



# Mathematical Handbook

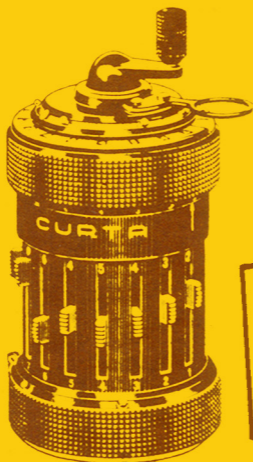
An Aid to Every Day  
Figuring Problems, Tables,  
Formulas  
Arithmetical Rules



WORLD  
FAMOUS

# CURTA

Mfd. in Liechtenstein



the high  
precision  
calculating  
machine

THE KEY TO EVERY  
CALCULATING PROBLEM

**A dwarf in size . . .**

**A giant in calculating efficiency**

Curta is a complete pocket size  
calculating machine for all four  
arithmetical operations

Like a chronometer or a miniature camera,  
the CURTA calculator is a precision machine  
of extremely small proportions.

This amazing new construction, manufac-  
tured with up to date production-methods by  
CONTINA Ltd., is a masterpiece of matchless  
craftsmanship.

CURTA is held in one hand while operated  
(see figure 2 , page 6 ) and is easily carried  
in a pocket or in a briefcase. Thus it fills  
a long felt gap in available calculating ma-  
chines and complies with the wishes of a  
great number of users demanding a small, yet  
complete and reliable individual instrument.

The **businessman** on his trips, the **professional account** at his client's offices, the **building contractor** on the building site, the **technician** in the workshop, the **draughtsman** at his drawing board, **professors** and **students**, they all use and prefer CURTA for its handiness and accuracy.

Wherever it is inconvenient to use noisy machines or to transport heavy and bulky instruments, all the outstanding advantages of the CURTA become fully evident. In the **offices** of private and public enterprises, in bureaus of the **administration**, in **banks**, in **booking offices**, in **test-laboratories**, to mention a few examples, CURTA is particularly appreciated for its quiet, convenient and fast operation: Unlike other machines, CURTA, held in one hand, is always in the operator's immediate angle of vision, right above his working place (see pages 5 and 6 ).

Due to these remarkable features, CURTA, ever since its first appearance, has been enthusiastically received both by experts and users and has been in rapidly growing demand all over the world.

With the CURTA a **miniature universal calculating machine** of an entirely new design has been created. Hand operated, with "safe-grip" setting knobs, visible setting dial and continuous tens transfer in the answering and the indicating dial. CURTA has the features and the perfection normally found only in more expensive modern calculating machines of far heavier weight and much larger size.



# CURTA

has the following features in common with heavy calculating machines:

## **Performance**

It adds, subtracts, multiplies, divides, squares, cubes, extracts, square roots. CURTA is therefore the ideal machine for invoicing, estimates, calculation of interest, currency conversions, figuring out percentages, etc.

## **Accuracy**

CURTA is fool-proof. Automatic devices prevent errors due to wrong handling. Special stops eliminate overspeeding of the axles in fast operation.

## **Speed**

Exceptionally fast operation is possible thanks to the small size of all moving parts, the continuous tens transfer in both dials and the one-way (clockwise) operation of the handle.

## **Visibility**

The neatly engraved figures appear clearly on the non-glare surface of the machine. The set numbers appear automatically in the horizontal setting dial.

## **Quality**

Only rigorously tested materials are selected for all parts of the CURTA. All parts are interchangeable and can easily be replaced.

## **Durability**

Practically no wear can be noticed even after years of use. Tests over a long period have shown that the whole mechanism of the CURTA will stand up to millions of rotations.

## **Attractive appearance**

Fine finish, shock-proof container.

## **Lower price**

Thanks to its modern design and the latest manufacturing methods CURTA is sold at a much lower price than any machine of comparable performance.

## **Resistance to corrosion**

CURTA is rust-proof and tropic-proof.

## **Silent action**

On account of the small size of all moving parts and the use of automatic locking devices.

## **Convenient and easy operation**

Thanks to the small weight, the easy action, the conveniently located "safe-grip" setting knobs, the clearly visible figures and the non-glare surface finish. For desk work the CURTA offers the special advantage that the operator remains in the same position for calculating as for his other work (compare the pictures on the two following pages).

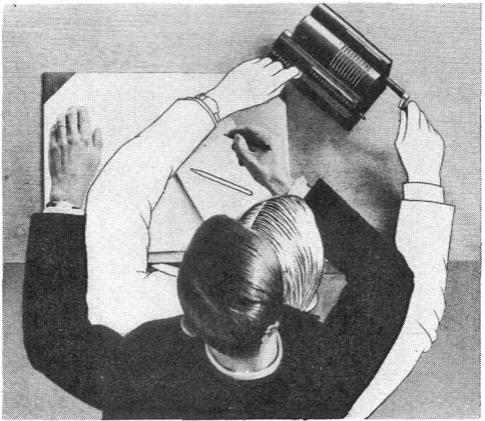


Fig. 1

## COMPARE

the usual way . . .

With a heavy calculating machine:

- concentration focused alternately on TWO points
- many movements
- additional strain

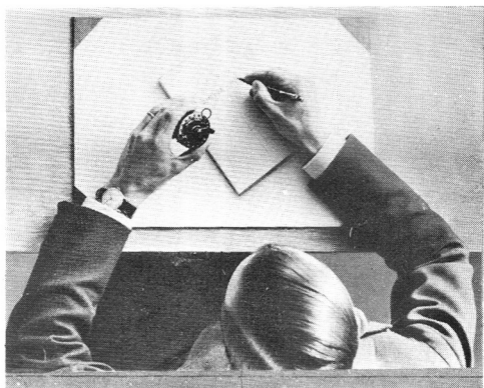


Fig. 2

... and the "CURTA" way

With the CURTA-Calculator

- concentration focused on ONE point only
- no unnecessary movements
- less strain

## Short Description

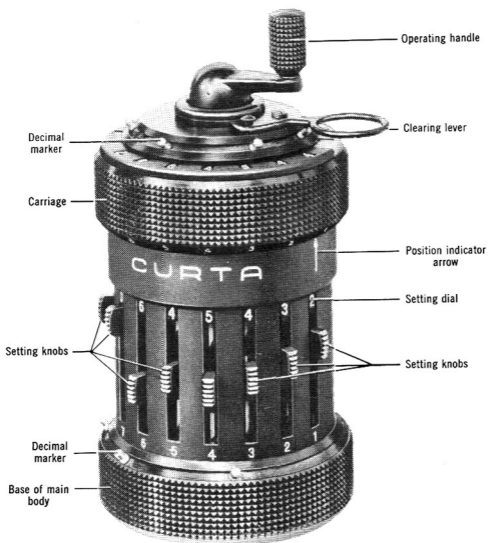


Fig. 3

The machine consists of the main body which bears at its top the revolving carriage (see fig. 3)

The main body contains the keyboard with the **setting knobs** protruding from slots, the adjustable white **decimal markers** at the base and the **setting dial** on top of the slots. The main axle, driven by the **operating handle**, passes through the center of the main body.

The carriage contains the **indicating dial** (white) and the **answering dial** (black), the **decimal markers** set in a groove and the **clearing lever** (see fig. 4). The clearing lever can be folded over when the machine is stored in its container.

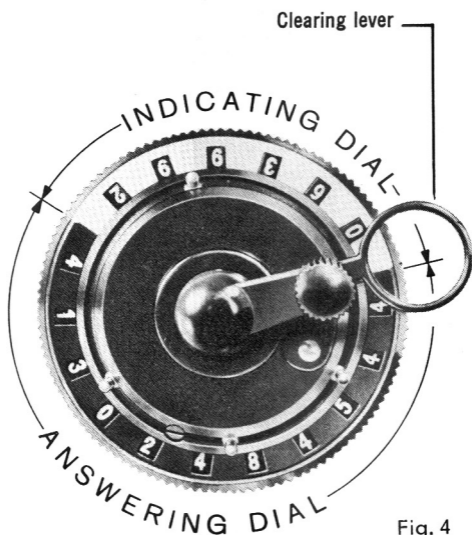


Fig. 4

The **handling of the machine** is similar to that of ordinary large machines, except that it is held in one hand, preferably in the left, with thumb and forefinger gripping the knurled edge of the carriage. The carriage, when lifted, can easily be rotated in either direction within the number of positions of the indicating dial; it is correctly fixed by stops, each of which is determined by the **position indicator arrow** being even with one of the numbers on the lower edge of the carriage.

The setting of numbers (for example the terms of addition, one of the two multiplication factors, or the divisor) is done with the knobs projecting from the slots. Their zero position is at the top of the slots. To set a determined figure, the corresponding setting knob is moved down until the desired figure appears on the setting dial. The number set can thus be readily checked.

The **operating handle** is provided with a distinctly felt stop which enables the operator to count each turn. With a gentle pull, respectively pressure, it can be brought into its upper or back into its lower position, this latter serving for addition and multiplication, whereas the upper is for subtraction and division. In both cases the handle is turned in the same clockwise direction. A safety device prevents it from being turned backwards.

The **indicating dial** (white dial) counts the turns of the handle and indicates the number of items of an addition, the multiplier of a multiplication, the quotient of a division and the root when extracting square-roots.

The white dial will register the number of turns of the handle in the place corresponding to the number on the carriage edge indicated by the position indicator arrow.

The **answering dial** (black dial) shows the result of additions, subtractions and multiplications and in division the dividend or remainder (according to the method of division selected).

The tens transfer mechanism in both these dials saves considerable time for many operations by reducing the number of turns of the handle (viz. in shortcut-multiplication).

Among other advantages it permits the addition of multipliers which is important in cubing and percentage calculations.

The answering and the indicating dial are cleared with the **clearing lever** (see figs. 3 and 4.) It can be turned in both directions; two stops are provided between the black and the white dial. With one full turn in either direction both dials are cleared; however each dial can be cleared separately by merely sliding the clearing lever over it from one stop to the other.



The reversing lever at the back of the machine acts on the indicating dial. This latter will operate in opposite sense to the answering dial when the reversing lever is brought into its lower position.

**Calculating example.** The numbers visible in figs. 3 and 4 illustrate the multiplication:

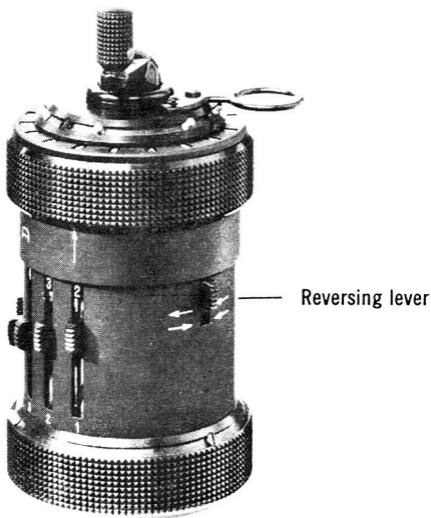


Fig. 5

Back view of the machine

645432 X 63992. The multiplicand appears in the setting dial (see fig. 3), the multiplier in the white dial and the product in the black dial (see fig. 4).

The total time required for this operation, including setting, is approx. 15 seconds when operating with 29 turns. In shortcut-multiplication, which is made possible by the tens transfer mechanism, only 13 turns are necessary, which corresponds to a calculating time of approx. 10 seconds.

In division, approximately 30 seconds in all, including setting, are required to ascertain a six digit quotient.

All other operations are performed in the shortest time by the same methods as used currently with large universal calculating machines.



The dust and shock proof container of the CURTA.

Fig. 6

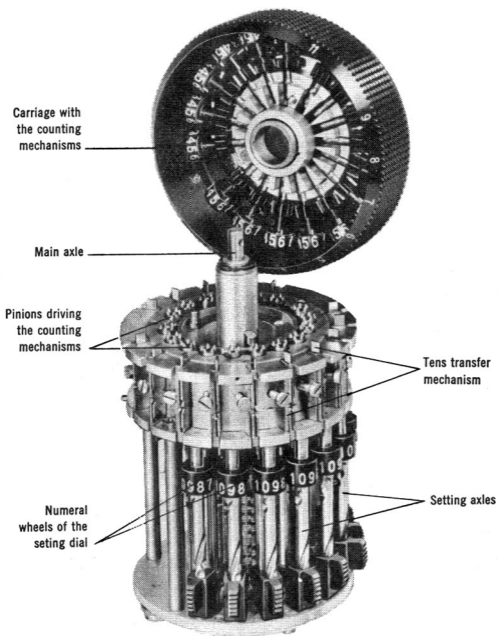
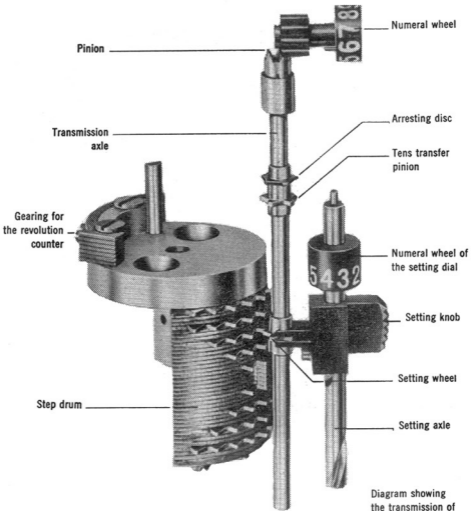


Fig. 7

View of the stripped main assemble with the carriage above.



**Fig. 8**

The above illustration shows that by means of the setting knobs the setting wheels on the setting axles are brought within range of the toothed segment of the step drum whose number of teeth corresponds to the figure set. When rotating, the single central step drum acts successively on each setting wheel. The rotation of the setting wheels is transmitted through the pinions directly to the numeral wheels of the counting mechanisms. For clarity's sake the above illustration is confined to one single digit.

In the Curta, subtraction is converted to mere addition, the step drum acting automatically with its complementary teething when it is placed in its upper position. These simple construction principles result in a considerable economy of parts and are responsible for the robust design to which the Curta owes its high dependability.

## CURTA COMES IN TWO MODELS

Both machines operate on the same principle, however Model # 2 is slightly larger to give you greater capacity.

### Specifications

	MODEL # 1	MODEL # 2
	8 X 6 X 11	11 X 8 X 15
Keyboard	8 columns	11 columns
Result Dial	11 columns	15 columns
Counting Dial	6 columns	8 columns
Add or Multiply to	11 places	15 places
Divide to	6 places	8 places
Diameter	2 $\frac{1}{16}$ in. (53 mm)	2 $\frac{9}{16}$ in. (65 mm)
Height	3 $\frac{3}{8}$ in. (85 mm)	3 $\frac{5}{8}$ in. (90 mm)
Weight	8 ozs. (230 g)	12 $\frac{1}{2}$ ozs. (360 g)

Our machines give the accuracy of a desk calculator plus the portability of a slide rule.

## SERVICE

Curta is made entirely of high quality metals, with the same manufacturing precision as a fine watch, therefore service required is kept at a minimum. We recommend, however, that once every two years, machines be sent in for cleaning and lubrication.

When machine does require service, you may return it to the dealer from which it was purchased. If you are some distance away, you may send it via ordinary parcel post, in its metal shock-proof container. Place the entire machine in its container into a small carton or wrap with several layers of newspaper or corrugated paper. Prices for servicing our machine are comparable to that of a watch rather than of a desk calculating machine.

## WHERE AND HOW TO BUY CURTA

You may purchase our machines from the dealer or distributor whose name appears on the back of this book. Our guarantee, our terms of sale, are the same regardless of which dealer your machine is purchased from: i.e. purchase may be made on a money back guarantee. Check with your dealer regarding local taxes, cash discount, open account, time payments, if desired, etc.

## ACCESSORY

For those who wish to use Curta in the field, we have a leather shoulder strap carrying case.

Leather case for Small Machine:  
No. 1 (holds calculator without metal case)

Leather case for Large Machine:  
No. 2 (holds calculator without metal case)

Leather case for Large Machine Only:  
No. S 2 (holds calculator in metal case)  
Also has belt loop

Every CURTA-machine is supplied with detailed operating instructions giving the elementary rules for addition, subtraction, multiplication and division.

In addition, a booklet containing the following computing examples for the CURTA calculating machines is included:

### General

Division by breaking down (subtractive method)

Division by multiplying by a reciprocal  
The rule of three

The rule of three in a single calculation (only CURTA Model # 2)

Extended rule of three  $\frac{a \times b \times c}{d \times e \times f}$

Calculation of roots

Continued multiplication  $a \times b \times c \times d \dots$ , etc.

Cubes without intermediate notes

### Commerce and Industry

Checking of invoices and goods

Percentage calculations

A) Percentage increase

B) Percentage decrease

(Continued on next page)

(Continued from preceding page)

- C) Profit margin
- D) Compound percentages
- E) Profit and loss
- F) Capital and interest

Costing

Costing with simultaneous control (only CURTA Model # 2)

Calculations with nines transfer

Exchange calculations

Calculations with English currency

## **STATISTICS**

Simultaneous accumulation of a sum and a sum of squares (only CURTA Model # 2)

Computation of arithmetic mean and standard deviation

## **Technical and Survey Calculations**

Division into a negative number (complementary number)

Calculation of co-ordinates

Determination of the amount of silver in an alloy (only CURTA Model # 2)

Determination of the angles in an acute-angled triangle, given three sides (only CURTA Model # 2)

Determination of a side of an obtuse-angled triangle (given the two other sides and their included angle)

Calculation of area from co-ordinates

Calculation of the distance between two points, given their co-ordinates (using Pythagoras' theorem)

Calculation of distance and azimuth (only CURTA Model # 2)

Linear interpolation



## ARITHMETICAL COMPUTATION

### FRACTIONS

**To Reduce Common Fractions:** Divide the numerator and denominator by common divisors until further reduction is impossible:  $63/81 = 21/27 = 7/9$ .

**To Reduce Improper Fractions:** Divide the numerator by the denominator, the quotient being a whole number and the remainder the new numerator:  $43/6 = 43 \div 6 = 7 \frac{1}{6}$ .

**To Express a Fraction as a Decimal:** Divide the numerator by the denominator:  $3/4 = 3.00 \div 4 = 0.75$ .

**To Reduce Complex Fractions:** First express both numerator and denominator as simple fractions then multiply the upper numerator by the lower denominator for the new numerator and the lower numerator by the upper denominator for the new denominator:  $\frac{1\frac{3}{4}}{5/6} = \frac{7/4}{5/6} = \frac{42}{20} = 2\frac{2}{20} = 2\frac{1}{10}$ .

**To Reduce Fractions to a Common Denominator:** Multiply the numerator of each fraction by the product of all of the denominators except its own for the new numerators and multiply all denominators together for the new common denominator:  $2/3, 1/4, 3/5 = 40/60, 15/60, 36/60$ .

**To Add Fractions:** Reduce to a common denominator and add the numerators:  $3/4 + 2/3 = 9/12 + 8/12 = 17/12 = 1\frac{5}{12}$ .

**To Subtract Fractions:** Reduce to a common denominator and subtract numerators:  $3/4 - 2/3 = 9/12 - 8/12 = 1/12$ .

**To Multiply Fractions:** Multiply the numerators for a new numerator and the denominators for a new denominator:  $3/4 \times 5/8 = 15/32$ .

**To Divide Fractions:** Invert the divisor and multiply:  $3/4 \div 7/8 = 3/4 \times 8/7 = 24/28 = 6/7$ .

## DECIMALS

**To Express a Decimal as a Fraction:** Ignore the decimal point and write the figures as the numerator of the fraction. For the denominator write a figure 1 with as many ciphers after it as there were figures following the

decimal point in the original decimal:  $.0125 = \frac{125}{10000}$

**To Add or Subtract Decimals:** Set down the figures so that the decimal points are one above the other and proceed as in simple addition or subtraction.

**To Multiply Decimals:** Proceed as in simple multiplication pointing off as many decimal places in the result as there are in the multiplier and multiplicand together.

**To Divide Decimals:** Proceed as in simple division pointing off as many decimal places in the quotient as there are decimal places in the dividend in excess of the divisor.

## RATIO AND PROPORTION

**Ratio:** The relation of one figure to another is termed the ratio and is sometimes expressed as a fraction with the first quantity as the numerator: the ratio of 1 to 2 =  $1:2 = \frac{1}{2}$ .

**Proportion:** When ratios are equal to each other they are said to be in proportion. The ratio of 3 to 6 =  $3:6 = \frac{1}{2}$ , therefore it is equal to and in proportion to the ratio of 1 to 2 and the proportion would be written  $3:6 = 1:2$  and read '3 is to 6 as 1 is to 2.'

The first and last terms in a statement of proportion are called the extremes and the middle terms the means. A rule of proportion is that 'the product of the extremes is equal to the product of the means'. Thus, in the example given above:  $3 \times 2 = 6$  and  $6 \times 1 = 6$ .

**Mean Proportional:** When the middle terms are identical this quantity is called the mean proportional of the first and last terms. In  $1:2 = 2:4$ , 2 is the mean proportional between 1 and 4. To find the mean proportional of any two terms multiply them and extract the square root of their product: Thus the mean proportional of 2 and 50 is  $\sqrt{2 \times 50} = \sqrt{100} = 10$  and therefore  $2:10 = 10:50$ .

**Formulas Based on Proportion:** If proportion is expressed algebraically as  $a:b=c:d$ , then  $ad = bc$   $\frac{a}{b} = \frac{c}{d}$   
 $a = \frac{bc}{d}$   $b = \frac{ad}{c}$   $c = \frac{ad}{b}$ , and  $d = \frac{bc}{a}$  ; thus having given any three terms the fourth can be determined.

## BUSINESS FORMULA

### DISCOUNT

To find the amount of a discount, multiply the list price, or base, by the rate of discount.

**Formula:**  $P = B \times R$ , indicating the first type of percentage problem.

To find the net price, subtract the amount of the discount from the original or list price.

**Formula:**

$$\begin{aligned} \text{Difference} &= \text{Base} - \text{Percentage} \\ D &= B - P \end{aligned}$$

### COMMISSION OR BROKERAGE

To find the commission, multiply the principal amount, or the base, by the rate of commission.

**Formula:**

Commission (P) = Base (B) x Rate (R),  
or  $P = B \times R$

### INTEREST

Interest problems employ the rules of percentage problems but include the additional factor of time.

The **interest** (I) is the amount of money paid for the use of money.

The **principal** (P) is the base, or the money for the use of which interest is paid.

The **rate** (R) is the percent charged on the basis of one year's use of the money.

The **time** (T) is the number of years, months and days over which the money is used. Note especially that 30 days are considered a month and 360 days are considered a year.

The **amount** (A) is the sum of the principal and the interest.

To find the interest for any given period of time, multiply the principal by the rate by the time.

**Formula:**  $I = P \times R \times T$

To find the amount, add the interest (I) to the principal (P).

**Formula:**  $A = P + I$

To find the rate when the principal, interest and time are given, divide the total interest by the time to get the amount of the interest for one year; then divide this quotient by the principal.

To find the time when the principal, interest and rate percent are given, multiply the principal by the rate to obtain the amount of interest for one year; then divide the total interest by the interest for one year.

To find the principal when the interest, the rate percent and the time are given, divide the interest by the time to get the interest for one year, then divide this by the rate.

To find the principal when the amount, rate percent and time are given, divide the given amount by the amount of \$1 for the given time at the given rate.

## COMPOUND INTEREST

Compound interest is interest which for each successive interest period is figured on a base that represents the original principal plus all the interest that has accrued in previous interest periods.

**To compute compound interest,** add the interest for each period to the principal before figuring the interest for the next period.

## PROFIT AND LOSS

### PROFIT AND LOSS BASED ON COST

**To find the percent gain or loss,** divide the amount gained or lost by the cost.

**To find the gain and the selling price when the cost and the percent gain are given,** multiply the cost by the percent gain and add the result to the cost.

**To find the loss and the selling price when the cost and the percent loss are given,** multiply the cost by the percent loss and subtract the product from the cost.

**To find the cost when the profit and the percent profit are given or to find the cost when the loss and the percent loss are given,** divide the profit or loss by the percent profit or loss.

**To find the cost when the selling price and the percent profit are given,** divide the selling price by 1 plus the percent profit.

To find the cost when the selling price and the percent loss are given, divide the selling price by 1 minus the percent loss.

### **PROFIT AND LOSS BASED ON SELLING PRICE**

To find the percent profit or loss, divide the amount gained or lost by the selling price.

To find the profit and the cost when the selling price and the percent profit are given, multiply the selling price by the percent profit and subtract the result from the selling price.

To find the loss and the cost when the selling price and the percent loss are given, multiply the selling price by the percent loss and add the result to the selling price.

To find the selling price when the profit and the percent profit are given, or to find the selling price when the loss and the percent loss are given, divide the profit or loss by the percent profit or loss.

To find the selling price when the cost and the percent profit are given, subtract the percent profit from 100% and divide the cost by the remainder.

To reduce percent profit on selling price to percent mark-up (percent profit on cost), divide profit on selling price by 100% minus percent profit on selling price.

To find the selling price when the cost and the percent loss are given, add the percent loss to 100% and divide the cost by this sum.

**To reduce percent mark-up (percent profit on cost) to percent profit on selling price,** divide percent mark-up by 100% plus percent mark-up.

**To reduce percent loss on selling price to percent loss on cost,** divide percent loss on selling price by 100% plus percent loss on selling price.

**To reduce percent loss on cost to percent loss on selling price,** divide percent loss on cost by 100% minus percent loss on cost.

## MULTIPLICATION OF DECIMALS

**To multiply decimals,** proceed as in multiplication of whole numbers. But in the product, beginning at the right, point off as many places as there are in the multiplier and in the multiplicand.

**To multiply a decimal by any multiple of ten,** move the decimal point as many places to the right as there are zeros in the multiplier.

## DIVISION OF DECIMALS

**Law of division:** A quotient is not changed when the dividend and divisor are both multiplied by the same number.

**To divide a decimal by a whole number,** proceed as with whole numbers, but place the decimal point in the quotient directly above the decimal point in the dividend.

**To divide a decimal by a decimal,** move the decimal point of the divisor to the right until it becomes a whole number (i.e. multiply it by ten or a multiple of ten). Next move the decimal point of the dividend the same number of places to the right, adding zeros if necessary.

COMPOUND INTEREST - Showing the amount of \$1.00 at various rates

Yr.	2%	2½%	3%	3½%	4%	4½%	5%	5½%	6%	7%
1	1.02000	1.02500	1.03000	1.03500	1.04000	1.04500	1.05000	1.05500	1.06000	1.07000
2	1.04040	1.05063	1.06090	1.07123	1.08160	1.09203	1.10250	1.11303	1.12360	1.14490
3	1.06121	1.07689	1.09273	1.10872	1.12486	1.14117	1.15763	1.17424	1.19102	1.22504
4	1.08243	1.10381	1.12551	1.14752	1.16986	1.19252	1.21551	1.23882	1.26248	1.31080
5	1.10408	1.13141	1.15927	1.18769	1.21665	1.24618	1.27628	1.30696	1.33823	1.40255
6	1.12616	1.15969	1.19405	1.22926	1.26532	1.30226	1.34010	1.37884	1.41852	1.50073
7	1.14869	1.18869	1.22987	1.27228	1.31593	1.36086	1.40710	1.45468	1.50363	1.60578
8	1.17166	1.21840	1.26677	1.31681	1.36857	1.42210	1.47746	1.53469	1.59385	1.71819
9	1.19509	1.24886	1.30477	1.36290	1.42331	1.48610	1.55133	1.61909	1.68948	1.83846
10	1.21899	1.28009	1.34392	1.41060	1.48024	1.55297	1.62889	1.70814	1.79085	1.96715
11	1.24337	1.31209	1.38423	1.45997	1.53945	1.62285	1.71034	1.80209	1.89830	2.10485
12	1.26824	1.34489	1.42576	1.51107	1.60103	1.69588	1.79586	1.90121	2.01220	2.25219
13	1.29361	1.37851	1.46853	1.56396	1.66507	1.77220	1.88565	2.00577	2.13293	2.40985
14	1.31948	1.41297	1.51259	1.61870	1.73168	1.85194	1.97993	2.11609	2.26090	2.57853
15	1.34587	1.44830	1.55797	1.67535	1.80094	1.93528	2.07893	2.23248	2.39656	2.75903
16	1.37279	1.48451	1.60471	1.73399	1.87298	2.02237	2.18287	2.35526	2.54035	2.95216
17	1.40024	1.52162	1.65285	1.79468	1.94790	2.11338	2.29202	2.48480	2.69277	3.15882
18	1.42825	1.55966	1.70243	1.85749	2.02582	2.20848	2.40662	2.62147	2.85434	3.37993
19	1.45681	1.59865	1.75351	1.92250	2.10685	2.30786	2.52695	2.76565	3.02560	3.61653
20	1.48595	1.63862	1.80611	1.98979	2.19112	2.41171	2.65330	2.91776	3.20714	3.86968



SIMPLE INTEREST - Showing the interest on \$1,000 at various rates;  
based on a 30-day month and a 360-day year.

Time	2½%	3%	3½%	4%	4½%	5%	5½%	6%
1 day	0.069	0.083	0.097	0.111	0.125	0.139	0.153	0.167
2 days	0.139	0.167	0.194	0.222	0.250	0.278	0.306	0.333
3 days	0.208	0.250	0.292	0.333	0.375	0.417	0.458	0.500
4 days	0.278	0.333	0.389	0.444	0.500	0.556	0.611	0.667
5 days	0.347	0.417	0.486	0.556	0.625	0.694	0.764	0.833
6 days	0.417	0.500	0.583	0.667	0.750	0.833	0.917	1.000
1 month	2.083	2.500	2.917	3.333	3.750	4.167	4.583	5.000
2 months	4.167	5.000	5.833	6.667	7.500	8.333	9.167	10.000
3 months	6.250	7.500	8.750	10.000	11.250	12.500	13.750	15.000
6 months	12.500	15.000	17.500	20.000	22.500	25.000	27.500	30.000
1 year	25.000	30.000	35.000	40.000	45.000	50.000	55.000	60.000

## TABLE OF CUMULATIVE DISCOUNTS AND NET PRICE FACTORS

To find the net price, multiply the base price by the number that is shown under the principal discount and opposite the desired additional discounts. To compute the net price on a \$10.50 article with discounts of 40-20-5: under 40 and opposite 20-5 we find the number .456. The product of .456 and \$10.50 is \$4.79 net.

To determine the conversion factor on any chain of cumulative discounts not shown in the table, multiply their complementary numbers. Example:

What is the conversion factor of 40-10-2?  
 Solution:  $.60 \times .90 \times .98 = .5920$ .

Additional Discounts	PRINCIPAL DISCOUNT (%)									
	10	20	25	30	35	40	42½	45	47½	
2½	.8775	.78	.73125	.6825	.63375	.585	.56063	.53625	.51188	
5	.855	.76	.7125	.665	.6175	.57	.54625	.5225	.49875	
5-2½	.8336	.741	.69469	.64838	.60206	.55575	.53259	.50944	.48628	
5-5	.8123	.722	.67688	.63175	.58663	.5415	.51894	.49638	.47381	
5-5-2½	.79199	.70395	.65995	.61596	.57196	.52796	.50596	.48397	.46197	
7½	.81169	.74	.69375	.6475	.60125	.555	.53188	.50875	.48563	
7½-2½	.7914	.7215	.67641	.63131	.58622	.54113	.51858	.49603	.47348	
7½-5	.77111	.703	.65906	.61513	.57119	.52725	.50528	.48331	.46134	
7½-5-2½	.67933	.68542	.64259	.59975	.55961	.51407	.49265	.47123	.44981	

PRINCIPAL DISCOUNT (%)

Additional Discounts	PRINCIPAL DISCOUNT (%)									
	10	20	25	30	35	40	42½	45	47½	
10	.81	.72	.675	.63	.585	.54	.5175	.495	.4725	
10-2½	.789	.702	.65813	.61425	.57038	.5265	.50456	.48263	.46069	
10-5	.7695	.684	.64125	.5985	.55575	.513	.49163	.47025	.44888	
10-5-2½	.7503	.6669	.62522	.58354	.54186	.50018	.47933	.45849	.43765	
10-7½	.74925	.666	.62438	.58275	.54113	.4995	.47869	.45788	.43706	
10-7½-2½	.73052	.64935	.60877	.56818	.5276	.48701	.46672	.44643	.42614	
10-7½-5	.71179	.6237	.59316	.55361	.51407	.47453	.45475	.43498	.41521	
10-7½-5-2½	.69398	.6081	.57833	.53977	.50122	.46266	.44338	.42411	.40483	
10-10	.729	.648	.6075	.567	.5265	.486	.46575	.4455	.42525	
10-10-2½	.70178	.6218	.59231	.55283	.51334	.47385	.45411	.43436	.41462	
10-10-5	.6925	.6156	.57713	.53865	.50018	.4617	.44246	.42323	.40399	
10-10-5-2½	.6752	.6002	.5627	.52518	.48768	.45016	.4314	.41264	.39389	
10-10-7½	.66433	.5994	.56194	.52448	.48701	.44955	.43082	.41209	.39336	
10-10-7½-2½	.64772	.58442	.54789	.51136	.47484	.43831	.42005	.40179	.38352	
10-10-7½-5	.63111	.56943	.53384	.49825	.46266	.42707	.40928	.39149	.37369	
10-10-7½-5-2½	.61533	.55519	.52049	.4858	.45109	.4164	.39905	.3817	.36435	
10-10-10	.6561	.5832	.54675	.5103	.47385	.4374	.41918	.40095	.38273	

Additional

PRINCIPAL DISCOUNT (%)

Discounts	PRINCIPAL DISCOUNT (%)									
	10	20	25	30	35	40	42½	45	47½	
10-10-10-2½	.6397	.56862	.53308	.49854	.462	.42647	.4087	.39093	.37316	
10-10-10-5	.6233	.55403	.51941	.48479	.45016	.41553	.39822	.3809	.36359	
10-10-10-5-2½	.60771	.54018	.49344	.47257	.4389	.40514	.38807	.37138	.3545	
10-10-10-10	.5905	.5248	.4921	.4593	.4265	.3937	.37725	.3609	.34445	
10-10-10-10-5	.561	.4986	.4675	.4363	.40518	.374	.35839	.34286	.32723	
15	.765	.68	.6375	.595	.5525	.51	.48875	.4675	.44625	
15-2½	.7459	.663	.62156	.5801	.53869	.4973	.47653	.4558	.43509	
15-5	.7268	.646	.60563	.5653	.52488	.4845	.46431	.44413	.42384	
15-10	.6885	.612	.57375	.5355	.49725	.459	.43988	.42075	.40163	
20	.72	.64	.6	.56	.52	.48	.46	.44	.42	
20-5	.684	.608	.57	.532	.494	.456	.437	.418	.399	
20-10	.648	.576	.54	.504	.468	.432	.414	.396	.378	
20-10-5	.6156	.5472	.513	.4788	.4446	.4104	.3933	.3762	.3591	
25	.675	.6	.5625	.525	.4875	.45	.43125	.4125	.39375	
25-5	.6413	.57	.53438	.4987	.46313	.4275	.4097	.39198	.37406	
25-10	.6075	.54	.50625	.4725	.43875	.405	.38813	.37125	.35438	
25-10-5	.5771	.513	.48094	.4488	.41681	.3848	.36872	.3527	.33666	

PRINCIPAL DISCOUNT (%)

Additional Discounts	50	52½	55	57½	60	62½	65	67½	70
2½	.4875	.46313	.43875	.41438	.39	.36563	.34125	.31688	.2925
5	.475	.45125	.4275	.40375	.38	.35625	.3325	.30875	.285
5-2½	.46313	.43997	.41681	.39366	.3705	.34734	.32419	.30103	.27788
5-5	.45125	.42869	.40613	.38356	.361	.33844	.31588	.29331	.27075
5-5-2½	.43997	.41797	.39597	.37397	.35198	.32998	.30798	.28598	.26398
7½	.4625	.43938	.41625	.39313	.37	.34688	.32375	.30063	.2775
7½-2½	.45094	.42839	.40584	.3833	.36075	.3382	.31566	.29311	.27056
7½-5	.43938	.41741	.39544	.37347	.3515	.32953	.30756	.28559	.26363
7½-5-2½	.42839	.40697	.38555	.36413	.34271	.32129	.29987	.27845	.25703
10	.45	.4275	.405	.3825	.36	.3375	.315	.2925	.27
10-2½	.43875	.41681	.39488	.37294	.351	.32906	.30713	.28519	.26325
10-5	.4275	.40613	.38475	.36338	.342	.32063	.29925	.27788	.2565
10-5-2½	.41681	.39597	.37513	.35429	.33345	.31261	.29177	.27093	.25009
10-7½	.41625	.39544	.37463	.35381	.333	.31219	.29138	.27056	.24975
10-7½-2½	.40584	.38555	.36526	.34497	.32468	.30438	.28409	.2638	.24351

PRINCIPAL DISCOUNT (%)

Additional Discounts	PRINCIPAL DISCOUNT (%)									
	50	52½	55	57½	60	62½	65	67½	70	
10-7½-5	.39544	.37567	.35589	.33612	.31635	.29658	.27681	.25703	.23726	
10-7½-5-2½	.38555	.36627	.347	.32772	.30844	.28916	.26989	.25061	.23133	
10-10	.405	.38475	.3645	.34425	.324	.30375	.2835	.26325	.243	
10-10-2½	.39488	.37513	.35539	.33564	.3159	.29616	.27641	.25667	.23693	
10-10-5	.38475	.36551	.34628	.32704	.3078	.28856	.26933	.25099	.23085	
10-10-5-2½	.37513	.35637	.33762	.31886	.30011	.28135	.26259	.24384	.22508	
10-10-7½	.37463	.35589	.33716	.31843	.2997	.28097	.27224	.24351	.22478	
10-10-7½-2½	.36526	.347	.32873	.31047	.29221	.27394	.25568	.23742	.21916	
10-10-7½-5	.35589	.3381	.3203	.30251	.28472	.26692	.24913	.23133	.21354	
10-10-7½-5-2½	.347	.32965	.3123	.29495	.2776	.26025	.2429	.22555	.2082	
10-10-10	.3645	.34628	.32805	.30983	.2916	.27338	.25515	.23693	.2187	
10-10-10-2½	.35539	.33762	.31985	.30208	.28431	.26654	.24877	.231	.21323	
10-10-10-5	.34628	.32897	.31165	.29434	.27702	.25971	.24239	.22508	.20777	
10-10-10-5-2½	.33762	.32074	.30386	.28698	.27009	.25321	.23633	.21945	.20257	

PRINCIPAL DISCOUNT (%)

Additional Discounts	50	52½	55	57½	60	62½	65	67½	70
10-10-10-10	.3281	.31164	.2952	.27884	.2624	.24604	.22964	.21323	.19683
10-10-10-10-5	.3116	.29606	.28044	.2649	.2493	.23374	.21815	.20257	.18699
15	.4250	.40375	.3825	.36125	.34	.31875	.2975	.27625	.255
15-2½	.4144	.39366	.37294	.35222	.3315	.31078	.29006	.26934	.24863
15-5	.4038	.38356	.36238	.3432	.323	.30281	.28262	.26244	.24225
15-10	.3825	.36338	.34425	.32513	.3062	.28668	.26775	.24863	.2295
20	.4	.38	.36	.34	.32	.3	.28	.26	.24
20-5	.38	.361	.342	.323	.304	.285	.266	.247	.228
20-10	.36	.342	.324	.306	.288	.27	.252	.234	.216
20-10-5	.342	.3249	.3078	.2907	.2736	.2565	.2394	.2233	.2052
25	.375	.35625	.3375	.31875	.3	.28125	.2625	.24375	.225
25-5	.2563	.33844	.32063	.30281	.285	.26719	.24938	.23156	.21375
25-10	.3375	.32063	.30375	.28788	.27	.25313	.23625	.22238	.2025
25-10-5	.32063	.3046	.28836	.27349	.2565	.24047	.22444	.21126	.19238

Additional Discounts	PRINCIPAL DISCOUNT (%)									
	7 2/2%	7 5	7 7 1/2%	8 0	8 2 1/2%	8 5	8 7 1/2%	9 0		
2 1/2%	.26813	.24375	.21938	.195	.17063	.14625	.12188	.0975		
5	.26125	.2375	.21375	.19	.16625	.1425	.11875	.095		
5-2 1/2%	.25472	.23156	.20841	.18525	.16209	.13894	.11578	.09263		
5-5	.24819	.22563	.20306	.1805	.15794	.13538	.11281	.09205		
5-5-2 1/2%	.24198	.21998	.19799	.17599	.15399	.13199	.10999	.08799		
7 1/2%	.25438	.23125	.20813	.185	.16188	.13875	.11563	.0925		
7 1/2-2 1/2%	.24802	.22547	.20292	.18038	.15783	.13528	.11273	.09019		
7 1/2-5	.24166	.21969	.19772	.17575	.15378	.13181	.10984	.08788		
7 1/2-5-2 1/2%	.23561	.2142	.19278	.17136	.14994	.12852	.1071	.08568		
10	.2475	.225	.2025	.18	.1575	.135	.1125	.09		
10-2 1/2%	.24131	.21938	.19774	.1755	.15356	.13163	.10969	.08755		
10-5	.23513	.21375	.19238	.171	.14963	.12825	.10688	.0855		
10-5-2 1/2%	.22925	.20841	.18757	.16673	.14588	.12504	.1042	.08336		
10-7 1/2%	.22894	.20813	.18731	.1665	.14569	.12488	.10406	.08325		
10-7 1/2-2 1/2%	.22321	.20292	.18263	.16234	.14205	.12175	.10146	.08117		



PRINCIPAL DISCOUNT (%)

Additional

Discounts

	7 2½	75	77½	80	82½	85	87½	90
10-7½-5	.21749	.19772	.17795	.15818	.1384	.11863	.09886	.07909
10-7½-5-2½	.21205	.19278	.1735	.15422	.13494	.11567	.09639	.07711
10-10	.22275	.2025	.18225	.162	.14175	.1215	.10125	.081
10-10-2½	.21718	.19744	.17669	.15795	.13821	.11846	.09872	.07898
10-10-5	.21161	.19238	.17314	.1539	.13466	.11543	.09619	.07695
10-10-5-2½	.20632	.18757	.16881	.15005	.1313	.11254	.09378	.07503
10-10-7½	.20604	.18731	.16858	.14985	.13112	.11239	.09366	.07493
10-10-7½-2½	.20089	.18263	.16437	.1461	.12784	.10958	.09131	.07305
10-10-7½-5	.19574	.17795	.16015	.14236	.12456	.10677	.08897	.07118
10-10-7½-5-2½	.19085	.1735	.15615	.1388	.12145	.1041	.08675	.0694
10-10-10	.20048	.18225	.16403	.1458	.12758	.10935	.09113	.0729
10-10-10-2½	.19546	.17769	.15592	.14216	.12439	.10662	.08885	.07108
10-10-10-5	.19045	.17314	.15582	.13851	.1212	.10388	.08657	.06926
10-10-10-5-2½	.18569	.16881	.15193	.13505	.11817	.10129	.08441	.06752

## Additional

## PRINCIPAL DISCOUNT (%)

Discounts	PRINCIPAL DISCOUNT (%)								
	7 2/2%	7 5	7 7 1/2%	8 0	8 2 1/2%	8 5	8 7 1/2%	9 0	
10-10-10-10	.18043	.16403	.14762	.13122	.11482	.09842	.08201	.06561	
10-10-10-10-5	.17141	.15582	.14024	.12466	.10908	.09349	.07791	.06233	
15	.23205	.2125	.19125	.17	.14875	.1275	.10625	.0765	
15-2 1/2%	.22625	.20719	.18647	.1658	.14503	.12431	.10359	.07459	
15-5	.22045	.20188	.18169	.1615	.13731	.12112	.10094	.07268	
15-10	.20885	.19125	.17213	.153	.13388	.11475	.09563	.06541	
20	.22	.2	.18	.16	.14	.12	.1	.08	
20-5	.209	.19	.171	.152	.133	.114	.095	.076	
20-10	.198	.18	.162	.144	.126	.108	.09	.072	
20-10-5	.1881	.171	.1539	.1368	.1197	.1026	.0855	.0684	
25	.20625	.1875	.16875	.15	.13125	.1125	.09375	.075	
25-5	.19594	.17813	.16031	.1425	.12469	.10688	.08906	.07125	
25-10	.18563	.16875	.15188	.135	.11813	.10125	.08438	.0675	
25-10-5	.17635	.16031	.14429	.1283	.11222	.09629	.08016	.06413	

STATISTICAL FORMULA  
MEASURES OF CENTRAL TENDENCY

Arithmetic Mean =  $\bar{X}$   
when X refers to the values of the individual items,  $\Sigma$  (sigma) means that these values are to be summed, and n refers to the number of items.

UNGROUPED DATA

$$\bar{X} = \frac{\Sigma X}{n}$$

GROUPED DATA

The mean of a frequency distribution with equal class intervals:

Where

$X_b$  = the mid point of any class

n = total frequencies

i = class width

For any class:

F = class frequency

d = unit deviation of class  
mid point from  $X_b$

$$\bar{X} = X_b + \frac{\Sigma Fd}{n} \cdot i$$

## MEDIAN (SHORT METHOD) GROUPED DATA

$$\text{MED} = L + \left[ \frac{\frac{N}{2} - \sum FP}{F_{\text{Med}}} \right] \cdot i$$

$L$  = lower limit of median class

$\frac{N}{2}$  = number of frequencies  $\div 2$

$\sum F_p$  = sum of the frequencies prior to the median class

$F_{\text{med}}$  = frequencies in median class

$i$  = width of the class

## MODE - GROUPED DATA

$$\text{MODE} = L_1 + \left[ \frac{d_1}{d_1 + d_2} \right] \cdot i$$

$L_1$  = lower limit of modal class

$d_1$  = absolute difference between modal class frequency and class frequency prior to it.

$d_2$  = absolute difference between modal class frequency and frequency subsequent to it.

## STANDARD DEVIATION

### Short Form Group Data (Small Sample)

$$s_x = i \sqrt{\frac{\sum Fd^2 - \left(\frac{\sum Fd}{n}\right)^2}{N - 1}}$$

### Large Sample Group Data

$$s_x = i \sqrt{\frac{\sum Fd^2}{N} - \left(\frac{\sum Fd}{N}\right)^2}$$

### Ungrouped Small Sample

$$s_x = \sqrt{\frac{\sum X^2}{N-1} - \frac{(\sum X)^2}{N(N-1)}}$$

$s_x$  = standard deviation

$\sum$  = sum

$d$  = deviations

$F$  = frequency

$N$  = number of items

$i$  = class width

$X$  = value of item

## SAMPLING

### For Infinite Populations

$$\sigma_{\bar{X}} = \frac{\sigma X}{\sqrt{n}}$$

### For Finite Populations

$$\sigma_{\bar{X}} = \sqrt{\frac{N - n}{N - 1} \cdot \frac{\sigma X}{\sqrt{n}}}$$

$\sigma \bar{x}$  = standard deviation of the population being sampled

$N$  = finite population size

$n$  = sample size

$\frac{N - n}{N - 1}$  = finite correction factor

## SAMPLING

Standard Deviation of the Sample Mean

### Infinite Populations

$$s \bar{x} = \frac{s_x}{\sqrt{n}}$$

### Finite Populations

$$s \bar{x} = \sqrt{\frac{N - n}{N - 1} \cdot \frac{s_x}{\sqrt{n}}}$$

$s_x$  = sample deviation

Confidence Interval for Population Mean Simple Large Random Sample

$$\bar{X} = \pm z s \bar{x}$$

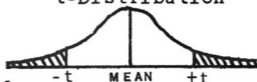
$z$  = normal deviate

### Small Sample

$$\bar{X} \pm t_{n-1} s \bar{x}$$

$t$  =  $t$  multiple

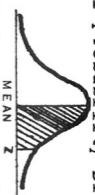
Table of t-Values Corresponding to Various Areas in Both Tails of t-Distribution



Degrees of Confidence	.90	.95	.98	.99
Degrees of Freedom	Total Area in Both Tails			
1	6.314	12.706	31.821	63.657
2	2.920	4.303	6.965	9.925
3	2.353	3.182	4.541	5.841
4	2.132	2.776	3.747	4.604
5	2.015	2.571	3.365	4.032
6	1.943	2.447	3.143	3.707
7	1.895	2.365	2.998	3.499
8	1.860	2.306	2.896	3.355
9	1.833	2.262	2.821	3.250
10	1.812	2.228	2.764	3.169
11	1.796	2.201	2.718	3.106
12	1.782	2.179	2.681	3.055
13	1.771	2.160	2.650	3.012
14	1.761	2.145	2.624	2.977
15	1.753	2.131	2.602	2.947
16	1.746	2.120	2.583	2.921
17	1.740	2.110	2.567	2.898
18	1.734	2.101	2.552	2.878
19	1.729	2.093	2.539	2.861
20	1.725	2.086	2.528	2.845
21	1.721	2.080	2.518	2.831
22	1.717	2.074	2.508	2.819
23	1.714	2.069	2.500	2.807
24	1.711	2.064	2.492	2.797
25	1.708	2.060	2.485	2.787
26	1.706	2.056	2.479	2.779
27	1.703	2.052	2.473	2.771
28	1.701	2.048	2.467	2.763
29	1.699	2.045	2.462	2.756
30	1.697	2.042	2.457	2.750
Normal Distribution	1.645	1.960	2.326	2.576

Illustration: The t-value for 9 degrees of freedom corresponding to area of .05 in both tails is 2.262.

Table of Areas from Mean to Distance z from Mean  
for Normal Probability Distribution



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.0000	.0040	.0080	.0120	.0160	.0199	.0239	.0279	.0319	.0359
0.1	.0398	.0438	.0478	.0517	.0557	.0596	.0636	.0675	.0714	.0753
0.2	.0793	.0832	.0871	.0910	.0948	.0987	.1026	.1064	.1103	.1141
0.3	.1179	.1217	.1255	.1293	.1331	.1368	.1406	.1443	.1480	.1517
0.4	.1554	.1591	.1628	.1664	.1700	.1736	.1772	.1808	.1844	.1879
0.5	.1915	.1950	.1985	.2019	.2054	.2088	.2123	.2157	.2190	.2224
0.6	.2257	.2291	.2324	.2357	.2389	.2422	.2454	.2486	.2518	.2549
0.7	.2580	.2612	.2642	.2673	.2704	.2734	.2764	.2794	.2823	.2852
0.8	.2881	.2910	.2939	.2967	.2995	.3023	.3051	.3078	.3106	.3133
0.9	.3159	.3186	.3212	.3238	.3264	.3289	.3315	.3340	.3365	.3389
1.0	.3413	.3438	.3461	.3485	.3508	.3531	.3554	.3577	.3599	.3621
1.1	.3643	.3665	.3686	.3706	.3729	.3749	.3770	.3790	.3810	.3830
1.2	.3849	.3869	.3888	.3907	.3925	.3944	.3962	.3980	.3997	.4015
1.3	.4032	.4049	.4066	.4082	.4099	.4115	.4131	.4147	.4162	.4177
1.4	.4192	.4207	.4222	.4236	.4251	.4265	.4279	.4292	.4306	.4319



z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
1.5	.4332	.4345	.4357	.4370	.4382	.4394	.4406	.4418	.4429	.4441
1.6	.4452	.4463	.4474	.4484	.4495	.4505	.4515	.4525	.4535	.4545
1.7	.4554	.4564	.4573	.4582	.4591	.4599	.4608	.4616	.4625	.4633
1.8	.4641	.4649	.4656	.4664	.4671	.4678	.4686	.4693	.4699	.4706
1.9	.4713	.4719	.4726	.4732	.4738	.4744	.4750	.4756	.4761	.4767
2.0	.4772	.4778	.4783	.4788	.4793	.4798	.4803	.4808	.4812	.4817
2.1	.4821	.4826	.4830	.4834	.4838	.4842	.4846	.4850	.4854	.4857
2.2	.4861	.4864	.4868	.4871	.4875	.4878	.4881	.4884	.4887	.4890
2.3	.4893	.4896	.4898	.4901	.4904	.4906	.4909	.4911	.4913	.4916
2.4	.4918	.4920	.4922	.4925	.4927	.4929	.4931	.4932	.4934	.4936
2.5	.4938	.4940	.4941	.4943	.4945	.4946	.4948	.4949	.4951	.4952
2.6	.4953	.4955	.4956	.4957	.4959	.4960	.4961	.4962	.4963	.4964
2.7	.4965	.4966	.4967	.4968	.4969	.4970	.4971	.4972	.4973	.4974
2.8	.4974	.4975	.4976	.4977	.4977	.4978	.4979	.4979	.4980	.4981
2.9	.4981	.4982	.4982	.4983	.4984	.4984	.4985	.4985	.4986	.4986
3.0	.49865	.4987	.4987	.4988	.4988	.4989	.4989	.4989	.4990	.4990
4.0	.4999683									

Illustration: For  $z = 1.93$ , shaded area is .4732 out of total area of 1.

# USEFUL TABLES AND RULES

## WEIGHTS AND MEASURES

### MEASURES OF LENGTH

12	inches (in.)	=	1 foot	ft.
3	feet	=	1 yard	yd.
5½	yards	=	1 rod	rd.
5,280	feet	=	1 statute mile	mi.
6,080	feet	=	1 nautical mile	mi.
6	feet	=	1 fathom	f.
7.92	inches	=	1 link	li.
100	links	=	1 chain	ch.
80	chains	=	1 statute mile	mi.
1	mil	=	.001 inch	
1	microinch	=	.000001 inch	

### MEASURES OF AREA

144	square inches (sq. in.)	=	1 square foot	sq. ft.
9	square feet	=	1 square yard	sq. yd.
30¼	square yards	=	1 square rod	sq. rd.
272¼	square feet	=	1 square rod	
160	square rods	=	1 acre	A.
640	acres	=	1 square mile	sq. mi.
1	circular inch	=	.7854 square inch	
1	square inch	=	1.2732 circular inches	
1	circular mil	=	area of a circle .001 inch in diameter	
1	square inch	=	1,273,239 circular mils	
A square 208.71 ft. on a side contains 1A., or 43,560 sq. ft.				
A square mile, or 640 A., is known as a <i>section</i> .				

### AVOIRDUPOIS WEIGHT

437.5	grains (gr.)	=	1 ounce	oz.
16	ounces (7,000 grains)	=	1 pound	lb.
2,000	pounds	=	1 short ton	T.
2,240	pounds	=	1 long ton	T.

### TROY WEIGHT

24	grains (gr.)	=	1 pennyweight	dwt.
20	pennyweights	=	1 ounce	oz.
12	ounces (5,760 grains)	=	1 pound	lb.

### APOTHECARIES' (DRUGGISTS') WEIGHT

20	grains (gr.)	=	1 scruple	sc.
3	scruples	=	1 dram	dr.
8	drams	=	1 ounce	oz.
12	ounces (5,760 grains)	=	1 pound	lb.
The grain has the same value in all three of these systems of weight.				

### CUBIC MEASURE

1,728	cubic inches (cu. in.)	=	1 cubic foot	cu. ft.
27	cubic feet	=	1 cubic yard	cu. yd.
128	cubic feet	=	1 cord (of wood)	cd.
16½ to 25	cubic feet	=	1 perch (of masonry)	P.
100	cubic feet	=	1 register ton	
{				
1	U. S. shipping ton.	= 40 cubic feet		
		= 31.16 imperial bushels		
		= 32.143 U. S. bushels		
1	British shipping ton.	= 42 cubic feet		
		= 32.719 imperial bushels		
		= 33.75 U. S. bushels		

## UNITED STATES LIQUID MEASURE

4 gills (gi.)	= 1 pint	= 1 pint	pt.
2 pints	= 1 quart	= 1 quart	qt.
4 quarts	= 1 gallon	= 1 gallon	gal.
31 1/2 gallons	= 1 barrel	= 1 barrel	bbl.

The U. S. gallon contains 231 cu. in.; hence, there are 7.481 gal. in a cu. ft.

## MEASURES OF TIME

60 seconds (sec.)	= 1 minute	= 1 minute	min.
60 minutes	= 1 hour	= 1 hour	hr.
24 hours	= 1 day	= 1 day	da.
7 days	= 1 week	= 1 week	wk.
365 days	= 1 year	= 1 year	yr.

## MISCELLANEOUS MEASURES

12 articles	= 1 dozen	1 league	= 3 miles
12 dozen	= 1 gross	1 fathom	= 6 feet
12 gross	= 1 great gross	1 hand	= 4 inches
20 articles	= 1 score	1 palm	= 3 inches
24 sheets	= 1 quire	1 span	= 9 inches
20 quires	= 1 ream		

## METRIC SYSTEM

### MEASURES OF LENGTH

1,000 microns	= 1 millimeter	= 1 millimeter	mm.
10 millimeters	= 1 centimeter	= 1 centimeter	cm.
10 centimeters	= 1 decimeter	= 1 decimeter	dm.
10 decimeters	= 1 meter	= 1 meter	m.
10 meters	= 1 decameter	= 1 decameter	Dm.
10 decameters	= 1 hectometer	= 1 hectometer	Hm.
10 hectometers	= 1 kilometer	= 1 kilometer	Km.

### MEASURES OF SURFACE (NOT LAND)

100 square millimeters (mm. <sup>2</sup> )	= 1 square centimeter	= 1 square centimeter	cm <sup>2</sup> .
100 square centimeters	= 1 square decimeter	= 1 square decimeter	dm <sup>2</sup> .
100 square decimeters	= 1 square meter	= 1 square meter	m <sup>2</sup> .

### MEASURES OF VOLUME

1,000 cubic millimeters (mm. <sup>3</sup> )	= 1 cubic centimeter	= 1 cubic centimeter	cm <sup>3</sup> .
1,000 cubic centimeters	= 1 cubic decimeter	= 1 cubic decimeter	dm <sup>3</sup> .
1,000 cubic decimeters	= 1 cubic meter	= 1 cubic meter	m <sup>3</sup> .

## UNITED STATES DRY MEASURE

2 pints (pt.)	= 1 quart	= 1 quart	qt.
8 quarts	= 1 peck	= 1 peck	pk.
4 pecks	= 1 bushel	= 1 bushel	bu.

The U. S. struck bushel (level full) contains 2,150.42 cu. in.; a heaped bushel contains 1 1/4 struck bushels.

## BRITISH IMPERIAL MEASURE

4 gills	= 1 pint	= 34.683 cu. in.	
2 pints	= 1 quart	= 69.366 cu. in.	
4 quarts	= 1 gallon	= 277.463 cu. in.	
2 gallons	= 1 peck	= 554.926 cu. in.	
4 pecks	= 1 bushel	= 2,219.704 cu. in.	

One imperial gallon contains approximately 1.2 U. S. gal.; and one imperial bushel contains approximately 1.03 U. S. bu.

## CIRCULAR MEASURE

60 seconds (")	= 1 minute	= 1 minute	'
60 minutes	= 1 degree	= 1 degree	°
90 degrees	= 1 quadrant	= 1 quadrant	□
360 degrees	= 1 circle	= 1 circle	⊙

### MEASURES OF CAPACITY

10 milliliters (ml.)	=	1 centiliter	cl.
10 centiliters	=	1 deciliter	dl.
10 deciliters	=	1 liter	l.
10 liters	=	1 decaliter	Dl.
10 decaliters	=	1 hectoliters	Hl.
10 hectoliters	=	1 kiloliters	Kl.

The liter is equal to the volume that is occupied by 1 cubic decimeter.

### MEASURES OF WEIGHT

10 milligrams (mg.)	=	1 centigram	cg.
10 centigrams	=	1 decigram	dg.
10 decigrams	=	1 gram	g.
10 grams	=	1 decagram	Dg.
10 decagrams	=	1 hectogram	Hg.
10 hectograms	=	1 kilogram	Kg.
1,000 kilograms	=	1 ton (metric)	M.T.

The gram is the weight of 1 cubic centimeter of pure distilled water at a temperature of 39.2° F.; the kilogram is the weight of 1 liter of water; the ton is the weight of 1 cubic meter of water.

## METRIC CONVERSION FACTORS

### MEASURES OF LENGTH

1 millimeter	=	.03937 in.
1 centimeter	=	.3937 in.
		= 39.37 in.
1 meter	=	3.28083 ft.
		= 1.0936 yd.
1 kilometer	=	3280.83 ft.
		= 1093.61 yd.
		= .62137 mi.
1 inch	=	25.4 mm.
		= 2.54 cm.
		= .0254 m.
1 foot	=	304.8 mm.
		= .3048 m.
1 yard	=	.9144 m.
1 mile	=	1.609 km.

### MEASURES OF AREA

1 square millimeter	=	.00155 sq. in.
1 square centimeter	=	.155 sq. in.
1 square meter	=	10.764 sq. ft.
		= 1.196 sq. yd.
1 are	=	.0247 acre
		= 1076.4 sq. ft.
1 hectare	=	2.471 acres
		= 107,640 sq. ft.
1 square kilometer	=	.3861 sq. mi.
		= 247.1 acres
1 square inch	=	645.2 sq. mm.
		= 6.452 sq. cm.
1 square foot	=	929 sq. cm.
		= .0929 sq. m.
1 square yard	=	.836 sq. m.
1 acre	=	40.47 ares
		= .4047 hec.
1 square mile	=	2.5899 sq. km.

## MEASURES OF VOLUME AND CAPACITY

		= 1 cu. dm.
	}	= 61.023 cu. in.
1 liter .....		= .0353 cu. ft.
	}	= 2.202 lb. water at 62° F.
		= 1.0567 U. S. qt.
1 cubic centimeter .....	}	= .2642 U. S. gal.
		= .061 cu. in.
1 cubic meter .....	}	= 264.2 U. S. gal
		= 1.308 cu. yd.
1 cubic inch .....	}	= 35.314 cu. ft.
		= 16.387 cu. cm.
1 cubic foot .....	}	= 28.317 cu. dm.
		= 28.317 l.
1 cubic yard .....	}	= .02832 cu. m.
		= .7645 cu. m.
1 U. S. gallon .....		= 3.785 l.
1 British gallon .....		= 4.543 l.
1 U. S. quart .....		= .946 l.

## MEASURES OF WEIGHT

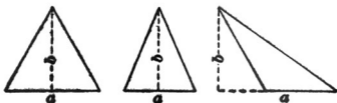
1 gram .....		= 15.432 gr.
	}	= 2.2046 lb. (av.)
1 kilogram .....		= 35.274 oz. (av.)
	}	= 2204.6 lb. (av.)
1 metric ton .....		= .9842 long ton
	}	= 1.1023 short ton
1 grain .....		= .0648 g.
1 ounce (av.) .....		= 28.35 g.
1 pound (av.) .....		= .4536 kg.
1 short ton .....		= .907 M. T.
	}	= 1.016 M. T.
1 long ton .....		= 1016 kg.

## MISCELLANEOUS CONVERSION FACTORS

		= 33,000 ft. - lb. per min.
	}	= 550 ft. - lb. per sec.
1 horsepower .....		= 2,546 B. t. u. per hr.
	}	= 42.4 B. t. u. per min.
		= .71 B. t. u. per sec.
	}	= 746 watts
		= 1,000 watts
1 kilowatt .....	}	= 1.34 hp
		= 44,250 ft. - lb. per min.
	}	= 57 B. t. u. per min.
		= Unit of electrical power
	}	= .00134 hp.
1 watt .....		= 44.25 ft. - lb. per min.
	}	= .74 ft. - lb. per sec.
		= 3.42 B. t. u. per hr.
a degree Fahrenheit .....		= .555°C.
1 degree centigrade .....		= 1.8°F.
1 B. t. u. .....		= 777.5 ft. - lb.
1 calorie .....		= 3.968 B. t. u.
1 pound per square inch .....		= .0703 kg. per sq. cm.
1 gram per square millimeter .....		= 1.422 lb. per sq. in.
1 pound per square foot .....		= 4.882 kg. per sq. m.
	}	= 1.133 ft. water
1 inch mercury .....		= .4912 lb. per sq. in.

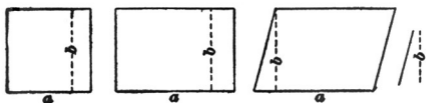
# MENSURATION

## TRIANGLES



Area = base  $a$  times  $\frac{1}{2}$  altitude  $b$ .

## QUADRILATERALS



Area = base  $a$  times altitude  $b$ .



Area = area of rectangle  $a$  plus area of triangles  $b$ ,  $c$ , and  $d$ .

Area = triangle  $e$  + area of triangle  $f$ .

Area = area of rectangle  $a$  plus area of triangles  $b$  and  $c$ .



## CIRCLE

Circumference of circle = 3.1416 times the diameter,  $3 \frac{1}{7}$  times the diameter, approximately;  $\pi$  times the diameter

(written  $\pi d$ ); 6.2832 times the radius, or  $2\pi r$ ; 4 times the area divided by the diameter.

Area of circle = half the diameter multiplied by half the circumference; .7854 times the square of the diameter; 3.1416 times the square of half the diameter; square of the radius multiplied by 3.1416: circumference times the diameter divided by 4

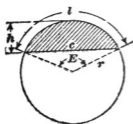
Radius of circle = half the diameter; circumference multiplied by .159155; circumference divided by 6.2832; .564189 times the square root of the area.

Diameter of circle = twice the radius; circumference divided by 3.1416; circumference multiplied by .3183; 1.128 times the square root of the area.



Sector

Area of sector of circle = length of arc  $l$  times half its radius  $r$ ; area of whole circle divided by 360 and multiplied by the number of degrees in the angle  $E$ . Square of the radius multiplied by the number of degrees in the angle  $E$  and by .00873.

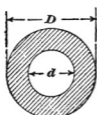


Segment

Area of segment of circle = area of sector minus the area of the triangle formed by the chord and the two radii =  $\frac{1}{2} lr - [c(r-h)]$ .

(Note: When either the angle E or the chord c is known the other may be found from a table of sines.)

Height h of segment of a circle =  
 $= r - \sqrt{r^2 - \frac{1}{4}c^2}$



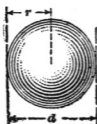
Ring

Area of ring = area of the large circle D minus the area of the small circle d  
 $= \frac{\pi}{4}(D^2 - d^2)$ .



Ellipse

Area of ellipse = product of long diameter D and short diameter d multiplied by .7854.

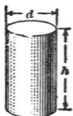


Sphere

Area of surface of sphere = square of diameter multiplied by 3.1416.

Volume of sphere = cube of the diameter multiplied by .5236; or the cube of the radius multiplied by 4.1888.

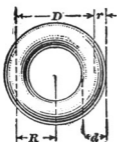




Cylinder

Area of surface of cylinder = circumference multiplied by the height plus the area of both ends.

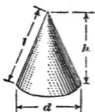
Volume of cylinder = area of base times the height or length; .7854 times square of diameter times height; 3.1416 times square of radius times height.



Circular Ring

Area of surface of circular link = 9.8696 times the mean diameter  $D$  times  $d$ .

Volume of circular link = 2.4674 times  $D$  times square of  $d$ .



Cone

Area of convex surface of cone = 1.5708 times diameter of base times slant height.

Total surface = convex surface plus .7854 times square of diameter.

Volume of cone = square of the diameter of the base multiplied by .7854 times one-third of the height.

## Powers and Roots

n	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt[3]{n}$
1	1	1	1.0000000	1.0000000
2	4	8	1.4142136	1.2599210
3	9	27	1.7320508	1.4422496
4	16	64	2.0000000	1.5874011
5	25	125	2.2360680	1.7099759
6	36	216	2.4494897	1.8171206
7	49	343	2.6457513	1.9129312
8	64	512	2.8284271	2.0000000
9	81	729	3.0000000	2.0800838
10	100	1000	3.1622777	2.1544347
11	121	1331	3.3166248	2.2239801
12	144	1728	3.4641016	2.2894285
13	169	2197	3.6055513	2.3513347
14	196	2744	3.7416574	2.4101423
15	225	3375	3.8729833	2.4662121
16	256	4096	4.0000000	2.5198421
17	289	4913	4.1231056	2.5712816
18	324	5832	4.2426407	2.6207414
19	361	6859	4.3588989	2.6684016
20	400	8000	4.4721360	2.7144176
21	441	9261	4.5825757	2.7589242
22	484	10648	4.6904158	2.8020393
23	529	12167	4.7958315	2.8438670
24	576	13824	4.8989795	2.8844991
25	625	15625	5.0000000	2.9240177
26	676	17576	5.0990195	2.9624961
27	729	19683	5.1961524	3.0000000
28	784	21952	5.2915026	3.0365890
29	841	24389	5.3851648	3.0723168
30	900	27000	5.4772256	3.1072325
31	961	29791	5.5677644	3.1413807
32	1024	32768	5.6568542	3.1748021
33	1089	35937	5.7445626	3.2075343
34	1156	39304	5.8309519	3.2396118
35	1225	42875	5.9160798	3.2710663

## Powers and Roots (Continued)

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt[3]{n}$
36	1296	46656	6.0000000	3.3019272
37	1369	50653	6.0827625	3.3322219
38	1444	54872	6.1644140	3.3619754
39	1521	59319	6.2449980	3.3912114
40	1600	64000	6.3245553	3.4199519
41	1681	68921	6.4031242	3.4482172
42	1764	74088	6.4807407	3.4760266
43	1849	79507	6.5574385	3.5033981
44	1936	85184	6.6332496	3.5303483
45	2025	91125	6.7082039	3.5568933
46	2116	97336	6.7823300	3.5830479
47	2209	103823	6.8556546	3.6088261
48	2304	110592	6.9282032	3.6342412
49	2401	117649	7.0000000	3.6593057
50	2500	125000	7.0710678	3.6840315
51	2601	132651	7.1414284	3.7084298
52	2704	140608	7.2111026	3.7325112
53	2809	148877	7.2801099	3.7562858
54	2916	157464	7.3484692	3.7797631
55	3025	166375	7.4161985	3.8029525
56	3136	175616	7.4833148	3.8258624
57	3249	185193	7.5498344	3.8485011
58	3364	195112	7.6157731	3.8708766
59	3481	205379	7.6811457	3.8929964
60	3600	216000	7.7459667	3.9148676
61	3721	226981	7.8102497	3.9364972
62	3844	238328	7.8740079	3.9578916
63	3969	250047	7.9372539	3.9790572
64	4096	262144	8.0000000	4.0000000
65	4225	274625	8.0622577	4.0207258
66	4356	287496	8.1240384	4.0412400
67	4489	300763	8.1853528	4.0615481
68	4624	314432	8.2462113	4.0816551
69	4761	328509	8.3066239	4.1015659
70	4900	343000	8.3666003	4.1212853

Powers and Roots (Continued)

$n$	$n^2$	$n^3$	$\sqrt{n}$	$\sqrt[3]{n}$
71	5041	357911	8.4261498	4.1408177
72	5184	373248	8.4852814	4.1601676
73	5329	389017	8.5440037	4.1793392
74	5476	405224	8.6023253	4.1983365
75	5625	421875	8.6602540	4.2171633
76	5776	438976	8.7177979	4.2358236
77	5929	456533	8.7749644	4.2543209
78	6084	474552	8.8317609	4.2726587
79	6241	493039	8.8881944	4.2908404
80	6400	512000	8.9442719	4.3088694
81	6561	531441	9.0000000	4.3267487
82	6724	551368	9.0553851	4.3444815
83	6889	571787	9.1104336	4.3620707
84	7056	592704	9.1651514	4.3795191
85	7225	614125	9.2195445	4.3968297
86	7396	636056	9.2736185	4.4140050
87	7569	658503	9.3273791	4.4310476
88	7744	681472	9.3808315	4.4479602
89	7921	704969	9.4339811	4.4647451
90	8100	729000	9.4868330	4.4814047
91	8281	753571	9.5393920	4.4979414
92	8464	778688	9.5916630	4.5143574
93	8649	804357	9.6436508	4.5306549
94	8836	830584	9.6953597	4.5468359
95	9025	857375	9.7467943	4.5629026
96	9216	884736	9.7979590	4.5788570
97	9409	912673	9.8488578	4.5947009
98	9604	941192	9.8994949	4.6104363
99	9801	970299	9.9498744	4.6260650
100	10000	1000000	10.0000000	4.6415888

# Five-Place Logarithms

N	1	2	3	4	5	6	7	8	9
0	00000	30103	47712	60206	69897	77815	84510	90309	95424
10	00432	00860	01284	01703	02119	02531	02938	03342	03743
11	04532	04922	05308	05690	06070	06446	06819	07188	07555
12	07918	08279	08636	09342	09691	10037	10380	10721	11059
13	11394	11727	12057	12710	13033	13354	13672	13988	14301
14	14613	14922	15534	15836	16137	16435	16732	17026	17319
15	17609	18184	18469	18752	19033	19312	19590	19866	20140
16	20412	20952	21219	21484	21748	22011	22272	22531	22789
17	23045	23553	23805	24055	24304	24551	24797	25042	25285
18	25527	26007	26245	26482	26717	26951	27184	27416	27646
19	27875	28330	28556	28780	29003	29226	29447	29667	29885
20	30103	30535	30750	30963	31175	31387	31597	31806	32015
21	32222	32634	32838	33041	33244	33445	33646	33846	34044
22	34242	34635	34830	35025	35218	35411	35603	35793	35984
23	36173	36549	36737	36922	37107	37291	37475	37658	37840
24	38021	38382	38561	38739	38917	39094	39270	39445	39620

Five-Place Logarithms (Continued)

N	0	1	2	3	4	5	6	7	8	9
25	39794	39967	40140	40312	40483	40654	40824	40993	41162	41330
26	41497	41664	41830	41996	42160	42325	42488	42651	42813	42975
27	43136	43297	43457	43616	43775	43933	44091	44248	44404	44560
28	44716	44871	45025	45179	45332	45484	45637	45788	45939	46090
29	46240	46389	46538	46687	46835	46982	47129	47276	47422	47567
30	47712	47857	48001	48144	48287	48430	48572	48714	48855	48996
31	49136	49276	49415	49554	49693	49831	49969	50106	50243	50379
32	50515	50651	50786	50920	51055	51188	51322	51455	51587	51720
33	51851	51983	52114	52244	52375	52504	52634	52763	52892	53020
34	53148	53275	53403	53529	53656	53782	53908	54033	54158	54283
35	54407	54531	54654	54777	54900	55023	55145	55267	55388	55509
36	55630	55751	55871	55991	56110	56229	56348	56467	56585	56703
37	56820	56937	57054	57171	57287	57403	57519	57634	57749	57864
38	57978	58092	58206	58320	58433	58546	58659	58771	58883	58995
39	59106	59218	59329	59439	59550	59660	59770	59879	59988	60097

Five-Place Logarithms (Continued)

N	0	1	2	3	4	5	6	7	8	9
40	60206	60314	60423	60531	60638	60746	60853	60959	61066	61172
41	61278	61384	61490	61595	61700	61805	61909	62014	62118	62221
42	62325	62428	62531	62634	62737	62839	62941	63043	63144	63246
43	63347	63448	63548	63649	63749	63849	63949	64048	64147	64246
44	64345	64444	64542	64640	64738	64836	64933	65031	65128	65225
45	65321	65418	65514	65610	65706	65801	65896	65992	66087	66181
46	66276	66370	66464	66558	66652	66745	66839	66932	67025	67117
47	67210	67302	67394	67486	67578	67669	67761	67852	67943	68034
48	68124	68215	68305	68395	68485	68574	68664	68753	68842	68931
49	69020	69108	69197	69285	69373	69461	69548	69636	69723	69810
50	69897	69984	70070	70157	70243	70329	70415	70501	70586	70672
51	70757	70842	70927	71012	71096	71181	71265	71349	71433	71517
52	71600	71684	71767	71850	71933	72016	72099	72181	72263	72346
53	72428	72509	72591	72673	72754	72835	72916	72997	73078	73159
54	73239	73320	73400	73480	73560	73640	73719	73799	73878	73957

Five-Place Logarithms (Continued)

N	0	1	2	3	4	5	6	7	8	3
55	74036	74115	74194	74273	74351	74429	74507	74586	74663	74741
56	74819	74896	74974	75051	75128	75205	75282	75358	75435	75511
57	75587	75664	75740	75815	75891	75967	76042	76118	76193	76268
58	76343	76418	76492	76567	76641	76716	76790	76864	76938	77012
59	77085	77159	77232	77305	77379	77452	77525	77597	77670	77743
60	77815	77887	77960	78032	78104	78176	78247	78319	78390	78462
61	78533	78604	78675	78746	78817	78888	78958	79029	79099	79169
62	79239	79309	79379	79449	79518	79588	79657	79727	79796	79865
63	79934	80003	80072	80140	80209	80277	80346	80414	80482	80550
64	80618	80686	80754	80821	80889	80956	81023	81090	81158	81224
65	81291	81358	81425	81491	81558	81624	81690	81757	81823	81889
66	81954	82020	82086	82151	82217	82282	82347	82413	82478	82543
67	82607	82672	82737	82802	82866	82930	82995	83059	83123	83187
68	83251	83315	83378	83442	83506	83569	83632	83696	83759	83822
69	83885	83948	84011	84073	84136	84198	84261	84323	84386	84448



Five-Place Logarithms (Continued)

N	0	1	2	3	4	5	6	7	8	9
70	84510	84572	84634	84696	84757	84819	84880	84942	85003	85065
71	85126	85187	85248	85309	85370	85431	85491	85552	85612	85673
72	85733	85794	85854	85914	85974	86034	86094	86153	86213	86273
73	86332	86392	86451	86510	86570	86629	86688	86747	86806	86864
74	86923	86982	87040	87099	87157	87216	87274	87332	87390	87448
75	87506	87564	87622	87679	87737	87795	87852	87910	87967	88024
76	88081	88138	88195	88252	88309	88366	88423	88480	88536	88593
77	88649	88705	88762	88818	88874	88930	88986	89042	89098	89154
78	89209	89265	89321	89376	89432	89487	89542	89597	89653	89708
79	89763	89818	89873	89927	89982	90037	90091	90146	90200	90255
80	90309	90363	90417	90472	90526	90580	90634	90687	90741	90795
81	90849	90902	90956	91009	91062	91116	91169	91222	91275	91328
82	91381	91434	91487	91540	91593	91645	91698	91751	91803	91855
83	91908	91960	92012	92065	92117	92169	92221	92273	92324	92376
84	92428	92480	92531	92583	92634	92686	92737	92788	92840	92891

Five-Place Logarithms (Continued)

N	0	1	2	3	4	5	6	7	8	9
85	92942	92993	93044	93095	93146	93197	93247	93298	93349	93399
86	93450	93500	93551	93601	93651	93702	93752	93802	93852	93902
87	93952	94002	94052	94101	94151	94201	94250	94300	94349	94399
88	94448	94498	94547	94596	94645	94694	94743	94792	94841	94890
89	94939	94988	95036	95085	95134	95182	95231	95279	95328	95376
90	95424	95472	95521	95569	95617	95665	95713	95761	95809	95856
91	95904	95952	95999	96047	96095	96142	96190	96237	96284	96332
92	96379	96426	96473	96520	96567	96614	96661	96708	96755	96802
93	96848	96895	96942	96988	97035	97081	97128	97174	97220	97267
94	97313	97359	97405	97451	97497	97543	97589	97635	97681	97727
95	97772	97818	97864	97909	97955	98000	98046	98091	98137	98182
96	98227	98272	98318	98363	98408	98453	98498	98543	98588	98632
97	98677	98722	98767	98811	98856	98900	98945	98989	99034	99078
98	99123	99167	99211	99255	99300	99344	99388	99432	99476	99520
99	99564	99607	99651	99695	99739	99782	99826	99870	99913	99957

LENGTHS OF CIRCULAR ARCS: RADIUS = 1

Sec.	Length	Min.	Length	Deg.	Length	Deg.	Length
1	.000048	1	.0002909	1	.0174533	61	1.0646508
2	.000097	2	.0005818	2	.0349066	62	1.0821041
3	.000145	3	.0008727	3	.0523599	63	1.0995574
4	.000194	4	.0011636	4	.0698132	64	1.1170107
5	.000242	5	.0014544	5	.0872665	65	1.1344640
6	.000291	6	.0017453	6	.1047198	66	1.1519173
7	.000339	7	.0020362	7	.1221730	67	1.1693706
8	.000388	8	.0023271	8	.1396263	68	1.1868239
9	.000436	9	.0026180	9	.1570796	69	1.2042772
10	.000485	10	.0029089	10	.1745329	70	1.2217305
11	.000533	11	.0031998	11	.1919862	71	1.2391838
12	.000582	12	.0034907	12	.2094395	72	1.2566371
13	.000630	13	.0037815	13	.2268928	73	1.2740904
14	.000679	14	.0040724	14	.2443461	74	1.2915436
15	.000727	15	.0043633	15	.2617994	75	1.3089969
16	.000776	16	.0046542	16	.2792527	76	1.3264502
17	.000824	17	.0049451	17	.2967060	77	1.3439035
18	.000873	18	.0052360	18	.3141593	78	1.3613568
19	.000921	19	.0055269	19	.3316126	79	1.3788101
20	.000970	20	.0058178	20	.3490659	80	1.3962634

LENGTHS OF CIRCULAR ARCS: RADIUS = 1 (Continued)

Sec	Length	Min.	Length	Deg.	Length	Deg.	Length
21	.0001018	21	.0061087	21	.3665191	81	1.4137167
22	.0001067	22	.0063995	22	.3839724	82	1.4311700
23	.0001115	23	.0066904	23	.4014257	83	1.4486233
24	.0001164	24	.0069813	24	.4188790	84	1.4660766
25	.0001212	25	.0072722	25	.4363323	85	1.4835299
26	.0001261	26	.0075631	26	.4537856	86	1.5009832
27	.0001309	27	.0078540	27	.4712389	87	1.5184364
28	.0001357	28	.0081449	28	.4886922	88	1.5358897
29	.0001406	29	.0084358	29	.5061455	89	1.5533430
30	.0001454	30	.0087266	30	.5235988	90	1.5707963
31	.0001503	31	.0090175	31	.5410521	91	1.5882496
32	.0001551	32	.0093084	32	.5585054	92	1.6057029
33	.0001600	33	.0095993	33	.5759587	93	1.6231562
34	.0001648	34	.0098902	34	.5934119	94	1.6406095
35	.0001697	35	.0101811	35	.6108652	95	1.6580628
36	.0001745	36	.0104720	36	.6283185	96	1.6755161
37	.0001794	37	.0107629	37	.6457718	97	1.6929694
38	.0001842	38	.0110538	38	.6632251	98	1.7104227
39	.0001891	39	.0113446	39	.6806784	99	1.7278760
40	.0001939	40	.0116355	40	.6981317	100	1.7453293

LENGTHS OF CIRCULAR ARCS: RADIUS = 1 (Continued)

Sec.	Length	Min.	Length	Deg.	Length	Deg.	Length
41	.0001988	41	.0119264	41	.7155850	101	1.7627825
42	.0002036	42	.0122173	42	.7330383	102	1.7802358
43	.0002085	43	.0125082	43	.7504916	103	1.7976891
44	.0002133	44	.0127991	44	.7679449	104	1.8151424
45	.0002182	45	.0130900	45	.7853982	105	1.8325957
46	.0002230	46	.0133809	46	.8028515	106	1.8500490
47	.0002279	47	.0136717	47	.8203047	107	1.8675023
48	.0002327	48	.0139626	48	.8377580	108	1.8849556
49	.0002376	49	.0142535	49	.8552113	109	1.9024089
50	.0002424	50	.0145444	50	.8726646	110	1.9198622
51	.0002473	51	.0148353	51	.8901179	111	1.9373155
52	.0002521	52	.0151262	52	.9075712	112	1.9547688
53	.0002570	53	.0154171	53	.9250245	113	1.9722221
54	.0002618	54	.0157080	54	.9424778	114	1.9896753
55	.0002666	55	.0159989	55	.9599311	115	2.0071286
56	.0002715	56	.0162897	56	.9773844	116	2.0245819
57	.0002763	57	.0165806	57	.9948377	117	2.0420352
58	.0002812	58	.0168715	58	1.0122910	118	2.0594885
59	.0002860	59	.0171624	59	1.0297443	119	2.0769418
60	.0002909	60	.0174533	60	1.0471976	120	2.0943951

TABLE OF DECIMAL EQUIVALENTS

	$\frac{1}{64}$	.01563		$3\frac{3}{64}$	.51563
	$\frac{1}{32}$	.03125		$\frac{17}{32}$	.53125
	$\frac{3}{64}$	.04688		$3\frac{5}{64}$	.54688
$\frac{1}{16}$		.0625	$\frac{9}{16}$		.5625
	$\frac{5}{64}$	.07813		$3\frac{7}{64}$	.57813
	$\frac{3}{32}$	.09375		$\frac{19}{32}$	.59375
	$\frac{7}{64}$	.10938		$3\frac{9}{64}$	.60938
$\frac{1}{8}$		.125	$\frac{5}{8}$		.625
	$\frac{9}{64}$	.14063		$4\frac{1}{64}$	.64063
	$\frac{5}{32}$	.15625		$2\frac{1}{32}$	.65625
	$1\frac{1}{64}$	.17188		$4\frac{3}{64}$	.67188
$\frac{3}{16}$		.1875	$1\frac{1}{16}$		.6875
	$1\frac{3}{64}$	.20313		$4\frac{5}{64}$	.70313
	$\frac{7}{32}$	.21875		$2\frac{3}{32}$	.71875
	$1\frac{5}{64}$	.23438		$4\frac{7}{64}$	.73438
$\frac{1}{4}$		.250	$\frac{3}{4}$		.750
	$1\frac{7}{64}$	.26563		$4\frac{9}{64}$	.76563
	$\frac{9}{32}$	.28125		$2\frac{5}{32}$	.78125
	$1\frac{9}{64}$	.29688		$5\frac{1}{64}$	.79688
$\frac{5}{16}$		.3125	$1\frac{3}{16}$		.8125
	$2\frac{1}{64}$	.32813		$5\frac{3}{64}$	.82813
	$1\frac{1}{32}$	.34375		$2\frac{7}{32}$	.84375
	$2\frac{3}{64}$	.35938		$5\frac{5}{64}$	.85938
$\frac{3}{8}$		.375	$\frac{7}{8}$		.875
	$2\frac{5}{64}$	.39063		$5\frac{7}{64}$	.89063
	$1\frac{3}{32}$	.40625		$2\frac{9}{32}$	.90625
	$2\frac{7}{64}$	.42188		$5\frac{9}{64}$	.92188
$\frac{7}{16}$		.4375	$1\frac{7}{16}$		.9375
	$2\frac{9}{64}$	.45313		$6\frac{1}{64}$	.95313
	$1\frac{5}{32}$	.46875		$3\frac{1}{32}$	.96875
	$3\frac{1}{64}$	.48438		$6\frac{3}{64}$	.98438
$\frac{1}{2}$		.500	1		1.00000

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