NOVUS Operations Guide

3500 3500 3500

NOVUS
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National Semiconductor

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The same National Semiconductor electronics have helped take Americans to the moon and back, and are the critical "guts" of high-performance products ranging from life-saving medical equipment to consumer products such as color tv's and digital watches.

You now own one of the world's most technically-advanced consumer products. We hope you'll be as proud to use it as we were to make it.

CONTENTS

Getting Started

Turn your Novus Sliderule on with the switch on the left side of the calculator. The calculator is automatically cleared and the display should now show 0. If it does not, check to see if the battery is properly connected.

Battery Installation

Your Novus Sliderule is powered by a 9-volt transistor battery which should give you about 15 hours of operation with normal use. The Sliderule will show a decimal point on the extreme left side of the display as a low-battery indicator. Although calculations can still be made while the low-battery indicator is on, the battery should be replaced as soon as possible. Continued use on a weak battery may result in inaccurate answers.

To change batteries, turn the machine over, place a small coin in the slot at the top of the battery door and pull gently toward you. The battery door will slip out. BE SURE THE CALCULATOR IS TURNED OFF BEFORE REPLACING THE BATTERIES.

Slip the slotted part of the battery door in toward the bottom of the machine and the battery door will snap back into place.

AC Adaptor

You can use your Sliderule on regular AC current by connecting the Novus AC Adaptor to the adaptor jack at the top of the machine. BE SURE YOUR CALCULATOR IS TURNED OFF BEFORE CONNECTING THE ADAPTOR.

Operations

Display

The Novus Sliderule will accept and display any positive or negative number between 0.0000001 and 99999999. Any result larger than 99999999 or smaller than −99999999 will result in an overflow indicated by all zeros and decimal points being displayed.

Automatic Display Shutoff

To save battery life, the Novus Sliderule automatically shuts off the display and shows all decimal points if no key has been touched for approximately 30 seconds. No data has been changed and further entries or operations will bring back the display. To restore the display without changing its contents, touch CHS twice.

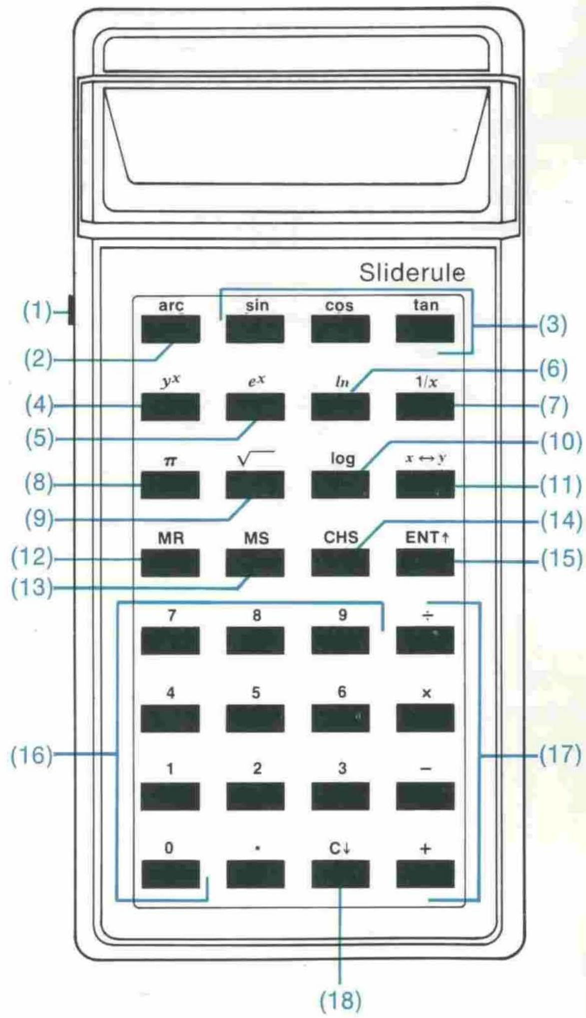
Reverse Polish Logic and the Stack Principle

The Novus Sliderule uses Reverse Polish logic with three registers called X, Y and Z. A register is an electronic element used to store data while it is being displayed, processed or waiting to be processed. The three registers are arranged in a "stack" as follows: (To avoid confusion between the name of a register and its contents, the registers in this diagram and the diagrams in Appendix A are represented by capital letters X, Y and Z and the contents of the registers by lowercase letters x, y and z).

CONTENTS	LOCATION
z	Z
y	Y
x	X

The display always shows the contents (x) of register X. See Appendix A for diagrams showing what happens to the stack for each operation on the Novus Sliderule.

Keyboard Layout



(1) On/off switch
(2) Inverse trig function key
(3) Trig function keys
(4) Power and root key
(5) Natural antilog key
(6) Natural log key
(7) Reciprocal key
(8) Pi entry key
(9) Square root key
(10) Common log key
(11) X-Y-exchange key
(12) Memory recall key
(13) Memory store key
(14) Change sign key
(15) Enter key
(16) Number entry keys
(17) Basic function keys
(18) Clear key

Keyboard Callout

NOTE: Any key referring to "x" is referring to the number NOW in the display. Any key referring to "y" is referring to the number PREVIOUSLY in the display.

arc — Touched before sin, cos or tan computes the inverse sine, cosine or tangent (in degrees), respectively, of the number in the display.

sin — Computes the sine of the angle (in degrees) in the display.

cos — Computes the cosine of the angle (in degrees) in the display.

tan — Computes the tangent of the angle (in degrees) in the display.

π — Enters Pi (π) = 3.1415926 into the display (X register).

log — Computes the common logarithm of the number in the display.

ln — Computes the natural logarithm of the number in the display.

e^x — Computes the natural antilogarithm of the number in the display. (Raises e = 2.718281 to the "x" power).

y^x — Raises "y" to the "x" power.

√‾ Computes the square root of the number in the display.

1/x Computes the reciprocal of the number in the display. (Divides 1 by "x").

x–y Exchanges the number now in the display for the number previously in the display.

MR Recalls the contents of memory to the display (X register).

MS Stores the number in the display in memory.

CHS Changes the sign of the number in the display.

ENT Enters the number in the display (x register) into a working register (y register).

÷ Divides "y" by "x".

× Multiplies "y" by "x".

− Subtracts "x" from "y".

+ Adds "x" to "y".

C Clears contents of display (x register) and rolls stack down.

Keying In and Entering Numbers

To enter the first number in a 2-function calculation, key in the number and touch ENT. If your number includes a decimal point, key it in with the number. If a decimal is keyed in more than once in a number entry, the calculator will use the last decimal keyed in. You do not have to key in the decimal in whole numbers.

To enter a negative number, key in the number and touch CHS.

Correcting Mistakes

To clear a wrong number entry, touch C. Touching C clears the X register (display) and drops the stack down.

Performing Calculations

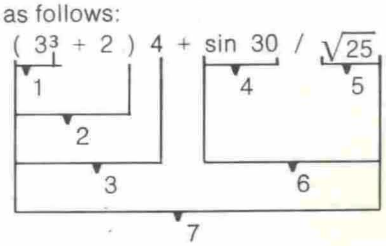
In addition to the separate memory, there are three locations where numbers can be kept and operated on. These locations are called registers and in your Sliderule these have been combined into an automatic stack. Your Novus Sliderule uses the three level stack along with Reverse Polish logic to enable you to perform calculations according to mathematical hierarchy.

Mathematical Hierarchy and Reverse Polish Logic

"Hierarchy" is a term for the rules of mathematics which tell you in which order to perform operations on numbers. Those rules are:

1. Do the problem left to right.
2. Do all operations within parentheses, if any, first.
3. Perform operations in the following order:
   a. raising to powers, taking roots, trig, log and reciprocal functions.
   b. multiplication and division,
   c. addition and subtraction.
4. Repeat steps 1 through 3 until the calculation is complete.

Example: The equation $(3^3 + 2)4 + \sin 30/\sqrt{25} = 116.1$ is solved according to the rules of hierarchy as follows:



1. $3^3 = 27.$
2. $2 + 27 = 29.$
3. $29 \times 4 = 116.$
4. $\sin 30 = .5$
5. $\sqrt{25} = 5.$
6. $.5 \div 5 = .1$
7. $116 + .1 = 116.1$

If you remember the following three steps in applying Reverse Polish logic to the rules of hierarchy, you will quickly master your Novus Sliderule and have confidence in its answers.

1. Starting at the left and working right, key in the next number (or the first if this is the beginning of a new problem).
2. Ask yourself: "Can an operation be performed according to the rules of hierarchy?" If so, perform all operations possible. If not, touch ENT
3. Repeat steps 1 and 2 until your calculation is complete.

Example: Following these three steps, you can calculate the equation $(3^3 + 2)4 + \sin 30/\sqrt{25}$ using Reverse Polish logic as follows:

KEY IN	DISPLAY SHOWS	COMMENTS
3	3	
ENT	3.	
3	3	
y^x	27.	3^3.
2	2	
+	29.	$(2 + 3^3)$.
4	4	
×	116.	$(2 + 3^3)4$.
30	30	
sin	.5	sin 30.
25	25	
$\sqrt{\ }$	5.	$\sqrt{25.}$
÷	.1	$.5 \div 5.$
+	116.1	$(2 + 3^3)4 + \sin 30/\sqrt{25.}$

Calculation is complete and performed according to the rules of hierarchy.

One-Factor Calculations

One-factor functions work directly on the number in the display. There is no need to touch ENT before performing the function.

Square Root and Reciprocal Functions

$\sqrt{\ }$ Computes the square root of the number in the display.

1/x Computes the reciprocal of the number in the display.

Example: Key in 2 1/x; display shows: .5.

Logarithmic Functions

ln Computes the natural logarithm of any positive number in the display.

e^x Computes the natural antilog of the number in the display by raising "e" (2.718281) to the power in the display.

log Computes the common logarithm of any positive number in the display.

Trigonometric Functions

sin Computes the sine of the angle (in degrees) in the display.

cos Computes the cosine of the angle (in degrees) in the display.

tan Computes the tangent of the angle (in degrees) in the display.

arc Touched before sin, cos, or tan, computes the arc sine, arc cosine or arc tangent (in degrees), respectively, of the number in the display.

Example: Key in 30 sin; display shows: .5. Key in .5 arc cos; display shows: 60.

Two-Factor Calculations

To perform two-factor calculations, key in the first factor, touch ENT, then key in the second factor and touch the desired function key.

+ Adds "x" to "y".

− Subtracts "x" from "y".

Example: Key in 2 ENT 3 +; display shows: 5.

× Multiplies "y" by "x".

÷ Divides "y" by "x".

Example: Key in 12.36 ENT 6 ÷; display shows: 2.06.

Power and Root Functions

y^x Raises "y" to the "x" power.

Example: Key in 5 ENT 3 y^x; display shows: 124.9999.*

Since taking the xth root of y is the same as raising y to the 1/x power, roots are obtained by touching 1/x before touching y^x. Example: key in 125 ENT 3 1/x y^x; display shows: 4.999995.*

**Note:* The reason for the small variation from the absolute answer is the Sliderule uses a log, antilog method of raising to powers; i.e., $y^x = e^{x \ln y}$. See Appendix A for a diagram of how this function works on the stack.

Chain Calculations

The number in the display is always ready to have calculations performed on it.

Example: (2 + 3) x (4 + 5) = 45.

KEY IN	DISPLAY SHOWS
2	2
ENT	2.
3	3
+	5.
4	4
ENT	4.
5	5
+	9.
×	45.

Memory

MS Stores the number in the display in memory (register M).

MR Recalls the contents of memory (register M) to the display (register X).

To clear memory, key in: 0 MS.

Error Conditions

In the event of an logic error (e.g., division by zero) the Novus Sliderule will display all zeros and decimal points. An error condition is reset by touching C. Memory is not affected by error conditions. See Appendix C, table 1, for a complete table of improper operations.

Radian/Degree Conversion

To convert radians to degrees or vice versa, key in 57.29578 MS. This constant can then be used for conversions.

Example: How many radians are in 15.7°?

KEY IN	DISPLAY SHOWS	COMMENTS
15.7	15.7	Number of degrees.
ENT	15.7	
RM	57.29578	Recall conversion constant.
÷	.27401669	Number of radians.

Example: How many degrees are in 2.56 radians?

KEY IN	DISPLAY SHOWS	COMMENTS
2.56	2.56	Number of radians.
ENT	2.56	
MR	57.29578	Recall conversion constant.
×	146.67719	Number of degrees.

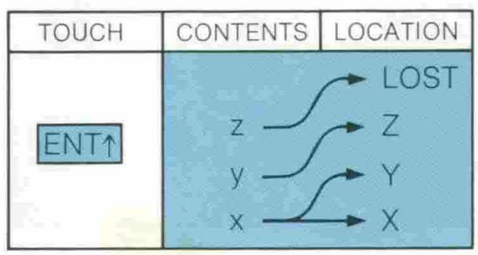
Example: What is the sine of 2.4 radians?

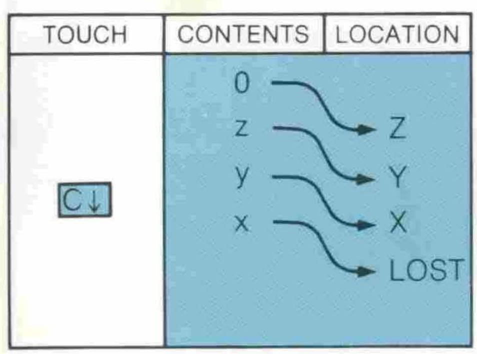
KEY IN	DISPLAY SHOWS	COMMENTS
2.4	2.4	Number of radians.
ENT	2.4	
MR	57.29578	Recall conversion constant.
×	137.50987	Convert to degrees.
sin	.6754633	Sine of 2.4 radians.

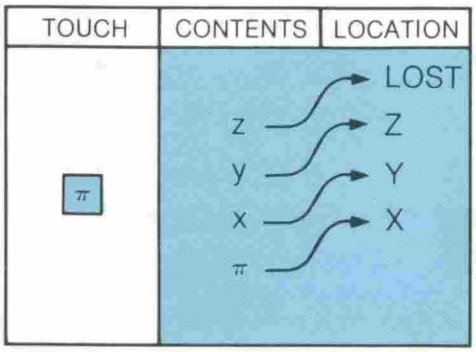
APPENDICES

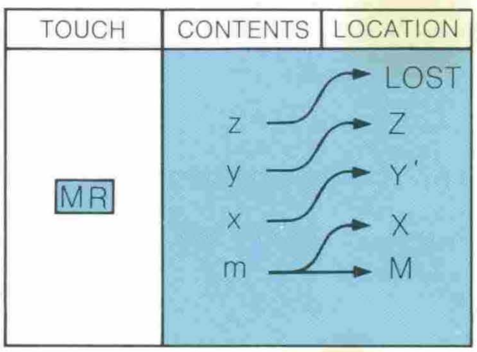
Appendix A — Stack Diagrams

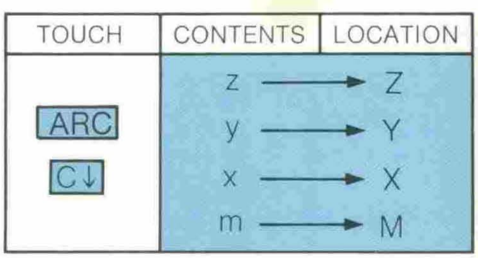
The following diagrams show what happens to the stack for each operation of the Novus Sliderule. Contents of registers are indicated by lower-case letters x, y and z. Locations are indicated by capital letters X, Y and Z. The display always shows the contents of register X. Memory is register M.

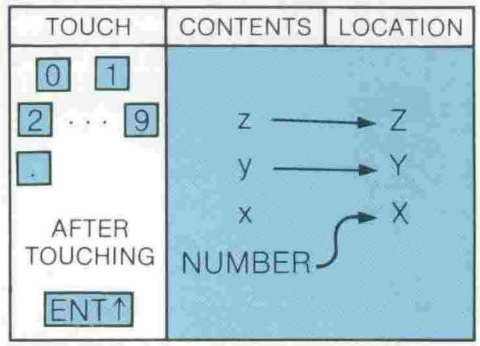


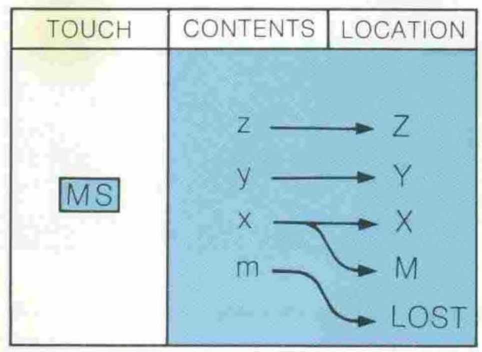


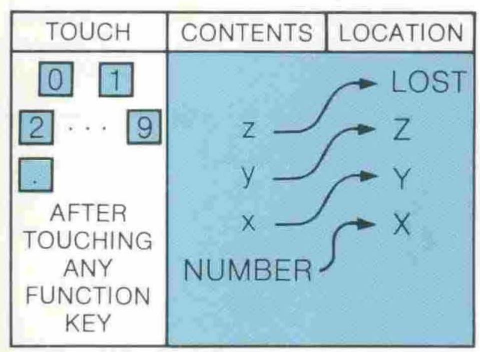

TOUCH
CONTENTS
LOCATION
π
z
y
x
π
LOST
Z
Y
X


TOUCH
CONTENTS
LOCATION
MR
z
y
x
m
LOST
Z
Y'
X
M


TOUCH
CONTENTS
LOCATION
ARC
C↓
z
y
x
m
Z
Y
X
M


TOUCH
CONTENTS
LOCATION
0 1
2 . . . 9
.
AFTER TOUCHING
ENT↑
z
y
x
NUMBER
Z
Y
X


TOUCH
CONTENTS
LOCATION
MS
z
y
x
m
Z
Y
X
M
LOST


TOUCH
CONTENTS
LOCATION
0 1
2 . . . 9
.
AFTER TOUCHING ANY FUNCTION KEY
z
y
x
NUMBER
LOST
Z
Y
X

TOUCH	CONTENTS	LOCATION
SIN	0	LOST
COS	z	Z
TAN	y	Y
ln	x	X
LOG	f(x)	LOST
e^x		

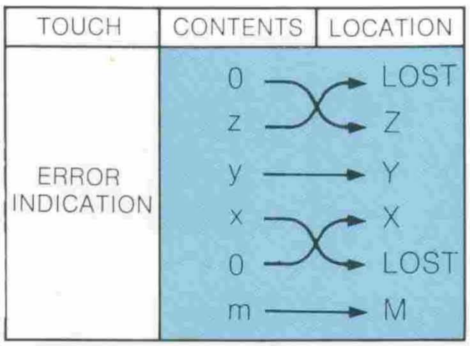
TOUCH	CONTENTS	LOCATION
	0	LOST
	z	Z
Y^x	y	X / Y
	x	Y^x / X

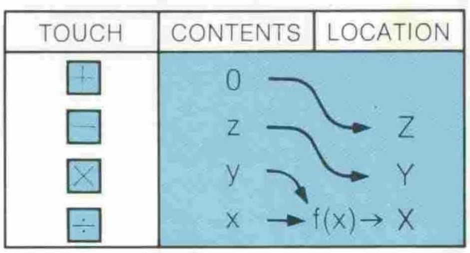
*Note: Performing any trig, log or antilog function clears register Z. f(x) is transferred to register X, and register Y remains unchanged. Performing the Y^x function clears register Z. The contents of register X are transferred to register Y and Y^x are transferred to register X.

TOUCH	CONTENTS	LOCATION
	z	Z
1/x	y	Y
√	x	X
	f(x)	LOST

TOUCH	CONTENTS	LOCATION
ARC	0	LOST
($\sin^{-1}$)	z	Z
or	y	Y
($\cos^{-1}$)	x	X
or	f(x)	LOST
($\tan^{-1}$)		

TOUCH	CONTENTS	LOCATION
	z	Z
X↔Y	y	Y
	x	X





f(x): $y + x \rightarrow X$

$y - x \rightarrow X$

$y \times x \rightarrow X$

$y \div x \rightarrow X$

Appendix B — Part 1 — Some Examples

In the previous sections of this manual, you have seen a summary of how the functions of the Novus Sliderule work. This appendix demonstrates the versatility of the Sliderule in a variety of disciplines.

MATHEMATICS

Example: Sum of products (2 x 3) + (4 x 5) = 26.

KEY IN	DISPLAY SHOWS
2	2
ENT	2.
3	3
×	6.
4	4
ENT	4.
5	5
×	20.
+	26.

Example: Product of sums (2 + 3) x (4 + 5) = 45.

KEY IN	DISPLAY SHOWS
2	2
ENT	2.
3	3
+	5.
4	4
ENT	4.

5	5	
+	9.	
×	45.	

Degrees, minutes and seconds to decimal degrees conversion

Example: Convert the following degrees, minutes and seconds to decimal degrees: 56°23′44.5″

KEY IN	DISPLAY SHOWS	COMMENTS
44.5	44.5	Seconds.
ENT	44.5	
60	60	60 seconds/minute.
MS	60.	
÷	.74166666	
23	23	Minutes.
+	23.741666	
MR	60.	60 minutes/degree.
÷	.39569443	
56	56	Degrees.
+	56.395694	Decimal degrees.

Polar to rectangular coordinate conversion

Example: Convert the coordinates $\Theta = 35°$, $R = 7$ to rectangular coordinates using the formulas:

$X = R \cos \Theta,$

$Y = R \sin \Theta.$

KEY IN	DISPLAY SHOWS	COMMENTS
7	7	R.
MS	7.	Store R in memory.
35	35	Θ.
ENT	35.	
ENT	35.	Store Θ in register Y.
cos	.8191521	Sin Θ.
MR	7.	Recall R.
×	5.7340647	X calculated.
x–y	35.	Retrieve Θ from register Y.
sin	.5735765	Sin Θ.
MR	7.	Recall R.
×	4.0150355	Y calculated.

Note: To see "X" again, touch x–y .

Example: Compute the area of a cone with radius 5 and height 15.

Using the formula: $A = \pi R \sqrt{R^2 + H^2} + \pi R^2$

Substituting: $A = \pi \times 5 \times \sqrt{5^2 + 15^2} + \pi \times 5^2$
$= 326.9045$

KEY IN	DISPLAY SHOWS
π	3.1415926
ENT	3.1415926
5	5
×	15.707963
MS	15.707963
5	5
ENT ×	25.
15	15
ENT ×	225.
+	250

√	15.811388
MR	15.707963
×	248.36469
5	5
ENT ×	25.
π	3.1415926
×	78.539815
+	326.9045

CHEMISTRY

Example: Determine the depression of the mercury column in a glass tube of inside diameter 0.6 mm which stands vertically with one end immersed in mercury. The angle of contact with the mercury is 120° and the surface tension is 490 dynes/cm.

Using the formula: $h = 2T/rdg\ (\cos \Theta)$

where: h = height of mercury in tube,
T = surface tension,
r = inside radius of tube (½ diameter),
d = density of the liquid = 13.6 g/cm^3 for mercury,
g = acceleration due to gravity = 980 cm/sec^2.

$$h = \frac{2 \times 490 \text{ dynes/cm}}{0.03 \text{ cm} \times 13.6 \text{ g/cm}^3 \times 980 \text{ cm/sec}^2} \times \cos 120^\circ = -1.225 \text{ cm.}$$

KEY IN	DISPLAY SHOWS	COMMENTS
2	2	
ENT	2.	
490	490	Surface tension.
×	980.	
.03	.03	Inside radius in cm.
ENT	.03	
13.6	13.6	Density of mercury.
×	.408	
980	980	Gravity.
×	399.84	
÷	2.4509803	
120	120	Angle of contact.
cos	.4999999	
×	−1.2254899	Depression of column in cm.

Example: What is the molarity of a solution that contains 135 grams of calcium chloride, $CaCl_2$, per liter?

Using the formula mass of $CaCl_2$:

1 Ca = 1 x 40.08 u = 40.08 u
2 Cl = 2 x 35.453 u = 70.906 u
110.986 u = 110.986 g/mole

in the equation: number of moles =

$$\frac{\text{mass of } CaCl_2}{\text{formula mass of } CaCl_2} = \frac{135 \text{ grams}}{110.986 \text{ g/mole}} = 1.21 \text{ moles.}$$

So the concentration of the solution is 1.21 moles per liter.

KEY IN	DISPLAY SHOWS	COMMENTS
40.08	40.08	Atomic mass of Ca.
ENT	40.08	

35.453	35.453	Atomic mass of Cl.
ENT	35.453	
2	2	
×	70.906	Atomic mass of Cl_2.
+	110.986	Formula mass of $CaCl_2$.
135	135	Grams of $CaCl_2$.
x–y	110.986	
÷	1.2163696	Moles/liter.

Example: Calculate the percentage by weight of 10 grams of a substance with normality of 0.15 in 45 milliliters of standard solution with mew of 0.03646.

Using the formula:

$$\%wt = \frac{(mew) \times N \times V \times 10^2}{W}$$

where: %wt = percentage by weight,
mew = millequivalent weight of substance,
N = normality of the substance,
V = volume of standard solution in milliliters, and
W = weight of sample in grams.

Substituting:

$$\%wt = \frac{0.03646 \times 0.15 \times 45 \times 10^2}{10} = 2.46105$$

KEY IN	DISPLAY SHOWS
.03646	.03646
ENT	.03646
.15	.15
×	.005469
45	45
×	.246105
10	10
ENT ×	100.
×	24.6105
10	10
÷	2.46105

ENGINEERING

Example: What is the equivalent resistance of a 220-ohm resistor, a 145-ohm resistor and a 175-ohm resistor connected in parallel?

Using the equation:

$$R_{eq} = \frac{1}{1/R_1 + 1/R_2 + 1/R_3}$$

$$= \frac{1}{1/220 + 1/145 + 1/175}$$

KEY IN	DISPLAY SHOWS	COMMENTS
220	220	R_1.
1/x	.00454545	$1/R_1$.
ENT	.00454545	
145	145	R_2.
1/x	.00689655	$1/R_2$.
+	.011442	
175	175	R_3.
1/x	.00571428	$1/R_3$.
+	.01715628	
1/x	58.2877	$R_{eq} = \frac{1}{1/R_1 + 1/R_2 + 1/R_3}$

Example: If the internal pressure of a tank of gas at 295°K is 1500 psi, what is the pressure if the temperature is raised to 303°K?

Using the formula:

$$P_2 = \frac{P_1 T_2}{T_1} = \frac{1500 \times 303}{295} = 1540.6779 \text{ psi.}$$

KEY IN	DISPLAY SHOWS
1500	1500
ENT	1500.
303	303
×	454500.
295	295
÷	1540.6779

Example: What is the equivalent impedance of a 325-ohm resistor and a 15.2-millihenry inductor at a frequency of 1500 Hz?

Using the formula: $Z_{eq} = R/\Theta$

where: $\Theta = \text{arc tan } \frac{2\pi fL}{R}$

$$= \text{arc tan } \frac{2 \times \pi \times 1500 \times .0152}{325}$$

$$= 23.78739° \text{ and}$$

$$R = \frac{2\pi fL}{\sin \Theta} = 355.17239$$

KEY IN	DISPLAY SHOWS	COMMENTS
2	2	
ENT	2.	
π	3.1415926	
×	6.2831852	

1500	1500	
×	9424.7778	
.0152	.0152	
×	143.25662	
MS	143.25662	Since you're going to use 2πfL again to calculate R, store it for further use.
325	325	
÷	.4407896	
arc tan	23.78739	Θ calculated.
sin	.4033439	
MR	143.25662	Recall 2πfL.
x–y	.4033439	Exchange X and Y registers so you can divide what was last in display by what is now in display.
÷	355.17239	R calculated.

STATISTICS

Example: Compute the mean (x) of the following data: (2, 7, 3, 5, 2).

Using the formula:

$$x = \frac{\Sigma x}{n}$$

KEY IN	DISPLAY SHOWS	COMMENTS
2	2	x_1.
ENT	2.	
7	7	x_2.
+	9.	

3	3	x_3. Repeat these steps n-1 times.
+	12.	
5	5	x_4.
+	17.	
2	2	x_5.
+	19.	
5	5	n
÷	3.8	Mean (x).

Example: Compute the harmonic mean (M_h) of the following data: (2, 7, 3, 5, 2).

Using the formula:

$$M_h = \frac{n}{\Sigma\, 1/x}$$

KEY IN	DISPLAY SHOWS	COMMENTS
2	2	x_1.
1/x	.5	
7	7	x_2.
1/x	.14285714	
+	.64285714	
3	3	x_3.
1/x	.33333333	Repeat these steps n-1 times.
+	.97619047	
5	5	x_4.
1/x	.2	
+	1.1761904	
2	2	x_5.
1/x	.5	
+	1.6761904	
5	5	n
x⇄y	1.6761904	
÷	2.9829546	Harmonic mean (M_h).

Example: Compute the geometric mean (M_g) of the following data: (2, 7, 3, 5, 2).

Using the formula:

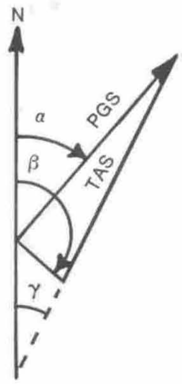
$$M_g \sqrt[n]{(x_1)\,(x_2)\,(x_3)\,\ldots\,(x_n)}$$

KEY IN	DISPLAY SHOWS	COMMENTS
2	2	x_1.
ENT	2.	
7	7	x_2.
×	14.	
3	3	x_3. Repeat these steps n-1 times.
×	42.	
5	5	x_4.
×	210.	
2	2	x_5.
×	420.	
5	5	n
1/x	.2	n^{th} root.
y^x	3.346952	Geometric mean (M_g).

NAVIGATION

Example: Find the predicted ground speed and true heading for a planned flight with the following flight trangle factors known:

$<\alpha$ = true course = 30° from North.
$<\beta$ = wind direction = 50° from North.
TAS = true air speed = 140 mph.
V = wind velocity = 42 mph.
$<\gamma$ = true heading = ?
PGS = predicted ground speed = ?



Predicted Ground Speed

Using the equation:

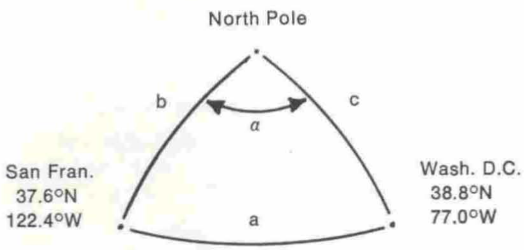
$$PGS = V\cos(\beta-\alpha) + \sqrt{[V\cos(\beta-\alpha)]^2 - V^2 + TAS^2}$$
$$= 42\cos(50-30) + \sqrt{[42\cos(50-30)]^2 - 42^2 + 140^2}.$$

KEY IN	DISPLAY SHOWS	COMMENTS
42	42	Wind velocity.
ENT	42.	
50	50	Wind direction ($<\beta$).
ENT	50.	
30	30	True course ($<\alpha$).
−	20.	
cos	.9396927	
×	39.467093	V cos ($\beta-\alpha$).
MS	39.467093	Store for further use.
ENT	39.467093	
×	1557.6514	$[V\cos(\beta-\alpha)]^2$.
42	42	V.
ENT	42.	
×	1764.	V^2.
−	−206.3486	$[V\cos(\beta-\alpha)]^2 - V^2$.
140	140	TAS.
ENT	140.	
×	19600.	TAS^2.
+	19393.652	$[V\cos(\beta-\alpha)]^2 - V^2 + TAS^2$.
√‾	139.26109	$\sqrt{[V\cos(\beta-\alpha)]^2 - V^2 + TAS^2}$.
MR	39.467093	V cos($\beta-\alpha$).
+	178.72818	$V\cos(\beta-\alpha) + \sqrt{[V\cos(\beta-\alpha)]^2 - V^2 + TAS^2}$ = Predicted ground speed.

Example: What is the great circle route between San Francisco and Washington, D.C.?

Using the formula:

$a = \text{arc cos}(\cos b \cos c + \sin b \sin c \cos \alpha) \times 60$



where: $\alpha = 122.4° - 77.0° = 45.4°$,
$b = 90° - 37.6° = 52.4°$, and
$c = 90° - 38.8° = 51.2°$.

$a = \text{arc cos}(\cos 52.4 \cos 51.2 + \sin 52.4 \sin 51.2 \cos 45.4) \times 60.$

KEY IN	DISPLAY SHOWS	COMMENTS
52.4	52.4	b.
cos	.6101452	cos b.
51.2	51.2	c.
cos	.6266039	cos c.
×	.38231936	cos b cos c.
MS	.38231936	Store in memory.
52.4	52.4	b.
sin	.7922897	sin b.
51.2	51.2	c.
sin	.779338	sin c.
×	.61746147	sin b sin c.
45.4	45.4	α.

KEY IN	DISPLAY SHOWS	COMMENTS
cos	.70215	cos α.
×	.43355248	sin b sin c cos α.
MR	.38231936	Recall memory.
+	.81587184	cos b cos c + sin b sin c cos α.
arc	.81587184	
cos	35.32634	arc cos (cos b cos c + sin b sin c cos α).
60	60	
×	2119.5804	Great circle distance.

FINANCE

Example: What will $7,000 be worth in 5 years if it is compounded annually at a rate of 8.2% per year?

Using the formula: $FV = PV(1 + i)^n$

where: FV = future value,
PV = present value,
i = interest per period (in decimal),
n = number of periods.

$= 7000\ (1 + .082)^5$

KEY IN	DISPLAY SHOWS	COMMENTS
1	1	
ENT	1.	
.082	.082	i.
+	1.082	
5	5	n.
y^x	1.482882	$(1 + i)^n$.
7000	7000	PV.
×	10380.874	Future value (FV).

Example: Compute the annual rate of return (after taxes) on an investment of \$10,000 which after 3½ years is worth \$12,550 if the tax rate is 38%.

Using the formula:

$$r = \frac{(FV - PV)\ (1 - \text{tax rate})}{PV} \times n$$

where: r = rate of return,
FV = future value,
PV = present value,
n = number of periods.

KEY IN	DISPLAY SHOWS	COMMENTS
12550	12550	FV.
ENT	12550.	
10000	10000	PV.
MS	10000.	Save for use in dividing.
−	2550.	FV − PV.
1	1	
ENT	1.	
.38	.38	Tax rate.
−	.62	1 − tax rate.
×	1581.	(FV − PV) (1 − tax rate).
MR	10000.	Recall PV.
÷	.1581	$\frac{(FV - PV)\ (1 - \text{tax rate})}{PV}$
3.5	3.5	n.
×	.55335	$\frac{(FV - PV)\ (1 - \text{tax rate})}{PV} \times n$.
100	100	
×	55.335	Multiply by 100 to make into whole percentage = rate of return.

Part 1.

What is the annual payment on a loan of \$86,000 taken for 10 years if the rate is 8% per year?

Using the formula:

$$PMT = PV \left[\frac{i}{1 - (1 + i)^{-n}} \right]$$

where: PMT = payment,
PV = present value,
i = interest rate per perior (in decimal),
n = number of periods.

KEY IN	DISPLAY SHOWS	COMMENTS
1	1	
ENT	1.	
.08	.08	i.
+	1.08	(1 + i).
10	10	n.
CHS	−10	
y^x	.4631941	$(1 + i)^{-n}$.
CHS	−.4631941	
1	1	
+	.5368059	$1 - (1 + i)^{-n}$.
.08	.08	
x–y	.5368059	
÷	.14902965	$\frac{i}{1 - (1 + i)^{-n}}$
86000	86000	PV.
×	12816.549	PMT.

Part 2.

In the above example (part 1), what is the remaining balance after the 6th payment?

Using the formula:

$$BAL_k = PMT\left[\frac{1-(1+i)^{k-n}}{i}\right]$$

where: k = number of payments made.

KEY IN	DISPLAY SHOWS	COMMENTS
1	1	
ENT	1.	
.08	.08	i.
MS	.08	Store for further use.
+	1.08	1 + i.
6	6	k.
ENT	6.	
10	10	n.
−	−4.	k − n.
y^x	.7350307	$(1+i)^{k-n}$.
CHS	−.7350307	
1	1	
+	.2649693	$1-(1+i)^{k-n}$.
MR	.08	Recall i.
÷	3.3121162	$\frac{1-(1+i)^{k-n}}{i}$
12816.55	12816.55	PMT (from part 1).
×	42449.902	Bal_k.

Appendix B — Part 2 — Hyperbolic and Inverse Hyperbolic Functions

The hyperbolic and inverse hyperbolic functions can be found by using the Gudermannian function:

$$gd\ x = 2 \text{ arc tan } e^x - \pi/2 \quad (\text{Note: } \pi/2 = 90°).$$

and the inverse Gudermannian function:

$$gd^{-1}\ x = \ln \tan\ [\pi/4 + x/2] \quad (\text{Note: } \pi/4 = 45°).$$

in conjunction with the following formulas:

$$\sinh x = \frac{e^x - e^{-x}}{2},$$

$$\cosh x = \frac{e^x + e^{-x}}{2},$$

$$\tanh x = \frac{\sinh x}{\cosh x} = \sin gd\ x,$$

$$\coth x = \frac{1}{\tanh x},$$

$$\text{sech } x = \frac{1}{\cosh x},$$

$$\text{csch } x = \frac{1}{\sinh x}.$$

$$\sinh^{-1} x = \ln\ [x + \sqrt{(x^2+1)}] = gd^{-1}(\sin^{-1} x),$$

$$\cosh^{-1} x = \text{sech}^{-1}\ 1/x,$$

$$\tanh^{-1} x = 1/2 \ln\ [1 + x/1 - x] = gd^{-1}(\sin^{-1} x),$$

$$\coth^{-1} x = \tanh^{-1} 1/x,$$

$$\text{sech}^{-1} x = [\ln 1/x + \sqrt{1/x^2 - 1}] = gd^{-1}(\cos^{-1} x),$$

$$\text{csch}^{-1} x = \sinh^{-1} 1/x.$$

Examples:

Gudermannian function: gd 0.225 = 12.7841.
Key in: .225 e^x arc tan 2 × 90 —
Display shows: 12.7841

Inverse Gudermannian function: gd⁻¹ 60° = 1.316958.
Key in: 60 ENT 2 ÷ 45 + tan ln
Display shows: 1.316958.

Hyperbolic sine: sinh 2.5 = 6.0502025.
Key in: 2.5 e^x ENT 1/x — 2 ÷
Display shows: 6.0502025.

Hyperbolic cosine: cosh 2.5 = 6.1322875.
Key in: 2.5 e^x ENT 1/x + 2 ÷
Display shows: 6.1322875.

Hyperbolic tangent: tanh 2.5 = .9866143.
Key in: 2.5 e^x arc tan 2 × 90 — sin
Display shows: .9866143.

Hyperbolic cotangent: coth 2.5 = 1.0135673.
Key in: 2.5 e^x arc tan 2 × 90 — sin 1/x
Display shows: 1.0135673.

Hyperbolic secant: sech 2.5 = .16307128.
Key in: 2.5 e^x ENT 1/x + 2 ÷ 1/x
Display shows: .16307128.

Hyperbolic cosecant: csch 2.5 = .16528372.
Key in: 2.5 e^x ENT 1/x — 2 ÷ 1/x
Display shows: .16528372.

Inverse hyperbolic sine: $\sinh^{-1}$ 30 = 4.094624.
Key in: 30 arc tan 2 ÷ 45 + tan ln
Display shows: 4.094624.

Inverse hyperbolic tangent: $\tanh^{-1}$ .52 = .5763396.
Key in: .52 arc sin 2 ÷ 45 + tan ln
Display shows: .5763396.

Inverse hyperbolic secant: sech^{-1} .52 = 1.271361.
Key in: .52 arc cos 2 ÷ 45 + tan ln
Display shows: 1.271361.

Inverse hyperbolic cosine: $\cosh^{-1}$ 30 = 4.094066.
Key in: 30 1/x arc cos 2 ÷ 45 + tan ln
Display shows: 4.094066.

Inverse hyperbolic cotangent: $\coth^{-1}$ 30 = 0.0333458.
Key in: 30 1/x arc sin 2 ÷ 45 + tan ln
Display shows: 0.0333458.

Inverse hyperbolic cosecant: csch^{-1} .52 = 1.408696.
Key in: .52 1/x arc tan 2 ÷ 45 + tan ln
Display shows: 1.408696.

Appendix C — Operating Limits

CONDITIONS FOR ERROR INDICATION

FUNCTION	CONDITION (X=contents of register X)
+, —, ×, ÷	X > 99999999
÷, 1/x	$\lvert X \rvert \leq 0.00000001$
$\sqrt{x}$	X < 0
Y^x	Y ≤ 0; 18.42060 < X ln Y < −28
LOG X, Ln x	X ≤ 0
e^x	18.42068 < X < −28
SIN, COS	X ≥ 7 radians, X ≥ 401°
TAN	$\lvert X \rvert \geq 90°$, X ≥ 7 radians
SIN^{-1}, COS^{-1}	X > 1
TAN^{-1}	X > 99999999

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- Trig and inverse trig functions
- Common and natural logs and anti-logs
- Fully addressable, accumulating memory

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The Programmable Electronic Slide Rule

- Same features as Novus 4510
- 100-step programming capability

Novus 4520 Scientist

The Scientist's Electronic Slide Rule

- Scientific notation
- Trig and inverse trig functions
- Common and natural logs and anti-logs

Novus 4525 Scientist PR

Scientist's Programmable Electronic Slide Rule

- Same features as Novus 4520
- 100-step programming capability

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- Fully addressable, accumulating memory
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The Electronic Financial Calculator

- Dedicated to solving financial calculations
- Pre-programmed financial equations
- Fully addressable, accumulating memory

Novus 6025 Financier PR

Programmable Electronic Financial Calculator

- Same features as the Novus 6020
- 100-step programming capability

Novus 6030 Statistician

The Electronic Statistical Calculator

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- Pre-programmed statistical equations
- Fully addressable, accumulating memory

Novus 6035 Statistician PR

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- 100-step programming capability

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Please retain for your records. See insert for trouble-shooting tips and product service locations.

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Serial Number____________________

Purchased from____________________

Date purchased____________________