HOW TO USE the

Pickett 400 BUSINESS

POCKET SLIDE RULE

by

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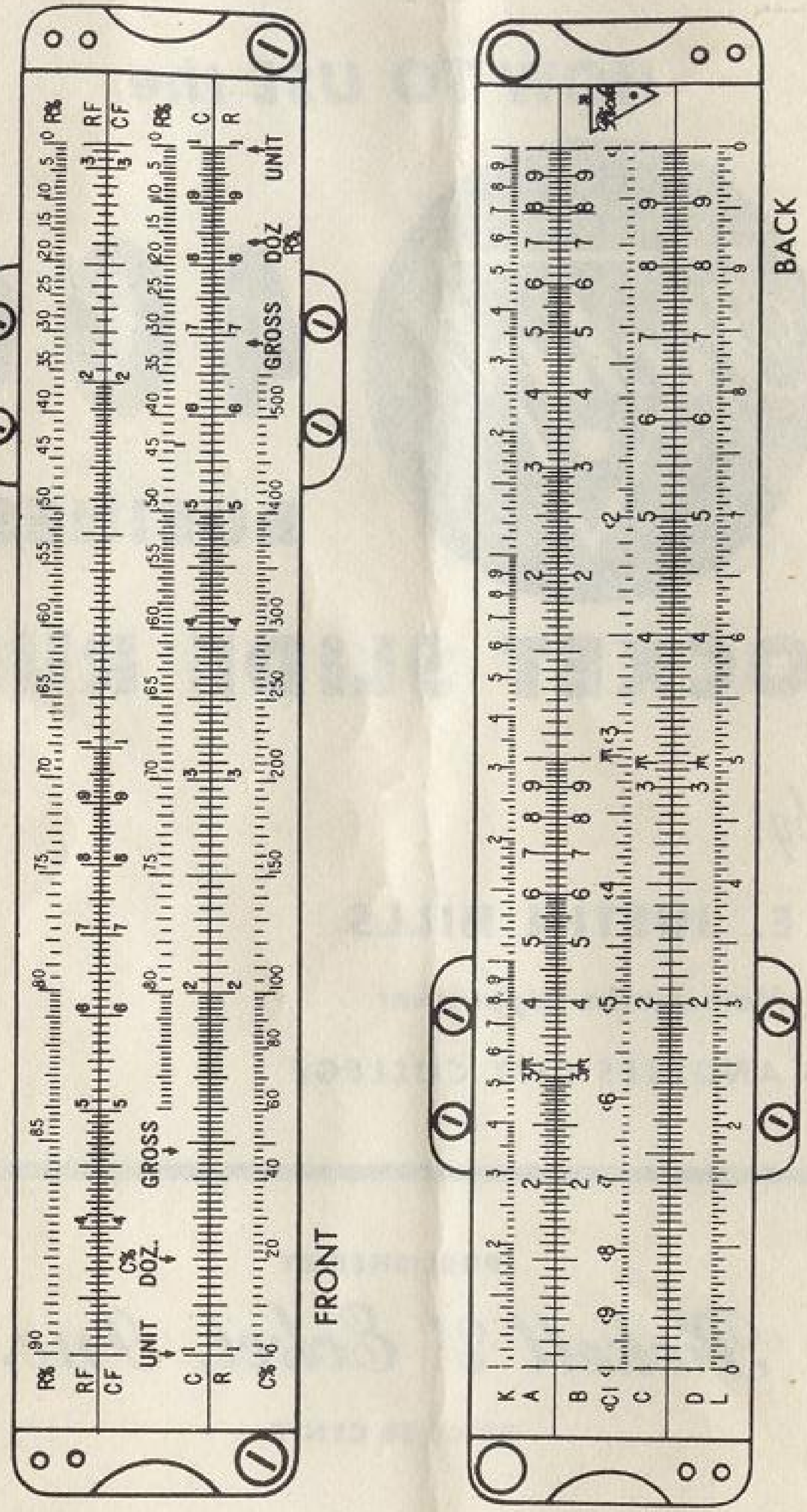

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GENERAL INFORMATION

The business rule is a mechanical device used to simplify computations. On it are number scales that can be used in solving many everyday problems met in business and merchandising.

Who Should Use The Rule

This rule should be a great service to merchants, accountants, buyers, sales people, and others who are interested in business procedures. Realtors, estimators, bankers, etc., will also find much use for the rule.

What Kinds Of Problems Can Be Solved

On the "front" side of the rule, problems pertaining to markup or markdown from cost to retail, are easily solved without having to understand how the instrument produces the result. On either side of the rule the following problems can be solved: (1) Simple interest and discount; (2) Pay rolls; (3) Pro-rating accounts; (4) Tax assessing; (5) Exchange of money; (6) Determining business ratios; (7) Conversion of weights and measures both foreign and domestic; (8) Maintained markup analysis; and other problems. It can also be used in solving ordinary problems of multiplication, division, proportion, squares and square roots, cubes and cube roots, logarithms, and other ordinary calculations.

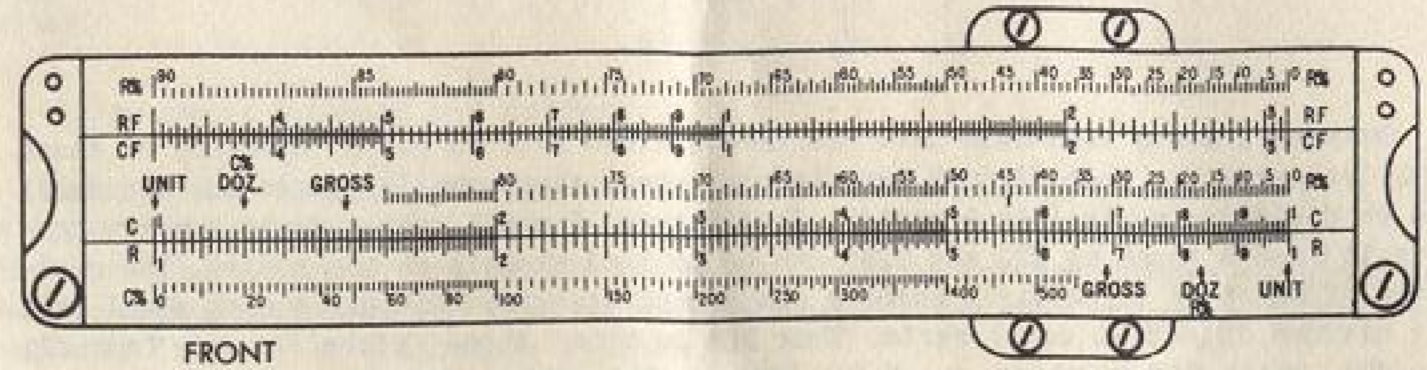
What Mathematical Background Is Needed

The only requirement needed to use the rule is an elementary knowledge of mathematics and some practice. Do not be overawed by the multiplicity of lines and figures, because, as you will soon see the reading and use of each of the scales can be learned easily. The slide rule is not an instrument for mathematicians only. No matter what your background has been, if computation of any kind is needed in your work or study, a slide rule can be a real help to you.

In the pages that follow, a detailed analysis of the uses of the business and merchandising rule is given. Part I shows how to use the scales on the "front" of the rule. These are the easiest scales to learn how to use. They have been numbered in such a way that they are easily read and the use of the scales is easily understood.

Part II considers the use of the scales on the back of the rule. They are the standard scales that appear on an ordinary slide rule. Many practical problems met in business will be considered. Most of the problems considered can be solved on both sides of the rule.

PART I MARKUP INTRODUCTION



The following operations can be done quickly and easily with the scales which are on the front face of the rule.

GIVEN	*TO FIND*
1. Cost and retail price	1. Cost or retail markup
2. Cost or retail and retail markup	2. Retail or cost
3. Cost or retail and cost markup	3. Retail or cost

In 2 and 3 cost can be per unit, per dozen, or per gross, while the retail is per unit.

The Slide Rule Itself

The slide rule consists of three parts: (1) the stock; (2) the slide; and (3) the indicator. On the stock and the slide there are several number scales.

Each scale on the front side of the rule is named by a letter that applies to business. The two basic scales are C (Cost) and R (Retail). The other scales are RF (Retail Folded), CF (Cost Folded), R% (Retail markup per cent), C% (Cost markup per cent). The following diagram shows how these scales are related to each other:

COST (C)	*MARKUP (M)*
RETAIL (R)	

$$\frac{M}{C} = C\% \qquad \frac{M}{R} = R\%$$

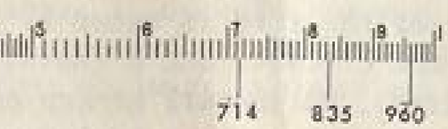
How To Read The Scales

In order to use the slide rule, a computer must know how to read the scales. On the front side of the rule, the basic scales, C and R, which are exactly alike, are divided into nine main parts. These main parts are shown in the following figure. Note that these parts are not of equal length. Those at the left end are longer than those at the right end.

Each part has been divided into many smaller parts by fine lines. The first part (between 1 and 2) has been divided into 10 parts; then each of these smaller parts has been divided into five parts. The position of *even* numbers of three digits can be located exactly on the scales, and odd numbers of three digits can be located at about the halfway positions between them. Thus the positions of three-digit numbers, such as 116, 138, 165, and 189, can be easily located on the scale.

Between 2 and 5 each main part has been divided into 10 parts; then each of these smaller parts has been divided into 2 parts (since these smaller parts are too small to be divided clearly into 5 parts). Thus between 2 and 5, three digit numbers ending in 0 and 5 (such as 220 and 225) can be located exactly on the scales. The position of the other three digit numbers can be approximated by assuming each small part is divided into five equal parts. Thus 223 is about three fifths the way from 220 to 225, while 386 is about one fifth the way from 385 to 390. After a little practice this is a very simple thing to do. Note also the position of such numbers as 214, 227, 259, and 278.

Between 5 and 1 (right end of the C and R scales) each main part has first been divided into 10 parts. But since the space is now too small for other divisions we assume that each space is divided into ten equal parts. Thus 625 is about half way from 620 to 630. 628 is about eight tenths of the way from 620 to 630. Note also the position of such numbers as 714, 835, and 960.



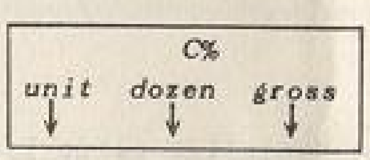
The CF and RF scales are also exactly alike. The 1 position is about in the middle of the scales. Each scale is a C or R scale "folded" so that the two 1 positions are at the same point.

The C% scale along the bottom edge of the rule is the same as the R scale except that a new set of numbers has been assigned to the lines. The position 1 on R is 0 (actually 0%) on C%, the position 120 on R is 20 (actually 20%) on C%, and so on.

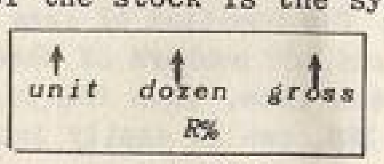
The two R% scales, one on the stock and one on the slide, are the same as the R and C scales except that a new set of numbers has been assigned to the lines. The position 1 (at the right end) of C and R is 0 (actually 0%) on R%, 950 on C and R is 5 (actually 5%) on R%, and so on.

Note that the values on the R% scales increase from the *right end* toward the *left end*, while the values on the C% scale increase from the *left end* toward the *right end*.

There are two symbols on the rule that are important in markup problems. On the left part of the slide is the symbol



and on the right part of the stock is the symbol



When the slide is moved or "set" the symbol at the left end points at a value on the C% scale, and the symbol at the right end points at a value on the R% scale on the slide.

Approximate Numbers and Answers

Every number is made up of digits. The number 34 is made up of two digits, 3 and 4. The value $3.84 is a three digit number. In many computations only the first three or four digits of the result are needed. This is because numbers obtained by measurement are approximate numbers. No measurement, even when the smallest measuring unit is used, is absolutely accurate.

On the slide rule we use approximate numbers of three digits. Numbers are "rounded off" to three digits. For example, the amount $38.22 will be "rounded off" to read $38.20. In most computations, as we shall see, such an approximate number is accurate enough for practical purposes.

In any problem solved on the slide rule, approximate three-digit numbers will be used and a three-digit answer will be accepted. That is, the answer to a problem will not have any greater degree of accuracy than the given data. For example, $25.82 times 32.88 becomes $25.80 x 32.9 = $849. (The exact answer is $848.9616.)

In locating any three digit number on a slide rule scale, the position of the decimal point is disregarded. Thus $25.80 is merely thought of as "two-five-eight". The decimal point position in an answer is determined by estimating the answer, as will be shown soon.

PROPORTION

No matter where the slide is set, numbers opposite each other on the C and R scales as well as those on the CF and RF scales will form a proportion. For example, when 1 on the C scale is put over 2 on the R scale, then 2 on the C scale is over 4 on the R scale, and 3 on the C scale is over 6 on the R scale, and 6 on the CF scale is under 12 on the RF scale, etc. Since $\frac{1}{2} = \frac{2}{4} = \frac{3}{6} = \frac{6}{12}$ etc., "1 is to 2 as 2 is to 4" etc., we see that the setting automatically gives many proportions.

Using the C, R, CF and RF Scales

If any number on C is put over any other number on R, then any third value on C is over the corresponding fourth value on R which will complete a proportion.

Also, if any number on CF is put under any other numberoon RF, then any third value on CF is under the corresponding fourth value on RF which will complete a proportion.

Illustrations: Find the values of X, Y, and Z in

$$\frac{3.84}{5.27} = \frac{5.83}{X} = \frac{Y}{31.4} = \frac{8.27}{Z}$$

Solution for X: By the use of the indicator, put 384 on C over 527 on R. Find X (800) on R under 583 on C. Therefore X = 8.00. That is, 3.84 is to 5.27 as 5.83 is to 8.00.

Solution for Y: With the same setting of the slide (384) on C over 527 on R), find Y (229) on C over 314 on R. Therefore Y = 22.9. That is, 3.84 is to 5.27 as 22.9 is to 31.4.

Solution for Z: With 384 on C over 527 on R, find Z (113) on RF over 827 on CF. Note that it was necessary to go to the CF scale since 827 on C was beyond the range of the R scale. Therefore Z = 11.3. That is, 3.84 is to 5.27 as 8.27 is to 11.3. Further discussion of proportion will be found in Part II.

Location Of The Decimal Point In The Answer

The location of the decimal point in the answer is determined by estimating. In the above illustrations, note that since 3.84 is about two-thirds of 5.27, then 5.83 must be about two-thirds of X, or 8.00, Y must be about two-thirds of 31.4 or 22.9, and 8.27 must be about two-thirds of Z, or 11.3. More help in locating the decimal point will be found in Part II.

SIX TYPES OF MARKUP PROBLEMS

There are six types of problems met in business transactions that pertain to markup. Any business concern is in existence to earn a profit. Articles that cost a certain amount per unit, per dozen, or per gross, will retail at some higher unit amount depending on the markup needed to make a success of the business.

There are four numbers involved in any markup problem:

Cost Price, per unit, per dozen, or per gross, indicated by C.

Retail Price, per unit, indicated by R.

Per cent Markup based on Cost, indicated by C%.

Per cent Markup based on Retail, indicated by R%.

Depending upon which of these is known, make *one* of the following settings of the slide.

(1) Cost on C scale opposite Retail on R scale. Cost can be in units, per dozen, or per gross.

(2) [C%: Unit dozen gross ↓ ↓ ↓] opposite per cent markup of Cost on C% scale.

(3) Per cent markup of Retail on R% scale opposite [↑ ↑ ↑ unit dozen gross R%]

Then each of the other two sentences tells how to find an unknown number:

In the illustrations that follow cost % per unit will be denoted by C%u; cost % per dozen by C%d; cost % per gross by C%g. In like manner we will use R%u, R%d, R%g.

1. Cost and Retail known, to find per cent markup on cost or on retail.

   Unit cost $120; retail $180

   Put 120 on C over 180 on R. By the use of the indicator below C%u read 50% on C%, and over R%u read 33.3% on R%.

   Therefore: If the unit cost is $120 and the unit retail is $180, the per cent markup on retail is 33.3%.

   Cost per dozen $120; retail per unit $18.

   Put 120 on C over 180 on R. By the use of the indicator, below C%d read 80 on C%, and over R%d read 44.5 on R%.

   Therefore: If the cost per dozen is $120 and the unit retail is $18, the per cent markup on cost is 80% and the per cent markup on retail is 44.5%.

2. Cost of an article and retail markup per cent known, to find the retail.

   Unit cost 80¢; retail markup 60%

   Put 60 on R% over R%u. Opposite 80 on CF read 20 on RF.

   Therefore: If the unit cost is 80¢ and the retail markup is 60%, the unit retail is $2.00. Or, if the cost per dozen is 80¢ and the retail markup is 60%, the retail per dozen is $2.00. Or, if the cost per gross is 80¢ and the retail markup is 60%, the retail per gross is $2.00.

   Cost per dizen $12.50; retail markup 40%

   Put 40 on R% over R%d. Opposite 125 on C, read 174 on R.

   Therefore: If the cost per dozen is $12.50 and the retail markup is 40%, the unit retail is $1.74.

   Cost per gross $4.50; retail markup 37.5%

   Put 37.5 on R%g. Opposite 450 on C, read 50 on R.

   Therefore: If the cost per gross is $4.50 and the retail markup is 37.5%, the unit retail is 5 cents.

3. Cost of an article and cost markup per cent known, to find the retail.

   Unit cost 75¢; cost markup 33.3%

   Put C%u over 33.3 on C%. Opposite 75 on C, read 10 on R.

   Therefore: If the unit cost is 75¢ and the cost markup is 33.3%, the retail is $1.00. Or, if the cost per dozen is 75¢ and the cost markup is 33.3%, the retail per dozen is $1.00. Or, if the cost per gross is 75¢ and the cost markup is 33.3%, the retail per gross is $1.00.

   Cost per dozen $12.50; cost markup 70%

   Put C%d over 70 on C%. Opposite 125 on C read 177 on R.

   Therefore: If the cost per dozen is $12.50 and the cost markup is 70%, the unit retail is $1.77.

   Cost per gross $4.50; cost markup 60%

   Put 60 on C% under C%g. Opposite 45 on C read 50 on R.

   Therefore: If the cost per gross is $4.50 and the cost markup is 60%, the unit retail is 5 cents.

4. Retail of an article and retail markup per cent known, to find the cost.

   Retail $22; retail markup 45%

   Put 45 on R%, over R%u. Opposite 22 on R read 121 on C.

   Therefore: If the retail is $22 and the retail markup is 45%, the cost is $12.10

   If you want the cost per dozen, put 45 on R% over R%d. Opposite 22 on R read 145 on R.

   Therefore: If the retail is $22 and the retail markup is 45%, the cost per dozen is $145. In like manner, the cost per gross is $1744.

5. Retail of an article and cost markup per cent known, to find the cost.

   Retail $8; cost markup 66.7%

   Put C%u over 66.7 on C%. Opposite 80 on R read 48 on C.

   Therefore: If the retail is $8 and the cost markup is 66.7%, the cost is $4.80. Or, put C%d over 66.7 on C% and read the cost per dozen, namely $57.60. Or, put C%g over 66.7 on C% and read the cost per gross, namely $691.

6. Cost markup per cent known, to find the retail markup per cent, and vice versa.

Retail markup 75%.
Put 75 on R% over R%u. Under C%u read 300 on C%.
Therefore: If the retail markup is 75%, the cost markup is 300%; or, if the cost markup is 300%, the retail markup is 75%.

SERIES DISCOUNTS

It is often necessary to find a single trade discount equivalent to a series of trade discounts, where each successive discount is computed on the net price after the preceding discount has been deducted.

Illustration: Find a single discount equivalent to discounts of 25%, 18%, and 8%.

To solve the problem, use the two R% scales, one on the upper stock and one on the slide. Put the indicator over 25 on the R% scale on the stock. Put the right end of the R% scale on the slide under the indicator. Move the indicator to 18 on the R% scale on the slide. Put the right end of the R% scale on the slide under the indicator. Put the indicator over 8 on the R% scale on the slide and read the answer (43.5%) on the R% scale on the stock. Now take the series of trade discounts in the reverse order and show that the answer is the same.

Having determined the single trade discount equivalent to a series of trade discounts, or having a single trade discount, determine the net cost by assuming this single trade discount is the retail markup per cent.

Illustration: What is the net cost of an article listed at $45 less discounts of 25%, 18%, and 8%?

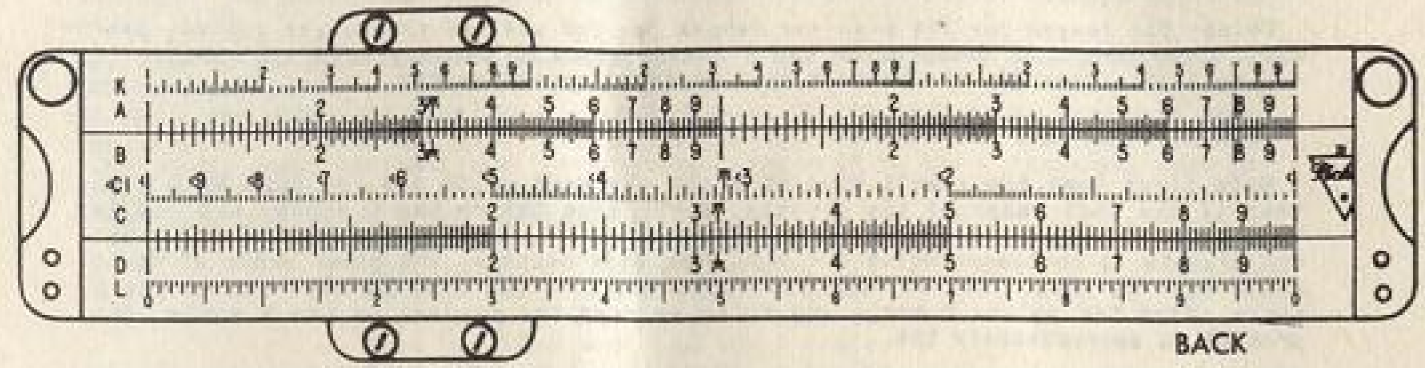
Since discounts of 25%, 18%, and 8% is equivalent to a single discount of 43.5%, put 43.5 on R% over R%u. Opposite 45 on R read 254 on C.
Therefore: If the list price of an article is $45 and the single trade discount is 43.5%, the net cost is $25.40.

The R% scale on the slide can also be used to determine the net amount of a bill if a *cash discount* is allowed. Such a discount is stated somewhat as follows: Terms 3/10 n/30. This means that a 3% discount is allowed on the price of merchandise if payment is made within 10 days; n/30 indicates that net, or full price, must be paid within 30 days.

Illustration: An invoice dated April 24, for $483, Terms 3/10n/30 is paid on May 1. Find the net amount of payment.

Put 3 on R% over R%u. Opposite 483 on R read 468 on C.
Therefore: If the cash discount allowed is 3% and the invoice is for $483, the net amount of payment is $468.

PART II USE OF THE SCALES ON BACK OF RULE



MULTIPLICATION

Numbers that are to be multiplied are called factors. The result is called the product. Thus, in the statement 6 x 7 = 42, the numbers 6 and 7 are factors, and 42 is the product.

EXAMPLE: Multiply 2 x 3

Setting the Scales: Set the left index of the C scale on 2 of the D scale. Find 3 on the C scale, and below it read the product, 6 on the D scale.
Think: The length for 2 plus the length for 3 will be the length for the product. This length, measured by the D scale, is 6.

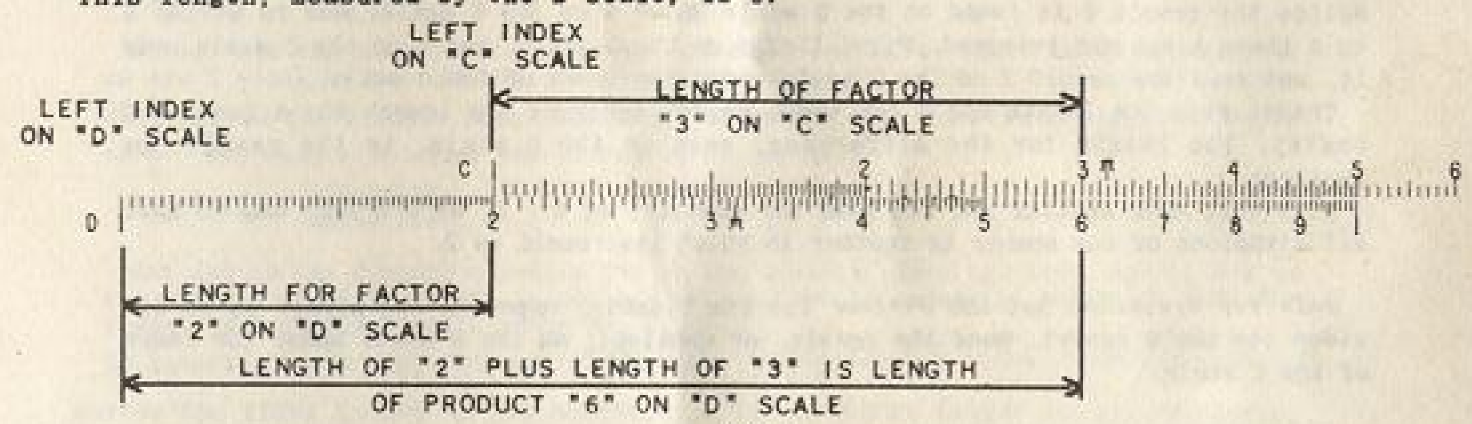


Fig.5

EXAMPLE: Multiply 4 x 2

Setting the Scales: Set the left index of the C scale on 4 of the D scale. Find 2 on the C scale, and below it read the product, 8, on the D scale.
Think: The length for 4 plus the length for 2 will be the length for the product. This length, measured by the D scale, is 8.

Rule for Multiplication: **Over one of the factors on the D scale, set the index of the C scale.* Locate the other factor on the C scale, and directly below it read the product on the D scale.**

*This may be either the left or the right index, depending upon which one must be used in order to have the other factor (on the C scale) located over the D scale. If the 'other factor' falls outside the D scale, the 'other index' is used.

EXAMPLE: Multiply 2.34 x 36.8

Estimate the result: First note that the result will be roughly the same as 2 x 40, or 80: that is, there will be two digits to the left of the decimal point. Hence, we can ignore the decimal points for the present and multiply as though the problem was 234 x 368.

Set the Scales: Set the left index of the C scale on 234 of the D scale. Find 368 on the C scale and read product 861 on the D scale.

Think: The length for 234 plus the length for 368 will be the length for the product. This length is measured on the D scale. Since we already knew the result was somewhere near 80, the product must be 86.1, approximately.

EXAMPLE: Multiply 28.3 x 5.46

Note first that the result will be about the same as 30 x 5, or 150. Note also that if the left index of the C scale is set over 283 on the D scale, and 546 is then found on the C scale, the slide projects so far to the right of the rule that the D scale is no longer below the 546. When this happens, the other index of the C scale must be used. That is, set the *right* index on the C scale over 283 on the D scale. Find 546 on the C scale and below it read the product on the D scale. The product is approximately 154.

These examples illustrate how in simple problems the decimal point can be placed by use of an estimate.

PROBLEMS	ANSWERS
1. 15 x 3.7	55.5
2. 280 x 0.34	95.2
3. 753 x 89.1	67,100
4. 9.54 x 16.7	159.5
5. 0.0215 x 3.79	0.0815

DIVISION

In mathematics, division is the opposite or *inverse* operation of multiplication. In using a slide rule this means that the process for multiplication is reversed. To help in understanding this statement, set the rule to multiply 2 X 4
Notice the result 8 is found on the D scale under 4 on the C scale. Now to divide 8 by 4 these steps are reversed. First find 8 on the D scale, set 4 on the C scale over it, and read the result 2 on the D scale under the index of the C scale.

Think: From the length for 8 (on the D scale) *subtract* the length for 4 (on the C scale). The length for the difference, read on the D scale, is the result, or quotient.

With this same setting you can read the quotient of 6 ÷ 3, or 9 ÷ 4.5, and in fact all divisions of one number by another in which the result is 2.

***Rule for Division:* Set the *divisor* (on the C scale) opposite the number to be divided (on the D scale). Read the result, or quotient, on the D scale under the index of the C scale.**

EXAMPLES:

(a) Find 63.4 ÷ 3.29. The quotient must be near 20, since 60 ÷ 3 = 20. Set indicator on 63.4 of the D scale. Move the slide until 3.29 of the C scale is under the hairline. Read the result 19.3 on the D scale at the C index.

(b) Find 26.4 ÷ 47.7. Since 26.4 is near 25, and 47.7 is near 50, the quotient must be roughly 25/50 = ½ = 0.5. Set 47.7 of C opposite 26.4 of D, using the indicator to aid the eyes. Read 0.553 on the D scale at the C index.

PROBLEMS	ANSWERS
1. 83 ÷ 7	11.85
2. 75 ÷ 92	0.815
3. 137 ÷ 513	0.267
4. 17.3 ÷ 231	0.0749
5. 8570 ÷ .0219	391,000

CONTINUED PRODUCTS

Sometimes the product of three or more numbers must be found. These "continued" products are easy to get on the slide rule.

EXAMPLE: Multiply 38.2 X 1.65 X 8.9

Estimate the result as follows: 40 X 1 X 10 = 400. The result should be, very roughly, 400.

Setting the Scales: Set left index of the C scale over 382 on the D scale. Find 165 on the C scale, and *set the hairline* on the indicator on it.* Move the index on the slide under the hairline. In this example if the *left* index is placed under the hairline, then 89 on the C scale falls outside the D scale. Therefore move the *right* index under the hairline. Move the hairline to 89 on the C scale and read the result (561) under it on the D scale.

Below is a general rule for continued products: a x b x c x d x e ....

Set hairline of indicator at a on D scale.
Move index of C under hairline.
Move hairline over b on the C scale.
Move index of C scale under hairline.
Move hairline over c on the C scale.
Move index of C scale under hairline.

Continue moving hairline and index alternately until all numbers have been set. Read result under the hairline on the D scale.

PROBLEMS	ANSWERS
1. 2.9 x 3.4 x 7.5	73.9
2. 17.3 x 43 x 9.2	6,840
3. 343 x 91.5 x 0.00532	167
4. 19 x 407 x 0.0021	16.25
5. 13.5 x 709 x 0.567 x 0.97	5260

COMBINED MULTIPLICATION AND DIVISION

Many problems call for both multiplication and division.

EXAMPLE: $\frac{42 \times 37}{65}$

First, set the division of 42 by 65; that is, set 65 on the C scale opposite 42 on the D scale.** Move the hairline on indicator to 37 on the C scale. Read the result 239 on the D scale under the hairline. Since the fraction $\frac{42}{65}$ is about equal to $\frac{2}{3}$, the result is about two-thirds of 37, or 23.9

EXAMPLE: $\frac{273 \times 548}{692 \times 344}$

Set 692 on the C scale opposite 273 on the D scale. Move the hairline to 548 on the C scale. Move the slide to set 344 on the C scale under the hairline. Read the result .628 on the D scale under the C index.

In general, to do computations of the type $\frac{a \times c \times e \times g \ldots\ldots}{b \times d \times f \times h \ldots\ldots}$, set the rule to divide the first factor in the numerator a by the first factor in denominator b, move the hairline to the next factor in the numerator c; move the slide to set next factor in denominator d, under the hairline. Continue moving hairline and slide alternately for other factors, (e, f, g, h, etc.). Read the result on the D scale.

If the last operation is one of multiplication, the answer is found under the hairline. If the last operation is one of division, the answer is found on the C scale index. Observe that this procedure requires that one locate the factor *a* on the D scale and find all other values on the C scale, excepting the answer, which is found on the D scale. Sometimes the slide must be moved so that one index replaces the other.***

*The product of 382 X 165 could now be read under the hairline on the D scale, but this is not necessary.

**The quotient, .646, need not be read.

***This statement assumes that up to this point only the C and D scales are being used. A later section will describe how this operation may be avoided by the use of the CI scale.

EXAMPLE: $\frac{2.2 \times 2.4}{8.4}$

If the rule is set to divide 2.2 by 8.4, the hairline cannot be set over the 2.4 of the C scale and at the same time remain on the rule. Therefore the hairline is moved to the C index (opposite 262 on the D scale) and the slide is moved end for end to the right (so that the left index falls under the hairline and over 262 on the D scale). Then the hairline is moved to 2.4 on the C scale and the result .628 is read on the D scale.

If the number of factors in the numerator exceeds the number in the denominator by more than one, the numbers may be grouped, as shown below. After the value of the group is worked out, it may be multiplied by the other factors in the usual manner.

$$\frac{a \times b \times c}{m \times n} \times d \times e$$

PROBLEMS	ANSWERS
1. $\frac{27 \times 43}{19}$	61.1
2. $\frac{842 \times 2.41 \times 173}{567 \times 11.52}$	53.7
3. $\frac{0.0237 \times 3970 \times 32 \times 6.28}{0.00029 \times 186000}$	351
4. $\frac{875 \times 1414 \times 2.01}{661 \times 35.9}$	105
5. $\frac{0.691 \times 34.7 \times 0.0561}{91,500}$	0.0000147

PROPORTION

Problems in proportion are very easy to solve. First notice that when the index of the C scale is opposite 2 on the D scale, the ratio 1 : 2 or ½ is at the same time set for all other opposite graduations; that is, 2 : 4, or 3 : 6, or 2.5 : 5, or 3.2 : 6.4, etc. It is true in general that for any setting the numbers for *all pairs of opposite graduations have the same ratio.* Suppose one of the terms of a proportion is unknown. The proportion can be written as $\frac{a}{b} = \frac{c}{x}$, where a, b, and c, are known numbers and x is to be found.

Rule: **Set *a* on the C scale opposite *b* on the D scale. Under *c* on the C scale read *x* on the D scale.**

EXAMPLE: Find x if $\frac{3}{4} = \frac{5}{x}$

Set 3 on C opposite 4 on D. Under 5 on C read 6.67 on D.

PROBLEMS	ANSWERS
1. $\frac{x}{42.5} = \frac{13.2}{1.87}$	300.
2. $\frac{90.5}{x} = \frac{3.42}{1.54}$	40.7
3. $\frac{43.6}{89.2} = \frac{x}{2550}$	1245

THE CI SCALE

The CI scale on the slide is a C scale which *increases from right to left.* It may be used for finding reciprocals. When any number is set under the hairline on the C scale its reciprocal is found under the hairline on the CI scale, and conversely.

EXAMPLES:

(a) Find 1/2.4. Set 2.4 on C. Read .417 directly above on CI.

(b) Find 1/60.5. Set 60.5 on C. Read .165 directly above on CI. Or, set 60.5 on CI, read .165 directly below on C.

The CI scale is useful in replacing a multiplication by a division. Since $a \times b = \frac{a}{1/b}$ any multiplication may be done by dividing the first factor by the reciprocal of the second. Thus to find $a \times b$ set the hairline on a, pull b on the CI scale under the hairline and read the result on the D scale under the index. This process may be used to avoid settings in which the slide projects far outside the rule.

EXAMPLES:

(a) Find 68.2 X 1.43. Consider this as 68.2 ÷ 1/1.43. Set the indicator on 68.2 of the D scale. Observe that if the left index is moved to the hairline the slide will project far to the right. Hence merely move 1.43 on CI under the hairline and read the result 97.5 on D at the C index.

(b) Find 2.07 X 8.4 X 16.1. Set the indicator on 2.07 on the D scale. Move slide until 8.4 on CI is under hairline. Move hairline to 16.1 on C. Read 280 on D under the hairline.

Conversely, one may replace a division with a multiplication when it is desirable.

EXAMPLES:

(a) Find 13.6 ÷ 87.5. Consider this as 13.6 x 1/87.5. Set left index of the C scale on 13.6 of the D scale. Move hairline to 87.5 on the CI scale. Read the result, .155 on the D scale.

An important use of the CI scale occurs in problems of the following type.

EXAMPLE: Find $\frac{13.6}{4.13 \times 2.79}$

This is the same as $\frac{13.6 \times (1/2.79)}{4.13}$.

Set 4.13 on the C scale opposite 13.6 on the D scale. Move hairline to 2.79 on the CI scale, and read the result, 1.180, on the D scale.

Thus by use of the CI scale, factors may be transferred from the numerator to the denominator of a fraction (or vice-versa) in order to make the settings more readily.

SQUARE ROOTS AND SQUARES

When a number is multiplied by itself the result is called the *square* of the number. Thus 25 or 5 x 5 is the square of 5. The factor 5 is called the *square root* of 25. Similarly, since 12.25 = 3.5 x 3.5, the number 12.25 is called the square of 3.5; also 3.5 is called the square root of 12.25. Squares and square roots are easily found on the slide rule.

Square Roots: To find square roots the A and D scales or the B and C scales are used.

Rule: **The square root of any number located on the A scale is found below it on the D scale.**

Also, the square root of any number located on the B scale (on the slide) is found on the C scale.

EXAMPLES: Find the $\sqrt{4}$. Place the hairline of the indicator over 4 on the left end of the A scale. The square root, 2, is read below on the D scale. Similarly the square root of 9 (or $\sqrt{9}$) is 3, found on the D scale below the 9 on the left end of the A scale.

In the discussion which follows, it will be necessary to refer to the number of "digits" and number of "zeros" in some given numbers.

When numbers are greater than 1 the number of *digits* to the left of the decimal point will be counted. Thus 734.05 will be said to have 3 digits. Although as written the number indicates accuracy to *five* digits, only three of these are at the left of the decimal point.

Numbers that are less than 1 may be written as *decimal fractions.* Thus .673, or six-hundred-seventy-three thousandths, is a decimal fraction. Another example is .000465. In this number three zeros are written to show where the decimal point is located. One way to describe such a number is to tell how many zeros are written to the right of the decimal point before the first non-zero digit occurs.

Reading the Scales: The A scale is a contraction of the D scale itself. The D scale has been shrunk to half its former length and printed twice on the same line. Between primary graduations 1 and 3 the secondary graduations represent *tenths*, and the shortest graduations represent five one hundreths. Thus the first mark to the right of 1 represents 105.

Between 3 and 6 the secondary graduations represent tenths, and between 6 and 1 the only secondary graduations are at the two tenths (2/10) position.

To find the square root of a number between 0 and 10 the left half of the A scale is used (as the examples above). To find the square root of a number between 10 and 100 the right half of the A scale is used. For example, if the hairline is set over the 16 on the right half of the A scale (near the middle of the rule) the square root of 16, or 4, is found below it on the D scale.

In general, to find the square root of any number with an odd number (1,3,5,7,...) of digits or zeros, the left half of the A scale is used. If the number has an even number (2,4,6,8,...) of digits or zeros, the right half of the scale A is used.

The table below shows the number of digits or zeros in the number N and its square root.

	ZEROS				or	DIGITS				
N	7 or 6	5 or 4	3 or 2	1	0	1 or 2	3 or 4	5 or 6	7 or 8	etc.
$\sqrt{N}$	3	2	1	0	0	1	2	3	4	etc.

This shows that numbers from 1 up to 100 have one digit in the square root; numbers from 100 up to 10,000 have two digits in the square root, etc. Numbers which are less than 1 and have, for example two or three zeros, have only one zero in the square root. Thus $\sqrt{0.004} = 0.0632$, and $\sqrt{0.0004} = 0.02$.

EXAMPLES:

(a) Find $\sqrt{248}$. This number has 3 (an *odd* number) digits. Set the hairline on 248 of the left A scale. Therefore the result on D has 2 digits, and is 15.75 approximately.

(b) Find $\sqrt{563000}$. The number has 6 (an *even* number) digits. Set the hairline on 563 of the right A scale. Read the figures of the square root on the D scale as 75. The square root has 3 digits and is 750 approximately.

(c) Find $\sqrt{.00001362}$. The number of *zeros* is 4 (an *even* number). Set the hairline on 1360 of the right half of the A scale. Read the figures 369 on the D scale. The result has 2 zeros, and is .00369.

All the above rules and discussion can be applied to the B and C scales if it is more convenient to have the square root on the slide rather than on the body of the rule.

Squares: **To find the square of a number, reverse the process for finding the square root.** Set the indicator over the number on the D scale and read the square of that number **on the A scale; or set the indicator over the number on the C scale and read the square on the B scale.**

EXAMPLES:

(a) Find $(1.73)^2$ or 1.73 X 1.73. Locate 1.73 on the D scale. On the A scale find the approximate square 3.

(b) Find $(62800)^2$. Locate 628 on the D scale. Find 394 above it on the A scale. The number has 5 digits. Hence the square has either 9 or 10 digits. Since, however, 394 was located on the right half of the A scale, the square has the *even* number of digits, or 10. The result is 3,940,000,000.

(c) Find $(.000254)^2$. On the A scale read 645 above the 254 of the D scale. The number has 3 zeros. Since 645 was located on the side of the A scale for "odd zero" numbers, the result has 7 zeros, and is 0.0000000645.

PROBLEMS	ANSWERS
1. $\sqrt{7.3}$	2.7
2. $\sqrt{73}$	8.54
3. $\sqrt{0.062}$	0.249
4. $\sqrt{0.00000094}$	0.00097
5. $(3.95)^2$	15.6
6. $(0.087)^2$	0.00757

Near the numeral 8 on the right end of the A and B scale, there is a special mark. This mark represents $\pi/4$. Since the area of a circle is equal to the product of $\pi/4$ and the diameter squared, this special mark is helpful. To find the area, set the C scale index over the diameter on the D scale. Move the hairline to the special mark on the B scale and read the area on the A scale.

CUBE ROOTS AND CUBES

Just above the A scale on the front of the rule is a scale marked with the letter K. The K scale is a contraction of the D scale. The D scale has been shrunk to one third of its former length and printed three times on the same line. This scale may be used for finding the cube or cube root of any number.

Reading the scale: Between primary graduations 1 and 2 the secondary graduations represent tenths, and the shortest graduations represent five one hundreths. Thus the first mark to the right of 1 represents 105. Between 2 and 4 the secondary graduations represent tenths, and between 4 and 1 the only secondary graduations are at the two tenths position.

Rule: **The cube root of any number located on the K scale is found directly below on the D scale.**

EXAMPLE: Find the $\sqrt[3]{8}$. Place the hairline of the indicator over the 8 at the left end of the K scale. The cube root, 2, is read directly below on the D scale.

To decide which part of the K scale to use in locating a number, mark off the digits in groups of three starting from the decimal point. If the left group contains one digit, the left third of the K scale is used; if there are two digits in the left group, the middle third of the K scale is used; if there are three digits, the right third of the K scale is used. In other words, numbers containing 1,4,7, ... digits are located on the left third; numbers containing 2,5,8, . . . digits are located on the middle third; and numbers containing 3,6,9, . . . digits are located on the right third of the K scale. The corresponding number of digits or zeros in the cube roots are shown in the table below.

	ZEROS				or	DIGITS		
N	11-10-9	8-7-6	5-4-3	2-1-0	1-2-3	4-5-6	7-8-9	10-11-12
$\sqrt[3]{N}$	3	2	1	0	1	2	3	4

EXAMPLES:

(a) Find $\sqrt[3]{6.4}$. Set hairline over 6.4 on the left most third of the K scale. Read 1.86 on the D scale.

(b) Find $\sqrt[3]{64}$. Set hairline over 6.4 on the middle third of the K scale. Read 4 on the D scale.

(c) Find $\sqrt[3]{640}$. Use the right most third of the K scale, and read 8.62 on the D scale.

(d) Find $\sqrt[3]{6,400}$. Use the left third of the K scale, but read 18.6 on the D scale.

(e) Find $\sqrt[3]{64,000}$. Use the middle third of the K scale, but read 40 on the D scale.

(f) Find $\sqrt[3]{0.0064}$. Use the left third of the K scale, since the first group of three, or 0.006, has only one non-zero digit. The D scale reading is then 0.1857.

(g) Find $\sqrt[3]{0.064}$. Use the middle third of the K scale, reading 0.4 on D.

Cubes: **To find the cube of a number, reverse the process for finding cube root. Locate the number on the D scale and read the cube of that number on the K scale.**

EXAMPLES:

(a) Find $(1.37)^3$. Set the indicator on 1.37 of the D scale. Read 2.57 on the K scale.

(b) Find $(13.7)^3$. The setting is the same as in example (a), but the K scale reading is 2570, or 1000 times the former reading.

(c) Find $(2.9)^3$ and $(29)^3$. When the indicator is on 2.9 of D, the K scale reading is 24.4. The result for 29^3 is therefore 24,400.

(d) Find $(6.3)^3$. When the indicator is on 6.3 of D, the K scale reading is 250.

PROBLEMS	ANSWERS
1. 2.45^3	14.7
2. $.738^3$	.402
3. $.0933^3$	.000812
4. $\sqrt[3]{71}$	4.14
5. $\sqrt[3]{.0315}$	.316

LOGARITHMS

The L scale is used for finding the logarithm (to the base 10) of any number. ***Rule:* Locate the number on the D scale, and read the mantissa of its logarithm (to base 10) on the L scale.**

EXAMPLE: Find log 425. Set the hairline over 425 on the D scale. Read the mantissa of the logarithm (.628) on the L scale. Since the number 425 has three digits, the charisteristic is 2 and the logarithm is 2.628.

If the logarithm of a number is known, the number itself may be found by reversing the above process.

EXAMPLE: If log x = 3.248, find x. Set the hairline over 248 of the L scale. Above it read the number 177 on the D scale. Then x=1770 approximately.

EXAMPLE: Find log .000627. Opposite 627 on the D scale find .797 on the L scale. Since the number has 3 zeros, the characteristic is -4, and the logarithm is usually written 6.797-10, or 0.797-4.

PROBLEMS	ANSWERS
1. log 3.26	.513
2. log .0194	8.288-10
3. log .931	9.969-10
4. log x=2.052	x=112.7
5. log X = 9.831 - 10	x=.678

Business ratios

A *ratio* is the quotient which results when one number is divided by another. For example, 55 ÷ 11 = 5. Thus 55 bears exactly the same relationship to 11 as 5 bears to 1. That is:

$$\frac{55}{11} = \frac{5}{1}$$

If the comparison of two large numbers, such as $8240 and $2060, is desired, determine the ratio to 1. That is, divide the larger number ($8240) by the smaller number ($2060). It is immediately apparent, since 8240 ÷ 2060 = 4, that 8240 is to 2060 as 4 is to 1.

In analyzing business records, ratios can be used to expedite comparisons, and ratios can be used to aid the decisions of management. They are helpful in controlling business enterprises.

Several common business ratios are given here. They can all be solved using the C and D scales. Only a brief explanation of each is presented.

If the current assets of a business (cash, accounts receivable, and inventory) is divided by the current liabilities (accounts that must be paid within a reasonable length of time), the quotient, expressed as a ratio to 1, is called the current ratio.

$$\frac{\text{Current assets}}{\text{Current liabilities}} = \text{Current ratio}$$

Illustration: If the current assets of a business enterprise amount to $238,853, and the accounts payable are $85,380, how does its current ratio compare with the average ratio for that line of business, which is 2½ to 1?

$$\frac{\text{Current assets}}{\text{Current liabilities}} = \frac{\$238,853}{\$85,380} = 2.8:1$$

Solution: Using the indicator, put 854 on C over 239 on D and read 280 on D under right index of C.

Thus there are $2.80 in current assets for every $1 of current liabilities. This is better than average, which is only $2.50 of current assets for every $1 of current liabilities.

The ratio between the total sales for a year and the merchandise on hand is called the merchandise turnover. Similar ratios are often computed, such as ratio of sales to net worth, sales to fixed assets, net worth to fixed assets, beginning and end of month stock-sales ratios, shortage to net sales, etc. The quotient in every case is expressed as a ratio to 1, or as a per cent (to be discussed later).

$$\frac{\text{Total sales}}{\text{Average inventory}} = \text{Merchandise turnover}$$

Illustration: If the total sales of a store were $142,000 and the average inventory was $35,000, how did the merchandise turnover compare with the national average for such a store, which was 5 to 1?

$$\frac{\text{Total sales}}{\text{Average inventory}} = \frac{142{,}000}{35{,}500} = 4{:}1.$$

Solution: Set 355 on C opposite 142 on D. Under the right index of C read 4 on D. This ratio is therefore below the national average, indicating that the store is carrying too heavy an inventory for the amount of business done; or, the store is carrying a larger inventory than is necessary.

To appraise the value of a corporate security one needs ratios for comparison. The two ratios most frequently met are the following:

1) $\frac{\text{Earnings available for bond interest}}{\text{Annual bond interest}} = \text{Bond interest coverage;}$

2) $\frac{\text{Amount of earnings}}{\text{Number of shares}} = \text{per share earnings,}$

$\frac{\text{Market price}}{\text{per share earnings}} = \text{Price earnings ratio.}$

Considering 1), if a corporation has earned $238,523, and if its bond interest charges are $61,835, the bond interest coverage would be:

$$\frac{238{,}523}{61{,}835} = \frac{239{,}000}{62{,}000} = \frac{239}{62} = 3.86{:}1.$$

Solution: Set 62 on C opposite 239 on D. Opposite the right index of C read 3.86 on D.

Considering 2), assume a company earned $430,000 last year, and the market price of its stock is 45. If there are 90,000 shares of stock outstanding, then the price earnings ratio is determined as follows:

$$\frac{430{,}000}{90{,}000} = \frac{4.78}{1} \text{ (the per share earnings); } \frac{45}{4.78} = \frac{9.4}{1}.$$

Solution: Set 90 on C opposite 430 on D. Move indicator to the right index of C, and read 4.78 on D. If now the slide is moved until 45 on C is under the hairline of the indicator, the result 9.4 can be read on C above the right index of D.

Per cents

Any ratio (or common fraction) can be changed into a per cent. "Per cent of" means "hundredths of". The ratio of 25 to 100 is the same as 25 per cent (written 25%).

There are three kinds of per cent problems. Two require division and one requires multiplication.

Since the C and R scales are exactly like the C and D scales, multiplication or division problems may be solved on either side of the slide rule. Moreover, the folded scales CF and RF can also be used. These have the advantage that if, after the slide has been set using the C and D or C and R scales, a reading is needed which falls *off the scale*, the result can usually be read on the CF or RF without resetting the slide.

Illustrations:

a. What is 27% of 835?

Solution: 835 × 27% = 835 × 0.27 = 225

Set right index of C opposite 835 on D (or R). Move indicator over 27 on C, and read 225 on D (or R). If, instead, the left index of C is set over 27 on D (or R), then 835 on C is off the scale. However, by moving the indicator to 835 on CF, the result 225 may be read on RF.

Therefore: 225 is 27% of 835.

b. 38.4 is what percent of 138?

Solution: 38.4 ÷ 138 = 0.278 = 27.8%

Set 138 on C opposite 38.4 on D (or R). Read 278 on D (or R) at the left index of C.

Therefore: 38.4 is 27.8% of 138.

c. 0.528 is 18% of what number?

Solution: 0.528 ÷ 18% = 0.528 ÷ 0.18 = 2.93

Set 18 on C opposite 528 on D (or R). Read 293 on D (or R) at the left index of C.

Therefore: 0.528 is 18% of 2.93.

Initial markup analysis

Suppose a merchant wants a 45% markup on sales in a certain department on goods costing $6,600. By the methods of Part I using the R% scale it is found that gross sales of $12,000 are needed. This is a total markup of $5400. If he knows from past experience that reductions (markdown) of $800 can be anticipated due to merchandise that does not sell readily, he should mark the merchandise of this department so as to total $12,000 + $800 or $12,800. The initial markup rate required in order to maintain a certain markup is given in the formula:

$$\text{Initial markup rate} = \frac{\text{Maintained markup} + \text{reductions}}{\text{Sales} + \text{reductions}}$$

$$\text{Thus: Initial markup rate} = \frac{45\% \cdot 12{,}000 + 800}{12{,}000 + 800} = \frac{5400 + 800}{12{,}800}$$

$$= \frac{6200}{12{,}800} = \frac{62}{128} = 0.485 = 48.5\%$$

He must therefore have a 48.5% markup based on sales in order to maintain a 45% markup. This problem is easily solved on the front of the rule as follows.

Set 6600 on CF opposite 12,800 on RF. Above Ⓡ read 48.5% on the R% scale. With this same setting of the slide, the retail price of any individual item may be found by moving the indicator to the cost on C or CF, and reading the retail on R or RF. Thus if the cost is $2.40 (found on C), the retail is $4.66, found on R.

In general, set total cost on C (or CF), *opposite the sum of gross sales and reductions* on R (or RF). Read initial markup rate on R% above Ⓡ. To price an individual item, move indicator to its cost on C (or CF), read retail on R (or RF).

Since 800 ÷ 12,000 = 6.67%, the previous example shows that an initial markup of 48.5% is required if the merchant desires to maintain a markup of 45%, and can anticipate a markdown (reduction) of 6.67%.

Type Form Y = X/a

Problems of the type form Y = X/a, where a is a constant and X and Y are variables, are met in several business calculations. Such problems can be solved by a single setting of the rule. To do so, rewrite the type form as a proportion; namely, $\frac{Y}{X} = \frac{1}{a}$. Put 1 on C over a on D; then any value of X on D will be under the corresponding value of Y on C, or vice versa.

Illustration: Given Y = X/120, determine the following unknown values:

X	42.8		387	
Y		1.27		0.227

Solution: Put the formula in proportion form: $\frac{Y}{X} = \frac{1}{120}$

Put the left index of C over 120 on D. Over 428 on D, read 357 on C; under 127 on C, read 1524 on D; over 387 on D, read 322 on C; under 227 on C, read 272 on D. That is:

X	42.8	152.4	387	27.2
Y	0.357	1.27	3.22	0.227

The position of the decimal point is determined by estimating the answer. For example, if X = 42.8, Y = $\frac{42.8}{120}$ or $\frac{40}{100}$ = 0.4

An important business application of the type form Y = X/a is in determining a part of the whole.

Illustration: The number of employees in five departments of a retail store is as follows: 27, 48, 18, 37 and 56. What per cent of all the employees is in each department?

Dept.	X	Y (%)
I	27	14.5
II	48	25.8
III	18	9.7
IV	37	19.9
V	56	30.1
a =	186	100.0

Solution: The formula used is $\frac{Y}{X} = \frac{1}{186}$.

Set 1 (or the left index) of C opposite 186 of R. Move indicator to 27 on R, read 14.5 on C. Move indicator to 48 on R, read 25.8 on R. Move indicator to 18 on RF, read 9.7 on CF, etc.

Using the type form Y = X/a, management can keep a careful check on: (1) Total sales per department vs. grand total sales; (2) Per cent employees in any department vs. per cent of sales by the same department (for example, if 25.8% of all employees are in Department II, and if they account for 32.6% of total sales, should a larger number of employees be assigned to that department?); (3) Trends in employment and sales from month to month, etc.

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HOW TO ADJUST YOUR SLIDE RULE

A perfect slide rule, when out of adjustment, often appears defective. Each rule is accurately adjusted before it leaves the factory. However, handling during shipment, dropping the rule, or even a series of slight jars while laying the rule down during use, may loosen the adjusting screws and throw the rule out of alignment. Follow these simple directions for slide rule adjustment.

CURSOR-HAIRLINE ADJUSTMENT • Loosen the bottom two screws on both Cursor windows on spacer opposite tension spring. Press with left thumb to maintain constant contact with edge of rule; align hairline with left hand indices and tighten screws on that side. Turn rule over and check alignment of hairline on other Cursor window. If necessary, loosen all screws on this side and align with left hand indices as needed, and tighten screws carefully.

SLIDER TENSION ADJUSTMENT • Loosen adjustment screws on end brackets; regulate tension of slider, tighten the screws using care not to misalign the scales. The adjustment needed may be a fraction of a thousandth of an inch, and several tries may be necessary to get perfect slider action.

SCALE LINE-UP ADJUSTMENTS • (1) Move slider until indices of C and D scales coincide. (2) Move cursor to one end. (3) Place rule on flat surface with face uppermost. (4) Loosen end plate adjusting screws slightly. (5) Adjust upper portion of rule until graduations on DF scale coincide with corresponding graduations on CF scale. (6) Tighten screws in end plates.

REPLACEABLE ADJUSTING SCREWS • All Pickett All-Metal rules are equipped with Telescopic Adjusting Screws. In adjusting your rule, if you should strip the threads on one of the Adjusting Screws, simply "push out" the female portion of the screw and replace with a new screw obtainable from your dealer, or from the factory at a cost of $.06 each in stamps.

HOW TO KEEP YOUR SLIDE RULE IN CONDITION

Always hold your rule between thumb and forefinger at the ENDS of the rule. This will insure free, smooth movement of the slider. Holding rule at center tends to bind the slider.

LUBRICATION • *Do not use ordinary lubricating oil on your slide rule. It turns black and dirties your hands and work.* Your slide rule is treated with a light "silicone" lubricant at the factory. This oil, which works into the surface of the metal, is designed to lubricate your rule indefinitely.

If your rule should run dry, or if the slider begins to move hard or with a dry, rasping sound:

1. Lubricate with a light "Silicone" lubricant. Work in well by moving slider back and forth, then wipe off. OR –
2. If a light silicone is unobtainable, simply rub tongues and grooves with a very soft lead pencil. Move slider back and forth to work the graphite well into the metal, then wipe excess graphite off.

MAINTENANCE • The body of your rule is made of magnesium. The edges, not covered with plastic, may gradually darken (or oxidize) with age. This ageing, or darkening, is a common characteristic of metals like magnesium, German silver, silver, brass, copper, pewter, etc.

This normal ageing or darkening of the rule affects neither the accuracy of the scales nor ease of operation.

Extreme atmospheric exposure tends to warp and distort wood, and to rust steel, which is common knowledge. This is not true of magnesium. Such exposure may tend to deposit an oxidation film on the surface, causing the slider to stick or move hard.

If this happens to your rule, take out the Telescopic Adjusting Screws and remove both Top Rule Member and Slider without disassembling the Cursor. Clean the oxidized edges of the rule with a silver polish, Bon Ami, rubber ink eraser or other cleaning agent. Slide Top Rule Member and Slider back into position. Relubricate. Then make Scale Line-Up and Slider-Tension Adjustments.

WHY YOUR RULE OPERATES BETTER WITH CONSTANT USE • Being made of metal, the moving parts of your slide rule "lap in" with use. This process of wearing smooth means your slide rule will operate with increasing smoothness year after year.

CLEANING • Wash surface of the rule with non-abrasive soap and water when cleaning the scales. If Cursor window becomes dulled from long use, simply polish and brighten the window surfaces with a small rag and tooth powder.

Pickett **ALL-METAL SLIDE RULES**

PICKETT & ECKEL, INC.

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