Revised

Rules, Tables and Formulæ

FOR

PATENT CIRCULAR SLIDE RULE

(HALDEN CALCULEX)

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FOR

PATENT CIRCULAR SLIDE RULE

(HALDEN CALCULEX)

FOR THE USE OF

ENGINEERS, ARCHITECTS, SURVEYORS, MANUFACTURERS, MILL OWNERS, TIMBER MERCHANTS, BUILDERS, MECHANICS, AND ALL BUSINESS MEN, &c.

J. HALDEN & CO., LTD.,
Manchester, London, Newcastle-on-Tyne, Birmingham, Glasgow and Leeds.

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Patent Circular Slide Rule, so that the two can be carried together in the waistcoat pocket without inconvenience, and always be at hand when required.

This book, which contains a comprehensive set of rules and gauge points for calculations required by people in various businesses, has now been revised, and many suggestions made by users incorporated, which we trust will prove useful. We shall be glad at any time to receive other data or formulæ which would render this book of still greater service to its users.

J. HALDEN & CO., LTD.,
8, Albert Square,
Manchester.

PATENT CIRCULAR SLIDE RULE

(HALDEN CALCULEX)

DESCRIPTION.

The Halden Calculex is a slide rule made up in circular form. The circular metal dial on which the scales are engraved (by a new process which gives exceptionally fine and distinct lines) consists of two pieces, an outer ring and an inner disc, the logarithmic scales being engraved on the inner edge of the outer ring and on the outer edge of the inner disc. (This disc corresponds to the "slide" of an ordinary slide rule, and can be revolved by thumb-nuts attached to the centre.)

The Calculex consists of two of these Dials, placed back to back, each of which is protected by a glass (or celluloid) disc, the whole being enclosed in a German-silver ring. On the inner surface of each of the glasses is engraved a fine "cursor" line—the glasses are moved by thumb pressure on their faces

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and arranged so that they can be revolved independently of the centre dial. The edges are bevelled so as to carry more comfortably in the pocket.

Scales.—On the *Front Face* (on which the name is printed) are the two logarithmic scales for **multiplication, division, proportion,** &c. These scales are the ordinary slide rule scales in circular form: the range 1—10 occupying one complete circle, there is thus no need for a second duplicate scale as the end of the scale being coincident with the beginning makes an endless series of logarithmic scales, and numbers can thus be read off from one to the infinite without interruption.

Concentric with the outer logarithmic scale *A* is a scale of **logarithms** read with the cursor in the usual manner. On the inner disc are the scales of the **square roots** of the *B* scale (logarithmic scale on the outer edge of the inner disc); this scale is continuous, but the range 1—10 occupies two complete circles; the figures commence on the inner circle, go once round to the starting point, and thence continue on the outer circle once round, again returning to the inner circle, and so on, *ad infinitum*.

Back Face.—The scales *A* and *B* for inverse proportion take the place of the front multiplying scales *A* and *B*, and are manipulated in the same manner.

The Scale of **Angles** takes the place of the scale of logarithms, and a scale of **cube roots** takes the place of the square root scale on the front face, and is continuous, similar to the latter scale, but the range 1—10 occupies three circles.

Users of the Slide Rule will appreciate the ease with which both square and cube roots (especially the latter) can be read off on the Calculex.

Explanation.

Before attempting any calculation upon the slide rule it is necessary to thoroughly understand the reading and value of the figures, both in decimals and whole numbers.

In all calculations, we *ignore the decimal point until the finish* and then place it (thus fixing the number of digits in the answer) by the methods described later.

The figures shown on the dial may have any value assigned to them, thus 7 may be ·007, ·07, ·7, 7, 70, 700, etc., and this will be more clearly seen by counting round the dial several times in sequence. For clearness, set the large arrows (front face) together, then, starting on the calculating scales *A* and *B*, at the top we read 1, following round in a clockwise direction we find 2 roughly at 4 o'clock the figures 11, 12, 13—19 may be read as 1.1, 1.2—1.9. Reading on we find 3, near 6 o'clock, then

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4, 5, 6, 7, 8 and 9 in sequence, and it should be noted that the successive intervals get smaller and smaller.

Following on round we reach 1 again, which now reads as 10; then 11, 12, 13, &c., up to 2, which now becomes 20; the large divisions (each divided again into halves) may be read as 21, 22, &c., up to 25 (marked) and thence to 3, 4 and 5, which are now 30, 40 and 50. It will now be found that between 50 and 60 there are only 10 divisions, which may be read as 51, 52, etc., to 60, and thence on past 70, 80 and 90 to 1, which now reads as 100.

Going round again the small divisions are now 102, 104, 106, &c., to 11, which now reads 110, 12 becomes 120, and so on to 2 which is now 200.

The small divisions are now 205, 210, 215, &c., to 25, which is now 250.

3 becomes 300, 4 becomes 400, and so on until we reach 1, which is now 1,000.

Again, starting at 1 as before and reading *backwards*, we should read ·9, ·8, ·7, &c., until we get back to 1 again, which would then be ·1, and if we go round again we should have ·09, ·08, ·07, &c., and the small divisions between would have corresponding values thus, ·099, ·098, ·097, &c.

Multiplication (Front Face).

Rule.—Set the arrow on *B* to one factor on *A*, and over the other factor on *B* read the answer on *A*.

Ex.—3 × 4.

Set the arrow on *B* to 3 on *A*, and over 4 on *B* you read 12 on *A*. It will also be seen that the two scales *A* and *B* form a multiplication table of the number to which the arrow *B* is pointed.

Note also that the same operations would hold good for 3×40, 30×40, ·3×·4, &c., the only difference being the position of the decimal point.

If there are three factors to multiply, proceed as above with the first two factors. Set arrow on *B* to the product and read result on *A* opposite third factor on *B*.

Another way:—On inverse scale, set the first factor on *A* to second on *B*. Turn over to front face and read result on *B* opposite third factor on *A*.

Ex.—6 × 2 × 5.

On inverse scale, set 6 on *A* to 2 on *B*. Turn over and read 60 on *B* opposite 5 on *A*.

To fix the position of the decimal point:—

The best and easiest way to do this is by inspection or mental calculation, thus:—

3 × 4 is obviously 12 and not 1·2 nor 120.
3 × 40 ,, ,, 120 ,, 12 nor 1,200.
30 × 40 ,, ,, 1,200 ,, 120 nor 12,000.
·3 × ·4 ,, ,, ·12 ,, 1·2 nor ·012.

For those who prefer a rule the following is given:—

The number of figures in the product equals the number of figures in the two factors added together,

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when the product comes anywhere *between the two arrows* from the *right* of $A1$. But if it comes between the two arrows on the *left* of $A1$ then deduct 1 figure.

Ex.—75 × 62 = 4650.

There are 4 figures in the two factors, and as the product comes between the two arrows from the *right* of $A1$ there should be 4 figures in the answer.

Ex.—75 × 124 = 9300.

There are 5 figures in these two factors, but as the product is found between the arrows from the left of $A1$ one figure must be deducted and the answer will therefore only contain 4 figures.

For those who prefer a rule the following is given :—

Where factors consist of whole numbers and decimals, of course we only count the figures to the *left* of the decimal point, both in the factors and the product ; and where factors are *wholly decimal* any 0's between the decimal point and the first significant figure count as negative digits, thus :—

439·5	=	3 digits	·4395	=	0 digit
43·95	=	2 ,,	·04395	=	—1 digit
4·395	=	1 digit	·004395	=	—2 digits

and so on.

Ex.—75 (2 digits) × ·0124 (—1 digit) = ·93.

The sum of the digits = 1, but as answer is to left of the arrows, deduct 1 = no digits.

Note.—If the total number of digits comes to a negative quantity, deducting one *increases* the negative number, thus :—deducting one from − 3 digits makes − 4, not − 2.

Ex.—·023 (− 1 digit) × ·0042 (− 2 digits) = ·0000968.

The sum of the digits = − 3, but as answer is to left of the arrows, deduct 1 = − 4 digits, *i.e.*, four noughts.

Division (Front Face).

Rule.—Set the divisor on B under the dividend on A, and the arrow on B will point to the quotient on A.

Ex.—84 ÷ 7.

Set 7 on B to 84 on A and the arrow points to the answer 12 on A.

Again note that the same operations would hold good for 8·4 ÷ 7, 840 ÷ 7, 84 ÷ 70, &c., the only difference being the position of the decimal point, and, as in multiplication, this is best placed by inspection or mental calculation, thus :—

84 ÷ 7	is obviously	12,	and not	1·2	nor 120.
8·4 ÷ 7	,, ,,	1·2,	,,	12	nor ·12.
840 ÷ 7	,, ,,	120,	,,	12	nor 1200.
84 ÷ 70	,, ,,	1·2,	,,	12	nor ·12.

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For those who prefer a rule the following is given :—

The number of figures in the quotient equals the number of figures in the dividend less those in the divisor, when the divisor comes anywhere between the two arrows from the right of *A*1; but if it comes between the arrows from the left, then add 1, being the reverse of that in multiplication. 0's between decimal point and significant figures count as negative digits as before.

Ex.—5950 ÷ 70 = 85.

The divisor comes between the arrows from the *right* of *A*1, and as there are 4 figures in the dividend and 2 in the divisor, 4 − 2 = 2 figures in the quotient.

Ex.—852 ÷ 12 = 71. Here the divisor is found from between the 2 arrows from the left of *A*1, therefore 3 − 2 = 1 + 1 = 2 figs. in the quotient.

Proportion (Front Face).

Rule.—Set the first term on *B* to the second term on *A*, and over the third term on *B* read the answer on *A*.

Ex.—As 6 : 42 : : 9 : X

Set 6 on *B* to 42 on *A*, and over 9 on *B* read 63 on *A*.

When the scale is set to any proportion it gives a complete range of proportion all in the same ratio.

Ex.—If a man can finish an article in 3 minutes (easily), how many should he do in a day of 10 hours?

Set 3 on *B* to 600 minutes on *A*, and over the arrow or 1 on *B* read the answer 200 on *A*.

Inverse Proportion (Back Face).

When more requires less, and less requires more.

Ex.—If 10 men will do certain work in 18 days, how many should do the same work in 6 days?

Set 10 on *B* to 18 on *A*, and under 6 on *A* read the answer 30 on *B*.

Also see the examples given under Levers, Speeds of Pulleys, &c.

Note.—When the scale is set it gives a complete range of factors having a common product.

Square Roots (Front Face).

Set the cursor to any number on *B*, and read the root of same under the cursor on Scale *C*.

Note.—If the number has an odd number of digits, read the roots on the centre circle, but if it has an even number of digits then read the root on the larger circle.

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Ex.—Find $\sqrt{60}$.

Set the cursor to 60 on *B*, and as the figs. are even read 7·75 under the cursor on the larger circle of *C*.

Ex.—Find $\sqrt{530}$.

Set the cursor to 530 on *B*, and as the figs. are odd read 23 under the cursor on the smallest scale of *C*.

The following table shows the relative values of Scales *B* and *C*.

From 1 to 10 on *B* read units on smallest circle *C*.
,, 10 ,, 100 ,, ,, larger ,,
,, 100 ,, 1000 ,, read tens on smallest ,,
,, 1000 ,, 10,000 ,, ,, larger ,,

Cube Roots (Back Face).

Note.—The figs. on this scale read in the reverse direction to the square roots on the Front Dial.

Set the cursor to any number on Scale *B*, and its cube root will be found under the cursor on Scale *C*.

Ex.—Find $\sqrt[3]{162}$.

Set the cursor to 162 on *B*, and read the answer 5·45 on the largest circle of *C*.

The relative values of Scales B and C.

From 1 to 10 on *B* read units on smallest circle *C*.
,, 10 ,, 100 ,, ,, ,, middle ,,
,, 100 ,, 1000 ,, ,, ,, largest ,,
,, 1000 ,, 10,000 ,, ,, tens on smallest circle.

Squares and Cubes of Numbers.

Set the cursor to the number on *C*, and read the answer on *B*.

Ex.—Find the cube of 30.

Set the cursor to 30 on *C* (Back Face), and read 27,000 on *B*.

To Multiply or Divide Squared Numbers.

Ex.—$4{\cdot}25^2 \times 3$.

Set 1 on *C* to 3 on *A*, and over 4·25 on *C* read 54·2 on *A*.

Ex.—$8^2 \div 16$.

Set 8 on *C* to 16 on *A*, and under 1 on *A* read 4 on *B*.

Find $\sqrt[4]{95}$ = the sq. root of the sq. root.

Set cursor over 95 on *B*, and read the sq. root 9·74 on *C*. Set cursor to 9·74 on *B*, and read 3·12 the 4th root on *C*.

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Find the 4th power of 2·45.

Set the cursor to 2·45 on *C*, and read 6 on *B*. Set cursor to 6 on *C*, and read 36 on *B*.

Find $\sqrt[9]{95}$ = the cube root of the cube root.

In extracting cube roots it must be remembered that the figures run from left to right on this scale.

Set cursor over 95 on *B*, and read the cube root 4·56 on middle scale. Set cursor to 4·56 on *B*, and read cube root 1·66 on smallest circle.

Logarithms (Front Face).

Set the cursor to any number on Scale *A*, and read the logarithm radially opposite to it on the outer scale.

Ex.—Find log. 15.

Set the cursor over 15 on *A*, and read ·176 on outer scale, this is the mantissa of the log. The characteristic must be determined by the ordinary rule for logarithms.

To convert common logs. to hyp. logs. × 2·3
" hyp. " comn. " ×·43

Trigonometrical Ratios (Back Face).

Sine.—Set the cursor to the angles in the outside circle, and read its value under the cursor on *A*.

Cosine.—Take the sine of the complement of angle.

Tangent.—Tan. $A = \frac{\text{Sin. } A}{\text{Cos. } A}$

Another way.—Set 1 on *B* to the angle on the outside circle (*Sine Scale*) and under the complement (90—angle) on the Sine Scale read Tan. on *B*.

Ex. Find Tan. 30°.

Set 1 on *B* to 30° on Sine Scale and under 60° (90—30) read ·577 on *B*.

Cotangent.—Cot. $A. = \frac{\text{Cos. } A}{\text{Sin. } A}$

Another way.—Set 1 on *B* to the complement of the angle on the outside circle, and under the given angle on this circle read Cot. on *B*.

Secant.—Take cosec. of the complement of angle.

Cosecant.—Set 1 on *B* to 1 on *A*. Opposite any angle on outside circle read cosec. on *B*.

To reduce Vulgar Fractions to Decimals.

Set the denominator on *B* to the numerator on *A*, and the arrow will point to the required decimal on *A*.

Ex.—Reduce $\frac{5}{8}$ to decimals.

Set 8 on *B* to 5 on *A*, and the arrow points to ·625 the answer on *A*.

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Ex.—Reduce $\frac{5}{8}$ to decimals.

Set ·32 on *B* to 5 on *A*, and read ·156 on *A* opposite the arrow 1 on *B*.

Decimals to Common Fractions.

Find common fraction of ·875.

Set 1 on *B* to ·875 on *A* and read $\frac{7}{8}$ on *A* and *B*.

To convert Weights and Measures into Decimals.

Set 8, 16, 32 or 64 for inches—12 for feet, or 36 for yards—upon *B* to 1 on *A*, and over any number of fractions on *B* read decimal equivalents on *A*.

Ex.—Find decimal equivalents of an inch in 8th, 16th or 32nd.

Set the denominator 8 on *B* to 1 on *A*, and over the numerator, say 4, on *B* read ·5 on *A*; also over 5 read ·625, and over 6 read ·75, &c. The same rule applies to 16ths, 32nds or any other fraction.

In the above manner any weights, measures or money may easily be converted into decimals by using 12 for shillings, 20 for pounds, 16 for lbs., 112 for cwts., &c.

Ex.—What is the decimal equivalent of 8*d.* ?

Set 12 on *B* to 1 on *A*, and over 8 on *B* read ·667 the answer on *A*.

Ex.—What is the decimal equivalent of 12/- ?

Set 20 on *B* to 1 on *A*, and over 12 on *B* read ·6 on *A*.

Equivalent Square.

Rectangles into Equivalent Squares.—Set one side on *B* to arrow *A*, under other side on *A* read area on *B* and side of square on *C*.

Ex.—Find equivalent square of 8″ × ½″.

Set 8 on *B* to arrow on *A*, and opposite ·5 on *A* read 4 (area) on *B* and 2 (side of sq.) on *C*.

Another way (Back Face).—Set the length on *A* to the width on *B*, move the cursor line round until the reading on *A* is same as on *B*. This occurs at 2 (which is side of square required).

The area 4 will be found under the 1 on either *A* or *B*.

Note.—Equal readings on *A* and *B* also occur at 6·3, this is side of square equivalent to 8 × 5 or 80 × ·5 and the area 4 under arrow is of course 40.

Which of the two is the correct one must be decided by mental calculation.

Diagonal of any Square.

Set 70 on *B* to 99 on *A*, and over the side of any size square on *B* read the diagonal of same on *A*.

Rectangles of any Proportions, all the same area.

Set 1 on *B* (*on inverse scale*) to the required area on *A*, and any measurement on *B* multiplied by that opposite to it on *A* = the same area.

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Ex.—A tank to contain a certain quantity must have 66 ft. bottom area, and can only be 5′ 6″ wide; what will its length be?

Set (*on inverse scale*) 1 on *B* to 66 on *A*, and opposite 5·5 read 12 ft. the answer.

SUPERFICIAL AREAS (Front Face).

To find area of any surface—Set g.p. (from table below) on *B* to length on *A*, and opposite breadth on *B* read area on *A*.

Dimensions.	Result in				
	sq. ins.	sq. ft.	sq. yds.	acres.	sq. miles.
ins. × ins.	1	144	1296		
ft. × ins.	·83	12	108		
ft. × ft.	·0694	1	9		
yds. × ft.		·33	3		
yds. × yds.		·11	1	4840	
rods × rods				160	
chs. × chs.				10	6400

Area of Polygons.

To find the area of a Polygon.—Set 1 on *C* to the constant in the following table on *A*, and over the length of one of the sides in ins. or ft. on *C* read area in same measure on *A*.

No. of sides	3	4	5	6	7	8	9	10	11	12
Constant	·433	1·0	1·72	2·6	3·63	4·83	6·18	7·7	9·36	11·2

Ex.—Find the area of an octagon the length of one side being 2½″.

Set 1 on *C* to 4·83 on *A*, and over 2·5 on *C* read 30·25 on *A*.

Circles, Areas, etc.

Set 1 on *C* to ·7854 on *A*, and over any dia. on *C* read area on *A* or *vice versâ*.

Areas and Circumferences of Circles.—Set π (3·14) on *B* to 2·5 on *A*, and under any area on *A* find its circumference on *C* or *vice versâ*.

Circles and Squares of Equal Area.—Set 7 on *B* to 6·2 on *A*, and over any dia. of circle on *B* read the side of square equal to the same area on *A*, or *vice versâ*.

Diameter in inches, area in square feet.—Set 144 on *B* to ·7854 on *A*, and over any dia. in ins. on *C* read area in sq. ft. on *A*. 13·55 on *C* = 1 sq. ft. on *A*.

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Areas of circles and inscribed squares.—Set 7 on *B* to 11 on *A*, and over area of inscribed sq. on *B* read area of circle on *A*.

Circumference	3·14	*A*	Circumference ..	6·28	*A*
Diameter	1	*B*	Radius	1	*B*
Side of inscribed square	7	*A*	Side of square ..	7	*A*
Diameter	9·9	*B*	Dia. = to square	7·9	*B*

Over any dia. on *B* read circumference, or side of sq. on *A*, or *vice versâ*.

CUBIC CONTENTS.

Prisms.—Set 1 on *B* to length on *A*, set cursor to width on *B*. Set g.p. (below) on *B* under cursor, and find result on *A* opposite depth on *B*.

Wedges.—Find volume of prism of same length, breadth and thickness and divide by 2.

Pyramids.—Same procedure but divide by 3.

Dimensions	Results in				
	Cub. ins.	Cub. ft.	Cub. yds.	Galls.	Bushels.
ins. × ins. × ins.	1	1728	46656	276	2208
ft. × ins. × ins.	·833	144	3888	23	184
ft. × ft. × ins.	·0695	12	324	1·92	15·3
ft. × ft. × ft.	·0058	1	27	·16	1·27

Cylinders and Pipes.—Set g.p. (below) on *B* to length on *A*. Read result on *A* opposite dia. on *C*.

Cones.—Find volume of cylinder of same diam. and length and divide by 3.

Dimensions	Results in				
	Cub. ins.	Cub. ft.	Cub. yds.	Galls.	Bushels.
ins. length × ins. dia.	1·27	220	198	351	280
ft. length × ins. dia.	1·06	183	1642	29·2	234
ft. length × ft. dia.	739	1·27	11·5	·204	1·62

Spheres.—Set g.p. (below) on *B* to dia. on *A*, and over dia. on *C* read volume on *A*.

Dimensions	Results in				
	Cub. ins.	Cub. ft.	Cub. yds.	Galls.	Bushels.
ins. dia.	1·91	3300	29970	528	4220
ft. dia.	·00111	1·91	17·19	·306	2·45

Another way (Back face).—Set diam. on *C* to ·524 on *A*. Read contents on *A* opposite 1 on *C*.

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MECHANICAL POWERS.

Inclined Planes, force to support weight upon.

Set height of plane on *B* to length of same on *A*, and under weight on *A* read force on *B*, also over arrow read ratio.

Ex.—What force will be required to support 500 lbs. on an incline 30″ long by 5″ rise?

Set 5″ on *B* to 30″ on *A*, and under 500 lbs. on *A* read 83·5 lbs. on *B*. Also read as 1 on *B* is to 6 on *A* = the ratio of either the force to the weight, or the length of incline to the height.

When the ratio of either force to weight or length of incline to height is decided,

Then set, say, 1 on *B* to 6 on *A*, and under any length on *A* read height of incline on *B*. Also under any weight on *A* read the force to sustain same on incline. This does not include friction.

Screws, Power of.

Set the pitch of screw in decimal parts of an inch on *B* to the circumference described by the force in inches on *A*, and under any weight on *A* read the force to turn the screw on *B*. Also the ratio of weight to force over 1 on *B*.

Ex.—What force is required at the end of a lever to equal a pressure of 400 lbs. by a screw with a $\frac{3}{4}$″ p. and a lever 15″ long?

Set ·75 on *B* to (15″=) 94″ cir. on *A*, and under 400 lbs. on *A* read 3·2 lbs. force required on *B*. Also the ratio of force and speed 1 on *B* to 125 on *A*.

This does not include friction (allow say 30 °/₀).

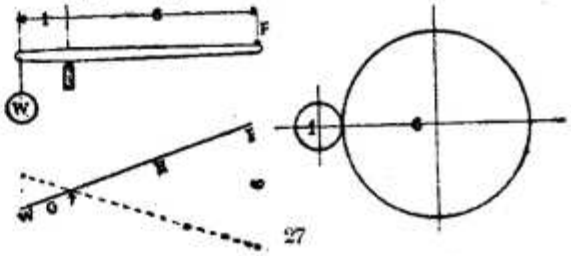
Levers and Wheels.

Assuming the weight or resistance to be overcome by a lever or wheel to be 300 lbs. and force to balance same 50 lbs.,

Set 50 lbs. on *B* to 300 on *A* (the arrow points to the ratio of either force or speed as 1 is to 6), and under any length of lever or radius of wheel on *A* read length of short arm or radius of pinion on *B*.

For all levers $\frac{G \quad W}{H} = F$

G = distance fulcrum to weight (*W*).
H = " " " force (*F*).



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Ex.—If the distance from the fulcrum of a lever to the weight is 3″ and the weight to be raised is 200 lbs., what length should the long arm of lever be with a force of 30 lbs.? Also what force would be required if the long arm were 24″ long?

(Back face) Set 3″ on *B* to 200 lbs. on *A*, and under 30 lbs. on *A* read 20″ length of lever on *B*, and over 24″ length of lever on *B* read 25 lbs. on *A*.

HYDRAULICS.

Weight and Volume of Water.

When any of the following combinations are set upon the calculator, scales *A* and *B* form a complete table of either weights and volumes or volumes and weights.

Ft. c.	.. ..	1	on *A*	Imperl. Pints	1·76	on *A*
Lbs.	.. ..	62·5	,, *B*	Litres	1	,, *B*
Ft. c.	.. ..	61	,, *A*	Cubic inches.	104	,, *A*
Cwt.	.. ..	34	,, *B*	Pints	3	,, *B*
Tons	.. ..	1	,, *A*	U.S. Galls.	1·2	,, *A*
Ft. c.	.. ..	36	,, *B*	Imperl. Galls.	1	,, *B*
Galls.	.. ..	100	,, *A*	Cubic inches	61	,, *A*
Ft. c.	.. ..	16	,, *B*	Litres	1	,, *B*
Galls.	.. ..	224	,, *A*	Litres.. ..	50	,, *A*
Tons	.. ..	1	,, *B*	Imperl. Galls.	11	,, *B*
Pounds	..	10	,, *A*	Lbs. fr. water	39	,, *A*
Imperl. Galls.		1	,, *B*	Lbs. sea water	40	,, *B*

Volumes of Square or Cylindrical Tanks, Pipes, &c., in cub. ins., cub. ft., or galls. (See Cubic Contents, pp. 24–5.)

Discharge of Pipes.—Set g.p. on *B* to velocity on *A*, and read discharge on *A* opposite diam. on *C*.

Velocity and Diameter	Discharge in				
	Cub. ins. p/min.	Cub. ft. p/min.	gals. per min.	gals. per hr.	tons per hr.
ft. per sec. × ins. dia.	177	305	420	700	312
ft. per min. × ins. dia.	106	183	292	420	188
ft. per min. × ft. dia.	739	127	204	340	152

For discharge of oils *in tons per hour*—multiply above results by specific gravity.

Pressure per sq. inch due to head.

Set 60 ft. on *B* to 26 lbs. on *A*, and over any head in ft. on *B* read pressure in lbs. per sq. inch on *A*.

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Force per sq. ft. against a plain surface, at right angles to the motion.

Set arrow to 976 on *A*, and over any velocity in ft. per second on *C* read pressure in lbs. per sq. ft. on *A* (8 ft. = 62·5 lbs.).

Pumps, discharge of.

Set 35·3 on *B* to length of stroke in ins. on *A* and over any dia. of barrel on *C* read galls. per stroke on *A* × no. of strokes = galls. per minute. An allowance of 10 to 40 per cent. must be made for loss by leakage.

Ice, Weight of, at 32°, 9 ft. cube = 520 lbs.

Set 9 ft. c. on *B* to 520 lbs. on *A*, and over any number of ft. c. on *B* read weight in pounds on *A*.

MACHINERY.

Gear Wheels.

To find the dia.—Set circumferential pitch in ins. on *B* to 3·141 on *A*, and under no. of teeth on *A* read dia. on *B*.

To find the circumferential pitch.—Set dia. in ins. on *B* to no. of teeth on *A*, and under 3·14 on *A* read pitch on B.

To find No. of Teeth.—Set circumferential pitch in ins. on *B* to 3·14 on *A*, and over dia. in inches on *B* read no. of teeth on *A*.

To find the dia. of a pair of Wheels, centres and speed given.—Set the rev. of both wheels added together on *B* to twice the distance of centres apart on *A*, and over revs. of wheels on *B* read dias. on *A*.

Ex.—Two shafts, *Y* and *Z*, 36″ apart, *Y* runs 80 rev., and is required to drive *Z* 120 rev. What will be the dias. of the wheels?

Set 120 + 80 = 200 on *B* to 36 × 2 = 72 on *A*, and over the rev. of each shaft on *B* read 28¾ and 43¼, the required dias. on *A*.

Pulleys and Wheels, Speed of.

On inverse scale set dia. of pulley or no. of teeth in wheel on *B* to its speed or rev. on *A*, and under any speed of driving shaft on *A* read dia. of driving pulley or no. of teeth in wheel on *B*.

Ex.—A machine has a 16″ pulley, which must be driven 160 rev. per minute from a shaft running at 95 rev. What size pulley will be required on same?

On inverse scale set 16″ on *B* to 160 on *A*, and under 95 on *A* read 27″ answer on *B*.

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Belts.

Speed of.—Set 382 on B to the rev. of pulley per minute on A, and over dia. in ins. on B read speed of belt in ft. on A.

Horse-power of.—Set 660 on B to speed of belt in ft. per minute on A (see above rule), and over width of belt in ins. on B read h.p. on A.

Width of for a given h.p.—Set as above, and under h.p. on A read width of belt in ins. on B.

Double belts: instead of 660 use 38 for g.p.

Shafting, H.P. of.—For ordinary mill work.

Set g.p. on B to cube of shaft dia. on A, and over any no. of rev. per minute on B read h.p. on A.

Ex.—What is the h.p. of a 3″ shaft running 120 rev. per min., bending moment=½ twist?

Set g.p. 57 on B to 27 (3^3) on A, and over 120 rev. on B read 56·9 h.p. on A.

Diameter of shaft.—Set rev. of shaft per minute on B to h.p. on A, and over g.p. on B read cube of shaft's dia. in ins. on A, the root of which equals shaft's dia.

Gauge Points (corresponding to 9000 lbs. sq. in. stress).

For twisting only	35·6
,, ,, plus bending (=½ twist) ..	57
,, ,, ,, ,, (=1 twist) ..	86
,, ,, ,, ,, (=1½ twist) ..	118

Span between bearings.—Span in ft. $K\sqrt[3]{\frac{}{D^2}}$

On inverse scale, set D (ins.) on A to D (ins.) on B.

Read $\sqrt[3]{\frac{}{D^2}}$ on C opposite 1 on A. Set this figure on to K on A and read Span (ft.) on B opposite 1 on A.

K (for shafts without pulleys)	= 6
(for shafts with ordinary number of pulleys)	= 5
(for shafts heavily laden)	= 4

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BEAMS & CANTILEVERS.

To find bending moment.—Set g.p. on *B* to length of span in ft. or ins. on *A*, opposite load in lbs. or tons on *B*, read bending moment on *A* in lbs.-ins., lbs.-ft., tons-ins., or tons-ft., according to units used.

G.P.'s.—Cantilever fixed one end, load at other .. 1
" " " load distributed 2
Beam, supported both ends, load at centre 4
" " " load distributed 8
" fixed " load at centre 8
" " " load distributed 12

Ex.—What is bending moment on a cantilever 10 ft. long loaded with 500 lbs. at end ?

Set 1 on *B* to 10 ft. on *A*, and opposite 500 on *B* read 5000 lbs. ft. on *A*.

What is bending moment on a beam 12 ft. long supported at each end, and carrying uniformly distributed load of 900 lbs. ?

Set 8 on *B* to 12 on *A*, and opposite 900 on *B* read 1,350 lbs. ft. on *A*.

MACHINE SHOP.

Cutting Speed.—Set 3·82 on *B* to diam. (ins.) on *A* and opposite r.p.m. on *B*, read cutting speed (ft. per min.) on *A*.

Time on Job.—Set r.p.m. on *B* to length of the job on *A*, and opposite cuts per inch on *B* read time (min.) on *A*.

STEAM AND PETROL ENGINES.

Indicated Horse-power.

Set the dia. of cylinder on *C* to g.p. on *A*. Now set the number found on *B* under the piston speed in feet per minute on *A* to 1 on *A*, and under any mean steam pressure in pounds per square inch on *A* read i.h.p. on *B*.

G.P. for double-acting steam engine 42
" single-acting " 84
" 2-stroke petrol engine 84
" 4-stroke " 168

Ex.—A steam engine has an 8" cylinder with a piston speed of 300 ft. per minute and a mean steam pressure of 40 lbs. per square inch.

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Set 8 on *C* to 42 on *A*, and under 300 ft. on *A* find 45·6 which set to 1 on *A*, and under 40 lbs. on *A* read 18·2 h.p., on *B*, or under 45 lbs., read 20·5 h.p., &c.

Taxable H.P. (or Treasury Rating) of Car.

Set g.p. 2·5 on *B* to number of cylinders on *A*. Read h.p. on *A* opposite cylinder bore on *C*.

Speed of Motor Car, Train, or Ship.

Set seconds per mile on scale *B* to g.p. 36 on scale *A*. Read miles per hour on *A* by arrow on *B*. (To read knots—set seconds per mile on *B* to g.p. 313 on *A*.)

Brake Horse Power.

Set 1 on *B* to the i.h.p. found above on *A*. Read B.H.P. on *A* opposite mechanical efficiency on *B*.

Expansion of Steam in Cylinder.

On Inverse Scale. Set the initial pressure of steam in pounds per sq. in. on *B* to the distance travelled by the piston at the point of cut-off on *A*, and under any other distance travelled by piston on *A* read the pressure of steam in cylinder in lbs. per sq. in.

Ex.—The initial pressure in a cylinder at the time of cut-off is 75 lbs. per sq. in., and the point of cut-off is 6″.

On Inverse Scale. Set 75 lbs. on *B* to 6″ on *A*, and under 10″ read 45 lbs. pressure, and under 15″ 30 lbs.; 20″, 27·5 lbs.; 25″, 18 lbs., &c.

Heating Surface of Boiler Tubes.

Set 3·82 on *B* to dia. (ins.) on *A*, opposite total length (ft.) on *B*. Read area in sq. ft. on *A*.

PUMPING ENGINES.

Set dia. of pump in inches on *C* to the effective steam pressure in lbs. on *A*, and under the pressure on pump in lbs. per sq. inch on *A* read dia. of cylinder on *C*.

Ex.—An 8″ pump is required to work against a pressure of 78 lbs. per sq. inch, the effective steam pressure is 15 lbs., what should be the dia. of the cylinder?

Set 8 on *C* to 15 lbs. on *A*, and under 78 lbs. on *A* read 18·25″ dia. on *C*.

For efficient working this must be increased from 15 to 30 per cent. according to circumstances, Therefore :—

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Set arrow (100) on B to area 262″ on A, and over, say, 125 = 25 per cent. on B read area 327=20·4″ dia. on A.

Head in ft. × ·434 or yds. × 1·3=pounds per sq. in.

ELECTRICITY.

Ohm's Law.

$$C = \frac{E}{R}, \quad R = \frac{E}{C} \quad E = R.C.$$

C = Current, E = E.M.F., R = Resistance.

These equations are of the form $\frac{a}{c} = x$, $ab = x$.

Operations for solving them are given on p. 79, eqs I & II.

$$C = \frac{NE}{R}, \quad R = \frac{NE}{C}, \quad \frac{CR}{E} = N$$

E = E.M.F. per cell. N = No. of cells.

These are of the form $\frac{ab}{c} = x$.

Operations are given on p. 86, eq. VII.

Current through parallel Resistances.

On inverse scale.—Set joint resistance on B to total current on A, and opposite resistance of separate branches on B read current on A.

Ex.—20, 50 and 100 ohms in parallel have 6 amps. through them. What current will pass each branch?

Joint resistance of 20, 50 and 100=12·5.

Set 12·5 on B to 6 on A, and opposite 20, 50 and 100 on B read 3·75, 1·5 and ·75 amps.

Kilowatts and H.P.

Set 1·34 on B to 1 on A, opposite H.P. on B read kilowatts on A.

BUILDING.

Brickwork.

1 rod = 272 ft. supr. 1½ brick thick = 306 cub. ft. = 11⅓ cub. yds. = 4,350 stock bricks in mortar = 15 tons or 110 lbs. per cubic ft.

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To reduce brickwork to standard thickness.

Bricks thick	½	1	—	—	—	—
Inches thick	4½	9	10	11	12	13
Ft. Supr. 1 Rod	816	408	366	334	306	282
Ft. Supr. on *A*.	27	27	27	27	27	27
Ft. Standard on *B*.	9	18	20	22	24	26
Ft. Supr. on *A*.	24	24	24	24	24	24
Ft. Cube on *B*.	9	18	20	22	24	26
No. Bricks on *A*.	214	428	474	521	568	618
Ft. Supr. on *B*.	40	40	40	40	40	40

When any of the above combinations are set together on scales *A* and *B* the latter form a complete table of ft. supr. and ft. standard or ft. supr. and ft. cube, &c.

1½ brick thick, or to ft. cube.

1½	—	—	—	—	2	2½	3
13½	14	15	16	17	18	22½	27
272	262	245	230	216	204	163	136
27	27	27	27	27	27	27	27
27	28	30	32	34	36	45	54
24	24	24	24	24	24	24	24
27	28	30	32	34	36	45	54
640	662	720	759	806	854	1065	1280
40	40	40	40	40	40	40	40

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Ex.—Reduce 42, 57, 130 ft. supr. 18″ work to standard work 1½ brick thick.

Set 36 on *B* to 27 on *A* (*see* Table), and below any ft. supr. on *A* read ft. standard on *B* thus—

Ft. supr. 18″ thick on *A*	27	42	57	130
Ft. standard 13½″ on *B*	36	56	76	173

Feet supr. to ft. cube may also be found in same manner, also ft. supr. and number of bricks.

Weights of Materials per ft. cube.

Concrete	120-140	Marble	170
Earth	80-120	Portland Stone	151
Granite (Aberdeen)	163	Sand	118
Limestone (Purbeck)	162	Slate, Welsh	180

Useful Tables.

Measurement—		*No. of bricks*—	
Ft. cube	45 on *A*	1,000 bricks	27 on *A*
Ft. standard	40 ,, *B*	Yds. cube	70 ,, *B*
Yds. cube	34 ,, *A*	No. bricks	355 ,, *A*
Rods standard	3 ,, *B*	Ft. cube	25 ,, *B*

Nogging—		
Bricks flat	900 on	*A*
Yds. supr. brick nogging	20 ,,	*B*
Bricks on edge	600 ,,	*A*
Yds. supr. brick nogging	20 ,,	*B*
Arches—		
Bricks	200 ,,	*A*
Ft. supr. gauged arches	20 ,,	*B*
Paving—		
Bricks on edge	1,040 ,,	*A*
Yds. supr. of paving	20 ,,	*B*
Paving bricks laid flat	720 ,,	*A*
Yds. supr. of paving	20 ,,	*B*
Paving bricks on edge	1,640 ,,	*A*
Yds. supr. of paving	20 ,,	*B*
10″ paving tiles	260 on	*A*
Yds. supr. of paving	20 ,,	*B*
12″ paving tiles	180 ,,	*A*
Yds. supr. paving	20 ,,	*B*
Dutch clinker on edge	2,800 ,,	*A*
Yds. supr. of paving	20 ,,	*B*
Mortar—		
Brickwork c. ft.	86 ,,	*A*
Mortar in same	20 ,,	*B*
1,000 bricks	3,300 ,,	*A*
Loads mortar	2 ,,	*B*
Weight—		
Cube ft.	56 ,,	*A*
Cwts. brickwork	55 ,,	*B*
Cube ft.	306 ,,	*A*
Tons brickwork	15 ,,	*B*
Rods standard	1 ,,	*A*
Tons brickwork	15 ,,	*B*

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Prices.—When any of the following combinations are set on scales *A* and *B* they form a complete table of the factors in question.

£ per rod	1·
Pence per ft. super, 3 bricks thick ..	1·77
,, ,, ,, 2½ ,, ,, ..	1·47
,, ,, ,, 2 ,, ,, ..	1·18
,, ,, ,, 1½ ,, ,, ..	·883
,, ,, ,, 12 in. (or cub. ft.) thick	·785
Pence per ft. super, 1 brick thick ..	·59
,, ,, ,, ½ ,, ,, ..	·294
Shillings per cub. yard	1·77

Ex.—Find weight of 85 cube ft. of brickwork in cwts.

Set 55 on *B* to ·56 on *A* (*see* Useful Tables), and under 85 on *A* read 83·5 cwt. on *B*.

Ex.—Find number of bricks required in 84 cub. ft.

Set 25 on *B* to 355 on *A*, and over 84 on *B* read 1.195 on *A*.

Land Measure.

Length and Breadth (or depth and frontage) to acres. Set depth on *B* to g.p. on *A*, then read :—

(i.) Frontage per acre on *A* opposite 1 on *B*.

(ii.) Acreage of plot on *B* opposite frontage on *A*.

(iii.) £ per acre on *A* opposite £ per unit frontage on *B*, or *vice versâ*.

Chains × chains, g.p.	= 10
Rods × Rods ,,	= 160
Yards × yards ,,	= 4840
Ft. × ft. ,,	= 43560

Other Useful Figures.

When any of the following combinations are set on scales *A* and *B* they form a complete table of the factors in question.

£ per acre	1
Shillings per sq. yd.	·00412
Pence per sq. yd...	·0494
Shillings per sq. rod .. .	·125
Pence per sq. rod	1·5

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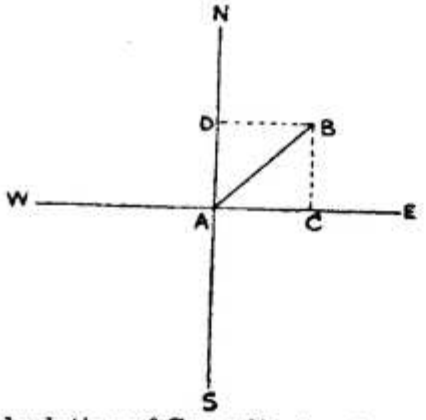
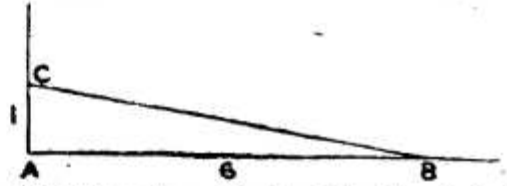


1.—Calculation of Co-ordinate of a survey.

Co-ordinate of point *B*.
Line *A-B*. *N* 46° *E*. 234 links.
Latitude *A-D* = 234 × cos *DAB*.
= 234 × ·695 = 162·6 links.
Departure *B-D* = 234 × Sine *DAB*.
= 234 × ·719 = 168·3 links.
Lat. 162·6 *N* Dep. 168·3 *E*.

This can be calculated to one decimal place with the circular rule.



2.—Given a roadway dipping 1 in 6 (say), to find dip in degrees and inches per yard and deduction of links per chain to convert dip distance to horizontal distances. The horizontal distance *A-B* is of course equivalent to the departure (in previous example) *i.e.*, *C-B* × Angle of dip.

Timber, Deals, &c.

To reduce feet run of any section to Petrograd Standard = 1.440 *ft.* 1½″ × 11″.

Width in Inches.	Thickness in Inches.		
	2½″	3″	4″
6	1584	1320	990
6½	1462	—	—
7	1357·7	1131·4	848
8	1188	990	742
9	1056	880	660
10	950·4	792	594
11	864	720	540
12	792	660	495

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Set 1,440 ft. (= Petrograd standard) on B to number of feet run according to section on A (see Table), and below any number of feet of that section on A read equivalent number of feet in Petrograd standard on B.

Ex.—Reduce 2,600 ft. 3″ by 7″ to Petrograd standard.

Set 1,440 on B to 1,131 on A, and under 2,600 ft. on A find 3,310 ft. standard on B.

Read feet run on A and standard on B.

Feet Run per Square.

On inverse scale. Set 6″ on B to 200 ft. run on A, and over any other width in inches on B read feet run per square on A, over 8″ read 150 ft., over 12″ 100 ft., &c.

Number of Squares in a Standard.

Any thickness.

On inverse scale. Set 3″ on B to 6·6 on A, and over any other thickness read squares per standard on A.

Feet Run per Square Yard.

On inverse scale. Set 6″ on B to 18 ft. run on A, and over any number of inches in width on B read feet run per square yard on A.

Square Yards per Standard.

On inverse scale. Set 1″ on B to 220 sq. yds. on A, and over any other thickness on B read square yards per standard.

Feet Run of any Section in one cubic ft.

On inverse scale. Set 9″ on B to 16 ft. on A, and over any number of square inches in any section on B read feet run per cubical ft. on A; over 6″ on B read 24 on A, and over 8″ read 18 ft. on A.

Cubic feet in a given number of feet run of any section.

On front face set 144 on B to the length in feet run on A, and over the area of section in square inches on B read cubic feet on A.

Ex.—How many cubic feet are there in 136 ft. $4\frac{1}{2}$″ by 2″?

Set 144 on B to 136 on A, and over 9″ area on B read $8\frac{1}{2}$ cubic ft. on A.

Also the cubic feet for any other area of the same length. Over $4\frac{1}{2}$″ read $4\frac{1}{4}$ ft. c., &c.

Round Timber.

To find the contents of round timber in cubic feet the length is usually multiplied by the square of the 1-4th of the mean girth, with an allowance of from 1-10th to 1-20th made for bark. This gives a result 21·5 per cent. low.

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Rule.—Set the g.p. on C to the length on A, and over the girth in inches on C read cubic feet on A.

	Allowance.	¼ Girth.	Whole Girth.
Oak, old thick bark ..	$\frac{1}{10}$ =	12·66	50·64
,, young thin bark.	$\frac{1}{12}$ =	12·55	50·2
Elm, Pine, Fir	$\frac{1}{16}$ =	12·43	49·72
Ash, Beech	$\frac{1}{20}$ =	12·3	49·2
No bark.....	—	12	48

Ex.—Find contents of an elm 30 ft. long 60″ girth.

For whole girth. Set 51·48 on *C* to 30 ft. on *A*, and over 60″ on *C* read 40·8 ft. on *A*.

For ¼ girth. Set 12·87 on *C* to 30 ft. on *A*, and over 15″ (= ¼ girth) on *C* read 40·8 ft. on *A*.

Hewn Timber and Scantlings.

Given length, breadth and thickness. Cubic contents may be calculated by cubic contents formulæ on p. 24.

Ex.—Find cubic contents in 20 ft. of timber 16″ × 18″.

Set 1 on *B* to 20 on *A*. Set cursor to 18″ on *B*.

Set g.p. 144 on *B* under cursor and find result on *A* opposite 16″ on *B* = 40 cub. ft.

If section in square inches be given and length in feet, set 144 on *B* to length on *A* and opposite the section on *B* read contents in cubic feet on *A*.

Ex.—Take same as above, 16″ × 18″ = 288 sq. ins.

Set 144 on *B* to 20 ft. on *A* and over 288 on *B*, read 40 cub. ft. on *A*.

Wall Paper.

Number of pieces of ordinary English paper required to cover a room.

Set the height of room in feet on *B* to 60 on *A*, and under the measurement round walls in feet on *A* read number of pieces of paper required on *B*.

For French paper add 50 %.

Allowance must be made for doors and windows.

Ex.—The height of a room is 11 ft. and measurement round same is 68 ft. How many pieces will be required?

Set 11 ft. on *B* to 60 ft. on *A*, and under 68 ft. on *A* read 12·5 pieces on *B*.

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Slates.—*Weight and No. per sq. ft.* Allowing 3″ Lap.

Name and Size.	No. per sq.	Sq. yds per 1200	Cwts. per 1200 Aver'ge	A = No. of Slates. B = sq. ft.	
Duchess 24 × 12	115	116	60	A	80
				B	70
Marchioness 22 × 11	138	97	60	A	80
				B	58
Countess 20 × 10	170	78	40	A	85
				B	50
Viscountess 16 × 10	220	60	35	A	90
				B	41
Ladies 16 × 8	275	48	25	A	55
				B	20
Small Ladies 14 × 8	328	40	18	A	95
				B	29
Doubles 13 × 7	412	32	15	A	70
				B	17

Ex.—Find the number of Duchess slates to cover 860 sq. ft.

Set 70 on B to 80 on A (*see* Table), and under 860 sq. ft. on B, read 983 on A.

Ex.—Find the weight of the above slates.

Set 60 on B to 1200 on A, and opposite 983 on A, read 49·2 cwts. on B.

Crane Chains.—Wt. Iron.

Ex.—Find the breaking-strain of a ½″ chain. The dia. of chains advance by 16ths of an inch in decimals.

Set 8-16ths dia. on C to 7·5 tons breaking-strain on A, and over any other dia. on C read its breaking-strain in tons on A. Over 9 read 9·49. Over 12 (¾)″ read 16·89, &c.

Admiralty proof strain. Set 8-16ths on C to 3 tons on A.

Safe working strain. Set 8-16ths on C to 1·5 ton on A.

Stud-Linked Cable Chains.

Set 8-16ths ins. on C to 6·75 tons b.s. on A, and over any other dia. on C read its breaking strain in tons on A.

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Admiralty proof strain Set 8 on *C* to 4·5 tons on *A*.

Safe working strain. Set 8 on *C* to 2·25 tons on *A*.

Ropes. White Manilla.

Breaking Strain. Set 3″ cir. on *C* to 2·8 tons on *A*, and over any other cir. on *C* read its breaking strain on *A*.

Working Load. Set 3″ cir. on *C* to 11·2 cwt. on *A*, and over any other cir. on *C* read safe load in cwts. on *A*.

Weight per fathom. Set 3″ cir. on *C* to 1·6 lbs. on *A*, and over any other cir. on *C* read weight in lbs. per fathom on *A*.

Tarred Russian.

Breaking Strain. Set 3″ cir. on *C* to 2·2 tons b.s. on *A*, and over any other cir. on *C* read breaking strain on *A*.

Working load in cwts. = the square of the circumference, and over 3″ cir. on *C* read 9 cwt. on *B*, &c.

Weight per fathom. Set 3″ cir. on *C* to 2·2 lbs. on *A*, and over any other cir. on *C* read lbs. per fathom on *A*.

Wire Ropes (Bullivants).

	Breaking Strain. Tons.	Working Load. Tons.
Crucible Steel.....	24·75	4·12
Crucible Steel—best sel.	26·5	4·4
Spec. mild Plough Steel	29	4·8
Spec. extra Plough Steel	31·75	5·3

To find either the breaking strain, working load, or weight per fathom :—

Set 3″ circumference on *C* to any of the above g.p.'s on *A*, and over any other cir. on *C* read strength of rope on *A*, either for breaking strain, working load, or weight per fathom.

Weight per fathom. 6 strands 7 wires each = 8·5 lbs., and 6 strands 6 wires each = 7·8 lbs. for ropes of 3″ circumference.

Stresses in Round Rod, Bolts, Wire, etc.

Set dia. of rod or wire (for bolts take dia. at

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bottom of thread) on *C* to g.p. on *A* and read stress on *A* for any load on *B*.

Load lbs. ; stress tons per sq. in. g.p. = 568
,, tons ; ,, ,, ,, ,, = 127
,, lbs. ; ,, lbs. ,, ,, = 127

Suspension and Tie Rods. Wt. Iron.

Safe load at 7 tons per square inch.

Round Bars.—Set 8 (eighths of an inch) on *C* to 5·5 tons safe load on *A*, and over any other dia. in eighths on *C* read safe load on *A*.

Square Bars.—Set 8 on *C* to 7 tons on *A*, and over side of square in 8ths on *C* read tons safe load on *A*.

Bars, Round or Square, compared.

Strength, Weight, or Area.

Set 1 on *B* to ·7854 on *A*. Then *B* gives area of square bar, *A* area of round bar, and *C* size of bar (diam. or side of square). Thus opposite 2·5 on *C* will be found 6·25 on *B* (area of 2½ square bar) and 4·9 on *A* (area of 2½ round bar).

Also over he weight of a 2″ round bar wt. iron = 10·49 lbs. per foot on *B* read weight of 2″ square bar = 13·36 lbs. per ft. on *A*. Also read relative tensile strengths in same manner.

In other words, a square bar is 27 per cen stronger (tensile) and heavier than a round bar.

Ultimate Tensile Strength of Materials.
Per sq. inch.

	Lbs.	T'ns.		Lbs.	T'ns.
Cast Iron ..	17,000	7·5	Mang. Bronze	60,000	27
Wrought—			Muntz.		
Iron Bars	54,000	24	Metal	49,000	22
Iron Plate	48,000	21·5	Ash ..	15,000	6·7
Mild Steel ..	70,000	31	Beech ..	12 000	5·4
Copper Bolts	36,000	16	Elm ..	13,000	5·8
,, Sheet	30,000	13·4	Pine ..	12,000	5·4
,, Wire.	58,000	26	Leather.	4,200	1·88
Gun Metal..	32,000	14·1			
Phos. Bronze	35,000	15·7			

Rule.—Set 1 on *B* to strength of material in above Table on *A*, and over any area in ins. on *B* read breaking strain in lbs. or tons per sq. inch on *A*.

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WEIGHTS OF MATERIALS.

Round and Square Bars. Rule.—For a given length of any dia. at one setting. Set the g.p. on *B* (*see* Table, pp. 60-61) to the length on *A*, and over dia. or side of square bar on *C*, read weight on *A*. For weight per foot take length = 1 ft.

Ex.—Find the weight per ft. of any dia. round iron.

Set the g.p. 381 on *B* to 1 (or any length) on *A*, and over any dia. on *C* read weight on *A*. *See* following example :—

Scale *A*	To 1	2·62	10·5	23·6	42	= lbs.
,, *B*	Set 381					
,, *C*		1″	2″	3″	4″	= ins. dia.

Rule.—For any length of a given size of bar at one setting. Set the side or dia. on *C* to the g.p. on *A* (*see* Table), and under any length on *A* read weight on *B*.

Ex.—Find weight of 3″ round bar, wrought iron any length.

Set 3″ on *C* radially opposite the g.p. 381 on *A*, and under any length on *A* read weight on *B* as follows :—

Scale *A*	To 381	1	2	3	4	= ft.
B	↕	23·6	47·2	70·8	94·4	= lbs.
,, *C*	Set 3″					

If any dimensions contain fractions convert them into decimals (see rule, page 19).

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Gauge points for weight, &c., of various Materials.

Material.	Per Cubic Ft.
Aluminium, cast, lbs.	160
Brass, ,,	505
Copper, ,,	552
Gun Metal, ,,	528
Iron, cast, average lbs.	450
,, wrot. ,, ,,	480
Lead, lbs.	712
Steel, ,,	490
Tin	462
Zinc	437
Water at lbs.	62·5
,, cwts.	·557
,, tons	·0279

Square.			Cylinder.		Globe.	
FFF	FII	III	FI	II	F	I
625	9	108	114	137	119	209
198	285	343	362	435	377	655
181	26	313	331	398	346	6
189	273	327	346	416	362	630
222	32	385	406	488	425	733
208	3	36	381	458	397	689
141	202	243	257	310	268	464
204	294	353	374	449	390	673
217	311	374	396	477	411	717
229	330	395	419	502	435	756
16	231	277	294	352	306	528
18	258	310	329	395	343	593
358	516	619	656	789	684	118

FFF = ft. × ft. × ft.
FII = ft. long × ins. sq.
III = ins. × ins. × ins.
FI = ft. long × ins. dia.
II = ins. long × ins. dia.
F = ft. dia.
I = ins. dia.

Weight of Globes, Spheres, etc.

Set the g.p. on *B* to the dia. on *A*, and over the dia. on *C* read the weight on *A*.

Ex.—Find the weight of a 6″ cast iron ball.

Set the g.p. 733 on *B* to 6″ on *A*, and over 6″ on *C* read 29·5 lbs. on *A*.

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Flat Bars, Rectangular Castings or Forgings, weight by above Table.

Set 1 on *B* to length on *A*, set cursor to width on *B*. Set g.p. on *B* under cursor and find result on *A* opposite depth or thickness on *B*.

Ex.—Find weight of 100 ft. 3″ × ¾″ Steel Bar. Set 1 on *B* to 100 on *A*. Set cursor to 3″ on *B*. Set 294 on *B* under cursor and read 767 lbs. on *A* opposite ·75 on B.

Hexagon Bars, weight, etc.

Find weight of square or round bar of thickness= to hexagon across flats by rule, p. 58. Then hexagon bar = sq. bar × ·8661 or round × 1·103.

The above gives weights for any thickness at same setting. For weights per foot take length = 1 ft.

Gauge Points for any other Material.

Set any of the following constants on *B* to the weight or capacity of one cubic ft. of the material on *A*, and under 1 on *A* read the required g.p. on *B*.

FFF = 1 on *B*. FII = 144. III = 1,728. FI = 183·3.
II = 22. F = 19. I = 33.

Pipes or Cylinders, weight of.

Weight of pipe = weight of solid cylinder of outside diameter minus weight of solid cylinder of inside diameter.

G. P.

Brass	363	C. Iron ..	408
Copper ..	331	W. Iron ..	381
G. M.	346	Lead	257

Set the g.p. on *B* to 1 ft. or any length on *A*, and over outside and inside dia. on *C* read weights of solid cylinders on *A*. The difference between them equals the weight of pipe or cylinder, which can be read off on the scale by the cursor. For 2 flanges of c. iron pipe reckon as 1 ft. of pipe.

Ex.—Find weight of 2 ft. of 4½″ c. iron pipe ½″ thick.

Set 408 on *B* to 2 ft. on *A*, and over 4·5 on *C* read 99 lbs. on *A*, and over 5·5 on *C* read 148 lbs. on *A*. 148—99 = 49 lbs.

Any other dia. and thickness may be calculated with the same setting.

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Weight of Sheet Metal, etc.

Set 833 on *B* to length (ft.) on *A*, set cursor to width (ft.) on *B*. Set FII g.p. (Table, p. 61) on *B* under cursor and find result on *A* opposite thickness (inches on *B*).

Ex.—Find weight of a sheet of steel 16 S.W.G. 6 ft. × 2 ft.

Set 833 on *B* to 6 on *A*. Set cursor to 2 on *B*. Set g.p. 294 on *B* under cursor and read 31·5 lbs. on *A* opposite ·064″ (= 16 S W.G.) on *B*.

For weights per sq. ft.

Take length and width = 1 ft.

Table of Gauges.

S.W.G.	ins.	S.W.G.	ins.	S.W.G.	ins.
7/0	·500	3	·252	14	·080
6/0	·464	4	·232	16	·064
5/0	·432	5	·212	18	·048
4/0	·400	6	·192	20	·036
3/0	·372	7	·176	22	·028
2/0	·348	8	·160	24	·022
0	·324	9	·144	26	·018
1	·300	10	·128	28	·0148
2	·276	12	·104	30	·0124

WEIGHTS AND MEASURES.

Avoirdupois Weight.		*Surveying Meas.*		*Ale and Beer Measures.*	
Dr. 16	*A*	Links ..100	*A*		
Ozs. 1	*B*	Ft. 66	*B*	*Dry Measure.*	
Ozs. 16	*A*	Ft. 66	*A*	Gills 4	*A*
Lbs. 1	*B*	Chains .. 1	*B*	Pints .. 1	*B*
Lbs. 14	*A*	Chains .. 10	*A*	Galls. .. 9	*A*
St. 1	*B*	Furl. 1	*B*	Firkins .. 1	*B*
Lbs. 28	*A*	Chains .. 80	*A*	Pints .. 8	*A*
Qrs. 1	*B*	Miles 1	*B*	Galls. .. 1	*B*
Lbs. 112	*A*	Furl. 8	*A*	Galls. .. 6 25	*A*
Cwts. 1	*B*	Miles .. 1	*B*	Cub. ft. .. 1	*B*
Cwts. 20	*A*	Miles 19	*A*	Pints .. 2	*A*
Tons 1	*B*	Ady. kts. 16.5	*B*	Quarts .. 1	*B*
Long Measure.		*Square Measure.*		Galls. .. 54	*A*
Ins. 12	*A*	Sq. ins. ..144	*A*	Hoghds. .. 1	*B*
Ft. 1	*B*	Sq. ft. .. 1	*B*	Cub. ins. 34·6	*A*
Ft. 3	*A*	Sq. ft. .. 9	*A*	Pints .. 1	*B*
Yds. 1	*B*	Sq. yds. .. 1	*B*	Bshls. .. 7	*A*
Ft. 6	*A*	Sq. yds. 60.5	*A*	Cub. ft. .. 9	*B*
Fathom .. 1	*B*	Sq. rods .. 2	*B*	Quarts .. 4	*A*
Yds. .. .. 5·5	*A*	Sq. yds. 4840	*A*	Galls. .. 1	*B*
Rods 1	*B*	Acres 1	*B*	Galls. .. 8	*A*
Yds. .. 1760	*A*	Sq. rods ..160	*A*	Bushls. .. 1	*B*
Miles 1	*B*	Acres 1	*B*	Cub. ins. ..276	*A*
Rods 320	*A*	Acres 640	*A*	Galls. .. 1	*B*
Miles 1	*B*	Sq. Miles .. 1	*B*	Bushls. .. 8	*A*
				Qrs. 1	*B*

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Ex.—To 8 pints on *A* set 1 gallon on *B* (see Table); then opposite any number of gallons on *B*, read pints on *A*, or *vice versâ*.

COMMERCIAL.

Interest or Discount.

Rule.—For given principal and rate of interest but varying periods at one setting. Set arrow on *B* to principal on *A*, and opposite rate of interest (or discount) on *B* read interest (or discount) per annum on *A*. Set cursor to this and bring 365 days on *B* to cursor; then opposite any number of days on *B* read interest (or discount) on *A*.

Ex.—**To find the interest** on £3,500 @ 4 per cent. for 90 days.

Set the arrow on *B* to 35 (hundred pounds) on *A*, and over 4 per cent. on *B* read £140 for one year on *A*. Then set 365 days on *B* to £140 the interest on *A* and over 90 days on *B* read the answer £34 10*s*. on *A*.

The shillings are only approximate, being in the decimal part of a pound it is difficult to read the exact amount.

Ex.—**To find the discount** on £560 @ 2½ per cent.

Set the arrow to £560 on *A*, and over the rate of discount 50*s*. on *B* read the answer 280*s*. on *A*.

Set 365 on *B* to 280 on *A* and opposite any number of days on *B* read discount on *A*.

Rule.—For given period and rate of interest, but varying principals.

Set 365 on *B* to rate of interest on *A*, and opposite number of days on *B* read interest on £100 on *A*. Mark with cursor and set 1 on *B* to it. Read interest on *A* opposite any principal on *B*.

Find the Interest on £32, 48, 60, and 80 @ 7½ per cent. for 160 days.

Set 365 on *B* to 7·5 on *A* and opposite 160 on *B* read £3·28 on *A*. Mark with cursor and set 1 on *B* to it read

A	1·05	1·58	1·97	2·63
B	32	48	60	80

To find the selling price of goods to realise a certain profit (as °/₀ on cost).

Set 100 + the percentage for profit on *B* to 100 on *A*, and under the cost price for any amount on *A* read the selling price with profit on *B*, or *vice versâ*.

Ex.—Find the selling prices of goods to realise 15 per cent. profit.

Set 100 + percentage of profit = 115 on *B* to 100 on *A*; and under any cost price on *A* read selling price on *B* at 15 per cent. profit, under £50 cost price read £57 10*s*. selling price, &c.

For profits as °/₀ of return —. Set 100 on *B* to 100 − °/₀ of profit and proceed as before.

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Percentage of loss.

Ex.—If 70 tons of coal are consigned to me and I only receive 63 tons, what percentage do I receive, and what is the loss?

Set the arrow or 100 on *B* to 70 tons on *A* and under 63 on *A* read 90 per cent. received on *B*, and from 90 to the arrow on *B* equals the loss 10 per cent.

Percentage of gain.

Set the arrow or 100 on *B* to the nett amount on *A*, and under the gross amount on *A* read the gain per cent. on *B* counting from the arrow.

Ex.—If 80 lbs. of goods gain 8 lbs. = 88 lbs. during the process of manufacture, what is the percentage of gain?

Set the arrow on *B* to 80 lbs. on *A*, and under 88 on *A* read 10 per cent. on *B*, counting from the arrow on *B* to 88 on *A*.

To find the percentage deducted from any amount.

Set the gross amount on *B* to the nett on *A*, and read the discount on *A* from 100 on *A* to the arrow on *B*.

Ex.—A cheque for £76 is received in settlement of an account for £80. What was the discount?

Set 80 on *B* to 76 on *A* and from 100 on *A* to the arrow on *B* = 5 per cent., the answer on *A*.

To find dividends.

Ex.—Set the total debts on *B* to the assets on *A*, and over each debt on *B* read the dividend for same on *A*.

Set debts =	£240	80	65	70	20	5	= debts.
To assets =	95	31·6	25·73	27·7	7·9	1·98	= divdnds.

To divide any amount into proportional parts.

Set the total number of parts on *B* to the amount on *A*, and over the number of parts on *B* read the value of each on *A*.

Ex.—Divide £174 into 3, 1, 2, and 5 = 11 parts. Set 11 on *B* to 174 on *A*, and over the parts on *B* read the values on *A*.

A	15·8	31·6	47·4	79
B	1	2	3	5

Compound Proportions.

Ex.—In the manufacture of an article certain ingredients are used in the following proportions:—2, 7, 13, 40, 62 lbs. = 124 lbs. altogether. It is required to make 5 cwt. at one time in exactly the same proportions.

Set 124 lbs. on *B* to 560 lbs. on *A*, and over the proportions on *B* read the quantities required on *A* to make up 5 cwt. as follows:—

A	560	9	31·5	58·5	181	280 = 560 lbs.
B	124	2	7	13	40	62 = 124

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Carpets, Linoleum, &c.

To find the number of yards required to cover a floor.

Set 3 on B to the length in feet on A, and over any number of widths required on B read yards on A.

Another way.—Set g.p. on B to the length in feet on A, and over any width in feet on B, read number of yards of carpet on A.

Allowance must be made for matching pattern, from half to one pattern for each length of carpet.

G.P.'s	For carpet	$21\frac{1}{2}$ in.	wide	= 5.375
,,	,,	27 ,, ...	,,	= 6.75
,,	,,	36 ,, ...	,,	= 9
,,	lino	6 ft.	,,	= 18

Salary, Wages, &c.

Shillings per week ..	10 A	Shillings per day ..	4 A
£ per annum	26 B	£ per annum ..	73 B
Pence per day ..	23 A	Pence per day ..	6 A
£ per annum	35 B	Shillings per month (30 days)	15 B

Pence per hour to shillings per week. Set 12 on B to number of hours worked on A and read shillings per week on A opposite pence per hour on B.

HIDES, VALUE OF.

To find the value of hides according to their average yield in pelt found in practice.

On inverse scale set the weight of hide on B to the price in pence per lb. on A, and over the weight of pelt on B find the cost of same per lb. on A.

If certain hides are 4*d.* per lb., the cost of pelt will be as follows :—

Hides.		Pelt.	Cost of Pelt.	
80 lbs.	yield	68 lbs.	4·7*d.*	Average 4·7*d.*
74 lbs.	,,	68½ lbs.	4·32*d.*	
90 lbs.	,,	71 lbs.	5·08*d.*	

To find the relative value of hides, set the weight of pelt on B to the average cost of same (say 4·7) on A, and over the weight of hide on B find its relative value per lb. on A as follows :—

Pelt.		Hide.		
68 lbs.	from	80	relative value	4*d.*
68½ lbs.	,,	74	,, ,,	4·32*d.*
71 lbs.	,,	90	,, ,,	3·71*d.*

Averaging.

If 70 butts (leather) weigh 1960 lbs. what is the average?

Set 70 on B to 1960 lbs. on A, and the arrow on B points to the answer 28 lbs. each on A.

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Tanning Material, Value of.

If a sample of tanning material at 7/- per cwt. produces 30° of strength, what strength should another sample at 6/- per cwt. show under the same conditions to be of equal value?

Set 7 on *B* to 30° on *A*, and over 6/- on *B* read 25·7° on *A*.

Or under any degrees of strength on *A* read its comparative value in shillings on *B*.

CLOTH TRADE.

Weight of Warp or Weft.

$$\frac{\textit{Width (ins.)} \times \textit{thds. per in.} \times \textit{length (36 in. yds.)}}{840 \times \textit{counts.}}$$

Set 840 on *B* to width (ins.) on *A*. Set cursor to thds. per in. on *B*. Set counts on *B* under cursor and read weight in lbs. on *A* opposite length (yds.) on *B*.

Weight per sq. yard or sq. metre.

Set length (36 in. yds.) on *B* to weight of roll (lbs.) on A. Set cursor to g.p. on *B*. Set width (ins.) on *B* under cursor. Read weight on *A* opposite 1 on *B*.

Ozs. per sq. yd. g.p. = 576.

Grams per sq. metre g.p. = 195.

PRICE OF GOODS.

By Weight. Per		*By Measure.* Per		*By Length.* Per	
Pence .. oz. 6 *A*	Shillings lb. 8 *B*	Pence .. pt. 3 *A*	Shillings gal. 2 *B*	Pence .. in. 6 *A*	Shillings ft. 6 *B*
Shillings oz. 5 *A*	£ .. lb. 4 *B*	Pence .. pt. 2 *A*	Shillings firkin 12 *B*	Pence .. in. 1 *A*	Shillings yd. 3 *B*
Pence .. lb. 6 *A*	Shillings st. 7 *B*	Pence .. pt. 3 *A*	Shillings bush. 16 *B*	Pence .. ft. 4 *A*	Shillings yd. 1 *B*
Pence lb. 6 *A*	Shillings, qr. 14 *B*	Pence .. qt. 3 *A*	Shillings gal. 1 *B*	*By Number.*	
Pence .. lb. 7·5 *A*	Shils. cwt. 70 *B*	Pence .. qt. 3 *A*	Shillings bush. 8 *B*	Pence, each 1 *A*	Shillings, per doz. 1 *B*
Pence .. lb. 7·5 *A*	£ .. cwt. 3·5 *B*	Shillings gal 5 *A*	£ .. bush. 2 *B*	Pence, each 3 *A*	Shillings, per score 5 *B*
Shillings lb. 2·5 *A*	£ .. cwt. 14 *B*	Shillings gal. 20 *A*	£ .. bar. 36 *B*	Pence, each 3 *A*	Shillings, per 100 25 *B*
Pence .. st. 9 *A*	Shillings cwt. 6 *B*	Shillings bush. 5 *A*	£ .. qr. 2 *B*	Pence, each 5 *A*	Shillings, per gross 60 *B*
Shillings st. 5 *A*	£ .. .. cwt. 2 *B*				
Shillings st. 5 *A*	£ .. .. ton. 40 *B*				
Shillings cwt 6 *A*	£ .. .. ton 6 *B*				

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Ex.—To 3*s.* per pint on *A* set 24*s.* per gall. on *B* (*see* Table), then over any other price per gall. on *B* read price per pint on *A*.

Pence as decimal of Shilling, also Inches as decimal of Foot.

1*d.*	2*d.*	3*d.*	4*d.*	5*d.*	6*d.*	7*d.*	8*d.*	9*d.*	10*d.*	11*d.*
·083	·166	·25	·333	·416	·5	·583	·666	·75	·833	·916

EXCHANGE RATES, ETC.

To convert price of goods in foreign currency and measure to price sterling and British measure, given the rate of exchange.

Set exchange rate on scale *B* to conversion factor on scale *A*. Opposite foreign price on *B* read price sterling on *A*.

Ex.—Goods at 250 francs per kilo. Exchange rate 50. Find price £ per ton.

Set 50 on *B* to 1,015 (kilos per ton) on *A*. Opposite 250 on *B* read £ per ton on *A*.

Ans.—£50·15 = £50 3*s.* 0*d.*

Ex.—Goods at 50 cents. per sq. ft. Exchange rate 4·40 (=440 cts.) to £1. Find price £ per sq. yd.

Set 440 on *B* to 9 (sq. ft. to sq. yd.) on *A*. Opposite 50 on *B* read £ per sq. yd. on *A*.

Ans.—£1·22 = £1 4*s.* 5*d.*

SUNDRY.

Falling Bodies.

To find the distance fallen in a given time.

Set 1 on *C* to 16·1 on *A*, and over any time falling in seconds on *C* read space fallen through in ft. on *A*. Over 5 seconds on *C* read 402 ft. on *A*, and over 7 read 790 ft.

To find the velocity acquired by a falling body in ft. per second at any time during its fall.

Set 1 on *B* to 32·2 on *A*, and over any number of seconds on *B* read the velocity in ft. per second on *A*. Over the 4th second on *B* read 128 ft. on *A*, and over the 5th second 160 ft. velocity per second.

Sound.

Sound travels about 370 yds. per second, or one mile in 4·75 seconds.

Set 1 mile on *B* to 4·75 seconds on *A*, and under 9½ seconds read 2 miles on *B*, also under 19 seconds read 4 miles, &c.

Or set 370 yds. on *B* to 1 second on *A*, and under 4 seconds on *A* read 1,480 yds., and under 7 read 2,600 yds. on *B*.

Wind.

Pressure of, in lbs. per sq. ft.

Set 40 miles per hour on *C* to 6·4 lbs. per sq. ft. on *A*, and over miles per hour on *C* read lbs. per sq. ft.

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on *A*, over 50 miles per hour read 10 lbs. per sq. ft., &c.

Velocity in ft. per second = miles per hour.

Set 44 ft. per second on *B* to 30 miles per hour on *A*, and over any number of ft. per second on *B* read miles per hour on *A*.

Pendulum, Vibration of.

A pendulum 39·138 inches long will make 1 vibration per second in London.

To find the time taken by pendulums of any other length to make 1 vibration.

Set the arrow or 1 on *B* to 39·14 on *A*, and under any other length on *A* read time on *C*. Under 20″ on *A* read ·715 secs. on *C* 22″ = ·75, 30″ = ·875, 36″ = ·96, 43″ = 1·108, &c.

To find the vibration per minute. Set the time taken for 1 vibration per second on *B* (*see* above) to 60 on *A* and the arrow will point to the vibrations of pendulum per minute on *A*.

Centrifugal Force.

Set g.p. 2,933 on *B* to the weight in lbs. on *A*. Set cursor to the rev. on *C*, bring 1 on *B* to cursor, and over radius in ft. on *B* read centrifugal force in lbs. on *A*.

Ex.—Find the centrifugal force of 40 lbs. making 130 rev. per minute in a circle of 2 ft. radius.

$$F = \frac{W \text{ Rad. } R^2}{2933}$$

Set 2,933 on *B* to 40 lbs. on *A*. Now bring cursor to 130 rev. on *C*. Set 1 on *B* to cursor, and over 2 ft. on *B* read 461 lbs. centrifugal force on *A*.

Temperature.

To convert Cent. to Fah. Set 10 on *A* to 18 on *B* and add 32 to reading on *B* opposite Cent. reading on *A*.

To convert Fah. to Cent. Subtract 32 from Fah. and read Cent. on *A* opposite this figure on *B*.

FOREIGN MEASURES.

The Metric System.

This system is now adopted in Austria, Germany, Greece, Holland, Italy, Norway, Portugal, Spain, Sweden, and Switzerland.

Lineal—

Millimètres	..	63·5 *A*	Millimètres	..	76 *A*
16th inches..	..	40 *B*	Inches	..	3 *B*
Millimètres	..	63·5 *A*	Centimètres	..	76 *A*
8th inches ..	..	20 *B*	Inches	..	30 *B*

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Lineal (*con.*)—			
Mètres	12	*A*	
Feet	39·37	*B*	
Mètres	36	*A*	
Yards	39·37	*B*	
Mètres	11	*A*	
Fathoms	6	*B*	
Mètres	40·2	*A*	
Rods	8	*B*	
Kilomètres	140	*A*	
Miles	87	*B*	
Square—			
Sq. centimètres	200	*A*	
Sq. inches	31	*B*	
Sq. mètres	6·5	*A*	
,, feet	70	*B*	
Sq. mètres	71	*A*	
,, yards	85	*B*	
Cubic—			
Cub. centimètres	360	*A*	
Cubic inches	22	*B*	
Cubic mètres	1·7	*A*	
,, feet	60	*B*	
Cubic mètres	23	*A*	
,, yards	30	*B*	

Capacity—			
Litres	17	*A*	
Pints	30	*B*	
Litres	50	*A*	
Imperl. galls.	11	*B*	
Litres	290	*A*	
Bushels	8	*B*	
Weights—			
Grammes	6·48	*A*	
Grains	100	*B*	
Grammes	5·3	*A*	
Drachms	3	*B*	
Grammes	85	*A*	
Ounces	3	*B*	
Kilogrammes	2·95	*A*	
Pounds	6·5	*B*	
Kilogrammes	305	*A*	
Cwts.	6	*B*	
Kilos	60	*A*	
Tons	59	*B*	

Ex.—To 50 litres on *A* set 11 impl. galls. on *B* (*see* above), then over any number of galls. on *B* read litres on *A*, or *vice versâ*.

A few Equations which can be solved by the Calculator in one setting.

Use front face unless otherwise specified.

I $a \times b = x$

Set 1 on *B* to *a* on *A*, read *x* on *A* opposite *b* on *B*.

Another way (*back face*)—Set *a* on *A* to *b* on *B*, read *x* on *A*, opposite 1 on *B*

II $\frac{a}{b} = x$

Set *b* on *B* to *a* on *A*, read *x* on *A* opposite 1 on *B*.

Another way (*back face*)—Set 1 on *B* to *a* on *A*, read *x* on *A* opposite *b* on *B*.

III $a^2 \times b = x$

Set *a* on *C* to 1 on *A*, and under *b* on *A* read *x* on *B*.

IV $a \times b \times c = x$

On back face set *a* on *B* to *b* on *A*, and on *front face* under *c* on *A* read *x* on *B*.

V $\frac{b}{a^2} = x$

Set *a* on *C* to *b* on *A*, and over 1 on *B* read *x* on *A*

VI $\sqrt{a^3 \times b} = x$

On back face set *a* on *C* to *b* on *A*, and on *front face* under 1 on *A* read *x* on *C*.

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VII $\dfrac{a \times b}{c} = x$

Set c on B to a on A, read x on A opposite b on B.

Another way (back face).—Set a on B to b on A, and under c on A read x on B.

VIII $\dfrac{a \times b^2}{c} = x$

Set b on C to c on A, and under a on A read x on B.

IX $\left(\dfrac{a}{b}\right)^2 = x$

Set b on B to a on A, and over 1 on B find quotient on A and over same number on B, read x on A (or over same number on C, read x on B).

X $(a \times b)^2 = x$

Set 1 on B to a on A and over b on B find product, and over same number on C read x on B.

XI $\dfrac{a^3}{b} = x$

On back face set a on C to 1 on A, and under b on A read x on B.

XII $\sqrt{a} = x$

Under a on B read x on C.

XIII $\sqrt{a} = x$

On back face under a on B read x on C.

XIV $\sqrt{\dfrac{a}{b}} = x$

Set a on B to b on A, and under 1 on A read x on C.

XV $\sqrt[3]{\dfrac{a}{b}} = x$

On back face set a on B to 1 on A, and under b on A read dividend on B, and the root or x on C.

XVI $\sqrt{a \times b \times c} = x$

On back face set a on B to b on A, and on *front face* under c on A read x on C.

XVII $\sqrt{a^2 \times b} = x$

Set a on C to 1 on A, and under b on A read x on C.

XVIII $\sqrt[3]{a \times b} = x$

On back face set a on B to b on A, and under 1 on A read x on C.

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XIX $\sqrt{a \times b} = x$

Set a on B to 1 on A, and under b on A read x on C.

XX $\sqrt{\frac{a \times b}{c}} = x$

On back face set a on B to b on A, and under c on A find dividend on B and under same number on B *front face* read x on C.

XXI $\sqrt[3]{\frac{a \times b}{c}} = x$

On back face set a on B to b on A and under c on A read x on C.

XXII $\sqrt[3]{\frac{a^2}{b}} = x$

Set a on C to b on A, and *on back face* under 1 on A read x on C.

XXIII $\frac{a\sqrt{b}}{c} = x$

Under b on B find the root, then *on back face* set this number on B to a on A, and under c on A read x on B.

XXIV **Quadratic** (*back face*).

$$Ex.—X^2 \pm 4X = +21$$

Set 1 on B to 21 on A. Read the roots where the *difference* of the figures on A and $B = 4$.
The roots are $+7$ and -3, or -7 and $+3$.

$$Ex.—X \pm 5X = -6.$$

Set 1 on B to 6 on A. Read the roots where the *sum* of the figures on A and $B = 5$.
The roots are -3 and -2 or $+3$ and $+2$.

Note.—If the R.H. side is + the roots will have opposite signs and the *difference* must be taken in reading the "Calculex" The sign of the *lesser* is the same as that of the co-efficient of "*X*." If the R.H. side is − the roots will have like signs, either both + or both −, hence the *sum* is taken in reading the "Calculex." The sign is *opposite* to the co-efficient of "*X*."

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To find the price per foot of Timber from the price per standard.

Set 99 on *B* to price in pounds per standard on *A* and over area in square inches on *B* read price per foot in pence on *A*.

Ex.—Find the price per foot of 9 × 3 timber at £22 per standard.

Set 99 on *B* to £22 on *A* and over 27 square inches on *B* read 6*d*. per foot on *A*.

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Neg. b. Metrics - Reverse
1 Bon 3.

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