# INSTRUCTION MANUAL FOR
HEMMI P452
SLIDE RULE

READING THE SCALES

* The scales of a slide rule are not equally graduated as those of a ruler to measure. For instance the D scale, which is the fundamental scale and is most used, is graduated as follows:

Between 1 and 2   .... 0.01 per a section
Between 2 and 4   .... 0.02 per a section
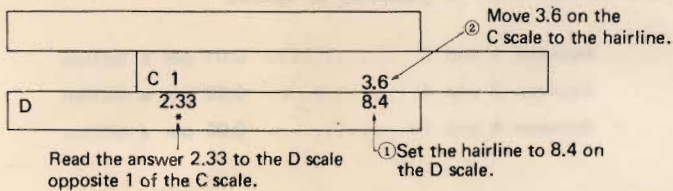Between 4 and 10 .... 0.05 per a section

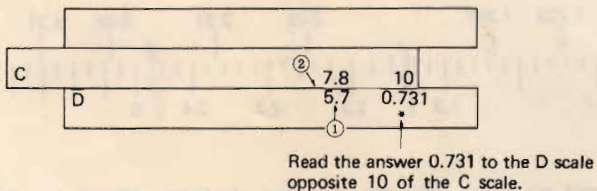* When reading between the graduation lines, you can determine the value by a visual estimate.
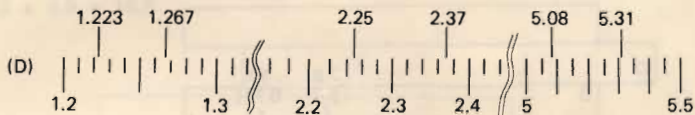
* You read on scales only the sequence of digits without regards to the location of the decimal point except on those scales LL1, LL2, LL3, L, ST, P, S and T. Namely, 2.37 on the D scale may represent 23.7, 237, 2370, 0.0237 or so on.

DIVISIONS

$8.4 \div 3.6 = 2.33$

Move 3.6 on the
C scale to the hairline. ②

C 1   3.6

D   2.33   8.4

Read the answer 2.33 to the D scale
opposite 1 of the C scale.

① Set the hairline to 8.4 on
the D scale.

$5.7 \div 7.8 = 0.731$

C

② 7.8   10

D   5.7   0.731

Read the answer 0.731 to the D scale
opposite 10 of the C scale.
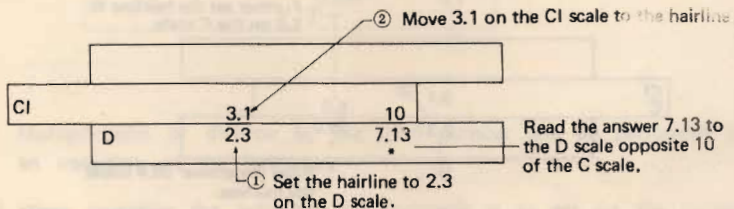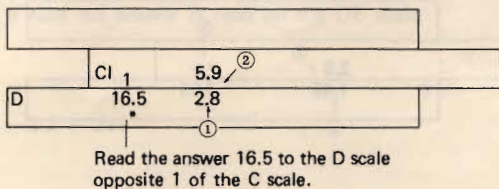
* The division with two numbers is solved by the D and C scales.
* The answer is read opposite 1 or 10 of the C scale.

MULTIPLICATIONS

$2.3 \times 3.1 = 7.13$

② Move 3.1 on the CI scale to the hairline

| CI | | 3.1 | | 10 | |
| D | | 2.3 | | 7.13 | |

Read the answer 7.13 to the D scale opposite 10 of the C scale.

① Set the hairline to 2.3 on the D scale.

$2.8 \times 5.9 = 16.5$

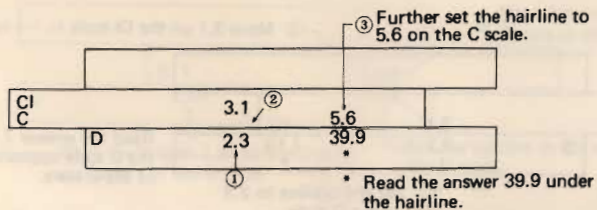| CI | 1 | 5.9 ② | |
| D | 16.5 | 2.8 | |
| | ① | | |

Read the answer 16.5 to the D scale opposite 1 of the C scale.
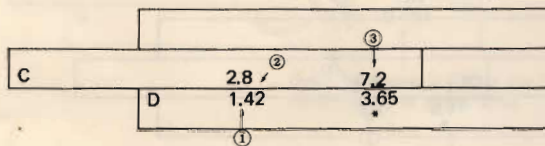
* The Multiplication with two numbers is solved by the D and CI scales.

* The answer is read in the same manner as divisions opposite 1 or 10 of the C scale.

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MULTIPLICATIONS AND DIVISIONS WITH THREE NUMBERS

2.3 x 3.1 x 5.6 = 39.9

③ Further set the hairline to
5.6 on the C scale.

CI
C   3.1 ②

5.6
D   2.3   39.9
①

* Read the answer 39.9 under
the hairline.

1.42 ÷ 2.8 x 7.2 = 3.65

③

C   2.8 ②   7.2
D   1.42   3.65
①

6.2 x 2.4 ÷ 5.3 = 2.81

③ Further set the hairline to 5.3 on the CI scale.

CI   5.3   2.4 ②
D   2.81   6.2
①

* Read the answer 3.65 under
the hairline.
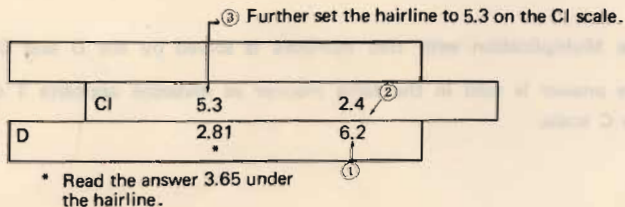
8.7 ÷ 4.8 ÷ 4.6 = 0.394
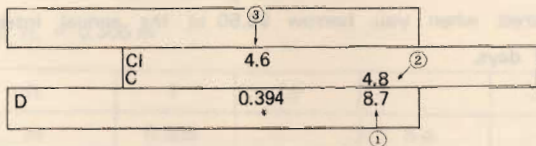
* Multiplication or division by the third number can be performed by an operation of the indicator.

1) When operating the indicator, the indicator is to set on the number of the C scale for multiplication.

2) The indicator is to set on the number of the CI scale for division.

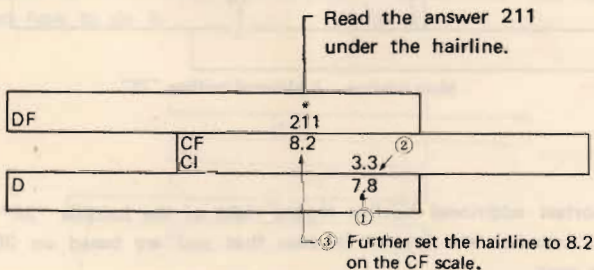* The answer is read on the D scale under the hairline.

* You may use the CF and CIF scales in place of the C and CI scales. In such a case the answer is read on the DF scale.

7.8 x 3.3 x 8.2 = 211

Read the answer 211 under the hairline.

③ Further set the hairline to 8.2 on the CF scale.

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CALCULATIONS OF INTEREST

Find the interest when you borrow $8.50 at the annual interest ratio of 7% for 48 days.

① Set the additional hairline "36" to 850 on the DF (CR) scale.
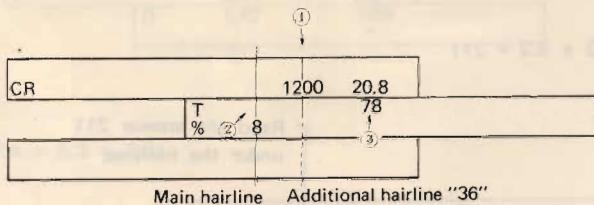
③ Further set the main hairline to 48 on the C (T) scale, and read the answer $7.93.

CR			850		
	% T	7		48	
R				7.93	

② Move 7 on the CI (%) scale to the Main hairline.
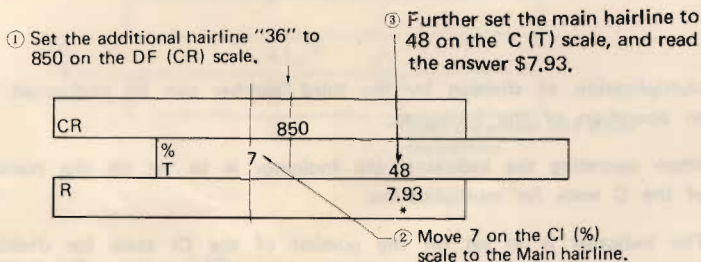
Find the interest when you borrow $1,200 at the annual interest ratio of 8% for 78 days. (The answer: $20.80)

			①		
CR			1200	20.8	
	T %	② 8		78 ③	

Main hairline   Additional hairline "36"

* The shortest additional hairline to the right of the hairline "36" is also used to calculate the interest in case that you are based on 365 days for one year.
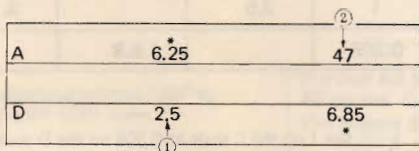
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PROPORTIONS

Fill the blanks in the following table.

Given: 1 ft. = 0.305 m

ft.	1	2.5		3.7
m	0.305		5.8	

The answer: 2.5 ft. = 0.763 m, 5.8 m = 19 ft., 3.7 ft. = 1.13 m

* You set 1 on the C scale at 0.305 on the D scale, and the C scale is used for the measurement of feet and the D scale for that of meter.

* When you cannot obtain the answer using the C and D scales, you may use instead the CF and DF scales. In case you cannot still solve by these CF and DF scales, you will once move the hairline to 1 on the C scale and again move 10 on the C scale to the hairline. The figure below shows how to do it.

SQUARES AND SQUARE ROOTS

1) $2.5^2 = 6.25$ 2) $\sqrt{47} = 6.85$

* A number on the D scale will have its square opposite on the A scale. The decimal point is located in the following manner.

  a) When the answer x^2 is read on the section $(1 - 10)$ of the A scale; Place number of $x^2 =$ (Place number of x) x 2 − 1

  b) When the answer x^2 is read on the section $(10 - 100)$ of the A scale; Place number of $x^2 =$ (Place number of x) x 2

* "Place number" in this manual is defined as follows:
  If the given number is larger than 1, the place number means the number of digits to left from the decimal point. If the given number is smaller than 1, the place number means the minus number of zeros being placed between the decimal point and the first significant figure of the number.

For example, the place number of

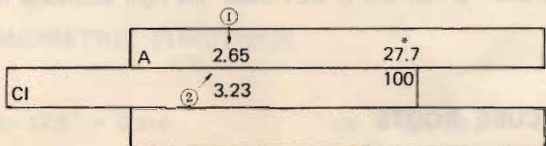|					
3250	is	4	0.325	is	0
325	is	3	0.0325	is	−1
32.5	is	2	0.00325	is	−2
3.25	is	1			

* The decimal point of a square root is placed as follows:

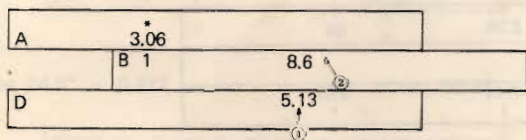$$\sqrt{325} \quad = \sqrt{3.25 \times 100} \quad = \sqrt{3.25} \times 10$$

$$\sqrt{0.00325} \quad = \sqrt{\dfrac{32.5}{10000}} \quad = \dfrac{\sqrt{32.5}}{100}$$

MULTIPLICATION AND DIVISION INVOLVING SQUARES AND SQUARE ROOTS
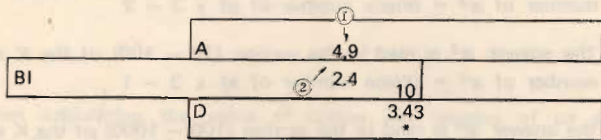
$2.65 \times 3.23^2 = 27.7$

$5.13^2 \div 8.6 = 3.06$

$\sqrt{4.9} \times 2.4 = 3.43$

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AREA OF A CIRCLE

Use of additional hairlines on the back face of indicator ;

a) When you set the center hairline to the diameter of a circle "d" on the D scale, you will read the area "a" on the A scale under the left additional hairline.

b) When you set the center hairline to the area of a circle "a", you will read the diameter "d" on the D scale under the right additional hairline.

CUBES AND CUBE ROOTS

1) $1.44^3 = 2.98$ 2) $\sqrt[3]{58} = 3.87$

		②	
K	* 2.98	58	
D	1.44 ↑ ①	3.87 *	

* Placing the decimal point of the cube.

  a) When the answer x^3 is read in the section $(1 - 10)$ of the K scale;
    Place number of x^3 = (Place number of x) x 3 − 2

  b) When the answer x^3 is read in the section $(10 - 100)$ of the K scale;
    Place number of x^3 = (Place number of x) x 3 − 1

  c) When the answer x^3 is read in the section $(100 - 1000)$ of the K scale;
    Place number of x^3 = (Place number of x) x 3

* Placing the decimal point of the cube root.

$$\sqrt[3]{3250} = \sqrt[3]{3.25 \times 1000} = \sqrt[3]{3.25} \times 10$$

$$\sqrt[3]{325000} = \sqrt[3]{325 \times 1000} = \sqrt[3]{325} \times 10$$

$$\sqrt[3]{0.0325} = \sqrt[3]{\frac{32.5}{1000}} = \frac{\sqrt[3]{32.5}}{10}$$

TRIGONOMETRIC FUNCTIONS

1) sin 12.5° = 0.216   2) tan 22.8° = 0.42

	*	*
D	0.216	0.42
S	12.5°	
T		22.8°
	①	②

1) cos 74.2° = 0.272   2) tan 55.9° = 1.477

CI		1.477 *
D	0.272	
S	74.2°	
T		55.9°
	①	②

* When calculating the value of cosine and tangent of an angle larger than 45°, you read from right to left using minor figures of the S and T scales.

$\sin 2.5° \div \tan 2.5° = 0.0436$

ST	2.5
D	0.0436 *

1)   arc sin $0.177 = 10.2°$ 2)   arc tan $0.62 = 31.8°$

	①	②
D	0.177	0.62
S	10.2°	
T	*	31.8° *

USE OF THE P SCALE

$\cos 9.85° = 0.9852$

	*
P	0.9852
S	9.85

* If the angle is smaller than $40°$, more precise value of cosine will be obtained by using the P and S scales as above.

* The P scale is also used to find the value of $\sqrt{1 - x^2}$ or $\sqrt{1 - x}$.

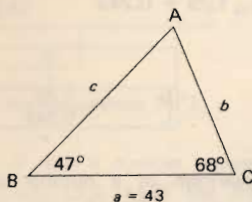1) $\sqrt{1 - 0.48^2} = 0.877$ 2) $\sqrt{1 - 0.035} = 0.9824$

	②	
A	0.035	
		①
D		0.48
P	0.9824	0.877
	*	*

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SOLUTIONS OF TRIANGLES

Given the triangle as below, find b and c using the law of sines,
$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}.$$
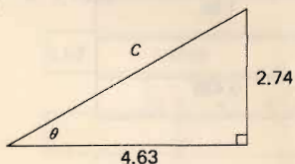
$\angle A = 180° - (47° + 68°) = 65°$

$$\frac{43}{\sin 65°} = \frac{b}{\sin 47°} = \frac{c}{\sin 68°}$$

C		34.7	43	44
S		47°	65°	68°
		③	①	④

(The answer: $b = 34.7$, $c = 44$)

Find θ and c in the triangle as below.

$$\theta = \tan^{-1} \frac{2.74}{4.63} \qquad c = \frac{2.74}{\sin \theta}$$

CI	1	①	5.28	4.63
D S T		2.74	30.6°	30.6°
			③	

(The answer: $\theta = 30.6°$, $c = 5.38$)

LOGARITHM

Common Logarithm (The base is 10.)

1) $\log_{10} 1.75 = 0.243$ 2) $\log_{10} 618 = 2.791$

	①	②
D	1.75	618
L	0.243	0.791

* The logarithm of a number consists of two parts called characteristic and mantissa.   The L scale is only able to calculate the mantissa of logarithm to the base 10.   The characteristic is separately determined by the mental calculation.

Natural logarithm (The base is e.)

* Since $\log_e x = 2.3 \log_{10} x$ you may solve natural logarithm by the L scale, and yet the LL scales will be more conveniently used for finding the natural logarithm.

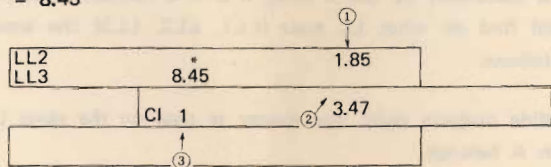1) $\log_e 8.5 = 2.14$ 2) $\log_e 1.55 = 0.438$

	①	②
LL2 LL3	8.5	1.55
D	2.14	0.438

EXPONENTS

$1.329^{1.68} = 1.613$

		①		
LL2		1.329	1.613	
CI		② 1.68	10	
			③	

$1.85^{3.47} = 8.45$

| LL2			
LL3		8.45	*	1.85 ①
	CI 1		② 3.47
	③	

* The LL scales are also used to calculate the exponents (A^x).

* When A^x is calculated by the CI scale, if x is a number between 1 and 10, you will find on what LL scale (LL1, LL2, LL3) the answer will appear as follows:

   a) If the slide projects left, the answer is read on the same LL scale to which A belongs.

   b) If the slide projects right, the answer is read on the LL scale one number more than that A belongs to.

* When reading the LL scales, you cannot change the position of decimal point as those scales C, D and so on before described.

$1.584^{\frac{1}{2.6}} = 1.1935$

		①
LL2	* 1.1935	1.584
	C 1	② 2.6
	③	

$1.224^{\frac{1}{5.1}} = 1.0404$

	①	*
LL1		1.0404
LL2	1.224	
C	② 5.1	10 ③
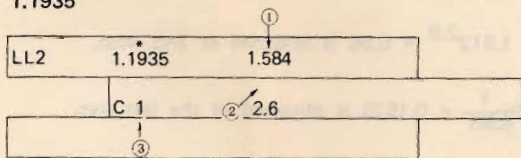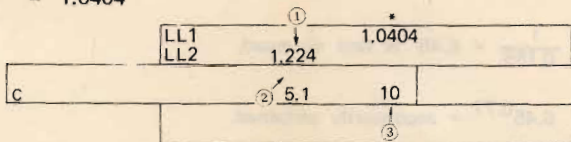
* When $A^{\frac{1}{x}}$ is calculated by the C scale, if x is a number between 1 and 10, you will find on what LL scale (LL1, LL2, LL3) the answer will appear as follows:

   a) If the slide projects right, the answer is read on the same LL scale to which A belongs.

   b) If the slide projects left, the answer is read on the LL scale on number less than that A belongs to.

$1.86^{-3.3} = 0.129$ (A > 1 and $x < 0$ in A^x)

   1) $1.86^{3.3} = 7.75$ is first obtained,

   2) $\frac{1}{7.75} = 0.129$ is secondarily obtained.

$0.523^{2.9} = 0.1525$ (A < 1 and $x > 0$ in A^x)

   1) $\frac{1}{0.523} = 1.912$ is obtained at 1st. step,

   2) $1.912^{2.9} = 6.56$ is obtained at 2nd. step,

   3) $\frac{1}{6.56} = 0.1525$ is obtained at the last step.

$0.155^{-0.77} = 4.2$ (A < 1 and $x < 0$ in A^x)

   1) $\frac{1}{0.155} = 6.45$ is first obtained,

   2) $6.45^{0.77} =$ secondarily obtained.