

Circular slide-rule КЛ-1

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The circular slide-rule КЛ-1 is designed to perform common mathematical operations such as multiplication, division, combined operations, squares, cubes, square-root and cube-root extractions, trigonometric functions of sine and tangent as well as inverse trigonometric functions, calculations of circle area and weight of right circular cylinders.

The circular slide-rule comprises a shell with two knobs, two index plates, one of which rotates with help of a black-dotted knob, and two pointers rotating with help of a red-dotted knob. A fixed indicator is located on the same side as the rotating index plate, adjacent to the black-dotted knob.

Two scales – an inner (basic) scale for calculation and an outer scale for squares - are displayed on the rotating index plate.

The fixed index plate has three scales: an outer scale which is similar to the inner scale on the rotating index plate,

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a central scale **S** of angles for calculating sines and an inner scale **T** of angles for calculating tangents.

Mathematical operations on the КЛ-1 slide-rule are to be carried out in the following way:

I. Multiplication

1. Using the black-dotted knob, turn the rotating index plate to set the first multiplier on the calculation scale coincident with the fixed indicator.
2. Using the red-dotted knob, set the pointer coincident with the index of the calculation scale.
3. Using the black-dotted knob, turn the index plate to set the second multiplier on the calculation scale coincident with the pointer.
4. Read the desired value of the product opposite the fixed indicator on the calculation scale. Numbers can be multiplied continuously.

II. Division

1. Using the black-dotted knob, turn the rotating index plate to set the dividend on the calculation scale under the fixed indicator.
2. Using the red-dotted knob, set the pointer coincident with the denominator on the calculation scale.
3. Using the black-dotted knob, turn the rotating index plate to set the index of the calculation scale coincident with the pointer.

4. Read the desired value of the quotient on the calculation scale opposite the fixed indicator. You can divide numbers continuously in this way.

III. Combined operations

1. Using the black-dotted knob, turn the index plate to set the first multiplier coincident with the fixed indicator on the calculation scale.
2. Using the red-dotted knob, set the pointer coincident with the denominator on the calculation scale.
3. Using the black-dotted knob, turn the rotating index plate to set the second multiplier coincident with the pointer on the calculation scale.
4. Read the final result opposite the fixed indicator on the calculation scale.

Example: $(2 * 12) / 6 = 4$

IV. Squares

1. Using the black-dotted knob, turn the rotating index plate to set the value of the number to be squared on the calculation scale coincident with the fixed indicator.
2. Read the desired value of the square of the number opposite the same indicator on the scale of squares.

V. Square roots

1. Using the black-dotted knob, turn the rotating index plate until the value of the number on the scale of squares is coincident with the fixed indicator.
2. Opposite the same indicator on the inner (calculation) scale read the desired value of the square root.

VI. Cubes

(no scale of cubes is available on this slide-rule)

1. Using the black-dotted knob, turn the rotating index plate until the number to be cubed is coincident with the fixed indicator.
2. Using the red-dotted knob, turn the pointer to set it coincident with the index of the calculation scale.
3. With the black-dotted knob, turn the rotating index plate until the number to be cubed on the scale of squares is coincident with the pointer.
4. Read the desired cube of this number on the scale of squares.

VII. Trigonometric functions of an angle

1. With the red-dotted knob, set the pointer on the fixed index plate coincident with the value of the desired angle on the sine scale (scale **S**) or on the tangent scale (scale **T**).

2. Read the relevant value of sine or tangent of this angle opposite the pointer on the fixed index plate on the outer (calculation) scale.
3. For obtaining values of the sine of angles ranging between 0 and 6 degrees, use the corresponding value of the tangent scale.
4. Cotangents of angles ranging between 6 and 45 degrees may be found as follows:
 - a) Set the pointer to the desired value of the angle on scale **T**.
 - b) Set the index of the rotating scale coincident with the fixed indicator;
 - c) The pointer on the calculation scale will indicate the cotangent.

VIII. Inverse trigonometric functions

1. With the red-dotted knob, set the pointer coincident with the value of the trigonometric function on the outer (calculation) scale of the fixed index plate.
2. Read the corresponding angle on the sine or tangent scale opposite the pointer.

IX. Circle area calculation

1. With the black-dotted knob, turn the rotating index plate to set the value of the diameter of the circle on the calculation scale.

2. Using the red-dotted knob, set the pointer coincident with the gauge point C ($= \sqrt{4/\pi} = 1.128$).
3. Using the black-dotted knob, turn the rotating index plate to set the index of the calculation scale coincident with the pointer.
4. Read the desired value of the area of the circle opposite the fixed indicator on the scale of squares.

X. Calculation of weight of right circular cylinder

(Specific gravity 7.85 g/cm^3 – steel)

Weight is calculated as follows:

- a) Weight of a running meter:
 1. Set the value of the diameter of circle in mm on the basic scale coincident with the fixed indicator;
 2. Position the pointer opposite the coefficient 0.404 on the basic calculation scale;

(Note: $0.404 = \sqrt{4/(\pi * 7.85)}$). For specific gravities other than 7.85 g/cm^3 , adjust the coefficient accordingly.)

3. Set the index on the rotating scale coincident with the pointer;
 4. Read the value of the weight (example $D = 50\text{mm}$; $L = 1 \text{ m}$; $W = 15.4 \text{ kg}$) opposite the pointer on the scale of squares.
- b) Weight of sections of various length: Begin as in steps 1 and 2 (see above);
 3. Set the value of the desired length on the scale of squares coincident with the pointer;
 4. Read the value of weight (example $D = 50\text{mm}$; $L = 0.52 \text{ m}$; $W = 8 \text{ kg}$) opposite the pointer on the scale of squares.

XI. Defining product and quotient orders

a) multiplication

If in multiplying two numbers the index of the calculation scale is positioned between the fixed indicator and the pointer clockwise from the indicator (Fig. 1), the order of multiplication shall be equal to the sum of orders of the multipliers minus 1.

Example: $22.5 * 1.6 = 36;$
 $(2 + 1 - 1 = 2).$

If the index of the calculation scale is positioned between the fixed indicator and the pointer counter-clockwise (Fig. 2), then the order of the product shall be equal to the sum of orders of multipliers.

Example: $62.3 * 2.4 = 149$
 $(2 + 1 = 3)$

b) division

Order of coefficient is to be defined following actions described for step 2, section II, prior to setting index of the calculation scale coincident with the pointer.

If in the course of division the index of the calculation scale is positioned between the fixed indicator and the pointer in the clockwise direction from the indicator (Fig. 1), then the order of coefficient shall be equal to the difference of the order of the dividend and denominator plus one.

Example: $34.5 : 1.5 = 23$
 $(2 - 1 + 1 = 2)$

If the index of the calculation scale is positioned between the fixed indicator and the pointer in the counter-clockwise direction from the indicator (Fig. 2), then the order of the quotient is equal to the difference of the orders of dividend and the denominator.

Example: $144 : 3.6 = 40;$
 $(3 - 1 = 2)$

General notes (Fig. 3, 4):

1. shell
2. black-dotted knob
3. red-dotted knob
4. rotating index plate
5. fixed indicator
6. basic (calculation) scale
7. scale of squares
8. pointer
9. fixed index plate
10. calculation scale
11. pointer