. SINE, TANGENT, COSINE

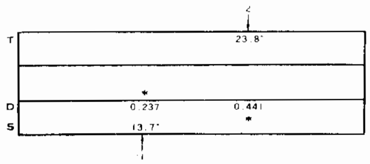
FUNDAMENTAL OPERATION (8) Sin θ. Tan θ

(1) When the hairline is set over θ on the S scale, sin θ is read under the hairline on the D scale.
(2) When the hairline is set over θ on the T scale, tan θ is read under the hairline on the D scale.



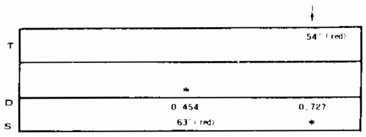
The value is read in the range 0.1 ~ 1 on the D scale.

Ex. 7.1 (i) sin 13.7° = 0.237 (ii) tan 23.8° 0.441



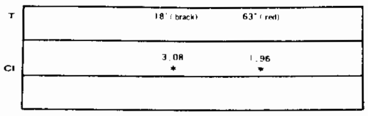
When the S scale is read from right to left using the red numbers, cos θ is found on the D scale under the hairline which sets θ on the S scale. When the T scale is used in the same manner, cot θ is found on the D scale under the hairline which sets θ on the T scale.

Ex. 7.2 cos 63° = 0.454 cot 54° = 0.727



The T scale covers the angles from 5.7° to 45°. The tangent of angles larger than 45° is found, basing on the formula $\cot\theta = \frac{1}{\tan(90° - \theta)}$, direct on the CI scale.
For example, $\tan 54° = \frac{1}{\tan 36°} = 1.377$

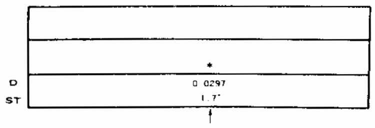
Ex. 7.3 tan 63° = 1.96 cot 18° = 3.08



§ 2. SINES AND TANGENTS OF VERY SMALL ANGLES.

The ST scale covers the very small angles ranging from about 0.6° to 5.7°, and is used to find sines and tangents of these angles. In this range of angles, the value of sine is almost equal to that of tangent ($\sin\theta \fallingdotseq \tan\theta$). The D scale is, when used with the ST scale, read at the range of 0.01 ~ 0.1.

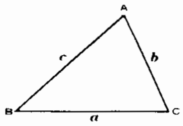
Ex. 7.4 sin 1.7° = 0.0297

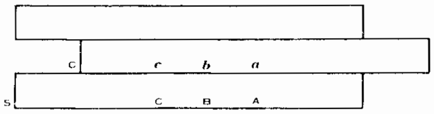


§ 3. SOLUTION OF TRIANGLES

FUNDAMENTAL OPERATION (9) THE LAW OF SINES
Given the triangle ABC, a is the side corresponding to A, b is the side corresponding to B, and c to C. The law of sines is

$$\frac{a}{\sin A} \quad \frac{b}{\sin B} \quad \frac{c}{\sin C}$$

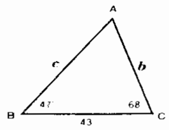


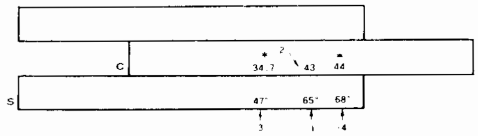


We can solve any triangle using the method solving proportional problems, when a side and its corresponding angle and another part are given.

Ex. 7.5 Find b and c.

∠A = 180° − (47° + 68°)
65°





Answer: b = 34.7, c = 44.0

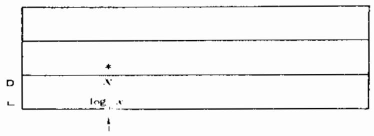
CHAPTER 8. LOGARITHMS (L SCALE)

§ 1. COMMON LOGARITHMS

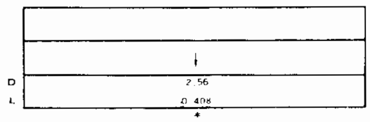
The L scale, which is a uniformly divided scale, is used with the D scale to find the mantissa of common logarithms. The characteristic of the logarithm is found by the place number of the given number. If the place number of the given number is m, the characteristic of the common logarithm found on the D scale is $m-1$.

FUNDAMENTAL OPERATION (10) $\log_{10} x$

(1) When the hairline is set over x on the D scale, $\log_{10} x$ is read under the hairline on the L scale.



Ex. 8.1 (1) $\log_{10} 2.56 = 0.408$ (2) $\log_{10} 0.256 = \bar{1}.408$
$\log_{10} 256 = 2.408$ $\log_{10} 25.6 = 1.408$
$\log_{10} 0.0256 = \bar{2}.408$ $\log_{10} 0.00256 = \bar{3}.408$



CHAPTER 9 EXPONENTS (LL SCALE)

No. P2 slide rule has, on the back of the slide, the LL scale (LL1, LL2, LL3) which is called the log log scale and is with the D scale used for calculating $\log_e x$, e^x and the exponents represented by A^x.

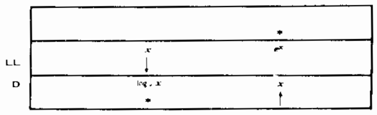
§ 1. NATURAL LOGARITHMS

FUNDAMENTAL (11) $\log_e x$, e^x

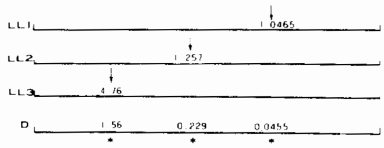
Remove and turn over the slide, and place the slide back into the rule.

(1) When the hairline is set over x on the LL scale, $\log_e x$ is read on the D scale.

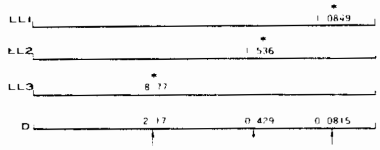
(2) e^x is found on the LL scale by moving the hairline over x on the D scale.



Ex. 9.1 $\log_e 4.76$ 1.56 $\log_e 1.257$ 0.229
$\log_e 1.0465$ 0.0455

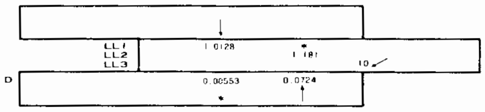


Ex. 9.2 $e^{2.17}$ 8.77 $e^{0.429}$ 1.536 $e^{0.0815}$ 1.0849



The common logarithm is also found by using the LL scale.
Move the slide to bring 10 on the LL3 scale to the index line of the D scale, then you can find $\log_{10} x$ on the D scale opposite x on LL scale.

Ex. 9.3 $\log_{10} 1.0128 = 0.00553$, $\log_{10}^{-1} 0.0724 = 1.181$

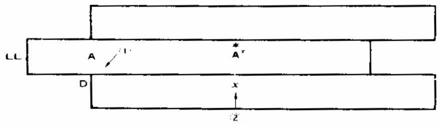


§2. EXPONENT

FUNDAMENTAL OPERATION (12) A^x

(1) Set A on the LL scale opposite the index of the D scale.

(2) Set the hairline over x on the D scale.
Read the answer on the LL scale under the hairline.

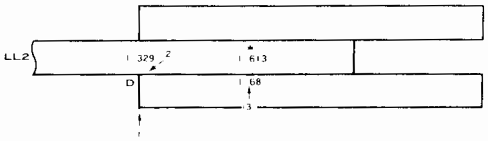


Since the slide rule has three LL scales, you must find on what LL scale the answer will appear. In the calculation of A^x, if x is a number between 1~10, the LL scale on which the answer appears will be determined as follows.

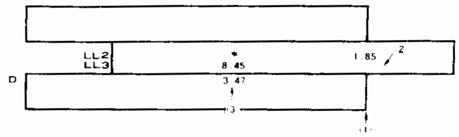
(1) When the slide protrudes to the left, use the LL scale having the same number as the LL scale on which A is set.

(2) When the slide protrudes the right, use the LL scale 1 number higher than the LL scale on which A is set.

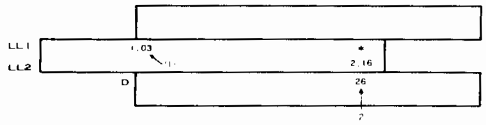
Ex. 9.4 $1.329^{1.68}$ 1.613



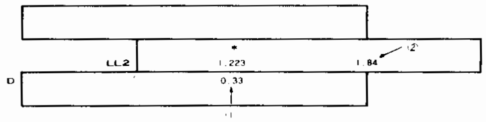
Ex. 9.5 $1.85^{3.47}$ 8.45



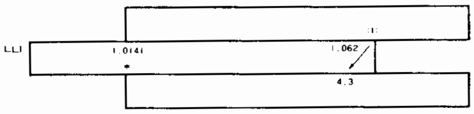
Ex. 9.6 $1.03^{26} = 1.03^{2.6\times10} = (1.03^{2.6})^{10} = 2.16$



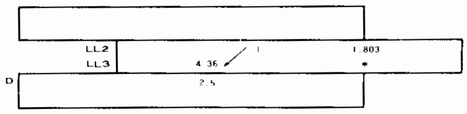
Ex. 9.7 $1.84^{0.33} = 1.84^{3.3\times0.1} = (1.84^{3.3})^{0.1} = 1.223$



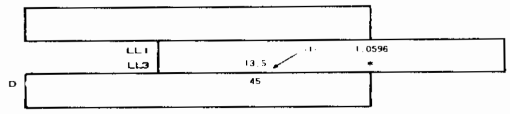
Ex. 9.8 $1.062^{\frac{1}{4.3}} = 1.0141$



Ex. 9.9 $4.36^{\frac{1}{2.5}} = 1.803$



Ex. 9.10 $13.5^{\frac{1}{45}} = 13.5^{\frac{1}{4.5}\times0.1} = (13.5^{\frac{1}{4.5}})^{0.1} = 1.0596$



Ex. 9.11 $1.074^{\frac{1}{0.38}} = 1.074^{\frac{1}{3.8}\times10} = (1.074^{\frac{1}{3.8}})^{10} = 1.207$

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