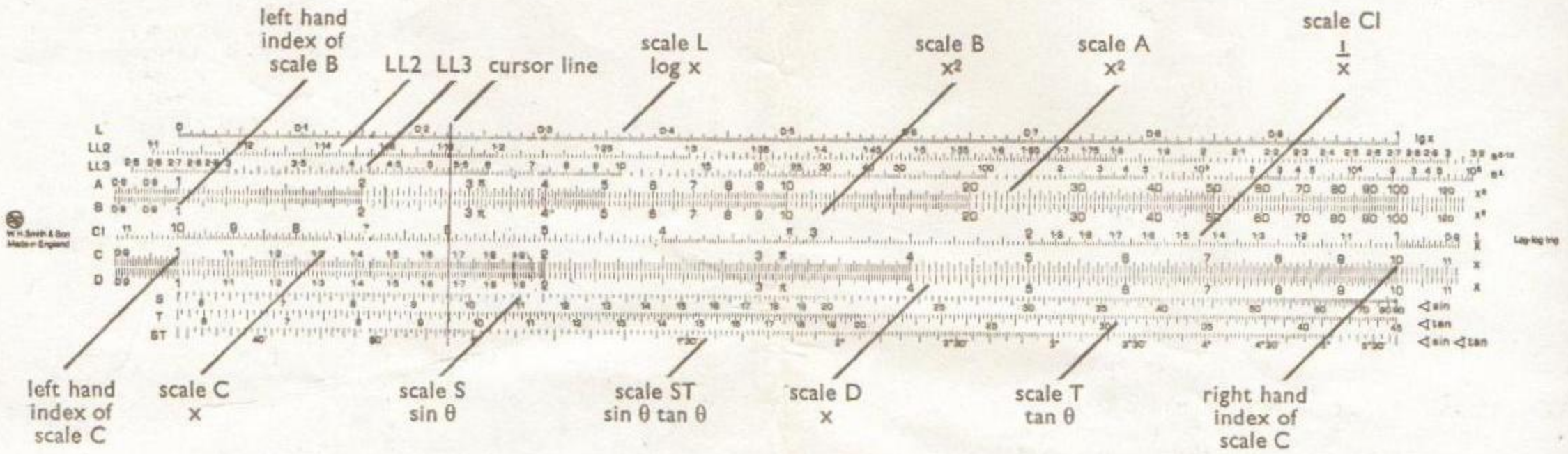
W. H. Smith & Son

Instruction Book for W. H. Smith & Son Slide Rules

For general school use
Technical Students,
Engineers, Draughtsmen
and Mathematicians

Before attempting to use a Slide Rule for calculations, it is necessary to become familiar with reading the scales, and for this purpose the two identical C and D scales should be studied, since the same principle is employed in marking all decimal scales.



The above illustration is representative only. This comprehensive book applies to any slide rule.

MARKINGS ON C AND D SCALES

Major divisions are 1 to 10.
Division 1 is the left hand index (L.H.I.).
Division 10 is the right hand index (R.H.I.).

between 1 and 10	the major divisions 1, 2, 3, etc., are figured.
between 1 and 2	major subdivisions 1·1, 1·2, etc., are figured and minor subdivisions are in tenths representing 1·01, 1·02, 1·03, etc.
between 2, 3, and 4	the subdivisions are as follows: longest lines represent 2·5, 3·5, etc. shorter lines represent 2·1, 2·2, etc. shortest lines represent 2·02, 2·04, etc.
between 4 and 10	the subdivisions are as follows: longest lines represent 4·5, 5·5, etc. shorter lines represent 4·1, 4·2, etc. shortest lines represent 4·05, 4·15, etc.

To the left of L.H.I. and to the right of R.H.I. there are some minor subdivisions known as 'extensions' in some, but not all, models.
It is necessary to remember that the position of the decimal point has no significance when finding a number on the scale, so if you want to find the point on the scale representing 152, then it will fall between major divisions 1 and 2. This will be 5/10ths of the way between 1 and 2, plus a further two minor subdivisions representing 2/10ths of the way along between 15 and 16. As the scale is graduated logarithmically, the interval between the major numbers (1-10) decreases as you proceed towards 10, so that there is insufficient room to provide 100 graduations, along the whole length. For example on a 10 in. rule there are only 50 divisions between 2 and 3 and 50 between 3 and 4. For the same reason there is room for only 20 divisions between the remaining major numbers, i.e. 4 to 10. However one proceeds as if there are 100 divisions between each, and uses the markings as a guide to where the 100 graduations would be if there was room.
The scale is so graduated that if you add the distance between 1 and 2 to the distance between 1 and 4 you arrive at the figure 8 which is 2×4. Conversely if you take away the distance between 1 and 2 from the distance between 1 and 6 you arrive at the figure 3 which is $6 \div 2$. That is why the scale C on the slide is identical to scale D on the stock so that you can add and subtract distances by sliding one against the other.

MULTIPLICATION

To demonstrate this, slide the 1 on scale C (L.H.I.) over 2 on scale D. You have now set the rule for multiplying by 2 and you can read 4, 6, 8, 10, etc., on D under the figures 2, 3, 4, 5, etc., on C. You will observe that the figures 6, 7, 8 and 9 cannot be multiplied in this position because they are too far to the right.
If, however, you slide the 10 on scale C (R.H.I.) over 2 you can now complete the multiplication and read 10, 12, 14, 16, 18 under 5, 6, 7, 8, and 9 on C.

DIVISION

This is very simply achieved by sliding the divisor on scale C over the number to be divided on scale D and reading the answer on D under the L.H.I. or R.H.I. of scale C.
As an exercise in scale reading it is suggested you set the rule for multiplying by 13·6, i.e. you slide the L.H.I. of scale C over 136 as shown in the illustration below. You can now read on D under any number on C the result of multiplying that number by 13·6.

For example

Under 2 on C you can read 27·2 on D which is 13·6 × 2.
Under 4 on C you can read 54·4 on D which is 13·6 × 4.
Under 6 on C you can read 81·6 on D which is 13·6 × 6.
Under ·665 on C you can read 9·04 on D which is 13·6 × ·665.

To multiply by 8 and 9 you must slide the R.H.I. of scale C over 13·6 when under 8 you can read nearly 109, actually 108·8. Care must be taken here and it will be seen the first two figures in the answer are less than 11. Under 9 you can read a result of just over 122, actually 122·4.

DECIMAL POINT

Before working examples it is well to remember that the position of the decimal point in an answer must be fixed mentally or, if complicated, worked roughly with paper and pencil since a position on the scale representing 136 could also represent 136000 or ·00136, etc. The quickest way to determine the position of the decimal point is to make a quick mental estimate. This has proved to be more effective than any set rules.

CURSOR

The function of the sliding cursor is to facilitate reading from one scale to another and to hold any position on a scale.

EXAMPLES IN MULTIPLICATION & DIVISION

Example I — *Multiply* 2·75 × 16·7.
Slide L.H.I. over 2·75 on D.
Place cursor over 16·7 on C.
Read off answer 45·9 underneath on D.

Example II — *Multiply* 192 × ·0721.
Slide R.H.I. over 192 on D.
Place cursor over 72 on C.
Read off answer 13·83 on D.

Example III — *Divide* 64 *by* 6.
Find number to be divided (64) on D.
Slide 6 on C over 64 on D.
Read off answer 10·66 on D under L.H.I.

Example IV — $\frac{3}{16} \times \frac{37}{7}$
Slide 16 on C over 3 on D.
Place cursor over 37 on C.
Slide 7 on C under cursor line.
Read off answer ·991 on D under R.H.I.

A AND B SCALES

The examples I-IV illustrate the use of the slide rule in multiplication and division singly or combined.
These operations can equally well be performed using scales A and B with more convenience but less accuracy.
Scale A being divided into two equal halves can be used for quickly finding the square or square root of a number.

SQUARE AND SQUARE ROOTS

With the cursor on any number on D, the square of that number lies on A under the hair line and vice versa.

CUBES AND CUBE ROOTS (K)

The K scale being divided into three equal parts serves to find cubes and Cube roots. Where Log-Log scales are provided these can be used.
With the cursor on any number on D, the cube of that number lies on K under the hair line and vice versa.

RECIPROCAL SCALE (CI)

The reciprocal scale is the centre of the slide, apart from its use in calculating the reciprocal of numbers, can be used in multiplication to save unnecessary movement of the slide, but beginners are advised first to master the use of the ordinary scales to avoid confusion.

Example V — 82×3.
Cursor over 82 on D. Slide 3 on CI under hair line.
Read off answer 246 on D under L.H.I.
$25 \div 4$.
Slide L.H.I. over 25 on D. Place cursor over 4 on CI.
Read off answer 6·25 on D under hair line.

Note : The reciprocal of any number on CI lies underneath on C and vice versa.

MANTISSA SCALE (L)

If the cursor line is placed on any number on D the mantissa of the logarithm of that number can be read off L.

SHORT CURSOR LINE

These relate the diameter with the area of a circle.
Place short cursor line over diameter on D and read off area on A under the centre cursor line.

LOG-LOG SCALES (Log-Log Trig model only)

These are marked LL2, LL3, and it should be noted that:

1. Any number on LL3 represents the 10th power of the number appearing opposite on LL2.
2. Within the limits of the scale opposite any number 'a' on D, e^a will be found on LL3.
3. Since the log-log scales do not extend to negative values, when evaluating expressions in the form x^{-n} use must be made of the relationship.

$$x^{-n} = \frac{1}{x^n} \text{ or } \left(\frac{1}{x}\right)^n$$

for which scale CI will be found useful.

Example VI — **Raising to Powers**
Evaluate $2{\cdot}23^{4{\cdot}5}$
For models with log-log scales on the face, proceed as follows:
With cursor align the R.H.I. of C, with 2·23 on LL2.
Place cursor over 4·5 on scale C read answer 37 under hair line on LL3.

Example VII — **Extraction of Roots**
Evaluate $\sqrt[4{\cdot}1]{65}$. Place cursor on 65 on LL3. Slide 4·1 on C under hair line. Slide cursor to L.H.I. and read off answer 2·768 on LL3 under hair line.

Example VIII Find $\log_e 4{\cdot}26$.
With the cursor align R.H.I. with 2·718 on LL2 (at this point it will be seen that scales C and D coincide).
Place cursor over 4·26 on LL3 and read the answer 1·446 on C under the hair line.

TRIGONOMETRICAL SCALES (Log-Log Trig model only)

These scales are engraved on the face of the rule and are drawn relative to scale D.
There is an additional scale named ST. This is for small angles for which the numerical value of the sine and tangent closely approximate. To find the numerical value of the sine or tangent of an angle, place the cursor line over the angle on the appropriate scale and read off the answer either on A or D under the hair line, according to the paragraph above.
The position of the decimal point can be found by memorising or referring to the following table.

Sin 0° 34′	=	0·01	Tan 0° 34′	=	0·01
Sin 5° 43′	=	0·1	Tan 5° 43′	=	0·1
Sin 90°	=	1·0	Tan 45°	=	1·0
			Tan 84° 17′	=	10·0

For angles greater than 45° up to 84° 17′ use:

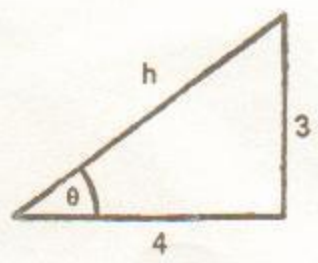
$$\text{Tan } \theta = \frac{1}{\text{Tan } (90-\theta)}$$

Example IX To find Tan 72° 30′.
90°−72°=17° 30′.
With cursor on 17° 30′ on T, after aligning scales C and D read off 3·17 on the reciprocal scale CI.

Example X Evaluate 2·17 sin b where b=31° 20′.
Place cursor over 31° 20′ on S.
Slide R.H.I. under cursor line.
Place cursor over 2·17 on C.
Read off answer 1·128 on D underneath.

To find the hypotenuse h and angle θ given the two sides of a right angle triangle.

Example XI



i.e. $\tan \theta = \frac{3}{4}$ and $h = \frac{3}{\sin \theta}$

Slide 4 on C over 3 on D and read off 36° 52′ for θ on the T scale under the R.H.I. To find h place the cursor over 36° 52′ on S. Slide 3 on C under the cursor line and read off h=5 over the right hand index of D.

Note to user

Your precision divided slide rule is made from a specially selected plastic material. This material will last indefinitely in normal use, and given reasonable care the slide rule will give many years' service. Care should be taken that it is not exposed to excessive temperature as damage would result. Hot radiator tops or car window sills in direct sun should be avoided.

To clean, do not use solvents or abrasives; lukewarm soapy water applied with cotton wool is best.

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