BOWMAR INSTRUMENT CORPORATION
8000 Bluffton Road
Fort Wayne, Indiana 46809

ATTN.: Customer Registration
Registration — Starting with Serial # please fill in all the blanks

<table>
<thead>
<tr>
<th>Model No. MX 140</th>
<th>Serial No.</th>
<th>Purchase Date</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Name</strong></td>
<td><strong>Street</strong></td>
<td><strong>City</strong></td>
</tr>
<tr>
<td><strong>State</strong></td>
<td><strong>ZIP</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Dealers Name</strong></td>
<td><strong>Type of Store:</strong></td>
<td><strong>How did you first hear about Bowmar Brains:</strong></td>
</tr>
<tr>
<td><strong>Dealer</strong></td>
<td><strong>Office Equip/Stationery</strong></td>
<td><strong>Friend</strong></td>
</tr>
<tr>
<td><strong>Mail Order</strong></td>
<td><strong>Radio/TV/Appliance</strong></td>
<td><strong>Magazine Ad</strong></td>
</tr>
<tr>
<td><strong>Other:</strong></td>
<td><strong>Other:</strong></td>
<td><strong>Other:</strong></td>
</tr>
<tr>
<td><strong>Who purchased:</strong></td>
<td><strong>Age:</strong></td>
<td><strong>Occupation</strong></td>
</tr>
<tr>
<td><strong>Self</strong></td>
<td><strong>24-35</strong></td>
<td><strong>Industry</strong></td>
</tr>
<tr>
<td><strong>Spouse</strong></td>
<td><strong>36-50</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Parent</strong></td>
<td><strong>Over 50</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Other:</strong></td>
<td><strong>Other:</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Was the calculator a gift?</strong></td>
<td><strong>Yes</strong></td>
<td><strong>No</strong></td>
</tr>
<tr>
<td><strong>Did you fill in ZIP?</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
WARRANTY

Bowmar/Ali, Inc. warrants to the purchaser of this new Bowmar Calculator that if the machine or any part thereof in the judgment of Bowmar is proven to be defective in material or workmanship within one year from date of original purchase, such defects will be repaired or replaced (at the Company's option) free of charge for parts and labor.

This warranty does not apply to any product which has been damaged by accident or which has been misused, altered, or repaired by anyone other than Bowmar.

This warranty is in lieu of all other warranties expressed or implied, and no person is authorized to assume for Bowmar any other liability in connection with the sale of this product.

To obtain repairs, the Calculator should be delivered, prepaid to Bowmar/Ali, Inc. at address shown below. Please enclose $1.00 with the unit to cover shipping and handling.

ALI SERVICE CENTER
BOX 648
WEST ACTON, MASS. 01720
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INTRODUCTION

The Bowmar MX140 is a calculator capable of rapid and accurate solutions to complex problems. Featuring an easy-to-read 12-digit display, it is designed to let you complete your calculations without resorting to paper and pencil.

We suggest that you read through and keep this booklet of operating instructions with your MX140 to be sure of obtaining all of the performance this versatile calculator can provide.

HIGHLIGHTS

• Scientific notation
• Parenthetical operation, 2 level
• Large LED display
• Fully floating decimal
• Full algebraic operation
• Fully operational memory
• Rechargeable and AC operation
• 115/230V switchable adapter/charger
OVERVIEW OF FEATURES

The MX140 performs the following functions:

- Basic Arithmetic (+, -, x, ÷)
- Trig Functions (SIN, COS, TAN)
- Inverse Trig Functions (SIN⁻¹, COS⁻¹, TAN⁻¹)
- Logarithms (LN, LOG)
- Antilogarithms (eX, 10X)
- Exponentiation (YX)
- Convenience Functions (1/X, X², √X, π)
- Memory (STO, RCL, M+, M-, MC, XM)
- Register Exchange Operations (XY, XM)
- Degree/Radian Selection (DEG/RAD)
- Automatic Error Detection and Indication
- Clearing Operations (C, CE, MC, CF, CF)
The following operating features are included:

- Data Entry in Standard or Scientific Notation
  (10-digit mantissa; 2-digit exponent)

  Example:

<table>
<thead>
<tr>
<th>Value</th>
<th>Possible Entry</th>
<th>Display</th>
</tr>
</thead>
<tbody>
<tr>
<td>10.052</td>
<td>10.052</td>
<td>10.052</td>
</tr>
<tr>
<td>6,000,000</td>
<td>6 F EE 6</td>
<td>6.6E+6</td>
</tr>
<tr>
<td>0.00023</td>
<td>.23 F EE F +/- 3</td>
<td>0.23E-3</td>
</tr>
</tbody>
</table>

- Automatic Selection of Correct Notation
  (Scientific or Standard) for Displayed Results

- Leading Zero to Avoid Misinterpretation of Decimal Point
• Algebraic Problem Entry

   NOTE: All operations are given equal precedence and are executed from left to right unless parentheses are used.

   Example: \[ 2 + 3 \times 6 = 30, \text{ but} \]
   \[ 2 + F (3 \times 6 F) = 20 \]

• Two Parentheses Levels

   Example: \[ 2 + F (3 \times F (4 + 5 F) F) = 29 \]

• Chain (Continuous) Calculations

   Example: \[ 4 \times 2 - 3 \div 5 = 10 \]

OPERATION

AC OPERATION

Connect the Charger to an appropriate electrical outlet as referenced on your Bowmar Charger. Plug the connector into the calculator and turn the power switch on.
BATTERY OPERATION

Disconnect the Charger cord and turn the power switch on. Batteries will need charging when Low Battery Indicator (L or £) appears on display.

BATTERY CHARGING

Simply follow the same procedure as in AC OPERATION. The calculator may be used during the charge period if desired. It requires 8 hours to fully charge a battery which has been completely discharged. In most cases, an overnight charge should be adequate.

NOTE: Although no damage will result from prolonged periods with the Charger connected, it is advisable to remove the Charger when it is not in use or after a full recharge cycle.

CAUTION: To avoid possible damage, use only the Charger provided with the MX140.
PHYSICAL CHARACTERISTICS

Temperatures:
- Operating: 0° to 50°C
- Storage: -20° to 70°C

Weight: 9 oz
Size: 1-1/2 x 3-1/8 x 5-1/4 in.

Power:
- AC Operation: 115/230V, 50/60 Hz
- Battery Operation: 4 hrs
- Charging Time: 8 hrs

KEYBOARD

The MX140 Keyboard consists of 20 keys: 2 Function Keys, F and F, and 18 Data Entry and Operation Keys. (See Diagram.) Each of these 18 keys has a primary function, labeled on the key top, and one or two auxiliary functions labeled above it. The selection of an auxiliary function is employed by depressing a Function Key. The F Key selects the left-hand auxiliary function (e.g., the SIN function above the 7 Key) while F selects the right-hand function (e.g., \( \sqrt{X} \) above the 8). If only one auxiliary function appears above the key, it will be selected by either F or F (e.g., 1/X above \( \div \)). If F is depressed when F was intended, simply press F and proceed, and vice versa. To cancel an initial depression of either F or F, depress Y^x which has its auxiliary functions (CF and CF) defined so as to negate an immediately preceding F or F depression.
DISPLAY

The Display consists of a 14-position readout. Position 1 (at left) contains the sign of the number displayed (unless it is positive) and/or an indication symbol. Positions 12 through 14 (toward right) display the magnitude, or mantissa, of the number. The last three positions (12 through 14) display the magnitude and sign of the exponent. An exponent will be displayed only if scientific notation (± A x 10 ± N) is used to enter a number or if the result of a calculation requires that the result be presented in this way.

Indication symbols that may appear in the left-most position are as follows:
- Negative Number
- Positive Answer Overflow or Underflow or Illegal Operation
- Negative Answer Overflow or Underflow or Illegal Operation
- Low Battery (Positive Number)
- Low Battery (Negative Number)
\ Radian Mode

The Display will appear blank during all periods of calculation.

In the following section we present each function key and various illustrating operational sequences through which you may familiarize yourself with the MX140.
OPERATING INSTRUCTIONS

DATA ENTRY
To begin a calculation, clear all MX140 registers and memory by pressing F C and F MC.

CE Clears an entry (or display).
0 → 9 Entry of numerical digits.
F π Entry of the constant π.
F EE Defines decimal point position
F +/- Change sign of mantissa or exponent (if EE was pressed prior to this). Cannot be used after =. In this case multiply by −1.

MATHEMATICAL FUNCTIONS OF TWO VARIABLES
In the operation of certain mathematical functions (+, −, ×, ÷, Y^x), two variables are employed. Operation of the following functions (+, −, ×, ÷, Y^x, =) computes any pending function and stores the new command.
Example: \( 3 \times 2 + 4 \div 5 = 2 \)

<table>
<thead>
<tr>
<th>Operate</th>
<th>Display</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3.</td>
<td>Stores multiply command.</td>
</tr>
<tr>
<td>( \times )</td>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>6.</td>
<td>Executes ( 3 \times 2 ) and stores a command.</td>
</tr>
<tr>
<td>4</td>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>( \div )</td>
<td>10.</td>
<td>Executes ( 8 \div 4 ) and stores divide command.</td>
</tr>
<tr>
<td>5</td>
<td>5.</td>
<td></td>
</tr>
<tr>
<td>=</td>
<td>2.</td>
<td>Executes ( 10 \div 5 ).</td>
</tr>
</tbody>
</table>

(= Computes all pending functions and sub-problems.)
POWER OF NUMBERS

$Y^x$ computes pending function and stores exponentiation command.

Example: $3^5 = 243$

<table>
<thead>
<tr>
<th>Operate</th>
<th>Display</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3</td>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>$Y^x$</td>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5.</td>
<td></td>
</tr>
<tr>
<td>=</td>
<td>243.</td>
<td>Answer</td>
</tr>
</tbody>
</table>

NOTE: If two or more of these function keys are depressed in direct sequence, the last key is assumed by the calculator. Therefore, if the wrong function key ($+, -, \times, \div, Y^x$) is depressed accidentally, merely press the proper key and continue.
### Example: $2 \times 3 - 1 = 5$

<table>
<thead>
<tr>
<th>Operate</th>
<th>Display</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>6.</td>
<td>Previous operation executed but wrong command stored.</td>
</tr>
<tr>
<td>-</td>
<td>6.</td>
<td>Correct command stored.</td>
</tr>
<tr>
<td>1</td>
<td>1.</td>
<td></td>
</tr>
<tr>
<td>=</td>
<td>5.</td>
<td></td>
</tr>
</tbody>
</table>
MATHEMATICAL FUNCTIONS OF ONE VARIABLE

Each operation consists of a function key depression followed by the appropriate operation key. The result immediately replaces the number operated upon in the display.

- **F LOG** Common (Base 10) log
- **F 10^x** Base 10 exponential
- **F LN** Natural log
- **F e^x** Base e exponential
- **F X^2** Square
- **F √X** Square root
- **F 1/X** Reciprocal
- **F SIN** Sine
- **F COS** Cosine
- **F TAN** Tangent
- **F SIN^(-1)** Arcsine
- **F COS^(-1)** Arcosine
- **F TAN^(-1)** Arctangent
TRIGONOMETRIC FUNCTION UNIT SELECTION

F  DEG  Selection of degree unit system for trig functions.

F  RAD  Selection of radian unit system for trig functions (indication light at left of display).

NOTE: At power on, the MX140 is set for degrees. Degree/Radian selection may be changed any time before, after, or during any problem.

INTERNAL REGISTER MANIPULATOR

F  X\to Y  Exchanges contents of X and Y registers. These registers are used in functions of two variables. For example, in the problem 2 \times 3 = , the 2 first enters the display (the X register) and then, when the x is entered, the 2 is moved to the Y register.
PARENTHESES

\[
\begin{align*}
F \{ & \text{Stores pending command and conditions calculator to accept} \\
& \text{sub-problem.} \\
F \} & \text{Computes sub-problem with parentheses pair displays result,} \\
& \text{and conditions calculator for execution of pending command.} \\
& \text{If no prior } \{ \text{ (open parenthesis) key was depressed, the close} \\
& \text{parenthesis key is ignored.}
\end{align*}
\]

Closing parenthesis is not necessary unless followed by another command. Pressing = after entering total problem will execute problem in proper sequence and display answer to total problem directly. Solution to intermediate sub-problem (in parentheses) may be displayed by closing the corresponding parenthetical expression.
Example 1:  $8 + (2 \times 3) = 14$

<table>
<thead>
<tr>
<th>Operate</th>
<th>Display</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>8.</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>8.</td>
<td></td>
</tr>
<tr>
<td>F [{</td>
<td>0.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>$\times$</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3.</td>
<td></td>
</tr>
<tr>
<td>=</td>
<td>14.</td>
<td></td>
</tr>
<tr>
<td>or F ]}</td>
<td>6.</td>
<td>Sub-problem executed and displayed,</td>
</tr>
<tr>
<td>=</td>
<td>14.</td>
<td></td>
</tr>
</tbody>
</table>

Possibilities for correct result

Prior command stored.
Example 2: \[ 8 + (2 \times (2 + 1)) = 14 \]

<table>
<thead>
<tr>
<th>Operate</th>
<th>Display</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>8</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>8</td>
<td></td>
</tr>
<tr>
<td>F [ (</td>
<td>0</td>
<td>Command stored.</td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>\times</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>F [ (</td>
<td>0</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>1</td>
<td></td>
</tr>
<tr>
<td>=</td>
<td>14</td>
<td>No closing parenthesis results in direct answer.</td>
</tr>
<tr>
<td>or F ] ]</td>
<td>3</td>
<td>Prior sub-problem executed and result displayed.</td>
</tr>
<tr>
<td>= 14</td>
<td></td>
<td></td>
</tr>
<tr>
<td>or F ] ]</td>
<td>3</td>
<td>Prior sub-problem executed and result displayed.</td>
</tr>
<tr>
<td>F ] ] = 14</td>
<td></td>
<td>First sub-problem executed and displayed.</td>
</tr>
</tbody>
</table>
The MX140 will handle a maximum of two parentheses levels (as in second example above). Attempts at using additional parentheses levels will cause an illegal entry indication (F) on display and terminate calculation.

Any number of parentheses pairs in succession is possible because closing a pair completes that sub-problem.

Example 3: \[(2 \times 4) \div (2 \times 5) - (2 \times 2) = 14\]

<table>
<thead>
<tr>
<th>Operate</th>
<th>Display</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>F (l</td>
<td>0.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>F )}</td>
<td>8.</td>
<td></td>
</tr>
<tr>
<td>+</td>
<td>8.</td>
<td></td>
</tr>
<tr>
<td>F l}</td>
<td>0.</td>
<td></td>
</tr>
<tr>
<td>Operate</td>
<td>Display</td>
<td>Comment</td>
</tr>
<tr>
<td>---------</td>
<td>---------</td>
<td>---------</td>
</tr>
<tr>
<td>2</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5.</td>
<td></td>
</tr>
<tr>
<td>F ]]</td>
<td>10.</td>
<td></td>
</tr>
<tr>
<td>-</td>
<td>18.</td>
<td></td>
</tr>
<tr>
<td>F [ ]</td>
<td>0.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2.</td>
<td></td>
</tr>
<tr>
<td>F ]]</td>
<td>4.</td>
<td></td>
</tr>
<tr>
<td>=</td>
<td>14.</td>
<td></td>
</tr>
</tbody>
</table>

Prior functions executed and new command, -, stored.
MEMORY CONTROL

The MX140 contains a memory register to assist in data manipulation.

- **F STO**: Copy of display is stored in memory. Display remains unchanged.
- **F RCL**: Contents of memory displayed. Memory remains unchanged.
- **F MC**: Clears memory only.
- **F M+**: Adds contents of display to contents of memory. Display remains unchanged.
- **F M-**: Subtracts contents of display from contents of memory. Display remains unchanged.
- **F →XM**: Exchanges contents of display and memory.

Memory operations can be used at any time.

**Example:**

1 + 2 F STO x 3 = 9.

(Memory contains 2)

3 x F RCL ÷ 4 = 1.5
ERROR CONDITIONS

There exists a limit to the magnitude of a number the MX140 is capable of handling. For excessively large or excessively small numbers, an overflow or underflow indication will appear.

Largest: \(9.999999999 \times 10^{99}\)  Smallest: \(10^{-99}\)

RESULT ERRORS

A result displayed with an overflow or underflow indication may be read correctly by adding +100 to a positive exponent and -100 to a negative exponent.

Example: \((9 \times 10^{99}) \times (2 \times 10^{25}) = 1.8 \times 10^{125}\)

<table>
<thead>
<tr>
<th>Operate</th>
<th>Display</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>9</td>
<td>9.0</td>
<td></td>
</tr>
<tr>
<td>F EE</td>
<td>9.99</td>
<td></td>
</tr>
<tr>
<td>99</td>
<td>9.99</td>
<td></td>
</tr>
<tr>
<td>X</td>
<td>9.99</td>
<td></td>
</tr>
</tbody>
</table>

(Cont)
FUNCTION ERRORS

Certain mathematical functions cannot be executed over the full range of numbers because they are undefined. The following table lists the functions of the calculator and the expected range. Functions used outside of this range will result in an error display, \( \text{ERR} \).

<table>
<thead>
<tr>
<th>Function</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>( X + Y )</td>
<td>All numbers</td>
</tr>
<tr>
<td>( X - Y )</td>
<td>All numbers</td>
</tr>
<tr>
<td>( X \times Y )</td>
<td>All numbers</td>
</tr>
<tr>
<td>( X \div Y )</td>
<td>All numbers ( (Y \neq 0) )</td>
</tr>
</tbody>
</table>

(Cont)
<table>
<thead>
<tr>
<th>Function</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>$Y^X$</td>
<td>$Y&gt;0$</td>
</tr>
<tr>
<td></td>
<td>$X&lt;100 \text{ LN } 10/</td>
</tr>
<tr>
<td>$\log (X)$</td>
<td>$X&gt;0$</td>
</tr>
<tr>
<td>$10^X$</td>
<td>$-99 &lt; X &lt; 100$</td>
</tr>
<tr>
<td>$\ln (X)$</td>
<td>$X&gt;0$</td>
</tr>
<tr>
<td>$e^X$</td>
<td>$X&lt;100 \text{ LN } 10$</td>
</tr>
<tr>
<td>$x^2$</td>
<td>$x&gt;0$</td>
</tr>
<tr>
<td>$\sqrt{x}$</td>
<td>All numbers</td>
</tr>
<tr>
<td>$1/x$</td>
<td>All numbers ($X \neq 0$)</td>
</tr>
<tr>
<td>$\sin (X)$</td>
<td>All numbers</td>
</tr>
<tr>
<td>$\cos (X)$</td>
<td>All numbers</td>
</tr>
<tr>
<td>$\tan (X)$</td>
<td>All numbers ($</td>
</tr>
<tr>
<td>$\sin^{-1} (X)$</td>
<td>$</td>
</tr>
<tr>
<td>$\cos^{-1} (X)$</td>
<td>$</td>
</tr>
<tr>
<td>$\tan^{-1} (X)$</td>
<td>All numbers</td>
</tr>
</tbody>
</table>

*N = Integer
ACCURACY

The accuracy of a device is defined in terms of its error. We categorize two types of errors and summarize the overall accuracy of the calculator in a table.

TRUNCATION ERROR

Truncation error is the error introduced when the mantissa of a number cannot fit on the display. When this occurs for a result, the calculator will round the 10th digit. Truncation errors are cumulative and increase (become worse) with successive operations.

ALGORITHMIC ERRORS

The limited precision of the constants used in a process may contribute to the overall accuracy of a calculation. Certain functions become less accurate within a range of inputs. Thus each function is capable of different degrees of accuracy.

The following chart summarizes the accumulated error from all causes and presents a maximum expected error for each function result.
Example: $\sqrt{3}$  
Display: 1.732050807

For $\sqrt{X}$, the chart defines error as "2 cnt in $D_{10}$" (read as 2 counts in digit 10). Therefore maximum error is ±2 in this digit (the last 7 on the right).

<table>
<thead>
<tr>
<th>Function</th>
<th>Entry Condition</th>
<th>Result Condition</th>
<th>Maximum Mantissa Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$X + Y$</td>
<td></td>
<td></td>
<td>1 cnt in $D_{10}$</td>
</tr>
<tr>
<td>$X - Y$</td>
<td></td>
<td></td>
<td>1 cnt in $D_{10}$</td>
</tr>
<tr>
<td>$X \times Y$</td>
<td></td>
<td></td>
<td>1 cnt in $D_{10}$</td>
</tr>
<tr>
<td>$X \div Y$</td>
<td></td>
<td></td>
<td>1 cnt in $D_{10}$</td>
</tr>
<tr>
<td>$Y^x$</td>
<td>$10^{-9} \leq</td>
<td>X \ln Y</td>
<td>&lt; 10^2 \ln 10$</td>
</tr>
<tr>
<td>$1/X$</td>
<td></td>
<td></td>
<td>1 cnt in $D_{10}$</td>
</tr>
<tr>
<td>$X^2$</td>
<td></td>
<td></td>
<td>1 cnt in $D_{10}$</td>
</tr>
<tr>
<td>$\sqrt{X}$</td>
<td></td>
<td></td>
<td>2 cnt in $D_{10}$</td>
</tr>
<tr>
<td>LOG $X$</td>
<td>$</td>
<td>R</td>
<td>&lt; \ln 10$</td>
</tr>
<tr>
<td></td>
<td>$</td>
<td>R</td>
<td>\geq \ln 10$</td>
</tr>
</tbody>
</table>

(Cont)
<table>
<thead>
<tr>
<th>Function</th>
<th>Entry Condition</th>
<th>Result Condition</th>
<th>Maximum Mantissa</th>
<th>Error</th>
</tr>
</thead>
<tbody>
<tr>
<td>$e^x$</td>
<td>$0 \leq</td>
<td>x</td>
<td>&lt; 10$</td>
<td>$0 \leq</td>
</tr>
<tr>
<td></td>
<td>$LN 10 \leq</td>
<td>x</td>
<td>&lt; LN 10$</td>
<td>$LN 10 \leq</td>
</tr>
<tr>
<td></td>
<td>$10 LN 10 \leq</td>
<td>x</td>
<td>&lt; 10^2 LN 10$</td>
<td>$10 LN 10 \leq</td>
</tr>
<tr>
<td>SIN</td>
<td>$0^\circ \leq</td>
<td>\phi</td>
<td>&lt; 360^\circ$ (or $2\pi$ RAD)</td>
<td>$0^\circ \leq</td>
</tr>
<tr>
<td>COS</td>
<td>$0^\circ \leq</td>
<td>\phi</td>
<td>&lt; 360^\circ$ (or $2\pi$ RAD)</td>
<td>$0^\circ \leq</td>
</tr>
<tr>
<td>TAN</td>
<td>$0^\circ \leq</td>
<td>\phi</td>
<td>&lt; 90^\circ$ (or $\pi/2$ RAD)</td>
<td>$0^\circ \leq</td>
</tr>
<tr>
<td>SIN$^{-1}$</td>
<td>$10^{-10} \leq</td>
<td>x</td>
<td>\leq 1$</td>
<td>$0 \leq</td>
</tr>
<tr>
<td>COS$^{-1}$</td>
<td>$10^{-10} \leq</td>
<td>x</td>
<td>\leq 1$</td>
<td>$0 \leq</td>
</tr>
<tr>
<td>TAN$^{-1}$</td>
<td>$90 \leq</td>
<td>x</td>
<td>&lt; 180^\circ$</td>
<td>$90 \leq</td>
</tr>
<tr>
<td>LN $x$</td>
<td>$</td>
<td>x</td>
<td>\geq 10$</td>
<td>$</td>
</tr>
<tr>
<td></td>
<td>$</td>
<td>x</td>
<td>&lt; 10$</td>
<td>$</td>
</tr>
</tbody>
</table>

$R$ = Result as displayed $E$ = Error
SAMPLE PROBLEMS

Following are seven categories of problems. With these problems we wish to illustrate practical uses for various functions on the calculator. Note that our methods for solution are not absolute, as you may prefer to solve the problem in a different manner and still attain the correct answer. In any case, you may find it useful to attempt to solve the problem yourself before examining our method of computation.

MATHEMATICS

Example 1: Find the length of H.

Solution: \( H = \sqrt{x^2 + y^2} \) (Pythagorean theorem)

Where: \( x = 25, y = 20 \)

Answer: \( 32.01562118 \)

Computation: \( 25 \times X^2 + 20 \times X^2 = \sqrt{X} \)
Example 2: \[5N^2 - 6N - 11\] Solve for \(N\).

Solution: In finding the two roots to a second order algebraic equation, the quadratic formula is typically employed.

\[N = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}\]  \hspace{1cm} \text{(quadratic formula)}

Where: \(a = 5\), \(b = -6\), \(c = -11\)

Answer: Root 1 \(\rightarrow N = 2.2\), Root 2 \(\rightarrow N = -1\)

Computation:

\[
\begin{align*}
&6 \ F \ X^2 \\
&- F (4 \ X 5 \ X 11 \ F +/-) \\
&= F \sqrt{X} \\
&\div 2 \div 5 = \\
\end{align*}
\]

Display

\[
\begin{align*}
\text{b}^2 \\
\text{-4ac} \\
\sqrt{\text{b}^2 - 4ac} \\
-b + \sqrt{\text{b}^2 - 4ac} \\
\text{Root 1} \\
\end{align*}
\]

\[
\begin{align*}
\text{NOTE: Do not clear memory until both roots are calculated.} \\
&F \ RCL \ F +/- \\
&+ 6 \\
&\div 2 \div 5 = \\
\end{align*}
\]

Root 2
Example 3: Find the approximate circumference of the following ellipse:

\[ a = 3, \ b = 2 \]

Solution:

\[ P = 2\pi \sqrt{\frac{a^2 + b^2}{2}} \]

Where: \( a = 3, \ b = 2 \)

Answer: 16.01904224

Computation:

\[ 3 F X^2 + 2 F X^2 \div 2 = F \sqrt{X} \times F \pi \times 2 = \]

Example 4: Solve: COS .4238

Answer: 0.911532862

Computation: F RAD .4238 F COS

Example 5: Solve: SIN 32° + TAN .325

Answer: 0.866867019

Computation: 32 F SIN + F RAD .325 F TAN =
Example 1: Find the torque on a loop of wire carrying 2 amps in a magnetic field of 0.4 wb/m².

\[
\tau = IAB \sin \theta
\]

Where:
- \( B = 0.4 \) wb/m²
- \( I = 2 \) amps
- \( \theta = 30^\circ \)
- \( A = \pi R^2 \) (area)
- \( R = 1.65 \) m

\[
\tau = 2 \times \pi X 1.65 \times 2 \times 30 \times \sin 30^\circ
\]

Answer: 3.421194393
Example 2: A rigid body with a mass of 1.5 kg is suspended as shown below. Calculate the moment of inertia of the body if the frequency is measured at 2 Hz. The center of inertia is 0.25 m (meters) from the pivot point.

Solution: \[ I = \frac{1}{(2\pi F)^2} MGL \]

Where:
- \( M = 1.5 \) kg
- \( G = 9.8 \text{ m/s}^2 \) (gravitational constant)
- \( L = 0.25 \text{ m} \)
- \( F = 2 \) Hz

Answer: 2,327,220,935.02 kg·m²

Computation: \[ 2 \times \pi \times 2 \times F \times \frac{1}{F} \times L \times M \times G \times L = \]
CHEMISTRY

Example 1: If 2 kg of nitrogen is compressed isothermally to half its original volume, what is the loss of energy? By immersing the apparatus in an ice-water bath, the temperature remains at a constant 273°K.

Solution: 

\[ W = \frac{(MRT)}{N} \ln \left( \frac{V_2}{V_1} \right) \]

Where:
- \( M = 2 \text{ kg} \)
- \( N = 28 \text{ kg/mole (molecular weight)} \)
- \( V_1 = \text{previous volume} \)
- \( V_2 = \text{present volume} \)
- \( V_2/V_1 = 0.5 \)
- \( R = 8310 \text{ V/kg - mole - °K (constant)} \)

Answer: \(-112321.0349\) joules

Computation: \(0.5 \times \ln 273 \times 8310 \times 2 \div 28 = \)
Example 2:  What is the change in entropy if two volumes of an ideal monatomic gas are connected and allowed to come to a thermal equilibrium? The two volumes have 1.2 kg masses, the same specific heat of 0.3, and different temperatures of $73^\circ K$ and $115^\circ K$.

Solution:  \[ S_2 - S_1 = M C \ln \frac{(T_1 + T_2)^2}{4T_1 T_2} \]

Where:  \[ S_2 - S_1 = \text{change in entropy} \]
\[ M = 1.2 + 1.2 = 2.4 \text{ kg} \]
\[ C = 0.3 \]
\[ T_1 = 73^\circ K \]
\[ T_2 = 115^\circ K \]

Answer:  \[ 3.686255568^{\circ2} \]

Computation:  \[ 73 + 115 = F \times 4 \div 73 \div 115 = F \times \ln \times .3 \times 2.4 = \]
Example 3: Calculate the MgO/FeO weight ratio for the ionic solid solution where Fe$^{2+}$ is substituted for Mg$^{2+}$ in the MgO Structure. The ion ratio is:

\[
\frac{\text{Mg}^{2+}}{\text{Fe}^{2+}} = \frac{17}{10} = \text{Mole Ratio}
\]

Atomic Numbers: O = 16, Mg = 24.31, Fe = 55.85
Avogadro's Number: \(6.02 \times 10^{23}\)

Solution:

\[
\text{Weight MgO} = \frac{17 (24.31 + 16)}{6.02 \times 10^{23}} = 17 (24.31 + 16)
\]

\[
\text{Weight FeO} = \frac{10 (55.85 + 16)}{6.02 \times 10^{23}} = 10 (55.85 + 16)
\]

Answer: \(9.37508698 \times 10^{-1}\)

Computation: \(17 \times F \{24.31 + 16\} \div 10 = 10 \times F \{55.85 + 16\} = \)
Example 1: Give the equivalent of the following parallel resistances.

4.7 MΩ  2 KΩ  100Ω  350Ω  220Ω

Solution:

\[ R_{eq} = \frac{1}{\frac{1}{4.7 \times 10^6} + \frac{1}{2000} + \frac{1}{100} + \frac{1}{350} + \frac{1}{220}} \]

Answer: 55.85715258Ω

Computation: 4.7 F EE 6 F 1/X + 2000 F 1/X + 100 F
1/X + 350 F 1/X + 220 F 1/X = F 1/X
Example 2: Find the current \( I(T) \) 0.1 msec after the switch is closed.

**Solution:** Expression for current in the RL network is:

\[
I(T) = \frac{V}{R} \left(1 - e^{-\frac{RT}{L}}\right)
\]

**Answer:** \(1.59467808^{-03} \text{amps}\)

**Computation:**

\[
100 \ F /- X .1 F EE 3 F /- + 1.5 = F e^X F /- + 1 X 24 + 100 =
\]
Example 3: What is the approximate self-inductance in microhenrys of the illustrated coil?

Solution:

\[ L = \frac{0.8(RN)^2}{6R + 9H + 10B} \]

\( H = 0.2 \text{ in.} \)
\( R = 1.5 \text{ in.} \)
\( B = 0.2 \text{ in.} \)
\( N = \text{no. of turns} = 25 \)

Answer: 87.890625 \( \mu \text{H} \)

Computation:

\[ 1.5 \times 25 = F \times \frac{X^2}{2} \times 0.8 + F \left( 6 \times 1.5 + F \left( 9 \times 0.2 \right) \right) + F \left( 10 \times 0.2 \right) = \]
MECHANICS

Example 1: What size pulley must be used on an 880 rpm meter employed to drive a fan at 210 rpm when the fan pulley diameter is 24 in.?

Solution: \[ D_r = \frac{D_n \times N_n}{N_r} \]

Where:  
- \( D_r \) = diameter of driver  
- \( D_n \) = diameter of driven = 24 in.  
- \( N_r \) = rev. of driver = 880 rpm  
- \( N_n \) = rev. of driven = 210 rpm

Answer: \( 5.727272727 \) in.

Computation: \( 24 \times 210 \div 880 = \)
Example 2: A steel pulley-carrying line shaft must transmit 4 hp at 300 rpm. How thick must the shaft be if the only force is torsional?

Solution: \[ D = 3.75 \]

\[ \sqrt[3]{\frac{HP}{N}} = 3.75 \left( \frac{HP}{N} \right)^{1/3} \]

Where: \( HP = 4 \) hp
\( N = 300 \) rpm

Answer: 0.889223325 in.

Computation: \( 3.75 \times F \left( 4 \div 300 \right)^{1/3} F \left( 1 \div 3 \right) = \)
Example 3: The shaft center distances between two pulleys in an open belt drive is 1.5 ft. If the pulley diameters are 6 in. and 3 in. respectively, what is the length of belting required?

Solution:

\[ L = \frac{\pi D_1}{2} + \frac{\pi D_2}{2} + 2\sqrt{C^2 + \left(\frac{D_1 - D_2}{2}\right)^2} \]

Where:
- \( D_1 = 6 \text{ in.} = 0.5 \text{ ft} \)
- \( D_2 = 3 \text{ in.} = 0.25 \text{ ft} \)
- \( C = 1.5 \text{ ft} \)

Answer: 4.188496889 ft

Computation: 
\[ F \pi X .5 \div 2 = F \text{ STO } F \pi X .25 \div 2 = F \text{ M+ } 2 \times F \text{ ( } 1.5 F X^2 + F \text{ ( } .5 - .25 \div 2 F \text{ ) } F X^2 F \text{ ) } F \text{ M+ } F \text{ RCL } \]
UNIT CONVERSIONS

Example 1: Convert the following from feet to meters.

A) 32 ft =
B) 10 ft =
C) 2 ft =
D) 0.25 ft =

Solution: 1 m = 3.280840 ft

Answer:
A) 9.753599687 m
B) 3.047999902 m
C) 6.0960998804 m
D) 0.761999756 m

Computation: 32 ÷ 3.28084 F STO = 2 ÷ F RCL =
10 ÷ F RCL = .25 ÷ F RCL =

Example 2: Convert the following from kilometers to miles.

A) 500 km =
B) 300 km =
C) 10 km =
D) 2 km =

Solution: 1 mi = 1.609344 km
Example 3: Convert the following from pounds to kilograms.

A) 200 lbs =
B) 10 lbs =
C) 5 lbs =
D) 0.25 lbs =

Solution: 1 lb = 0.453592 kg

Answer:  
A) 90.7184 kg  
B) 4.53592 kg  
C) 2.26796 kg  
D) 0.113398 kg

Computation:  
200 X .453592 F STO =  
10 X F RCL =  
5 X F RCL =  
.25 X F RCL =
Example 1: Finance — What will the monthly payment be on a $100,000 loan, borrowed for three years at 13% per year?

\[ M = \frac{P \cdot \frac{i (1 + i)^n}{(1 + i)^n - 1}} \]

Where:
- \( M \) = monthly payment
- \( P \) = principal ($100,000)
- \( i \) = monthly interest rate (annual rate \( .13 \)/12)
- \( n \) = number of periods = 12 months \( \times \) 3 years = 36

Answer: \( 3369.395253 = 3369.40 \)

Computation: \( .13 \div 12 + 1 \ Y^x 36 = F \ STO \ X \ .13 \div 12 \div \ F \ (F \ RCL \ -1=X 100000 = \)
Example 2: Inventory Management – If the demand for widgets is uniform and at the rate of 2,000 per month, the setup cost for a lot of widgets is $25,000, and the cost of holding a widget in inventory for a month is $1.75, in what size lots should widgets be manufactured?

\[ Q = \sqrt{\frac{2KM}{h}} \]

Where:  
- \( Q \) = “Economic Order Quantity”
- \( K \) = setup cost = 25000
- \( M \) = demand per unit time = 2000
- \( h \) = holding cost per unit time = 1.75

Answer: \( 7559.289459 \approx 7559 \) widgets

Computation: \( 2 \times 25000 \times 2000 \div 1.75 = \text{F} \sqrt{X} \)
Example 3: Marketing (and Statistics) — A survey of 1,945 readers of Playhouse Magazine found the distribution of "regular" and "occasional" readers by sex as shown in the following table:

<table>
<thead>
<tr>
<th>Type of Reader</th>
<th>Female</th>
<th>Male</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Regular</td>
<td>152</td>
<td>523</td>
<td>675</td>
</tr>
<tr>
<td>Occasional</td>
<td>498</td>
<td>772</td>
<td>1295</td>
</tr>
<tr>
<td>Total</td>
<td>650</td>
<td>1295</td>
<td>1945</td>
</tr>
</tbody>
</table>

Using a $\chi^2$ (chi squared) test, determine whether there is a relationship between sex and the type of reader of Playhouse.

NOTE: At the .01 probability level, $\chi^2 = 6.635$. 

$$
\chi^2 = \sum_{i=1}^{s} \frac{(X_i - \theta_i)^2}{\theta_i}
$$