TO THE CONSUMER

FULL ONE YEAR WARRANTY

For one year from date of purchase, APF will repair defects in material or workmanship, free of charge, which appear in the operation of this electronic calculator, unless caused by damage resulting from corrosive leakage of batteries or from the unreasonable use of this product.

To obtain service under this warranty, return this calculator to your Dealer with evidence of date of purchase, or return it directly to APF Service, prepaid, with proof of purchase date.

The above warranty gives you specific legal rights, and you may also have other rights which vary from state to state.

OUT OF WARRANTY SERVICE. State the nature of your difficulty. As with any fine equipment, pack carefully and forward via insured prepaid parcel post to:

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Long Island City, N.Y. 11101

or

APF SERVICES LTD.
47 Valley Brook Dr.
Don Mills, Ont. Canada

APF ELECTRONICS, INCORPORATED
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mark 55

advanced scientific calculator

operating instructions

APF ELECTRONICS INC. NEW YORK N.Y. 10022

Index to Keyboard Functions

Below is a layout of the Mark 55 keyboard. After each function are the page numbers giving a definition (first number) and basic example (second number) of that function.

DPS	: 8 , 8	HYP	: 18, 18	INV	: 7 , 17	log	: 15, 15	clr	: 11, 11
SHIFT	: 7 , 8	RCL	: 22, 22	STO	: 22, 22	ln	: 15, 15	CLX	: 11, 11
→pol	: 21, 21	→rad	: 18, 18	rad	: 16, 17	$\bar{x}s$	: 24, 24	$\sqrt{\ }$ $\bar{x}$	: 15, 16
SIN	: 16, 17	COS	: 16, 17	TAN	: 16, 17	$\Sigma+$	: 24, 24	Y^x	: 19, 19
						x!	: 15, 16	C→F	: 26, 26
7	: 7	8	: 7	9	: 7	+/−	: 7 , 8	÷	: 10, 13
						%	: 19, 20	ltr→gal	: 26, 26
4	: 7	5	: 7	6	: 7	x↔y	: 11, 21	x	: 10, 13
						Δ%	: 20, 20	cm→in	: 26, 26
1	: 7	2	: 7	3	: 7	↓	: 11, 11	−	: 10, 13
LAST X	: 14, 15	π	: 7 , 8	1/x	: 15, 16	sci	: 8 , 8	kg→lb	: 26, 26
0	: 7		: 7	EE	: 7 , 13	ENT	: 9 , 11	+	: 10, 13

Table of Contents

Section III
Practical Examples

Section IV
Useful Equations

Appendixes

Section I
Introduction

Your APF Mark 55 Advanced Scientific Calculator utilizes recent developments in semiconductor integrated circuitry, to provide you with a powerful computational instrument, capable of solving a wide variety of problems. The Mark 55 is a portable calculator capable of operating from either a self contained rechargeable battery pack, or from an A.C. adaptor.

Your calculator uses the more efficient method of Reverse Polish Notation (RPN). With RPN you have a four (4) register operand stack. Add to this feature nine (9) storage memories and you can work the most complicated mathematical equations with full confidence of accuracy. Entries or results can be as small as 0.1×10^{-99} or as large as $9.99999999999 \times 10^{99}$, and can be displayed in either a twelve (12) digit floating decimal mode or a scientific notation mode with a ten (10) digit mantissa and two (2) digit exponent.

The following is a list of some of the features of your calculator:

- Basic Add, Subtract, Multiply, Divide
- Clear entry, Clear overflow, Clear display, Clear registors
- Trig functions—calculate in radians or degrees
- ln, log, e^x, 10^x
- Powers: y^x, Roots: $\sqrt[x]{y}$: Functions of x: $\sqrt{x}$, 1/x, x^2, x!
- Hyperbolic functions
- Vector addition/subtraction
- Percentages: addon/discount/yield/Δpercentage/gross profit margin
- Statistical: $\Sigma+$, $\Sigma-$, averages, standard deviations
- 9 storage memories
- π: to 12 digit accuracy
- +/−: sign change
- Polar/Rectangular conversions
- Radian/Degree conversion
- Metric/U.S. unit conversions

Although the Mark 55 was designed primarily for scientists and engineers, its price puts it well within the reach of students and schools, and its power makes it invaluable for any commercial or industrial manager.

Please review the instructions in this manual. Work through the examples illustrated, and within a very short time, you will become proficient in using your new calculator.

CONVENIENT, RAPID, ACCURATE. YOU WILL FIND MANY USES FOR YOUR ELECTRONIC CALCULATOR.

Portable Battery or A.C. Operation

Battery Operation

Your handheld portable electronic calculator is made with a sealed rechargeable NI-CAD battery pack. Under normal operating conditions you can expect about 5-7 hours of calculation time for a fully charged battery.

The NI-CAD battery pack is fully charged and tested at the factory before shipping. However, due to shelf life discharging, we recommend that you charge the batteries for 24 hours prior to use. When the battery is almost discharged, the display will appear dim and calculations will become erratic. To prevent improper calculations the battery should be recharged as soon as possible.

NOTE: As a general rule, if improper operation occurs, first try the calculator with its adaptor/charger connected. If operation is then normal, this indicates that the batteries are low.

Battery Charging

Connect the adaptor/charger (Type 415) into a convenient source of 110-120 volts A.C. Turn the calculator power switch off and push the adaptor/charger plug firmly into the rear socket of the calculator. Check that the plug is inserted all the way. A full charge will take approximately 14 hours and is best done overnight. For the first hour of charging, the on/off switch must be in the off position.

NOTE: Operating the calculator during charging will increase the time required for a full charge.

A.C. Operation

Connect the charger/adaptor (Type 415) to a source of 110-120 volt A.C. Turn the power switch to the off position and push the charger/adaptor plug firmly into the rear socket of the calculator. Then simply turn the power switch on.

NOTE: When disconnecting the charger/adaptor, turn the power switch off and always disconnect the plug from the calculator first.

Care of Your Calculator

For best care of your calculator, the following points should be noted:

- Never use any other A.C. adaptor/recharger except the model type 415 (included). Improper input could do permanent damage to your calculator.
- As with all fine equipment, protect your calculator from shock. Also protect your machine from dirt, dampness and abrasion. Your calculator is supplied with a protective carrying case.
- Never attempt to take your calculator apart. This should be done only by qualified APF service personnel.
- For best service, the calculator should be used and recharged at least monthly. Turn the power switch off when not in use.
- Do not store your calculator in an area where temperature will exceed 120F. Such temperatures could be experienced in a closed automobile during summer.
- If the calculator has been chilled at below freezing temperatures, allow the machine to warm to several hours before operating.
- Never clean the calculator with solvents, such as paint thinner. Use only a water dampened soft cloth.

Section II
General Operating Instructions
Fundamentals

Getting Started

Your APF Mark 55 is shipped with its batteries in place. Refer to page 4 for battery and A.C. operation.

Keys and Switches

The figure on page 6 illustrates the keyboard layout.

POWER SWITCH—Slide the power switch to the left to turn the calculator on.

SHIFT KEY—The keyboard consists of 30 keys. In order to give your Portable Calculator maximum capability in a minimum size, 17 keys incorporate a SHIFT FUNCTION SYSTEM similar to a typewriter. THE CALCULATOR RESPONDS TO THE FUNCTION IMPRINTED ON THE KEYS IN THE UNSHIFTED MODE; AND THE FUNCTIONS ABOVE THE KEYS IN THE SHIFTED MODE. To use the unshifted function simply touch the selected key. To use the shifted function, first touch the shift key [SHIFT], then the key with the desired function printed above it.

Also there are 4 dual function keys (SHIFT/DPS, INV/STO, HYP/RCL, 0/LASTX), which do not require touching the shift key prior to using either function. Which function is performed, is determined by the next key touched.

Refer to the KEY INDEX (inside front cover), for further description on these keys.

NOTE: In all examples and explanations in this book, nonshifted functions are indicated by [FUNCTION], and shifted functions are indicated by [SHIFT] *(italics)*.

DATA ENTRY KEYS

NUMERIC KEYS–Standard [1] to [9] keyboard is provided as well as [0] and decimal point [.]

[+/−]—Change sign key. Changes the sign of the display from + to − or − to +

[SHIFT] (π)—Enters the value of the constant pi (π) to 12 significant digits (3.14159265359)

[EE]—sets the two right most digits to zero and prepares the calculator to accept the subsequent number as an exponent of 10.

[INV]—Instructs the calculator to calculate the inverse function of the next key touched. (i.e. [INV] [ln] results in e^x)

Display Formats and Number Entry

Entered numbers or results can be displayed in either the normal mode or the scientific mode.

NORMAL MODE—This mode displays entries or results in a signed 12 digit floating decimal or fixed decimal point mode.

SCIENTIFIC MODE—This mode displays entries or results with a signed 10 digit mantissa (with fixed or floating decimal point) and a signed 2 digit exponent. NOTE: The calculator automatically goes into the scientific mode when a result or entry exceeds 999999999999.

[DPS]—Decimal point set—prepares the calculator to set the display format as specified by the next key entry.

[DPS] *(sci)*—Will set the display format to scientific notation mode. (decimal point in the mantissa is floating).

[DPS] [INV] *(sci)*—Will set the display to the normal 12 digit floating decimal mode.

[DPS] [N]—Will set the number of digits to the right of the decimal point to N places. N is any numeric key from 0 through 9. You can set a fixed decimal point in either the 12 digit normal mode display, or in the 10 digit mantissa of a scientific mode display.

Converting between various display modes does not destroy data, and the calculator always performs calculations internally to 12 significant digits. When a fixed point display mode is used, the calculator will round the display to the appropriate number of decimal places. That is, if you are in fixed point 3 mode, an internal result of 2.61271 will be displayed as 2.613.

Example—Enter the value of negative pi *(π)*, in floating point mode. Set the decimal point to 7 places. Change to scientific mode. Set the mantissa to 2 decimal places and then convert back to floating decimal mode.

NOTE: When power is first turned on, the calculator automatically goes to fixed decimal point mode — 2 places.

Key Sequence	Display	Comments
Power "on"	0.00	
[DPS] [INV] *(sci)*	0.	
[SHIFT] *(π)*	3.14159265359	π to 12 digits
[+/−]	-3.14159265359	negative π
[DPS] [7]	-3.1415927	round to 7 places
[DPS] *(sci)*	-3.141592653 00	floating decimal in mantissa
[DPS] [2]	-3.14 00	round down to 2 places
[DPS] [INV] *(sci)*	-3.14159265359	return to floating decimal mode

Reverse Polish Notation And the Operand Stack

To perform calculations, the Mark 55 uses Reverse Polish Notation (RPN), also known as Lukasiewicz Notation. RPN is the efficient method used by computers to evaluate mathematical expressions. With RPN, there is one basic rule to follow: Always enter the operand (number) or operands first, then perform the operation. As a simple example, to add 2+3, first enter the 2 and 3, and then perform the (+) operation.

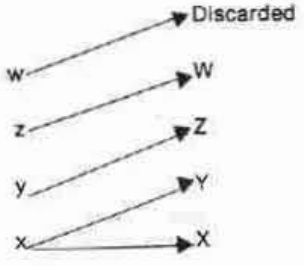
To allow entry of operands, there are 4 memory registers arranged in a vertical stack. For explanation purposes, the register names will be designated by upper case X, Y, Z, and W. Their contents (the number stored in them), will be respectively designated by a lower case x, y, z, and w.

Register Name	Contents	
W	w	Top Of Stack
Z	z	
Y	y	
X	x	Bottom Of Stack

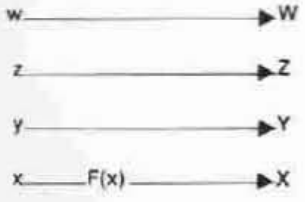
NOTE: The contents of the X register (x) is always displayed.

When a number is keyed in, it goes into the X register.

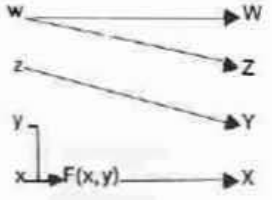
[ENT] — touching the enter key copies the contents of the X register into the Y register. Also the contents of the Y and Z registers are moved up one place. The contents of the W register are discarded.



Single Variable Functions - Functions such as x^2 are called single variable functions since they only require a single operand in order to be performed. When a single variable function is performed [F(x)], only the contents of the X register are effected.



Two Variable Functions - Functions such as Add are called 2 variable functions. When a 2 variable function is performed, the X and Y registers are used and the result is placed in the X register, the contents of the W and Z registers move down one place.



Basic Functions Defined

[+]—Adds the contents of X and Y registers. Places the result in X and pulls the stack down. $(y+x)\rightarrow X$

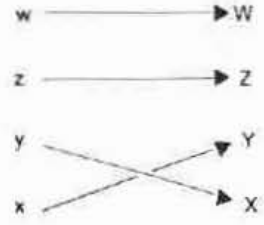
[−]—Subtracts the contents of X from the contents of Y. Places the result in X and pulls the stack down. $(y-x)\rightarrow X$

[×]—Multiplies the contents of Y and X registers. Places the result in X and pulls the stack down $(y\times x)\rightarrow X$

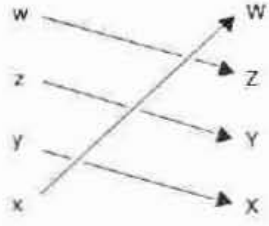
[÷]—Divides the contents of Y by the contents of X. Places the result in X and pulls the stack down. $(y\div x)\rightarrow X$

Stack Manipulation - There are two functions used to move the contents of the stack registers.

[x←→y] - Simultaneously switches the contents of the X and Y registers. The W and Z registers remain the same.



[↓]—Rotate Key - moves the contents of each register in the stack down one position and moves the contents of the X to the W register.



Clearing

[CLX]—Touching this key will clear only the X register (the display). It is also used during overflow and underflow. (see page 27).

[SHIFT] *(clr)*—Touching this function will clear the X, Y, Z, and W registers. NOTE: Although it is not necessary, but might be comforting, touch [SHIFT] *(clr)* prior to starting a new claculation.

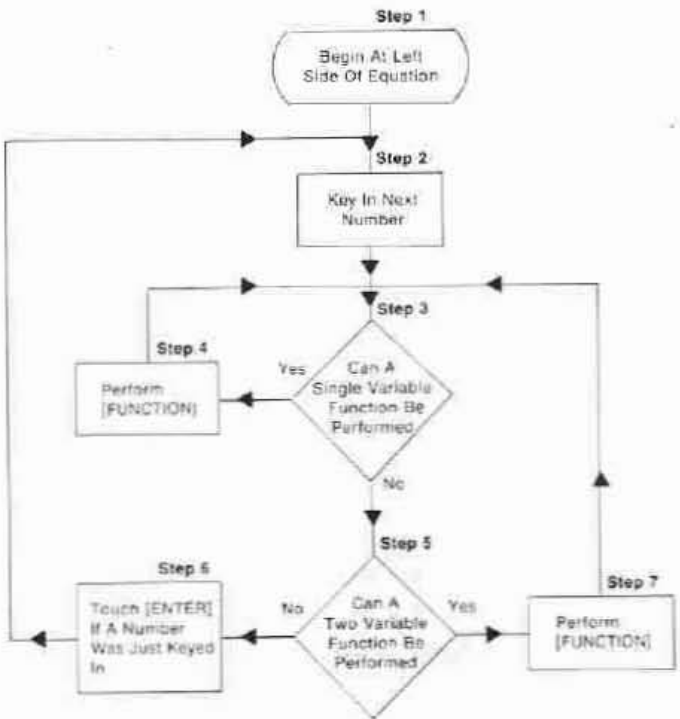
Basic Example

Key Sequence	Display	Comments
[SHIFT] *(clr)*	0	clear x, y, z, w
10	10	10 goes into X
[ENT] 20	20	pushes the stack up and 20 into X
[ENT] 30	30	pushes the stack up and 30 into X
[ENT] 40	40	pushes the stack up and 40 into X
[CLX]	0.	clears X; Y, Z, and W remain the same
[↓]	30.	rotate stack
[SHIFT] *(clr)*	0.	clears X, Y, Z, and W
[↓] [↓] [↓]	0.	

NOTE: To clear all registers including the storage memories, turn the calculator power on and off.

How To Use RPN
To Evaluate Mathematical Equations

To enter and solve problems using RPN, and the operational stack, simply follow the rules outlined in the flow chart below. (A flow chart is a path of simple steps to follow)



NOTE: During Step 6, you only have to touch [ENTER] if the number was just keyed in. Whenever the display contains the result of a Function, it is not necessary to touch [ENTER] before keying in a number.

Example 1: to calculate 6÷2−3

Key Sequence	Display	Comments
[SHIFT] *(clr)*	0.	Clear all registers in stack.
6	6	Key in first number - step 2
[ENT]	6.	Steps 3 and 5 are no - so go to step 6.
2	2	Back at step 2.
[÷]	8.	Go to step 7. Then steps 3 and 5 are no. Then Step 6 is omitted since the display contains a result of a [Function].
3	3	Step 2
[−]	5.	Steps 3-5-7. **answer**

NOTE: All fractions should be mentally rewritten as (numerator)÷(denominator)

Example 2: to calculate $\frac{6}{\frac{1}{2}+\frac{3}{4}}$

Mentally rewrite this as 6÷[(1÷2)+(3÷4)]

Key Sequence	Display	Comments
[SHIFT] *(clr)*	0.	
6	6	Key in and enter
[ENT]	6.	first number.
1	1	Key in and enter
[ENT]	1.	2nd number.
2[÷]	0.5	Key in 2 and perform division.
3	3	Key in 3(automatic enter of 0.5).
[ENT]	3.	Enter 3
4[÷]	0.75	Key in 4 and perform division.
[+]	1.25	Add x, and y registers.
[÷]	4.8	Divide y by x - **answer**

Example 3: to calculate $\frac{-100\times10^{-3}}{(50\times10^{3})\,(0.2\times10^{-6})}$

Key Sequence	Display	Comments
[SHIFT] *(clr)*	0.	Clear registers.
100[+/−] [EE] 3[+/−]	−100.−03	Key numerator and
[ENT]	−0.1	Enter
50[EE] 3[ENT]	50000.	Key in 50×10^{3} and enter.
.2[EE] 6[+/−][X]	0.01	Key in $.2\times10^{-6}$ and multiply.
[÷]	−10.	Divide - **answer**

Serial and Mixed Calculations:

If after a calculation occurs, a new number is keyed in, an automatic [ENTER] is first performed, permitting serial calculations.

Example: to calculate 6−3−8+9−63

Key Sequence	Display	Comments
[SHIFT] *(clr)*	0.	
6 [ENT]	6.	Enter first number and
3[+]	9.	2nd number and perform addition. It is not necessary to [ENTER] 9 since it is a result of a calculation.
8[−]	1.	Enter 8 and subtract
9[+]	10.	Enter 9 and add
63[−]	−53.	Enter 63, subtract - **answer**

Example: to calculate

$[\{(6\times4)-4\}+\{11-(18-3)\}]\times\{(23+9-14)\div(3\times.5)\}$

Key Sequence	Display	
6[ENT] 4[X]	24.	start at left side
4[−]	20.	
11 [ENT] 18[ENT] 3[−][−]	5.	
[+]	25.	
23 [ENT] 9[−] 14[−]	18.	
3[ENT][.5][X]	1.5	
[÷]	12.	
[X]	300.	**answer**

Correcting Input Errors

If a number is incorrectly keyed in, simply touch [CLX] and then enter the correct number.

Example: to calculate 12×7

Key Sequence	Display	Comments
[SHIFT] *(clr)*	0.	Clear stack
12[ENT]	12.	Enter 12 to Y register
8	8	
"MISTAKE", "MISTAKE"		
[CLX]	0.	Clear only x
7	7	
[X]	84	**answer**

[RCL] [LST X] - Besides the 4 register operand stack, there is an additional register used to store the number that was in the X register when the last function was performed. To bring this number back to the x register, simply touch the sequence [RCL] [LST X]. This function is useful for repeatedly using an operand in several calculations. (ex.: as a constant)

Single Variable Functions

Logarithms and Exponentials

[ln] - Calculates the log, base e, of the display.

[SHIFT] *(log)* calculates the log, base 10, of the display.

[INV] [ln] − e^x - calculates the natural anti-log - raises e to the power in the display.

[SHIFT] [INV] *(log)* − 10^x - calculates the common anti-log - raises 10 to the power in the display.

Example: to calculate ln3+ln30 to 2 decimal places

Key Sequence	Display	Comments
[DPS] 2	0.00	Set decimal to 2 places
3 [ln]	1.10	Calculate ln 3
30 [ln]	3.40	Calculate ln 30
[+]	4.50	Add x and y register - **answer**

Example: to calculate log $.5+10^{-5}$ to 2 decimal places

Key Sequence	Display	Comments
[DPS] 2	0.00	Set decimal 2 places
.5 [SHIFT] *(log)*	−0.30	Calculate log .5
[RCL] [LST X]	0.50	Recall last argument and
[SHIFT][INV] *(log)*	3.16	Use to calculate 10^{-5}
[+]	2.86	Add x and y - **answer**

Example: to calculate $e^{-(10/6)}$ to two decimal places

Key Sequence	Display	Comments
[DPS] [2]	0.00	Set decimal to 2 places
10 [+/−] [ENT] 6 [÷]	−1.67	Calculate (−10/6)
[INV] [ln]	0.19	**answer**

x^2, $\sqrt{x}$, 1/X and X!

[SHIFT] *(1/x)* - Calculates the reciprocal of the display.

[SHIFT] $(\sqrt{x})$ - Calculates the square root of the display.

[SHIFT] [INV] $(\sqrt{x})-x^2$ - Calculates the square of the display.

[SHIFT] *(x!)* - Calculates the factorial of the display (that is the product of (X) (X−1) (X−2) . . . (1). The maximum number whose factorial can be calculated is 69. However, by using overflow interpretation (see page 27) the factorial of numbers up to 120 can be calculated.

Example: to calculate $\sqrt{170-38}$ to 2 decimal places

Key Sequence	Display	Comments
[DPS] 2	0.00	Set decimal to 2 places
170 [ENT] 38[−]	132.00	
[SHIFT] *(√x)*	11.49	**answer**

Example: to calculate $\left(\frac{1}{\sqrt{28}+\sqrt{36}}\right)^2$ to 4 decimal places

Key Sequence	Display	Comments
[DPS] [4]	0.0000	Set decimal to 4 places
28 [SHIFT] *(√x)*	5.2915	Calculate $\sqrt{28}$
36 [SHIFT] *(√x)*	6.0000	Calculate $\sqrt{36}$
[+]	11.2915	Add x and y
[SHIFT] *(1/x)*	0.0886	Calculate reciprocal
[SHIFT] [INV] *(√x)*	0.0078	x^2 - **answer**

Example: to calculate $\frac{13!}{(13-11)!}$ to floating decimal

Key Sequence	Display	Comments
[DPS][INV] *(sci)*	0.	Set floating decimal
13 [SHIFT] *(x!)*	6227020800.	13!
[RCL] [LST X]	13.	Recall 13
11 [−]	2.	Perform subtraction
[SHIFT] *(x!)* [÷]	3113510400.	**answer**

Trigonometric Calculation

The Mark 55 will calculate trig or inverse trig functions in degrees or radians.

[SHIFT] *(rad)* - Causes the calculator to interpret the displayed angle, (for inverse functions to calculate an angle), as being in radians. A decimal point will be lit in the right most digit to indicate radians mode. The calculator will remain in this mode until power "on" or until the degrees mode is selected.

[SHIFT] [INV] *(rad)* - causes the calculator to interpret the displayed angle, (for inverse functions to calculate an angle), as being in degrees.

SINE, COSINE, AND TANGENT

[SIN] - Determines the "sine" of the displayed angle in radians or degrees.

[COS] - Determines the "cosine" of the displayed angle in radians or degrees.

[TAN] - Determines the "tangent" of the displayed angle in radians or degrees.

Example: to calculate sin 42° in floating decimal mode

Key Sequence	Display	
[DPS] [INV] *(sci)*	0.	
[SHIFT] [INV] *(rad)*	0.	
42 [SIN]	.669130606358	**answer**

Example: to calculate cos $(2\pi - 4.19)$ to 2 decimal places

Key Sequence	Display	
[DPS] 2	0.00	
[SHIFT] *(rad)*	0.00 .	
2 [ENT][SHIFT] *(π)* [X]	6.28 .	
4.19 [−]	2.09 .	
[COS]	−0.50 .	**answer**

Example: to calculate tan $.75\pi$ + sin 510° to 2 decimal places

Key Sequence	Display	
[DPS] 2	0.00	
[SHIFT] *(rad)*	0.00 .	
.75 [ENT] [SHIFT] *(π)* [X]	2.36 .	
[TAN]	−1.00 .	
[SHIFT][INV]*(rad)*	−1.00	
510 [SIN] [+]	−0.50	**answer**

INVERSE SINE, INVERSE COSINE, AND INVERSE TANGENT

[INV] [SIN] − $\sin^{-1}$ - calculates the value of the angle (in radians or degrees), whose sine is displayed.

[INV] [COS] − $\cos^{-1}$ - calculates the value of the angle (in radians or degrees), whose cosine is displayed.

[INV] [TAN] − $\tan^{-1}$ - calculates the value of the angle (in radians or degrees), whose tangent is displayed.

Example: to calculate $\cos^{-1}.6$ in degrees

Key Sequence	Display	
[DPS] 2	0.00	
[SHIFT] [INV] *(rad)*	0.00	
.6 [INV] [COS]	53.13	**answer**

Example: to calculate $\pi/6 + \tan^{-1} 1$ in radians to 2 decimal places

Key Sequence	Display	
[DPS] 2[SHIFT] *(rad)*	0.00 .	
[SHIFT] *(π)* [ENT] 6 [÷]	0.52 .	
1 [INV] [TAN]	0.79 .	
[+]	1.31 .	**answer**

Radian/Degree Conversions

[SHIFT] (→rad) - assumes the displayed number to be in degrees and converts it to radians.

[SHIFT][INV] (→rad) - assumes the displayed number to be in radians and converts it to degrees.

NOTE: Whether the angle mode selector is in radian or degree mode, has no effect on the above conversion functions.

Example: convert π radians to degrees

Key Sequence	Display	
[SHIFT] (π)	3.14	
[SHIFT] [INV] (→rad)	180.00	**answer**

Example: convert −57° to radians in 1 decimal place

[DPS] 1	0.0	
57 [+/−]	−57	
[SHIFT] (→rad)	−1.0	**answer**

Hyperbolic Functions

The Mark 55 will calculate 3 basic types of hyperbolic functions as well as their inverses.

[HYP] [SIN] - Calculates the "hyperbolic sine" of the displayed number.

[HYP] [COS] - Calculates the "hyperbolic cosine" of the displayed number.

[HYP] [TAN] - Calculates the "hyperbolic tangent" of the displayed number.

[HYP] [INV] [SIN] - Calculates the "inverse Hyperbolic sine" of the displayed number.

[HYP] [INV] [COS] - Calculates the "inverse Hyperbolic cosine" of the displayed number.

[HYP] [INV] [TAN] - Calculates the "inverse Hyperbolic tangent" of the displayed number.

Example: to calculate sinh 30 and cosh 30 in degrees to 2 decimal places.

[DPS] 2	0.00	
[SHIFT] [INV] (rad)	0.00	
30 [HYP] [SIN]	5.34E12	**answer 1.**
[RCL] [LAST X]	30.00	
[HYP] [COS]	5.34E12	**answer 2**

Example: to calculate $\tanh^{-1}$ (.9)

[DPS] 2	0.00	
.9 [HYP] [INV] [TAN]	1.47	**answer**

Two Variable Functions

The two variable functions calculate results using data in the X and Y registers. NOTE: In two variable problems, it might occur that the values of X and Y are interchanged. This can be corrected by using the [X↔Y] key to interchange the values in X and Y.

Powers and Roots:

[Y^x] - calculates the "X" power of the number in the Y register. The answer appears in the X register and the stack is pulled down. X or Y can be whole numbers or fractions. X can be positive or negative but Y must be positive.

[INV] [Y^x] - $\sqrt[X]{Y}$ - calculates the Xth root of Y. The answer appears in the X register and the stack is pulled down. X or Y can be whole numbers or fractions. X can be positive or negative but Y must be positive.

Example: To calculate $6.2^{(1.625)}$ - (floating decimal mode)

Key Sequence	Display	
[DPS] [INV] (sci)	0	
6.2 [ENT]	6.2	
1.625 [Y^x]	19.592820637	**answer**

Example: To calculate $30^{(\log 4000)}$ to 2 decimal places

Key Sequence	Display	
[DPS] 2	0.00	
30 [ENT]	30.00	
4000 [SHIFT] (log)	3.60	
[Y^x]	209256.70	**answer**

Example: To calculate $\sqrt[3]{86} + \sqrt[3]{296}$ to 2 decimal places

Key Sequence	Display	
[DPS] 2	0.00	
86 [ENT]	86.00	
3 [INV] [Y^x]	4.41	
296 [ENT]	296.00	
[RCL] [LST X]	3.00	
[INV] [Y^x]	6.66	
[+]	11.06	**answer**

Percentage Calculations:

Your calculator has functions for 3 types of percentages.

[SHIFT] [%] Converts the displayed number from a percentage to a decimal, multiplies this by the contents of the Y register and places the result in X. Y remains unchanged. (X % of Y→X)

Example: To calculate 200×5%

Key Sequence	Display	
200 [ENT]	200.00	
5 [SHIFT]*(%)*	10.00	**answer**

Since the Mark 55 still retains the original base number in Y, you can simply calculate markon or discount.

Example: Buy at $42.00 and markon 40% - what is profit and selling price?

Key Sequence	Display	
42 [ENT]	42.00	
40 [SHIFT] *(%)*	16.80	**profit**
[+]	58.80	**selling price**

Example: You normally sell at $89.96. Mark down by 30%. What is discount and selling price?

Key Sequence	Display	
89.96 [ENT]	89.96	
30 [SHIFT] *(%)*	26.99	**discount**
[−]	62.97	**selling price**

[SHIFT] *(Δ%)* - Calculates the percentage difference between the numbers in the X and Y registers; places the resulting percentage in X and leaves Y unchanged.

$$\frac{X-Y}{Y} \cdot (100) \rightarrow X$$

Example: Gasoline last year was 35¢/gal. This year it is 55¢/gal. What is the percentage increase?

Key Sequence	Display	
.35 [ENT]	0.35	
.55 [SHIFT] *(Δ%)*	57.14	**answer**

[SHIFT] [INV] *(%)* - Calculates the GROSS PROFIT MARGIN, using the sale price as the percentage base. Places the answer in the X register which can then be added to the Y register to obtain the selling price.

Example: Your product cost $60.00. In order to contribute a gross profit margin of 25%; what should you sell it at?

Key Sequence	Display	Comments
60 [ENT]	60.00	Enter cost
25	25.	Key in GPM
[SHIFT] [INV] *(%)*	20.00	**profit**
[+]	80.00	**selling price**

Polar and Rectangular Coordinate Conversions

[SHIFT] *(→pol)* - will convert the rectangular coordinates located in the X and Y registers, into polar coordinates. (A radius and angle). The radius will be displayed in the X register, and the angle will be placed in the Y register. NOTE: The angle will be calculated in degrees or radians depending on the angle mode selected. (see page 16)

[SHIFT] [INV] *(→pol)* - will convert the polar coordinates (radius is in X and the angle in Y) into rectangular coordinates. NOTE: The angle in Y will be interpreted as degrees or radians depending upon the angle mode selected. The resultant rectangular coordinates are placed in the X and Y registers.

Example: Convert rectangular coordinates (1, 1) to polar coordinates with the angle in degrees.

Key Sequence	Display	Comments
[DPS] 2 [SHIFT] [INV] *(rad)*	0.00	
1 [ENT]	1.00	
[SHIFT] *(→pol)*	1.41	**radius**
[X↔Y]	45.00	**angle in degrees**

Example: Convert the rectangular coordinates (3, 4) to polar, with the angle in radians

Key Sequence	Display	Comments
[SHIFT] *(rad)* [DPS] 2	0.00 .	
4 [ENT] 3	3 .	
[SHIFT] *(→pol)*	5.00 .	**radius**
[X↔Y]	0.93 .	**angle in radians**

Example: Convert polar coordinates (2, 120) to rectangular

Key Sequence	Display	Comments
[DPS] 3[SHIFT][INV] *(rad)*	0.000	Set 3 decimal places and degrees mode
120 [ENT] 2	2	Enter angle then radius
[SHIFT][INV] *(→pol)*	−1.000	**x coordinate**
[X↔Y]	1.732	**y coordinate**

Example: Convert polar coordinates (6, 1) to rectangular

Key Sequence	Display	Comments
[SHIFT] *(rad)* [DPS]3	0.000 .	
1 [ENT] 6	6 .	
[SHIFT][INV] *(→pol)*	3.242 .	**x component**
[X↔Y]	5.049 .	**y component**

Memory Operations

To allow additional flexibility in calculations, the MARK 55 has 9 user accessible memories. These are in addition to the 4 register operand stack, and the last x register.

Storage/Recall

[STO] [N] - N is any numeric key 1-9. This key sequence will clear memory N and store in memory N, the data displayed. The displayed number is not effected.

[RCL] [N] - N is any numeric key 1-9. This key sequence will clear the display and recall the number stored in memory N to the display. The number also remains in memory.

Example: Store 10 in memory 1; 20 in memory 2; multiply the display by 2 and put the result in memory 3. Then recall memories 1, 2, and 3.

Key Sequence	Display	Comments
10 [STO] [1]	10.	Key in 10 and store in memory 1.
20 [STO] [2]	20.	Key in 20 and store in memory 2.
2 [X]	40.	Multiply by 2
[STO] [3]	40.	Store in memory 3
[RCL] [1]	10.	Recall memory 1
[RCL] [2]	20.	Recall memory 2
[RCL] [3]	40.	Recall memory 3

Unrestricted and restricted storage:

Memories #7, 8, and 9 are used to place results during certain statistical calculations. Any previously stored data will be lost in these 3 registers during these calculations and therefore, they should not be used during these times (see pages 24, 25 for details) NOTE: Memories 1-6 are unrestricted and may be used at any time.

Clearing Memories -

Although it is not necessary to clear the memories since, when storing data the old data is written over, clearing can be done by storing zero or by turning power "off" and "on".

Memory--Display Exchange:

[STO] [RCL] [N] - Will simultaneously place the contents of the display in memory N and the contents of memory N into the display.

Example: STORE 10 in memory 1, and 2. Key in 3 and exchange with memory 1. Recall memory 1 and 2.

Key Sequence	Display	Comments
10 [STO][1][STO][2]	10.	Store 10 in memory 1 and 2
3 [STO][RCL][1]	10.	Key in 3 and exchange with memory 1
[RCL][1]	3.	Recall memory 1
[RCL][2]	10.	Recall memory 2

Performing Arithmetic With Memories:

When the contents of a memory are recalled to the display, the stack is pushed down (i.e. x→Y, y→Z, z→W). This allows you to use the contents of a memory to add, subtract, multiply or divide with the display. If you want to save the original contents of the display, either store it in a memory or first touch [ENT] before recalling the memory.

Example: Store 10 in memory 1. Find the log 10,000 then add it to memory 1. Then multiply the log 10,000 by 3.

Key Sequence	Display	Comments
10 [STO] 1	10.	Store 10 in memory 1
10,000 [SHIFT] *(log)*	4.	Compute the log 10,000
[STO] 2[RCL] 1	10	Save log 10,000 and recall memory 1
[+] [STO] 1	14.	Add and store in memory 1
[RCL] 2 [3] [X]	12.	Recall log 10,000 and Multiply by 3

Statistical Functions

Summation, Mean and Variance:

The MARK 55 will easily handle calculations involving mean, variance and summations. When performing these calculations memory registers 7, 8, and 9 are used.

[Σ +] - This is the sigma key or summation key. When this key is pressed, the following occurs:

1) Memory #7 is incremented by 1 - This counts the number of entries made.
2) The number in the display (X register) is added to the contents of memory #9 - summation.
3) The square of the number in the display (x^2) is added to the contents of memory #8.
4) The contents of the Y register are added to an internal memory - this is used for vector addition.

[SHIFT] *(x̄, s)* - Calculates the arithmetic mean and the standard deviation. The mean is placed in the X register and the unbiased standard deviation in the Y register. NOTE: After calculating the mean and standard deviation, additional entries may be made since memories 7, 8, and 9 have not been effected.
Before beginning a new statistical calculation, touch [SHIFT] *(clr)* which causes the calculator to ignore (but does not clear) any numbers in memories 7, 8, and 9.

Example: In a survey of a company, the ages of the employees were 56, 73, 71, 49, 27, 42, 32, and 28. What is the mean age and standard deviation. Also the number of employees and the sum of their ages.

Key Sequence	Display	Contents
[SHIFT] *(clr)*	0.	
56 [Σ +] 73 [Σ+] 71 [Σ+]	71.	
49 [Σ +] 27 [Σ+] 42 [Σ+]	42.	
32 [Σ +] 28 [Σ +]	28.	
[SHIFT] *(x̄, s)*	47.25.	Mean of ages
[X↔Y]	18.3127590181	Standard deviation
[RCL] 7	8.	# of employees
[RCL] 9	378.	Sum of ages

Two new employees join the company whose ages are 24 and 29. What is the new mean and standard deviation?

Key Sequence	Display	Comments
24 [Σ +] 29 [Σ+]	29.	
[SHIFT] *(x̄, s)*	43.1	Mean age
[X↔Y]	18.4056150852	Standard Deviation

[INV] [Σ +]; Σ −; This key sequence is used to perform error recovery. That is, it will decrement by 1 memory #7, subtract the displayed number from memory #9, subtract the square of the displayed number from register 8.

Example: What is the average of 90, 100, and 200. Enter 10 instead of 100 and perform error recovery.

Key Sequence	Display	Comments
[SHIFT] *(clr)*	0.	
90 [Σ +]	90.	
10 [Σ +]	10.	"MISTAKE" "MISTAKE"
10 (INV) [Σ +]	10.	Correct mistake
100 [Σ +] 200 [Σ +]	200.	
[SHIFT] *(x̄, s)*	130.	Mean
[X↔Y]	60.827625303	Standard deviation

Dual Summation

When using the summation function [Σ +], both the summation of the X register and Y register contents is performed. This can be used to perform dual summation.
[RCL] [Σ +] - will bring to the display, the sum of the X register entries and then touching [X↔Y]will show the sum of the Y register entries.

Vector Addition/Subtraction

Example: There are 3 vectors with X and Y components of (3, 4) (3, 7) and (10, 14). What is the resultant vector by adding these 3 together. Also express as a magnitude and radius.

Key Sequence	Display	Comments
[SHIFT] *(clr)* [DPS] 2	0.00	
4 [ENT] 3 [Σ +]	3.00	Enter and sum vector 1
7 [ENT] 3 [Σ +]	3.00	Enter and sum vector 2
14 [ENT] 10 [Σ +]	10.00	Enter and sum vector 3
[RCL] [Σ +]	16.00	Resultant x component
[X↔Y]	25.00	Resultant y component
[X↔Y] [SHIFT] *(→pol)*	29.68	Resultant magnitude
[X↔Y]	57.38	Resultant angle in degrees

Metric/U.S. Conversions

[SHIFT] *(c→f)* - interprets the display as being in centigrade and converts to farenheit temperature.
[SHIFT] [INV] *(c→f)* - interprets the display as being in farenheit and converts to centigrade temperature.
[SHIFT] *(ltr→gal)* - interprets the display as being in liters and converts to gallons.
[SHIFT] [INV] *(ltr→gal)* - interprets the display as being in gallons and converts to liters.
[SHIFT] *(cm→in)* - interprets the display as being in centimeters and converts to inches.
[SHIFT] [INV] *(cm→in)* - interprets the display as being in inches and converts to centimeters.
[SHIFT] *(kg→lb)* - interprets the display as being in kilograms and converts to pounds.
[SHIFT] [INV] *(kg→lb)* - interprets the display as being in pounds and converts to kilograms.

Example: While in Europe, a scale reads that you weigh 80 kilograms. What would you weigh in New York? (Assume no effects from gravitational variations).

Key Sequence	Display	Comments
[SHIFT] *(clr)* [DPS] 2	0.00	
80 [SHIFT] *(kg→lb)*	176.37	**answer in pounds**

Example: The temperature in Los Angeles is 85° farenheit. What is the equivalent in centigrade?

Key Sequence	Display	Comments
[SHIFT] *(clr)* [DPS] 2	0.00	
85 [SHIFT] [INV] *(c→f)*	29.44	**answer**

Example: Convert 12° centigrade to farenheit, 12 liters to gallons, 12 inches to centimeters and 12 pounds to kilograms.

Key Sequence	Display	Comments
[DPS] 2	0.00	
12	12	12 degrees centigrade to
[SHIFT] *(c→f)*	53.60	Farenheit degrees
[RCL] [LST X]	12.00	12 liters to
[SHIFT] *(ltr→gal)*	3.17	Gallons
[RCL] [LST X]	12.00	12 inches to
[SHIFT] [INV] *(cm→in)*	30.48	Centimeters
[RCL] [LST X]	12.00	12 pounds to
[SHIFT] [INV] *(kg→lb)*	5.44	kilograms

Operating Limits

Overflow and Underflow

Whenever the result of a calculation is outside of the range of the calculator, overflow (greater than $9.99999999999\times10^{99}$) or underflow (less than 0.1×10^{-99}) occurs. This will be indicated by the display flashing "on" and "off". To interpret the result in the display during overflow (or underflow) simply touch [CLX] once and then mentally add 100 to the exponent if overflow occurred, or subtract 100 from the exponent if underflow occurred. This will allow you to obtain a result with a 10 digit mantissa with the correct exponent of 10. Note: if during overflow (or underflow) indication, the exponent is 99 (or −99) then the result was outside the capability of the calculator and adding 100 (or −100) to the exponent will not give the correct answer.

Example: Calculate 100!

Key Sequence	Display	Comments
[DPS] [INV] *(sci)*	0	
100	100	
[SHIFT] *(x!)*	9.332621544 57	Flashing
[CLX]	9.332621544 57	Add 100 to exponent to give answer of $9.332621544\times10^{157}$

Example: To calculate: $.0001-1\times10^{99}$

Key Sequence	Display	Comments
[DPS][INV] *(sci)*	0.	
.0001 [ENT]	0.0001	
[EE] 99	1. 99	
[−]	1. −03	Flashing
[CLX]	0.001	Subtract 100 from exponent to give answer of 0.001×10^{-100}

Error Conditions

There are certain operations that cannot be performed on the Mark 55, and attempt to perform this will cause an error condition. An error condition is indicated by a flashing 0. 00. To remove an error condition, touch [CLX] once. The following is a list of calculations that will cause an error calculation:

Calculation	Error Range
$\sqrt{X}$	$X<0$
X!	$X<0$ or X is not an integer
$Y^{\times}\sqrt[X]{Y}$	$Y\leq0$
SIN^{-1}, COS^{-1}	$X>1$ or $X<-1$
lnx, logx	$X\leq0$

Section III
Practical Examples

To further assist you in understanding how to use your calculator, some basic examples of problem solving are given in this section. It should be noted that the methods outlined here are not the only way to solve the problems, but are used to give you a "flow" of problem solving. NOTE: Section IV contains groups of useful equations. Some of these equations are used in the following examples.

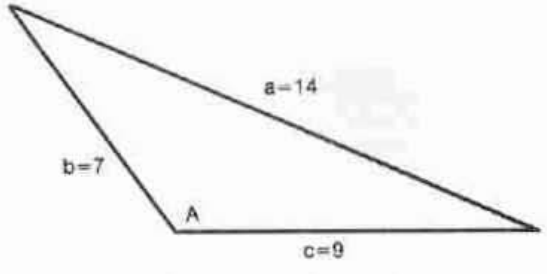
Mathematics

Example: What are the 2 roots of the quadratic equation, $x^2+x-42=0$:

Solution: Use $X_1, X_2=\frac{(-b\pm\sqrt{b^2-4ac})}{2a}$ where a=1, b=1, c=−42

Key Sequence	Display	Comments
1 [+/−] [ENT]	−1.	Enter −b
1 [SHIFT] [INV] ($\sqrt{x}$) [ENT]	1.	Calculate $\sqrt{b^2-4ac}$
4 [ENT] 1 [X] 42 [+/−] [X]	−168.	and store the
[−] [SHIFT] ($\sqrt{x}$) [STO] 1	13.	result in memory 1
[+]	12.	
2 [ENT] 1 [X] [STO] [2]	2.	Calculate 2a and store in memory 2
[÷]	6.	X_1 **−root 1**
1 [+/−] [RCL] 1 [−]	−14.	
[RCL] 2 [−]	−7.	X_2 **−root 2**

Example: For the triangle shown, what is the angle A

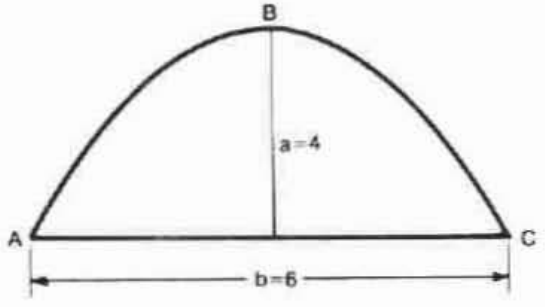


Solution: Using $a^2=b^2+c^2-2bc\ \cos A$ we obtain

$$A=\cos^{-1}\left(\frac{b^2+c^2-a^2}{2bc}\right) = \cos^{-1}\left(\frac{(7)^2+(9)^2-(14)^2}{(2)\ (7)\ (9)}\right)$$

Key Sequence	Display	Comments
[SHIFT] [INV] *(rad)*	0.	
7 [SHIFT] [INV] ($\sqrt{x}$)	49.	b^2
9 [SHIFT] [INV] ($\sqrt{x}$) [+]	130.	b^2+c^2
14 [SHIFT] [INV] ($\sqrt{x}$) [−]	−66.	$b^2+c^2-a^2$
2 [ENT] 7[x] 9[x] [÷]	−0.52380952381	
[INV] [COS]	121.588135505	**answer** in degrees

Example: Given a parabola as shown, what is the arc length ABC?



solution:

Arc length $=(N\div2)+(b^2\div8a)\ \ln[(4a+N)\div b)]$
where $N=\sqrt{b^2+16a^2}$

Therefore:
$N=\sqrt{(6)^2+16(4)^2}$
Arc length $=[N\div2]+[(6\cdot6)\div(8\cdot4)]\ \ln[(4\cdot4+N)\div6]$

Key Sequence	Display	Comments
[DPS] 2	0.00	
6 [SHIFT] [INV] ($\sqrt{x}$)	36.00	Calculate N
16 [ENT] 4	4	and
[SHIFT] [INV] ($\sqrt{x}$) [X]	256.00	store in
[+] [SHIFT] ($\sqrt{x}$) [STO] 1	17.09	memory 1
2 [÷]	8.54	
6 [ENT] [x]	36.00	
8 [ENT] 4 [X] [÷]	1.13	
4 [SHIFT] [INV] ($\sqrt{x}$)	16.00	
[RCL] 1 [+]	33.09	
6 [÷] [ln] [X] [+]	10.46	**answer**

Business and Finance

Example: $10,000 is deposited in a bank at 7.75% per year, compounded quarterly. What is the total amount after 6 years?

Solution: Using Amount = $p(1+I)^N$

I = interest per period = $\frac{.0775}{4}$

N = Number of periods = (4).(6)

Key Sequence	Display	
10,000 [ENT]	10000.	
1 [ENT] .0775 [ENT] 4 [÷]	0.019375	
[+] 4[ENT] 6 [X] [Y^X]	1.5849496899	
[x] [DPS] 2	15849.50	**answer**

Example: You are obtaining a mortgage for $30,000. One bank offers you a 30 year mortgage at 8% per year and the other bank a 25 year mortgage at 8.5%. Which one will give you the lower monthly payment and what is the percentage difference between the 2 payments.

Solution: Using the formula

Payment = $\frac{I.P}{1-(1+I)^{-N}} = \frac{-I.P}{(1+I)^{-N}-1}$

P = principal N = number of payment periods
I = interest per period as a decimal

Key Sequence	Display	Comments
[DPS] 4	0.0000	
.08 [ENT] 12 [÷] [STO] 4	0.0067	Calculate I_1: store in 4
[+/−] 30000[X]	−200.0000	
[RCL] [4] 1 [+]	1.0067	
30 [ENT] 12 [X] [+/−]	−360.0000	Calculate $-n_1$
[Y^X] 1 [−] [÷]	220.1294	1st payments
[STO] 1	220.1294	Store in memory 1
.085 [ENT] 12 [÷] [STO] 4	0.0071	Calculate I_2: store in 4
[+/−] 30000 [X]	−212.5000	
[RCL] [4] 1[+]	1.0071	
25 [ENT] 12 [X] [+/−]	−300.0000	Calculate $-n_2$
[Y^X] 1 [−] [÷]	241.5681	2nd payments
[RCL] 1 [SHIFT] (Δ%)	−8.8748	Percent difference

Statistics

Example: For the values 4, 9, 11, 4, and 3, what is the mean, unbiased standard deviation and unbiased variance? What is the biased standard deviation and variance?

Solution: The mean and unbiased standard deviation can be automatically calculated. Then variance = (standard deviation)^2.

To find the biased variance use var = $\frac{\Sigma x^2 - N\bar{x}^2}{N}$:

Σx^2 = sum of squares of entries
N = number of entries
$\bar{x}^2$ = mean squared

Key Sequence	Display	Comments
[SHIFT] (clr)		
4 [Σ+] 9[Σ+] 11[Σ+]	11.	Enter the values with
4 [Σ+] 3[Σ+]	3.	the summation function
[SHIFT] ($\bar{x}$, s)[STO] 1	6.2	Calculate mean, and store in memory 1
[X↔Y]	3.56370593625	Unbiased standard deviation
[SHIFT] [INV] ($\sqrt{x}$)	12.7000000001	Unbiased variance
[RCL] 8	243.	Sum of squares
[RCL] 7	5.	Number of entries
[RCL] 1 [ENT] [X]	38.44	mean squared
[x] [−] [RCL] 7 [÷]	10.16	Biased variance
[SHIFT] ($\sqrt{x}$)	3.18747549011	Biased standard deviation

Combinations

Example: From a group of 36 people, how many subgroups of 6 people can be formed.

Solution:

Use $C_r^n = C_6^{36} = \frac{36!}{6!\,(36-6)!}$

Key Sequence	Display	
36 [SHIFT] (x!)	3.719933267 41	
6 [SHIFT] (x!)	720.	
36 [ENT] 6 [−]	30.	
[SHIFT] (x!)	2.652528598 32	
[X] [÷]	1947792.	Number of subgroups of 6 people

Permutations

Example: Find the number of arrangements that can be made from the numbers 1 through 6 taking 3 at a time.

Solution: using $p = \frac{N!}{(N-R)!} = \frac{6!}{(6-3)!}$

Key Sequence	Display	
6 [SHIFT] *(x!)*	720.	
[RCL] [LST X] 3 [−]	3.	
[SHIFT] *(X!)* [÷]	120.	**answer**

Probability

Example: You choose 3 items from a group of 16. There are 5 defective pieces in the group of 16. a) What is the probability that all 3 items are defective? b) that none are defective?

Solution:

S = number of ways 3 items can be chosen from

$= C\binom{16}{3} = \frac{16!}{3!\ (16-3)!}$

A = number of ways 3 defective items can be chosen from 5 defective items

$= C\binom{5}{3} = \frac{5!}{3!\ (5-3)!}$

B = number of ways that 2 non defective items can be chosen from 11 non-defective items

$= C\binom{11}{3} = \frac{11!}{3!\ (11-3)!}$

a) then P(A) = probability all 3 are defective $= \frac{A}{S}$

b) P(B) = probability none are defective $= \frac{B}{S}$

Key Sequence	Display	Comments
[SHIFT]*(clr)*[DPS] 2	0.00	
16 [SHIFT]*(x!)* 3 [SHIFT]*(x!)*	6.00	Calculate S
16 [ENT] 3 [−]	13.00	and store
[SHIFT]*(x!)*[x][÷][STO] 1	560.00	in memory 1.
5 [SHIFT]*(x!)* 3[SHIFT]*(x!)*	6.00	Calculate A and
5 [ENT] 3[−] [SHIFT]*(x!)*	2.00	divide by S for
[×][÷][RCL] 1 [÷]	0.02	**answer a.**
11[SHIFT]*(x!)* 3[SHIFT]*(x!)*	6.00	Calculate B
11 [ENT] 3[−]	8.00	and divide
[SHIFT]*(x!)*[×][÷]	165.00	by S for
[RCL] 1 [÷]	0.29	**answer b**

Electrical Engineering

Example: A coil having inductance of 0.034 henries and a resistance of 14 ohms, is connected across 117 volts, 60 hertz. What is the current through the coil and the power absorbed by the coil?

Solution:

Using $I = V/Z$ where $Z = \sqrt{R^2 + (2\pi fL)^2}$

and power $= VI \cos \sigma$ when $\sigma = \tan^{-1}\left(\frac{2\pi fL}{R}\right)$

Key Sequence	Display	Comments
[DPS] 3	0.000	
14 [ENT] [X]	196.000	R^2
2 [ENT] [SHIFT] *(π)* [X]	6.283	2π
60 [X] .034 [X] [STO] 1	12.818	$2\pi fL$ and store in 1
[SHIFT] [INV] *($\sqrt{x}$)* [+]	360.293	$R^2 + (2\pi fL)^2$
[SHIFT] *($\sqrt{x}$)* 117	117	
[X↔Y] [÷]	6.164	I (current)
117 [X]	721.180	V I
[RCL] 1 [ENT] 14 [÷]	0.916	$2\pi fL \div R$
[INV] [TAN] [COS]	0.738	
[X]	531.917	Power

Example: What is the equivalent resistance of 3 parallel resistors whose values are 100 ohms, 220 ohms, and 560 ohms.

Solution: Using $R_T = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$

Key Sequence	Display	
[DPS] 2	0.00	
100 [SHIFT] *(1/x)*	0.01	
220 [SHIFT] *(1/x)*	4.55 −03	
560 [SHIFT] *(1/x)*	1.79 −03	
[+] [+] [SHIFT] *(1/x)*	61.23	**answer**

Example: The power output of an amplifier is increased from 3 to 5 watts. What is the change in db (decibles)

Solution: Using $N = 10 \log \frac{P^2}{P_1}$

Key Sequence	Display	
[DPS] 2	0.00	
10 [ENT] 5 [ENT] 3 [÷]	1.67	
[SHIFT] *(log)* [X]	2.22	**answer**

Example: A step voltage (Vi) of 35 volts is applied across a series rc network. r=50K, c=.2 mfd. What is the voltage across the capacitor (Vc) after 100 miliseconds.

Solution: Using $Vc = Vi\,(1 - e^{-t/rc})$

Key Sequence	Display	Comments
[DPS] *(sci)*	0. 00	Set scientific mode
100 [+/−] [EE] 3[+/−][ENT]	−1. −01	Enter −t
50[EE] 3[ENT]	5 04	Enter r
.2[EE]6[+/−][X][−]	−1. 01	Calculate −t/rc
[INV] [ln]	4.539992976 −05	Calculate $e^{-t/rc}$
[+/−] 1[+] 35[X]	3.499841100 01	**answer in volts**

Example: Paralell plate capacitor, has plate area of $2.2m^2$, and plate separation of 6.1mm in a vacuum, a potential difference of 8000 volts is applied. What is a) the capacitance, b) the charge on the capacitor, c) the electric intensity between the plates?

Solution:

a) using $C = \frac{\epsilon_0 A}{d} = \frac{(8.85\times10^{-12})(2.2)\,coul^2}{6.1\times10^{-3}\quad N.M}$

b) charge = Q = C Vab coulombs

c) $E = \frac{Q}{\epsilon_0 A}\ \frac{Newtons}{coulomb}$

Key Sequence	Display	Comments
[SHIFT] *(clr)* [DPS] *(sci)*	0. 00	
[DPS] 2	0.00 00	
8.85 [EE]12[+/−] [ENT]	8.85−12	Calculate $\epsilon_0 A$ and
2.2 [X] [STO] 1	1.95−11	store in 1 for part c.
6.1 [EE]3 [+/−] [−]	3.19−09	**capacitance**
8000 [X]	2.55−05	**charge**
[RCL] 1 [−]	1.31 06	**electric intensity**

Mechanical Engineering

Example: A shaft, 3 inches in diameter (d), has a 3000 inch-pounds bending moment (M) and a 4000 inch-pounds torque (T). What is the maximum stress?

Solution: Use maximum stress $= \frac{16\,(M + \sqrt{M^2+T^2})}{d^3\pi}$

Key Sequence	Display	Comments
[DPS] *(sci)*	0. 00	Set scientific display
16 [ENT] 3000 [ENT]	3. 03	Enter 16
[SHIFT] [INV] *(√x)*	9. 06	M^2
4000 [SHIFT] [INV] *(√x)*	1.6 07	T^2
[+] [SHIFT] *(√x)* [+] [X]	1.28 05	$16\,(M+\sqrt{M^2+T^2})$
3[ENT] [Y^x][SHIFT]*(π)*[X]	8.482300164 01	$d^3\pi$
[−]	1.509024645 03	**answer**

Example: A uniform power cable is hung between 2 poles of equal height and 50 feet apart (2X). The weight of the cable (W) is 1.1 pound/foot. The tension at the lowest point (T) is 65 lbs. What is the length of the cable?

Solution: Using $L = \frac{2T}{W}\ SINh\ \frac{WX}{T}$

Key Sequence	Display	Comments
[DPS] 2	0.00	
2 [ENT] 65 [X]	130.00	2T
1.1 [÷]	118.18	2T/W
1.1 [ENT] 50 [ENT] 2[−][X]	27.50	WX
65 [÷] [HYP] [SIN]	0.44	sinh (WX/T)
[X]	51.51	**answer in feet**

Example: Determine the moment of inertia of a hollow circular cylinder about its axis. The outer radius is 3 feet (R_1), the inner radius 2.25 feet (R_2), the length is 5 feet l and the material has a mass of 435 lb/ft^2 (m).

Solution: Use $I = \frac{\pi m l\,(r_1^4 - r_2^4)}{2}$

Key Sequence	Display	Comments
[DPS] 2	0.00	
[SHIFT] *(π)* [ENT] 435 [X]	1366.59	
5 [X]	6832.96	πml
3 [ENT] 4 [Y^x]	81.00	r_1^4
2.25 [ENT] 4 [Y^x] [−]	55.37	$r_1^4 - r_2^4$
[X] 2[÷]	189174.35	**answer**

Simple Harmonic Motion

Example: When the balance wheel of a watch is displaced 45° from its equilibrium position, it begins to move with an angular acceleration of 30 rad/sec². Find the frequency F.

Solution: Using $F = \frac{1}{T} = \frac{1}{2\pi}\sqrt{\frac{25\ \text{rad/sec}}{\pi/4\ \text{rad}}}$

Key Sequence	Display	Comments
[DPS] 2	0.00	
2 [ENT] [SHIFT] *(π)* [X]	6.28	2π
[SHIFT] *(1/x)*	0.16	$1/2\pi$
25 [ENT] [SHIFT] *(π)* [ENT]	3.14	
4 [÷] [÷]	31.83	$25/(\pi/4)$
[SHIFT] *(√x)* [x]	0.90	**answer**

Rectilinear Motion

Example: A ball is thrown upward with an initial velocity (Vo) of 40 meters/sec. What is the height (S) at the end of 2.5 seconds (t)?

Solution: Using $S = Vot - \frac{gt^2}{2}$ where $g = 9.807$ meter/sec²

Key Sequence	Display	Comments
[DPS] 2	0.00	
40 [ENT] 2.5 [X]	100.00	Vot
.5 [ENT] 9.807 [X]	4.90	g/2
2.5 [SHIFT] [INV] *(√x)*	6.25	t^2
[X] [−]	69.35	**answer in meters**

Navigation

Example: An airplane has an air speed of 600 mph, at a bearing of 45°; it is fighting a head wind of 60 mph, at the heading of 225°. What is the ground speed, and final heading of the airplane?

Solution: This is simply the summation of 2 vectors

Key Sequence	Display	Comments
[SHIFT] *(clr)*	0.	
45. [ENT] 600	600	Enter first vector
[SHIFT] [INV] *(→pol)*	424.26	and convert to rectangular.
[Σ+]	424.26	Sum x, y components
225 [ENT] 60	60	Enter 2nd vector and
[SHIFT] [INV] *(→pol)*	−42.43	convert to rectangular.
[Σ+] [RCL] [Σ+]	381.84	Sum x, y components and recall
[SHIFT] *(→pol)*	540.00	**ground speed**
[X↔Y]	45.00	**final heading**

Atomic and Nuclear Physics

Example: What is the ratio of the electrical force (fe) and gravitational force (fg) between 2 electrons?

Solution: $\frac{Fe}{Fg} = \frac{K\,(q^2/r^2)}{G\,(m^2/r^2)} = \frac{Kq^2}{Gm^2}$

$K = 9\times10^9$ nt−m²/coul² $\quad G = 6.6732\times10^{-11}$ nt−m²/Kg²
mass $= 9.10956\times10^{-31}$kg $\quad q = 1.60219\times10^{-19}$ coul

Key Sequence	Display	Comments
[DPS] *(sci)* [DPS] 2	0.00 00	
9 [EE] 9 [ENT]	9.00 09	
1.60219 [EE] 19 [+/−] [ENT]	1.60−19	q
[X] [X]	2.31−28	Kq^2
6.6732 [EE] 11 [+/−] [ENT]	6.67−11	G
9.10956 [EE] 31 [+/−]	9.10956 −31	m
[SHIFT] [INV] *(√x)* [X]	5.54−71	Gm^2
[÷]	4.17 42	**answer**

Quantum Physics

Example: What is the mass of an electron traveling at half the speed of light? Also at 3/5 the speed of light what is the % increase.

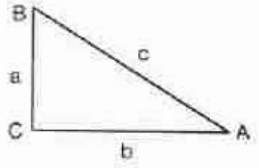
Solution: Using $m = \frac{mo}{\sqrt{1-(N)^2}}$ where $N = \frac{v}{c}$

In case 1 N=.5 and in case 2 N=.6

Key Sequence	Display	Comments
9.10956 [EE] 31[+/−] [ENT]	9.10956 −31	Enter mo (rest mass)
1 [ENT] .5 [SHIFT] [INV] *(√x)*	0.25	
[−]	0.75	$1-N^2$
[SHIFT] *(√x)* [÷] [STO] 1	1.051881383 −30	mass at v=.5c
9.10956 [EE] 31 [+/−] [ENT]	9.10956 −31	Enter mo
1 [ENT] .6[SHIFT] [INV] *(√x)*	0.36	$1-N^2$
[−]	0.64	
[SHIFT] *(√x)* [÷]	1.138695 −30	mass at v=.6c
[RCL] 1 [X↔Y] [SHIFT]*(Δ%)*		
[DPS] 2	8.25	Increase of 8.25%

Section IV
Useful Equations

Trigonometry

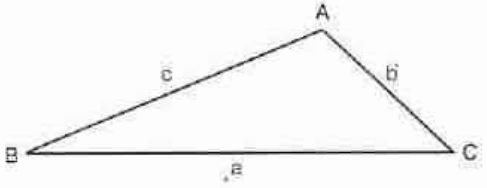


sin A	=	a/c	csc A	=	1/sin A
cos A	=	b/c	sec A	=	1/cos B
tan A	=	a/b	cot A	=	1/tan B

Relationships Among Trigonometric Functions

$\sin^2 A + \cos^2 A = 1$
$\tan^2 A + 1 = \sec^2 A$
$1 + \cot^2 A = \csc^2 A$

Relationships Between Sides and Angles of a Plane Triangle



law of sines:

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

law of cosines:

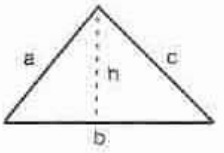
$a^2 + b^2 - 2ab \cos C = c^2$

Law of Tangents.

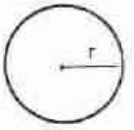
$$\frac{a+b}{a-b} = \frac{\text{Tan } \frac{1}{2}(A+B)}{\text{Tan } \frac{1}{2}(A-B)}$$

Geometry

Triangle: perimeter = a + b + c
area = ½ (bh)



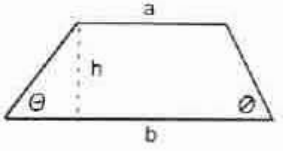
Circle: circumference $= 2\pi r$
area $= \pi r^2$



Analytic Equation

$$\frac{x^2}{r^2} + \frac{y^2}{r^2} = 1$$

Trapezoid:



$$\text{area} = \frac{1}{2} h(a+b)$$

$$\text{perimeter} = a + b + h\left(\frac{1}{\text{Sin}\Theta} \quad \frac{1}{\text{Sin}\varnothing}\right)$$

Ellipse

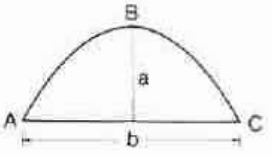
area $= \pi ab$

a = Semi-major axis
b = Semi-minor axis

Analytic Equation

$$\frac{X^2}{a^2} + \frac{Y^2}{b^2} = 1$$

Parabola



$$\text{Area} = \frac{2}{3} ab$$

Arc Length ABC

$$= \frac{\sqrt{b^2+16a^2}}{2} + \frac{b^2}{8a} \ln\left(\frac{4a + \sqrt{b^2+16a^2}}{b}\right)$$

Analytic Equation

$x^2 = \pm 2PY$

Sphere: area $= 4\pi r^2$ volume $= \frac{4\pi r^3}{3}$

Regular Polygon of N Sides

$$\text{Area} = \frac{1}{4} Nb^2 \text{Cot}\left(\frac{\pi}{N}\right)$$

Perimeter = Nb.

Logarithms

$\log_a x = \frac{\log_{10} x}{\log_{10} a}$ converting log (any base) of x to $\log_{10} x$

$\log xy = \log x + \log y$

$\log (x/y) = \log x - \log y$

$\log (x^Y) = Y \log x$

$\log_a b = 1/\log_b a$

Complex numbers

$x + iy = r(\cos\theta + i \sin\theta)$

where $r = \sqrt{x^2 + y^2}$

$\theta = \text{TAN}^{-1} \frac{Y}{X}$

Euler identities

$e^{i\theta} = \cos\theta + i \sin\theta$

$e^{-i\theta} = \cos\theta - i \sin\theta$

$i = \sqrt{-1}$

Business and Finance

Interest Compounded

$A = P(1+i)$

A=future value
P=present value
i=interest per period in decimal
N=number of periods
PMT=payments per period

Payments

$\text{Payment} = \frac{Pi}{1-(1+i)^N}$

Annuities

$A = PMT[\frac{(1+i)^{} - 1}{i}]$

Statistics

$\text{Mean} = \frac{\Sigma X_N}{N} = \bar{X}$

	unbiased	biased
Variance	$\frac{\Sigma X^2_N - N\bar{x}^2}{N-1}$	$\frac{\Sigma X^2_N - N\bar{x}^2}{N}$
Standard Deviation	$\sqrt{\text{variance}}$	$\sqrt{\text{variance}}$

where
ΣX_N=each terms value summed
ΣX_N^2=sum of the squares of each term
N=number of terms

Appendix A
Physical Constants

Physical Constant	Value	Units	Symbol
Avogadro Number	6.02217×10^{23}	Particles/mole	No
Boltzman Constant	1.38062×10^{-23}	Joule/°K	K
Electron Charge	1.60219×10^{-19}	Coulomb	e
Electron Mass	9.10956×10^{-31}	Kg	me
Electron Volt	1.60219×10^{-19}	Joules	eV
Faraday Constant	9.64867×10^{4}	C mole^{-1}	F
Gas Constant	8.31434	Joules/Mole-K	Ro
Gravitational Constant	6.6732×10^{-11}	Nt−M^2/Kg^2	G
Permeability of a Vacuum	$4\pi\times10^{-7}$	Nt/Amp^2	μo
Permittivity of a Vacuum	$1/36\pi\times10^{9}$	Coulomb^2/N−M^2	ϵo
Planck Constant	6.62619×10^{-34}	Joules−Sec	h
Proton Mass	1.67261×10^{-27}	Kg	mp
Rydberg Constant	1.09737×10^{7}	/Meter	Rc_0
Speed of Light	2.99792×10^{8}	M/Sec	c

Appendix B
Prefixes For Power of Ten

Prefix	Symbol	Multiple
Tera	T	10^{12}
Giga	G	10^{9}
Mega	M	10^{6}
Kilo	k	10^{3}
Hecto	h	10^{2}
Deka	da	10
Deci	d	10^{-1}
Centi	c	10^{-2}
Milli	m	10^{-3}
Micro	u	10^{-6}
Nano	n	10^{-9}
Pico	p	10^{-12}
Femto	f	10^{-15}
Atto	a	10^{-18}

Appendix C
Conversions Factors

Length

1 kilometer (km) = 1000 meters (m)
1 meter (m) = 1000 centimeters (cm)
1 centimeter (cm) = 10^{-2} m
1 millimeter (mm) = 10^{-3} m
1 micron (μ) = 10^{-6} m
1 millimicron (mμ) = 10^{-9} m
1 angstrom (A) = 10^{-10} m

1 inch (in.) = 2.540cm
1 foot (ft) = 30.48 cm
1 mile (mi) = 1.609 km
1 mil = 10^{-3} in.
1 centimeter = 0.3937 in.
1 meter = 39.37 in
1 kilometer = 0.6214 mile

Area

1 square meter (m^2) = 10.76 ft^2
1 square foot (ft^2) = 929 cm^2

1 square mile (mi^2) = 640 acres
1 acre = 43,560 ft^2

Volume

1 liter (l) = 1000 cm^3 = 1.057 quart (qt) = 61.02 in^3 = 0.03532 ft^3
1 cubic meter (m^3) = 1000 l = 35.32 ft^3
1 cubic foot (ft^3) = 7.481 U.S. gal = 0.02832 m^3 = 28.32 l
1 U.S. gallon (gal) = 231 in^3 = 3.785 l;
1 British gallon = 1.202 U.S. gallon = 277.4 in^3

Mass

1 kilogram (kg) = 2.2046 pounds (lb) = 0.06852 slug;
1 lb = 453.6 gm = 0.0318 slug
1 slug = 32.174 lb = 14.59 kg

Speed

1 km/hr = 0.2778 m/sec = 0.6214 mi/hr = 0.9113 ft/sec
1 mi/hr = 1.467 ft/sec = 1.609 km/hr = 0.4470 m/sec = 1.1508 knots

Density

1 gm/cm^3 = 10^3 kg/m^3 = 62.43 lb/ft^3 = 1.940 slug ft^3
1 lb/ft^3 = 0.01602 gm/cm^3;
1 slug/ft^3 = 0.5154 gm/cm^3

Force

1 newton (nt) = 10^5 dynes = 0.1020 kg = 0.2248 lb
1 pound weight (lb) = 4.448 nt = 0.4536 kg = 32.17 poundals
1 kilogram weight (kg) = 2.205 lb = 9.807 nt
1 U.S. short ton = 2000 lb; 1 long ton = 2240 lb;
1 metric ton = 2205 lb

Energy

1 joule = 1 nt m = 10^7 ergs = 0.7376 ft lb = 0.2389 cal = 9.481×10^{-4} Btu
1 ft lb = 1.356 joules = 0.3239 cal = 1.285×10^{-3} Btu
1 calorie (cal) = 4.186 joules = 3.087 ft lb = 3.968×10^{-3} Btu
1 Btu (British thermal unit) = 778 ft lb = 1055 joules = 0.293 watt hr
1 kilowatt hour (kw hr) = 3.60×10^6 joules = 860.0 kcal = 3413 Btu
1 electron volt (ev) = 1.602×10^{-19} joule

Power

1 watt = 1 joule/sec = 10^7 ergs/sec = 0.2389 cal/sec
1 horsepower (hp) = 550 ft lb/sec = 33,000 ft lb/min = 745.7 watts
1 kilowatt (kw) = 1.341 hp = 737.6 ft lb/sec = 0.9483 Btu/sec

Pressure

1 nt/m^2 = 10 dynes/cm^2 = 9.869×10^{-6} atmosphere = 2.089×10^{-2} lb/ft^2
1 lbwt/in^2 = 6895 nt/m^2 = 5.171 cm mercury = 27.68 in. water
1 atmosphere (atm) = 1.013 c 10^5 nt/m^2 = 1.013×10^6 dynes/cm^2
= 14.70 lb/in^2 = 76 cm mercury = 406.8 in. water