PROPORTION

14. Rule 1.—Set the first term on index to the second term on A. or B., then the third term on index will shew the fourth term or answer on A. or B., according as A. or B. has been used.

Rule 2.—Set the second term on index to the first term on A. or B., then the third term on A. or B. will shew the fourth term or answer on index.

Note.—The first and third are generally taken on the same side, as are also the second and fourth.

Ex. 1.—If 3 yards of cloth cost 4 shillings, what will 9 yards cost?

This may be stated either of the two following ways:—

Yds.		Sh.		Yds.		Sh.
3	:	4	: :	9	:	12
Yds.		Yds.		Sh.		Sh.
3	:	9	: :	4	:	12

Then, by the first rule, set 3 on index to 4 on A. or B., then 9 on index will shew 12 on A. or B.

Or, set 3 on index to 9 on A. or B., then 4 on index will shew 12 on A. or B.

By Rule 2, set 4 on index to 3 on side A. or B., then 9 on side A. or B. shews 12 on index.

Or, set 9 on index to 3 on A. or B., and 4 on A. or B. shews 12 on index.

Ex. 2.—If 14 men perform a piece of work in 6 days, in what time will 24 men perform it?

Here the statement is:—

24 : 14 : : 6 : $3\frac{1}{2}$ days.

Set 24 on index to 14 on A. or B., then 6 on index will shew $3\frac{1}{2}$ on A. or B.

Or, by Rule 2, set 14 on index to 24 on A. or B., then 6 on A. or B. shews $3\frac{1}{2}$ on index.

15. When remainders or fractions occur, their values may be read on the scale, by an expert operator, with almost perfect accuracy. By persons unacquainted with the scale, however, recourse must be had, either to the diagonal on side B. for decimals, or in the following manner for regular fractions:

Set the index one division down on the perpendicular of the divisor (the first term in proportion) on A.; take the remainder on a pair of dividers, move the dividers along the index from the pivot towards side B. till they exactly coincide with the space between the index and side A., then will side A. shew the numerator of the regular fraction.

Ex. 1.—Divide 700 by 9.

Set 100 on index to 9 on A., then 700 on A. will shew on index 77 with a remainder.

To find the value of the remainder, take the remainder on dividers and set the index one division below 9 on A.; then if the dividers be moved along the index, it will be found to coincide with the space between the index and side A. at 7, which is therefore the numerator of the fraction, and hence the quotient is 77 7-9.

If the same extent on the dividers be applied to the space between side B. and the diagonal, it will be found to coincide at 77, and the whole length of B. being 100, this number will be 77-100 or .77, and in this case, therefore, the quotient is 77.77 +.

The small diagonal between the third and fourth divisions on D. may be employed in the same manner.

SIMPLE INTEREST.

16. To calculate the interest of any principal, at any rate per cent.. for one year.

Rule.—Set 100 on index to the rate per cent. on A. or B., then opposite the principal on index is the answer on A. or B.

Note.—If the large divisions on the scale be assumed as £1, each of the smaller divisions will become one-tenth or 2 shillings.

Ex.—What is the interest of £80 for one year, at 6 per cent.?

Set 100 on index to 6 on A. or B., then opposite 80 on index is £4 16s. on A. or B., that is four large divisions, each £1, and eight small divisions, each two shillings.

As interest, partnership, profit and loss, discount, commission and brokerage, &c., are simply variations of the Rule of Three, the learner will have no difficulty in solving any problems in them, with the aid of the rules given in Article 14. Duodecimals can be performed by the rule given in Article 11.

EXTRACTION OF SQUARE ROOT.

17. The square root of a number is that number which, multiplied by itself, gives the proposed number.

Rule.—Let the number, whose root is required, be taken on A. or B., and let £100 on index be set to a trial divisor on A. or B.; then, if the trial divisor or index show the given number on A. or B., the trial divisor is the root required: if not, vary the trial divisor by moving the index either way, according as the trial divisor shows a result greater or less than the given number; and continue this until the trial divisor taken on index show the given number on A. or B.

Ex.—Required the square root of 600?

If 20 be assumed as a trial divisor, set 100 on index to 20 on A., then 20 on index shows only 400 on A., which is less than the given number 600; hence the trial divisor 20 is less than the root required. If 30 be assumed, A. will be found to be greater than the root required: hence the root must lie between 20 and 30. By moving the index, the operator will find that, when 100 on index is set to 24.5 nearly, or 24.49 on A., 24.49 on index will shew 600 on A.

Note.—The square root of any number, not exceeding 1000, is extracted more conveniently on side B. than A.

EXTRACTION OF THE CUBE ROOT.

18. Rule.—Set 100 on index to trial divisor, or assumed root on A. or B., then opposite trial divisor on index is its square on A. or B., and opposite this square taken on index is the given number on A. or B., if the assumed root be the correct one: if otherwise, the index must be moved, as in square root until the correct root be found. When the index is set for any trial root it is not necessary to move it until the correctness or incorrectness of the trial root is determined.

Ex.—Required the cube root of 46,000.

Here the given number can be divided only into two periods, hence there can be only two figures and a decimal fraction in the root. The cube root of the first period 46 is 3 +. 100 on index, therefore, must be set to a number between 3 and 4.

Let it be set on index to 35 on A., and 35 on index will shew 1225 on A., and 1225 on index will shew nearly 43,000 on A., which is less than the given number. Hence 35 is less than the required root. By a similar process 36 will be found to be greater. The correct root must therefore lie between 35 and 36, and by setting 100 on index to 35.8, and proceeding as before, the result is found to be 46,000 nearly. Hence 35.8 is nearly the root required.

PART II.

PLANE TRIGONOMETRY.

Remarks, &c.

19. The lines joining the corresponding divisions on the opposite sides, D. and B., are called *parallels*, in order to distinguish them from those joining A. and C., which are called *perpendiculars*.

20. The perpendicular on the 60th division, being a tangent to the arc, is called a line of tangents; and whenever the word "tangent" is used in the rules for calculation, it must be understood to mean some portion of this line.

21. The perpendicular from any degree on the quadrant to side A., is the sine of that degree, and its numerical value to radius 60 is reckoned on B.; the parallel on side D. is the cosine, and its numerical value is reckoned on A.; and if the index be set to any degree on the quadrant its intersection with the line of tangents will show, on the index, the numerical value of the secant, and on the line of tangents, the numerical value of the tangent to the same radius 60. These values being divided by 60 give the natural sines, cosines, &c.

22. If 100 or 1 on side A. or index be considered as radius, and a quadrant conceived to be described from 100 on A. to 100 on D., the side B. becomes the tangent to the arc which was conceived to be thus formed, and by placing the index to any degree on the quadrant, the perpendicular from 100 or 1 on index to side A. will be the natural sine of that degree; the parallel on side D. the natural cosine, and the intersection of index with side B. will show on index the natural secant, and on side B. the natural tangent.

23. If the natural tangent of any degree above 59° be required, it will be necessary to use the semi or quarter tangent as found on the perpendiculars of 30 and 15 respectively.

24. In the solution of problems by the scale, when the words sines, cosines, tangents, cotangents, &c., are used, they must be understood to mean their numerical values to radius 60.

25. The division of radius into sixty equal parts agrees with the division of a degree of longitude on the equator into sixty minutes; and thus affords an easy way of finding the length of a degree of longitude in any parallel of latitude. The parallel from any degree on the quadrant to side D. will be the length of a degree of longitude in the parallel of that degree. For example, the length of a degree of longitude in the parallel of 30° is the measure from 30° on quadrant to side D., which being reckoned on side A. shows 52, which is the length of a degree of longitude in the parallel of 30°.

26. The meridional difference of latitude can be readily found without the aid of any tables. Thus, set the index to middle latitude on quadrant, and the intersection of the tangent with the index shows on the index the length of a meridional degree in that parallel (assuming the middle of the degree as the parallel); and if this be multiplied by the difference of latitude, in degrees, the product is the meridional difference of latitude.

27. The principles on which the calculations in Trigonometry are founded, are certain relations or proportions existing between the sides of triangles and certain lines connected with the angles, called *trigonometrical lines or ratios*, and the principles on which the use of the scale, in Trigonometry, is based, may be thus explained:—

Let A B C be a triangle, and let D E or any other line be drawn parallel to B C, one of the sides of the triangle; then A C : A B : A D or A E : A C = A D : A B. See figure 1.

Now, by means of the index, an indefinite number of triangles, with lines parallel to some of the sides, can be formed; and hence an indefinite number of proportions.

RIGHT ANGLED TRIGONOMETRY.

Definitions and Principles.

28. Every triangle consists of six parts, viz., three sides and three angles; and when any three of these are given, unless it be the three angles, the other three can be found.

29. The sum of the three angles of any plane triangle is equal to two right angles or 180°.

30. The greatest side of every triangle is opposite to the greatest angle.

31. The complement of an arc is its difference from a quadrant.

32. The supplement of an arc is its difference from a semicircle.

33. The complement of an angle is its difference from a right angle.

34. The supplement of an angle is its difference from two right angles.

35. The sine of an arc is a straight line drawn from one extremity of the arc, perpendicular, to the radius passing through the other extremity.

36. The tangent of an arc is a straight line touching the arc