GAUGE POINTS

Some constants appearing in everyday calculations are engraved on the rules.

Those appearing on the rules are as under:

$$\pi = 3.14$$

$$c = \sqrt{\frac{4}{\pi}} = 1.128$$

$$c_1 = \sqrt{\frac{40}{\pi}} = 3.568$$

$$\rho = \frac{200 \times 100 \times 100}{\pi} = 636620$$

$$\rho' = \frac{180 \times 60}{\pi} = 3438$$

$$\rho'' = \frac{180 \times 60 \times 60}{\pi} = 206265$$

ABRIDGED LIST OF B.R.L. SLIDE RULES

Full list will be sent on application

COLUMN 'A'

10″ (25 cm) Models		
Students	No. 1	27/6
	No. 2	27/6
General Purpose	A.G.1	33/–
	A.G.2.	46/–
	G.22.	33/–
	G.23	36/–
	G.27	33/–
	G.29	45/–
	A.G.5 (Rietz)	55/–
Log-Log	A.L.4	46/–
	A.L.6 (Trigs)	55/–
Electricians	E.25	60/–
	E.13	75/–
Darmstadt	D.26	62/6
Technicians	T.11	70/–
	T.12	70/–
5-6″ (12-15 cm.) Pocket Models		
General Purpose	P.14	27/–
	Plus P.T. on leather case 8d.	
	P.15	23/6
	Plus P.T. on leather case 8d.	
	P.19	20/–
	Plus P.T. on leather case 8d.	
Electricians	P.16	29/–
	Plus P.T. on leather case 8d.	
Log-Log	P.17	27/–
	Plus P.T. on leather case 8d.	
Darmstadt	P.28	35/–
	Plus P.T. leather case 9½d.	

COLUMN 'B'

JANUS Series Double sided Models approx. 10″ to 12″ models		
Log-Log Duplex	T.50	90/–
	T.51	63/–
Navigators	N.52	80/–
Traction Engineers	TR.53	80/–
20″ (50 cm.) Models		
Log-Log	T.20	147/–
Rietz (projected)	T.30	147/–
ACCESSORIES		
"Fullview" Pedestal Magnifier	L.18	21/–
"Magnex" Magnifier (clip-on)	L.22 (Size 1)	8/9
	(Size 2)	9/3
Pouch for L22	W.9	2/– (Plus P.T. 4d.)
Spare Cursors		
For standard 10″ rules	L.13	6/3
For Wide 10″ rules	L.14	7/9
For Pocket rules	L.15	4/6
For standard 20″ rules	L.16	7/9
For Janus models T.50, N.52, TR.53	L.20	12/–
For Janus model T.51	L.21	11/–

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B-R-L

SLIDE RULES
INSTRUCTION BOOKLET

BLUNDELL RULES LIMITED, LYNCH LANE, WEYMOUTH, DORSET, ENGLAND.

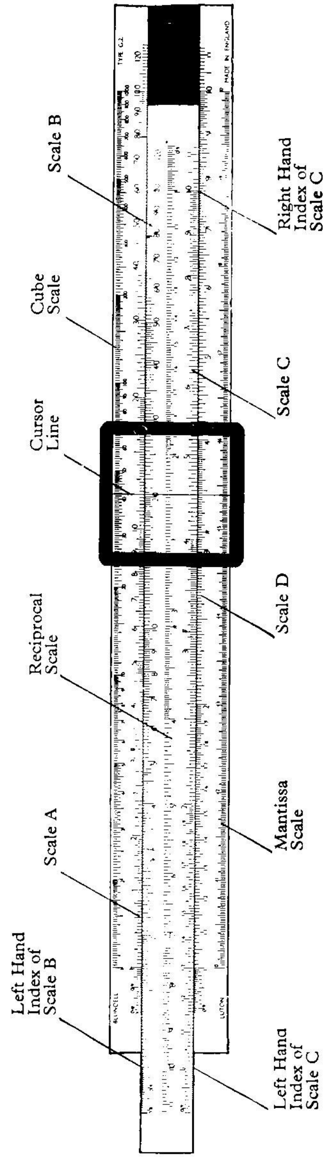
PRICE 6d. EACH

10086/10/55/12m/L 4

INDEX

SIMPLE INSTRUCTIONS IN THE USE OF THE B·R·L SLIDE-RULES

These instructions are intended for those who have not previously used a slide-rule and pre-suppose only familiarity with the decimal system.



MULTIPLICATION

Example I

Multiply 2.75 x 16.7 Answer = 45.925

Slide the scale C to the right until the 1 on Scale C (called the left hand index) is over 2.75 on Scale D.

Now find 16.7 on Scale C and the answer lies underneath it on Scale D.

It is usual to slide the cursor along until the centre black line coincides with the 16.7 on Scale C—the answer 45.9 can then easily be read off Scale D.

Note.—No greater accuracy than 45.9 can be achieved with a 10″ rule and the position of the decimal point must be fixed by inspection.

Example II

Multiply 192 x 72.1 Answer = 13843

If the left hand index on Scale C is placed over 192 on Scale D it will be seen that when you slide the cursor to cover 721 on scale C it will fall off the rule.

In this case you use the right hand 10 on Scale C (called the right hand index) to cover the 192 on Scale D.

Find 721 with the cursor on Scale C and read off the answer underneath on Scale D.

The nearest answer obtainable on a 10″ rule lies between 13830 and 13850.

Example III

Calculate the selling price of 17 articles costing 84/3d. each to secure profit of 12½% on cost.

The sum to be worked out can be expressed as follows :

$$84.25 \text{ (shillings)} \times 17 \text{ (articles)} \times \frac{112.5}{100} \text{ increase}$$

or (84.25 x 17 x 1.125) shillings = £80-11-3.

Find the first number 84.25 on Scale D and slide the right hand index of Scale C over it. Slide the cursor to 17 on Scale C and the product of 84.25 x 17 (viz. 1432 shillings) lies on the cursor line on Scale D.

For the percentage increase one must multiply this product by 1.125. It is convenient to keep the cursor where it is and slide the left hand index of Scale C until it coincides with the cursor line. Now slide the cursor to 1.125 on Scale C and the answer (1611 shillings) lies below on Scale D.

DIVISION

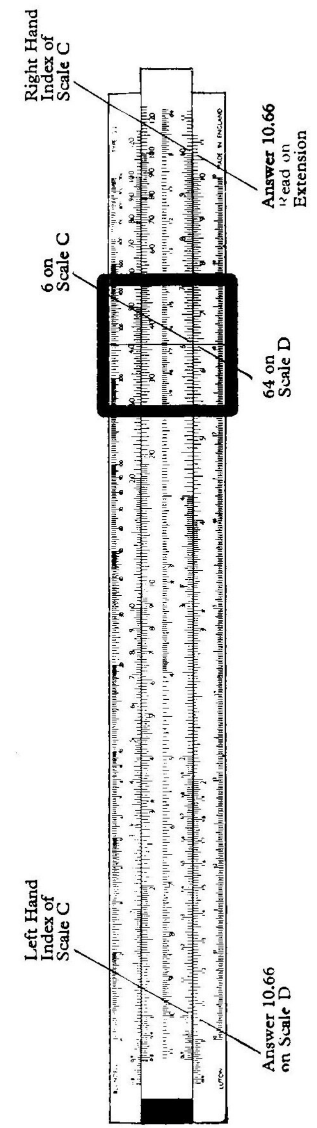
Example IV

To divide say 64 by a series of numbers.

Find 64 on Scale D and place the cursor line over it. Keeping the cursor stationary find the number which you wish to divide by (divisor) on Scale C and slide the Scale C along until that number coincides with the line on the cursor. The answer will lie on Scale D under either the left or right index of Scale C.

Note the positions on the rule are the same whether the dividend be 64, 0.64 or 6400 and the divisor 32, .032 or 3200.

The illustration shows 64 divided by 6 = 10.66 and demonstrates the use of the extension on the scales since the answer can be read from either end.



COMBINED MULTIPLICATION & DIVISION

Example V

To find 3/16th of 5.2/7ths.

This sum can be written 3/16 x 37/7 and can be tackled in various ways on the slide rule.

Perhaps the easiest is first to multiply 3 by 37 and then divide the product by 7 and the answer by 16. The operations are as follows:

Place the left hand Scale C index over 3 on Scale D and slide the cursor to the extreme right over 37 on Scale C. The product lies where the cursor line cuts Scale D at 111.

To divide by 7, hold the 111 on the cursor, and slide 7 of Scale C on to the cursor line. The answer (15.86) lies on Scale D under the Scale C left hand index.

To divide by 16, hold the position by sliding the cursor to 15.86 on Scale D (where the Scale C left hand index is) and then slide the 16 on Scale C to the cursor line.

The final answer (.991) lies underneath the right hand Scale C index on Scale D.

These operations can be performed in 20 seconds or less with practice.

Position of the decimal point

The quickest way to determine the position of the decimal point is to make a quick mental calculation. This has proved to be more effective than any set rules.

Example. 33 x 600

Answer is in the region of 20,000, and not 2,000 or 2,000,000.

A & B SCALES

The *Examples I-V* illustrate the use of the slide rule in multiplication and division, singly or combined. These operations can be equally well performed using Scales A & 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, SQUARE ROOT

Example VI 2.2^2 Answer = 4.84

Put cursor on 2.2 on Scale D, and read result on Scale A. The answer lies between 4.8 and 4.85.

Example VII $\sqrt{15}$ Answer = 3.87

Put cursor line on 15 on Scale A, and read result on Scale D. The answer lies between 3.86 and 3.88.

CUBE SCALE (sometimes marked " K ")

This scale is used for quickly finding the cube or cube root of a number.

Example VIII To find the cube root of 19.7

As two whole numbers precede the decimal point use the middle of the three equal scales (into which the cube scale is divided). Place the cursor line on 19.7 and read off 2.7 approximately underneath on the D scale. For amounts with one or four whole numbers before the decimal point use the left hand section of the cube scale and so on.

RECIPROCAL SCALE

The reciprocal scale in 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 IX Multiplication. 82 x 3 Answer = 246

Set cursor line over 82 on Scale D, and slide 3 on reciprocal scale along to cover it. Read result, 246, on Scale D, under left hand index of Scale C.

Example X Division $\frac{25}{4}$ Answer 6.25

Set left hand index on Scale C over 25 on Scale D, move cursor to 4 on reciprocal scale, and read result, 6.25, where cursor line cuts Scale D.

MANTISSA SCALE

If the cursor line is placed on any number on Scale D, the mantissa of the logarithm of that number can be read off on the scale at the bottom of the rule and vice-versa.

Where the mantissa scale is engraved on the back of the slide as in our Technician's Rule Type T12 slide any number on Scale C over the left hand index of Scale D and the mantissa of that number will appear under the left hand window index at the back of the rule.

RED CURSOR LINE

Setting the red cursor line on Scale D on the diameter of a circle, the area of the circle will be found under the black line on Scale A and vice-versa.

LOG-LOG SCALES

The top log-log scale (UL) extends from 1.1 to 3.2 and the bottom log-log scale (LL) from 2.5 to 100,000 and on the Technician's Rule an extra scale (LI) extends from 1.11 down to 1.01.

The uses of the two log-log scales in combination with the linear scale, usually described as C scale, are manifold, and after having studied the main applications, as shown in the following paragraphs, the mathematically trained user will have no difficulty in becoming familiar with all its applications.

Raising to Powers

Example: $1.13^{2 \cdot 5} = 1.357$.

With the cursor line, set 1 on linear Scale C under 1.13 on UL scale, and over 2.5 on Scale C read the result 1.357 on UL scale. The same applies to values on LL scale.

Extraction of Roots

Example: $\sqrt[4 \cdot 1]{65} = 2.768$.

With the cursor line, set 4.1 on Scale C above 65 on LL scale, and read under 1 on Scale C the result on LL scale, which is 2.768.

The logarithm of a number to any base may be found within the limits of the log-log scales.

Example: Find $\log_e 4.26$.

With the cursor line, align the 10 of Scale C with 2.718 on the UL scale, (at this point it will be seen that Scales C and D are

coincident), slide the cursor to 4.26 on the LL scale, and the answer 1.446 is read above on Scale C.

Note also :

(1) The LL scale represents the 10th power of any number above it on the UL scale. The corresponding rule applies for the 10th root.

(2) Under every number "a" on the linear Scale D of the body will be found e^a on the LL scale.

(3) Since the log-log scale does not extend to negative values, when evaluating expressions of the form x^{-n} use must be made of the relationship $x^{-n} = \frac{1}{x^n}$ or $\left(\frac{1}{x}\right)^n$ for which the red reciprocal scale on the slide will be useful.

JANUS SERIES OF DOUBLE-SIDED SLIDE RULES

Model No. T.50

This model contains a number of scales used in the range of single-faced rules and in addition, a set of extra Log-Log scales.

Details concerning all Log-Log scales are as follows:

(A) *Log-Log Scales*

LL1	extends from	1.01 to 1.105
LL2	,, ,,	1.105 to 2.72
LL3	,, ,,	2.72 to 22,000

(B) *Reciprocal Log-Log Scales, relative to the A and B Scales* $e^{-\cdot 001}$ to e^{-10}

LL0	extends from	.999 to .905
LL00	,, ,,	.905 to .00009

A.1 *Examples in the use of Log-Log Scales LL1, LL2, LL3.*

Raising to Powers:

Example: $1.13^{2 \cdot 5} = 1.357$

Set the hair line over 1.13 on scale LL2. Slide the 1 of scale C to the hair line and then set cursor to 2.5 on scale C and read off 1.357 on scale LL2. The same applies to values on LL3 scale.

Extraction of Roots:

Example: $\sqrt[4.1]{65} = 2.768$

With the cursor line set 4.1 on scale C above 65 on LL3 scale, and read under 1 on scale C the result on LL3 scale, which is 2.768.

Logarithms:

The logarithm of a number to any base may be found within the limits of the Log-Log scales.

Example: Find $\log_e 4.26$

With the cursor line set the 10 of scale C in line with 2.718 on the LL2 scale (at this point it will be seen that scales C and D are coincident), slide the cursor to 4.26 on the LL3 scale, and the answer 1.446 is read above on scale C.

Note also:

(1) The LL3 scale represents the 10th power of any number below it on the LL2 scale. The corresponding rule applies for the 10th root.

(2) Under every number " a " on the linear scale D will be found e^a on the LL3 scale.

B1. *Examples in the use of reciprocal Log-Log scales LL0 and LL00.*

These scales bear a relationship to the A scale such that $y = e^{-x}$ where y is the reading on LL0 or LL00 and x is the value on scale A.

Values of e^{-x} can be read off directly from scales LL0 and LL00. The cursor line is placed on the value of x on scale A and the corresponding value of e^{-x} is found immediately above on scale LL0 or LL00.

Example 1. To evaluate e^{-3} set the cursor line on 3 of the right-hand decade of scale A and read off 0.05 above on scale LL00. or

e^{-1} that is $\frac{1}{e}$ can be seen to be 0.368 by moving the cursor line over the central 1 on scale A.

It should be noted that values on scale LL0 are the tenth root of corresponding values on scale LL00.

Example 2. Evaluate 0.8^2. Set cursor line over 0.8 on scale LL00 slide 1 on B scale under cursor line. Move cursor line to 2 on scale B. Read off answer 0.64 on scale LL00.

Example 3. Evaluate $\sqrt[4]{0.2} = 0.2^{0.25}$. Set cursor line over 0.2 on scale LL00 slide 1 on scale B under cursor line. Move cursor to the left on to 0.25 on scale B. Read off answer 0.669 on scale LL00.

TRIGONOMETRICAL SCALES

Where these scales appear on the back of the slide, the latter should be turned back to front when using the trigonometrical scales. Since the sine and tangent of an angle closely approximate for small angles the two scales are engraved as one scale marked S & T in the centre of the slide.

Commencing on the left at about 34′ where the tangent of that angle is 0.01 the scale is so constructed that the angle 5° 43′ appears at the right hand end over the index 10 on Scale D, representing a tangent of 0.1.

Note.—All the trigonometrical scales are drawn relative to Scale D. For angles greater than 5° 43′ the upper S scale is used for sines and the lower T scale is used for tangents.

(*Further Note*). The sub-divisions between the figures are not necessarily constructed in decimal intervals on the trigonometrical scales, as on the rest of the rule, but on the basis of 60 minutes to one degree, and special care should be taken when reading.

To find the numerical value of the Sine or Tangent of an angle

Align the ends of the trigonometrical scales with the Left and Right indices on Scale D. Slide the cursor line over any angle marked on Scales S & T or S, and the numerical value of the sine of that angle will appear lower down the hair line on Scale D.

By using the Scales S & T or T, the numerical value of the tangent of any angles less than 45° will be found in the same way.

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

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

Example 1. To find Tan 72° 30′

90°—72° 30′ = 17° 30′

Place cursor line on the right hand index of Scale D and slide 17° 30′ on the T scale also on to the cursor line. Under the left hand index of the T scale one can read 3.17 on Scale D.

Example II. To evaluate 2.17 sin b where b = 31° 20′

Slide the right hand index of Scale T over 217 on Scale D. Next place the cursor line over 31° 20′ on the S scale and read off underneath 1.128 on Scale D.

Or where the indices are inscribed on the window at the back of the rule the following procedure may be adopted if preferred : with the C scale of the slide uppermost move the slide to the right until 31° 20′ on the S scale appears opposite the upper index in the right hand window at the back. Now looking at the face of the rule move the cursor line on 2.17 on Scale D. The answer 1.128 lies above on Scale C.

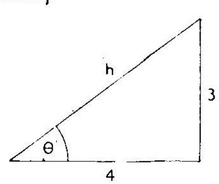
Example III. To evaluate $\frac{\tan b}{2.17}$ where b = 31° 20′

Align the T scale with Scale D and with the cursor on tan 31° 20′ read off .608 on Scale D. Now reverse the slide without moving the cursor and place 2.17 of the C scale on the hair line and read off the answer .2807 on Scale D under the left hand index of Scale C.

Or, using the window indices : Slide 217 on Scale C over the left hand index of Scale D. Place the cursor line on the right hand index (10) of Scale C. Now looking at the back of the rule move the slide to the right until 31° 20′ on Scale T appears over the lower index in the right hand window.

The answer .2807 can be read on the hair line on Scale C.

Example IV



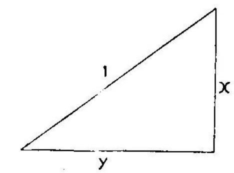
i.e. $\tan\theta = \frac{3}{4}$ and $h = \dfrac{3}{\sin\theta}$

To find the hypotenuse h and angle θ given the 2 sides of a right angled triangle. Place the right hand index of Scale T over 4 on Scale D. Slide the cursor line to 3 on Scale D and read off $\theta =$ 36° 52′ on the T scale above. Keeping the cursor stationary, move the slide to the right until 36° 52′ on Scale S lies under the hair line of the cursor. The hypotenuse 5 can be read off on Scale D under the right hand index of Scale T.

For the solution of triangles, by making use of the appropriate formula, the slide rule is invaluable and with practice great saving in time can be achieved.

THE $\sqrt{1-x^2}$ SCALE OR THE PYTHAGORIAN SCALE

For a right angle triangle with a hypotenuse of unity we have referring to Fig.



$y = \sqrt{1-x^2}$

It is according to this relationship that the scale $\sqrt{1-x^2}$ is calculated so that direct reference to the D scale gives an immediate solution to the foregoing equation. The $\sqrt{1-x^2}$ is usually engraved on a slide rule immediately below the D scale and runs from the approximate value of $y = \sqrt{1-x^2} = 0.995$ situated immediately below x=1 on the D scale to $y = \sqrt{1-x^2} = 0$ situated immediately below x = 10 on the D scale. It should be appreciated that in actual fact the scale is calculated for value of x less than unity.

1. *Example* $\sqrt{1-0.6^2} = 0.8$

Place the cursor line on 0.6 on the D scale and read the corresponding value of y = 0.8 on the $\sqrt{1-x^2}$ scale. Alternatively, place the cursor line on 0.8 on the D scale and read the corresponding value of y = 0.6 on the $\sqrt{1-x^2}$ scale.

2. The solution of any right angle triangle

Consider a right angle triangle whose hypotenuse is 25, whose base is 15. To find the vertical y

$$\begin{aligned} y &= \sqrt{25^2-15^2} \\ &= 25\sqrt{1-\left(\frac{15}{25}\right)^2} \\ &= 25\sqrt{1-0.6^2} \\ &= 25 \times 0.8 \\ &= 20 \end{aligned}$$

3. *In the Vector calculations*

Consider an apparent electrical load (KVA) = 100% where the actual effective load (KW) is 85%, i.e. where the phase angle $\phi = 31° 47'$ or $\cos\phi = 0.85$ then the wattless load $= \sqrt{1-0.85^2} = 0.526$, i.e. 52.6% wattless KVA or reactive KVA.

4. *Trigonometrical Functions.*

Since $\cos\theta = \sqrt{1-\sin^2\theta}$ and

$\sin\theta = \sqrt{1-\cos^2\theta}$

the $\sqrt{1-x^2}$ scale provides a ready means of conversion from $\sin\theta$ to $\cos\theta$ and vice-versa.

For example if $\cos\theta = 0.5$ set the cursor to 0.5 on the D scale. An immediate value for $\sin\theta = 0.866$ can be read off from the $\sqrt{1-x^2}$ scale.

Naturally, each individual operator will most probably find specialised uses of the scale to suit the specific jobs in hand.

LOG-LOG SCALE FOR COMPOUND INTEREST (LI)

Note.—For the sake of uniformity, Log-Log Scales will be marked LL1, LL2, LL3 in all new editions of existing models as they are brought out. Particulars are as follows:

LL1 Scale extends from 1.01 to 1.1
LL2 ,, ,, ,, 1.1 to 2.72
LL3 ,, ,, ,, 2.72 to 10^4

Until the changeover is complete, both sets of markings may be used.

The log-log scale L1 on Technician's slide rules extends from 1.01 to 1.10 and therefore can be used for speedy calculation in compound interest.

Using the formula $A = P\left(1 + \frac{p}{100}\right)^n$ where—

A stands for accrued amount.
P ,, ,, for principal invested.
p ,, ,, rate of interest (percentage).
n ,, ,, number of years.

with three of these values given the fourth can easily be found on the slide rule.

Example 1. £557 invested at $7\frac{1}{2}$% for $13\frac{1}{2}$ years. How much has it become?

substituting in the above formula:

$$A = 557\left(1 + \frac{7\frac{1}{2}}{100}\right)^{13\frac{1}{2}} \quad \text{or } 557\,(1.075)^{13.5}$$

we now require to raise 1.075 to the power of 13.5 and multiply the result by 557.

With the cursor place the right hand index of Scale C under 1.075 on LI scale. Slide the cursor to the left over 13.5 on Scale C and read off 2.66 underneath on the LL scale. Now multiply 2.66 by the principal, £557 on the C & D scales which gives £1,482 approximately.

Note.—When raising a number to a power as high as 13.5 it is sometimes difficult without practice to decide on which log-log scale to read off the answer.

With the cursor on 1.075 on the LI scale the number appearing immediately underneath on the UL scale is the 10th power of 1.075, viz. 2.06 while the 100th power will appear lower down still on the LL scale, viz. 1,380 approximately.

It is clear when remembering this that the result of raising a small number like 1.075 to the 13.5th power will not be much greater than raising it to the 10th power.

Example II. What sum must be invested at $4\frac{1}{4}$% to accrue to £2,000 in 16 years?

substituting known values in the formula we have $2000 = P\,(1.0425)^{16}$.

To find P we must raise 1.0425 to the 16th power and divide the result into 2000.

Place the cursor over 1.0425 on LI scale and move the slide to the right until the left hand index of the C scale coincides with the hair line. Now move the cursor to the right over 16 on the C scale and read off 1.945 on the UL scale.

Divide this into 2000 with the CD scales.

Answer = £1,030 approx.

FOLDED SCALES

The CF and DF scales on rules engraved with these instead of the usual AB are of the same length and dividings as the CD but they commence and end with π and the one index is near the centre of the scale. They may therefore be used for multiplying or dividing a number by π, e.g. set the hair line opposite a number on the D Scale. That number is multiplied by π on the DF Scale. Conversely a number on the DF Scale is divided by π on the D Scale. This is useful for example in calculating the diameters of circles. They may be used interchangeably with the CD and thus an answer may be read somewhere off the face of the rule without re-adjustment and with the same accuracy, or alternatively a setting can be made on either set of scales to avoid unnecessary slide movement.

To evaluate $\frac{3.26 \times 2.54}{9.8}$

Slide the 9.8 on C over the 3.26 on D (which is the same thing as sliding the 9.8 on CF under the 3.26 on DF).

Since 2.54 on C is off the scale use the CF and with the cursor over 2.54 on CF read the answer .845 on DF.