"HALF-HOUR" INSTRUCTIONS

FOR THE USE OF THE

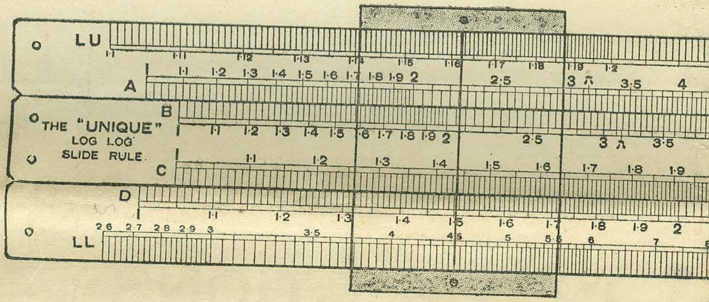
BRITISH MADE

"UNIQUE" LOG-LOG SLIDE RULE.

CONTAINING

CONVERSION TABLE

FOR MONEY CALCULATIONS.



SINCE the operations of multiplication and division occur so frequently in the computation of numerical results, any mechanical means of performing them rapidly is valuable. Various forms of Slide Rules are obtainable, with the aid of which, results, sufficiently accurate for most purposes, may be readily obtained. Compared with ordinary or contracted methods, or the use of logarithms, computation by the Slide Rule is less laborious, less liable to error, and very much more expeditious.

An illustration of the 10in. "Unique" Slide Rule is given above, and an inspection of the rule itself shows that the essential parts consist of four scales, denoted for reference in the illustration by the letters A, B, C and D, and a log-log scale running along the top and bottom edges, denoted by LU and LL. A transparent cursor with a fine line drawn across it is supplied to assist in certain operations.

The scales are in all cases divided in decimals, and practice in reading them may be necessary. It is obviously quite impossible to number every division, and in reading a position in any scale, the nearest number to the left, or to the right, must be carefully observed, and the divisions of the scale followed until the exact position is reached. For example, in the illustration of the rule, the cursor line is standing at 1.1622 in LU, at 2.26 in A, at 2.07 in B, at 1.438 in C, at 1.504 in D, and at 4.5 in LL.

(The comprehensive numbering of the scales is a distinctive feature of the Unique Slide Rule, and in this respect it is superior to the more expensive instruments, most of which are numbered in an inadequate and misleading manner).

MULTIPLICATION may be effected by using scale A in conjunction with scale B, or by using scale C in conjunction with scale D. Supposing multiplication of 25 and 45 is desired, the procedure, using scales A and B, is :—Adjust the slide so that the 1 on B is brought into coincidence with 25 on A, and read the answer, 1125, on A opposite 45 on B. It will be observed that

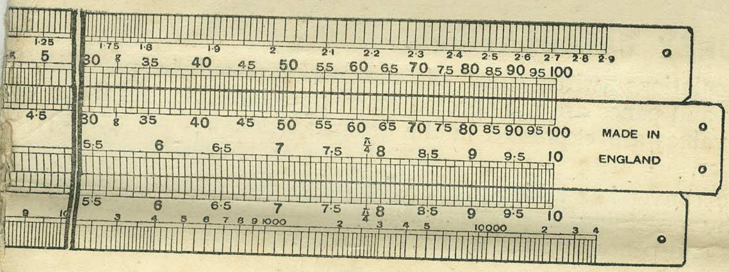
25 appears twice in scale A ; it is immaterial which reading is taken, nor does it matter whether 1, 10 or 100 in scale B is brought into coincidence with 25 in scale A, the answer, 1125, will be found in A, opposite either position of the line 45 in B. When scales C and D are employed the procedure is similar. Move the slide so that the 1 on C is brought opposite 25 on D and read the answer in scale D, opposite 45 in scale C. In this example the answer is off the scale, and cannot be obtained by this setting of the rule, but if the 10 in scale C is moved to position opposite 25 in D, the answer, 1125, is found coincident with 45 in C. Using scales A and B the delay occasioned by the double setting need never occur, and it is for this reason that the upper pair of scales is sometimes employed in multiplication. Greater accuracy will always be obtained when scales C and D are used, and their use in multiplication and division generally, is strongly recommended.

In the example the answer is 1125, but it is apparent, that the manipulation of the slide rule would be exactly the same, in the multiplication of any two numbers in which two five, and four five are the only significant figures, for example, $25 \times 45 = 1125$; $2.5 \times 45 = 112.5$; $.25 \times 4.5 = 1.125$; $.025 \times .45 = .01125$. The position of the decimal point in the answer is easily determined by inspection. When three or more numbers are to be multiplied together, the computation is effected by a series of operations, the cursor line being used to mark the intermediate answers until the final result is reached.

DIVISION. Set the slide so that the divisor on scale C is coincident with the dividend on scale D, the result will be found in D opposite 1 or 10 in C.

For example, suppose it is desired to divide 13.9 by 5.65. Adjust the slide so that 565 in scale C is coincident with 139 in scale D. Opposite 10 in C will be found the result in D. viz., 246. Inserting the decimal point, the result 2.46 is obtained.

In computing the value of an expression such as the following : $\frac{86.2 \times .049 \times 18 \times 1.7}{22.5 \times 11.45 \times .8}$ it is evident that repeated multiplication of the four numbers of the numerator, followed by division separately, by the three numbers of the denominator will give the result, but time is saved by dividing and multiplying alternately. Use scales C and D find 862 on D and bring 225 on C into coincidence ; adjust cursor line to 18 in C, then move slide to bring 8 on C under cursor line ; move cursor line into position above 49 in C and adjust slide so that 1145 in C lies under cursor line ; read the answer, 627, in D opposite 17 in C. Approximate cancellation of the numbers will fix the position of decimal point in



the answer. 22.5 divides 86.2 approximately 4, and the 4 thus obtained divides 11.45 nearly 3, which leaves 6 in the numerator when divided into 18 ; .8 into 1.7 gives roughly 2, and the result is approximately $6 \times 2 \times .05 = 12 \times .05 = .6$. The answer, therefore, is .627.

Frequently the position of decimal point may be determined without resorting to the approximation indicated above, *e.g.*, suppose the fraction $\frac{51.9}{69.7}$ is desired as a percentage. Using the Slide Rule to divide 519 by 697, the result, 745 obtained, is obviously 74.5 per cent.

Those using the Slide Rule for the first time are advised to master the operations of multiplication and division, as explained above, before reading any further. Practice with simple numbers giving results easily checked is recommended, e.g., *using scales C and D evaluate* $\frac{2 \times 12 \times 6}{4 \times 9}$ *and see if the answer is 4. Now repeat, taking the numbers in a different order, and see if the result is the same. Take note of the time saved by dividing and multiplying alternately, as described in the example given earlier. Half-an-hour spent on similar simple examples will suffice to teach the use of the rule for the fundamental operations of multiplication and division.*

The following rules, based upon the manipulation of the Slide Rule, are sometimes used to fix the decimal point, but their use is not recommended. In multiplication, when the 1 of scale C is used in the setting of the slide, the number of digits occurring before the decimal point of the answer is one less than the sum of the numbers of digits appearing before the decimal points of the original numbers. When the 10 of scale C is used in setting, the number of digits before the decimal point of the answer is the same as the sum of the numbers of digits preceding the decimal points of the original numbers. When dividing, if the answer appears opposite 1 in C the number of digits preceding the decimal point of the answer is one greater than the difference obtained by subtracting the number of digits lying before the decimal point of the divisor from the number of digits appearing before the decimal point of the dividend, but if the answer is found opposite 10 in C the number of digits preceding its decimal point is the same as the difference between the numbers of digits appearing before the decimal points of dividend and divisor respectively. When the numbers to be multiplied together or divided are of values less than unity, the number of ciphers immediately following the decimal points must be taken into account and reckoned as negative in the application of the rules for fixing the position of decimal point in the answer.

SQUARES. Numbers may be squared by multiplication direct, but results are more readily obtained by reading in scale A the squares of numbers directly opposite in scale D, the cursor or, preferably the slide, being used to project from one scale to the other.

The calculation of the area of a circle from the diameter is a computation often desired. Find the number representing diameter on D and bring the 1 or 10 of scale C into coincidence with it. The answer appears in A opposite the line at 785 in B.

SQUARE ROOTS. The square roots of all numbers in scale A appear directly below in scale D. Since, however, any number appears twice in scale A, care is necessary in selecting the one to be used. The rule is :—If the original number has an odd number of digits preceding its decimal point, or, when less than unity, has an odd number of ciphers immediately following its decimal point, the left-hand half of scale A must be used. When the number of digits preceding, or the ciphers immediately following the decimal point in the original number is even, the right-hand half of scale A must be used.

CUBES of numbers may be found by repeated multiplication, or more quickly by moving the 1 or 10 of scale C into coincidence with the number to be cubed in D, and reading the answer in A directly opposite the original number in B.

CUBE ROOTS. Find the number whose cube root is required in scale A and place the cursor line over it. Move the slide until the numer in scale B, directly under the cursor line, is exactly the same as that in D opposite 1 or 10 in C. There will be three positions of the slide satisfying these conditions, and care must be taken to select, by inspection, the one giving the correct value.

Squares, square roots, cubes and cube roots may be evaluated with the aid of the log-log scale, sometimes with a higher degree of accuracy than is possible with scales A, B, C and D.

MONEY CALCULATIONS.

Calculations with sums of money expressed in pounds, shillings and pence are not effected easily by Slide Rule, but if the money values are expressed in the decimal system, there are no difficulties.

The conversion tables printed below facilitate such calculations, by providing a simple and rapid method of converting shillings and pence into the decimal equivalents of the pound, and *vice versa*.

The table may be used also for converting cwts. and quarters into decimals of the ton, and *vice versa*.

The smaller table shews pence as decimals of the shilling.

The following examples are designed to illustrate the value of the Slide Rule in this work.

Example 1. **Calculate the cost of 43 articles at £3 6s. 10d. each.**

In the larger table, in the column headed 6s., and in the line marked 10d., is the number .342. £3 6s. 10d. is therefore £3.342. To multiply 3.342 by 43, set 10 in scale C opposite 3.342 in scale D, then opposite 43 in C will be found 143.7 in D. The result, therefore, is £143.7 or £143 14s., by the slide rule, and the exact amount is £143 13s. 10d.

TABLE FOR CONVERTING SHILLINGS AND PENCE INTO POUNDS AND HUNDREDWEIGHTS AND QUARTERS INTO TONS.

PENCE	QUARTERS	SHILLINGS OR CWTS.																			
			1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19
0			·050	·100	·150	·200	·250	·300	·350	·400	·450	·500	·550	·600	·650	·700	·750	·800	•850	·900	•950
1		·004	·054	·104	·154	·204	·254	·304	·354	·404	·454	·504	·554	·604	·654	·704	·754	·804	·854	·904	·954
2		·008	058	·108	·158	·208	·258	·308	·358	·408	·458	·508	·558	·608	·658	·708	·758	·808	·858	·908	·958
3	1	·012	·062	·112	·162	·212	·262	·312	·362	·412	·462	·512	·562	·612	·662	·712	·762	·812	·862	·912	·962
4		·017	·067	·117	·167	·217	·267	·317	·367	·417	·467	·517	·567	·617	·667	·717	·767	·817	·867	·917	·967
5		·021	·071	·121	·171	·221	·271	·321	·371	·421	·471	·521	·571	·621	·671	·721	·771	·821	·871	·921	·971
6	2	·025	·075	·125	·175	·225	·275	·325	·375	·425	·475	·525	·575	·625	·675	·725	·775	·825	·875	·925	·975
7		·029	·079	·129	·179	·229	·279	·329	·379	·429	·479	·529	·579	·629	·679	·729	·779	·829	·879	·929	·979
8		033	·083	·133	·183	·233	·283	·333	·383	·433	·483	·533	·583	·633	·683	·733	·783	·833	·883	·933	·983
9	3	·037	·087	·137	·187	·237	·287	·337	·387	·437	·487	·537	·587	·637	·687	·737	·787	·837	·887	·937	·987
10		·042	·092	·142	·192	·242	·292	·342	·392	·442	·492	·542	·592	·642	·692	·742	·792	·842	·892	·942	·992
11		·046	·096	·146	·196	·246	·296	·346	·396	·446	·496	·546	·596	·646	·696	·746	·796	·846	·896	·946	·996

PENCE EXPRESSED AS DECIMALS OF A SHILLING.

½d. is ·042/- 1d. is ·083/- 2d. is ·167/- 3d. is ·250/- 4d. is ·333/- 5d. is ·417/-
6d. is ·500/- 7d. is ·583/- 8d. is ·667/- 9d. is ·750/- 10d. is ·833/- 11d. is ·917/-

2. **Calculate 28% of £61 10s.** To multiply 61.5 by 28, find 61.5 in D and bring 10 of C into coincidence. Opposite 28 in C read 17.22 in D. The result is £17 4s. 5d., which is correct to the nearest penny.

3. **Find the cost of 16 tons 3 cwts. 2 quarters of material at £1 2s. 8d. per ton.**

The table gives 3 cwts. 2 quarters as .175 tons and 2s. 8d. as £.133.

Multiply 16.175 by 1.133 using scales C and D, and the result will be found to be £18.33, which converts into £18 6s. 7d., which is within one penny of the exact amount.

4. **Find the cost of 15½ yards of material at 8s. 4½d. per yard.**

Using the smaller table, 4d. is seen to be .333s., and ½d. is .042s., which added together give .375s. 8s. 4½d. is therefore 8.375s. Use scales C and D to multiply 15.5 by 8.375 and the result will be found to be 129.8s., which is £6 9s. 10d. The exact value is £6 9s. 9¾d.

Even when the money amounts must be obtained with absolute correctness the Slide Rule will give a ready means of securing a rapid check on the result, and its value in this connection is obvious.

LOG-LOG COMPUTATIONS.

The tenth powers of all numbers in L U lie immediately below in L L, and the tenth roots of numbers in L L lie directly above in L U.

Examples (*a*) $1.8^{10} = 357$

(*b*) $12^{10} = (1{\cdot}2 \times 10)^{10} = (1{\cdot}2^{10})\ (10^{10}) = 6{\cdot}2 \times 10^{10}$

(*c*) $\sqrt[10]{50} = 1.48$

(*d*) $\sqrt[10]{2} = \sqrt[10]{\frac{20}{10}} = \frac{1{\cdot}35}{1{\cdot}259} = 1{\cdot}072$

Natural logarithms may be obtained by reading opposite the number whose logarithm is desired in L U or L L, the logarithm in D.

Examples (*e*) $\log e\ 9 = 2{\cdot}2$ (*f*) $\log e\ 1{\cdot}5 = {\cdot}405$

Powers of e may be obtained by reading opposite the exponent in D, the result in L U or L L.

Examples (*g*) $e^4 = 54{\cdot}6$

(*h*) $e^{\cdot 3} = 1{\cdot}35$

(*i*) $e^{12} = (e^4)^3 =$ from (*g*) above $(54{\cdot}6)^3 = (5{\cdot}46 \times 10)^3$ $= 162000$ see (*k*) below.

Roots of e may be evaluated by using the reciprocal of the exponent in the foregoing rule.

Example (*j*) $\sqrt[8]{e} = e^{\cdot 125} = 1{\cdot}133$

The most useful purpose which the log-log Scale serves is computing powers and roots when exponents are fractional.

Example (*k*) To evaluate $6{\cdot}4^{3{\cdot}21}$

Set the cursor line over 6·4 in L L and bring 1 of C into coincidence with it. Read the answer 387 in L L opposite 3·21 in C, again using the cursor.

Example (*l*) To evaluate $\sqrt[5]{30}$

Place the cursor line over 30 in L L, move slide so that 5 in C is brought under the cursor line and read the result 1·973 in L U *opposite 10 in C,* again using the cursor.

If the answer lies outside the range of the log-log scale, *i.e.*, is greater than 40,000 or less than 1.1, it may be found as indicated below.

Example (*m*) Evaluate $2{\cdot}1^{20}$

$(2{\cdot}1)^{20} = (2{\cdot}1^4)^5 = (19{\cdot}45)^5$ *see (k)*

$(19{\cdot}45)^5 = (1{\cdot}945)^5 \times 10^5 = 279 \times 10^5$ *see (k)*

$= 2{,}790{,}000$

Alternatively

$(2{\cdot}1)^{20} = (2{\cdot}1^{10})^2 = (1670)^2$ *see (a)*

$(1670)^2 = (1{\cdot}670)^2 \times (1000)^2$

$= 2{\cdot}79 \times (1000)^2$

$= 2{,}790{,}000$

Example (*n*) Evaluate $1{\cdot}2^{\cdot13}$

$$1{\cdot}2^{\cdot13} = \left(\frac{12}{10}\right)^{\cdot13} = \frac{(12)^{\cdot13}}{(10)^{\cdot13}} = \frac{1{\cdot}38}{1{\cdot}35} = 1{\cdot}023$$

If the exponent is negative, proceed as with a positive exponent and then find the reciprocal of the result.

SINES, COSINES, TANGENTS. The majority of Slide Rules give Sines and Tangents of angles on the reverse of the slide, but the value of this arrangement is small on account of the crowding together of the scales and the absence of the smaller angles. The table on the back of the UNIQUE Slide Rule gives values of Sines, Cosines, Tangents and Cotangents, of all angles. Values should be taken from the table and used in computations when necessary.