Novus 4520 Scientist

Operations Guide

Made in America, with pride, by National Semiconductor

All the advanced electronics in this Novus calculator are manufactured by National Semiconductor Corporation, a world leader in the design and production solid-state electronic components. National is a multinational, NYSE-listed company that's demonstrated unparalleled growth over the last six years.

Your Novus calculator is built in the USA. That's because American technology—and specifically the know-how of National Semiconductor—is the key to this product's quality, reliability and computation "horsepower." No other manufacturer can equal National's ability to produce rugged, performance-packed components in the large volumes that result in quality products with small price tags.

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.

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Getting Started

Turn your Novus Scientist 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 needs recharging by connecting the Novus AC charger.

AC Charger

Your Novus Scientist is powered by rechargeable batteries. The Scientist 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 charged as soon as possible. Continued use on a weak battery may result in inaccurate answers. To charge the batteries connect the Novus AC Charger to the jack on the top left side of the machine. A typical full charge takes five hours. You can operate your calculator while the charger is connected. BE SURE THE CALCULATOR IS TURNED OFF BEFORE CONNECTING THE AC CHARGER.

Operation

Display

The Novus Scientist displays an 8-digit mantissa and a 2-digit exponent. The calculator will accept and display any positive or negative number between –1 x 10^{-99} and 9.9999999 x 10^{99}. Any result larger than 9.9999999 x 10^{99} will result in an overflow indicated by the display of 8 mantissa digits of the result and the two least significant digits of the 3-digit exponent. Computed results between the range of 0.1 and 99999999 are displayed in floating point format. Results smaller than 0.1 or larger than 99999999 are automatically converted to scientific notation format.

Automatic Display Shutoff

To save battery life, the Novus Scientist shuts off all but the most significant digit of the mantissa if no key has been pressed for approximately 30 seconds. No data has changed and to restore the display without changing its contents, touch CHS twice.

Reverse Polish Logic and the Stack Principle

The Novus Scientist uses Reverse Polish logic with four registers called X, Y, Z and T. A register is an electronic element used to store data while it is being displayed, processed or waiting to be processed. The four 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, Z and T and the contents of the registers by lower case letters x, y, z and t).

CONTENTS	LOCATION
t	T
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 of the Novus Scientist.

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.

Scientific Notation

Any number can be entered into the Novus Scientist in scientific notation—that is, as a number (mantissa) multiplied by 10 raised to a power (exponent). The exponent indicates how many places the decimal point should be moved. If the exponent is positive, the decimal is moved to the right. If the exponent is negative, the decimal is moved to the left. For example: 1200 can be entered as 1.2 x 10^3. Key in: 1.2 EE 3, the display shows: 1.2 03. Note: The last two digits on the right side of the display are used to indicate exponents.

Very large and very small numbers must be entered in scientific notation. For example: 134,000,000,000,000 (written 1.34 x 10^{14}) must be keyed in: 1.34 EE 14; display shows: 1.34 14. To enter a negative exponent, touch CHS after keying in the exponent. Example: .000000000034 (written 3.4 x 10^{-11}) must be keyed in: 3.4 EE 11 CHS, display shows: 3.4 –11.

If EE has not been preceded by a mantissa entry the EE depression is ignored.

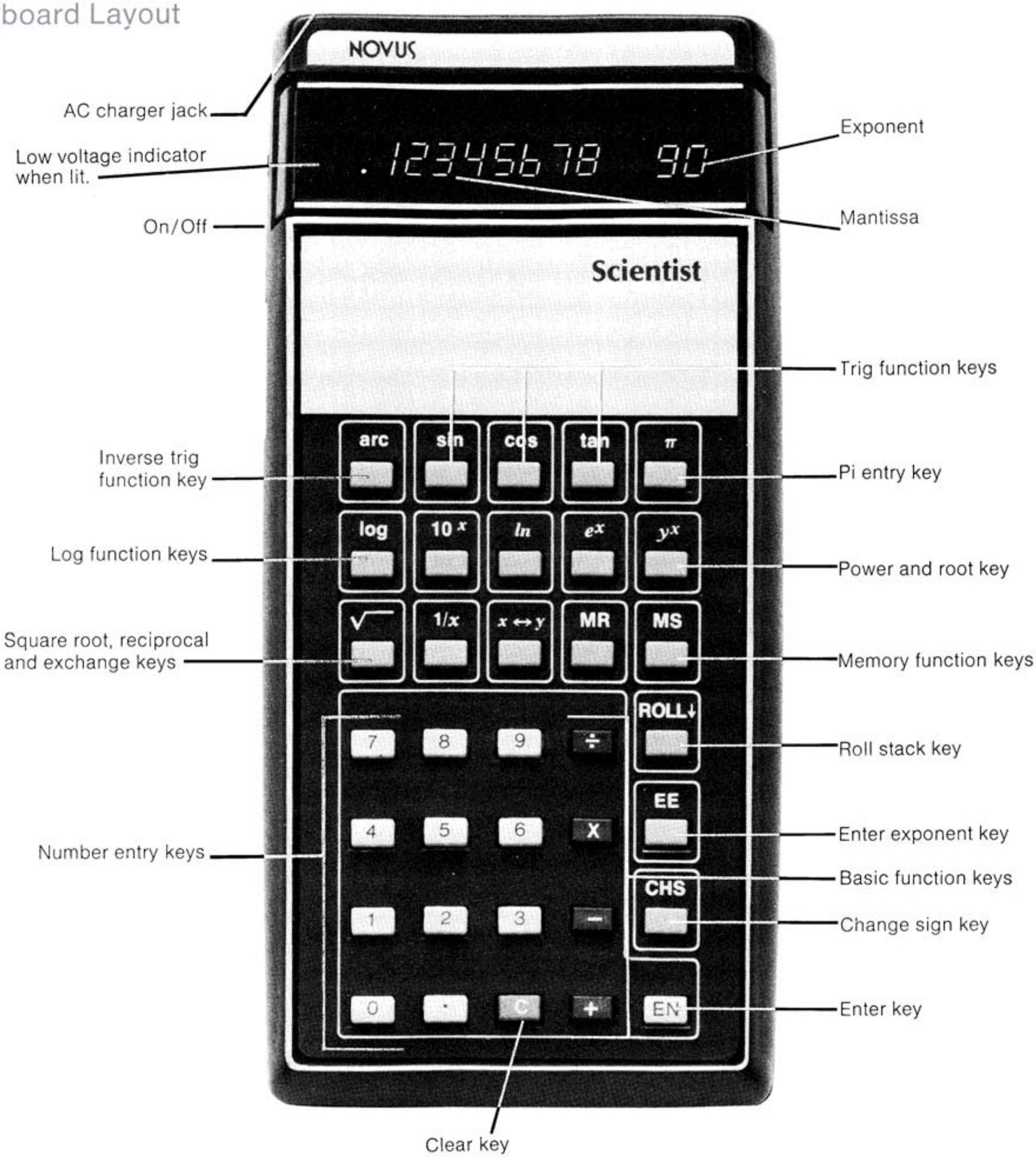
Correcting Mistakes

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

To correct a wrong exponent entry, just key in the correct exponent. If more than two numbers are keyed in after touching EE, the calculator retains the last two numbers keyed in as the exponent.

To correct a wrong mantissa entry after EE has been touched, touch • (decimal). This will clear the display to 0 and allow re-entry of the mantissa and exponent.

Keyboard Layout



Keyboard Callouts

Note: Any reference to ‘x’ is to the number NOW in the display. Any reference to ‘y’ is to the number LAST 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) = 3.1415927 into the display (X register), and raises stack.
log	Computes the common logarithm of the number in the display.
10^x	Computes the common antilogarithm of the number in the display. (Raises 10 to ‘x’ power).
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 = 2.7182812 to the ‘x’ power).
y^x	Raises ‘y’ to the ‘x’ power.
$\sqrt{\ }$	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 with the number last in the display.
MR	Recalls the contents of memory to the display (X register), and raises stack.
MS	Stores the number in the display in memory.
ROLL	Moves the contents of register X to register T, the contents of register Y to register X, the contents of register Z to register Y and the contents of register T to register Z.
EE	Instructs the calculator to accept the next number keyed in as an exponent of 10.
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.

Performing Calculations

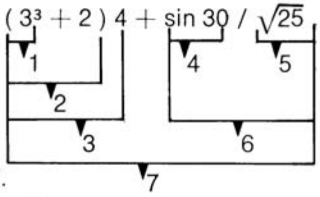
In addition to the separate memory, there are four locations where numbers can be kept for operations. These locations are called registers and in the Scientist these have been combined into an automatic stack. The Novus Scientist uses the four-level stack along with Reverse Polish logic to allow calculations according to mathematical hierarchy.

Mathematical Hierarchy and Reverse Polish Logic

Hierarchy is a term for the rules of mathematics referring to the order of performance of 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 Scientist 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.

Following these three steps, you can calculate the example 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	26.999981*	3^3.
2	2	
+	28.999981	$(3^3 + 2)$
4	4	
×	115.99992	$(3^3 + 2)4$
30	30	
sin	0.5000002	sin 30
25	25	
$\sqrt{\ }$	5.	$\sqrt{25}$.
÷	0.1	$.5 \div 5$
+	116.09992	$(3^3 + 2)4 + \sin 30/\sqrt{25}$.

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

*See note page 7.

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

√	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: 0.5.

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' (2.7182812) to the power in the display.
log	Computes the common logarithm of any positive number in the display.
10^x	Computes the common antilog of the number in the display by raising 10 to the power 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: 0.5000002
Key in: .5 arc cos ; display shows: 60.000454

Two-Factor Calculations

To perform two-factor calculations, key in the first factor, touch ENT , 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: 124.99984.*

Since taking the x^{th} root of y is the same as raising y to the 1/x power, to obtain roots, touch 1/x before touching y^x.

Example: Key in: 125 ENT 3 1/x y^x; display shows: 5.0000001.*

*Note: The actual results which occur when performing special functions must be rounded off to the third to sixth decimal place for greater accuracy. The inaccuracy (e.g., $3^3 = 26.999981$ instead of 27) of answers occurs because extra guard digits and rounding techniques are not employed during calculations in order to simplify the technical design of your calculator.

Chain Calculations

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

Example: (2 +3) × (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).

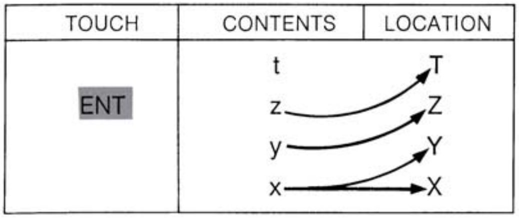
To clear memory, key in: 0 MS.

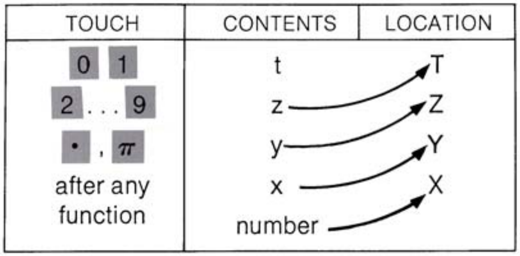
Error Conditions

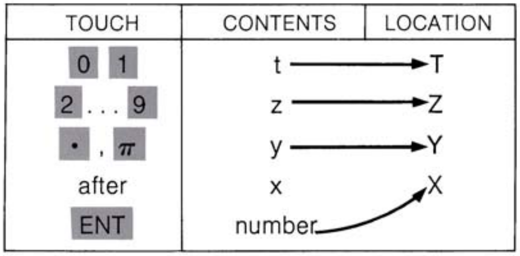
In the event of a logic error (e.g., division by zero) the Novus Scientist will display all zeros and decimal points. An error condition is reset by touching C. All registers are cleared to zero. Memory is not affected by error conditions. See Appendix C, Table 1, for a complete table of improper operations.

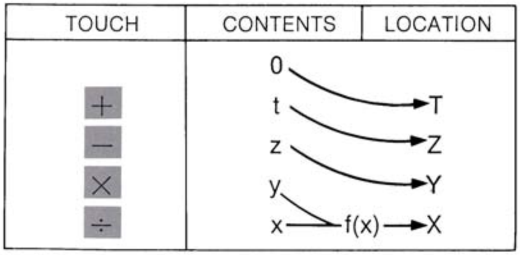
Appendix A — Stack Diagrams

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









f(x): $y + x \rightarrow X$
$y - x \rightarrow X$
$y \times x \rightarrow X$
$y \div x \rightarrow X$

TOUCH	CONTENTS	LOCATION
C↓	0	T
	t	Z
	z	Y
	y	X
	x	lost

TOUCH	CONTENTS	LOCATION
CHS	t	T
	z	Z
	y	Y
	x—CHS	x→X

TOUCH	CONTENTS	LOCATION
MS	t	T
	z	Z
	y	Y
	x	X M
	m	lost

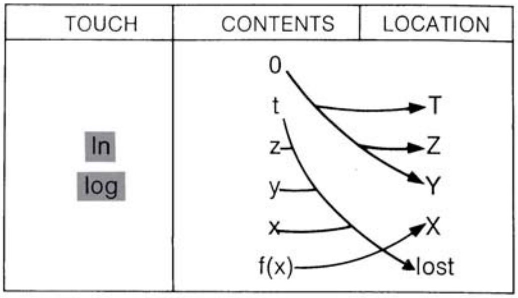
TOUCH	CONTENTS	LOCATION
X →Y	t	T
	z	Z
	y	X
	x	Y

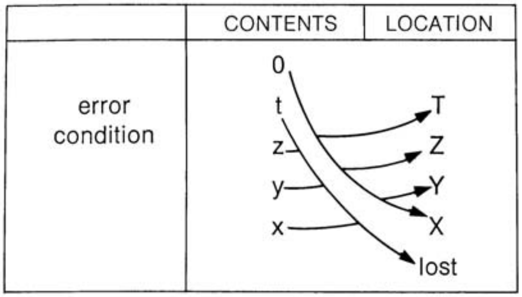
TOUCH	CONTENTS	LOCATION
EE after number entry	t	T
	z	Z
	y	Y
	x	X*

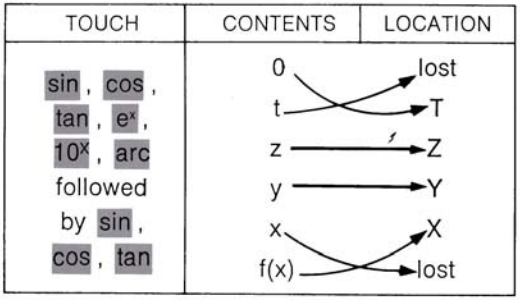
*Note: Calculator conditioned to accept exponent.

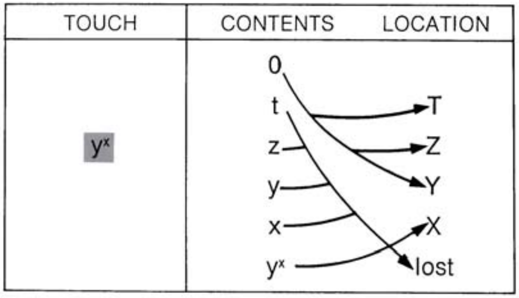
TOUCH	CONTENTS	LOCATION
ROLL	t	Z
	z	Y
	y	X
	x	T

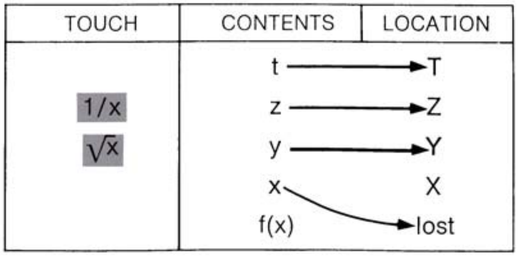
TOUCH	CONTENTS	LOCATION
MR	t	lost
	z	T
	y	Z
	x	Y
	m	X M


TOUCH
CONTENTS
LOCATION
ln
log
0
t
z
y
x
f(x)
T
Z
Y
X
lost


CONTENTS
LOCATION
error condition
0
t
z
y
x
T
Z
Y
X
lost


TOUCH
CONTENTS
LOCATION
sin, cos, tan, eˣ, 10ˣ, arc followed by sin, cos, tan
0
t
z
y
x
f(x)
lost
T
Z
Y
X
lost


TOUCH
CONTENTS
LOCATION
yˣ
0
t
z
y
x
yˣ
T
Z
Y
X
lost


TOUCH
CONTENTS
LOCATION
1/x
√x
t
z
y
x
f(x)
T
Z
Y
X
lost

Appendix B—Part 1
Some Examples

In the previous sections of this manual is a summary of how the functions of the Novus Scientist work. This appendix demonstrates the versatility of the Scientist in a variety of disciplines.

MATHEMATICS

Real roots of a quadratic equation.
Given the equation $2x^2 + 3x - 4$, find the roots: x_1 and x_2.

Roots x_1 and x_2 can be found from the equation:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} = \frac{-b}{2a} \pm \frac{\sqrt{b^2 - 4ac}}{2a}$$

where: $a = 2$, $b = 3$ and $c = -4$.

STEP	KEY IN	DISPLAY SHOWS	COMMENTS
1		2	a.
2	ENT	2.	
3	+	4.	2a.
4	MS	4.	Save for use in dividing.
5	3	3	b.
6	CHS	-3.	-b.
7	x-y	4.	
8	÷	-0.75	$-b/2a$.
9	ENT	-0.75	
10	ENT	-0.75	Save in register Z for further use in addition and subtraction of the radical.
11	×	0.5625	$b^2/4a^2$.
12	4 CHS	4 -4.	 c.
13	ENT	-4.	
14	+	-8.	2c.
15	MR	4.	2a.
16	÷	-2.	c/a.
17	−	2.5625	$b^2/4a^2 - c/a = b^2 - 4ac/2a$.
18	√	1.600781	$\sqrt{b^2 - 4ac}/2a$.
19	MS	1.600781	
20	+	0.850781	First real root. $x_1 = -b/2a + \sqrt{b^2 - 4ac}/2a$.
21	MR	1.600781	$\sqrt{b^2 - 4ac}/2a$.
22	−	-0.75	$-b/2a + \sqrt{b^2 - 4ac}/2a$ $- \sqrt{b^2 - 4ac}/2a = -b/2a$.
23	MR	1.600781	$\sqrt{b^2 - 4ac}/2a$.
24	−	-2.350781	Second real root. $x_2 = -b/2a - \sqrt{b^2 - 4ac}/2a$.

Degrees, minutes and seconds to decimal degrees conversion. 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.	
÷	0.7416666	
23	23	Minutes.
+	23.741666	
MR	60.	60 minutes/degree.
÷	0.3956944	
56	56	Degrees.
+	56.395694	Decimal degrees.

Polar to rectangular coordinate conversion. Convert coordinates $\Theta = 35°$, $R = 7$ to rectangular coordinates.

Using the formula:

$$X = R \cos \Theta \text{ and}$$
$$Y = R \sin \Theta$$

KEY IN	DISPLAY SHOWS	COMMENTS
35	35	θ.
ENT	35.	
7	7	R.
MS	7	Store R in register M.
x–y	35.	
ENT	35.	Store θ in register Y.
cos	0.8191518	cos θ.
MR	7.	Recall R.
×	5.7340626	X displayed = R cos θ.
x–y	35.	θ.
sin	0.5735766	sin θ.
MR	7.	Recall R.
×	4.0150362	Y displayed = R sin θ.

Note: To see X again, touch x–y.

See Appendix B — Part 4 for a stack diagram of this example.

Rectangular to polar coordinate conversion. Convert coordinates X=6, Y=8 to polar coordinates R and Θ.

Using the formula:

$$R = \sqrt{X^2 + Y^2}$$

$$\Theta = \text{arc tan}\ \frac{Y}{X}$$

KEY IN	DISPLAY SHOWS	COMMENTS
6	6	X coordinate.
ENT	6.	
ENT	6.	Store X in register Z.
×	36.	X^2.
8	8	Y coordinate.
MS	8	Store Y in register M.
ENT	8.	
×	64.	Y^2.
+	100.	$X^2 + Y^2$.
√	10.	$R = \sqrt{X^2 + Y^2}$.
x–y	6.	Recover X.
MR	8.	Recall Y.
x–y	6.	Exchange to divide Y by X.
÷	1.3333333	Y/X.
arc	1.3333333	
tan	53.12998	Θ = arc tan Y/X.

Note: To see R again, touch x–y .

See Appendix B — Part 4 for a stack diagram of this example.

PHYSICS

What gravitational force does the earth exert on the moon? From Newton's law of universal gravitation,

$$F = G\,\frac{m_1 m_2}{r^2}$$

where: m_1 = mass of the earth = 5.98×10^{24} kg,
m_2 = mass of the moon = 7.36×10^{22} kg,
r = distance from the earth to the moon = 3.84×10^8 m
G = Universal gravitational constant = 6.67×10^{-11} N–m²/ kg²

therefore:

$$F = 6.67 \times 10^{-11} \times \frac{5.98 \times 10^{24} \times 7.36 \times 10^{22}}{(3.84 \times 10^8)^2}$$

$$= 1.99 \times 10^{20} \text{ newtons.}$$

KEY IN	DISPLAY SHOWS		COMMENTS
6.67	6.67		
EE	6.67		
11	6.67	11	
CHS	6.67	–11	Universal gravitational constant.
ENT	6.67	–11	
5.98	5.98		
EE	5.98		
24	5.98	24	Mass of the earth.
ENT	5.98	24	
7.36	7.36		
EE	7.36		
22	7.36	22	Mass of the moon.
×	4.40128	47	$m_1 m_2$.

3.84	3.84		
EE	3.84		
8	3.84	08	Distance from earth to moon.
ENT	3.84	08	
×	1.47456	17	r^2.
÷	2.984809	30	$m_1 m_2/r^2$.
×	1.9908676	20	F = gravitational force.

How many electrons pass a certain point per second in a wire that carries a current of 12 amps?

Since 1 amp is defined as 1 coulomb/second, 12 A = 12 C/s. The electron charge = e = 1.6 × 10^{-19}C, so a current of 12A corresponds to a flow of:

$$\frac{12 \text{ C/s}}{1.6 \times 10^{-19} \text{ C/electron}} = 7.5 \times 10^{19} \text{ electrons/sec.}$$

KEY IN	DISPLAY SHOWS		COMMENTS
12	12		Amperes.
ENT	12.		
1.6	1.6		
EE	1.6		
19	1.6	19	
CHS	1.6	–19	Electron charge.
÷	7.5	19	Electrons/second.

What is the velocity of a proton (mass = 1.67 × 10^{-27} kg) which is accelerated through a potential difference of 300 volts?

Since the charge on a proton is +e, its kinetic energy is 300eV (electron-volts) x 1.6 x 10^{-19} joules/eV = 4.8 x 10^{-17} joules.

Using the equation KE = ½mv², where KE = kinetic energy of the electron, m = mass of the proton = 1.67 x 10^{-27} and v = velocity of the electron.

$$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2 \times 4.8 \times 10^{-17}}{1.67 \times 10^{-27}}}$$
$$= 2.397 \times 10^{5} \text{ meters/sec.}$$

KEY IN	DISPLAY SHOWS		COMMENTS
300	300		Potential difference in eV.
ENT	300.		
1.6	1.6		
EE	1.6		
19	1.6	19	
CHS	1.6	–19	Mass of proton.
×	4.8	–17	Kinetic energy of proton.
2	2		
×	9.6	–17	
1.67	1.67		
EE	1.67		
27	1.67	27	
CHS	1.67	–27	Mass of the proton.
÷	5.7485029	10	
√	239760.35		Velocity of the proton.

What is the attractive force between a proton (charge +e) and an electron (charge −e) in a hydrogen atom where the radius of the electron orbit is 5.3 x 10^{-11} m?

Using Coulomb's law:

$$F = k\frac{Q_1Q_2}{r^2}$$

where: k = Universal constant = 9.0×10^9 N–m²/C²

Q_1 = charge on particle 1 = charge of proton = 1.6×10^{-19}C,

Q_2 = charge on particle 2 = charge of electron = 1.6×10^{-19}C,

r = distance between two charges = 5.3×10^{-11}m.

$$F = 9.0 \times 10^9 \times \frac{(1.6 \times 10^{-19})^2}{(5.3 \times 10^{-11})^2}$$

$$= 8.2 \times 10^{-8} \text{ newtons.}$$

KEY IN	DISPLAY SHOWS		COMMENTS
9.0	9.0		
EE	9.0		
9	9.0	09	Universal constant.
ENT	9.	09	
1.6	1.6		
EE	1.6		
19	1.6	19	
CHS	1.6	−19	$Q_1 = Q_2$.
ENT	1.6	−19	
×	2.56	−38	Q_1Q_2.
5.3	5.3		
EE	5.3		
11	5.3	11	
CHS	5.3	−11	r.
ENT	5.3	−11	
×	2.809	−21	r^2.
÷	9.113563	−18	Q_1Q_2/r^2.
×	8.2022067	−08	Attractive force F.

One of the predictions of Einstein's theory of relativity is that the mass of moving body is greater than its mass at rest. Using the equation:

$$M = \frac{M_O}{\sqrt{1 - v^2/c^2}}$$

Where: M = mass of the moving body,

M_O = mass of the body at rest,

v = velocity of the body,

c = speed of light (2.997×10^8 m/sec).

Find the mass of an electron traveling at 75% of the speed of light. If the rest mass of an electron is 9.109×10^{-31} kg. If $v = .75c$, then the equation becomes:

$$M = \frac{M_O}{\sqrt{1 - (.75c)^2/c^2}} = \frac{M_O}{\sqrt{1 - (.75)^2}}$$

Substituting:

$$M = \frac{9.109 \times 10^{-31}}{\sqrt{1 - (.75)^2}}$$

KEY IN	DISPLAY SHOWS		COMMENTS
9.109	9.109		
EE	9.109	00	
31	9.109	31	
CHS	9.109	−31	Mass of electron at rest.
ENT	9.109	−31	
1	1		
ENT	1.		
.75	0.75		
ENT	0.75		
×	0.5625		$(.75)^2$
—	0.4375		$1 - (.75)^2$
√	0.6614378		$\sqrt{1 - (.75)^2}$
÷	1.3771514	−30	Mass of electron travelling at 75% the speed of light, $= M_o/\sqrt{1 - (.75)^2}$

Determine the rise 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 57.3° 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/cm³ for mercury,
g = acceleration due to gravity = 980 cm/sec².

$$h = \frac{2 \times 490 \text{ dynes/cm}}{0.03 \text{ cm} \times 13.6 \text{ g/cm}^3 \times 980 \text{ cm/sec}^2} \times \cos 57.3^\circ$$
$$= 1.324119$$

KEY IN	DISPLAY SHOWS	COMMENTS
2	2	
ENT	2.	
490	490	Surface tension.
×	980.	
.03	0.03	Inside radius in cm.
ENT	3. -02	
13.6	13.6	Density of mercury.
×	0.408	
980	980.	Gravity.
×	399.84	
÷	2.4509803	
57.3	57.3	Angle of contact.
cos	0.5402406	
×	1.324119	Rise of column in cm.

How many gram-atoms of Iron (Fe) are present in 250 grams of iron?

Since the atomic mass of Fe = 55.847 atomic mass units (u) = 55.847 grams/gram atom,

$$\text{Gram-atoms of Fe} = \frac{\text{mass of Fe}}{\text{atomic mass of Fe}}$$
$$= \frac{250 \text{ grams}}{55.847 \text{ g/gram-atom}}$$

KEY IN	DISPLAY SHOWS	COMMENTS
250	250	Grams of Fe.
ENT	250.	
55.847	55.847	Atomic mass of Fe.
÷	4.476516	Gram-atoms of Fe in 250 grams.

In the above example, how many atoms of Fe are in the sample?

Since the number of atoms in a sample of any substance is the number of gram-atoms it contains multiplied by Avogadro's number ($N = 6.023 \times 10^{23}$ atoms/gram-atom),

Atoms of Fe = 4.476516 gram-atoms x 6.023×10^{23} atoms/gram-atom = 4.476516 x 6.023×10^{23} = 2.6962×10^{24} atoms.

KEY IN	DISPLAY SHOWS	COMMENTS
4.476516	4.476516	Gram-atoms of Fe.
ENT	4.476516	
6.023	6.023	
EE	6.023	
23	6.023 23	Avogadro's number.
×	2.6962055 24	Atoms of Fe.

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

Using the formula mass of $CaCl_2$:

$$\begin{array}{l}1\ \mathrm{Ca} = 1 \times 40.08\ \mathrm{u} = \ \ 40.08\ \ \mathrm{u}\\ 2\ \mathrm{Cl} = 2 \times 35.453\ \mathrm{u} = \underline{\ \ 70.906\ \mathrm{u}}\\ \qquad\qquad\qquad\qquad 110.986\ \mathrm{u} = 110.986\ \mathrm{g/mole}\end{array}$$

in the equation:

$$\text{number of moles} = \frac{\text{mass of } CaCl_2}{\text{formula mass of } CaCl_2}$$

$$= \frac{135\ \text{grams}}{110.986\ \text{g/mole}} = 1.21\ \text{mole.}$$

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

What is the tension at the ends of a cable where the span is 700 feet and the sag is 45 feet if each cable of the suspension bridge carries a horizontal load of 620 lbs/ft?

Using the equation:

$$T = \tfrac{1}{2} wa \sqrt{1 + a^2/16d^2}$$

where: T = tension,
w = weight (horizontal load),
a = length of span,
d = sag,

$$= \tfrac{1}{2} \times 620 \times 700 \times \sqrt{1 + 700^2/16 \times 45^2}$$

$$= 871342\ \text{lbs.}$$

KEY IN	DISPLAY SHOWS	COMMENTS
700	700	Length of span (a).
MS	700.	
ENT	700.	
×	490000.	a^2.
16	16.	
ENT	16.	
45	45	Sag (d).
ENT	45.	
×	2025.	d^2.
×	32400.	$16d_2$.
÷	15.123456	$a^2/16d^2$.
1	1	
+	16.123456	$1 + a^2/16d^2$.
√	4.015401	$\sqrt{1 + a^2/16d^2}$.
MR	700.	a.
×	2810.7807	$a \times \sqrt{1 + a^2/16d^2}$.
620	620	Weight (w).
×	1742684.	$w \times a \times \sqrt{1 + a^2/16d^2}$.

1	1	
ENT	1.	
2	2	
÷	0.5	
×	871342.	½ x w x a x $\sqrt{1 + a^2/16d^2}$.

After how long a time will the charge oscillations in a LCR circuit decay to half-amplitude if L = 10 mh, C = 1.0 μf and R = 0.1 ohm?

The oscillation amplitude will have decreased to half when the amplitude factor $e^{-Rt/2L}$ in the equation $q = q_m e^{-Rt/2L} \cos_\omega{}' t$ has the value one-half, or

$$½ = e^{-R/t2L}$$

This leads to the equation:

$$t = \frac{2L}{R} \ln 2$$

$$= \frac{(2)\ (10 \times 10^{-3})\ (\ln 2)}{0.10}$$

KEY IN	DISPLAY SHOWS	COMMENTS
2	2	
ENT	2.	
10	10	
EE	10	
3	10 03	
CHS	10 -03	Inductance (L).
×	2. -02	2L.
2	2	
ln	0.6931475	
×	1.386295 -02	2L ln 2.
.10	0.10	Resistance (R).
÷	0.1386295	Seconds to decrease to half amplitude. = t = 2L/R ln 2.

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	4.545454 -03	$1/R_1$.
ENT	4.545454 -03	
145	145	R_2.
1/x	6.896551 -03	$1/R_2$.
+	1.1442005 -02	
175	175	R_3.
1/x	5.714285 -03	$1/R_3$.
+	1.715629 -02	
1/x	58.28766	$R_{eq} = \frac{1}{1/R_1 + 1/R_2 + 1/R_3}$

Find the capacitance of a capacitor having eleven 1-sq-inch plates with a dielectric of mica 5 mils thick.

Using the formula:

$$C = \frac{0.0885\ kA\ (n - 1)}{d}$$

where: k = dielectric constant = 6.5 for mica,
A = area of one plate in square centimeters,
n = the number of plates,
d = distance between plates in centimeters.

$$= \frac{0.0885 \times 1 \times (2.54\ cm/in)^2 \times (11 - 1)}{5 \times 10^{-3}\ in \times 2.54\ cm/in}$$

= 449.58 picofarads.

KEY IN	DISPLAY SHOWS	COMMENTS
0.0885	0.0885	
ENT	8.85 -02	
2.54	2.54	cm/in.
ENT	2.54	
×	6.4516	$(cm/in)^2$.
×	0.5709666	
11	11	n.
ENT	11.	
1	1	
−	10.	
×	5.709666	0.0885kA (n−1).
5	5	
EE	5.	
3	5. 03	
CHS	5. -03	d.
ENT	5. -03	
2.54	2.54	
×	1.27 -02	
÷	449.58	

STATISTICS

Compute the mean ($\bar{x}$) of the following data: (2, 7, 3, 5, 2).

Using the formula:

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

KEY IN	DISPLAY SHOWS	COMMENTS
2	2	x_1.
ENT	2.	
7	7	x_2.
+	9.	
3	3	x_3.
+	12.	Repeat these steps n−1 times.
5	5	x_4.
+	17.	
2	2	x_5.
+	19.	
5	5	n.
÷	3.8	Mean ($\bar{x}$).

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

Using the formula:

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

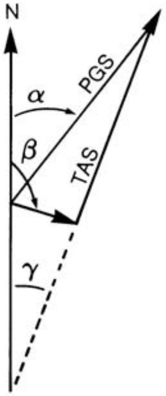
KEY IN	DISPLAY SHOWS	COMMENTS
2	2	x_1.
1/x	0.5	
7	7	x_2.
1/x	0.1428571	
+	0.6428571	
3	3	x_3.
1/x	0.3333333	
+	0.9761904	Repeat these steps n–1 times.
5	5	x_4.
1/x	0.2	
+	1.1761904	
2	2	x_5.
1/x	0.5	
+	1.6761904	
5	5	n.
x–y	1.6761904	
÷	2.9829546	Harmonic mean (M_h).

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

Using the formula:

$$M_g = \sqrt[n]{(x_1)\ (x_2)\ (x_3)\ \dots\ (x_n)}$$

KEY IN	DISPLAY SHOWS	COMMENTS
2	2	x_1.
ENT	2.	
7	7	x_2.
×	14.	
3	3	x_3.
×	42.	Repeat these steps n–1 times.
5	5	x_4.
×	210.	
2	2	x_5.
×	420.	
5	5	n.
1/x	0.2	n^{th} root.
y^x	3.3469546	Geometric mean (M_g).



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

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

Predicted Ground Speed

Using the equation:

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

KEY IN	DISPLAY SHOWS	COMMENTS
42	42	Wind velocity (V).
ENT	42.	
50	50	Wind direction ($\measuredangle\beta$).
ENT	50.	
30	30	True course ($\measuredangle\alpha$).
−	20.	
cos	0.9396926	
×	39.467089	V cos ($\beta-\alpha$).
MS	39.467089	Store for further use.
ENT	39.467089	
×	1557.6511	[V cos ($\beta-\alpha$)]^2.
42	42	V.
ENT	42.	
×	1764.	V^2.
−	−206.3489	[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	39.467089	V cos ($\beta-\alpha$).
+	178.72817	V cos ($\beta-\alpha$) $+\sqrt{[V\cos(\beta-\alpha)]^2 - V^2 + TAS^2}$. = Predicted ground speed.

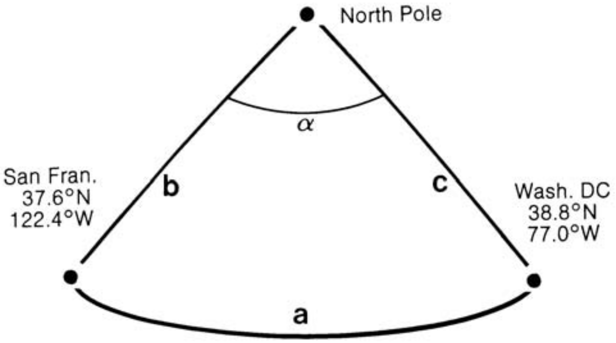
True Heading

Using the equation:

$$\begin{aligned} \measuredangle\gamma &= \alpha - \text{arc sin } (V\sin(\beta-\alpha)/TAS) \\ &= 30 - \text{arc sin } (42\sin(50-30)/140) \end{aligned}$$

KEY IN	DISPLAY SHOWS	COMMENTS
30	30	True course (α).
ENT	30.	
MS	30.	Save for further use.
42	42	Wind velocity (V).
ENT	42.	
50	50	Wind direction (β).

ENT	50.	
MR	30.	Recall α.
−	20.	
sin	0.3420203	sin ($\beta-\alpha$).
×	17.101015	V sin ($\beta-\alpha$).
140	140	TAS.
÷	0.1221501	V sin ($\beta-\alpha$)/TAS.
arc	0.1221501	
sin	7.0155541	arc sin [V sin ($\beta-\alpha$)/TAS].
−	34.984446°	α − arc sin [V sin ($\beta-\alpha$)/TAS]. = True heading.



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

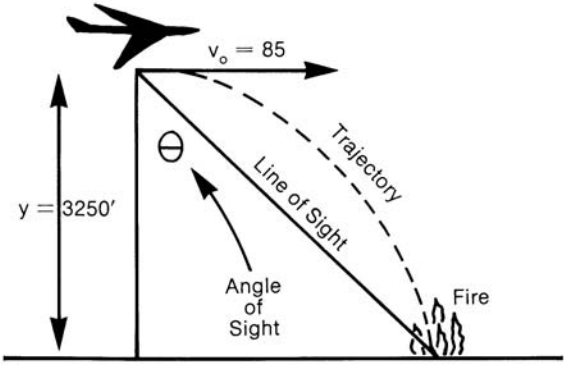
Using the formula:

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

where: $\alpha = 122.4° - 77° = 45.4°$,
$b = 90° - 37.6° = 52.4°$, 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	0.6101454	cos b.
51.2	51.2	c.
cos	0.6266041	cos c.
×	0.3823196	cos b cos c.
52.4	52.4	b.
sin	0.7922894	sin b.
51.2	51.2	c.
sin	0.7793377	sin c.
×	0.6174609	sin b sin c.
45.4	45.4	α.
cos	0.7021533	cos α.
×	0.4335522	sin b sin c cos α.
+	0.8158718	cos b cos c + sin b sin c cos α.
arc	0.8158718	
cos	35.326047	arc cos (cos b cos c + sin b sin c cos α).
60	60	
×	2119.5628	Great circle distance.



Calculate the angle of sight Θ that chemical retardant should be dropped from a fire-fighting plane to reach the fire if the plane is at 3250 feet with a velocity of 85 mph? Using the formula:

$$\Theta = \tan^{-1} \frac{v_O t}{y}$$

Where: Θ = angle of sight,
v_O = velocity of the plane,
y = altitude of the plane,
t = time of fall for the retardant.

Time of fall for the retardant can be calculated using the formula:

$$t = \sqrt{2y/g}$$

Where: g = force of gravity = 32 ft/sec².

KEY IN	DISPLAY SHOWS	COMMENTS
2	2	Calculate t first.
ENT	2.	
3250	3250	Altitude of the plane.
MS	3250.	Store for use in calculating Θ.
×	6500.	
32	32	Force of gravity.
÷	203.125	
√	14.252192	$t = \sqrt{2y/g}$ calculated.
85	85	Velocity of the plane.
ENT	85.	
5280	5280	Feet/mile.
×	448800.	
3600	3600	Seconds/hour.
÷	124.66666	Speed expressed as ft/sec.
×	1776.7731	$v_o t$.
MR	3250	Recall altitude.
÷	0.5466994	$v_o t/y$.
arc tan	28.665174	Angle of sight Θ.

FINANCE

What will $7,000 be worth in five 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	0.082	i.
+	1.082	
5	5	n.
y^x	1.4829825	$(1 + i)^n$.
7000	7000	PV.
×	10380.877	Future value (FV).

Compute the annual rate of return (after taxes) of 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	0.38	Tax rate.
−	0.62	1 − tax rate.
×	1581.	(FV − PV) (1 − tax rate).
MR	10000.	Recall PV.
÷	0.1581	(FV − PV) (1 − tax rate)/PV.
3.5	3.5	n.
×	0.55335	(FV − PV) (1 − tax rate)/PV x 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 period (in decimal),
n = number of periods.

KEY IN	DISPLAY SHOWS	COMMENTS
1	1	
ENT	1.	
.08	0.08	i.
+	1.08	(1 + i).
10	10	n.
CHS	−10	
y^x	0.4631938	$(1 + i)^{-n}$.
CHS	−0.4631938	
1	1	
+	0.5368062	$1 - (1 + i)^{-n}$.
.08	0.08	i.
x–y	0.5368062	
÷	0.1490295	$i/1 - (1 + i)^{-n}$.
86000	86000	PV.
×	12816.537	PMT.

See Appendix B — Part 4 for a stack diagram of this example.

Part 2.
In the above example (part 1), what is the remaining balance after the sixth 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	0.08	i.
MS	8. −02	Store for further use.
+	1.08	1 + i.
6	6	k.
ENT	6.	
10	10	n.
−	−4.	k − n.
y^x	0.7350301	$(1 + i)^{k-n}$.
CHS	−0.7350301	
1	1	
+	0.2649699	$1 - (1 + i)^{k-n}$.
MR	8. −02	Recall i.
÷	3.312123	$1 - (1 + i)^{k-n}/i$.
12816.55	12816.55	PMT (from Part 1).
×	42449.99	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:

$\mathrm{gd}\,x = 2 \arctan e^x - \pi/2$ (Note: $\pi/2 = 90°$).

and the inverse Gudermannian function:

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

in conjunction with the following formulas:

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

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

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

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

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

$$\tanh^{-1} x = ½ \ln\,[1 + x/1 - x] = \mathrm{gd}^{-1}(\sin^{-1} x),$$

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

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

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

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

$$\mathrm{csch}\,x = \frac{1}{\sinh x}$$

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

Examples:

Gudermannian function: gd 0.225 = 12.78301
Key in: .225 e^x arc tan 2 × 90 —
Display shows: 12.78301

Inverse Gudermannian function: gd^{-1} 60° = 1.3169571
Key in: 60 ENT 2 ÷ 45 + tan ln
Display shows: 1.3169571

Hyperbolic sine: sinh 2.5 = 6.050203
Key in: 2.5 e^x ENT 1/x — 2 ÷
Display shows: 6.050203

See Appendix B — Part 4 for a stack diagram of this example.

Hyperbolic cosine: cosh 2.5 = 6.132288
Key in: 2.5 e^x ENT 1/x + 2 ÷
Display shows: 6.132288

Hyperbolic tangent: tanh 2.5 = 0.9866173
Key in: 2.5 e^x arc tan 2 × 90 — sin
Display shows: 0.9866173

Hyperbolic cotangent: coth 2.5 = 1.013564
Key in: 2.5 e^x arc tan 2 × 90 — sin 1/x
Display shows: 1.013564

Hyperbolic secant: sech 2.5 = 0.1630712
Key in: 2.5 e^x ENT 1/x + 2 ÷ 1/x
Display shows: 0.1630712

Hyperbolic cosecant: csch 2.5 = 0.1652837
Key in: 2.5 e^x ENT 1/x — 2 ÷ 1/x
Display shows: 0.1652837

Inverse hyperbolic sine: $\sinh^{-1}$ 30 = 4.0947481
Key in: 30 arc tan 2 ÷ 45 + tan ln
Display shows: 4.0947481

Inverse hyperbolic tangent: $\tanh^{-1}$ .52 = 0.5763266
Key in: .52 arc sin 2 ÷ 45 + tan ln
Display shows: 0.5763266

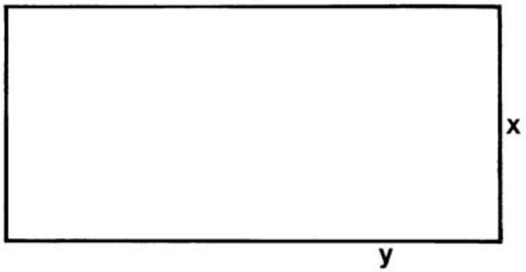
Inverse hyperbolic secant: sech^{-1} .52 = 1.2713823
Key in: .52 arc cos 2 ÷ 45 + tan ln
Display shows: 1.2713823

Inverse hyperbolic cosine: $\cosh^{-1}$ 30 = 4.0941957
Key in: 30 1/x arc cos 2 ÷ 45 + tan ln
Display shows: 4.0941957

Inverse hyperbolic cotangent: $\coth^{-1}$ 30 = 3.334028 -02
Key in: 30 1/x arc sin 2 ÷ 45 + tan ln
Display shows: 3.334028 -02

Inverse hyperbolic cosecant: csch^{-1} .52 = 1.4086939
Key in: .52 1/x arc tan 2 ÷ 45 + tan ln
Display shows: 1.4086939

Appendix B — Part 3
Some Common Mathematical Formulae with Examples



Rectangle, area and perimeter

Rectangle of width X and length Y

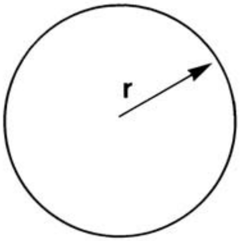
Area = XY

Perimeter = 2X + 2Y

Example: Rectangle of width 4 and length 8:

Area: Key in: 4 ENT 8 ×
Display shows: 32.

Perimeter: Key in: 2 ENT 4 × 2 ENT 8 × +
Display shows: 24.



Circle, area and circumference

Circle of radius r.

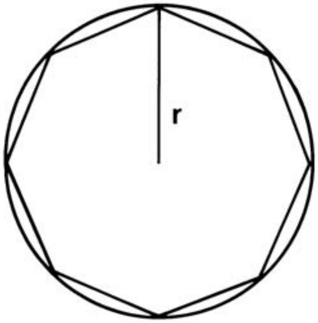
Area = πr^2

Circumference = $2\pi r$

Example: Circle of radius 5.

Area: Key in: π ENT 5 ENT × ×
Display shows: 78.539817

Circumference: Key in: 2 ENT π × 5 ×
Display shows: 31.415927



Regular polygon circumscribed in a circle, area and perimeter

Regular polygon with n sides circumscribed in a circle of radius r.

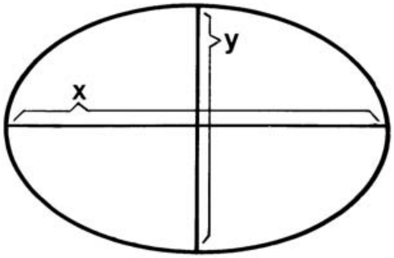
Area = $\frac{1}{2} nr^2 \sin 360/n$

Perimeter = $2nr \sin 180/n$

Example: Polygon with 8 sides inscribed in a circle of radius 5.

Area: Key in: 1 ENT 2 ÷ 8 × 5 ENT × × 360 ENT 8 ÷ sin ×
Display shows: 70.71064

Perimeter: Key in: 2 ENT 8 × 5 × 180 ENT 8 ÷ sin ×
Display shows: 30.614688



Ellipse, area and circumference

Ellipse of major axis X and minor axis Y.

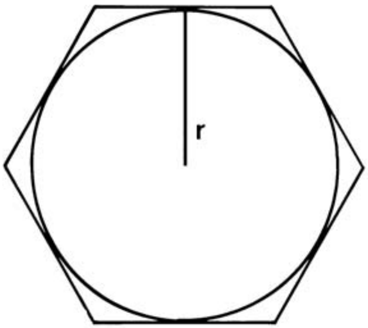
Area = $\frac{1}{4}\pi XY$

Circumference =
$2\pi\sqrt{1/8(X^2 + Y^2)}$

Example: Ellipse of major axis 8 and minor axis 4.

Area: Key in: 1 ENT 4 ÷ π × 8 × 4 ×
Display shows: 25.132739

Circumference: Key in: 1 ENT 8 ÷ 8 ENT × 4 ENT × + × √ 2 × π ×
Display shows: 19.869172



Regular polygon circumscribing a circle, area and perimeter

Regular polygon with n sides circumscribing a circle of radius 5.

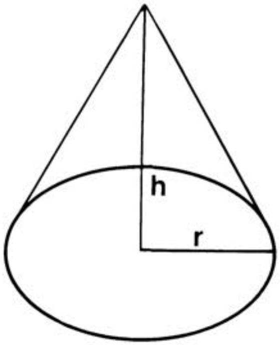
Area = $nr^2 \tan 180/n$

Perimeter = $2nr \tan 180/n$

Example: Polygon with 8 sides circumscribing a circle of radius 5.

Area: Key in: 8 ENT 5 ENT × × 180 ENT 8 ÷ sin ×
Display shows: 76.53672

Perimeter: Key in: 2 ENT 8 × 5 × 180 ENT 8 ÷ tan ×
Display shows: 33.137096



Cone, area and volume

Cone of radius r and height h

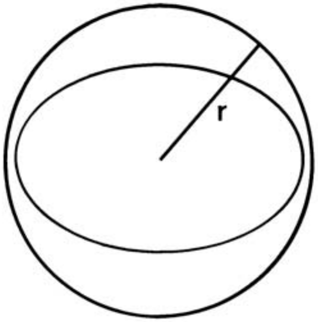
Volume = $\frac{1}{3}\pi r^2 h$

Area = $\pi r\sqrt{r^2 + h^2}$

Example: Cone of radius 5 and height 10.

Volume: Key in: 1 ENT 3 ÷ π × 5 ENT × × 10 ×
Display shows: 261.79935

Area: Key in: π ENT 5 MS × MR ENT × 10 ENT × + √ ×
Display shows: 175.62035



Sphere, area and volume

Sphere of radius r.

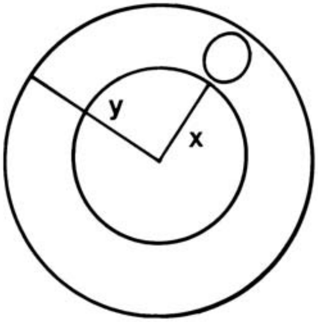
Volume = $4/3\pi r^3$

Area = $4\pi r^2$

Example: Sphere of radius 5.

Volume: Key in: 5 ENT 3 y^x π × 4 ENT 3 ÷ ×
Display shows: 523.59809

Area: Key in: 4 ENT π × 5 ENT × ×
Display shows: 314.15925



Torus, area and volume

Torus of inner radius x and outer radius y.

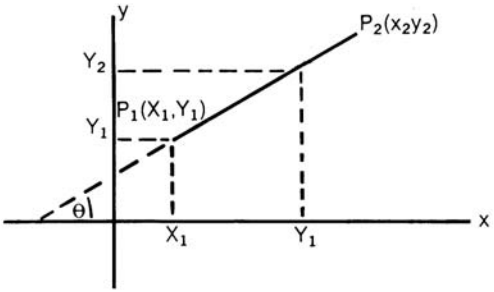
$$\text{Volume} = \tfrac{1}{4}\pi^2 (x+y)\,(y-x)^2$$

$$\text{Area} = \pi^2(y^2-x^2)$$

Example: Torus with inner radius 2 and outer radius 4.

Volume: Key in: 1 ENT 4 ÷ π ENT × × 2
ENT 4 + 4 ENT 2 − ENT ×
× ×
Display shows: 59.217626

Area: Key in: π ENT × 4 ENT × 2
ENT × − ×
Display shows: 118.43525



Distance between two points, P_1 and P_2

Distance d between two points $P_1(x_1y_1)$ and $P_2(x_2y_2)$.

$$d = \sqrt{(x_2-x_1)^2 + (y_2-y_1)^2}$$

Example: Distance between points $P_1(3,4)$ and $P_2(5,8)$.

Key in: 5 ENT 3 − ENT × 8 ENT 4 −
ENT × + √
Display shows: 4.472135

Slope and angle of line between points

Slope and angle of line between points P_1 and P_2.

$$\text{Slope} = m = y_2 - y_1 / x_2 - x_1 = \tan \Theta$$

Example: Slope: Key in: 8 ENT 4 − 5
ENT 3 − ÷
Display shows: 2.

Angle: Key in: arc tan
Display shows: 63.434781°

Appendix B — Part 4
Stack Diagrams for Some Examples

STACK DIAGRAM FOR: X=R COS Θ, Y=R SIN Θ

REGISTER CONTENTS

M				R	R	R	R	R	R	R	R	R	R			
T								R				R				
Z						R	R	Θ	R	R	R	R COS Θ	R			
Y		Θ	Θ	Θ	R	Θ	Θ	COS Θ	Θ	R COS Θ	R COS Θ	SIN Θ	R COS Θ			
X	Θ	Θ	R	R	Θ	Θ	COS Θ	R	X = R COS Θ	Θ	SIN Θ	R	Y=R SINΘ			
KEY IN	Θ	ENT	R	MS	X–Y	ENT	COS	MR	X	X–Y	SIN	MR	X			

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

REGISTER CONTENTS

M																
T																
Z																
Y		1	1		1 + i	1+i			$-(1+i)^{-n}$		$1-(1+i)^{-n}$	i		$\frac{i}{1-(1+i)^{-n}}$		
X	1	1	i	1 + i	n	–n	$(1+i)^{-n}$	$-(1+i)^{-n}$	1	$1-(1+i)^{-n}$	i	$1-(1+i)^{-n}$	$\frac{i}{1-(1+i)^{-n}}$	PV	PV $\left[\frac{i}{1-(1 + i)^{-n}}\right]$	
KEY IN	1	ENT	i	+	n	CHS	Y^x	CHS	1	+	i	x–y	÷	PV	X	

STACK DIAGRAM FOR SINH X = $\frac{e^x - e^{-x}}{2}$

REGISTER CONTENTS

M																
T																
Z																
Y			e^x	e^x		$e^x - e^{-x}$										
X	X	e^x	e^x	e^{-x}	$e^x - e^{-x}$	2	$\frac{e^x - e^{-x}}{2}$									
KEY IN	X	e^x	ENT	$\frac{1}{x}$	−	2	÷									

STACK DIAGRAM OF R = $\sqrt{x^2 + y^2}$ AND Θ = ARC TAN $\frac{y}{x}$

REGISTER CONTENTS

M						Y	Y	Y	Y	Y	Y					
T							X									
Z			X		X	X	X^2	X				$\sqrt{x^2+y^2}$	$\sqrt{x^2+y^2}$			
Y		X	X	X	X^2	X^2	Y	X^2	X	X	$\sqrt{x^2+y^2}$	X	Y	$\sqrt{x^2+y^2}$	$\sqrt{x^2+y^2}$	
X	X	X	X	X^2	Y	Y	Y	Y^2	x^2+y^2	$\sqrt{x^2+y^2}$	X	Y	X	$\frac{y}{x}$	$\frac{y}{x}$	$\text{TAN}^{-1}\frac{y}{x}$
KEY IN	X	ENT	ENT	X	Y	MS	ENT	X	+	$\sqrt{\ }$	x–y	MR	x–y	÷	ARC	TAN

Appendix C — Tables

Table 1: Conditions for Error Indication

FUNCTION	CONDITION (x = contents of register X)
$\div$ or $1/x$	$\lvert x \rvert = 0$
y^x	$y < 0$ $x \log y > 99$
e^x	$\lvert x \rvert > 99$
10^x	$\lvert x \rvert > 99$
log x or ln x	$x \leqslant 0$
sin x, cos x, tan x	$x < 0$ or $x > 90$
arc sin x or arc cos x	$x < 0$ or $x > 1$
arc tan x	$x < 0$

Table 2: Range of Functions

FUNCTION	RANGE
$+, -, \times, \div, 1/x$	$\pm 1 \times 10^{-99} \leqslant x \leqslant \pm 9.9999999 \times 10^{99}$
$\sqrt{x}$	$\pm 1 \times 10^{-99} \leqslant x \leqslant \pm 9.9999999 \times 10^{99}$
log x	$0 < x \leqslant +9.9999999 \times 10^{99}$
ln x	$0 < x \leqslant +9.9999999 \times 10^{99}$
10^x	$\pm 1 \times 10^{-99} \leqslant x \leqslant +99$
e^x	$\pm 1 \times 10^{-99} \leqslant x \leqslant +99$
y^x	$y > 0$
sin, cos, tan	$0° \leqslant x < +90°$
arc sin, arc cos	$0 \leqslant x \leqslant +1$
arc tan	$0 \leqslant x \leqslant 9.9999999 \times 10^{99}$

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- Common and natural logs and anti-logs
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- 100-step programming capability

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NOVUS, the consumer products division of National Semiconductor Corporation, is proud to guarantee your electronic calculator to be free from defects in workmanship and materials for a period of one year from the date of your purchase. Defects caused by abuse, accidents, modifications, negligence, misuse or other causes beyond the control of NOVUS are, of course, not covered by this warranty, nor are batteries. Should the calculator prove defective within 30 days of purchase, NOVUS will repair or, at its discretion, replace it free of charge. If the defect occurs after 30 days from date of purchase, a charge of $3.50 will be made for handling and insurance. If your calculator becomes defective after the one-year period, NOVUS will make repairs for a nominal charge of $20.00. Simply mail it prepaid and insured with your check or money order to the nearest NOVUS service center. Repair prices are subject to change without notice. Please do not send or include cash. Make your check or money order payable to NOVUS. Upon receipt, your calculator will be promptly serviced and returned to you freight prepaid.

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Registration Certificate

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Model Number 4520

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Purchase Date________________________
(month/day/year)

Purchased from________________________

Address________________________

City, State, Zip________________________

Your Name________________________

Your Address________________________

City, State, Zip________________________

Optional Information

Was this calculator purchased for:
☐ Gift ☐ Personal use

What is your occupation?
☐ Student or Teacher ☐ Professional
☐ Executive ☐ Financial or Commercial
☐ Engineering or Scientific ☐ Statistical fields
☐ Other occupation____________________

What is your age group?
☐ Under 18 ☐ 18-34 ☐ 35-49 ☐ 50-over

Where will you most use your Novus calculator?
☐ At home ☐ At school ☐ At work
☐ During travel

Where did you learn about the Novus calculators?
☐ Magazine ☐ Newspaper ☐ Television
☐ Radio ☐ Mail ☐ Store salesman
☐ Friend
☐ Other________________________

What most attracted you to your Novus calculator?
☐ Appearance ☐ Size ☐ Reputation
☐ Price ☐ Features and capabilities

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NOVUS Warranty Certificate
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Serial Number________________________

Purchased from________________________

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