1010SL EXTENDED SQUARE ROOT SCALE SUPPLEMENT TO M-12R

THE $\sqrt{\ }$ SCALES: Square Roots and Squares

When a number is multiplied by itself the result is called the *square* of the number. Thus 25 or 5×5 is the square of 5. The factor 5 is called the *square root* of 25. Similarly, since $12.25=3.5\times3.5$, the number 12.25 is called the square of 3.5; also 3.5 is called the square root of 12.25. Squares and square roots are easily found on a slide rule.

Square Root. Just below the D scale is another scale marked with the square root symbol, $\sqrt{\ }$.

Rule. **The square root of any number located on the D scale is found directly below it on the $\sqrt{\ }$ scale.**

EXAMPLES: Find $\sqrt{4}$. Place the hairline of the indicator over 4 on the D scale. The square root, 2, is read directly below. Similarly, the square root of 9 (or $\sqrt{9}$) is 3, found on the $\sqrt{\ }$ scale directly below the 9 on the D scale.

Reading the Scales. The square root scale directly below the D scale is an enlargement of the D scale itself. The D scale has been "stretched" to double its former length. Because of this the square root scale seems to be cut off or to end with the square root of 10, which is about 3.16. To find the square root of numbers greater than 10 the bottom $\sqrt{\ }$ scale is used. This is really the rest of the stretched D scale. The small figure 2 near the left end is placed beside the mark for 3.2, and the number 4 is found nearly two inches farther to the right. In fact, if 16 is located on the D scale, the square root of 16, or 4, is directly below it on the *bottom scale* of the rule.

In general, the square root of a number between 1 and 10 is found on the upper square root scale. The square root of a number between 10 and 100 is found on the lower square root scale. If the number has an odd number of digits or zeros (1, 3, 5, 7,...), the upper $\sqrt{\ }$ scale is used. If the number has an even number of digits or zeros (2, 4, 6, 8,...), the lower $\sqrt{\ }$ scale is used. The first three (or in some cases even four) figures of a number may be set on the D scale, and the first three (or four) figures of the square root are read directly from the proper square root scale.

The table below shows the number of digits or zeros in the number N and its square root.

ZEROS					or	DIGITS				
	U L	U L	U L	U	L	U L	U L	U L	U L	
N	7 or 6	5 or 4	3 or 2	1	0	1 or 2	3 or 4	5 or 6	7 or 8	etc.
$\sqrt{N}$	3	2	1	0	0	1	2	3	4	etc.

The above table is reproduced on some models of Pickett Slide Rules.

This shows that numbers from 1 up to 100 have one digit in the square root; numbers from 100 up to 10,000 have two digits in the square root, etc. Numbers which are less than 1 and have, for example, either two or three zeros, have only one zero in the square root. Thus $\sqrt{0.004}=0.0632$, and $\sqrt{0.0004}=0.02$.

EXAMPLES:

(a) Find $\sqrt{248}$. Set the hairline on 248 of the D scale. This number has 3 (an *odd* number) digits. Therefore the figures in the square root are read from the upper $\sqrt{}$ scale as 1575. The resulth as 2 digits, and is 15.75 approximately.

(b) Find $\sqrt{563000}$. Set the hairline on 563 of the D scale. The number has 6 (an *even* number) digits. Read the figures of the square root on the bottom scale as 75. The square root has 3 digits and is 750 approximately.

(c) Find $\sqrt{.00001362}$. Set the hairline on 1362 of the D scale. The number of *zeros* is 4 (an *even* number). Read the figures 369 on the bottom scale. The result has 2 zeros, and is .00369.

Squaring is the opposite of finding the square root. Locate the number on the proper $\sqrt{}$ scale and with the aid of the hairline read the square on the D scale.

EXAMPLES:

(a) Find $(1.73)^2$ or 1.73×1.73. Locate 1.73 on the $\sqrt{}$ scale. On the D scale find the approximate square 3.

(b) Find $(62800)^2$. Locate 628 on the $\sqrt{}$ scale. Find 394 above it on the D scale. The number has 5 digits. Hence the square has either 9 or 10 digits. Since, however, 628 was located on the lower of the $\sqrt{}$ scales, the square has the *even* number of digits, or 10. The result is 3,940,000,000.

(c) Find $(.000254)^2$. On the D scale read 645 above the 254 of the $\sqrt{}$ scale. The number has 3 zeros. Since 254 was located on the upper of the $\sqrt{}$ scales, the square has the odd number of digits, or 7. The result is 0.0000000645.

PROBLEMS	ANSWERS
1. $\sqrt{7.3}$	2.7
2. $\sqrt{73}$	8.54
3. $\sqrt{841}$	29
4. $\sqrt{0.062}$	0.249
5. $\sqrt{0.00000094}$	0.00097
6. $(3.95)^2$	15.6
7. $(48.2)^2$	2320
8. $(0.087)^2$	0.00757
9. $(0.00284)^2$	0.00000807
10. $(635000)^2$	4.03×10^{11}