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 of solid-state electronic components. National is a multinational, NYSE-listed company that has 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.

CONTENTS

2 Getting Started
2 Battery Installation
2 AC Adaptor
3 Operations
  Display
  Automatic Display Shutoff
  Reverse Polish Logic and the Stack Principle
4 Keyboard Layout
5 Keyboard Callout
  Keying In and Entering Numbers
  Correcting Mistakes
7 Performing Calculations
  Mathematical Hierarchy and Reverse Polish Logic
  One-Factor Calculations
  Square Root and Reciprocal Functions
  Logarithmic Functions
  Trigonometric Functions
  Two-Factor Calculations
  Power and Root Functions
  Chain Calculations
11 Memory
  Error Conditions
12 Degree/Radian Conversions
13 Appendices
  Appendix A — Stack Diagrams
  Appendix B — Part 1: Some Examples
    Mathematics
    Chemistry
    Engineering
    Statistics
    Navigation
    Finance
  Appendix B — Part 2:
    Hyperbolic and Inverse Hyperbolic Functions
  Appendix C —
    Conditions for Error Indication
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.

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).

<table>
<thead>
<tr>
<th>CONTENTS</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<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 (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.
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 Slide rule 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 $(3^3 + 2)^4 + \sin 30 \div \sqrt{25} = 116.1$ is solved according to the rules of hierarchy as follows:

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.

\[
\begin{array}{c}
\sqrt{} & \text{Computes the square root of the number in the display.} \\
1/x & \text{Computes the reciprocal of the number in the display. (Divides 1 by "x").} \\
X-Y & \text{Exchanges the number now in the display for the number previously in the display.} \\
MR & \text{Recalls the contents of memory to the display (X register).} \\
MS & \text{Stores the number in the display in memory.} \\
CHS & \text{Changes the sign of the number in the display.} \\
ENT & \text{Enters the number in the display (x register) into a working register (y register).} \\
\div & \text{Divides "y" by "x".} \\
\times & \text{Multiplies "y" by "x".} \\
- & \text{Subtracts "x" from "y".} \\
+ & \text{Adds "x" to "y".} \\
C & \text{Clears contents of display (x register) and rolls stack down.} \\
\end{array}
\]
1. \(3^3 = 27\).
2. \(2 + 27 = 29\).
3. \(29 \times 4 = 116\).
4. \(\sin 30 = .5\)
5. \(\sqrt{25} = 5\).
6. \(.5 + 5 = .1\)
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:

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>ENT</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td></td>
</tr>
<tr>
<td>(^y)</td>
<td>27</td>
<td>(3^3)</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>(+)</td>
<td>29</td>
<td>((2 + 3^3))</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td></td>
</tr>
<tr>
<td>(\times)</td>
<td>116</td>
<td>((2 + 3^3)4)</td>
</tr>
</tbody>
</table>

30 \(\sin\) .5 \(\sin 30\).
25 \(\sqrt{25}\) \(5\).
.1 \(.5 + 5\).
\(\sqrt{25}\).
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.
\textbf{cos} Computes the cosine of the angle (in degrees) in the display.

\textbf{tan} Computes the tangent of the angle (in degrees) in the display.

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

Example: Key in 30 \textbf{sin}; display shows: 0.5. Key in \textbf{.5 arc cos}; display shows: 60.

\textbf{Two-Factor Calculations}

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

\begin{itemize}
  \item \textbf{+} Adds "x" to "y".
  \item \textbf{-} Subtracts "x" from "y".
  \item \textbf{X} Multiplies "y" by "x".
  \item \textbf{÷} Divides "y" by "x".
\end{itemize}

Example: Key in 2 \textbf{ENT} 3 \textbf{+}; display shows: 5.

\textbf{Power and Root Functions}

\begin{itemize}
  \item \textbf{y^x} Raises "y" to the "x" power.
  \item \textbf{\sqrt[x]{y}} Takes the xth root of y.
\end{itemize}

Example: Key in 5 \textbf{ENT} 3 \textbf{y^x}; display shows: 124.9999.\textsuperscript{*}

\textbf{Chain Calculations}

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

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

\begin{tabular}{ll}
\textbf{KEY IN} & \textbf{DISPLAY SHOWS} \\
2 & 2 \\
3 & 3 \\
+ & 5. \\
4 & 4 \\
\textbf{ENT} & 4. \\
5 & 5 \\
+ & 9. \\
x & 45. \\
\end{tabular}

\textbf{Memory}

\begin{itemize}
  \item \textbf{MS} Stores the number in the display in memory (register M).
  \item \textbf{MR} Recalls the contents of memory (register M) to the display (register X).
\end{itemize}

To clear memory, key in: 0 \textbf{MS}.

*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.
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°?

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>15.7</td>
<td>15.7</td>
<td>Number of degrees.</td>
</tr>
<tr>
<td>ENT</td>
<td>15.7</td>
<td></td>
</tr>
<tr>
<td>RM</td>
<td>57.29578</td>
<td>Recall conversion constant.</td>
</tr>
<tr>
<td>8</td>
<td>.27401669</td>
<td>Number of radians.</td>
</tr>
</tbody>
</table>

Example: How many degrees are in 2.56 radians?

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.56</td>
<td>2.56</td>
<td>Number of radians.</td>
</tr>
<tr>
<td>ENT</td>
<td>2.56</td>
<td></td>
</tr>
<tr>
<td>MR</td>
<td>57.29578</td>
<td>Recall conversion constant.</td>
</tr>
<tr>
<td>X</td>
<td>146.67719</td>
<td>Number of degrees.</td>
</tr>
</tbody>
</table>

Example: What is the sine of 2.4 radians?

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2.4</td>
<td>2.4</td>
<td>Number of radians.</td>
</tr>
<tr>
<td>ENT</td>
<td>2.4</td>
<td></td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>TOUCH</th>
<th>CONTENTS</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>π</td>
<td>z</td>
<td>LOST</td>
</tr>
<tr>
<td></td>
<td>y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>m</td>
<td></td>
</tr>
</tbody>
</table>

AFTER TOUCHING ANY FUNCTION KEY

<table>
<thead>
<tr>
<th>TOUCH</th>
<th>CONTENTS</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>z</td>
<td></td>
</tr>
<tr>
<td></td>
<td>y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>m</td>
<td></td>
</tr>
</tbody>
</table>

TOUCH CONTENTS LOCATION

<table>
<thead>
<tr>
<th>TOUCH</th>
<th>CONTENTS</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>1</td>
<td>z</td>
</tr>
<tr>
<td>2</td>
<td>...</td>
<td>9</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

AFTER TOUCHING

<table>
<thead>
<tr>
<th>TOUCH</th>
<th>CONTENTS</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>z</td>
<td></td>
</tr>
<tr>
<td></td>
<td>y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>m</td>
<td></td>
</tr>
</tbody>
</table>

TOUCH CONTENTS LOCATION

<table>
<thead>
<tr>
<th>TOUCH</th>
<th>CONTENTS</th>
<th>LOCATION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>z</td>
<td>LOST</td>
</tr>
<tr>
<td></td>
<td>y</td>
<td></td>
</tr>
<tr>
<td></td>
<td>x</td>
<td></td>
</tr>
<tr>
<td></td>
<td>m</td>
<td></td>
</tr>
</tbody>
</table>

AFTER TOUCHING NUMBER
*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 \( \sqrt{x} \) function clears register Z. The contents of register X are transferred to register Y and \( Y^x \) are transferred to register 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 \((2 \times 3) + (4 \times 5) = 26\).

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>ENT</td>
<td>2.</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>X</td>
<td>6.</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>ENT</td>
<td>4.</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>X</td>
<td>20.</td>
</tr>
<tr>
<td>+</td>
<td>26.</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>ENT</td>
<td>2.</td>
</tr>
<tr>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>+</td>
<td>5.</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
</tr>
<tr>
<td>ENT</td>
<td>4.</td>
</tr>
</tbody>
</table>
Degrees, minutes and seconds to decimal degrees conversion

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

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>44.5</td>
<td>44.5</td>
<td>Seconds.</td>
</tr>
<tr>
<td>ENT</td>
<td>44.5</td>
<td></td>
</tr>
<tr>
<td>60</td>
<td>60</td>
<td>60 seconds/minute.</td>
</tr>
<tr>
<td>MS</td>
<td>60.</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>.74166666</td>
<td>Minutes.</td>
</tr>
<tr>
<td>23</td>
<td>23</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>23.741666</td>
<td></td>
</tr>
<tr>
<td>MR</td>
<td>60.</td>
<td>60 minutes/degree.</td>
</tr>
<tr>
<td>=</td>
<td>.39569443</td>
<td>Degrees.</td>
</tr>
<tr>
<td>56</td>
<td>56</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>56.395694</td>
<td>Decimal degrees.</td>
</tr>
</tbody>
</table>

Polar to rectangular coordinate conversion

Example: Convert the coordinates θ = 35°, R = 7 to rectangular coordinates using the formulas:

\[ X = R \cos θ, \]
\[ Y = R \sin θ. \]

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>7</td>
<td>7</td>
<td>R.</td>
</tr>
<tr>
<td>MS</td>
<td>7.</td>
<td>Store R in memory.</td>
</tr>
<tr>
<td>ENT</td>
<td>35.</td>
<td></td>
</tr>
<tr>
<td>ENT</td>
<td>35.</td>
<td></td>
</tr>
<tr>
<td>cos</td>
<td>.8191521</td>
<td>Sin θ.</td>
</tr>
<tr>
<td>MR</td>
<td>7.</td>
<td>Recall R.</td>
</tr>
<tr>
<td>×</td>
<td>5.7340647</td>
<td>X calculated.</td>
</tr>
<tr>
<td>X-Y</td>
<td>35.</td>
<td>Retrieve θ from register Y.</td>
</tr>
<tr>
<td>sin</td>
<td>.5735765</td>
<td>Sin θ.</td>
</tr>
<tr>
<td>MR</td>
<td>7.</td>
<td>Recall R.</td>
</tr>
<tr>
<td>×</td>
<td>4.0150355</td>
<td>Y calculated.</td>
</tr>
</tbody>
</table>

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: \[ A = \pi \times 5 \times \sqrt{5^2 + 15^2 + \pi \times 5^2} \]

\[ = 326.9045 \]

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
</tr>
</thead>
<tbody>
<tr>
<td>π</td>
<td>3.1415926</td>
</tr>
<tr>
<td>ENT</td>
<td>3.1415926</td>
</tr>
<tr>
<td>×</td>
<td>15.707963</td>
</tr>
<tr>
<td>MS</td>
<td>15.707963</td>
</tr>
<tr>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>ENT x</td>
<td>25.</td>
</tr>
<tr>
<td>15</td>
<td>15</td>
</tr>
<tr>
<td>ENT x</td>
<td>225.</td>
</tr>
<tr>
<td>+</td>
<td>250</td>
</tr>
</tbody>
</table>
**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: \[ h = \frac{2T \cdot rdg \cdot (\cos \theta)}{d \cdot r^2 \cdot g} \]
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.

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

<table>
<thead>
<tr>
<th>Key In</th>
<th>Display Shows</th>
<th>Comments</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>ENT</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>490</td>
<td>490</td>
<td>Surface tension.</td>
</tr>
</tbody>
</table>

**Example:** What is the molarity of a solution that contains 135 grams of calcium chloride, CaCl₂, per liter?

Using the formula mass of CaCl₂:
- \( 1 \text{ Ca} = 1 \times 40.08 \text{ u} = 40.08 \text{ u} \)
- \( 2 \text{ Cl} = 2 \times 35.453 \text{ u} = 70.906 \text{ u} \)
- \(110.986 \text{ u} = 110.986 \text{ g/mole} \)

in the equation: \[ \text{number of moles} = \frac{\text{mass of CaCl₂}}{\text{formula mass of CaCl₂}} = \frac{135 \text{ grams}}{110.986 \text{ g/mole}} = 1.21 \text{ moles}. \]

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

<table>
<thead>
<tr>
<th>Key In</th>
<th>Display Shows</th>
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</thead>
<tbody>
<tr>
<td>40.08</td>
<td>40.08</td>
<td>Atomic mass of Ca.</td>
</tr>
<tr>
<td>ENT</td>
<td>40.08</td>
<td></td>
</tr>
</tbody>
</table>
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: 

\[
\% \text{wt} = \left( \frac{\text{mew}}{W} \right) \times N \times V \times 10^2
\]

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

Substituting: 

\[
\% \text{wt} = \frac{0.03646 \times 0.15 \times 45 \times 10^2}{10} = 2.46105
\]

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: 

\[
R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}
\]

KEY IN | DISPLAY SHOWS | COMMENTS
--- | --- | ---
220 | 220 | \( R_1 \)
\( \frac{1}{220} \) | \( \frac{1}{220} \) | \( \frac{1}{R_1} \)
\( \frac{1}{145} \) | \( \frac{0.00454545}{145} \) | \( \frac{1}{R_2} \)
\( \frac{1}{175} \) | \( \frac{0.00571428}{175} \) | \( \frac{1}{R_3} \)
\( \frac{1}{58.2877} \) | \( \frac{1}{58.2877} \) | \( \frac{1}{R_{eq}} \)

\( R_{eq} = \frac{1}{\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}} \)
**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:

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

**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:

\[ Z_{eq} = \frac{R}{\tan(2\pi fL)} \]

where:

\[ \tan(2\pi fL) = \frac{1500 \times 0.0152}{295} = 0.4407896 \]

\[ \arctan(0.4407896) = 23.78739° \]

1500 \times 23.78739 = 355.17239 ohms.

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

Using the formula:

\[ \bar{x} = \frac{\sum x}{n} \]

**Statistics**

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

Using the formula:

\[ \bar{x} = \frac{\sum x}{n} \]

<table>
<thead>
<tr>
<th>KEY IN</th>
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<tbody>
<tr>
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<td>2</td>
<td></td>
</tr>
<tr>
<td>ENT</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>(\pi)</td>
<td>3.1415926</td>
<td></td>
</tr>
<tr>
<td>(\bar{x})</td>
<td>6.2831852</td>
<td></td>
</tr>
</tbody>
</table>
Example: Compute the harmonic mean ($M_h$) of the following data: (2, 7, 3, 5, 2).

Using the formula:

$$M_h = \frac{n}{\sum \frac{1}{x_i}}$$

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<thead>
<tr>
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</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td>$x_1$</td>
</tr>
<tr>
<td>1/x</td>
<td>.5</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>$x_2$</td>
</tr>
<tr>
<td>1/x</td>
<td>.14285714</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>.64285714</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>$x_3$</td>
</tr>
<tr>
<td>1/x</td>
<td>.33333333</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>.97619047</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>$x_4$</td>
</tr>
<tr>
<td>1/x</td>
<td>.2</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>1.1761904</td>
<td></td>
</tr>
</tbody>
</table>

Repeat these steps $n-1$ times.

$$n \times \frac{1}{x_1} + \frac{1}{x_2} + \frac{1}{x_3} + \frac{1}{x_4} = \frac{1}{M_h}$$

$$M_h = \frac{n}{x_1 + x_2 + x_3 + x_4}$$

$$M_h = \frac{5}{2 + 7 + 3 + 5} = \frac{5}{17} \approx 0.294$$

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

Using the formula:

$$M_g = \sqrt[n]{x_1 \times x_2 \times x_3 \times \cdots \times x_n}$$

<table>
<thead>
<tr>
<th>KEY IN</th>
<th>DISPLAY SHOWS</th>
<th>COMMENTS</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2</td>
<td>$x_1$</td>
</tr>
<tr>
<td>ENT</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>7</td>
<td>$x_2$</td>
</tr>
<tr>
<td>X</td>
<td>14</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>$x_3$</td>
</tr>
<tr>
<td>X</td>
<td>42</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>$x_4$</td>
</tr>
<tr>
<td>X</td>
<td>210</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>$x_5$</td>
</tr>
<tr>
<td>X</td>
<td>420</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>$n$</td>
</tr>
<tr>
<td>1/x</td>
<td>.2</td>
<td></td>
</tr>
<tr>
<td>y^n</td>
<td>3.346952</td>
<td>Geometric mean ($M_g$).</td>
</tr>
</tbody>
</table>

Repeat these steps $n-1$ times.
Example: Find the predicted ground speed and true heading for a planned flight with the following flight triangle factors known:

<α = true course = 30° from North.
<β = wind direction = 50° from North.
TAS = true air speed = 140 mph.
V = wind velocity = 42 mph.
γ = 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.
50 | 50 | Wind direction (<β).
30 | 30 | True course (<α).
20. | | 
.9396927 | | 
39.467093 | V cos (β-α). | 
39.467093 | Store for further use.
39.467093 | 1557.6514 | \([V \cos(\beta - \alpha)]^2\).
42 | 42 | V. 
42. | | 
1764. | | V^2.
-206.3486 | | \([V \cos(\beta - \alpha)]^2 - V^2\).
140 | 140 | TAS.
140. | | 
19600. | | TAS^2.
19393.652 | | \([V \cos(\beta - \alpha)]^2 - V^2 + TAS^2\).
139.26109 | | \(\sqrt{[V \cos(\beta - \alpha)]^2 - V^2 + TAS^2} = PGS\).
39.467093 | | V cos (β-α).
178.72818 | | V cos (β-α) + \(\sqrt{[V \cos(\beta - \alpha)]^2 - V^2 + TAS^2} = PGS\).
Example: What is the great circle route between San Francisco and Washington, D.C.?

Using the formula:

\[ a = \arccos(\cos b \cos c + \sin b \sin c \cos \alpha) \times 60 \]

\[ \text{where: } \alpha = 122.4^\circ - 77.0^\circ = 45.4^\circ, \]
\[ b = 90^\circ - 37.6^\circ = 52.4^\circ, \]
\[ c = 90^\circ - 38.8^\circ = 51.2^\circ. \]
\[ a = \arccos((\cos 52.4 \cos 51.2 + \sin 52.4 \sin 51.2 \cos 45.4) \times 60). \]

**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: \( FV = PV(1 + i)^n \)

\[ FV = 7000 (1 + .082)^5 \]

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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.
10000 | 10000 | PV.
10000 | 10000 | Save for use in dividing.
2550 | 2550 | FV - PV.
1 | 1 | 
1. | 1. | 
.38 | .38 | Tax rate.
.62 | .62 | 1 - tax rate.
1581 | 1581 | (FV - PV) (1 - tax rate).
10000 | 10000 | Recall PV.
.1581 | .1581 | (FV - PV) (1 - tax rate) \( PV \).
3.5 | 3.5 \( n \) | Recall PV.
.55335 | .55335 | (FV - PV) (1 - tax rate) \( PV \).
100 | 100 | Multiply by 100 to make into whole percentage = rate of return.
55.335 | 55.335 | 

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 | 
.08 | .08 | i.
1.08 | 1.08 | (1 + i).
10 | 10 | n.
-10 | -10 | 
.4631941 | .4631941 | (1 + i)^{-n}.
-4631941 | -4631941 | 
1 | 1 | 
.5368059 | .5368059 | 1 - (1 + i)^{-n}.
.08 | .08 | 
.5368059 | .5368059 | 
1.14902965 | 1.14902965 | 
86000 | 86000 | PV.
86000 | 86000 | 
12816.549 | PMT. |
Appendix B — Part 2 — Hyperbolic and Inverse Hyperbolic Functions

The hyperbolic and inverse hyperbolic functions can be found by using the Gudermannian function:
\[ \text{gd} x = 2 \arctan e^{-x/2} \]  (Note: \( x = 90^\circ \)).
and the inverse Gudermannian function:
\[ \text{gd}^{-1} x = \ln \tan \left( \frac{x}{2} \right) \]  (Note: \( x = 45^\circ \)).
in conjunction with the following formulas:

- \[ \sinh x = \frac{e^x - e^{-x}}{2} \]
- \[ \cosh x = \frac{e^x + e^{-x}}{2} \]
- \[ \tanh x = \frac{\sinh x}{\cosh x} = \sin \text{gd} x, \cosh x \]
- \[ \coth x = \frac{1}{\tanh x}, \sech x = \frac{1}{\cosh x} \]
- \[ \text{csch} x = \frac{1}{\sinh x} \]

\[ \sinh^{-1} x = \ln \left[ x + \sqrt{x^2 + 1} \right] = \text{gd}^{-1}(\sinh^{-1} x), \]
\[ \cosh^{-1} x = \sech^{-1} \frac{1}{x}, \tanh^{-1} x = \frac{1}{2} \ln \left[ 1 + \frac{1}{x^2} \right] = \text{gd}^{-1}(\sinh^{-1} x), \]
\[ \coth^{-1} x = \tanh^{-1} \frac{1}{x}, \sech^{-1} x = \left[ \ln \left( \frac{1}{x^2} + 1 \right) \right] = \text{gd}^{-1}(\cos^{-1} x), \]
\[ \text{csch}^{-1} x = \sinh^{-1} \frac{1}{x}. \]
Appendix C - Operating Limits

CONDITIONS FOR ERROR INDICATION

FUNCTION | CONDITION (X=contents of register X)
---|---
$+$, $-$, $\times$, $\div$ | $X > 99999999$
$+$, $1/x$ | $|X| \leq 0.00000001$
$\sqrt{X}$ | $X < 0$
$Y^X$ | $Y \leq 0; 18.42060 < X \ln Y < -28$
$\log X$, $\ln X$ | $X \leq 0$
e$^X$ | $18.42068 < X < -28$
$\sin$, $\cos$ | $X \geq 7$ radians, $X \geq 401^\circ$
$\tan$ | $|X| \geq 90^\circ$, $X \geq 7$ radians
$\sin^{-1}$, $\cos^{-1}$ | $X > 1$
$\tan^{-1}$ | $X > 99999999$

Examples:

Gudermannian function: $\text{gd} \ 0.225 = 12.7841$.
Key in: $0.225 \ \text{e}^X \ \text{arc} \ \tan \ 2 \times 90$  —  Display shows: 12.7841
Inverse Gudermannian function: $\text{gd}^{-1} \ 60^\circ = 1.316958$.
Key in: $60 \ \text{ENT} \ 2 \ \text{arc} \ \tan$  —  Display shows: 1.316958
Hyperbolic sine: $\sinh \ 2.5 = 6.1322875$.
Key in: $2.5 \ \text{e}^X \ \text{ENT} \ 1/x = 2$  —  Display shows: 6.1322875
Hyperbolic cosine: $\cosh \ 2.5 = 6.0502025$.
Key in: $2.5 \ \text{e}^X \ \text{ENT} \ 1/x = 2$  —  Display shows: 6.0502025
Hyperbolic tangent: $\tanh \ 2.5 = .9866143$.
Key in: $2.5 \ \text{e}^X \ \text{arc} \ \tan \ 2 \times 90$  —  Display shows: .9866143
Hyperbolic cotangent: $\coth \ 2.5 = 1.0135673$.
Key in: $2.5 \ \text{e}^X \ \text{arc} \ \tan \ 2 \times 90$  —  Display shows: 1.0135673
Hyperbolic secant: $\text{sech} \ 2.5 = .16307128$.
Key in: $2.5 \ \text{e}^X \ \text{ENT} \ 1/x = 2$  —  Display shows: .16307128
Hyperbolic cosecant: $\text{csch} \ 2.5 = .16528372$.
Key in: $2.5 \ \text{e}^X \ \text{ENT} \ 1/x = 2$  —  Display shows: .16528372
Inverse hyperbolic sine: $\sinh^{-1} \ 30 = 4.094624$.
Key in: $30 \ \text{arc} \ \tan \ 2 \ \text{arc} \ \tan$  —  Display shows: 4.094624
Inverse hyperbolic tangent: $\tanh^{-1} \ .52 = .5763396$.
Key in: $.52 \ \text{arc} \ \sin \ 2 \ \text{arc} \ \tan$  —  Display shows: .5763396
Other Products

Other "professional" calculators from NOVUS...

Novus 4510 Mathematician
The Electronic Slide Rule
• Trig and inverse trig functions
• Common and natural logs and anti-logs
• Fully addressable, accumulating memory

Novus 4515 Mathematician PR
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

Novus 6010 International Computer
The Electronic Measurement Converter
• Over 65 international measurement conversions
• Fully addressable, accumulating memory
• Total calculating capability with live percent

Novus 6020 Financier
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
• Dedicated to solving statistical calculations
• Pre-programmed statistical equations
• Fully addressable, accumulating memory

Novus 6035 Statistician PR
Programmable Electronic Statistical Calculator
• Same features as the Novus 6030
• 100-step programming capability

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Sunnyvale, CA 94086
(408) 732-5000
Consumer Warranty

Model Number 3500

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