Made in America, with pride, by National Semiconductor

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

Your Nova 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 "know-how." 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.
Getting Started

Turn your Novus Scientific 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 Scientific is powered by rechargeable batteries. The Scientific will show a decimal point on the extreme left side of the display as a low-battery indicator. Although calculations can still be made whilst the low-battery indicator is on, the battery should be charged as soon as possible. Continued use on a weak battery may result in incorrect 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.

Display

The Novus Scientific displays an 8-digit mantissa and a 2-digit exponent. The calculator will accept and display any positive or negative number between $1 \times 10^{-8}$ and $9.999999 \times 10^{8}$. Any result larger than $9.999999 \times 10^{8}$ 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 -1 and 6999999 are displayed in floating point format. Results smaller than 0.1 or larger than 6999999 are automatically converted to scientific notation format.

Automatic Display Shutoff

To save battery life, the Novus Scientific 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 ONS twice.

Reverse Polish Logic and the Stack Principle

The Novus Scientific 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).

<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>T</td>
<td>T</td>
</tr>
<tr>
<td>z</td>
<td>Z</td>
</tr>
<tr>
<td>y</td>
<td>y</td>
</tr>
<tr>
<td>x</td>
<td>x</td>
</tr>
</tbody>
</table>

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

Operation

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 whose numbers.

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

Scientific Notation

Any number can be entered into the Novus Scientific 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 $1.2 \times 10^{3}$. Key in: 1.2 EE 3, the display shows: 1.2 EE 3. 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 as $1.34 \times 10^{14}$) must be keyed in: 1.34 EE 14, the display shows: 1.34 EE 14. To enter a negative exponent, touch ONS after keying in the exponent. Example: 0.000000000001 (written as $3 \times 10^{-11}$) must be keyed in: 3 EE 11 ONS, the display shows: 3 EE 11.

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

Correcting Mistakes

To clear a wrong 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 keys 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 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.

- 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 1 (the contents of register Y in register X, the contents of register Z in register Y, and the contents of register T in 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 held for operations. These locations are called registers and in the Scientist these have been combined into an automatic stack as well. The Novec Scientist uses the 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. These 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 \((3 + 2) \times 4 + \sin 30 \div \sqrt{25} = 116.1\) is solved according to the rules of hierarchy as follows:

\[
\begin{align*}
1 & \quad \text{Eval} \quad 3 + 2 = 5 \\
2 & \quad \text{Eval} \quad 5 \times 4 = 20 \\
3 & \quad \text{Eval} \quad 20 \div \sin 30 = 20 \\
4 & \quad \text{Eval} \quad 20 \div \sqrt{25} = 20 \\
5 & \quad \text{Result} \quad 116.1
\end{align*}
\]

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. Start at the left and working right, key in the next number for 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 \((3 + 2) \div 4 + \sin 30 \div \sqrt{25} \div \sqrt{20} \times 4\) using Reverse Polish logic as follows:

<table>
<thead>
<tr>
<th>Key in</th>
<th>Display Shows</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>3 + 2</td>
<td>5</td>
<td></td>
</tr>
<tr>
<td>\div 4</td>
<td>1.25</td>
<td></td>
</tr>
<tr>
<td>\sin 30</td>
<td>0.5</td>
<td></td>
</tr>
<tr>
<td>\div \sqrt{25}</td>
<td>0.2</td>
<td></td>
</tr>
<tr>
<td>\times 4</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>Key in</td>
<td>Display Shows</td>
<td>Comments</td>
</tr>
<tr>
<td>116.1</td>
<td>116.1</td>
<td></td>
</tr>
</tbody>
</table>

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**
  - \(\sqrt{x}\): Computes the square root of the number in the display.
  - \(x^2\): Computes the reciprocal of the number in the display.

Example: Key in: \(2 \quad \sqrt{2}\); display shows: 2

- **Logarithmic Functions**
  - \(\ln x\): Computes the natural logarithm of any positive number in the display.
  - \(10^x\): Computes the natural logarithm of the number in the display by raising 10 to the power of the number.
  - \(\log x\): Computes the common logarithm of any positive number in the display.

Example: Key in: \(1000\); \(\log\) \(1000\); display shows: 3

- **Trigonometric Functions**
  - \(\sin x\): Computes the sine of the angle (in degrees) in the display.
  - \(\cos x\): Computes the cosine of the angle (in degrees) in the display.
  - \(\tan x\): Computes the tangent of the angle (in degrees) in the display.

Example: Key in: \(30\); \(\sin\); display shows: 0.5000000

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'.
- \(\times\) Multiplies 'y' by 'x'.
- \(\div\) Divides 'y' by 'x'.

Example: Key in: \(2\); \(\times\); \(3\); \(\div\); \(5\); \(\mod\); display shows: 5

Power and Root Functions

- \(\sqrt[n]{x}\): Raises 'y' to the 'x' power.

Example: Key in: \(2\); \(\sqrt[5]{2}\); display shows: 124.99984

Since taking the \(n^{th}\) root of 'y' is the same as raising to the \(\frac{1}{n}\) power, to obtain roots, touch \(\sqrt[n]{x}\) before touching \(y^n\).

Example: Key in: \(125\); \(\sqrt[3]{5}\); display shows: 5.0000000

- **Note:** The scientist must enter the \(n^{th}\) root of a number by touching the \(\sqrt[n]{x}\) key. The \(n^{th}\) root is entered first in the equation followed by the number to be divided. By touching the \(\sqrt[n]{x}\) key, the system will calculate the root of the number entered. The \(n^{th}\) root is calculated by touching the \(\sqrt[n]{x}\) key.
Error Conditions

In the event of a logic error (e.g., division by zero) the Nexus Scientif 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 Nexus Scientif. Contents of registers are indicated by lower case letters x, y, z, and t. Locations are indicated by digital letters X, Y, Z and T. The display always shows the contents of register X. Memory is register M.
Appendix B—Part I

Some Examples

In the previous sections of this manual is a summary of how to use the
Novus Scientific calculator.
This appendix demonstrates the versatility of the
Scientific Calculator in a variety of disciplines.

MATHEMATICS

Roots of a quadratic equation.

Given the equation $2x^2 + 3x - 4 = 0$, find the roots $x_1$ and $x_2$.

Roots $x_1$ and $x_2$ can be found from the equation:

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

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

<table>
<thead>
<tr>
<th>Step</th>
<th>Key In</th>
<th>Display Shows</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>[ENT]</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>$+-$</td>
<td>4</td>
<td>$2a$</td>
</tr>
<tr>
<td>4</td>
<td>[M+]</td>
<td>4</td>
<td>Save for use in dividing.</td>
</tr>
<tr>
<td>5</td>
<td>3</td>
<td>3</td>
<td>$b$</td>
</tr>
<tr>
<td>6</td>
<td>[CHS]</td>
<td>-3</td>
<td>$-b$</td>
</tr>
<tr>
<td>7</td>
<td>$\times$</td>
<td>4</td>
<td>$c$</td>
</tr>
<tr>
<td>8</td>
<td>[X^2]</td>
<td>-0.75</td>
<td>$-b/2a$</td>
</tr>
<tr>
<td>9</td>
<td>[ENT]</td>
<td>-0.75</td>
<td>Save in register Z for further use in addition and subtraction of the answer.</td>
</tr>
<tr>
<td>10</td>
<td>[ENT]</td>
<td>-0.75</td>
<td>Save in register Z for further use in addition and subtraction of the answer.</td>
</tr>
<tr>
<td>11</td>
<td>$X_1$</td>
<td>0.5825</td>
<td>$b/4a$</td>
</tr>
<tr>
<td>12</td>
<td>[CHS]</td>
<td>-4</td>
<td>$c$</td>
</tr>
</tbody>
</table>
Degrees, minutes and seconds to decimal degrees conversion. Convert the following degrees, minute and seconds to decimal degrees:

56° 25' 44.5"

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>56</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>ENT</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>25.0000</td>
<td></td>
</tr>
<tr>
<td>.5</td>
<td>.50000</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>56.25000</td>
<td></td>
</tr>
</tbody>
</table>

Polar to rectangular coordinate conversion. Convert coordinates θ = 56°, R = 7 to rectangular coordinates.

Using the formula:

\[ X = R \cos \theta \]  
\[ Y = R \sin \theta \]

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>θ = 56</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>R = 7</td>
<td>7</td>
<td></td>
</tr>
</tbody>
</table>

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

Using the formula:

\[ R = \sqrt{X^2 + Y^2} \]
\[ \theta = \arctan \left( \frac{Y}{X} \right) \]

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>x = 6</td>
<td>6</td>
<td></td>
</tr>
<tr>
<td>y = 8</td>
<td>8</td>
<td></td>
</tr>
</tbody>
</table>

Physics:

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

\[ F = \frac{G m_1 m_2}{r^2} \]

where:
\[ m_1 = \text{mass of the earth} = 5.98 \times 10^{24} \text{ kg} \]
\[ m_2 = \text{mass of the moon} = 7.36 \times 10^{22} \text{ kg} \]
\[ r = \text{distance from the earth to the moon} = 3.84 \times 10^8 \text{ m} \]
\[ G = \text{Universal gravitational constant} = 6.67 \times 10^{-11} \text{ N m}^2 \text{ kg}^{-2} \]

Therefore:

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

\[ F = 1.99 \times 10^{20} \text{ newtons.} \]
Using the equation \( KE = \frac{1}{2}mv^2 \), where \( KE \) = kinetic energy of the electron, \( m \) = mass of the proton = 1.67 x 10^-27 kg and \( v \) = velocity of the electron.

\[
\frac{v}{\text{cm}} = \frac{2 \times 4.9 \times 10^{-17}}{2.87 \times 10^{-17}} = 2.697 \times 10^3 \text{ cm/s}
\]

Using Coulomb's law:

\[
F = k \frac{Q_1 Q_2}{r^2}
\]

where: \( k \) = Universal constant = 9.0 x 10^9 N m^2/C^2, \( Q_1 \) = charge on particle 1 = charge of proton = 1.6 x 10^-19 C, \( Q_2 \) = charge on particle 2 = charge of electron = 1.6 x 10^-19 C, \( r \) = distance between two charges = 5.3 x 10^-10 m.

\[
F = \frac{9.0 \times 10^9 \times (1.6 \times 10^{-19})^2}{(5.3 \times 10^{-10})^2} = 5.8 \times 10^{-4} \text{ newton}
\]

What is the velocity of a proton (mass = 1.67 x 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 79.9 ev (electron-volt) = 1.6 x 10^-19 joules.}

What is the effective 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?

\[
F = \frac{9.113532 x 10^{-19} \times Q_1 Q_2}{r^2}
\]

\[
F = 8.202067 \times 10^{-9} \text{ newton}
\]

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:

\[
M = \frac{M_0}{\sqrt{1 - v^2/c^2}}
\]

Where: \( M \) = mass of the moving body, \( M_0 \) = mass of the body at rest, \( v \) = velocity of the body, \( c \) = speed of light (2.997 x 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 x 10^-31 kg, if \( v = .75c \), then the equation becomes:

\[
M = \frac{M_0}{\sqrt{1 - (.75)^2}} = \frac{M_0}{.75}
\]

Substituting:

\[
M = \frac{M_0}{.75}
\]

\[
M = \frac{9.109 \times 10^{-31}}{.75}
\]

\[
M = 1.214 \times 10^{-31} \text{ kg}
\]

What is the velocity of a proton (mass = 1.67 x 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 79.9 ev (electron-volt) = 1.6 x 10^-19 joules.}

What is the effective 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?

\[
F = \frac{9.113532 x 10^{-19} \times Q_1 Q_2}{r^2}
\]

\[
F = 8.202067 \times 10^{-9} \text{ newton}
\]

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:

\[
M = \frac{M_0}{\sqrt{1 - v^2/c^2}}
\]

Where: \( M \) = mass of the moving body, \( M_0 \) = mass of the body at rest, \( v \) = velocity of the body, \( c \) = speed of light (2.997 x 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 x 10^-31 kg, if \( v = .75c \), then the equation becomes:

\[
M = \frac{M_0}{\sqrt{1 - (.75)^2}} = \frac{M_0}{.75}
\]

Substituting:

\[
M = \frac{9.109 \times 10^{-31}}{.75}
\]

\[
M = 1.214 \times 10^{-31} \text{ kg}
\]
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: $h = \frac{RT}{\rho g}$ (cos $\theta$)

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

$h = \frac{2 \times 490 \text{ dynes/cm}}{0.129 \text{ g/cm}^3 \times 13.6 \text{ g/cm}^3} \times \cos 57.3°$

$= 1.324119$

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>ENT 2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>ENT 2</td>
<td></td>
</tr>
<tr>
<td>490</td>
<td>ENT 800</td>
<td>Floating tension.</td>
</tr>
<tr>
<td>03</td>
<td>ENT -02</td>
<td>Inside radius in cm.</td>
</tr>
<tr>
<td>13.6</td>
<td>ENT 13.6</td>
<td>Density of mercury.</td>
</tr>
<tr>
<td>X</td>
<td>0.426</td>
<td></td>
</tr>
<tr>
<td>980</td>
<td>ENT 980</td>
<td>Gravity.</td>
</tr>
<tr>
<td>X</td>
<td>399.84</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>2.4508903</td>
<td></td>
</tr>
<tr>
<td>57.3</td>
<td>ENT 57.3</td>
<td>Angle of contact.</td>
</tr>
<tr>
<td>100</td>
<td>ENT 0.100</td>
<td>Angle of contact.</td>
</tr>
<tr>
<td>X</td>
<td>1.3224068</td>
<td>Rise of column in cm.</td>
</tr>
</tbody>
</table>

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,

\[
\text{Gram-atoms of Fe} = \frac{\text{mass of Fe}}{\text{atomic mass of Fe}} = \frac{250 \text{ grams}}{55.847 \text{ g/gram-atom}} = 4.470516 \text{ gram-atoms of Fe}
\]

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>250</td>
<td>ENT 250</td>
<td>Grams of Fe</td>
</tr>
<tr>
<td>55.847</td>
<td>ENT 55.847</td>
<td>Atomic mass of Fe</td>
</tr>
<tr>
<td>+</td>
<td>4.470516</td>
<td>Gram-atoms of Fe in 250 grams.</td>
</tr>
</tbody>
</table>

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

Since the number of atoms in a sample of an element is the number of gram-atoms multiplied by Avogadro's number (N = 6.023 x 10$^{23}$ atoms/gram-atom),

\[
\text{Atoms of Fe} = 4.470516 \times 6.023 \times 10^{23} = 26.692 \times 10^{23} \text{ atoms}
\]

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>4.470516</td>
<td>ENT 4.470516</td>
<td>Gram-atoms of Fe,</td>
</tr>
<tr>
<td>6.023</td>
<td>ENT 6.023</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>ENT 23</td>
<td>Avogadro's number,</td>
</tr>
<tr>
<td>X</td>
<td>2.66920555</td>
<td>Avogadro's number,</td>
</tr>
</tbody>
</table>

What is the molarity of a solution that contains 135 grams of calcium chloride, CaCl$_2$, per liter?

Using the formula mass of CaCl$_2$:

\[
\begin{align*}
1 \text{ Ca} & = 1 \times 40.08 \text{ u} = 40.08 \text{ u} \\
2 \text{ Cl} & = 2 \times 35.453 \text{ u} = 70.906 \text{ u} \\
& = 110.986 \text{ u} = 110.986 \text{ g/mole} \\
\end{align*}
\]

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 the concentration of the solution is 1.21 moles/liter.

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<thead>
<tr>
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<th>COMMENTS</th>
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<tbody>
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<td>X</td>
<td>70.906</td>
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<tr>
<td>+</td>
<td>110.986</td>
<td>Formula mass of CaCl$_2$.</td>
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<td>135</td>
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<td>X</td>
<td>110.986</td>
<td>Grams of CaCl$_2$.</td>
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<tr>
<td>+</td>
<td>1.2153998</td>
<td>Mole per liter.</td>
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<tr>
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<tr>
<td>MB</td>
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<tr>
<td>X</td>
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<td>100</td>
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<td>X</td>
<td>600</td>
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<td>ENT 40</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>174.2684</td>
<td></td>
</tr>
</tbody>
</table>

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 800 lb, what is the tension at the ends of each cable?

Using the equation:

\[
\begin{align*}
T & = \frac{w}{\sqrt{h^2 + \frac{4}{3} l^2}} \\
\text{where:} & \quad T = \text{tension}, \\
\text{w} & = \text{weight (horizontal load)}, \\
\text{a} & = \text{length of span,} \\
\text{d} & = \text{sag,} \\
& = \frac{1}{2} \times 620 \times 700 \times \sqrt{1 + \frac{4}{3} (700)^2} \\
& = 871347 \text{ lbs.}
\end{align*}
\]
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:

\[ R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} = \frac{1}{1/220 + 1/145 + 1/175} \]

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

Using the formula:

\[ C = \frac{0.0885 \text{ uF}}{d^{(n-1)}} \]

where:
- \( k \) = dielectric constant = 6.6 for mica,
- \( A \) = area of one plate in square centimeters,
- \( n \) = the number of plates,
- \( d \) = distance between plates in centimeters.

\[ \frac{0.0885 \times 1 	imes (2.54 \text{ cm/cm})}{\pi x (11 - 1)} \]

\[ 5 \times 10^{-3} x (2.54 \text{ cm/cm}) \]

\[ 440.67 \text{ picofarads} \]
Compute the harmonic mean ($M_h$) of the following data: (2, 7, 3, 5, 2).
Using the formula:
$$M_h = \frac{1}{n} \sum_{i=1}^{n} x_i$$

Compute the geometric mean ($M_g$) of the following data: (2, 7, 3, 5, 2).
Using the formula:
$$M_g = \sqrt[n]{x_1 \cdot x_2 \cdot \ldots \cdot x_n}$$

Find the predicted ground speed and true heading for a planned flight with the following flight triangle factors known:
- $\theta$ = true course = 30° from North.
- $\gamma$ = wind direction = 45° from North.
- TAB = true air speed = 140 mph.
- $V$ = wind velocity = 42 mph.
- $\phi$ = true heading = ?
- PGS = predicted ground speed = ?

**Predicted Ground Speed**
Using the equation:
$$PGS = V \cos(\theta - \alpha) + \sqrt{V^2 \cos^2(\theta - \alpha) \sin^2(TAB) + (V^2 - TAB^2)}$$

$$= 42 \cos(30° - 30°) + \sqrt{(42^2 \cos^2(30° - 30°) \sin^2(140°))}$$

**True Heading**
Using the equation:
$$\gamma = -\arcsin \left( \frac{V \sin(\alpha - \theta) - TAB}{V} \right)$$

$$= -30 - \arcsin(42 \sin(30° - 30°)/140°)$$
What is the great circle route between San Francisco and Washington D.C.? Using the formula:

\[ \cos b = \cos b \cos c \cos a - \sin b \sin a \cos a \]

where:
- \( a = 122.4^\circ \)
- \( b = 90^\circ - 77.6^\circ = 12.4^\circ \)
- \( c = 90^\circ - 52.4^\circ = 37.6^\circ \)

\( a = \arccos (\cos 22.4 \cos 52.4 \cos 90) + \arcsin (\sin 22.4 \sin 52.4 \cos 45.4) \times 60 \)

FINANCE

What will $7,000 be worth in five years if it is compounded annually at a rate of 6.2% per year?

Using the formula:

\[PV = FV(1 + r)^t\]

Where:
- \( PV \) = present value,
- \( FV \) = future value,
- \( r \) = interest per period (in decimal),
- \( t \) = number of periods,
- \( n = 7000 \times (1 + 0.062)^t \)

### KEY TO DISPLAY SHOWS

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<td>0.622</td>
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</tr>
<tr>
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<tr>
<td>g^x</td>
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</tr>
<tr>
<td>x^2</td>
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<td>Future value (FV).</td>
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</table>

Compute the annual rate of return (after taxes) of an investment of $10,000 which, after 3.5 years is worth $12,550 if the tax rate is 36%.

Using the formula:

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

Where:
- \( r \) = rate of return,
- \( FV \) = future value,
- \( PV \) = present value,
- \( n \) = number of periods.

### KEY TO DISPLAY SHOWS

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<td>PV</td>
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<tr>
<td>x^2</td>
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<td>PV - PV</td>
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Appendix B—Part 3
Hyperbolic and inverse Hyperbolic Functions

The hyperbolic and inverse hyperbolic functions can be found by using the Gudermannian function:
\[ \text{gd} x = 2 \arctan e^{-x} - x/2 \]
and the inverse Gudermannian function:
\[ \text{gd}^{-1} x = \ln \left[ \sqrt{1 + 3x^2} / 2 \right] \]
in conjunction with the following formulas:
\[ \sinh x = e^x - e^{-x} \]
\[ \cosh x = \frac{e^x + e^{-x}}{2} \]
\[ \tanh x = \sinh x / \cosh x \]
\[ \coth x = \frac{1}{\tanh x} \]
\[ \text{sech} x = \frac{1}{\cosh x} \]
\[ \text{csch} x = \frac{1}{\sinh x} \]
\[ \text{sech}^{-1} x = \ln \left[ \sqrt{1 + x^2} / x \right] \]
\[ \text{csch}^{-1} x = \ln \left[ \sqrt{1 + x^2} / x \right] \]

Part 1
What is the annual payment on a loan of $89,000 taken for 10 years if the rate is 8% per year?

Using the formula:
\[ P = \frac{PV 
\times \left[ 1 - \left( \frac{1}{1 + i} \right)^n \right]}{i} \]

where:
- \( P \) = payment,
- \( PV \) = present value,
- \( i \) = interest rate per period (in decimal),
- \( n \) = number of periods.

<table>
<thead>
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<td>1.08</td>
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<td>10</td>
<td></td>
</tr>
<tr>
<td>CHS</td>
<td>-10</td>
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<td>(1 + 0.8)</td>
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<td></td>
</tr>
<tr>
<td>24</td>
<td>x = 24</td>
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Appendix B—Part 4
Stack diagram

See Appendix B—Part 4 for a stack diagram of this example.
Appendix B—Part II
Some Common Mathematical Formulas 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 = \( \pi r^2 \)
Circumference = \( 2\pi r \)
Example: Circle of radius 5.
Area: Key in: \( \pi \) ENT 5 \(^2\)
Display shows: 78.539817
Circumference: Key in: 2 \( \pi \) ENT 5 \( \times \)
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 = \( \frac{1}{2} \times r \times \sin \frac{360}{n} \)
Perimeter = \( 2nr \sin \frac{180}{n} \)
Example: Polygon with 8 sides inscribed in a circle of radius 5.
Area: Key in: 1 ENT 8 \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \)
Display shows: 78.539817
Perimeter: Key in: 2 ENT 8 \( \times \) 5 \( \times \) \( \times \) \( \times \) \( \times \) \( \times \)
Display shows: 31.415927

Regular polygon inscribed in a circle, area and perimeter
Regular polygon with n sides inscribed in a circle of radius 5.
Area = \( \frac{1}{2} \times r \times \sin \frac{180}{n} \)
Perimeter = \( \frac{2n}{180} \times 180 \)
Example: Polygon with 8 sides inscribed in a circle of radius 5.
Area: Key in: 8 \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \)
Display shows: 31.415927

Cone, area and volume
Cone of radius r and height h.
Volume = \( \frac{1}{3} \pi r^2 h \)
Area = \( \pi r^2 + \pi r \times h \)
Example: Cone of radius 5 and height 10.
Volume: Key in: 1 ENT 3 \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \)
Display shows: 261.79935
Area: Key in: \( \pi \) ENT 5 \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \)
Display shows: 175.28039

Sphere, area and volume
Sphere of radius r.
Volume = \( \frac{4}{3} \pi r^3 \)
Area = \( 4\pi r^2 \)
Example: Sphere of radius 5.
Volume: Key in: 4/3 \( \pi \) ENT 5 \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \)
Display shows: 523.59875
Area: Key in: \( 4 \times \) \( \pi \) ENT 5 \( \times \) \( \times \) \( \times \) \( \times \) \( \times \) \( \times \)
Display shows: 314.15927
Example: Sphere of radius r.
Volume: Key in: 5 ENT \(y^3\) ENT 3 + X
Display shows: 523.5985
Area: Key in: 4 ENT \(x\) ENT 5 ENT X X
Display shows: 314.1593

Torus, area and volume
Torus of inner radius r and outer radius R.
Volume: \(\frac{1}{2}\pi r^2 (R^2 - r^2)\)
Area: \(\pi r^2 (2R - r)\)
Example: Torus with inner radius 2 and outer radius 5.
Volume: Key in: 1 ENT 4 + - X ENT X 2
ENT 4 + 4 ENT 2 - ENT X X
Display shows: 50.3176
Area: Key in: \(\pi\) ENT \(4\) ENT X 2
ENT X \(\pi\)
Display shows: 118.4353

Distance between two points, \(P_1\) and \(P_2\).
Distance \(d\) between points \(P_1(x_1,y_1)\) and \(P_2(x_2,y_2)\):
\[d = \sqrt{(x_2-x_1)^2 + (y_2-y_1)^2}\]
Example: Distance between points \(P_1(3,4)\) and \(P_2(5,8)\).
Key in: 5 ENT 3 - ENT X 8 ENT 4 -
ENT X + \(\sqrt{\text{ }}\)
Display shows: 4.472135

Stack Diagrams for Some Examples

**STACK DIAGRAM FOR:** \(X = R \cos \theta, Y = R \sin \theta\)

**REGISTER CONTENTS**

**STACK DIAGRAM FOR: PMT = \(\frac{i}{1 - (1+i)^{-N}}\)**

**REGISTER CONTENTS**
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The Electronic Slide Rule
- Trig and inverse trig functions
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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. Warranty
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 $5.50 will be
made for handling and return shipment. 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.

Consumer Warranty

Guarantee Form

Please fill in this form and mail it within 10 days from date
of purchase to the NOVUS service center in your area

Model Number 4520

Serial Number:__________________________

Purchase Date:
(month/day/year)
Purchased from:__________________________

Address:________________________________

City, State, Zip. __________________________

Your Name________________________________

Your Address:______________________________

City, State, Zip. __________________________

NOVUS INC. 1177 Kern Avenue
San Diego, CA 92086
(619) 733-2600

Other "professional" calculations from NOVUS...
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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 16
- [ ] 16-34
- [ ] 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
- [ ] Price
- [ ] Features and capabilities
- [ ] Size
- [ ] Reputation

Warranty Information

For Your Records

NOVUS Warranty Certificate
Please retain for your records. See insert for product service locations.

Model Number

Serial Number

Purchased from

Date purchased

Notes