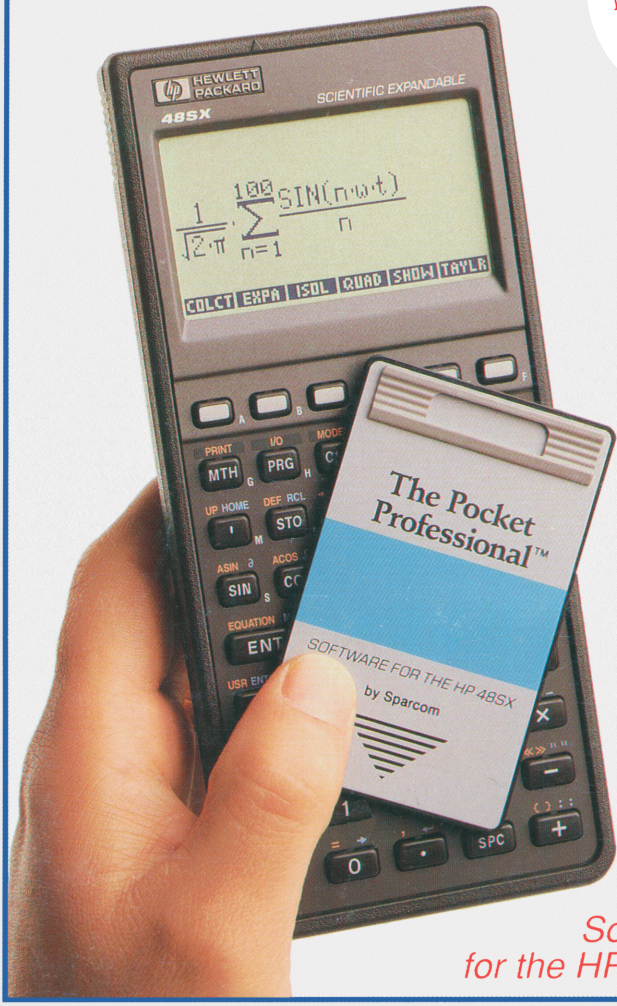
Sparcom

Pocket Professional™

OWNER'S MANUAL

MATH•*Pro*™
User's Guide



Software
for the HP 48SX

PocketProfessional®

MATH•*Pro*™

User's Guide

SPARCOM CORPORATION

Edition 1 September 1993
Software Reorder No. 10201-1A Manual Reorder No. 10201-1M

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Customer satisfaction is important to Sparcom Corporation. Technical support is available Monday through Friday, 9 a.m. to 5 p.m. Pacific Coast Time. The support phone number is (503) 757-8416. Your questions are also welcome by facsimile (503) 753-7821 or by e-mail (Internet: support@sparcom.com).

Credits

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- **Acknowledgments:** Joseph Horn (for Closest Fraction) and Wayne Scott (for Polynomial Roots).
- **Special Thanks:** Dr. Thomas P. Dick.

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Printing History

Edition 1 September 1993

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Chapter 1

Getting Started

PocketProfessional® software is the first of its kind, developed to provide speed, efficiency and portability to students and professionals in technical fields. When you slide a PocketProfessional plug-in card into your HP 48GX or HP 48SX, your calculator is instantly transformed into an electronic "textbook," ready to efficiently solve your technical problems.

PocketProfessional Math•*Pro*™ is state-of-the-art mathematics software for the HP 48GX and HP 48SX calculators. Sparcom Corporation would like to thank previous owners of PocketProfessional software for their many helpful suggestions and comments.

This chapter covers:

- ❑ Key Features of Math•*Pro*
- ❑ How to Use This Manual
- ❑ Manual Conventions
- ❑ Differences between HP 48GX and HP 48SX
- ❑ Installing and Removing a Card
- ❑ Starting Math•*Pro*
- ❑ Using the Home Screen
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Key Features of Math•*Pro*

- ❑ *Highest speed and performance of any HP 48 software sold today*
- ❑ *Easy-to-use, intuitive menu-based interface*
- ❑ *Context-sensitive help text for every screen*
- ❑ *Advanced math analysis routines, equations, and reference tables*
- ❑ *Integrated access to the HP 48 stack for calculations*
- ❑ *Comprehensive documentation for quick reference*
- ❑ *Learn one Pro product and you can use them all!*

How to Use This Manual

This manual is designed as a learning and reference tool to be used with your PocketProfessional Math•*Pro* software. This section explains the layout of the manual.

Manual Organization

The manual is divided into four parts: Analysis, Equations, Reference, and Programming & Advanced Use. These sections mirror the divisions within Math•*Pro*, with the addition of an advanced section for experienced users.

- ❑ **Part 1: Analysis** includes analysis routines to perform calculations, such as polynomial root-finding, curve fitting, or hyperbolic functions. Easy-to-use, intuitive analysis screens are available for each routine.

- ❑ **Part 2: Equations** includes an equation library of over a hundred solvable equations organized in related groups. Full descriptions of each variable, a variety of user-selectable units, and diagrams are included.

- ❑ **Part 3: Reference** includes reference tables based on information in standard reference books, such as integral tables or trigonometric identities.

- ❑ **Part 4: Programming & Advanced Use** includes detailed syntax for each programmable command included in Math•*Pro* and other tips for experienced users.

What to Read Next...

To get the most information from this manual, read the following sections:

❶ Read all of this chapter, "Getting Started." You will learn how to install Math•*Pro*, and you will be introduced to the menus and screens of Math•*Pro*, which provide easy-to-use, intuitive access to all the features.

❷ Read the Analysis, Equations and Reference tutorials. You will learn how to use each major section of Math•*Pro* through the help of numerous examples and context-sensitive help.

❸ Use the table of contents and index to locate further topics of interest.

❹ Refer to Appendix D, "Questions and Answers," to answer the most commonly asked questions about Math•*Pro*.

Manual Conventions

There are a few simple conventions used throughout this manual:

- ❑ Keys on the HP 48 keyboard are shown in a boxed typeface, such as [ENTER].
- ❑ Keys such as [ON]-[I/O] displayed with a hyphen between them should be pressed at the same time. Do not press the hyphen.
- ❑ Menu keys are located at the bottom of the HP 48 screen and correspond directly to the top row of keys on the HP 48 keyboard. They are shown in an inverse typeface, such as HOME.
- ❑ Programmable commands are shown in uppercase letters, such as SIN. Uppercase is also used to show field names, like RESULT, which are displayed on the HP 48 screen.
- ❑ Steps to be followed in a particular order are denoted by ❶, ❷, ❸, etc.
- ❑ HP 48 variables/directories are listed in single quotes, such as 'SPARCOM'.
- ❑ Equation variables are shown in boldface to separate them from the text, as in: "The **Icc** axis is parallel to any side of a cube."
- ❑ All examples assume that pressing [α][α] locks Alpha entry mode. If your HP 48 has system flag -60 set, you should press [α] instead of [α][α].

Differences between HP 48GX and HP 48SX

This manual was written using the HP 48GX as the standard, with notations made for the HP 48SX where necessary. The following keys are different between the HP 48GX and HP 48SX, but they perform the same function:

HP 48GX	HP 48SX	Description
[→] [LIBRARY]	[←] [LIBRARY]	Displays all libraries.
[ON]-[I/O]	[ON]-[MTH]	Performs a screen dump.
[→] [CMD]	[→] [VISIT]	Displays an item if it is wide for the screen.

Installing and Removing a Card

The HP 48GX and HP 48SX have two ports for installing PocketProfessional plug-in cards. A card can be installed in either port.

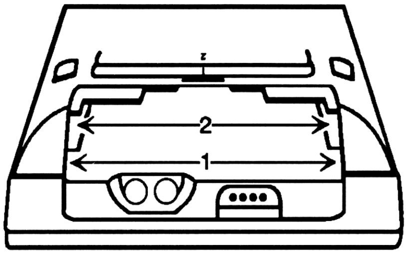
> **Warning: Turn off the HP 48 before installing or removing a card! Otherwise, user memory may be erased.**

Installing a Card

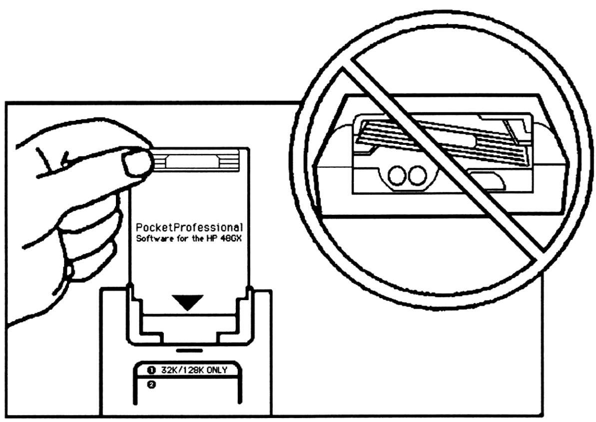
To install a card, follow these steps:

❶ Press [→] [OFF] to turn the HP 48 off. Do not turn it on until you have completed the installation procedure.

❷ Remove the port cover. Press against the grip lines and push forward. Lift the cover to expose the two plug-in ports, as shown below:



❸ Select either empty port for the card, and position the card just outside the slot. (HP 48GX users will find that placing the card in Port 1 gives optimal performance.) Point the triangular arrow on the card toward the HP 48 port opening, as shown below:



❹ Slide the card firmly into the slot. After you first feel resistance, push the card about 5-6 mm (about 1/4 inch) further, until it is fully seated.

❺ Replace the port cover. Press [ON] to turn the HP 48 on.

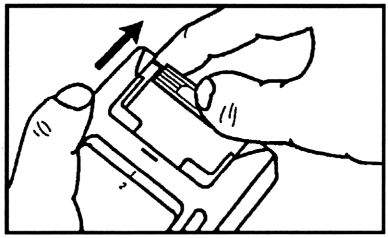
Removing a Card

To remove a card, follow these steps:

❶ Press [⮫] [OFF] to turn the HP 48 off. Do not turn it on until you have completed the removal procedure.

❷ Remove the port cover. Press against the grip lines and push forward. Lift the cover to expose the two plug-in ports, as shown above.

❸ Press against the card's grip and slide the card out of the port, as shown:



❹ Replace the port cover. Press ON to turn the HP 48 on.

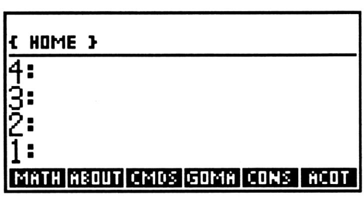
Starting Math•*Pro*

To start Math•*Pro*, follow these steps:

❶ Install the card as described above and press ON to turn the HP 48 on.

❷ HP 48GX users: Press ↱ LIBRARY to display the available libraries.
HP 48SX users: Press ↰ LIBRARY to display the available libraries.

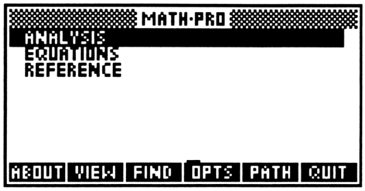
❸ Find and press MATH to display the Math•*Pro* library menu.



❹ Press MATH to start Math•*Pro*, or press ABOUT to display product information and the current revision of Math•*Pro*. The other menu keys in the Math•*Pro* library menu are covered in Chapter 31, "Programmable Commands."

Using the Home Screen

The home screen appears when you start Math•*Pro*.



The home screen lists the three major sections of Math•*Pro*: Analysis, Equations, and Reference. A section is selected by moving the highlight bar up or down (▲ or ▼) to the desired section and pressing ENTER or ►.

To move back to a previous screen at any time, press ◄ or UP. To return to the home screen at any time, press ↱ HOME or HOME.

ABOUT Displays product information and current revision of Math•*Pro*.

VIEW Displays the highlighted item in a text view. This is useful if the screen is displayed in the large font and the item scrolls off the right side of the screen with "..." (an ellipsis) displayed.

FIND Searches for the specified character or string. To perform a search, enter a letter or string of letters of the desired word or sequence and press ENTER. FIND only searches the current screen for a match.

OPTS Displays the options menu. See the next section, "Options Menu."

PATH Displays screens chosen to reach the current screen. After pressing this key, you will see the path listing in the title bar of the screen. Press →STK to place this path list on the stack.

QUIT Quits Math•*Pro* and returns to the HP 48 stack.

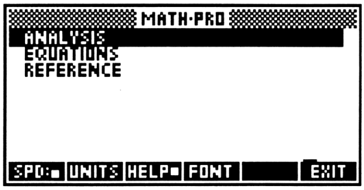
At screens other than the home screen, two new menu keys may appear:

HOME Goes to the home screen.

UP Goes to the previous screen.

Options Menu

The options menu helps you customize settings and is available throughout Math•*Pro*. Pressing OPTS displays the following menu keys:



SPD:▪ Changes the scrolling speed of the highlight bar. The bar on the right shows the current level of speed: a tall bar indicates fast scrolling speed, while a short bar indicates slow scrolling speed.

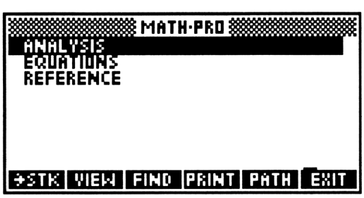
UNITS Toggles units on or off. When the block inside the key appears (UNIT▪), units are turned on.

HELP Toggles display of help text on the bottom of the screen. When the block inside the key appears (HELP▪), help is turned on.

FONT Toggles font size between large and small. The default setting is the small font, which displays information in condensed, uppercase letters only. The large font displays information in a larger, case-sensitive font.

EXIT Leaves the options menu. Returns to the regular menu.

At the options menu, press [NXT] to display the following additional menu keys:



→STK Copies one or all of the items shown to the HP 48 stack. Pressing this key prompts you for ONE or ALL.

VIEW Displays the highlighted item in a text view. This is useful if the screen is displayed in the large font and the item scrolls off the right side of the screen with "..." (an ellipsis) displayed.

FIND Searches for the specified character or string. To perform a search, enter a letter or string of letters of the desired word or sequence and press ENTER. FIND only searches the current screen for a match.

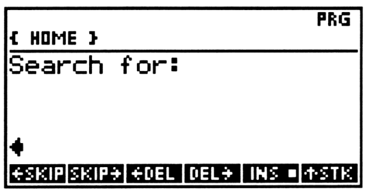
PRINT Prints one or all of the items shown to an HP 48 printer.

PATH Displays screens chosen to reach the current screen. After pressing this key, you will see the path listing in the title bar of the screen. Press →STK to place this path list on the stack.

EXIT Leaves the options menu. Returns to the regular menu.

Using the Find Option

To initiate a search, press FIND to display the following screen:

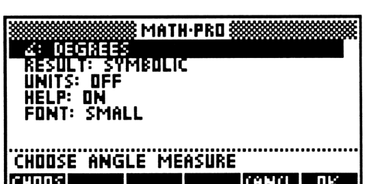


The HP 48 is now ready to search for the information entered at the command line. The calculator is already locked in Alpha entry mode, which activates the capital letters printed to the lower right of selected keys.

To perform a search, enter a letter or string of letters of the desired word or sequence and press ENTER. The search function is not case-sensitive. FIND then searches the current screen for a match. To abort the search, press ON. To repeat the search, press the FIND key again and the last search word will be displayed. Press the ENTER key to renew the search.

Custom Settings Screen

The custom settings screen is displayed by pressing CST and is available throughout Math•*Pro*.



To change any of these settings, move the highlight bar to the desired item and press CHOOS or +/-. Then press OK to implement the changes, or to exit the screen without changing the settings, press CANCL or ON.

Settings Descriptions

- ∠: *Angle measure*: Press CHOOS to select degrees, radians, or grads. Determines how trigonometric/hyperbolic functions will interpret inputs.
- **RESULT:** *Result mode*: Press CHOOS to select symbolic or numeric. Determines whether functions will return symbolic or numeric results.
- **UNITS:** *Units*: Press CHOOS to select on or off. Determines whether units are on or off for Equations and Reference.
- **HELP:** *Help text*: Press CHOOS to select on or off. Determines whether context-sensitive help text is displayed on the screen.
- **FONT:** *Font size*: Press CHOOS to select on or off. Determines whether screens use the large or small font to display items.

Memory Requirements

Approximately 5K bytes free memory is needed for optimal use of Math•*Pro*, although complicated operations may require more memory. If Math•*Pro* seems to be functioning incorrectly, low memory may be the cause. For more information about free memory, see your HP 48 manual.

Home Screen Key Summary

Key	Action
ABOUT	Displays product information and current revision.
VIEW	Displays the highlighted item in a text view.
FIND	Searches for the specified character or string.
OPTS	Displays the options menu.
PATH	Displays screens chosen to reach the current screen.
QUIT	Quits Math•*Pro* and returns to the HP 48 stack.
HOME	Goes to the home screen.
UP	Goes to the previous screen.

Key	Action
[▲] or [▼]	Moves the highlight bar up or down one item.
[←][▲] or [←][▼]	Moves the highlight bar to top or bottom of screen.
[→][▲] or [→][▼]	Moves the highlight bar to top or bottom of list.
[◄] or [←][UP]	Goes to the previous screen.
[→][◄] or [→][HOME]	Goes to the home screen.
[ENTER] or [►]	Enters the highlighted section.
[NXT] or [←][PREV]	Goes to the next or previous menu row (if appropriate).
[CST]	Goes to the custom settings screen.
[←][CST] or [→][CST]	Goes to the first or second page of the options menu.
[→][CMD]	HP 48GX: Displays the highlighted item in a text view.
[→][VISIT]	HP 48SX: Displays the highlighted item in a text view.
[ON]	Quits Math•*Pro* to the HP 48 stack.

Options Menu Key Summary

Key	Action
SPD:■	Changes the scrolling speed of the highlight bar.
UNIT▪	Toggles units on or off.
HELP▪	Toggles display of help text at the bottom of the screen.
FONT	Toggles font size between large and small.
→STK	Copies one or all of the items shown to the HP 48 stack.
VIEW	Displays the highlighted item in a text view.
FIND	Searches for the specified character or string.
PRINT	Prints one or all of the items shown to an HP 48 printer.
PATH	Displays screens chosen to reach the current screen.
EXIT	Leaves the options menu.

Part 1

Analysis

Chapter 2

Analysis Tutorial

Math•*Pro* is divided into three major sections: Analysis, Equations, and Reference. This chapter addresses the Analysis section, which includes analysis routines covering algebraic functions, arithmetic functions, curve fitting functions, hyperbolic functions, integration functions, special functions and trigonometric functions.

The analysis routines are indispensable tools for performing quick calculations. You can find roots of a polynomial, determine the prime factors of a number, fit points to a curve, calculate hyperbolic or trigonometric functions, approximate definite integrals—all with context-sensitive help.

This chapter is a tutorial designed to introduce you to the analysis routines, show you the keys available at each screen, and provide numerous examples to help you learn to efficiently use the analysis routines.

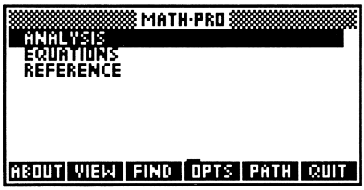
This chapter covers:

- ❑ Finding Analysis
- ❑ Analysis Screens
- ❑ Options Menu
- ❑ Custom Settings Screen
- ❑ Analysis Screen Key Summary
- ❑ Options Menu Key Summary

Finding Analysis

The Analysis section is found at the home screen of Math•*Pro*. To get there, first install Math•*Pro* as described in Chapter 1, "Getting Started." Then, to start Math•*Pro*:

- ❑ HP 48GX users: Press [→] [LIBRARY] MATH MATH.
- ❑ HP 48SX users: Press [←] [LIBRARY] MATH MATH.

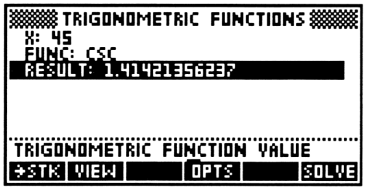


This is the home screen. To return here at any time, press [→] [HOME] or [→] [◄]. Move the highlight bar to Analysis and press [ENTER] or [►] to select that section.

Analysis Screens

Math•*Pro* is structured with screens to choose a specific topic or item. The screen now displays Analysis as its title, and lists selections, as shown in the screen below. Pressing [ENTER] or [►] selects the category of your choice. Pressing [◄] or UP returns you to the previous screen, or HOME returns you to the home screen.

Example: *Calculate a trigonometric function.* What is the cosecant of 45°? The answer can be found in the Trigonometric Functions section. Move the highlight bar to Trigonometric Functions and press [ENTER] or [►].



The X field is an *edit field*, so type 45 and press ENTER to enter 45° as the value of X. The highlight bar will automatically move to the next field. (Note: Press CST if you need to set the angle measurement to degrees.)

The FUNC field is a *choose field*, so press CHOOS to display a list of the possible choices for the field. Scroll down to CSC and press OK or ENTER to select cosecant as the function to use. (Instead of pressing CHOOS, you can also press +/- to toggle through all the possible choices.)

The RESULT field is a *result field* and will contain the result of the analysis routine. Press SOLVE to perform the calculation, and the result 1.41421356237 will appear in the RESULT field.

Field Types

Analysis screens use three basic types of fields.

When the highlight bar has selected a particular field type, the menu keys will change to reflect operations specific to that type of field, as described below. OPTS and SOLVE are always present, regardless of the field type.

- **Edit Fields:** These fields accept values entered from the keyboard. In the above example, the X field is an example of an edit field.

  Edit field menu: EDIT, STACK, OPTS, TYPES and SOLVE.

- **Choose Fields:** These fields accept one of a pre-defined list of possible choices. In the above example, the FUNC field is an example of a choose field.

  Choose field menu: CHOOS, OPTS and SOLVE.

- **Result Fields:** These fields display the result of a calculation. In the above example, the RESULT field is an example of a result field. (Note: A result field is often labeled RESULT, but not always.)

  Result field menu: →STK, VIEW, OPTS and SOLVE.

Analysis Screen Menu Keys

These are descriptions of the various menu keys available at an Analysis screen:

OPTS (All fields) Displays the options menu. For more information, see "Options Menu."

SOLVE (All fields) Performs a calculation using the displayed values. The result is displayed in the result field.

EDIT (Edit fields only) Edits the highlighted item for an edit field. Press [ENTER] to save edit changes or [ON] to cancel editing.

STACK (Edit fields only) Copies the highlighted item to the HP 48 stack and temporarily goes to the HP 48 stack environment. While at the stack, you can use all the normal built-in functions of your HP 48 to manipulate or change the copied item. When you have finished editing the item, press **OK** to leave the stack and insert the edited item into the current edit field, or press **CANCL** to leave the stack without changing the value of the current edit field.

TYPES (Edit fields only) Displays the allowed object types for an edit field. Press **CANCL** to return to the analysis screen, or scroll down to a type and press **OK** or [ENTER] to start a new item of that type and insert the appropriate delimiters for that type on the command line.

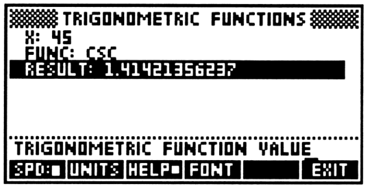
CHOOS (Choose fields only) Displays the possible choices for a choose field. Highlight the desired value and press [ENTER] or **OK**, or press **CANCL** to abort the selection.

→STK (Result fields only) Copies one or all of the items shown to the HP 48 stack. For more information, see "Options Menu."

VIEW (Result fields only) Displays the highlighted item in a text view. For more information, see "Options Menu."

Options Menu

The options menu helps you customize settings and is available throughout Math•*Pro*. Pressing **OPTS** displays the following menu keys:



SPD:■ Changes the scrolling speed of the highlight bar. The bar on the right shows the current level of speed: a tall bar indicates fast scrolling speed, while a short bar indicates slow scrolling speed.

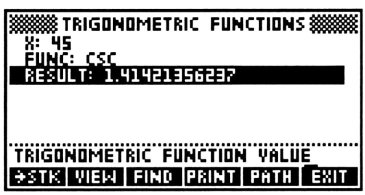
UNITS Toggles units on or off. When the block inside the key appears (**UNIT■**), units are turned on.

HELP Toggles display of help text on the bottom of the screen. When the block inside the key appears (**HELP■**), help is turned on.

FONT Toggles font size between large and small. The large font is case-sensitive, while the small font contains condensed, uppercase letters.

EXIT Leaves the options menu. Returns to the regular menu.

At the options menu, press [NXT] to display the following additional menu keys:



→STK Copies one or all of the items shown to the HP 48 stack. Pressing this key prompts you for **ONE** or **ALL**.

VIEW Displays the highlighted item in a text view. This is useful if the screen is displayed in the large font and the item scrolls off the right side of the screen with "..." (an ellipsis) displayed. Press [⬅] or [➡] **VIEW** to display the highlighted item in a graphics view.

FIND Searches for the specified character or string. **FIND** only searches the current screen for a match.

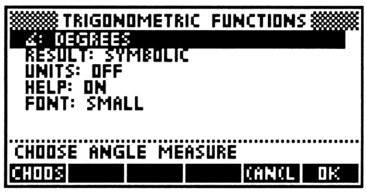
PRINT Prints one or all of the items shown to an HP 48 printer.

PATH Displays screens chosen to reach the current screen. After pressing this key, you will see the path listing in the title bar of the screen. Press **→STK** to place this path list on the stack.

EXIT Leaves the options menu. Returns to the regular menu.

Custom Settings Screen

The custom settings screen is displayed by pressing [CST] and is available throughout Math•*Pro*.



To change any of these settings, move the highlight bar to the desired item and press **CHOOS** or [+/-]. Then press **OK** to implement the changes, or to exit the screen without changing the settings, press **CANCL** or [ON].

Settings Descriptions

- ❑ ∠: *Angle measure*: Press **CHOOS** to select degrees, radians, or grads. Determines how trigonometric/hyperbolic functions will interpret inputs.
- ❑ **RESULT:** *Result mode*: Press **CHOOS** to select symbolic or numeric. Determines whether functions will return symbolic or numeric results.
- ❑ **UNITS:** *Units*: Press **CHOOS** to select on or off. Determines whether units are on or off for Equations and Reference.
- ❑ **HELP:** *Help text*: Press **CHOOS** to select on or off. Determines whether context-sensitive help text is displayed on the screen.
- ❑ **FONT:** *Font size*: Press **CHOOS** to select on or off. Determines whether screens use the large or small font to display items.

Analysis Screen Key Summary

Key	Action
OPTS	Displays the options menu.
SOLVE	Performs a calculation using the displayed values.
EDIT	Edits the highlighted item for an edit field.
STACK	Copies the highlighted item to the HP 48 stack and temporarily goes to the HP 48 stack environment.
TYPES	Displays the allowed object types for an edit field.
CHOOS	Displays the possible choices for a choose field.
→STK	Copies one or all of the items shown to the HP 48 stack.
VIEW	Displays the highlighted item in a text view. Press ↱ or ↰ VIEW to show the item in a graphics view.

Key	Action
▲ or ▼	Moves the highlight bar up or down one item.
↰ ▲ or ↰ ▼	Moves the highlight bar to top or bottom of screen.
↱ ▲ or ↱ ▼	Moves the highlight bar to top or bottom of list.
◄ or ↰ UP	Goes to the previous screen.
↱ ◄ or ↱ HOME	Goes to the home screen.
ENTER or ►	Enters the highlighted section (for a screen). Edits the highlighted item (for an edit field). Displays the possible choices (for a choose field). Copies item(s) shown to the stack (for a result field).
NXT or ↰ PREV	Goes to the next or previous menu row (if appropriate).
CST	Goes to the custom settings screen.
↰ CST or ↱ CST	Goes to the first or second page of the options menu.
↱ CMD	HP 48GX: Displays the highlighted item in a text view.
↱ VISIT	HP 48SX: Displays the highlighted item in a text view.
ON	Quits Math•*Pro* to the HP 48 stack.

Options Menu Key Summary

Key	Action
SPD:▪	Changes the scrolling speed of the highlight bar.
UNIT▪	Toggles units on or off.
HELP▪	Toggles display of help text at the bottom of the screen.
FONT	Toggles font size between large and small.
→STK	Copies one or all of the items shown to the HP 48 stack.
VIEW	Displays the highlighted item in a text view. Press ⮫ or ⮨ VIEW to show the item in a graphics view.
FIND	Searches for the specified character or string.
PRINT	Prints one or all of the items shown to an HP 48 printer.
PATH	Displays screens chosen to reach the current screen.
EXIT	Leaves the options menu.

Chapter 3

Algebraic Functions

This chapter covers the Analysis section on Algebraic Functions:

- ❑ Delta Function
- ❑ Partial Fraction Expansion
- ❑ Piecewise Functions
- ❑ Polynomial Coefficients
- ❑ Polynomial Equation
- ❑ Polynomial Roots
- ❑ Symbolic Simplification
- ❑ Taylor Polynomial

Finding Algebraic Functions

To find Algebraic Functions, install Math•*Pro* and do the following:

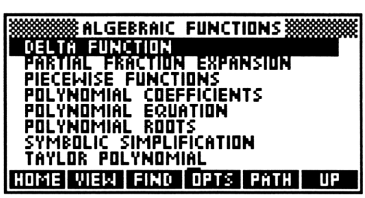
❶ HP 48GX users: Press [↱] [LIBRARY] to display available libraries.
HP 48SX users: Press [↰] [LIBRARY] to display available libraries.

❷ Press MATH to display the Math•*Pro* library menu.

❸ Press MATH to start Math•*Pro* and show the home screen.

❹ Move the highlight bar to Analysis and press [ENTER] or [►].

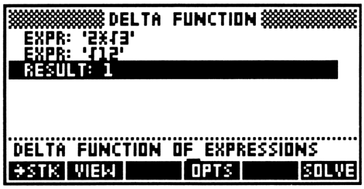
❺ Move the highlight bar to Algebraic Functions and press [ENTER] or [►].



❻ Move the highlight bar to the desired section and press [ENTER] or [►]. Then skip to the appropriate section below.

Delta Function

The delta function δ(F,G) compares two expressions and returns a 0 if they are different and a 1 if they are the same. When algebraic expressions are used in symbolic results mode, the == sign may appear in the result if the expressions cannot be completely evaluated.



Example: Compare the expressions 2√3 and √12. Type 2 [*] [√x] 3 and [√x] 12 for the two expressions. (Note: Press [CST] if you need to set the results mode to numeric.) Press SOLVE. The result is 1, which means they are the same.

Field Descriptions

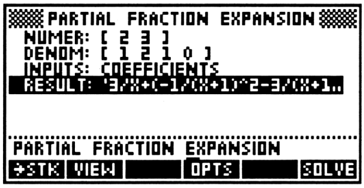
- **EXPR:** *Expression*: Real number, complex number, global name, algebraic or unit.
- **EXPR:** *Expression*: Real number, complex number, global name, algebraic or unit.
- **RESULT:** *Delta function*: 0 or 1. If algebraic expressions are used, the result may be an algebraic expression of the form 'expr1==expr2'.

Partial Fraction Expansion

The partial fraction expansion function separates a rational function of the form $f(x)/g(x)$ by splitting it into a sum of fractions with simpler denominators.

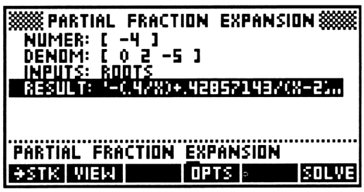
Example: *Coefficients format*. What is the partial fraction expansion of the rational function $\frac{2x+3}{x^3+2x^2+x}$?

Type the coefficients [2 3] for the numerator and [1 2 1 0] for the denominator. Press SOLVE. The result is shown below:

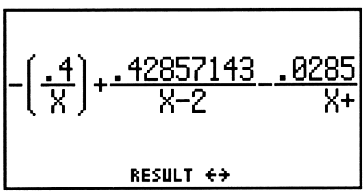


Example: *Roots format.* What is the partial fraction expansion of the rational function $\dfrac{x+4}{x(x-2)(x+5)}$?

Move the highlight bar to the INPUTS field and press [+/-] to select roots as the input type instead of coefficients. Type the roots [-4] for the numerator and [0 2 -5] for the denominator. Press SOLVE. The result is shown below:



Move the highlight bar to the RESULT field and press [◄] or [►] VIEW to display the equation in a graphics view.



Press [◄] and [►] to scroll the equation.

Field Descriptions

❑ **NUMER:** *Numerator coefficients or roots*: Real [1 2] or complex [(1,1) (2,2)] array.

❑ **DENOM:** *Denominator coefficients or roots*: Real [1 2] or complex [(1,1) (2,2)] array.

❑ **INPUTS:** *Form of numerator and denominator*: Press CHOOS to select Coefficients or Roots. Determines whether NUMER and DENOM are interpreted as coefficients or roots.

❑ **RESULT:** *Partial fraction expansion*: Algebraic.

Piecewise Functions

Piecewise functions take on different functional forms (expressions) over different regions of the independent variable:

$$f(x) = \begin{cases} \text{expression}_1 & \text{region}_1 \\ \text{expression}_2 & \text{region}_2 \end{cases}$$

The HP 48 can manipulate and plot piecewise functions if they are entered in the IFTE (If-Then-Else) format:

$$\text{f(x)} = \text{IFTE(region}_1\text{, expression}_1\text{, expression}_2\text{)}$$

Math•*Pro* enables you to easily enter a piecewise function as one or more *terms*, where each term is specified by two fields: one for the expression (EXPR) and the other for the corresponding region (REGION). Then, Math•*Pro* will generate the appropriate IFTE representation of the piecewise function.

Entry Rules

❶ Use == in place of =. The HP 48 uses the = operator only for assigning variables, while the == command is used to check for equality. Therefore, the region X=0 should be entered as 'X==0'. The most common operators used in regions are found in the TEST menu: ==, ≠, <, >, ≤ and ≥.

❷ To make a section of a piecewise function undefined, enter Undefined as the expression for the term, along with the corresponding region. An Undefined term will automatically be appended to complete all one-term piecewise functions. (Note: Undefined is simply a global name that presumably does not exist in user memory and will therefore remain unevaluated when plotting.)

❸ Always specify terms in the function in order of increasing regions. For example, specify the term for the region X<-3 before the term for the region X<3. This is because the HP 48 will not properly evaluate expression like '-3<X<3', so this region must be entered as 'X<3'. However, this would incorrectly imply that the corresponding expression should be used for all values of X<3, so you must have first entered a term for the region X≤-3.

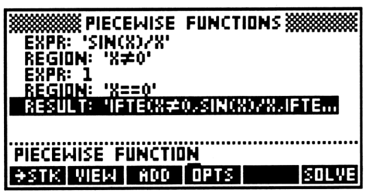
❹ For regions like X = 2,3 the entry must be split into two separate terms because the HP 48 will not recognize an expression like 'X==2,3'. Therefore, enter the same expression twice, for two different regions: 'X==2' and 'X==3'.

Example: Define the piecewise function $f(x)=\begin{cases} \sin(x)/x & x \neq 0 \\ 1 & x = 0 \end{cases}$

This will require two terms. The first term consists of the expression 'SIN(X)/X' and the region 'X≠0'. Enter these into the EXPR and REGION fields. The key sequence for typing in 'X≠0' is: ['] [α] X [PRG] TEST ≠ 0 [ENTER].

The second term consists of the expression 1 and the region 'X==0'. Press ADD to create new EXPR and REGION fields for this term and enter the values as shown.

Press SOLVE to get the result:



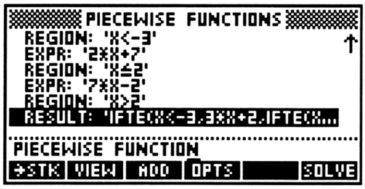
Example: Define the piecewise function: $f(x)=\begin{cases} 3x+2 & x<-3 \\ 2x+7 & -3 \leq x \leq 2 \\ 7x-2 & x>2 \end{cases}$

This will require three terms. The first term consists of the expression '3*X+2' and the region 'X<-3'. Enter this information into the fields for expression and region.

The second term consists of the expression '2*X+7' and the region 'X≤2'. Press ADD to create new EXPR and REGION fields for this term and enter the values as shown.

The third term consists of the expression '7*X-2' and the region 'X>2'. Press ADD to create new EXPR and REGION fields for this term and enter the values as shown.

Press SOLVE to get the result:



Field Descriptions

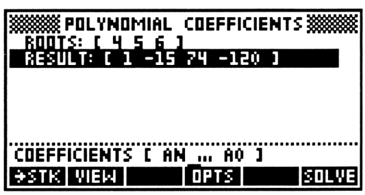
❑ **EXPR:** *Expression*: Real number, complex number, global name, algebraic or unit.

❑ **REGION:** *Region of validity*: Real number, global name or algebraic.

❑ **RESULT:** *Piecewise function*: Algebraic.

Polynomial Coefficients

The polynomial coefficients function takes the roots (real or complex) of a polynomial and returns the coefficients (real or complex) of the polynomial.



Example: What are the coefficients of the polynomial that has the roots 4, 5, and 6? (What equation results when (x-4), (x-5), and (x-6) are multiplied?) Type in [4 5 6] for the roots. Press SOLVE. The result is [1 -15 74 -120], which means the polynomial is $x^3 - 15x^2 + 74x - 120$.

Field Descriptions

❑ **ROOTS:** *Polynomial roots*: Real [1 2] or complex [(1,1) (2,2)] array.

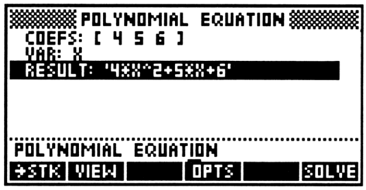
❑ **RESULT:** *Polynomial coefficients*: Real or complex array.

Notes

Round-off error limits the accuracy of coefficients returned by the polynomial coefficients function, so the coefficients are automatically rounded to 8 digit accuracy.

Polynomial Equation

The polynomial equation function takes the coefficients (real or complex) of a polynomial and returns the polynomial as an algebraic expression. The coefficients must be entered in descending order, as in: [AN … A2 A1 A0], which represents the equation 'AN*X^N+ ... +A2*X^2 +A1*X +A0'.



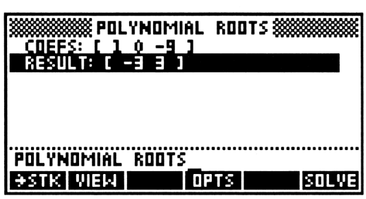
Example: The coefficients (in descending order) of an equation are 4, 5, and 6. Enter [4 5 6] as the coefficients. Press SOLVE. The result is '4*X^2+5*X+6'.

Field Descriptions

- ❑ **COEFS:** *Polynomial coefficients*: Real [1 2] or complex array [(1,1)].
- ❑ **VAR:** *Variable*: Global name.
- ❑ **RESULT:** *Polynomial equation*: algebraic.

Polynomial Roots

The polynomial roots function takes the coefficients (real or complex) of a polynomial and returns the roots of that polynomial.



Example: What are the roots of the polynomial $x^2 - 9 = 0$? Type in [1 0 -9] in COEFS. Press SOLVE. The result is [-3 3], which means the polynomial has the two roots 3 and -3.

Field Descriptions

- ❑ **COEFS:** *Polynomial coefficients*: Real [1 2] or complex array [(1,1)].

- ❑ **RESULT:** *Polynomial roots*: Real or complex array.

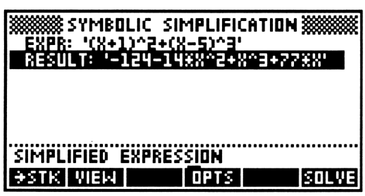
Notes

Round-off error limits the accuracy of roots returned by the polynomial roots function, so the roots are automatically rounded to 8 digit accuracy. To improve the accuracy of a particular root, use the built-in HP 48 solver to solve the original polynomial equation for 'X', using the value of the desired root returned by the polynomial roots function as a guess.

The polynomial roots function is based on a routine developed by Wayne Scott, using the Bairstow algorithm for finding quadratic factors.

Symbolic Simplification

The symbolic simplification function returns the simplified form of an expression.



Example: Simplify the expression $(x+1)^2+(x-5)^3$. Enter '(X+1)^2+(X-5)^3' as the expression. Press SOLVE. The result is $x^3-14x^2+77x-124$.

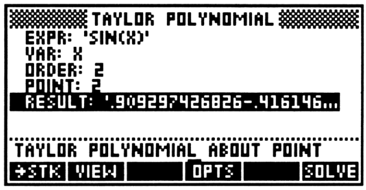
Field Descriptions

- ❑ **EXPR:** *Expression*: Real number, complex number, global name or algebraic.

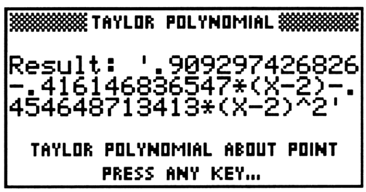
- ❑ **RESULT:** *Simplified expression*: Real number, complex number, global name, or algebraic.

Taylor Polynomial

The Taylor polynomial function computes the Taylor polynomial of a function to the specified order about a given point.



Example: What is the 2nd-order Taylor polynomial of 'SIN(X)' about the point x=2? Enter 'SIN(X)' for the expression, X for the variable, 2 for the order and 2 for the point. (Note: Press CST if you need to set the angle measure to radians.) Press SOLVE. Press VIEW to display the result in a text view:



Field Descriptions

- ❑ **EXPR:** *Expression*: Global name or algebraic.
- ❑ **VAR:** *Variable*: Global name.
- ❑ **ORDER:** *Order of Taylor polynomial*: Real number.
- ❑ **POINT:** *Point about which to expand*: Real number, complex number or global name.
- ❑ **RESULT:** *Taylor polynomial*: Algebraic.

Chapter 4

Arithmetic Functions

This chapter covers the Analysis section on Arithmetic Functions:

- ❑ Closest Fraction
- ❑ Greatest Common Divisor
- ❑ Least Common Multiple
- ❑ Logarithm, Any Base
- ❑ Nth Roots of a Number
- ❑ Prime Factorization
- ❑ Reduce Fraction

Finding Arithmetic Functions

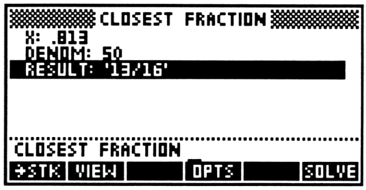
To find Arithmetic Functions, install Math•*Pro* and do the following:

❶ HP 48GX users: Press ⮫ LIBRARY to display available libraries.
HP 48SX users: Press ⮨ LIBRARY to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Analysis and press ENTER or ►.
❺ Move the highlight bar to Arithmetic Functions and press ENTER or ►.

❻ Move the highlight bar to the desired section and press ENTER or ►.
Then skip to the appropriate section below.

Closest Fraction

The closest fraction function converts a rational or irrational expression to the closest fraction equivalent given a maximum denominator.



Example: What is the closest fraction to .813 with a maximum denominator of 50? Type in .813 for X and 50 for the denominator. Press SOLVE. The result is '13/16'.

Field Descriptions

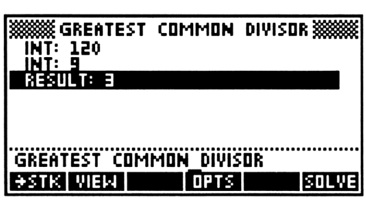
- ❑ **X:** *Value*: Real number, complex number, list, global name, algebraic or unit.
- ❑ **DENOM:** *Maximum denominator*: Integer greater than zero, global name or algebraic.
- ❑ **RESULT:** *Closest fraction*: Algebraic.

Notes

The closest fraction function is based on a routine developed by Joseph Horn.

Greatest Common Divisor

The greatest common divisor function produces the greatest common divisor of two integers.



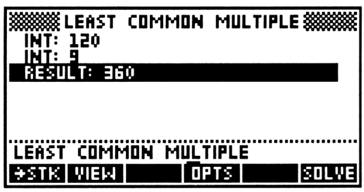
Example: What is the greatest common divisor of 120 and 9? Type in 120 for the first integer and 9 for the second. Press SOLVE.

Field Descriptions

- ❑ **INT:** *Value*: Integer, global name or algebraic.
- ❑ **INT:** *Value*: Integer, global name or algebraic.
- ❑ **RESULT:** *Greatest common divisor*: Integer.

Least Common Multiple

The least common multiple function produces the least common multiple of two integers.



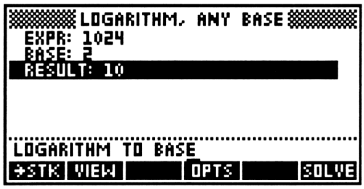
Example: What is the least common multiple of 120 and 9? Type in 120 for the first integer and 9 for the second. Press SOLVE.

Field Descriptions

- ❑ **INT:** *Value*: Integer $\neq 0$, global name or algebraic.
- ❑ **INT:** *Value*: Integer $\neq 0$, global name or algebraic.
- ❑ **RESULT:** *Least common multiple*: Integer.

Logarithm, Any Base

The logarithm (any base) function produces the logarithm of a function to any specified base: $\log_{BASE}(EXPR) = RESULT$.



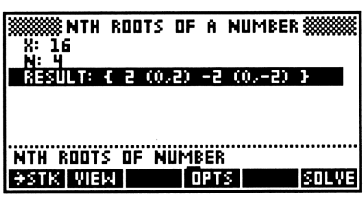
Example: What is the logarithm of 1024 in base 2? Type in 1024 for the expression and 2 for the base. Press SOLVE. The result is 10, which means $2^{10} = 1024$.

Field Descriptions

- ❑ **EXPR:** *Expression*: Real number, complex number, global name or algebraic.
- ❑ **BASE:** *Base*: Real number, complex number, global name or algebraic.
- ❑ **RESULT:** *Logarithm in specified base*: Real number, complex number or algebraic.

Nth Roots of a Number

The nth roots of a number function produces the *n* *n*th roots of a real or complex number. An *n*th root of a number is a root which, when raised to the nth power, returns the original number: an *n*th root = $x^{1/n}$. The nth roots will be returned as a list of n items.



Example: What are the four 4th roots of 16? (What are the four numbers, which when raised to the 4th power, return 16?) Type in 16 for X and 4 for N. Press SOLVE. The results are { (2,0) (0,2) (-2,0) (0,-2) }, which means that $2^4 = 2i^4 = -2^4 = -2i^4 = 16$.

Field Descriptions

- ❑ **X:** *Value*: Real number or complex number.

❑ **N:** *Value*: Integer greater than zero.

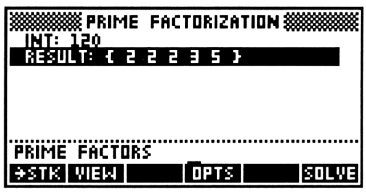
❑ **RESULT:** *N* n*th roots of X*: List.

Notes

Round-off error limits the accuracy of roots returned by the *n*th roots function, so the roots are automatically rounded to 10 digit accuracy.

Prime Factorization

The prime factorization function returns the prime factors of an integer, in a list. The number 1 is not considered a prime factor.



Example: What are the prime factors of 120? Type in 120 as the integer. Press SOLVE. The results are { 2 2 2 3 5 }, which means that 2 x 2 x 2 x 3 x 5 = 120.

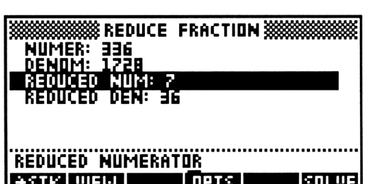
Field Descriptions

❑ **INT:** *Integer*: Integer greater than zero.

❑ **RESULT:** *Prime factorization*: List.

Reduce Fraction

The reduce fraction function reduces a fraction numerator and denominator to lowest terms.



Example: Reduce 336 / 1728. Type in 336 for the numerator and 1728 for the denominator. Press SOLVE. The results are 7 and 36, which means that 336/1728 reduces to 7/36.

Field Descriptions

- ❑ **NUMER:** *Numerator*: Integer.
- ❑ **DENOM:** *Denominator*: Integer ≠ 0.
- ❑ **REDUCED NUM:** *Reduced numerator*: Integer.
- ❑ **REDUCED DEN:** *Reduced denominator*: Integer.

Chapter 5

Curve Fitting Functions

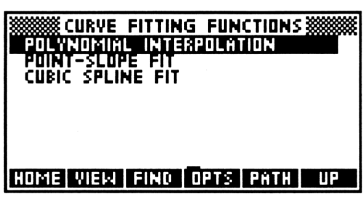
This chapter covers the Analysis section on Curve Fitting Functions:

- ❑ Polynomial Interpolation
- ❑ Point-Slope Fit
- ❑ Cubic Spline Fit

Finding Curve Fitting Functions

To find Curve Fitting Functions, install Math•*Pro* and do the following:

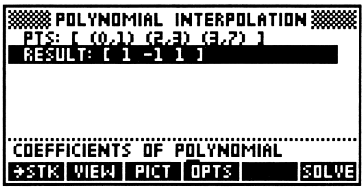
❶ HP 48GX users: Press [↱] [LIBRARY] to display available libraries.
HP 48SX users: Press [↰] [LIBRARY] to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Analysis and press [ENTER] or [►].
❺ Move the highlight bar to Curve Fitting Functions and press [ENTER] or [►].



❻ Move the highlight bar to the desired section and press [ENTER] or [►].
Then skip to the appropriate section below.

Polynomial Interpolation

The polynomial interpolation function produces the coefficients of a polynomial which connects an arbitrarily large number of input points. The order of the polynomial produced may be as high as one less than the total number of input points. There must be at least two input points, but there is no upper limit on the number of points. The points are entered as a complex array.



Example: What is the polynomial which connects the points: (0,1), (2,3), and (3,7)? Enter the complex array [(0,1) (2,3) (3,7)] for the points. Press SOLVE. The result is [1 -1 1], which means the polynomial is $x^2 - x + 1$.

Field Descriptions

- ❑ **PTS:** *Points*: Complex [(1,1) (2,2)] array.

- ❑ **RESULT:** *Coefficients of interpolating polynomial*: Real [1 2] or complex [(1,1) (2,2)] array.

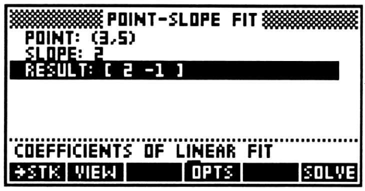
Notes

Round-off error limits the accuracy of coefficients returned by the polynomial interpolation function, so the coefficients are automatically rounded to 10 digit accuracy.

The polynomial interpolation function is based on an algorithm in Press, Flannery, Teukolsky, and Vetterling, *Numerical Recipes in C*, Cambridge University Press, Cambridge, 1989, §3.5.

Point-Slope Fit

The point-slope fit function produces the coefficients of a linear function whose graph passes through a given point on a line with a given slope at that point.



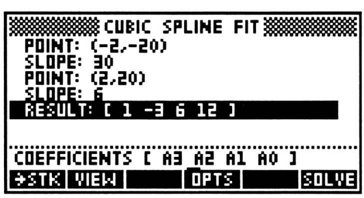
Example: What is the equation of the line that passes through the point (3,5) with a slope of 2? Enter (3,5) for the point and 2 for the slope. Press SOLVE. The result is [2 -1], which means the line is $2x-1$.

Field Descriptions

- **POINT:** *Point on line*: Complex number.
- **SLOPE:** *Slope at point*: Real number.
- **RESULT:** *Coefficients of linear fit*: Real [1 2] array.

Cubic Spline Fit

The cubic spline fit function produces the coefficients of a cubic function (also known as a cubic spline) whose graph passes through two given points with given slopes at those points.



Example: What cubic equation passes through the point (-2,-20) with slope 30 and the point (2,20) with slope 6? Enter (-2,-20) as the first point, 30 as the first slope, (2,20) as the second point and 6 as the second slope. Press SOLVE. The result is [1 -3 6 12], which means the cubic equation passing through those points with those slopes is $x^3-3x^2+6x+12$.

Field Descriptions

- ❑ **POINT:** *First point*: Complex number.
- ❑ **SLOPE:** *Slope at first point*: Real number.
- ❑ **POINT:** *Second point*: Complex number.
- ❑ **SLOPE:** *Slope at second point*: Real number.
- ❑ **RESULT:** *Coefficients of cubic fit*: Real [1 2] array.

Chapter 6

Hyperbolic Functions

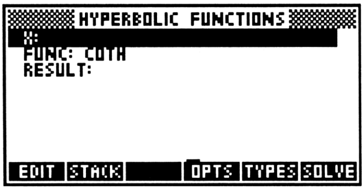
This chapter covers the Analysis section on Hyperbolic Functions:

- ❑ Hyperbolic Sine
- ❑ Hyperbolic Cosine
- ❑ Hyperbolic Tangent
- ❑ Hyperbolic Cotangent
- ❑ Hyperbolic Secant
- ❑ Hyperbolic Cosecant
- ❑ Inverse Hyperbolic Sine
- ❑ Inverse Hyperbolic Cosine
- ❑ Inverse Hyperbolic Tangent
- ❑ Inverse Hyperbolic Cotangent
- ❑ Inverse Hyperbolic Secant
- ❑ Inverse Hyperbolic Cosecant

Finding Hyperbolic Functions

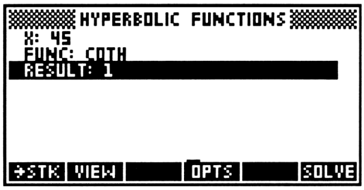
To find Hyperbolic Functions, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [→] [LIBRARY] to display available libraries.
HP 48SX users: Press [←] [LIBRARY] to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Analysis and press [ENTER] or [►].
❺ Move the highlight bar to Hyperbolic Functions and press [ENTER] or [►].



Hyperbolic Functions

This section covers the hyperbolic functions and their inverses: SINH, COSH, TANH, COTH, SECH, CSCH, ASINH, ACOSH, ATANH, ACOTH, ASECH, and ACSCH.



Example: What is the hyperbolic cotangent of 45°? Enter 45 for X and press CHOOS to select COTH. (Note: Press CST if you need to set the angle measure to degrees.) Press SOLVE. The result is 1.

Field Descriptions

- **X:** *Value*: Real number, complex number, global name or algebraic.

- **FUNC:** *Hyperbolic function*: Press CHOOS to select SINH, COSH, TANH, COTH, SECH, CSCH, ASINH, ACOSH, ATANH, ACOTH, ASECH or ACSCH. (Note: SINH, COSH, TANH, ASINH, ACOSH and ATANH are built-in functions of the HP 48, while COTH, SECH, CSCH, ACOTH, ASECH and ACSCH are new functions included in Math•*Pro*.)

- **RESULT:** *Hyperbolic function value*: Real number, complex number or algebraic.

Chapter 7

Integration Functions

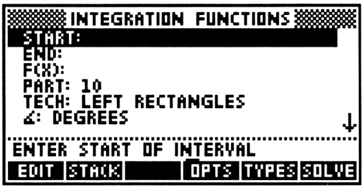
This chapter covers the Analysis section on Integration Functions:

- ❑ Left Rectangles
- ❑ Right Rectangles
- ❑ Midpoint Rectangles
- ❑ Trapezoidal Method
- ❑ Simpson's Rule

Finding Integration Functions

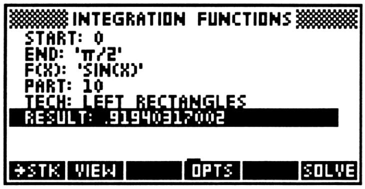
To find Integration Functions, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [→] [LIBRARY] to display available libraries.
HP 48SX users: Press [←] [LIBRARY] to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Analysis and press [ENTER] or [►].
❺ Move the highlight bar to Integration Functions and press [ENTER] or [►].



Integration Functions

The integration functions all approximate the definite integral of a function over a specified closed interval and number of partitions. The left, right, and mid-point rectangle functions are based on the Riemann lower, upper and midpoint sums, while the trapezoidal method and Simpson's rule are based on different algorithms.



Example: Approximate the area under the curve sin(x) on the interval [0,π/2] using Simpson's rule with 10 partitions. Enter 0 for the start of the interval and 'π/2' for the end of the interval. Enter 'SIN(X)' for the function and 10 for the number of partitions. Press CHOOS to select Simpson's Rule. (Note: Press CST if you need to set the angle measure to radians.) Press SOLVE. The result is 1.00000339223.

Field Descriptions

- **START:** *Interval start*: Real number, global name or algebraic.
- **END:** *Interval end*: Real number, global name or algebraic.
- **F(X):** *Function*: Real number, global name or algebraic. If an algebraic, the independent variable must be X.
- **PART:** *Number of partitions*: Integer. (Note: For Simpson's rule, the number of partitions must be an *even* integer.)
- **TECH:** *Integration technique*: Press CHOOS to select Left Rectangles, Right Rectangles, Midpoint Rectangles, Trapezoidal Method, or Simpson's Rule.
- **RESULT:** *Integral approximation*: Real number.

Chapter 8

Special Functions

This chapter covers the Analysis section on Special Functions:

- ❑ Bessel Function
- ❑ Beta Function
- ❑ Error Function
- ❑ Gamma Function

Finding Special Functions

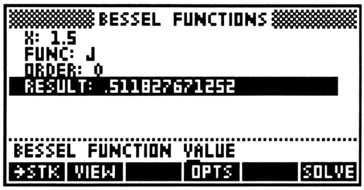
To find Special Functions, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [↱] [LIBRARY] to display available libraries.
HP 48SX users: Press [↰] [LIBRARY] to display available libraries.
❷ Press [MATH] to display the Math•*Pro* library menu.
❸ Press [MATH] to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Analysis and press [ENTER] or [►].
❺ Move the highlight bar to Special Functions and press [ENTER] or [►].

❻ Move the highlight bar to the desired section and press [ENTER] or [►].
Then skip to the appropriate section below.

Bessel Functions

The Bessel functions compute the numerical values for the Bessel functions of the first and second kind, $J_n(X)$ and $Y_n(X)$.



Example: What is the value of $J_0(1.5)$? Enter 1.5 for X, press CHOOS to select J, and enter 0 for the order. Press SOLVE. The result is .511827671252.

Field Descriptions

- ❑ **X:** *Value*: Real number, global name or algebraic.
- ❑ **FUNC:** *Bessel function type*: Press CHOOS to select J or Y.
- ❑ **ORDER:** *Bessel function order*: Integer.
- ❑ **RESULT:** *Bessel function value*: Real number.

Notes

The Bessel functions are based on algorithms in Press, William H., et al., *Numerical Recipes in C*, Cambridge University Press, Cambridge, 1989, §6.4.

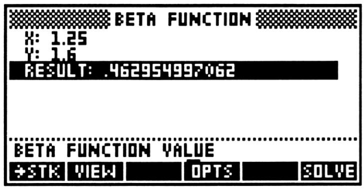
Beta Function

The beta function computes the numerical value for a beta function of two real arguments. The definition of the beta function is:

$$\beta(x,y)=\int_0^1 t^{x-1}(1-t)^{y-1}\,dt \quad x>0\ y>0$$

The beta function relates to the classical gamma function as follows:

$$\beta(x,y)=\frac{\Gamma(x)\Gamma(y)}{\Gamma(x+y)}$$



Example: What is the value of β(1.25,1.6)? Enter 1.25 for X and 1.6 for Y. Press SOLVE. The result is .462954997062.

Field Descriptions

❑ **X:** *Value*: Real number, global name or algebraic.

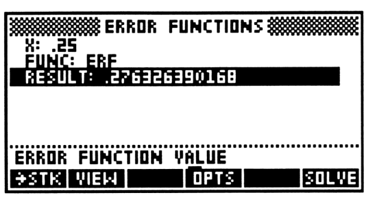
❑ **Y:** *Value*: Real number, global name or algebraic.

❑ **RESULT:** *Beta function value*: Real number.

Error Functions

The error functions compute the numerical values for the error function and complementary error functions of one real argument. The definitions of the error function and complementary error function are:

$$erf(x) = \frac{2}{\sqrt{\pi}} \int_0^x e^{-t^2} dt \qquad erfc(x) \equiv 1 - erf(x) = \frac{2}{\sqrt{\pi}} \int_x^\infty e^{-t^2} dt$$



Example: What is the value of erf(.25)? Enter .25 for X and press CHOOS to select ERF. Press SOLVE. The result is .276326390168.

Field Descriptions

❑ **X:** *Value*: Real number, global name or algebraic.

❑ **FUNC:** *Error function type*: Press CHOOS to select ERF or ERFC.

- ❑ **RESULT:** *Error function value*: Real number.

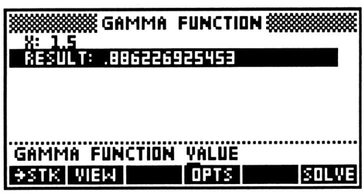
Gamma Function

This command computes the numerical value for a gamma function of one real argument. The definition of the gamma function is:

$$\Gamma(x) = \int_0^\infty t^{x-1} e^{-t} dt \quad x>0$$

The gamma function relates to the factorial function as follows:

$$\Gamma(x+1) = x!$$



Example: What is the value of $\Gamma(1.5)$? Enter 1.5 for X and press SOLVE. The result is .886226925453.

Field Descriptions

- ❑ **X:** *Value*: Real number, global name or algebraic.

- ❑ **RESULT:** *Gamma function value*: Real number.

Chapter 9

Trigonometric Functions

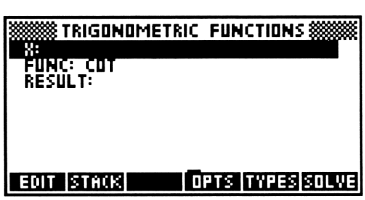
This chapter covers the Analysis section on Trigonometric Functions:

- ❑ Sine
- ❑ Cosine
- ❑ Tangent
- ❑ Cotangent
- ❑ Secant
- ❑ Cosecant
- ❑ Inverse Sine
- ❑ Inverse Cosine
- ❑ Inverse Tangent
- ❑ Inverse Cotangent
- ❑ Inverse Secant
- ❑ Inverse Cosecant

Finding Trigonometric Functions

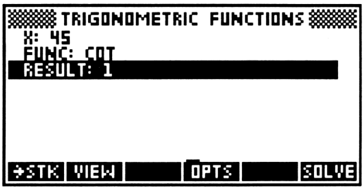
To find Trigonometric Functions, install Math•*Pro* and do the following:

❶ HP 48GX users: Press ↱ LIBRARY to display available libraries.
HP 48SX users: Press ↰ LIBRARY to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Analysis and press ENTER or ►.
❺ Move the highlight bar to Trigonometric Functions and press ENTER or ►.



Trigonometric Functions

This section covers the trigonometric functions and their inverses: SIN, COS, TAN, COT, SEC , CSC, ASIN, ACOS, ATAN, ACOT, ASEC, and ACSC.



Example: What is the cotangent of 45°? Enter 45 for X and press CHOOS to select COT. (Note: Press CST if you need to set the angle measure to degrees.) Press SOLVE. The result is 1.

Field Descriptions

- **X:** *Value*: Real number, complex number, global name or algebraic.

- **FUNC:** *Trigonometric function*: Press CHOOS to select SIN, COS, TAN, COT, SEC, CSC, ASIN, ACOS, ATAN, ACOT, ASEC or ACSC. (Note: SIN, COS, TAN, ASIN, ACOS and ATAN are built-in functions of the HP 48, while COT, SEC, CSC, ACOT, ASEC and ACSC are new functions included in Math•*Pro*.)

- **RESULT:** *Trigonometric function value*: Real number, complex number or algebraic.

Part 2

Equations

Chapter 10

Equation Tutorial

Math•*Pro* is divided into three major sections: Analysis, Equations, and Reference. This chapter addresses the Equations section, which includes an equation library covering coordinate systems, circles, triangles, polygons, planar bounded solids, cylinders and cones, spherical figures and analytic geometry.

The equation library is divided into three different screens: Equation, Plotter, and Solver. The Equation screen displays a group of related equations, which can be selected for solving. The Plotter screen is designed for plotting any of the equations in the equation library, one at a time. And the Solver screen is where you enter and convert values and then solve for unknowns. A helpful mathematical figure can be displayed from any of these three screens.

This chapter is a tutorial designed to introduce you to the equation library, show you the keys available at each screen, and provide numerous examples to help you learn to efficiently use the equation library.

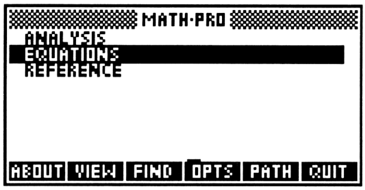
This chapter covers:

- ❑ Finding Equations
- ❑ Equation Screens
- ❑ Solver Screens
- ❑ Plotter Screens
- ❑ Options Menu
- ❑ Custom Settings Screen
- ❑ Equation Screen Key Summary
- ❑ Solver Screen Key Summary
- ❑ Plotter Screen Key Summary
- ❑ Options Menu Key Summary

Finding Equations

The Equations section is found at the home screen of Math•*Pro*. To get there, first install Math•*Pro* as described in Chapter 1, "Getting Started." Then, to start Math•*Pro*:

- ❑ HP 48GX users: Press [↱] [LIBRARY] [MATH] [MATH].
- ❑ HP 48SX users: Press [↰] [LIBRARY] [MATH] [MATH].



This is the home screen. To return here at any time, press [↱] [HOME] or [↱] [◄]. Move the highlight bar to Equations and press [ENTER] or [►] to select that section.

Equation Screens

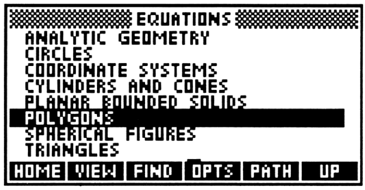
The Equation screen displays a group of related equations for solving. The equations can be selected or viewed, and a picture can be displayed at any time.

This section covers:

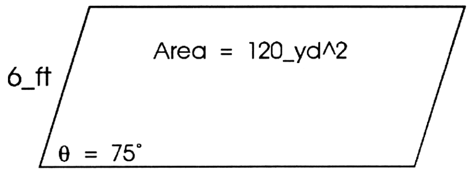
- ❑ Finding the Equation Screen
- ❑ Displaying a Picture
- ❑ Selecting Equations
- ❑ Equation Screen Menu Keys

Finding the Equation Screen

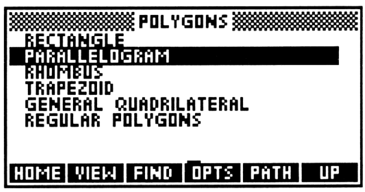
Math•*Pro* is structured with screens to choose a specific topic or item. The screen now displays Equations as its title, and lists selections, as shown in the screen below. Pressing [ENTER] or [►] selects the category of your choice. Pressing [◄] or [UP] returns you to the previous screen, or [HOME] returns you to the home screen.



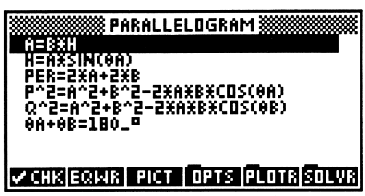
Example: *Find the perimeter of a parallelogram.* What is the perimeter of a parallelogram with an angle of 75°, a side of 6 ft, and an area of 120 yd^2?



The answer can be found in the Parallelogram section, which is found in the Polygons section. Move the highlight bar to Polygons and press ENTER or ►.



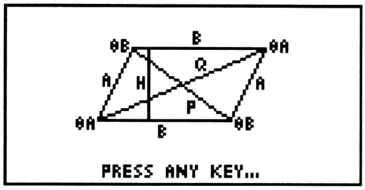
Move the highlight bar to Parallelogram and press ENTER or ►.



This is an Equation screen, which displays the six parallelogram equations.

Displaying a Picture

Press **PICT** to display the diagram of a parallelogram.



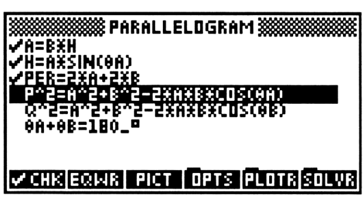
Press any key to return to the previous screen.

Selecting Equations

When solving a problem, one or more of the equations from the Equation screen can be selected for use by the solver at the Solver screen. Sometimes you will want to solve all of the equations together, but it may be the case that you will be able to quickly select a single equation or a subset of the entire equation set to speed up the solving operation. (Solving one or two equations is faster than solving many equations.)

Example (cont.): *Select the necessary equations.* The values of side **a**, angle **θa**, and area **A** are all known and the value of the perimeter **per** is wanted. Which equations should be solved? Equation 3 is needed to find **per** given **a** and **b**, but side **b** is unknown. So equation 1 is needed to find **b** given **A** and **h**, but the altitude **h** is also unknown. So equation 2 is needed to find **h** given **a** and **θa**, both of which are known. Therefore, solving equations 1, 2, and 3 will enable you to find **per** given **a**, **θa**, and **A**.

To select equations 1, 2, and 3, press **✓CHK** **✓CHK** **✓CHK**.



Now that the needed equation have been selected, you are ready to go to the Solver screen.

Equation Screen Menu Keys

These are descriptions of the various menu keys available at an Equation screen:

✓CHK Checks or unchecks the highlighted equation. Only checked equations will be solved (unless none are checked, in which case all will be solved).

EQWR Displays the highlighted equation in a graphics view.

PICT Displays a picture.

OPTS Displays the options menu. For more information, see "Options Menu."

PLOTR Goes to the Plotter screen. For more information, see "Plotter Screens."

SOLVR Goes to the Solver screen. Solves only the checked equations (unless none are checked, in which case all will be solved). For more information, see "Solver Screens."

Solver Screens

The Solver screen is where values for each of the equation variables are entered. Variables can also be edited, copied to the stack, or converted to different units. After all the known variables have been entered, you can solve for the values of unknown variables.

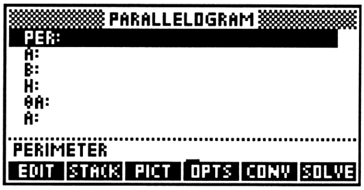
This section covers:

- ❏ Finding the Solver Screen
- ❏ Entering Values and Solving (Units On)
- ❏ Entering Values and Solving (Units Off)
- ❏ Converting a Value
- ❏ Solver Icons
- ❏ Known Variables
- ❏ Wanted Variables
- ❏ No Solution Found
- ❏ Resetting Variables
- ❏ Using the Stack
- ❏ Solver Screen Menu Keys

Finding the Solver Screen

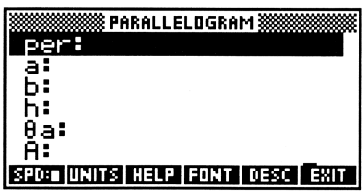
The Solver screen is accessible from the Equation screen or the Plotter screen by pressing SOLVR.

Example (cont.): *Go to the Solver screen.* Press SOLVR to go to the Solver screen.



The variables **per**, **a**, **b**, **h**, **θa**, and **A** are from the three selected equations.

The small font shows variables only in uppercase, which makes it difficult to distinguish between side **a** and area **A**. Press OPTS FONT to switch to the large font, which is case-sensitive. Also, press HELP▪ to turn help text off so that all six variables can be displayed at once in the large font.



Press EXIT to leave the options menu and return to the regular menu.

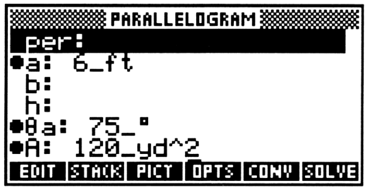
Entering Values and Solving (Units On)

When entering values into equation variables, the values are handled differently by the solver if units are on or off. When units are turned on, the solver will keep track of which units you enter with the variables and will automatically perform unit conversions during solving. Calculated values of variables will be returned in SI units or in other units you specify. Solving with units on takes more time than solving with units off.

Example (cont.): *Enter the known values.* Recall that the three known variables are **θa** is 75°, **a** is 6 ft, and **A** is 120 yd^2. Before entering these values, press OPTS UNITS to turn units on and then press EXIT to leave the options menu. Now enter the known variables:

❶ Move the highlight bar to **a**, type 6 and press FT to enter 6 ft.
❷ Move the highlight bar to **θa**, type 75 and press ° to enter 75°.
❸ Move the highlight bar to **A**, type 120 and press NXT YD^2 to enter 120 yd^2.

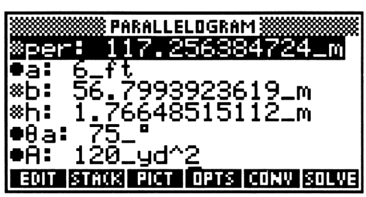
The solid circles which appear next to **a**, **θa**, and **A** indicate they are *known.*



If you make a mistake or want to change the value of a variable, move the highlight bar to the variable and press EDIT. The existing value will be placed on the command line for editing. After you have finished editing the value, press ENTER to change the value or ON to abort the change. Alternatively, to *replace* the existing value of a variable, move the highlight bar to the variable, type in the new value, and press ENTER or a unit menu key to complete the entry. Any time you edit or change a variable, it will be marked as known.

You have now entered the known variables, so it is time to solve for the unknown variables. Press SOLVE. The solver will scan through the selected equations and select equation 2 to solve first, to find **h**. Then equation 1 will be solved to find **b**. And finally, equation 3 will be solved to find **per**.

The shaded circles which appear next to **per**, **b**, and **h** indicate that solutions were found for those variables.

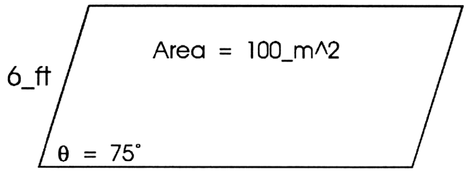


The answer is that the perimeter of the parallelogram is 117.256384724 m.

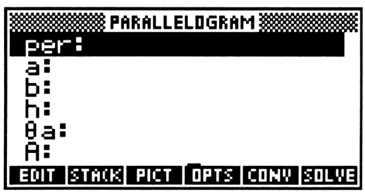
Entering Values and Solving (Units Off)

When units are turned off, the solver will not keep track of which units you enter with the variables, and all variables will be displayed in SI units. However, you can still enter values with non-SI units, and the values will automatically be converted to SI units upon entry. Calculated values of variables will be returned in SI units. Solving with units off takes less time than solving with units on because no unit conversions need to be performed.

Example: *Find the perimeter of another parallelogram.* Find the perimeter of a parallelogram identical to the previous example, except with an area of 100 m^2? Solve this related problem with units off.



Reset all the variables by pressing DEL or RESET and then ALL.



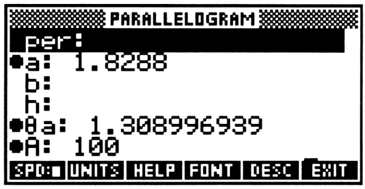
Recall that the three known variables are **θa** is 75°, **a** is 6 ft, and **A** is 100 m^2. Before entering these values, to turn units off, press CST to display the custom settings screen, move the highlight bar to Units, press +/- to turn units off, and press OK to change the setting. Now enter the known variables:

❶ Move the highlight bar to **a**, type 6 and press FT to enter 6 ft. Note that the value which appears on the screen is 1.8288. This is because the value 6 ft has been converted into the default SI unit for length: meters. The unit m is not displayed by the value because units are off.

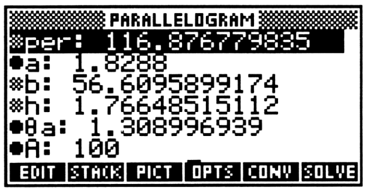
❷ Move the highlight bar to **θa**, type 75 and press ° to enter 75°. The value is converted to the SI unit for angles: radians. Note that when units are off, the default unit for angles is always radians, regardless of the angle measure setting of your HP 48.

❸ Move the highlight bar to **A**, type 100 and press M^2 or ENTER to enter 100 m^2. The value appears as 100, because it is already in the default SI unit for area: square meters.

The solid circles which appear next to **a**, **θa**, and **A** indicate they are known.



You have now entered the known variables, so it is time to solve for the unknown variables. Press SOLVE. The solver will again scan through and solve equation 2, equation 1, and equation 3. The shaded circles which appear next to **per**, **b**, and **h** indicate that exact solutions were found for those variables.

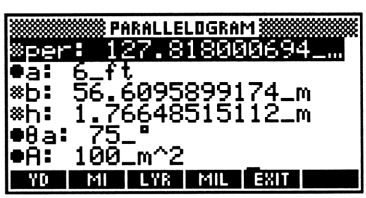


The answer is that the perimeter is 116.876779835 meters.

Converting a Value

Once a variable value has been entered, it can easily be converted to different units. To do this, press CONV. The available units for the highlighted variable will be displayed as a menu (press NXT for more menu keys, if appropriate).

Example (cont.): *Convert the perimeter from meters to yards.* Move the highlight bar to **per** and press CONV. (Pressing CONV will automatically turn units on, because when units are off, values are always in SI units and therefore cannot be converted.) Then press NXT YD to convert the perimeter from meters to yards.

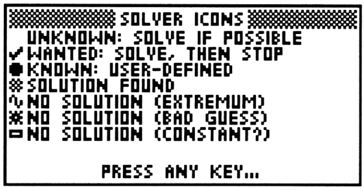


The answer is that the perimeter is 127.818000694 yd.

If desired, perform unit conversion of other variables by moving the highlight bar to the desired variable and selecting a unit from the menu. When you have finished converting variables, press EXIT (or NXT EXIT, if appropriate) to leave the convert menu and return to the regular menu.

Solver Icons

Press NXT ICONS to display the screen explaining the icons.



Press any key to return to the previous screen. (For more information, see Chapter 33, "Advanced Use of the Solver.")

Known Variables

A solid circle (●) indicates a variable is known. The values of known variables are never changed by the solver, because those variables are considered user-defined. Every time you enter a value for a variable, the variable is automatically marked as known. To remove the known icon from a variable, move the highlight bar to the variable and press KNOW or +/-, and the solid circle will disappear, which means the variable is unknown (no longer known). Every time you want to solve equations, you must pick some variables to be known and enter values for them, so the solver can use the known variables to calculate values for any unknown variables.

Wanted Variables

A check mark (✓) indicates a variable is wanted. It is not necessary to mark the desired variables(s) as wanted in order to calculate their values, because the solver will calculate the values of *all* unknown variables (those with no icons) if none are marked as wanted. The reason you might want to mark one or more variables as wanted is if you want the solver to *stop* after it has found the values of those wanted variables and not continue to calculate the values of all remaining unknown variables. If you are solving multiple equations with many variables and you only want the value of a specific variable, it is a good idea to mark that variable as wanted by selecting it with the highlight bar and pressing WANT. To remove a wanted icon from a variable, move the highlight bar to the variable and press WANT.

The solver may still calculate the values of other unknown variables in addition to those specifically marked as wanted, most likely because it is impossible to calculate the value of the wanted variable(s) without first calculating the values of other variables (In the two parallelogram examples, even if **per** had been marked as wanted, the solver would still have needed to solve for **b** and **h**, because without values for them, it would be impossible to calculate **per**.)

No Solution Found

When the solver cannot find a solution, three kinds of messages can be displayed: no solution (extremum), no solution (bad guess) and no solution (constant). The no solution (extremum) message is displayed when either the solver found a point where the value of the equation approximates a local minimum or maximum, or where the solver stopped searching at the largest (MAXR) or smallest (–MAXR) range of numbers. The no solution (bad guess) message is displayed when one or more of the initial guesses are outside the domain of the equation. The no solution (constant) message is displayed when the value of the equation is the same value at every point sampled. (For more information, see Chapter 33, "Advanced Use of the Solver.")

Resetting Variables

To reset the values of variables, press [DEL] or RESET and select ONE or ALL. This will clear the values of the selected variables at the Solver screen and will also purge the selected variables from user memory, where they are created by the solver each time you enter a value or press SOLVE.

Using the Stack

There are two stack-related commands: →STK, which copies one or all of the variables shown to the HP 48 stack for later use without leaving the Solver screen; and STACK, which copies the value of the highlighted variable to the HP 48 stack for immediate use and temporarily goes to the HP 48 stack environment.

Solver Screen Menu Keys

These are descriptions of the various menu keys available at the Solver screen:

EDIT — Edits the highlighted variable. Press [ENTER] to save edit changes or [ON] to cancel editing.

STACK — Copies the highlighted variable to the HP 48 stack and temporarily goes to the HP 48 stack environment. While at the stack, you can use all the normal built-in functions of your HP 48 to manipulate or change the copied value. When you have finished editing the value, press OK to leave the stack and insert the edited value into the current variable, or press **CANCL** to leave the stack without changing the value of the current variable.

PICT Displays a picture.

OPTS Displays the options menu. For more information, see "Options Menu."

CONV Displays the convert menu for the highlighted variable. For more information, see "Converting a Value."

SOLVE Solves the equation(s) using the displayed values. For more information, see "Entering Values and Solving."

KNOW Marks or unmarks the highlighted variable as *known*. For more information, see "Known Variables."

WANT Marks or unmarks the highlighted variable as *wanted.* For more information, see "Wanted Variables."

RESET Resets one or all of the variables. For more information, see "Resetting Variables."

ICONS Displays the icons used to indicate variable status. For more information, see Chapter 33, "Advanced Use of the Solver."

PLOTR Goes to the Plotter screen. For more information, see "Plotter Screens."

EQNS Goes to the Equation screen. For more information, see "Equation Screens."

Plotter Screens

The Plotter screen is where any of the equations in the Math•*Pro* equation library can be plotted. A variety of plot parameters can be specified. Also, the HP 48 graphics environment is available from the Plotter screen.

This section covers:

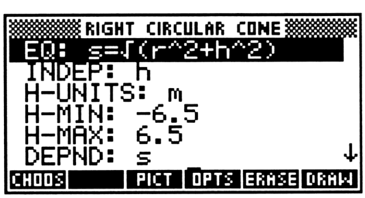
- ❏ Finding the Plotter Screen
- ❏ Selecting an Equation to Plot
- ❏ Setting Extra Variables
- ❏ Selecting the Independent Variable and Units
- ❏ Setting the Horizontal Range
- ❏ Selecting the Dependent Variable and Units
- ❏ Setting the Vertical Range
- ❏ Drawing the Plot
- ❏ Field Types
- ❏ Field Descriptions
- ❏ Plotter Screen Menu Keys

Finding the Plotter Screen

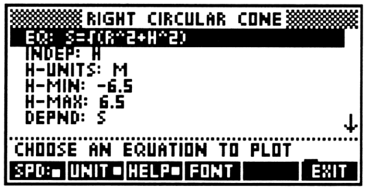
The Plotter screen is accessible from the Equation screen or the Solver screen by pressing PLOTR.

Example: *Plot volume vs. radius for a cone.* Use the plotter to find how the volume of a right circular cone varies as a function of the radius, using a cone with height 10 m and varying the radius from 0 m to 5 m.

Press ⮫ HOME to return to the home screen. Then select Equations, Cylinders and Cones, and Right Circular Cone, which will bring you to the Equation screen for a right circular cone. Press PLOTR to go to the Plotter screen.



The small font can fit more information on the screen, so press OPTS FONT to switch to the small font. Press HELP to turn help text on. (Also, be sure units are on.)



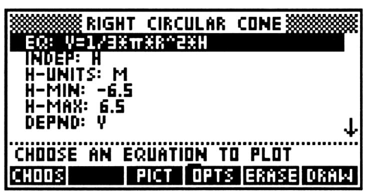
Press EXIT to leave the options menu and return to the regular menu.

Selecting an Equation to Plot

The first step at the Plotter screen is to select an equation to plot. Selecting an equation automatically sets default values for the independent and dependent variables and units.

❑ The EQ field contains the equation to plot.

Example (cont.): *Select the equation to plot volume vs. radius.* Move the highlight bar to the EQ field and press CHOOS. Scroll down to the equation V=1/3*π*R^2*H and press OK or ENTER to select that equation to plot.

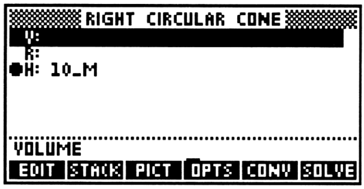


The independent variable defaults to the altitude, **h**, and the dependent variable defaults to the volume, **V**.

Setting Extra Variables

In the equation to be plotted, the independent and dependent variables will vary, but all other variables must have values, which will be unchanged by plotting. Those values should be entered at the Solver screen.

Example (cont.): *Enter the altitude.* The equation to be plotted contains the variables **V**, **r** and **h**. Of these, **V** and **r** will be the dependent and independent variables, but a value still must be entered for **h**. Press NXT SOLVR to go to the Solver screen. Move the highlight bar to **h**, type 10, and press M to enter 10 m as the value of **h**.



Press [NXT] PLOTR to return to the Plotter screen.

Selecting the Independent Variable and Units

The independent variable is what varies across the horizontal axis of the plot. Changing the independent variable automatically resets the independent variable units to the default SI unit for that variable.

- ❑ The INDEP field contains the independent variable.
- ❑ The H-UNITS field contains the independent variable units, but is only present if units are turned on.

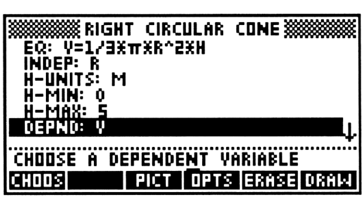
Example (cont.): *Set radius as the independent variable.* Move the highlight bar to INDEP and press [+/-] [+/-] to toggle the value of the independent variable to **R**, the radius. This will automatically set H-UNITS to meters, the SI unit for **R**, the radius.

Setting the Horizontal Range

The horizontal range controls the minimum and maximum values of the independent variable, which is plotted along the horizontal range.

- ❑ The H-MIN field contains the horizontal minimum value.
- ❑ The H-MAX field contains the horizontal maximum value.

Example (cont.): *Vary the radius from 0 to 5 m.* Move the highlight bar to H-MIN, type 0, and press [ENTER] to enter 0 as the value of H-MIN. Then type 5 and press [ENTER] to enter 5 as the value of H-MAX.



Unlike at the Solver screen, it is not necessary to enter units for H-MIN and H-MAX, because units are specified by the H-UNITS field for the horizontal axis.

Selecting the Dependent Variable and Units

The dependent variable is what varies along the vertical axis of the plot. Changing the dependent variable automatically resets the dependent variable units to the default SI unit for that variable.

- ❑ The DEPND field contains the dependent variable.

- ❑ The V-UNITS field contains the dependent variable units, but is only present if units are turned on.

Example (cont.): *Set volume as the dependent variable.* To find how the volume varies as a function of the radius, the dependent variable should be **V**, the volume. However, DEPND should already be set to **V**, so you do not need to change it. Also, V-UNITS has automatically been set to m^3, the SI unit for **V**.

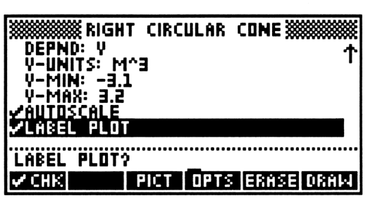
Setting the Vertical Range

The vertical range controls the minimum and maximum values of the dependent variable, which is plotted along the vertical axis.

- ❑ The V-MIN field contains the vertical minimum value. This field is ignored if autoscale is on.

- ❑ The V-MAX field contains the vertical maximum value. This field is ignored if autoscale is on.

Example (cont.): *Autoscale the plot.* Move the highlight bar down to AUTOSCALE and press ✓CHK to turn autoscale on.

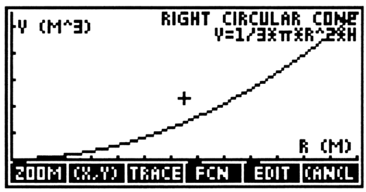


V-MIN and V-MAX only apply when autoscale is off.

Drawing the Plot

After you have specified the plot parameters, pressing DRAW will graph the equation in the HP 48 graphics environment. As with the built-in plotting routines of the HP 48, you can overlay multiple plots by pressing DRAW more than once with different parameters without pressing ERASE between plots.

Example (cont.): *Draw the plot.* Press ERASE to erase any previous plots and then press DRAW to create a new plot in the HP 48 graphics environment. (The following screen is from an HP 48GX.)



The answer is indicated by the plot, which clearly shows the second-order (parabolic) relationship between the radius and the volume. When you have finished viewing the plot, press ON to return to the Plotter screen.

Field Types

The Plotter screen uses three basic kinds of fields.

When the highlight bar has selected a particular field type, the menu keys will change to reflect operations specific to that type of field, as described below. OPTS, ERASE and DRAW (and EQNS and SOLVR, on the next page of the menu) are always present, regardless of the field type.

- ❑ **Edit Fields:** These fields accept values entered from the keyboard. The H-MIN, HMAX, V-MIN and V-MAX fields are edit fields.

  Edit field: EDIT, STACK, PICT, OPTS, ERASE and DRAW.

- ❑ **Choose Fields:** These fields accept one of a pre-defined list of possible values, which must be selected from a pre-defined list.

  Choose field: CHOOS, PICT, OPTS, ERASE and DRAW.

- ❑ **Check Field:** These fields control certain options, and a check selects an option. The AUTOSCALE and LABEL PLOT fields are check fields.

  Check field: ✓CHK, PICT, OPTS, ERASE and DRAW

Field Descriptions

These are detailed descriptions of each of the fields at the Plotter screen.

- ❑ **EQ:** *Equation to plot*: Press CHOOS to select from equations at Equation screen for current section.
- ❑ **INDEP:** *Independent variable*: Press CHOOS to select from variables in current equation.
- ❑ **H-UNITS:** *Horizontal axis units*: Press CHOOS to select from units allowed for current independent variable. (This field is only present if units are on.)
- ❑ **H-MIN:** *Horizontal axis*: Minimum value.
- ❑ **H-MAX:** *Horizontal axis*: Maximum value.
- ❑ **DEPND:** *Dependent variable*: Press CHOOS to select from variables in current equation. Should be different from the independent variable.
- ❑ **V-UNITS:** *Vertical axis units*: Press CHOOS to select from units allowed for current dependent variable. (This field is only present if units are on.)
- ❑ **V-MIN:** *Vertical axis*: Minimum value. Not used if autoscale is on.
- ❑ **V-MAX:** *Vertical axis*: Maximum value. Not used if autoscale is on.
- ❑ **AUTOSCALE:** *Autoscale vertical axis?* Press ✓CHK to control whether vertical axis is autoscaled (checked) or specified by V-MIN and V-MAX (unchecked).
- ❑ **LABEL PLOT:** *Label plot?* Press ✓CHK to control whether plot is labeled (checked) or not labeled (unchecked).

Plotter Screen Menu Keys

These are descriptions of the various menu keys available at the Plotter screen:

PICT (All fields) Displays a picture.

OPTS (All fields) Displays the options menu. For more information, see "Options Menu."

ERASE (All fields) Erases any previous plots.

DRAW (All fields) Plots the current equation. Uses the HP 48 graphics environment. To create an overlay plot, press **DRAW** multiple times without pressing **ERASE** between plots.

EQNS (All fields) Goes to the Equation screen. For more information, see "Equation Screens."

SOLVR (All fields) Goes to the Solver screen. For more information, see "Solver Screens."

EDIT (Edit fields only) Edits the highlighted item for an edit field. Press [ENTER] to save edit changes or [ON] to cancel editing.

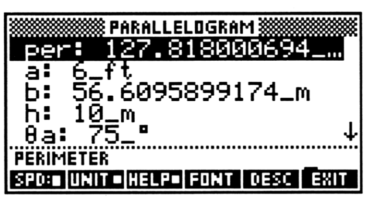
STACK (Edit fields only) Copies the highlighted item to the HP 48 stack and temporarily goes to the HP 48 stack environment. While at the stack, you can use all the normal built-in functions of your HP 48 to manipulate or change the copied item. When you have finished editing the item, press **OK** to leave the stack and insert the edited item into the current edit field, or press **CANCL** to leave the stack without changing the value of the current edit field.

CHOOS (Choose fields only) Displays the possible choices for a choose field. Highlight the desired value and press [ENTER] or **OK**, or press **CANCL** to abort the selection.

✓CHK (Check fields only) Toggles a check mark for a check field.

Options Menu

The options menu helps you customize settings and is available throughout Math•*Pro*. Pressing **OPTS** displays the following menu keys:



SPD:■ Changes the scrolling speed of the highlight bar. The bar on the right shows the current level of speed: a tall bar indicates fast scrolling speed, while a short bar indicates slow scrolling speed.

UNITS Toggles units on or off. When the block inside the key appears (**UNIT▪**), units are turned on.

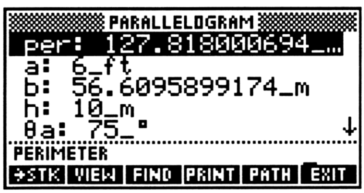
HELP Toggles display of help text on the bottom of the screen. When the block inside the key appears (**HELP▪**), help is turned on.

FONT Toggles font size between large and small. The large font is case-sensitive, while the small font contains condensed, uppercase letters.

DESC Toggles positions of variable values and descriptions. When the block inside the key appears (**DESC▪**), then the variable values and descriptions are switched.

EXIT Leaves the options menu. Returns to the regular menu.

At the options menu, press [NXT] to display the following additional menu keys:



→STK Copies one or all of the items shown to the HP 48 stack. Pressing this key prompts you for **ONE** or **ALL**.

VIEW Displays the highlighted item in a text view. This is useful if the screen is displayed in the large font and the item scrolls off the right side of the screen with "..." (an ellipsis) displayed. Press [↰] or [↱] **VIEW** to display the highlighted item in a graphics view.

FIND Searches for the specified character or string. **FIND** only searches the current screen for a match.

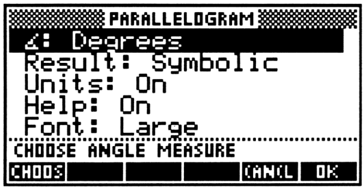
PRINT Prints one or all of the items shown to an HP 48 printer.

PATH Displays screens chosen to reach the current screen. After pressing this key, you will see the path listing in the title bar of the screen. Press **→STK** to place this path list on the stack.

EXIT Leaves the options menu. Returns to the regular menu.

Custom Settings Screen

The custom settings screen is displayed by pressing CST and is available throughout Math•*Pro*.



To change any of these settings, move the highlight bar to the desired item and press CHOOS or +/-. Then press OK to implement the changes, or to exit the screen without changing the settings, press CANCL or ON.

Settings Descriptions

❑ ∠: *Angle measure*: Press CHOOS to select degrees, radians, or grads. Determines how trigonometric/hyperbolic functions will interpret inputs.

❑ **RESULT:** *Result mode*: Press CHOOS to select symbolic or numeric. Determines whether functions will return symbolic or numeric results.

❑ **UNITS:** *Units*: Press CHOOS to select on or off. Determines whether units are on or off for Equations and Reference.

❑ **HELP:** *Help text*: Press CHOOS to select on or off. Determines whether context-sensitive help text is displayed on the screen.

❑ **FONT:** *Font size*: Press CHOOS to select on or off. Determines whether screens use the large or small font to display items.

Equation Screen Key Summary

Key	Action
✓CHK	Checks or unchecks the highlighted equation.
EQWR	Displays the highlighted equation in a graphics view.
PICT	Displays a picture.
OPTS	Displays the options menu.
PLOTR	Goes to the Plotter screen.
SOLVR	Goes to the Solver screen.

Key	Action
▲ or ▼	Moves the highlight bar up or down one item.
← ▲ or ← ▼	Moves the highlight bar to top or bottom of screen.
→ ▲ or → ▼	Moves the highlight bar to top or bottom of list.
◄ or ← UP	Goes to the previous screen.
→ ◄ or → HOME	Goes to the home screen.
ENTER or ►	Enters the highlighted section (for a screen). Checks or unchecks the highlighted equation.
+/-	Checks or unchecks the highlighted equation.
NXT or ← PREV	Goes to the next or previous menu row (if appropriate).
CST	Goes to the custom settings screen.
← CST or → CST	Goes to the first or second page of the options menu.
→ CMD	HP 48GX: Displays the highlighted item in a text view.
→ VISIT	HP 48SX: Displays the highlighted item in a text view.
ON	Quits Math•*Pro* to the HP 48 stack.

Solver Screen Key Summary

Key	Action
EDIT	Edits the highlighted variable.
STACK	Copies the highlighted variable to the HP 48 stack and temporarily goes to the HP 48 stack environment.
PICT	Displays a picture.
OPTS	Displays the options menu.
CONV	Displays the convert menu for the highlighted variable.
SOLVE	Solves the equation(s) using the displayed values.
KNOW	Marks or unmarks the highlighted variable as *known*.
WANT	Marks or unmarks the highlighted variable as *wanted*.
RESET	Resets one or all of the variables.
ICONS	Displays the icons used to indicate variable status.
PLOTR	Goes to the Plotter screen.
EQNS	Goes to the Equation screen.

Key	Action
[▲] or [▼]	Moves the highlight bar up or down one item.
[⬅][▲] or [⬅][▼]	Moves the highlight bar to top or bottom of screen.
[➡][▲] or [➡][▼]	Moves the highlight bar to top or bottom of list.
[◄] or [⬅][UP]	Goes to the previous screen.
[➡][◄] or [➡][HOME]	Goes to the home screen.
[ENTER] or [►]	Edits the highlighted variable.
[+/-]	Marks or unmarks the highlighted variable as *known*.
[NXT] or [⬅][PREV]	Goes to the next or previous menu row (if appropriate).
[CST]	Goes to the custom settings screen.
[⬅][CST] or [➡][CST]	Goes to the first or second page of the options menu.
[VAR]	Toggles positions of variable values and descriptions.
[DEL]	Resets one or all of the variables.
[⬅][UNITS] or [➡][UNITS]	Toggles units on or off.
[➡][CMD] or [➡][VISIT]	Displays the highlighted item in a text view.
[ON]	Quits Math•*Pro* to the HP 48 stack.

Plotter Screen Key Summary

Key	Action
PICT	Displays a picture.
OPTS	Displays the options menu.
ERASE	Erases any previous plots.
DRAW	Plots the current equation.
EQNS	Goes to the Equation screen.
SOLVR	Goes to the Solver screen.
EDIT	Edits the highlighted item for an edit field.
STACK	Copies the highlighted item to the HP 48 stack and temporarily goes to the HP 48 stack environment.
CHOOS	Displays a list of possible values for a choose field.
✓CHK	Toggles a check mark for a check field.

Key	Action
▲ or ▼	Moves the highlight bar up or down one item.
◀┐ ▲ or ◀┐ ▼	Moves the highlight bar to top or bottom of screen.
┌▶ ▲ or ┌▶ ▼	Moves the highlight bar to top or bottom of list.
◀ or ◀┐ UP	Goes to the previous screen.
┌▶ ◀ or ┌▶ HOME	Goes to the home screen.
ENTER or ▶	Edits the highlighted item (for an edit field). Displays the possible choices (for a choose field). Checks or unchecks highlighted item (for check field).
+/-	Displays the possible choices (for a choose field). Checks or unchecks highlighted item (for check field).
NXT or ◀┐ PREV	Goes to the next or previous menu row (if appropriate).
CST	Goes to the custom settings screen.
◀┐ CST or ┌▶ CST	Goes to the first or second page of the options menu.
◀┐ UNITS or ┌▶ UNITS	Toggles units on or off.
┌▶ CMD	HP 48GX: Displays the highlighted item in a text view.
┌▶ VISIT	HP 48SX: Displays the highlighted item in a text view.
ON	Quits Math•*Pro* to the HP 48 stack.

Options Menu Key Summary

Key	Action
SPD:■	Changes the scrolling speed of the highlight bar.
UNIT■	Toggles units on or off.
HELP■	Toggles display of help text at the bottom of the screen.
FONT	Toggles font size between large and small.
DESC■	Toggles positions of variable values and descriptions.
→STK	Copies one or all of the items shown to the HP 48 stack.
VIEW	Displays the highlighted item in a text view. Press ⮕ or ⬅ VIEW to show the item in a graphics view.
FIND	Searches for the specified character or string.
PRINT	Prints one or all of the items shown to an HP 48 printer.
PATH	Displays screens chosen to reach the current screen.
EXIT	Leaves the options menu.

Chapter 11

Analytic Geometry

This chapter covers the Equations section on Analytic Geometry:

- ❑ Parabola
- ❑ Ellipse
- ❑ Hyperbola

Finding Analytic Geometry

To find Analytic Geometry, install Math•*Pro* and do the following:

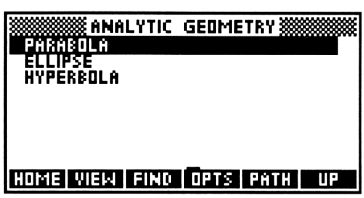
❶ HP 48GX users: Press [→] [LIBRARY] to display available libraries.
HP 48SX users: Press [←] [LIBRARY] to display available libraries.

❷ Press MATH to display the Math•*Pro* library menu.

❸ Press MATH to start Math•*Pro* and show the home screen.

❹ Move the highlight bar to Equations and press [ENTER] or [►].

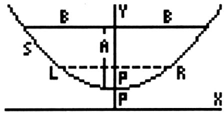
❺ Move the highlight bar to Analytic Geometry and press [ENTER] or [►].



❻ Move the highlight bar to the desired section and press [ENTER] or [►]. Then skip to the appropriate section below.

Parabola

These equations describe the properties of a parabola. The first equation defines the latus rectum, **lr** (the distance from L to R in the picture), in terms of the vertex to focus distance, **p**. The second equation links the arc length, **s**, with **a**, the vertex to segment edge distance, and **b**, the bisector to the parabola. The last equation shows the area of the segment, **Aseg**, in terms of **a** and **b**.

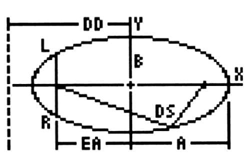


Variable	Description	Unit
a	vertex to segment edge	m
Aseg	segment area	m^2
b	bisector to parabola	m
lr	latus rectum	m
p	vertex to focus	m
s	arc length	m

$$lr=4\cdot p \qquad s=\sqrt{4\cdot a^2+b^2}+\frac{b^2}{2\cdot a}\cdot LN\left(\frac{2\cdot a+\sqrt{4\cdot a^2+b^2}}{b}\right) \qquad Aseg=\frac{4}{3}\cdot a\cdot b$$

Ellipse

These equations describe the principal properties of an ellipse. The first equation defines the area **A** of the ellipse in terms of semimajor axis **a** and semiminor axis **b**. The second equation computes circumference **C** in terms of **a** and **b**. The third equation calculates the eccentricity **E** in terms of **a** and **b**. The latus rectum **lr** is defined by the fourth equation using **b** and **a**. The last two equations describe the center to directrix **dd** and sum of foci to point **ds** in terms of semimajor axis **a** and eccentricity **E**.



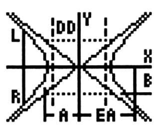
Variable	Description	Unit
A	area	m^2
a	semimajor axis	m
b	semiminor axis	m
C	circumference	m
dd	center to directrix	m
ds	sum of foci to point	m
E	eccentricity	unitless
lr	latus rectum	m

$$A=\pi\cdot a\cdot b \qquad C=2\cdot\pi\cdot\sqrt{\frac{a^2+b^2}{2}} \qquad E=\frac{\sqrt{a^2-b^2}}{a}$$

$$lr=\frac{2\cdot b^2}{a} \qquad dd=\frac{a}{E} \qquad ds=2\cdot a$$

Hyperbola

These equations describe properties of a hyperbola. The first equation defines the eccentricity **E** of the hyperbola in terms of semitransverse axis **a** and semiconjugate axis **b**. The second equation computes latus rectum **lr** in terms of **a** and **b**. The last two equations describe the center to directrix **dd** and difference of foci to point **ds** in terms of semitransverse axis **a** and eccentricity **E**.



Variable	Description	Unit
a	semitransverse axis	m
b	semiconjugate axis	m
dd	center to directrix	m
ds	difference of foci to point	m
E	eccentricity	unitless
lr	latus rectum	m

$$E=\frac{\sqrt{a^2+b^2}}{a} \qquad lr=\frac{2\cdot b^2}{a} \qquad dd=\frac{a}{E}$$

$$ds=2\cdot a$$

Chapter 12

Circles

This chapter covers the Equations section on Circles:

- ❑ Circles
- ❑ Sector and Segment
- ❑ Circular Ring
- ❑ Semicircle

Finding Circles

To find Circles, install Math•*Pro* and do the following:

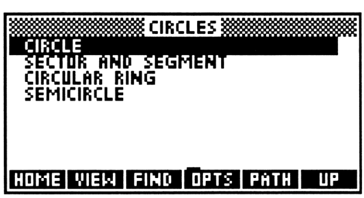
❶ HP 48GX users: Press [↱] [LIBRARY] to display available libraries.
HP 48SX users: Press [↰] [LIBRARY] to display available libraries.

❷ Press **MATH** to display the Math•*Pro* library menu.

❸ Press **MATH** to start Math•*Pro* and show the home screen.

❹ Move the highlight bar to Equations and press [ENTER] or [►].

❺ Move the highlight bar to Circles and press [ENTER] or [►].



❻ Move the highlight bar to the desired section and press [ENTER] or [►].
Then skip to the appropriate section below.

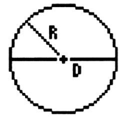
Variables

The table below lists all the variables used in this section, along with a brief description and appropriate units.

Variable	Description	Unit
A	area	m^2
Asec	sector area	m^2
Aseg	segment area	m^2
b	segment base	m
C	circumference	m
d	diameter	m
δ	separation of axes	m
h1	segment height	m
h2	partial height	m
hc	height of centroid	m
I	area moment parallel to Ic axis	m^4
Ic	area moment at centroid	m^4
Icc	mass moment at centroid	kg*m^2
Iz	area moment about z-axis	m^4
Izz	mass moment about z-axis	kg*m^2
J	mass moment parallel to Icc axis	kg*m^2
m	mass	kg
θ	angle	r
r	radius	m
ri	inner radius	m
ro	outer radius	m
s	arc length	m

Circle

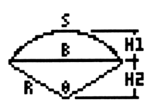
These equations describe the properties of a circle. The first three equations define diameter **d**, circumference **C** and area **A** of a circle in terms of the radius **r.** The middle three equations shows the computation of area moment, **Ic** about an axis through the centroid in the plane of the circle, area moment **Iz** about an axis through the centroid perpendicular to the plane of the circle, while area moment **I** is about an axis separated a distance **δ** from the centroid and is in the plane of the circle. The final set of equations focus on computation details for mass moments of the circle. The centroid is located at the center of the circle.



$d=2\cdot r$	$C=2\cdot\pi\cdot r$	$A=\pi\cdot r^{2}$
$I=Ic+A\cdot\delta^{2}$	$Ic=\frac{1}{4}\cdot\pi\cdot r^{4}$	$Iz=\frac{1}{2}\cdot\pi\cdot r^{4}$
$J=Icc+m\cdot\delta^{2}$	$Icc=\frac{1}{4}\cdot m\cdot r^{2}$	$Izz=\frac{1}{2}\cdot m\cdot r^{2}$

Sector and Segment

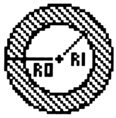
These equations describe the properties of a sector and segment. The sector is the figure bounded by the two radii and the arc **s**, while the segment is the figure bounded by the segment base **b** and the arc **s**. The first four equations define the segment height **h1**, the arc length **s** and the partial height **h2** in terms of radius of the circle **r**, the angle **θ** formed at the center of the circle and the segment base **b.** The fifth equation links **b** with **r** and **θ**. The next equation couples **b** with **r** and **h1**. The last two equations focus on sector area and segment area. When solving for **θ**, an appropriate initial guess may help the solver find a solution in the desired quadrant.



$h1=r-h2$	$s=r\cdot\theta$	$h2=r\cdot\cos\left(\frac{\theta}{2}\right)$
$h2=\frac{1}{2}\cdot\sqrt{4\cdot r^{2}-b^{2}}$	$b=2\cdot r\cdot\sin\left(\frac{\theta}{2}\right)$	$b=\sqrt{4\cdot h1\cdot(2\cdot r-h1)}$
$Asec=\frac{1}{2}\cdot r\cdot s$	$Aseg=\frac{1}{2}\cdot r^{2}\cdot(\theta-\sin(\theta))$	

Circular Ring

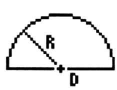
These equations describe a circular ring. The first equation is the cross-sectional area **A**. The next defines the area moment, **Ic**, about an axis through the centroid in the ring plane. The area moment, **Iz**, is about an axis through the centroid perpendicular to the ring plane, while the area moment, **I**, is about an axis in the ring plane a distance **δ** from the centroid.



$A=\pi\cdot(ro^2-ri^2)$	$I=Ic+A\cdot\delta^2$	$Ic=\frac{1}{4}\cdot\pi\cdot(ro^4-ri^4)$
$Iz=\frac{1}{2}\cdot\pi\cdot(ro^4-ri^4)$	$J=Icc+m\cdot\delta^2$	$Icc=\frac{1}{4}\cdot m\cdot(ro^2-ri^2)$
$Izz=\frac{1}{2}\cdot m\cdot(ro^2-ri^2)$		

Semicircle

These equations describe a semicircle. The first equations define diameter **d** and area **A** in terms of the radius, **r**. The third equation defines the centroid height, **hc**, as measured vertically from the center of the base diameter. The equation for **Ic** defines the area moment of inertia about an axis through the centroid in the semicircle plane. The equation for **Iz** defines the area moment of about the centroid axis perpendicular to the semicircle plane.



$d=2\cdot r$	$A=\frac{1}{2}\cdot\pi\cdot r^2$	$hc=\frac{4}{3}\cdot\pi\cdot r$
$I=Ic+A\cdot\delta^2$	$Ic=r^4\cdot\left(\frac{\pi}{8}-\frac{8}{9\cdot\pi}\right)$	$Iz=\frac{1}{4}\cdot\pi\cdot r^4$

Chapter 13

Coordinate Systems

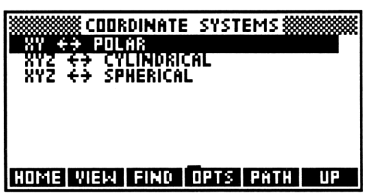
This chapter covers the Equations section on Coordinate Systems:

- ❑ XY ↔ Polar
- ❑ XYZ ↔ Cylindrical
- ❑ XYZ ↔ Spherical

Finding Coordinate Systems

To find Coordinate Systems, install Math•*Pro* and do the following:

❶ HP 48GX users: Press ⮫ LIBRARY to display available libraries.
HP 48SX users: Press ⮪ LIBRARY to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Equations and press ENTER or ►.
❺ Move the highlight bar to Coordinate Systems and press ENTER or ►.



❻ Move the highlight bar to the desired section and press ENTER or ►.
Then skip to the appropriate section below.

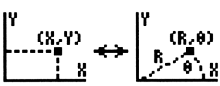
Variables

The table below lists all the variables used in this section, along with a brief description and appropriate units.

Variable	Description	Unit
φ	azimuthal angle	r
θ	polar angle	r
r	radial distance	unitless
x	abscissa	unitless
y	ordinate	unitless
z	z-axis distance	unitless

XY ↔ Polar

These equations describe the relationship between Cartesian and polar coordinates in two dimensions. The first two equations define **x** and **y** coordinate values in terms of **r** and **θ**. The last two equations show the inverse relationship between **r**, **θ** and **x**, **y**. When solving for **θ**, an appropriate initial guess may help the solver find a solution in the desired quadrant.

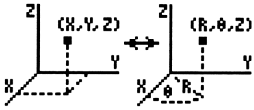


$$x = r \cdot \mathrm{COS}(\theta) \qquad y = r \cdot \mathrm{SIN}(\theta) \qquad r = \sqrt{x^2 + y^2}$$

$$\theta = \mathrm{ASIN}\left(\frac{y}{r}\right)$$

XYZ ↔ Cylindrical

These equations describe the relationship between Cartesian and cylindrical coordinates in three dimensions. The first three equations define the relationship between the Cartesian coordinates **x**, **y** and **z** and the cylindrical coordinates **r**, **θ** and **z**. The last two equations show the inverse relationship between **r**, **θ** and **x**, **y**. When solving for **θ**, an appropriate initial guess may help the solver find a solution in the desired quadrant.

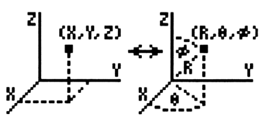


$$x=r\cdot COS(\theta) \qquad y=r\cdot SIN(\theta) \qquad z=z$$

$$r=\sqrt{x^2+y^2} \qquad \theta=ASIN\left(\frac{y}{r}\right)$$

XYZ ↔ Spherical

These equations describe the relationship between Cartesian and spherical coordinates. The first three equations show the relationship between the Cartesian coordinates **x**, **y** and **z** and the spherical coordinates **r**, **θ** and **ϕ**. The last three equations show the inverse relationship between **r**, **θ** and **ϕ** and **x**, **y** and **z**. When solving for **θ** or **ϕ**, an appropriate initial guess may help the solver find a solution in the desired quadrant.



$$x=r\cdot COS(\theta)\cdot SIN(\phi) \qquad y=r\cdot SIN(\theta)\cdot SIN(\phi) \qquad z=r\cdot COS(\phi)$$

$$r=\sqrt{x^2+y^2+z^2} \qquad \theta=ASIN\left(\frac{y}{r}\right) \qquad \phi=ACOS\left(\frac{z}{\sqrt{x^2+y^2+z^2}}\right)$$

Chapter 14

Cylinders and Cones

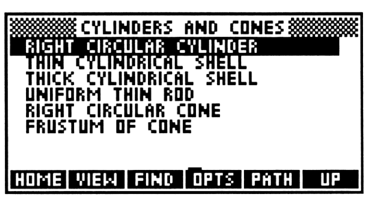
This chapter covers the Equations section on Cylinders and Cones:

- ❑ Right Circular Cylinder
- ❑ Thin Cylindrical Shell
- ❑ Thick Cylindrical Shell
- ❑ Uniform Thin Rod
- ❑ Right Circular Cone
- ❑ Frustum of Cone

Finding Cylinders and Cones

To find Cylinders and Cones, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [↱] [LIBRARY] to display available libraries.
HP 48SX users: Press [↰] [LIBRARY] to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Equations and press [ENTER] or [►].
❺ Move the highlight bar to Cylinders and Cones and press [ENTER] or [►].



❻ Move the highlight bar to the desired section and press [ENTER] or [►].
Then skip to the appropriate section below.

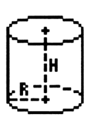
Variables

The table below lists all the variables used in this section, along with a brief description and appropriate units.

Variable	Description	Unit
δ	separation of axes	m
h	altitude	m
hc	height of centroid	m
Icc	mass moment at centroid	kg*m^2
Izz	mass moment about z-axis	kg*m^2
J	mass moment parallel to Icc axis	kg*m^2
m	mass	kg
L	lateral surface area	m^2
r	base radius	m
ri	inner radius	m
ro	outer radius	m
s	slant height	m
T	total surface area	m^2
V	volume	m^3

Right Circular Cylinder

These equations describe properties of a right circular cylinder, including mass moments of inertia. The first equation defines the surface area **L** of the cylinder in terms of the height **h** and the radius **r**. The second equation defines the total surface area **T** including the top and bottom flat surfaces in terms of **r** and **h**. The third equation defines the volume **V** in terms of **r** and **h**. The last three equations compute the mass moment of inertia. The mass moment **Izz** is about the axis of symmetry of the cylinder. The mass moment **Icc** is about an axis through the centroid perpendicular to the axis of the cylinder. The mass moment **J** is about an axis perpendicular to **Icc** but offset by a distance **δ**.



$$L=2\cdot\pi\cdot r\cdot h \qquad T=2\cdot\pi\cdot r\cdot(r+h) \qquad V=\pi\cdot r^2\cdot h$$

$$J=Icc+m\cdot\delta^2 \qquad Icc=\frac{1}{4}\cdot m\cdot r^2+\frac{1}{12}\cdot m\cdot h^2 \qquad Izz=\frac{1}{2}\cdot m\cdot r^2$$

Thin Cylindrical Shell

These equations describe the mass moments of inertia of a thin cylindrical shell. The mass moment **Izz** is about the axis of symmetry of the cylinder and is defined by the mass **m** and radius **r** of the cylinder. The mass moment **Icc** is about an axis through the centroid perpendicular to the axis of the shell. The mass moment **J** is about the axis perpendicular to **Icc** but offset by a distance **δ**.

$$J=Icc+m\cdot\delta^2 \qquad Icc=\frac{1}{2}\cdot m\cdot r^2+\frac{1}{12}\cdot m\cdot h^2 \qquad Izz=m\cdot r^2$$

Thick Cylindrical Shell

These equations compute the mass moment of inertia of a thick cylindrical shell. The mass moment about the axis of the shell, **Izz**, is defined in terms of inner radius **ri** and outer radius **ro**. The mass moment **Icc** is about an axis through the centroid perpendicular to the axis of the shell. The mass moment **J** is about an axis perpendicular to **Icc** but offset by a distance **δ**.

$$J=Icc+m\cdot\delta^2 \qquad Icc=\frac{1}{4}\cdot m\cdot\left(ri^2+ro^2\right)+\frac{1}{12}\cdot m\cdot h^2 \qquad Izz=\frac{1}{2}\cdot m\cdot\left(ri^2+ro^2\right)$$

Uniform Thin Rod

These equations compute the mass moment of inertia of a thin rod. The mass moment **Icc** is about an axis perpendicular to the length of the rod through its centroid. The mass moment **J** is about an axis perpendicular to **Icc** but offset by a distance **δ**.

$$J=Icc+m\cdot\delta^2 \qquad Icc=\frac{1}{12}\cdot m\cdot h^2$$

Right Circular Cone

These equations describe the properties of a right circular cone, including mass moments of inertia. The first equation defines the slant height **s** in terms of base radius **r** and height of the cone **h**. The second equation specifies the lateral surface area **L** in terms of **r** and **s**. The third equation defines the total surface area **T** in terms of **r** and **s**. The fourth equation defines the volume **V** of a cone in terms of base radius **r** and height **h**. The centroid of the cone is found along the vertical axis a distance **hc** from the base plane. The last three equations define the mass moments of the cone. The mass moment **Icc** is about an axis through the centroid and parallel to the base plane. The mass moment **Izz** is about the vertical axis of the cone. The mass moment **J** is about an axis perpendicular to **Icc** but offset by a distance **δ**.

$$s=\sqrt{r^2+h^2} \qquad L=\pi\cdot r\cdot s \qquad T=\pi\cdot r\cdot(r+s)$$

$$V=\frac{1}{3}\cdot\pi\cdot r^2\cdot h \qquad hc=\frac{3\cdot h}{4} \qquad J=Icc+m\cdot\delta^2$$

$$Icc=\frac{3}{20}\cdot m\cdot r^2+\frac{3}{80}\cdot m\cdot h^2 \qquad Izz=\frac{3}{10}\cdot m\cdot r^2$$

Frustum of Cone

These equations describe the properties of the frustum of a right circular cone. The first equation defines the slant height **s** in terms of base radius **ro** and top radius **ri** and height of the cone **h**. The second equation specifies the lateral surface area **L** in terms of **ro**, **ri** and **s**. The third equation defines the total surface area **T** in terms of **ro**, **ri** and **s**. The fourth equation defines the volume **V** in terms of **ro**, **ri** and height **h**.

$$s=\sqrt{(ro-ri)^2+h^2} \qquad L=\pi\cdot(ro+ri)\cdot s \qquad T=\pi\cdot\left(ro^2+ri^2+(ro+ri)\cdot s\right)$$

$$V=\frac{1}{3}\cdot\pi\cdot h\cdot\left(ro^2+ri^2+ro\cdot ri\right)$$

Chapter 15

Planar Bounded Solids

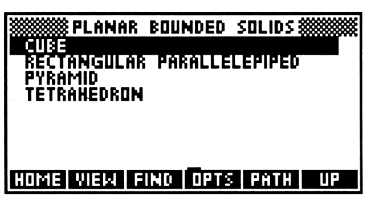
This chapter covers the Equations section on Planar Bounded Solids:

- ❑ Cube
- ❑ Rectangular Parallelepiped
- ❑ Pyramid
- ❑ Tetrahedron

Finding Planar Bounded Solids

To find Planar Bounded Solids, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [→] [LIBRARY] to display available libraries.
HP 48SX users: Press [←] [LIBRARY] to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Equations and press [ENTER] or [►].
❺ Move the highlight bar to Planar Bounded Solids and press [ENTER] or [►].



❻ Move the highlight bar to the desired section and press [ENTER] or [►].
Then skip to the appropriate section below.

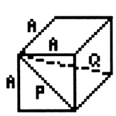
Variables

The table below lists all the variables used in this section, along with a brief description and appropriate units.

Variable	Description	Unit
A	face area	m^2
a	side a	m
B	base area	m^2
b	side b	m
c	side c	m
δ	separation of axes	m
h	altitude	m
Icc	mass moment at centroid	kg*m^2
J	mass moment parallel to Icc axis	kg*m^2
m	mass	kg
p	face diagonal	m
q	solid diagonal	m
T	total surface area	m^2
V	volume	m^3

Cube

These equations describe properties of a cube. The first equation describes the cube face area **A** in terms of the cube side **a**. The second equation shows the total surface area **T** in terms of the face area. The volume **V** is defined in terms of side **a**. The fourth equation links the face diagonal **p** with side **a**, while the fifth equation links the long diagonal **q** with side **a**. The mass moment, **Icc** is about an axis through the cube centroid. The mass moment **Jcc** is about an axis parallel to **Icc** but offset by a distance **δ**. The **Icc** axis is parallel to any side.



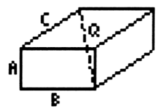
$$A=a^2 \qquad T=6\cdot A \qquad V=a^3$$

$$p=a\cdot\sqrt{2} \qquad q=a\cdot\sqrt{3} \qquad Icc=\frac{1}{6}\cdot m\cdot a^2$$

$$J=Icc+m\cdot\delta^2$$

Rectangular Parallelepiped

These equations describe properties of a rectangular parallelepiped, including the mass moments of inertia. The first two equations link the total surface area **T** and volume **V** with the sides of the parallelepiped **a**, **b** and **c**. The third equation computes the long diagonal **q** in terms of **a**, **b** and **c**. The mass moment **Icc** is about an axis through the centroid and parallel to side **a**. The centroid is located at the center of the parallelepiped. The mass moment parallel to the **Icc** axis, **J,** is defined in terms of **Icc**, **m** and **δ.**



$$T=a\cdot(a\cdot b+b\cdot c+c\cdot a) \qquad V=a\cdot b\cdot c \qquad q=\sqrt{a^2+b^2+c^2}$$

$$Icc=\frac{1}{12}\cdot m\cdot\left(b^2+c^2\right) \qquad J=Icc+m\cdot\delta^2$$

Pyramid

This equation computes the volume **V** of the pyramid in terms of its base area **B** and altitude **h**.

$$V=\frac{1}{3}\cdot B\cdot h$$

Tetrahedron

These equations describe the geometrical properties of a tetrahedron: a pyramid formed by four equilateral triangles. The first equation links face area **A** with the base **a**. The second equation shows the relationship between total surface area **T** and face area **A**. The third equation links the volume **V** of the tetrahedron to the side **a**. The last equation shows the relationship between the altitude **h** of the tetrahedron and side **a**.

$$A=\frac{1}{4}\cdot a^2\cdot\sqrt{3} \qquad T=4\cdot A \qquad V=\frac{1}{12}\cdot a^3\cdot\sqrt{2}$$

$$h=a\cdot\sqrt{\frac{2}{3}}$$

Chapter 16

Polygons

This chapter covers the Equations section on Polygons:

- ❑ Rectangle
- ❑ Parallelogram
- ❑ Rhombus
- ❑ Trapezoid
- ❑ General Quadrilateral
- ❑ Regular Polygon

Finding Polygons

To find Polygons, install Math•*Pro* and do the following:

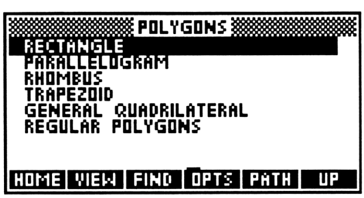
❶ HP 48GX users: Press [→] [LIBRARY] to display available libraries.
HP 48SX users: Press [←] [LIBRARY] to display available libraries.

❷ Press MATH to display the Math•*Pro* library menu.

❸ Press MATH to start Math•*Pro* and show the home screen.

❹ Move the highlight bar to Equations and press [ENTER] or [►].

❺ Move the highlight bar to Polygons and press [ENTER] or [►].



❻ Move the highlight bar to the desired section and press [ENTER] or [►].
Then skip to the appropriate section below.

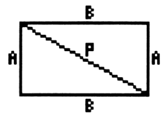
Variables

The table below lists all the variables used in this section, along with a brief description and appropriate units.

Variable	Description	Unit
A	area	m^2
a	side a	m
b	side b	m
c	side c	m
δ	separation of axes	m
d	side d	m
h	altitude	m
I	area moment parallel to Ic axis	m^4
Ic	area moment at centroid	m^4
Icc	mass moment at centroid	kg*m^2
Iz	area moment about z-axis	m^4
Izz	mass moment about z-axis	kg*m^2
J	mass moment parallel to Icc axis	kg*m^2
m	mass	kg
med	median	m
n	number of sides	unitless
p	short diagonal	m
per	perimeter	m
q	long diagonal	m
θ	vertex angle	r
θa	angle θa	r
θb	angle θb	r
rc	circumscribed circle radius	m
ri	inscribed circle radius	m
s	semiperimeter	m

Rectangle

These equations describe the properties of a rectangle, including area and mass moments of inertia and the parallel-axis theorems. The centroid is located at the center of the rectangle. The first three equations in this set show the relationship between area **A**, diagonal **p**, perimeter **per** and the two sides **a** and **b**. The next three equations show the area moment **Ic** about an axis passing through the centroid in the plane of the rectangle, area moment **Iz** about an axis through the centroid normal to the plane of the rectangle and the area moment **I** about an axis a distance **δ** from the centroid in the plane of the rectangle. The corresponding mass moments are **Icc**, **Izz** and **J** as shown in the last three equations.



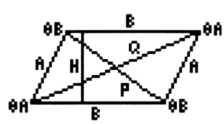
$$A=a\cdot b \qquad p^2=a^2+b^2 \qquad per=2\cdot a+2\cdot b$$

$$I=Ic+A\cdot\delta^2 \qquad Ic=\frac{1}{12}\cdot a\cdot b^3 \qquad Iz=\frac{1}{12}\cdot a\cdot b\cdot\left(a^2+b^2\right)$$

$$J=Icc+m\cdot\delta^2 \qquad Icc=\frac{1}{12}\cdot m\cdot b^2 \qquad Izz=\frac{1}{12}\cdot m\cdot\left(a^2+b^2\right)$$

Parallelogram

These equations describe the properties of a parallelogram. The first equation computes the area **A** of the parallelogram in terms of side **a** and altitude **h**. The second equation defines altitude, **h**, in terms of side **b** and angle **θa.** The perimeter **per** is given by the third equation. The fourth and fifth equations define the short and the long diagonals **p** and **q** of the parallelogram in terms of the sides **a** and **b** and the angles **θa** and **θb**. The last equation of this set shows the supplementary property of **θa** and **θb**. When solving for **θa** or **θb**, an appropriate initial guess may help the solver find a solution in the desired quadrant.



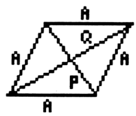
$$A=b\cdot h \qquad h=a\cdot\text{SIN}(\theta a) \qquad per=2\cdot a+2\cdot b$$

$$p^2=a^2+b^2-2\cdot a\cdot b\cdot\text{COS}(\theta a) \qquad q^2=a^2+b^2-2\cdot a\cdot b\cdot\text{COS}(\theta b)$$

$$\theta a+\theta b=180\_^\circ$$

Rhombus

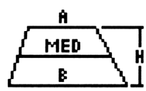
These equations show the properties of a rhombus, a regular four sided figure with all equal sides. The first equation calculates the area **A** in terms of its long and short diagonal **p** and **q**. The second equation relates perimeter **per** with the side of the rhombus **a**. The final equation shows the relationship between **p**, **q** and **a**.



$$A=\frac{1}{2}\cdot p\cdot q \qquad per=4\cdot a \qquad p^2+q^2=4\cdot a^2$$

Trapezoid

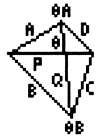
These equations define some of the basic properties of a trapezoid. The first equation connects the area of the trapezoid **A** with the two parallel sides **a** and **b** and the altitude, **h**. The second defines **A** in terms of **med** and **h**. The third equation defines **med** in terms of **a** and **b**.



$$A=\frac{1}{2}\cdot(a+b)\cdot h \qquad A=med\cdot h \qquad med=\frac{1}{2}\cdot(a+b)$$

General Quadrilateral

These equations describe the properties of a general quadrilateral of sides **a**, **b**, **c** and **d**. The first two equations define the semiperimeter, **s**, and perimeter, **per**, in terms of the four sides: **a**, **b**, **c** and **d**. The third equation relates the area, **A**, to the diagonals **p** and **q** and the acute angle of intersection of the diagonals, **θ**. The next equation defines the area, **A**, in terms of the four sides, **a**, **b**, **c** and **d**, and the angle **θ**. The fifth equation computes the area in terms of the four sides, **a**, **b**, **c**, and **d**, and the two diagonals **p** and **q**, but not the angle **θ**. The sixth equation is the extension of the classical triangle equation to a quadrilateral, and defines the area, **A**, in terms of the four sides, **a**, **b**, **c**, and **d**, the semiperimeter, **s**, and the two exterior angles, **θa** and **θb**. The final two equations show the relationship between the short diagonal, **p**, and either sides **a** and **d** and angle **θa** or sides **b** and **c** and angle **θb**. When solving for **θ**, **θa**, or **θb**, an appropriate initial guess may help the solver find solution in the desired quadrant.



$$s=\frac{1}{2}\cdot(a+b+c+d) \qquad per=2\cdot s \qquad A=\frac{1}{2}\cdot p\cdot q\cdot SIN(\theta)$$

$$A=\frac{1}{4}\cdot\left(b^2+d^2-a^2-c^2\right)\cdot TAN(\theta) \qquad A^2=\frac{1}{16}\cdot\left(4\cdot p^2\cdot q^2-\left(b^2+d^2-a^2-c^2\right)^2\right)$$

$$A^2=(s-a)\cdot(s-b)\cdot(s-c)\cdot(s-d)-a\cdot b\cdot c\cdot d\cdot COS\left(\frac{\theta a+\theta b}{2}\right)^2$$

$$p^2=a^2+d^2-2\cdot a\cdot d\cdot COS(\theta a) \qquad p^2=b^2+c^2-2\cdot b\cdot c\cdot COS(\theta b)$$

Regular Polygon

These equations describe key properties of a regular polygon. The first equation expresses the relationship between the side **a** of the polygon and inscribed circle radius **ri** and **n** the number of sides of the regular polygon. The second equation shows the connection between circumscribed circle radius **rc**, and **a** and **n**. The total perimeter **per** is defined by **n** and **a**. The area of the regular polygon **A**, is computed using the fourth equation in terms of **ri** and **n**. The last equation solves for the angle **θ** formed by two adjacent sides of a regular polygon. When solving for **θ**, an appropriate initial guess may help the solver find a solution in the desired quadrant.

$$a=2\cdot ri\cdot TAN\left(\frac{180\_°}{n}\right) \qquad a=2\cdot rc\cdot SIN\left(\frac{180\_°}{n}\right) \qquad per=n\cdot a$$

$$A=n\cdot ri^2\cdot TAN\left(\frac{180\_°}{n}\right) \qquad \theta=\frac{n-2}{n}\cdot 180\_°$$

Chapter 17

Spherical Figures

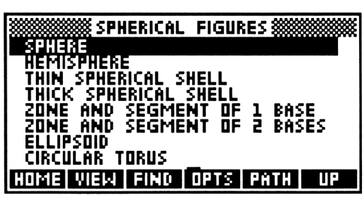
This chapter covers the Equations section on Spherical Figures:

- ❑ Sphere
- ❑ Hemisphere
- ❑ Thin Spherical Shell
- ❑ Thick Spherical Shell
- ❑ Zone and Segment of 1 Base
- ❑ Zone and Segment of 2 Bases
- ❑ Ellipsoid
- ❑ Circular Torus

Finding Spherical Figures

To find Spherical Figures, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [↱] [LIBRARY] to display available libraries.
HP 48SX users: Press [↰] [LIBRARY] to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Equations and press [ENTER] or [►].
❺ Move the highlight bar to Spherical Figures and press [ENTER] or [►].



❻ Move the highlight bar to the desired section and press [ENTER] or [►].
Then skip to the appropriate section below.

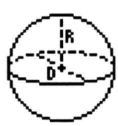
Variables

The table below lists all the variables used in this section, along with a brief description and appropriate units.

Variable	Description	Unit
a	semiaxis a	m
b	semiaxis b	m
c	semiaxis c	m
d	sphere diameter	m
δ	separation of axes	m
h	zone altitude	m
hc	height of centroid	m
Icc	mass moment at centroid	kg*m^2
Izz	mass moment about z-axis	kg*m^2
J	mass moment parallel to Icc axis	kg*m^2
m	mass	kg
p	zone diagonal	m
r	sphere radius	m
r1	zone base radius	m
r2	zone ceiling radius	m
ri	inner radius	m
ro	outer radius	m
S	surface area	m^2
V	volume	m^3

Sphere

These equations constitute properties of a sphere. The first equation links the diameter **d** with the radius **r**. The second equation defines the surface area **S** in terms of the radius **r**. The third equation specifies the volume **V** in terms of the radius **r**. The mass moment **Icc** is about an axis through the centroid. The mass moment **J** is about an axis perpendicular to **Icc** but offset by a distance **δ**.



$$d=2\cdot r \qquad S=4\cdot\pi\cdot r^2 \qquad V=\frac{4}{3}\cdot\pi\cdot r^3$$

$$J=Icc+m\cdot\delta^2 \qquad Icc=\frac{2}{5}\cdot m\cdot r^2$$

Hemisphere

These equations constitute properties of a hemisphere. The first equation links the diameter **d** with the radius **r**. The second equation defines the surface area **S** in terms of the sphere radius **r**. The third equation specifies the volume **V** of the sphere in terms of its radius **r**. The centroid is located along the vertical axis of the hemisphere a distance **hc** above the base plane. The last three equations focus on mass moment computation. The mass moment **Icc** about an axis through the centroid of the hemisphere and parallel to the base plane is given by the next to last equation. The mass moment **Izz** is about the vertical axis of the hemisphere. The mass moment **J** is about an axis parallel to **Icc**, but offset by a distance **δ,** as shown by the last equation.

$$d=2\cdot r \qquad S=2\cdot\pi\cdot r^2 \qquad V=\frac{2}{3}\cdot\pi\cdot r^3$$

$$hc=\frac{3\cdot r}{8} \qquad J=Icc+m\cdot\delta^2 \qquad Icc=\frac{83}{320}\cdot m\cdot r^2$$

$$Izz=\frac{2}{5}\cdot m\cdot r^2$$

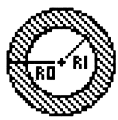
Thin Spherical Shell

These equations describe the mass moments of inertia of a thin spherical shell. The thickness of the shell is negligible. The mass moment **Icc** is about an axis through the centroid in terms of the mass of the shell **m** and the radius **r**. The mass moment **J** is about an axis parallel to the **Icc** axis but offset a distance **δ**. The picture shows a cross-section of the thin spherical shell.

$$J=Icc+m\cdot\delta^2 \qquad Icc=\frac{2}{3}\cdot m\cdot r^2$$

Thick Spherical Shell

These equations describe the mass moments of inertia of a thick spherical shell. The mass moment **Icc** is about an axis through the centroid in terms of the mass of the shell **m** and the inner radius **ri** and outer radius **ro**. The mass moment **J** is about an axis parallel to the **Icc** axis but offset a distance **δ**. The picture shows a cross-section of the thick spherical shell.



$$J=Icc+m\cdot\delta^2 \qquad Icc=\frac{\frac{2}{5}\cdot m\cdot\left(ro^5-ri^5\right)}{ro^3-ri^3}$$

Zone and Segment of 1 Base

These equations in this topic describe geometrical properties of a spherical zone segment with one base. The first equation shows the relationship between the diameter **d** and the radius of the sphere **r**. The second equation specifies **S**, the surface area of the zone segment, in terms of radius **r** and the height **h**. The third equation gives an alternate form for **S** in terms of the zone diagonal **p**. The last two equations represent the volume **V** of the zone segment in two distinct ways: the first using sphere radius **r** and zone height **h** as the key variables, while the second equation uses zone base radius **r1** and zone height **h** as its variables.

$$d=2\cdot r \qquad S=2\cdot\pi\cdot r\cdot h \qquad S=\pi\cdot p^2$$

$$V=\frac{1}{3}\cdot\pi\cdot h^2\cdot(3\cdot r-h) \qquad V=\frac{1}{6}\cdot\pi\cdot h\cdot\left(3\cdot r1^2+h^2\right)$$

Zone and Segment of 2 Bases

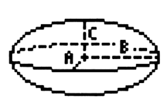
These equations describe geometrical properties of a spherical zone segment with two parallel bases. The first equation shows the relationship between the diameter **d** and the radius of the sphere **r**. The second equation specifies **S**, the surface area of the zone segment, in terms of radius **r** and the height **h**. The third equation gives the volume **V** of the zone segment in terms of zone base radius **r1** and zone ceiling radius **r2** and the segment height **h**. The last equation specifies **h** in terms of **r**, **r1** and **r2**.

$$d=2\cdot r \qquad S=2\cdot\pi\cdot r\cdot h \qquad V=\frac{1}{6}\cdot\pi\cdot h\cdot\left(3\cdot r1^2+3\cdot r2^2+h^2\right)$$

$$h=\sqrt{r^2-r2^2}-\sqrt{r^2-r1^2}$$

Ellipsoid

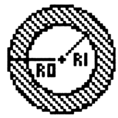
These equations describe an ellipsoid, including mass moments of inertia. The volume of the ellipsoid **V** is given by the first equation in terms of its three semiaxes **a**, **b** and **c**. The mass moment **Icc** is about the semiaxis **a** and through the centroid of the ellipsoid. The third equation shows the mass moment **J** about an axis parallel to **Icc** axis but offset by a distance **δ**. The centroid of the ellipsoid is at the center of the ellipsoid.



$$V=\frac{4}{3}\cdot\pi\cdot a\cdot b\cdot c \qquad J=Icc+m\cdot\delta^2 \qquad Icc=\frac{1}{5}\cdot m\cdot\left(b^2+c^2\right)$$

Circular Torus

These equations describe the properties of a circular torus. The picture is a cross-section of the circular torus. The first equation specifies the total surface area of the torus. The second equation represents the volume **V** of the torus in terms of inner radius **ri** and outer radius **ro**.



$$S=\pi^2\cdot\left(ro^2-ri^2\right) \qquad V=\frac{1}{4}\cdot\pi^2\cdot(ro+ri)\cdot(ro-ri)^2$$

Chapter 18

Triangles

This chapter covers the Equations section on Triangles:

- ❑ Right Triangles
- ❑ Equilateral Triangles
- ❑ General Triangles
- ❑ Laws of SIN, COS and TAN

Finding Triangles

To find Triangles, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [↱] [LIBRARY] to display available libraries.
HP 48SX users: Press [↰] [LIBRARY] to display available libraries.
❷ Press **MATH** to display the Math•*Pro* library menu.
❸ Press **MATH** to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Equations and press [ENTER] or [►].
❺ Move the highlight bar to Triangles and press [ENTER] or [►].

❻ Move the highlight bar to the desired section and press [ENTER] or [►]. Then skip to the appropriate section below.

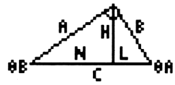
Variables

The table below lists all variables used in this section, along with a brief description and appropriate units.

Variable	Description	Unit
A	area	m^2
a	side a	m
b	side b	m
c	side c	m
δ	separation of axes	m
h	altitude	m
hc	height of centroid	m
I	area moment parallel to Ic axis	m^4
Ic	area moment at centroid	m^4
Iz	area moment about z-axis	m^4
l	distance to vertex	m
med	median to side c	m
n	distance to vertex	m
per	perimeter	m
θa	angle opposite side a	r
θb	angle opposite side b	r
θc	angle opposite side c	r
s	semiperimeter	m
t	bisector of θc	m

Right Triangle

These equations describe the properties of a right triangle. The first three equations link the hypotenuse **c**, area **A** and perimeter **per** with the sides of the triangle **a**, **b** and **c**. The next three equations connect the height **h**, vertex distances **l** and **n** to the sides **a**, **b** and **c**. The next equation shows the relationship between **a**, **c** and **θa**. The next equation shows that the sum of **θa** and **θb** is 90°. An alternative link between **l**, **b** and **θa** is shown by the next equation. The height of the centroid from the base is shown by the equation connecting **hc** and **h**. The last three equations compute area moment **Ic** about an axis through the centroid in the plane of the triangle, area moment **Iz** about an axis through the centroid and normal to the plane of the triangle and the area moment, **I**, about an axis in the plane of the triangle a distance **δ** away from the centroid. When solving for **θa** or **θb**, an appropriate initial guess may help the solver find a solution in the desired quadrant.



$$c^2=a^2+b^2 \qquad A=\frac{1}{2}\cdot a\cdot b \qquad per=a+b+c$$

$$h=\frac{a\cdot b}{c} \qquad l=\frac{b^2}{c} \qquad n=\frac{a^2}{c}$$

$$a=c\cdot SIN(\theta a) \qquad \theta a+\theta b=90\_° \qquad l=b\cdot COS(\theta a)$$

$$hc=\frac{h}{3} \qquad I=Ic+A\cdot\delta^2 \qquad Ic=\frac{1}{36}\cdot c\cdot h^3$$

$$Iz=\frac{1}{36}\cdot c\cdot h\cdot\left(h^2+c^2-c\cdot l+l^2\right)$$

Equilateral Triangle

These equations shown below describing the properties of an equilateral triangle. The first two equations link the area **A** and perimeter **per** with side **a**. Third and fourth equations define the altitude of the equilateral triangle **h** and the height of the centroid from the base **hc** in terms of the side of the triangle **a**. The last three equations compute the area moment **Ic**, about an axis through the centroid in the plane of the triangle, area moment **Iz**, about an axis through the centroid normal to the plane of the triangle and area moment **I**, about an axis in the plane of the triangle a distance **δ** away from the centroid.

$$A=\frac{1}{4}\cdot a^2\cdot\sqrt{3} \qquad per=3\cdot a \qquad h=\frac{1}{2}\cdot a\cdot\sqrt{3}$$

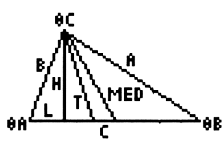
$$hc=\frac{h}{3} \qquad I=Ic+A\cdot\delta^2 \qquad Ic=\frac{1}{36}\cdot a\cdot h^3$$

$$Iz=\frac{1}{36}\cdot a\cdot h^3+\frac{7}{9}\cdot a^3\cdot h$$

General Triangle

The equations presented in this set solve a variety of types of problems relating to triangles. These equations characterize the properties of a general triangle, which is defined by the angles **θa**, **θb** and **θc**, which are opposite the sides **a, b** and **c**. An important property of a general triangle is that the sum of **θa**, **θb** and **θc** is 180°, and this is shown by the first equation. The next three equations are the three alternate forms of the Law of Cosines, and they relate one angle of the triangle to the three sides. The following three equations are the three alternative forms of the Law of Sines, and they relate two sides to two angles of the triangle. The next two equations indicate the relationship between the area, **A**, and the altitude, **h**, the side **c**, and the three angles. Two more equations define the semiperimeter, **s**, and the perimeter, **per**, in terms of the three sides.

The 12th equation links the area, A, with the semiperimeter and the three sides. The bisector of angle **θc** is defined by **t** in the picture, and its value is computed using **a**, **b** and **θc**. The median to side **c** from angle **θc** is defined in terms of the three sides. Next is given **l**, the distance from angle **θa** to the intersection of the altitude, **h**, and side **c**, using the basic definition of cosine. The height of the centroid, **hc**, is given in terms of the altitude, **h**. The last three equations focus on computing the area moment **Ic** about an axis in the plane of the triangle through the centroid, area moment **Iz** about an axis through the centroid normal to the plane of the triangle and area moment **I** about an axis in the plane of the triangle a distance **δ** from the centroid. When solving for **θa**, **θb** or **θc**, an appropriate initial guess may help the solver find solution in the desired quadrant.



$$\theta a+\theta b+\theta c=180\_°$$

$$a^2=b^2+c^2-2\cdot b\cdot c\cdot COS(\theta a)$$

$$b^2=c^2+a^2-2\cdot c\cdot a\cdot COS(\theta b)$$

$$c^2=a^2+b^2-2\cdot a\cdot b\cdot COS(\theta c)$$

$$\frac{a}{SIN(\theta a)}=\frac{b}{SIN(\theta b)} \qquad \frac{b}{SIN(\theta b)}=\frac{c}{SIN(\theta c)} \qquad \frac{c}{SIN(\theta c)}=\frac{a}{SIN(\theta a)}$$

$$A=\frac{1}{2}\cdot h\cdot c$$

$$A=\frac{c^2\cdot SIN(\theta a)\cdot SIN(\theta b)}{2\cdot SIN(\theta c)}$$

$$s=\frac{1}{2}\cdot(a+b+c) \qquad per=2\cdot s \qquad A^2=s\cdot(s-a)\cdot(s-b)\cdot(s-c)$$

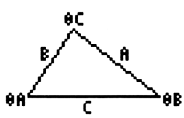
$$t=2\cdot\left(\frac{a\cdot b}{a+b}\right)\cdot\mathrm{COS}\left(\frac{\theta c}{2}\right) \qquad med^2=\frac{a^2}{2}+\frac{b^2}{2}-\frac{c^2}{4}$$

$$l=b\cdot\mathrm{COS}(\theta a) \qquad hc=\frac{h}{3} \qquad I=Ic+A\cdot\delta^2$$

$$Ic=\frac{1}{36}\cdot c\cdot h^3 \qquad Iz=\frac{1}{36}\cdot c\cdot h\cdot\left(h^2+c^2-c\cdot l+l^2\right)$$

Laws of SIN, COS, TAN

These equations define the general form of the Law of Sines, the Law of Cosines, and the Law of Tangents. An important property of a triangle is that the sum of **θa**, **θb** and **θc** is 180°, and this is shown by the first equation. The second equation is the Law of Sines, and it relates the two sides **a** and **b** to the two opposite angles **θa** and **θb**. The third equation is the Law of Cosines, and it relates the three sides **a**, **b** and **c**, to the angle **θa**. (If a different angle than **θa** is known, imagine rotating the triangle until the known angle corresponds to **θa** in the picture.) The fourth equation is the Law of Tangents, and it relates the two sides **a** and **b** to the two opposite angles **θa** and **θb**. When solving for **θa**, **θb** or **θc**, an appropriate initial guess may help the solver find solution in the desired quadrant.



$$\theta a+\theta b+\theta c=180\_° \qquad \frac{a}{\mathrm{SIN}(\theta a)}=\frac{b}{\mathrm{SIN}(\theta b)}$$

$$a^2=b^2+c^2-2\cdot b\cdot c\cdot\mathrm{COS}(\theta a) \qquad \frac{a+b}{a-b}=\frac{\mathrm{TAN}\left(\frac{1}{2}\cdot(\theta a+\theta b)\right)}{\mathrm{TAN}\left(\frac{1}{2}\cdot(\theta a-\theta b)\right)}$$

Part 3

Reference

Chapter 19

Reference Tutorial

Math•*Pro* is divided into three major sections: Analysis, Equations, and Reference. This chapter addresses the Reference section, which includes reference tables covering constants, derivatives, Greek alphabet, hyperbolics, integrals, quadric surfaces, series, SI prefixes, transforms, trigonometry and vectors.

The reference tables contain indispensable information for solving problems. You can find physical constants, solve derivatives, look up hyperbolic or trigonometric identities, scan through and solve hundreds of integrals, access Fourier, Laplace, and Z transforms, determine vector formulas—all with context-sensitive help. Many reference tables include a picture or custom solving routine based on the information contained in the table.

This chapter is a tutorial designed to introduce you to the reference tables, show you the keys available at each screen, and provide numerous examples to help you learn to efficiently use the reference tables.

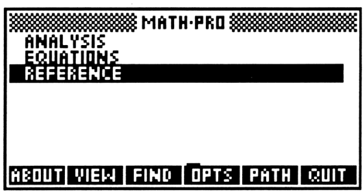
This chapter covers:

- ❑ Finding Reference
- ❑ Reference Screens
- ❑ Options Menu
- ❑ Custom Settings Screen
- ❑ Reference Screen Key Summary
- ❑ Options Menu Key Summary

Finding Reference

The Reference section is found at the home screen of Math•*Pro*. To get there, first install Math•*Pro* as described in Chapter 1, "Getting Started." Then, to start Math•*Pro*:

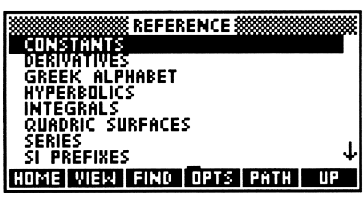
- ❑ HP 48GX users: Press [↱] [LIBRARY] MATH MATH.
- ❑ HP 48SX users: Press [↰] [LIBRARY] MATH MATH.



This is the home screen. To return here at any time, press [↱] [HOME] or [↱] [◄]. Move the highlight bar to Reference and press [ENTER] or [►] to select that section.

Reference Screens

Math•*Pro* is structured with screens to choose a specific topic or item. The screen now displays Reference as its title, and lists selections, as shown in the screen below. Pressing [ENTER] or [►] selects the category of your choice. Pressing [◄] or UP returns you to the previous screen, or HOME returns you to the home screen.



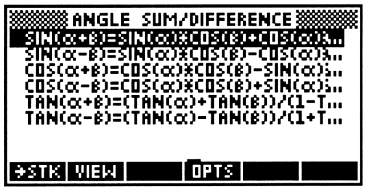
This section covers:

- ❑ Using a Reference Table
- ❑ Using a Reference Table which Solves
- ❑ Reference Screen Menu Keys

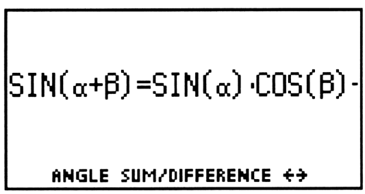
Using a Reference Table

Most reference tables contain specific information organized in the same manner as a printed reference book. The information may consist of data, equations, text, or a combination of these types.

Example: *Look up a trigonometric identity.* What is the expanded form of $\sin(\alpha+\beta)$? The answer can be found in the Trigonometry section. Move the highlight bar to Trigonometry and press [ENTER] or [►]. Then move the highlight bar to Angle Sum/Difference and press [ENTER] or [►].



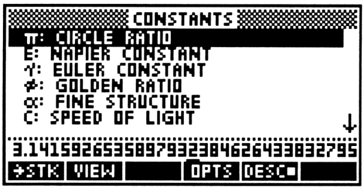
The first equation is the desired identity. Press [←] **VIEW** or [→] **VIEW** to display the equation in a graphics view.



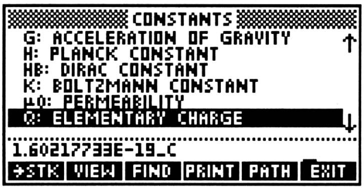
Press [◄] or [►] to scroll. Press any key to return to the previous screen.

Example: *Look up a constant.* What is the elementary charge on an electron? The answer can be found in the Constants section. If necessary, type [◄][◄] to go to the Reference section. Then move the highlight bar to Constants and press [ENTER] or [►].

The screen displays the constants and their values, and the help text contains the name of the constant. Instead of scrolling through this list, search for the word "charge" in the name of a constant. First, press **DESC** or [VAR] to toggle the position of the constant values and the help text, because FIND only searches the information shown on the main display area (not the help text).



To activate the search feature, press OPTS NXT FIND. The search feature is not case-sensitive, so type CHARGE and press ENTER.



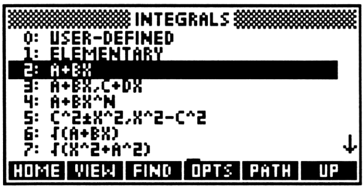
The elementary charge is the constant q and its value is 1.60217733E-19 C. Press EXIT to leave the options menu.

(Note: When you exit the Constants section, the position of the constant values and the help text will revert to the default setting. Pressing DESC only toggles the positions while you are at a particular screen.)

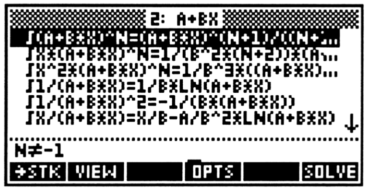
Using a Reference Table which Solves

Example: *Look up and solve an indefinite integral.* What is $\int (2+7x)^3 dx$?

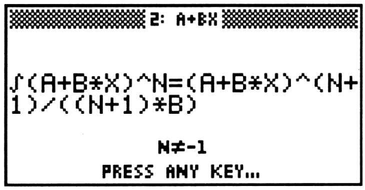
The answer can be found in the Integrals section. If necessary, press ◄ to go to the Reference section. Then move the highlight bar to Integrals and press ENTER or ►.



The integrand $2+7x$ is of the form A+BX, so move the highlight bar to A+BX and press ENTER or ►.



The first integral in the list matches the integrand form, so it should be used to solve the problem. Because the integral is too wide for the screen, you can examine it fully by pressing VIEW to see it in a text view.



The statement N≠1 is a constraint (special condition) for the integral. Press any key to return to the previous screen.

To solve the integral, make sure the highlight bar is still at the first integral and press SOLVE. Type in 2 for A, 7 for B, and 3 for N. Press SOLVE.

The answer is $\int (2+7x)^3 dx = \frac{(2+7x)^4}{28} + C$. In the answer, C represents a constant of integration, which remains unspecified for the indefinite result.

Reference Screen Menu Keys

These are descriptions of the various menu keys available at a Reference screen:

→STK Copies one or all of the items shown to the HP 48 stack. For more information, see "Options Menu."

VIEW Displays the highlighted item in a text view. For more information, see "Options Menu."

PICT — Displays a picture (if appropriate). This key will not appear for reference tables which do not have a picture.

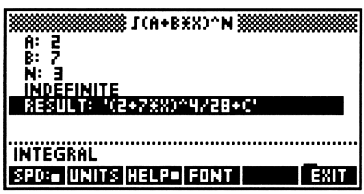
OPTS — Displays the option menu. For more information, see “Options Menu.”

DESC▪ — Toggles positions of data and help text (if appropriate). This key will not appear for reference tables which do not have switchable help text. For more information, see “Options Menu.”

SOLVE — Activates the custom solving routine (if appropriate). This key will not appear for reference tables which do not have a custom solving routine.

Options Menu

The options menu helps you customize settings and is available throughout Math•*Pro*. Pressing OPTS displays the following menu keys:



SPD: ▪ — Changes the scrolling speed of the highlight bar. The bar on the right shows the current level of speed: a tall bar indicates fast scrolling speed, while a short bar indicates slow scrolling speed.

UNITS — Toggles units on or off. When the block inside the key appears (UNIT▪), units are turned on.

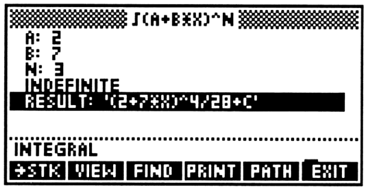
HELP — Toggles display of help text on the bottom of the screen. When the block inside the key appears (HELP▪), help is turned on.

FONT — Toggles font size between large and small. The large font is case-sensitive, while the small font contains condensed, uppercase letters.

DESC — Toggles positions of data and help text (if appropriate). When the block inside the key appears (DESC▪), then the data and help text are switched. This key will not appear for reference tables which do not have switchable help text.

EXIT Leaves the options menu. Returns to the regular menu.

At the options menu, press [NXT] to display the following additional menu keys:



→STK Copies one or all of the items shown to the HP 48 stack. Pressing this key prompts you for **ONE** or **ALL**.

VIEW Displays the highlighted item in a text view. This is useful if the screen is displayed in the large font and the item scrolls off the right side of the screen with "..." (an ellipsis) displayed. Press [◄] or [►] **VIEW** to display the highlighted item in a graphics view.

FIND Searches for the specified character or string. **FIND** only searches the current screen for a match.

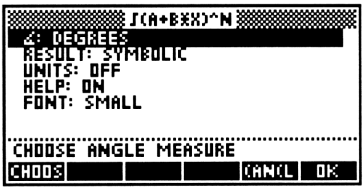
PRINT Prints one or all of the items shown to an HP 48 printer.

PATH Displays screens chosen to reach the current screen. After pressing this key, you will see the path listing in the title bar of the screen. Press **→STK** to place this path list on the stack.

EXIT Leaves the options menu. Returns to the regular menu.

Custom Settings Screen

The custom settings screen is displayed by pressing CST and is available throughout Math•*Pro*.



To change any of these settings, move the highlight bar to the desired item and press CHOOS or +/-. Then press OK to implement the changes, or to exit the screen without changing the settings, press CANCL or ON.

Settings Descriptions

- ❑ ∠: *Angle measure*: Press CHOOS to select degrees, radians, or grads. Determines how trigonometric/hyperbolic functions will interpret inputs.

- ❑ **RESULT:** *Result mode*: Press CHOOS to select symbolic or numeric. Determines whether functions will return symbolic or numeric results.

- ❑ **UNITS:** *Units*: Press CHOOS to select on or off. Determines whether units are on or off for Equations and Reference.

- ❑ **HELP:** *Help text*: Press CHOOS to select on or off. Determines whether context-sensitive help text is displayed on the screen.

- ❑ **FONT:** *Font size*: Press CHOOS to select on or off. Determines whether screens use the large or small font to display items.

Reference Screen Key Summary

Key	Action
→STK	Copies one or all of the items shown to the HP 48 stack.
VIEW	Displays the highlighted item in a text view. Press ⮫ or ⮪ VIEW to show the item in a graphics view.
PICT	Displays a picture (if appropriate).
OPTS	Displays the option menu.
DESC▪	Toggles positions of data and help text (if appropriate).
SOLVE	Activates the custom solving routine (if appropriate).

Key	Action
▲ or ▼	Moves the highlight bar up or down one item.
⮪ ▲ or ⮪ ▼	Moves the highlight bar to top or bottom of screen.
⮫ ▲ or ⮫ ▼	Moves the highlight bar to top or bottom of list.
◄ or ⮪ UP	Goes to the previous screen.
⮫ ◄ or ⮫ HOME	Goes to the home screen.
ENTER or ►	Enters the highlighted section (for a screen). Edits the highlighted item (for an edit field). Activates the custom solving routine (if appropriate). Copies item(s) shown to the stack (for a result field).
NXT or ⮪ PREV	Goes to the next or previous menu row (if appropriate).
CST	Goes to the custom settings screen.
⮪ CST or ⮫ CST	Goes to the first or second page of the options menu.
VAR	Toggles positions of data and help text (if appropriate).
⮪ UNITS or ⮫ UNITS	Toggles units on or off.
⮫ CMD	HP 48GX: Displays the highlighted item in a text view.
⮫ VISIT	HP 48SX: Displays the highlighted item in a text view.
ON	Quits Math•*Pro* to the HP 48 stack.

Options Menu Key Summary

Key	Action
SPD:■	Changes the scrolling speed of the highlight bar.
UNIT▪	Toggles units on or off.
HELP▪	Toggles display of help text at the bottom of the screen.
FONT	Toggles font size between large and small.
DESC▪	Toggles positions of data and help text (if appropriate).
→STK	Copies one or all of the items shown to the HP 48 stack.
VIEW	Displays the highlighted item in a text view. Press [→] or [←] VIEW to show the item in a graphics view.
FIND	Searches for the specified character or string.
PRINT	Prints one or all of the items shown to an HP 48 printer.
PATH	Displays screens chosen to reach the current screen.
EXIT	Leaves the options menu.

Chapter 20

Constants

Constants includes 43 constants, which can be viewed, copied to the stack, or printed.

This chapter covers:

- ❑ Finding Constants
- ❑ Using Constants

Finding Constants

To find Constants, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [↱] [LIBRARY] to display available libraries.
HP 48SX users: Press [↰] [LIBRARY] to display available libraries.
❷ Press **MATH** to display the Math•*Pro* library menu.
❸ Press **MATH** to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Reference and press [ENTER] or [►].
❺ Move the highlight bar to Constants and press [ENTER] or [►].

Using Constants

To select a constant, scroll through the Constants section with ▲ and ▼ or search with FIND. When you have found the desired item:

- ❑ Press VIEW to display it in a text view.
- ❑ Press →STK to copy one or all to the HP 48 stack.
- ❑ Press OPTS NXT PRINT to print one or all to a printer.

When you have finished with Constants, press ◄ to go to the previous screen, ↱ HOME to go to the home screen, or ON to quit Math•*Pro*.

Example: Look up the value of the Boltzmann constant. To search for it, press OPTS NXT FIND, type 1.38 and press ENTER to start the search. The highlight bar will move to the first match, which is the answer. Press VIEW to display the constant in a text view:

When you have finished viewing the constant, press any key to return to the previous screen. Press EXIT to exit the options menu.

Notes

Based on Cohen and Taylor, *The 1986 adjustment of the fundamental physical constants*, Rev. Mod. Phys., Vol. 59, No. 4, October 1987, 1139-1145.

Chapter 21

Derivatives

Derivatives includes 41 derivatives, which can be viewed, copied to the stack, printed, or solved.

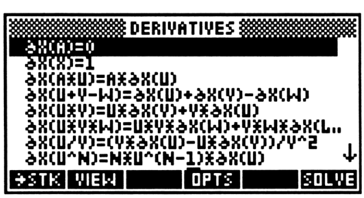
This chapter covers:

- ❑ Finding Derivatives
- ❑ Using Derivatives
- ❑ Solving Derivatives
- ❑ Derivatives Reference

Finding Derivatives

To find Derivatives, install Math•*Pro* and do the following:

❶ HP 48GX users: Press ⮫ LIBRARY to display available libraries.
HP 48SX users: Press ⮪ LIBRARY to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Reference and press ENTER or ▶.
❺ Move the highlight bar to Derivatives and press ENTER or ▶.



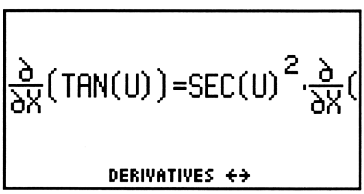
Using Derivatives

To select a derivative, scroll through the Derivatives section with [▲] and [▼] or search with [FIND]. When you have found the desired item:

- ❑ Press [VIEW] to display it in a text view.
- ❑ Press [⬅] or [➡][VIEW] to display it in a graphics view.
- ❑ Press [→STK] to copy one or all to the HP 48 stack.
- ❑ Press [OPTS] [NXT] [PRINT] to print one or all to a printer.
- ❑ Press [SOLVE] to solve it.

When you have finished with Derivatives, press [◄] to go to the previous screen, [➡][HOME] to go to the home screen, or [ON] to quit Math•*Pro*.

Example: *Look up a derivative.* What is $\frac{\partial}{\partial x}\tan(x)$? To search for it, press [OPTS] [NXT] [FIND], type TAN and press [ENTER] to start searching. The highlight bar will move to the first match, which is the answer. Press [⬅][VIEW] to display the derivative in a graphics view:



When you have finished viewing the derivative, press any key to return to the previous screen. Press [EXIT] to exit the options menu.

Solving Derivatives

All of the derivatives are templates for solving, and each template is useful for solving derivatives of a particular form. Each form contains one or more "place holder" variables for you to enter your own functions and constants:

- ❑ A, N, and M are place holders for *constants with respect to X* (such as 10).

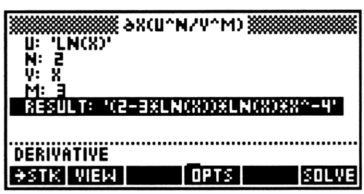
- ❑ U, V, and W are place holders for *functions of X* (such as $\ln(X)$ or X^3) or for *constants with respect to X* (such as 10 or π).

- ❑ If you enter an expression containing a variable other than X (such as 3*Y or Z^2 or R+S) for A, N, M, U, V, or W, it will be treated as constant with respect to X, and the derivative result will reflect that assumption. If the other variables are actually functions of X, they must be entered as Y(X), Z(X), etc., but this means the result may contain derY(X,1), derZ(X,1), etc., which represents the user-defined derivatives of Y and Z.

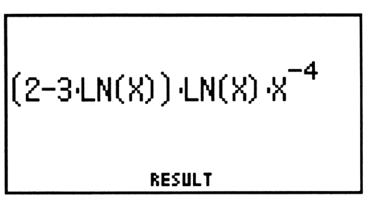
To solve a derivative, scroll through the Derivatives section with [▲] and [▼] or search with FIND. When you have found the desired item, press SOLVE. Then replace the place holder variables in the derivative and press SOLVE to calculate the derivative.

When you have finished with Derivatives, press [◄] to go to the previous screen, [↱] [HOME] to go to the home screen, or [ON] to quit Math•*Pro*.

Example: *Solve a derivative.* What is $\dfrac{\partial}{\partial X}\dfrac{[\ln(X)]^2}{X^3}$? This derivative is of the form $\dfrac{U^N}{V^M}$, where U, V, N, and M are place holder variables. For this example, U is $\ln(X)$, N is 2, V is X, and M is 3. Press [↱] [▲] [↰] [▼] [▼] [▼] [▼] [▼] to move the highlight bar to the appropriate derivative and press SOLVE. Type in [↱] [LN] [α] X for U, 2 for N, [α] X for V, and 3 for M. Press SOLVE.



Press [↰] VIEW to view the result in a graphics view:



When you have finished viewing the derivative, press any key to return to the previous screen.

Derivatives Reference

$\frac{\partial}{\partial X}(A)$	$\frac{\partial}{\partial X}(X)$	$\frac{\partial}{\partial X}(A \cdot U)$
$\frac{\partial}{\partial X}(U+V-W)$	$\frac{\partial}{\partial X}(U \cdot V)$	$\frac{\partial}{\partial X}(U \cdot V \cdot W)$
$\frac{\partial}{\partial X}\left(\frac{U}{V}\right)$	$\frac{\partial}{\partial X}\left(U^{N}\right)$	$\frac{\partial}{\partial X}(\sqrt{U})$
$\frac{\partial}{\partial X}\left(\frac{1}{U}\right)$	$\frac{\partial}{\partial X}\left(\frac{1}{U^{N}}\right)$	$\frac{\partial}{\partial X}\left(\frac{U^{N}}{V^{M}}\right)$
$\frac{\partial}{\partial X}\left(U^{N} \cdot V^{M}\right)$	$\frac{\partial}{\partial X}(\mathrm{LN}(U))$	$\frac{\partial}{\partial X}\left(A^{U}\right)$
$\frac{\partial}{\partial X}(\mathrm{EXP}(U))$	$\frac{\partial}{\partial X}\left(U^{V}\right)$	$\frac{\partial}{\partial X}(\mathrm{SIN}(U))$
$\frac{\partial}{\partial X}(\mathrm{COS}(U))$	$\frac{\partial}{\partial X}(\mathrm{TAN}(U))$	$\frac{\partial}{\partial X}(\mathrm{COT}(U))$
$\frac{\partial}{\partial X}(\mathrm{SEC}(U))$	$\frac{\partial}{\partial X}(\mathrm{CSC}(U))$	$\frac{\partial}{\partial X}(\mathrm{ASIN}(U))$
$\frac{\partial}{\partial X}(\mathrm{ACOS}(U))$	$\frac{\partial}{\partial X}(\mathrm{ATAN}(U))$	$\frac{\partial}{\partial X}(\mathrm{ACOT}(U))$
$\frac{\partial}{\partial X}(\mathrm{ASEC}(U))$	$\frac{\partial}{\partial X}(\mathrm{ACSC}(U))$	$\frac{\partial}{\partial X}(\mathrm{SINH}(U))$
$\frac{\partial}{\partial X}(\mathrm{COSH}(U))$	$\frac{\partial}{\partial X}(\mathrm{TANH}(U))$	$\frac{\partial}{\partial X}(\mathrm{COTH}(U))$
$\frac{\partial}{\partial X}(\mathrm{SECH}(U))$	$\frac{\partial}{\partial X}(\mathrm{CSCH}(U))$	$\frac{\partial}{\partial X}(\mathrm{ASINH}(U))$
$\frac{\partial}{\partial X}(\mathrm{ACOSH}(U))$	$\frac{\partial}{\partial X}(\mathrm{ATANH}(U))$	$\frac{\partial}{\partial X}(\mathrm{ACOTH}(U))$
$\frac{\partial}{\partial X}(\mathrm{ASECH}(U))$	$\frac{\partial}{\partial X}(\mathrm{ACSCH}(U))$	

Chapter 22

Greek Alphabet

Greek Alphabet includes 24 Greek characters, which can be viewed.

This chapter covers:

- ❑ Finding Greek Alphabet

Finding Greek Alphabet

To find Greek Alphabet, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [→] [LIBRARY] to display available libraries.
HP 48SX users: Press [←] [LIBRARY] to display available libraries.

❷ Press MATH to display the Math•*Pro* library menu.

❸ Press MATH to start Math•*Pro* and show the home screen.

❹ Move the highlight bar to Reference and press [ENTER] or [►].

❺ Move the highlight bar to Greek Alphabet and press [ENTER] or [►].

❻ Press any key to return to the previous screen.

(Note that the uppercase and lowercase Greek letters alternate positions.)

Chapter 23

Hyperbolics

Hyperbolics includes definitions, pictures, relations, angle sum/difference, half angle, double angle, multiple angle, function product, function sum/difference, power relations, and complex arguments, which can be viewed, copied to the stack, or printed.

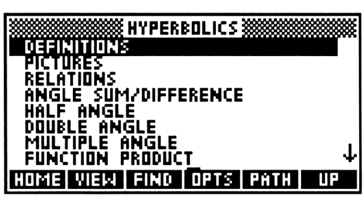
This chapter covers:

- ❑ Finding Hyperbolics
- ❑ Using Hyperbolics

Finding Hyperbolics

To find Hyperbolics, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [↱] [LIBRARY] to display available libraries.
HP 48SX users: Press [↰] [LIBRARY] to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Reference and press [ENTER] or [►].
❺ Move the highlight bar to Hyperbolics and press [ENTER] or [►].



❻ Move the highlight bar to the desired section and press [ENTER] or [►].

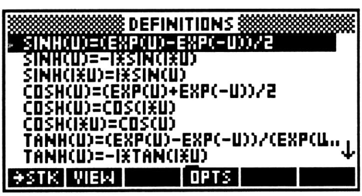
Using Hyperbolics

To select a hyperbolics formula, move the highlight bar to the desired section and press [ENTER] or [►]. Then scroll through the Hyperbolics section with [▲] and [▼] or search with [FIND]. When you have found the desired item:

- ❑ Press [VIEW] to display it in a text view.
- ❑ Press [⬅] or [➡][VIEW] to display it in a graphics view.
- ❑ Press [→STK] to copy one or all to the HP 48 stack.
- ❑ Press [OPTS] [NXT] [PRINT] to print one or all to a printer.

When you have finished with Hyperbolics, press [◄] to go to the previous screen, [➡][HOME] to go to the home screen, or [ON] to quit Math•*Pro*.

Example: What is the definition of sinh(u)? To find it, move the highlight bar to Definitions and press [ENTER] or [►].



The first three formulas are possible answers.

Chapter 24

Integrals

Integrals includes hundreds of integrals, which can be viewed, copied to the stack, printed, or solved.

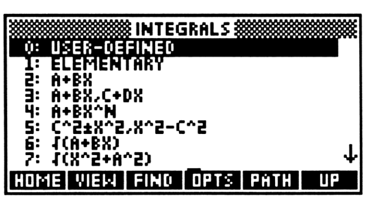
This chapter covers:

- ❑ Finding Integrals
- ❑ Using Integrals
- ❑ Solving Integrals
- ❑ Entering User-Defined Integrals
- ❑ Integrals Reference

Finding Integrals

To find Integrals, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [→] [LIBRARY] to display available libraries.
HP 48SX users: Press [←] [LIBRARY] to display available libraries.
❷ Press [MATH] to display the Math•*Pro* library menu.
❸ Press [MATH] to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Reference and press [ENTER] or [►].
❺ Move the highlight bar to Integrals and press [ENTER] or [►].



Using Integrals

To select an integral, move the highlight bar to the desired section and press ENTER or ►. Then scroll through the Integrals section with ▲ and ▼ or search with FIND. When you have found the desired item:

- Press VIEW to display it in a text view.

- Press ← or → VIEW to display it in a graphics view.

- Press →STK to copy one or all to the HP 48 stack.

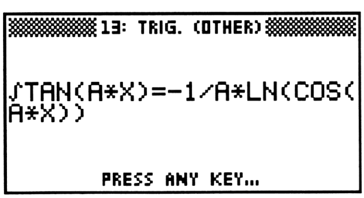
- Press OPTS NXT PRINT to print one or all to a printer.

- Press SOLVE to solve it.

When you have finished with Integrals, press ◄ to go to the previous screen, → HOME to go to the home screen, or ON to quit Math•*Pro*.

Example: *Look up an indefinite integral.* What is $\int \tan(x)\,dx$? To find it, move the highlight bar to 13: Trig. (Other) and press ENTER or ►.

The first formula is the answer. Press VIEW to view it in a text view:



When you have finished viewing the integral, press any key to return to the previous screen.

Solving Integrals

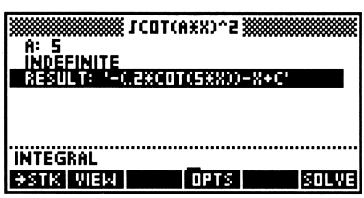
All of the integrals are templates for solving, and each template is useful for solving integrals of a particular form. Each form contains one or more "place holder" variables for you to enter your own constants:

- ❑ A, B, C, D, N, and M are place holders for *constants with respect to X* (such as 10 or π).
- ❑ If you enter an expression containing a variable other than X (such as 3Y or Z^2 or R+S) for A, B, C, D, N, or M, it will be treated as constant with respect to X, and the integral result will reflect that assumption. Unlike in Derivatives, the place holder variables *cannot* be functions of X, because integration forms are rigidly defined, unlike derivative forms, which can always accommodate functions of X.

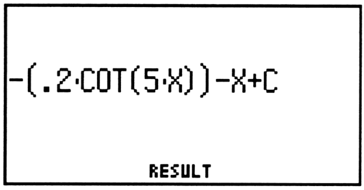
To solve an integral, move the highlight bar to the desired section and press [ENTER] or [►]. Then scroll through the Integrals section with [▲] and [▼] or search with **FIND**. When you have found the desired item, press **SOLVE**. Then replace the place holder variables in the integral and press **SOLVE** to calculate the integral.

When you have finished with Integrals, press [◄] to go to the previous screen, [↱] [HOME] to go to the home screen, or [ON] to quit Math•*Pro*.

Example (cont.): *Look up and solve an indefinite integral.* What is $\int \cot(5x)^2 dx$? This integral is of the form $\mathrm{COT}(\mathrm{A} \cdot \mathrm{X})^2$, where A is 5. Press [↱] [▼] to move the highlight bar to the appropriate integral and press **SOLVE**. Type in 5 for A. Press **SOLVE**.



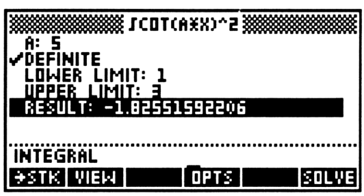
Press [↰] **VIEW** to view the result in a graphics view:



The answer is $\int \cot(5x)^2 dx = -(.2\cot(5x)) - x + C$. In the answer, C represents a constant of integration, which remains unspecified for the indefinite result.

When you have finished viewing the integral, press any key to return to the previous screen.

Example (cont.): *Solve a definite integral.* What is $\int_1^3 \cot(5x)^2 dx$? Move the highlight bar to the INDEFINITE field and press ✓CHK. A check mark will be placed next to the field, the field label will change to DEFINITE, and two new fields will appear for the limits. Enter 1 for the lower limit and 3 for the upper limit. (Note: Press CST if you need to set the angle measure to radians.) Press SOLVE.



The answer is $\int_1^3 \cot(5x)^2 dx = -1.82551592206$.

Entering User-Defined Integrals

In addition to looking up and solving integrals, Math•*Pro* allows you to enter your own user-defined integral forms into the reference table. All user-defined integral forms are listed in the User-Defined section of Integrals.

Math•*Pro* cannot *solve* any integral you enter. Instead, as explained above, solving an integral involves selecting an integral form and replacing the place holder variables in the already stored solution. When you enter a new user-defined integral form, you must also enter the solution to that integral—either worked out by hand or copied from a reference book. Then Math•*Pro* will be able to solve that integral form in the future. Math•*Pro* does not actually integrate arbitrary expressions.

This section covers:

- ❑ Adding a User-Defined Integral
- ❑ Deleting a User-Defined Integral
- ❑ Editing a User-Defined Integral
- ❑ Converting Old User-Defined Integrals

Adding a User-Defined Integral

To add a user-defined integral, move the highlight bar to Reference and press ENTER or ►. Then move the highlight bar to Integrals and press ENTER or ►. Then move the highlight bar to 0: User-Defined and press ENTER or ►. Then:

❶ Press FORM to display the form menu.

❷ Press ADD to add a new user-defined integral form.

❸ Type in the new integral form and press ENTER. See the examples below.

❹ Press EXIT to leave the form menu and return to the regular menu.

❺ To solve the new user-defined integral, move the highlight bar to it and press SOLVE. For more information, see "Solving Integrals."

Integral Examples

Example: *Indefinite Integrals*. All indefinite integral forms should be entered without limits. The variable of integration will be assumed to be X.

When solving indefinite integral forms, you will be given the option to solve these forms indefinitely (which will add an integration constant, *C*) or definitely (which will allow you to enter limits).

- ❑ The indefinite integral $\int \cos(x)\,dx = \sin(x)$ should be entered as:

  ' ∫COS(X)=SIN(X) '

  When solving this integral indefinitely, you will not be allowed to enter anything because there are no place holder variables. When solving this integral definitely, you will be allowed to enter the lower and upper limits.

❑ The indefinite integral $\int \frac{x}{a+bx}dx = \frac{x}{b} - \frac{a}{b^2}\ln(a+bx)$ should be entered as:

'∫X/(A+B*X)=X/B-A/B^2*LN(A+B*X)'

When solving this integral indefinitely, you will be allowed to enter A and B. When solving this integral definitely, you will be allowed to enter A and B and the lower and upper limits.

❑ The indefinite integral $\int \sqrt{a+bx}\,dx = \frac{2}{3b}\sqrt{(a+bx)^3}$ should be entered as:

'∫√(A+B*X)=2/(3*B)*√((A+B*X)^3)

When solving this integral indefinitely, you will be allowed to enter A and B. When solving this integral definitely, you will be allowed to enter A and B and the lower and upper limits.

Example: *Definite Integrals*. All definite integral forms should be entered with limits and with the variable of integration.

When solving definite integral forms, they will be solved definitely, and you will not be given the option to enter limits.

❑ The definite integral $\int_0^\infty \frac{\cos(x)}{x}dx = \infty$ should be entered as (∞ is [α] [➡] I):

'∫(0,∞,COS(X)/X,X)=∞'

When solving this integral, you will not be allowed to enter anything, because there are no place holder variables. (Note: The ∞ character has no special meaning to the HP 48—it is merely a variable name, such as X, Y, or Z. Its presence in this integral is for reference purposes only.)

❑ The definite integral $\int_0^1 x^{m-1}(1-x)^{n-1}\,dx = \beta(m,n)$ should be entered as:

'∫(0,1,X^(M-1)*(1-X)^(N-1),X)=BETA(M,N)'

When solving this integral, you will be allowed to enter M and N. (Note: The beta function is not a built-in HP 48 function—it is part of Math•*Pro*.)

For more information about integrals, see your HP 48 manual.

Deleting a User-Defined Integral

To delete a user-defined integral, go to 0: User-Defined and move the highlight bar to the desired integral. Then:

❶ Press FORM to display the form menu.

❷ Press DEL to delete the highlighted user-integral form.

❹ Press EXIT to leave the form menu and return to the regular menu.

Editing a User-Defined Integral

To edit a user-defined integral, go to 0: User-Defined and move the highlight bar to the desired integral. Then:

❶ Press FORM to display the form menu.

❷ Press EDIT to edit the highlighted user-integral form. When finished editing, press ENTER to save changes or ON to clear the command line and ON to abort editing without saving changes.

❹ Press EXIT to leave the form menu and return to the regular menu.

Converting Old User-Defined Integrals

In addition to Math•*Pro*, the PocketProfessional Mathematics Pac, Calculus Pac, and Physics Pac also support user-defined integrals. When you enter the User-Defined section of Integrals in Math•*Pro*, any existing old user-defined integral data from one of those pacs will automatically be converted to the new format used by Math•*Pro*. The new user-defined integral data is stored in the variable named 'INTEG' in the { HOME SPARCOM } directory.

However, the original copy of the old user-defined integral data will remain in either the { HOME MATHD } directory (if from the Mathematics Pac) or the { HOME SPARCOM } directory (if from the Calculus Pac or Physics Pac). The old user-defined integral data is stored in the variable named 'USRINTEG'. If you no longer need the old data, purge the variable named 'USRINTEG'.

Integrals Reference

1: Elementary Integrals

$\int A\,dX$	$\int X^N\,dX$	$\int \frac{1}{X}\,dX$	$\int EXP(A\cdot X)\,dX$
$\int B^{A\cdot X}\,dX$	$\int LN(X)\,dX$	$\int A^X\cdot LN(A)\,dX$	$\int \frac{1}{A^2+X^2}\,dX$
$\int \frac{1}{A^2-X^2}\,dX$	$\int \frac{1}{X^2-A^2}\,dX$	$\int \frac{1}{\sqrt{A^2-X^2}}\,dX$	$\int \frac{1}{\sqrt{X^2+A^2}}\,dX$
$\int \frac{1}{\sqrt{X^2-A^2}}\,dX$	$\int \frac{1}{X\cdot\sqrt{X^2-A^2}}\,dX$	$\int \frac{1}{X\cdot\sqrt{A^2+X^2}}\,dX$	$\int \frac{1}{X\cdot\sqrt{A^2-X^2}}\,dX$

2: A+BX Integrals

$\int (A+B\cdot X)^N\,dX$	$\int X\cdot(A+B\cdot X)^N\,dX$	$\int X^2\cdot(A+B\cdot X)^N\,dX$	$\int \frac{1}{A+B\cdot X}\,dX$
$\int \frac{1}{(A+B\cdot X)^2}\,dX$	$\int \frac{X}{A+B\cdot X}\,dX$	$\int \frac{X}{(A+B\cdot X)^2}\,dX$	$\int \frac{X}{(A+B\cdot X)^N}\,dX$
$\int \frac{X^2}{A+B\cdot X}\,dX$	$\int \frac{X^2}{(A+B\cdot X)^2}\,dX$	$\int \frac{1}{X\cdot(A+B\cdot X)}\,dX$	$\int \frac{1}{X\cdot(A+B\cdot X)^2}\,dX$
$\int \frac{1}{X^2\cdot(A+B\cdot X)}\,dX$	$\int \frac{1}{X^2\cdot(A+B\cdot X)^2}\,dX$		

3: A+BX,C+DX Integrals

$\int \frac{1}{(A+B\cdot X)\cdot(C+D\cdot X)}\,dX$	$\int \frac{X}{(A+B\cdot X)\cdot(C+D\cdot X)}\,dX$	$\int \frac{1}{(A+B\cdot X)^2\cdot(C+D\cdot X)}\,dX$
$\int \frac{X}{(A+B\cdot X)^2\cdot(C+D\cdot X)}\,dX$	$\int \frac{X^2}{(A+B\cdot X)^2\cdot(C+D\cdot X)}\,dX$	$\int \frac{A+B\cdot X}{C+D\cdot X}\,dX$

4: A+BX^N Integrals

$\int \frac{1}{A+B\cdot X^2}\,dX$	$\int \frac{1}{A+B\cdot X^2}\,dX$	$\int \frac{1}{A+B\cdot X^2}\,dX$	$\int \frac{X}{A+B\cdot X^2}\,dX$
$\int \frac{X^2}{A+B\cdot X^2}\,dX$	$\int \frac{X^2}{A+B\cdot X^2}\,dX$	$\int \frac{1}{A^2-B^2\cdot X^2}\,dX$	$\int \frac{1}{X\cdot\left(A+B\cdot X^2\right)}\,dX$
$\int \frac{1}{A+B\cdot X^3}\,dX$	$\int \frac{X}{A+B\cdot X^3}\,dX$	$\int \frac{X^2}{A+B\cdot X^3}\,dX$	$\int \frac{1}{X\cdot\left(A+B\cdot X^N\right)}\,dX$

5: C^2±X^2,X^2-C^2 Integrals

$\int \frac{1}{C^2+X^2}\,dX$	$\int \frac{1}{C^2-X^2}\,dX$	$\int \frac{1}{X^2-C^2}\,dX$	$\int \frac{X}{C^2+X^2}\,dX$
$\int \frac{X}{C^2-X^2}\,dX$	$\int \frac{X}{\left(C^2+X^2\right)^{N+1}}\,dX$	$\int \frac{X}{\left(C^2-X^2\right)^{N+1}}\,dX$	$\int \frac{X}{X^2-C^2}\,dX$
$\int \frac{X}{\left(X^2-C^2\right)^{N+1}}\,dX$			

6: √(A+BX) Integrals

$\int \sqrt{A+B\cdot X}\,dX$	$\int X\cdot\sqrt{A+B\cdot X}\,dX$	$\int X^2\cdot\sqrt{A+B\cdot X}\,dX$	$\int \frac{\sqrt{A+B\cdot X}}{X}\,dX$
$\int \frac{\sqrt{A+B\cdot X}}{X}\,dX$	$\int \frac{\sqrt{A+B\cdot X}}{X^2}\,dX$	$\int \frac{\sqrt{A+B\cdot X}}{X^2}\,dX$	$\int \frac{1}{\sqrt{A+B\cdot X}}\,dX$
$\int \frac{X}{\sqrt{A+B\cdot X}}\,dX$	$\int \frac{X^2}{\sqrt{A+B\cdot X}}\,dX$	$\int \frac{1}{X\cdot\sqrt{A+B\cdot X}}\,dX$	$\int \frac{1}{X\cdot\sqrt{A+B\cdot X}}\,dX$
$\int \frac{1}{X^2\cdot\sqrt{A+B\cdot X}}\,dX$	$\int \frac{1}{X^2\cdot\sqrt{A+B\cdot X}}\,dX$	$\int (A+B\cdot X)^{\frac{N}{2}}\,dX$	$\int (A+B\cdot X)^{\frac{-N}{2}}\,dX$
$\int X\cdot(A+B\cdot X)^{\frac{N}{2}}\,dX$	$\int X\cdot(A+B\cdot X)^{\frac{-N}{2}}\,dX$		

7: √(X^2+A^2) Integrals

$\int \sqrt{X^2+A^2}\,dX$	$\int \frac{1}{\sqrt{X^2+A^2}}\,dX$	$\int \frac{1}{X\cdot\sqrt{X^2+A^2}}\,dX$	$\int \frac{\sqrt{X^2+A^2}}{X}\,dX$
$\int \frac{X}{\sqrt{X^2+A^2}}\,dX$	$\int X\cdot\sqrt{X^2+A^2}\,dX$	$\int \sqrt{\left(X^2+A^2\right)^3}\,dX$	$\int \frac{1}{\sqrt{\left(X^2+A^2\right)^3}}\,dX$
$\int \frac{X}{\sqrt{\left(X^2+A^2\right)^3}}\,dX$	$\int X\cdot\sqrt{\left(X^2+A^2\right)^3}\,dX$	$\int X^2\cdot\sqrt{X^2+A^2}\,dX$	$\int \frac{X^2}{\sqrt{X^2+A^2}}\,dX$
$\int \frac{1}{X^2\cdot\sqrt{X^2+A^2}}\,dX$	$\int X^2\cdot\sqrt{\left(X^2+A^2\right)^3}\,dX$	$\int \frac{\sqrt{X^2+A^2}}{X^2}\,dX$	$\int \frac{X^2}{\sqrt{\left(X^2+A^2\right)^3}}\,dX$
$\int \frac{X^3}{\sqrt{\left(X^2+A^2\right)^3}}\,dX$	$\int \frac{1}{X\cdot\sqrt{\left(X^2+A^2\right)^3}}\,dX$	$\int \frac{1}{X^2\cdot\sqrt{\left(X^2+A^2\right)^3}}\,dX$	$\int \frac{1}{X^3\cdot\sqrt{\left(X^2+A^2\right)^3}}\,dX$

8: √(X^2-A^2) Integrals

$\int \sqrt{X^2-A^2}\,dX$	$\int \frac{1}{\sqrt{X^2-A^2}}\,dX$	$\int \frac{1}{X\cdot\sqrt{X^2-A^2}}\,dX$	$\int \frac{\sqrt{X^2-A^2}}{X}\,dX$
$\int \frac{X}{\sqrt{X^2-A^2}}\,dX$	$\int X\cdot\sqrt{X^2-A^2}\,dX$	$\int \sqrt{\left(X^2-A^2\right)^3}\,dX$	$\int \frac{1}{\sqrt{\left(X^2-A^2\right)^3}}\,dX$
$\int \frac{X}{\sqrt{\left(X^2-A^2\right)^3}}\,dX$	$\int X\cdot\sqrt{\left(X^2-A^2\right)^3}\,dX$	$\int X^2\cdot\sqrt{X^2-A^2}\,dX$	$\int \frac{X^2}{\sqrt{X^2-A^2}}\,dX$
$\int \frac{1}{X^2\cdot\sqrt{X^2-A^2}}\,dX$	$\int X^2\cdot\sqrt{\left(X^2-A^2\right)^3}\,dX$	$\int \frac{\sqrt{X^2-A^2}}{X^2}\,dX$	$\int \frac{X^2}{\sqrt{\left(X^2-A^2\right)^3}}\,dX$
$\int \frac{X^3}{\sqrt{\left(X^2-A^2\right)^3}}\,dX$	$\int \frac{1}{X\cdot\sqrt{\left(X^2-A^2\right)^3}}\,dX$	$\int \frac{1}{X^2\cdot\sqrt{\left(X^2-A^2\right)^3}}\,dX$	$\int \frac{1}{X^3\cdot\sqrt{\left(X^2-A^2\right)^3}}\,dX$
$\int \frac{1}{(X-A)\cdot\sqrt{X^2-A^2}}\,dX$	$\int \frac{1}{(X+A)\cdot\sqrt{X^2-A^2}}\,dX$		

9: √(A^2-X^2) Integrals

$$\int \sqrt{A^2-X^2}\,dX \qquad \int \frac{1}{\sqrt{A^2-X^2}}\,dX \qquad \int \frac{1}{X\cdot\sqrt{A^2-X^2}}\,dX \qquad \int \frac{\sqrt{A^2-X^2}}{X}\,dX$$

$$\int \frac{X}{\sqrt{A^2-X^2}}\,dX \qquad \int X\cdot\sqrt{A^2-X^2}\,dX \qquad \int \sqrt{\left(A^2-X^2\right)^3}\,dX \qquad \int \frac{1}{\sqrt{\left(A^2-X^2\right)^3}}\,dX$$

$$\int \frac{X}{\sqrt{\left(A^2-X^2\right)^3}}\,dX \qquad \int X\cdot\sqrt{\left(A^2-X^2\right)^3}\,dX \qquad \int X^2\cdot\sqrt{A^2-X^2}\,dX \qquad \int X^2\cdot\sqrt{\left(A^2-X^2\right)^3}\,dX$$

$$\int X^3\cdot\sqrt{\left(A^2-X^2\right)^3}\,dX \qquad \int \frac{X^2}{\sqrt{A^2-X^2}}\,dX \qquad \int \frac{1}{X^2\cdot\sqrt{A^2-X^2}}\,dX \qquad \int \frac{\sqrt{A^2-X^2}}{X^2}\,dX$$

$$\int \frac{X^2}{\sqrt{\left(A^2-X^2\right)^3}}\,dX \qquad \int \frac{X^3}{\sqrt{\left(A^2-X^2\right)^3}}\,dX \qquad \int \frac{1}{X\cdot\sqrt{\left(A^2-X^2\right)^3}}\,dX \qquad \int \frac{1}{X^2\cdot\sqrt{\left(A^2-X^2\right)^3}}\,dX$$

$$\int \frac{1}{X^3\cdot\sqrt{\left(A^2-X^2\right)^3}}\,dX \qquad \int \frac{1}{\left(B^2-X^2\right)\cdot\sqrt{A^2-X^2}}\,dX \qquad \int \frac{1}{\left(B^2-X^2\right)\cdot\sqrt{A^2-X^2}}\,dX \qquad \int \frac{1}{\left(B^2+X^2\right)\cdot\sqrt{A^2-X^2}}\,dX$$

$$\int \frac{\sqrt{A^2-X^2}}{B^2+X^2}\,dX$$

10: Trig. (SIN) Integrals

$$\int \mathrm{SIN}(A\cdot X)\,dX \qquad \int \mathrm{SIN}(A\cdot X)^2\,dX \qquad \int \frac{1}{\mathrm{SIN}(A\cdot X)^2}\,dX$$

$$\int \mathrm{SIN}(M\cdot X)\cdot\mathrm{SIN}(N\cdot X)\,dX \qquad \int \frac{1}{1+\mathrm{SIN}(A\cdot X)}\,dX \qquad \int \frac{1}{1-\mathrm{SIN}(A\cdot X)}\,dX$$

$$\int \frac{1}{A+B\cdot\mathrm{SIN}(X)}\,dX \qquad \int \frac{\mathrm{SIN}(A\cdot X)}{1+\mathrm{SIN}(A\cdot X)}\,dX \qquad \int \frac{\mathrm{SIN}(A\cdot X)}{1-\mathrm{SIN}(A\cdot X)}\,dX$$

$$\int \frac{1}{\mathrm{SIN}(A\cdot X)\cdot\left(1+\mathrm{SIN}(A\cdot X)\right)}\,dX \qquad \int \frac{1}{\mathrm{SIN}(A\cdot X)\cdot\left(1-\mathrm{SIN}(A\cdot X)\right)}\,dX \qquad \int \frac{1}{\left(1+\mathrm{SIN}(A\cdot X)\right)^2}\,dX$$

$\int \frac{1}{(1-\mathrm{SIN}(A\cdot X))^2}\,dX$	$\int \frac{\mathrm{SIN}(A\cdot X)}{(1+\mathrm{SIN}(A\cdot X))^2}\,dX$	$\int \frac{\mathrm{SIN}(A\cdot X)}{(1-\mathrm{SIN}(A\cdot X))^2}\,dX$
$\int X\cdot\mathrm{SIN}(A\cdot X)\,dX$	$\int X^2\cdot\mathrm{SIN}(A\cdot X)\,dX$	$\int X\cdot\mathrm{SIN}(A\cdot X)^2\,dX$
$\int X^2\cdot\mathrm{SIN}(A\cdot X)^2\,dX$	$\int \frac{X}{1+\mathrm{SIN}(A\cdot X)}\,dX$	$\int \frac{X}{1-\mathrm{SIN}(A\cdot X)}\,dX$
$\int \frac{X}{\mathrm{SIN}(A\cdot X)^2}\,dX$	$\int \frac{\mathrm{SIN}(A\cdot X)}{\sqrt{1+B^2\cdot\mathrm{SIN}(A\cdot X)^2}}\,dX$	$\int \frac{\mathrm{SIN}(A\cdot X)}{\sqrt{1-B^2\cdot\mathrm{SIN}(A\cdot X)^2}}\,dX$

11: Trig. (COS) Integrals

$\int \mathrm{COS}(A\cdot X)\,dX$	$\int \mathrm{COS}(A\cdot X)^2\,dX$	$\int \frac{1}{\mathrm{COS}(A\cdot X)^2}\,dX$
$\int \mathrm{COS}(M\cdot X)\cdot\mathrm{COS}(N\cdot X)\,dX$	$\int \frac{1}{1+\mathrm{COS}(A\cdot X)}\,dX$	$\int \frac{1}{1-\mathrm{COS}(A\cdot X)}\,dX$
$\int \frac{1}{A+B\cdot\mathrm{COS}(X)}\,dX$	$\int \frac{\mathrm{COS}(A\cdot X)}{1+\mathrm{COS}(A\cdot X)}\,dX$	$\int \frac{\mathrm{COS}(A\cdot X)}{1-\mathrm{COS}(A\cdot X)}\,dX$
$\int \frac{1}{\mathrm{COS}(A\cdot X)\cdot(1+\mathrm{COS}(A\cdot X))}\,dX$	$\int \frac{1}{\mathrm{COS}(A\cdot X)\cdot(1-\mathrm{COS}(A\cdot X))}\,dX$	$\int \frac{1}{(1+\mathrm{COS}(A\cdot X))^2}\,dX$
$\int \frac{1}{(1-\mathrm{COS}(A\cdot X))^2}\,dX$	$\int \frac{\mathrm{COS}(A\cdot X)}{(1+\mathrm{COS}(A\cdot X))^2}\,dX$	$\int \frac{\mathrm{COS}(A\cdot X)}{(1-\mathrm{COS}(A\cdot X))^2}\,dX$
$\int X\cdot\mathrm{COS}(A\cdot X)\,dX$	$\int X^2\cdot\mathrm{COS}(A\cdot X)\,dX$	$\int X\cdot\mathrm{COS}(A\cdot X)^2\,dX$
$\int X^2\cdot\mathrm{COS}(A\cdot X)^2\,dX$	$\int \frac{X}{1+\mathrm{COS}(A\cdot X)}\,dX$	$\int \frac{X}{1-\mathrm{COS}(A\cdot X)}\,dX$
$\int \sqrt{1-\mathrm{COS}(A\cdot X)}\,dX$	$\int \sqrt{1+\mathrm{COS}(A\cdot X)}\,dX$	$\int \frac{X}{\mathrm{COS}(A\cdot X)^2}\,dX$

12: Trig. (SIN and COS) Integrals

$$\int \sin(A\cdot X)\cdot\cos(A\cdot X)\,dX \qquad \int \sin(M\cdot X)\cdot\cos(N\cdot X)\,dX \qquad \int \sin(A\cdot X)^2\cdot\cos(A\cdot X)^2\,dX$$

$$\int \sin(A\cdot X)\cdot\cos(A\cdot X)^M\,dX \qquad \int \sin(A\cdot X)^M\cdot\cos(A\cdot X)\,dX \qquad \int \frac{\sin(A\cdot X)}{\cos(A\cdot X)^2}\,dX$$

$$\int \frac{\sin(A\cdot X)^2}{\cos(A\cdot X)}\,dX \qquad \int \frac{\cos(A\cdot X)}{\sin(A\cdot X)^2}\,dX \qquad \int \frac{1}{\sin(A\cdot X)\cdot\cos(A\cdot X)}\,dX$$

$$\int \frac{\sin(X)^2}{A+B\cdot\cos(X)^2}\,dX \qquad \int \frac{1}{A^2\cdot\cos(X)^2+B^2\cdot\sin(X)^2}\,dX \qquad \int \frac{\cos(C\cdot X)^2}{A^2+B^2\cdot\sin(C\cdot X)^2}\,dX$$

$$\int \frac{\sin(C\cdot X)\cdot\cos(C\cdot X)}{A\cdot\cos(C\cdot X)^2+B\cdot\sin(C\cdot X)^2}\,dX \qquad \int \frac{\cos(C\cdot X)}{A\cdot\cos(C\cdot X)+B\cdot\sin(C\cdot X)}\,dX \qquad \int \frac{\sin(C\cdot X)}{A\cdot\sin(C\cdot X)+B\cdot\cos(C\cdot X)}\,dX$$

$$\int \frac{\sin(A\cdot X)}{1+\cos(A\cdot X)}\,dX \qquad \int \frac{\sin(A\cdot X)}{1-\cos(A\cdot X)}\,dX \qquad \int \frac{\cos(A\cdot X)}{1+\sin(A\cdot X)}\,dX$$

$$\int \frac{\cos(A\cdot X)}{1-\sin(A\cdot X)}\,dX \qquad \int \frac{\sin(A\cdot X)}{\cos(A\cdot X)\cdot(1+\cos(A\cdot X))}\,dX \qquad \int \frac{\sin(A\cdot X)}{\cos(A\cdot X)\cdot(1-\cos(A\cdot X))}\,dX$$

$$\int \frac{\cos(A\cdot X)}{\sin(A\cdot X)\cdot(1+\sin(A\cdot X))}\,dX \qquad \int \frac{\cos(A\cdot X)}{\sin(A\cdot X)\cdot(1-\sin(A\cdot X))}\,dX \qquad \int \frac{1}{\sin(A\cdot X)+\cos(A\cdot X)}\,dX$$

$$\int \frac{1}{\sin(A\cdot X)-\cos(A\cdot X)}\,dX \qquad \int \frac{1}{1+\cos(A\cdot X)+\sin(A\cdot X)}\,dX \qquad \int \frac{1}{1+\cos(A\cdot X)-\sin(A\cdot X)}\,dX$$

$$\int \frac{1}{A^2\cdot\cos(C\cdot X)^2-B^2\cdot\sin(C\cdot X)^2}\,dX \qquad \int \frac{X+\sin(X)}{1+\cos(X)}\,dX \qquad \int \frac{X-\sin(X)}{1-\cos(X)}\,dX$$

$$\int \frac{\cos(A\cdot X)}{\sqrt{1+B^2\cdot\sin(A\cdot X)^2}}\,dX \qquad \int \frac{\cos(A\cdot X)}{\sqrt{1-B^2\cdot\sin(A\cdot X)^2}}\,dX$$

13: Trig. (Other) Integrals

$$\int \tan(A\cdot X)\,dX \qquad \int \cot(A\cdot X)\,dX \qquad \int \sec(A\cdot X)\,dX \qquad \int \sec(A\cdot X)\,dX$$

$$\int \csc(A\cdot X)\,dX \qquad \int \csc(A\cdot X)\,dX \qquad \int \tan(A\cdot X)^2\,dX \qquad \int \cot(A\cdot X)^2\,dX$$

14: Inverse Trigonometric Integrals

$$\int \mathrm{ASIN}(A\cdot X)\,dX \qquad \int \mathrm{ACOS}(A\cdot X)\,dX \qquad \int \mathrm{ATAN}(A\cdot X)\,dX$$

$$\int \mathrm{ACOT}(A\cdot X)\,dX \qquad \int \mathrm{ASEC}(A\cdot X)\,dX \qquad \int \mathrm{ACSC}(A\cdot X)\,dX$$

$$\int X\cdot \mathrm{ASIN}(A\cdot X)\,dX \qquad \int X\cdot \mathrm{ACOS}(A\cdot X)\,dX \qquad \int X\cdot \mathrm{ATAN}(A\cdot X)\,dX$$

$$\int X\cdot \mathrm{ACOT}(A\cdot X)\,dX \qquad \int X\cdot \mathrm{ASEC}(A\cdot X)\,dX \qquad \int X\cdot \mathrm{ACSC}(A\cdot X)\,dX$$

$$\int \frac{\mathrm{ASIN}(A\cdot X)}{X^2}\,dX \qquad \int \frac{\mathrm{ACOS}(A\cdot X)}{X^2}\,dX \qquad \int \frac{\mathrm{ATAN}(A\cdot X)}{X^2}\,dX$$

$$\int \frac{\mathrm{ACOT}(A\cdot X)}{X^2}\,dX \qquad \int \frac{1}{\sqrt{1-A^2\cdot X^2}}\cdot \mathrm{ASIN}(A\cdot X)\,dX \qquad \int \frac{1}{\sqrt{1-A^2\cdot X^2}}\cdot \mathrm{ACOS}(A\cdot X)\,dX$$

15: Logarithmic Integrals

$$\int \mathrm{LN}(A\cdot X+B)\,dX \qquad \int X^N\cdot \mathrm{LN}(A\cdot X)\,dX \qquad \int \mathrm{LN}(X)^N\,dX$$

$$\int \frac{\mathrm{LN}(X)^N}{X}\,dX \qquad \int \frac{1}{X\cdot \mathrm{LN}(X)}\,dX \qquad \int \frac{1}{X\cdot \mathrm{LN}(X)^N}\,dX$$

$$\int X^M\cdot \mathrm{LN}(X)^N\,dX \qquad \int \frac{\mathrm{LN}(A\cdot X+B)}{X^2}\,dX \qquad \int \mathrm{LN}\left(\frac{X+A}{X-A}\right)dX$$

$$\int \frac{1}{X^2}\cdot \mathrm{LN}\left(\frac{X+A}{X-A}\right)dX \qquad \int \mathrm{LN}\left(X^2+A^2\right)dX \qquad \int \mathrm{LN}\left(X^2-A^2\right)dX$$

$$\int \mathrm{LN}\left(X+\sqrt{X^2+A^2}\right)dX \qquad \int \mathrm{LN}\left(X+\sqrt{X^2-A^2}\right)dX$$

16: Exponential Integrals

$\int \mathrm{EXP}(A\cdot X)\,dX$	$\int X\cdot \mathrm{EXP}(A\cdot X)\,dX$	$\int X^M\cdot \mathrm{EXP}(A\cdot X)\,dX$
$\int \frac{1}{1+\mathrm{EXP}(X)}\,dX$	$\int A^X-A^{-X}\,dX$	$\int \frac{\mathrm{EXP}(A\cdot X)}{B+C\cdot \mathrm{EXP}(A\cdot X)}\,dX$
$\int \frac{X\cdot \mathrm{EXP}(A\cdot X)}{(1+A\cdot X)^2}\,dX$	$\int X\cdot \mathrm{EXP}\left(-X^2\right)\,dX$	$\int \mathrm{EXP}(A\cdot X)\cdot \mathrm{SIN}(B\cdot X)\,dX$
$\int \mathrm{EXP}(A\cdot X)\cdot \mathrm{COS}(B\cdot X)\,dX$		

17: Hyperbolic Integrals

$\int \mathrm{SINH}(X)\,dX$	$\int \mathrm{COSH}(X)\,dX$	$\int \mathrm{TANH}(X)\,dX$	$\int \mathrm{COTH}(X)\,dX$
$\int \mathrm{SECH}(X)\,dX$	$\int \mathrm{CSCH}(X)\,dX$	$\int X\cdot \mathrm{SINH}(X)\,dX$	$\int X\cdot \mathrm{COSH}(X)\,dX$
$\int \mathrm{SECH}(X)\cdot \mathrm{TANH}(X)\,dX$	$\int \mathrm{CSCH}(X)\cdot \mathrm{COTH}(X)\,dX$	$\int \mathrm{SINH}(X)^2\,dX$	$\int \mathrm{COSH}(X)^2\,dX$
$\int \mathrm{TANH}(X)^2\,dX$	$\int \mathrm{COTH}(X)^2\,dX$	$\int \mathrm{SECH}(X)^2\,dX$	$\int \mathrm{CSCH}(X)^2\,dX$
$\int \mathrm{ASINH}\left(\frac{X}{A}\right)dX$	$\int \mathrm{ACOSH}\left(\frac{X}{A}\right)dX$	$\int \mathrm{ACOSH}\left(\frac{X}{A}\right)dX$	$\int \mathrm{ATANH}\left(\frac{X}{A}\right)dX$
$\int \mathrm{ACOTH}\left(\frac{X}{A}\right)dX$	$\int \mathrm{ASECH}(X)\,dX$	$\int \mathrm{ACSCH}(X)\,dX$	$\int X\cdot \mathrm{ASINH}\left(\frac{X}{A}\right)dX$
$\int X\cdot \mathrm{ACOSH}\left(\frac{X}{A}\right)dX$	$\int X\cdot \mathrm{ATANH}\left(\frac{X}{A}\right)dX$	$\int X\cdot \mathrm{ACOTH}\left(\frac{X}{A}\right)dX$	$\int X\cdot \mathrm{ASECH}(X)\,dX$
$\int X\cdot \mathrm{ACSCH}(X)\,dX$			

18: Definite Integrals

$$\int_0^1 X^{M-1}\cdot(1-X)^{N-1}\,dX \qquad \int_1^\infty \frac{1}{X^M}\,dX \qquad \int_0^\infty \frac{1}{(1+X)\cdot\sqrt{X}}\,dX \qquad \int_0^A X^M\cdot\left(A^2-X^2\right)^{\frac{N}{2}}\,dX$$

$$\int_0^{\frac{\pi}{2}} \mathrm{SIN}(X)^N\,dX \qquad \int_0^{\frac{\pi}{2}} \mathrm{COS}(X)^N\,dX \qquad \int_0^\infty \frac{\mathrm{SIN}(M\cdot X)}{X}\,dX \qquad \int_0^\infty \frac{\mathrm{SIN}(M\cdot X)}{X}\,dX$$

$$\int_0^\infty \frac{\mathrm{SIN}(M\cdot X)}{X}\,dX \qquad \int_0^\infty \frac{\mathrm{COS}(X)}{X}\,dX \qquad \int_0^\infty \frac{\mathrm{TAN}(X)}{X}\,dX \qquad \int_0^\infty \frac{\mathrm{SIN}(P\cdot X)^2}{X^2}\,dX$$

$$\int_0^\infty \frac{\mathrm{SIN}(X)^3}{X^3}\,dX \qquad \int_0^\infty \frac{\mathrm{SIN}(X)^4}{X^4}\,dX \qquad \int_0^{\frac{\pi}{2}} \frac{1}{1+\mathrm{TAN}(X)^M}\,dX \qquad \int_0^\infty \mathrm{EXP}(-A\cdot X)\,dX$$

$$\int_0^\infty \mathrm{EXP}\left(-A^2\cdot X^2\right)dX \qquad \int_0^B \mathrm{EXP}\left(-A\cdot X^2\right)dX \qquad \int_B^\infty \mathrm{EXP}\left(-A\cdot X^2\right)dX \qquad \int_0^\infty X\cdot\mathrm{EXP}\left(-X^2\right)dX$$

$$\int_0^\infty X^2\cdot\mathrm{EXP}\left(-X^2\right)dX$$

Chapter 25

Quadric Surfaces

Quadric surfaces includes 17 quadric surfaces, which can be viewed, copied to the stack, or printed.

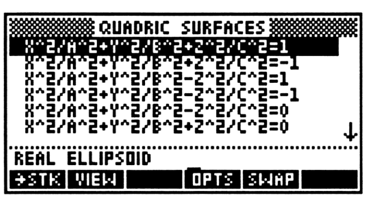
This chapter covers:

- ❑ Finding Quadric Surfaces
- ❑ Using Quadric Surfaces

Finding Quadric Surfaces

To find Quadric Surfaces, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [→] [LIBRARY] to display available libraries.
HP 48SX users: Press [←] [LIBRARY] to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Reference and press [ENTER] or [►].
❺ Move the highlight bar to Quadric Surfaces and press [ENTER] or [►].



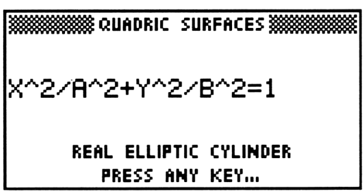
Using Quadric Surfaces

To select a quadric surface, scroll through the Quadric Surfaces section with ▲ and ▼ or search with FIND. When you have found the desired item:

- ❑ Press VIEW to display it in a text view.
- ❑ Press ⬅ or ➡ VIEW to display it in a graphics view.
- ❑ Press →STK to copy one or all to the HP 48 stack.
- ❑ Press OPTS NXT PRINT to print one or all to a printer.

When you have finished with Quadric Surfaces, press ◄ to go to the previous screen, ➡ HOME to go to the home screen, or ON to quit Math•*Pro*.

Example: What is the equation for a real elliptic cylinder? To search for it, first press DESC or VAR to toggle the position of the quadric surface equations and the descriptions (the help text), because FIND only searches the information shown on the main display area (not the help text). Then type OPTS NXT FIND, type CYLINDER and press ENTER to start the search. The highlight bar will move to the first match, which is the answer. Press VIEW to display the quadric surface in a text view:



When you have finished viewing the constant, press any key to return to the previous screen. Press EXIT to exit the options menu.

Chapter 26

Series

Series includes Taylor, binomial, exponential/logarithmic, and trigonometric/ hyperbolic series, which can be viewed, copied to the stack, or printed.

This chapter covers:

- ❑ Finding Series
- ❑ Using Series

Finding Series

To find Series, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [→] [LIBRARY] to display available libraries.
HP 48SX users: Press [←] [LIBRARY] to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Reference and press [ENTER] or [►].
❺ Move the highlight bar to Series and press [ENTER] or [►].

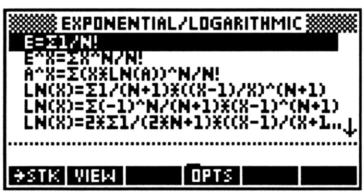
Using Series

To select a series, move the highlight bar to the desired section and press [ENTER] or [►]. Then scroll through the Series section with [▲] and [▼] or search with FIND. When you have found the desired item:

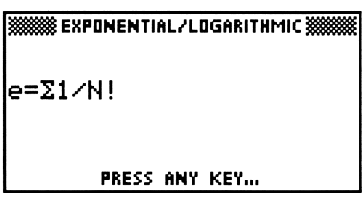
- ❏ Press VIEW to display it in a text view.
- ❏ Press [⮢] or [⮣] VIEW to display it in a graphics view.
- ❏ Press →STK to copy one or all to the HP 48 stack.
- ❏ Press OPTS [NXT] PRINT to print one or all to a printer.

When you have finished with Series, press [◄] to go to the previous screen, [⮣] [HOME] to go to the home screen, or [ON] to quit Math•*Pro*.

Example: What is the series definition of e? To find it, move the highlight bar to Exponential/Logarithmic and press [ENTER] or [►].



The first formula is the answer. Press VIEW to view it in a text view:



When you have finished viewing the series, press any key to return to the previous screen.

Chapter 27

SI Prefixes

SI Prefixes includes 20 SI prefixes, which can be viewed, copied to the stack, or printed. (SI is an abbreviation for Le Systeme International d'Unites.)

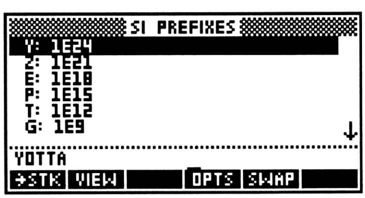
This chapter covers:

- ❑ Finding SI Prefixes
- ❑ Using SI Prefixes

Finding SI Prefixes

To find SI Prefixes, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [→] [LIBRARY] to display available libraries.
HP 48SX users: Press [←] [LIBRARY] to display available libraries.
❷ Press **MATH** to display the Math•*Pro* library menu.
❸ Press **MATH** to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Reference and press [ENTER] or [►].
❺ Move the highlight bar to SI Prefixes and press [ENTER] or [►].



Using SI Prefixes

To select an SI prefix, scroll through the SI Prefixes section with [▲] and [▼] or search with FIND. When you have found the desired item:

- Press VIEW to display it in a text view.
- Press →STK to copy one or all to the HP 48 stack.
- Press OPTS [NXT] PRINT to print one or all to a printer.

When you have finished with SI Prefixes, press [◄] to go to the previous screen, [↱] [HOME] to go to the home screen, or [ON] to quit Math•*Pro*.

Chapter 28

Transforms

Transforms includes definitions, Fourier finite sine, Fourier finite cosine, Fourier sine, Fourier cosine, Fourier transforms, Laplace transforms, and Z transforms, which can be viewed, copied to the stack, or printed.

This chapter covers:

- ❑ Finding Transforms
- ❑ Using Transforms

Finding Transforms

To find Transforms, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [↱] [LIBRARY] to display available libraries.
HP 48SX users: Press [↰] [LIBRARY] to display available libraries.
❷ Press [MATH] to display the Math•*Pro* library menu.
❸ Press [MATH] to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Reference and press [ENTER] or [►].
❺ Move the highlight bar to Transforms and press [ENTER] or [►].

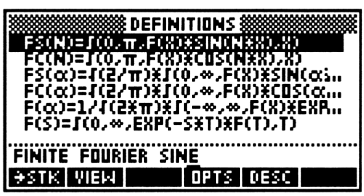
Using Transforms

To select a transform, move the highlight bar to the desired section and press ENTER or ►. Then scroll through the Transforms section with ▲ and ▼ or search with FIND. When you have found the desired item:

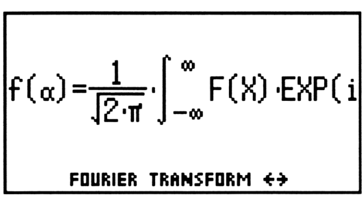
- ❑ Press VIEW to display it in a text view.
- ❑ Press ← or → VIEW to display it in a graphics view.
- ❑ Press →STK to copy one or all to the HP 48 stack.
- ❑ Press OPTS NXT PRINT to print one or all to a printer.

When you have finished with Transforms, press ◄ to go to the previous screen, → HOME to go to the home screen, or ON to quit Math•*Pro*.

Example: What is the definition of the Fourier transform? To find it, move the highlight bar to Definitions and press ENTER or ►.



Move the highlight bar down the list to read the help text and find the definition. (It is the fifth formula.) Press ← VIEW to view it in a graphics view:



Press ◄ and ► to scroll. When you have finished viewing the transform, press any key to return to the previous screen.

Chapter 29

Trigonometry

Trigonometry includes definitions, pictures, relations, reductions, angle sum/difference, half angle, double angle, multiple angle, function product, function sum/difference, power relations, exponential relations, and quadrant signs, which can be viewed, copied to the stack, or printed.

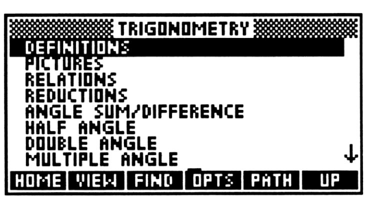
This chapter covers:

- ❑ Finding Trigonometry
- ❑ Using Trigonometry

Finding Trigonometry

To find Trigonometry, install Math•*Pro* and do the following:

❶ HP 48GX users: Press [→] [LIBRARY] to display available libraries.
HP 48SX users: Press [←] [LIBRARY] to display available libraries.
❷ Press MATH to display the Math•*Pro* library menu.
❸ Press MATH to start Math•*Pro* and show the home screen.
❹ Move the highlight bar to Reference and press [ENTER] or [►].
❺ Move the highlight bar to Trigonometry and press [ENTER] or [►].



❻ Move the highlight bar to the desired section and press [ENTER] or [►].

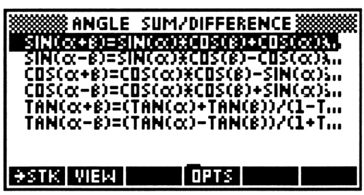
Using Trigonometry

To select a trigonometry formula, move the highlight bar to the desired section and press [ENTER] or [►]. Then scroll through the Trigonometry section with [▲] and [▼] or search with **FIND**. When you have found the desired item:

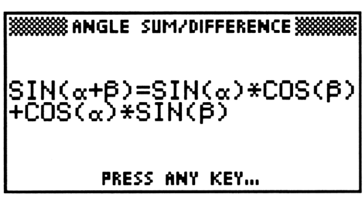
- ❑ Press **VIEW** to display it in a text view.
- ❑ Press [↰] or [↱] **VIEW** to display it in a graphics view.
- ❑ Press **→STK** to copy one or all to the HP 48 stack.
- ❑ Press **OPTS** [NXT] **PRINT** to print one or all to a printer.

When you have finished with Trigonometry, press [◄] to go to the previous screen, [↱] [HOME] to go to the home screen, or [ON] to quit Math•*Pro*.

Example: What is the expanded form of sin(α+β)? To find it, move the highlight bar to Angle Sum/Difference and press [ENTER] or [►].



The first formula is the answer. Press **VIEW** to view it in a text view:



When you have finished viewing the formula, press any key to return to the previous screen.

Chapter 30

Vectors

Vectors includes definitions, dot products, cross products, del operator, gradient, divergence, curl, and Laplacian, which can be viewed, copied to the stack, or printed.

This chapter covers:

- ❑ Finding Vectors
- ❑ Using Vectors

Finding Vectors

To find Vectors, install Math•*Pro* and do the following:

1. HP 48GX users: Press [↱] [LIBRARY] to display available libraries.
   HP 48SX users: Press [↰] [LIBRARY] to display available libraries.
2. Press **MATH** to display the Math•*Pro* library menu.
3. Press **MATH** to start Math•*Pro* and show the home screen.
4. Move the highlight bar to Reference and press [ENTER] or [►].
5. Move the highlight bar to Vectors and press [ENTER] or [►].

6. Move the highlight bar to the desired section and press [ENTER] or [►].

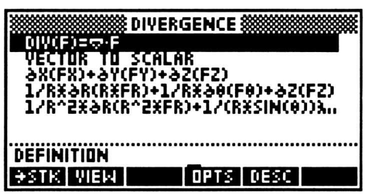
Using Vectors

To select a vector formula, move the highlight bar to the desired section and press ENTER or ►. Then scroll through the Vectors section with ▲ and ▼ or search with FIND. When you have found the desired item:

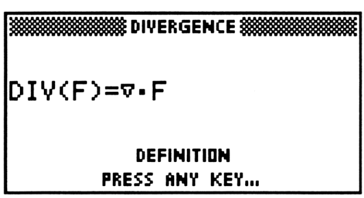
- ❑ Press VIEW to display it in a text view.
- ❑ Press ↰ or ↱ VIEW to display it in a graphics view.
- ❑ Press →STK to copy one or all to the HP 48 stack.
- ❑ Press OPTS NXT PRINT to print one or all to a printer.

When you have finished with Vectors, press ◄ to go to the previous screen, ↱ HOME to go to the home screen, or ON to quit Math•*Pro*.

Example: What is the definition of divergence? To find it, move the highlight bar to Divergence and press ENTER or ►.



The first formula is the answer. Press VIEW to view it in a text view:



When you have finished viewing the vector formula, press any key to return to the previous screen.

Part 4

Programming & Advanced Use

Chapter 31

Programmable Commands

This chapter covers programming with Math•*Pro* and includes a summary of the programmable commands. Each of these commands can be executed directly from the HP 48 stack or included in user programs. For more information about programming, see the HP 48 manual.

This chapter covers:

- ❑ Finding Commands
- ❑ Object Syntax
- ❑ Mathematics Commands
- ❑ Algebraic Functions
- ❑ Arithmetic Functions
- ❑ Curve Fitting Functions
- ❑ Hyperbolic Functions
- ❑ Integration Functions
- ❑ Special Functions
- ❑ Trigonometric Functions

Finding Commands

To find a programmable command from the stack, install Math•*Pro* and either:

❑ Type in the command name.
To do this, type [α] [α] followed by the command name.

❑ Use the Math•*Pro* library menu to find the command.
To do this, press (48GX) [↱] [LIBRARY] or (48SX) [↰] [LIBRARY] and [MATH].

❑ Use the CMDSMATH command menus to find the command.
To do this, press (48GX) [↱] [LIBRARY] or (48SX) [↰] [LIBRARY] and [MATH] [CMDS].

Only the first two methods will work if the command line is active.

Object Syntax

These are the various objects listed as inputs or outputs in this chapter.

Object Syntax	Description	Examples
x y a b c d	Real number	1.523 5.55 10
m n	Positive integer (real number)	1 2 3
(x,y)	Complex number or rectangular point	(0,1) (1,2) (1.5,-3.3)
z	Real or complex number	1.523 (0,1)
x_unit	Real number with units	10_m/s 20.587_ft
{list}	List of objects	{ 2 2 3 } { (0,1) (1,2) }
[array]	Real or complex array	[1 2 3] [(0,1) (1,2)]
'name'	Global or local name	'X' 'Y' 'Z'
'symb'	Algebraic expression or name	'SIN(X)' 'LN(Z)' 'X'
T/F	0 (False) or 1 (True)	0 1

Mathematics Commands

These are the commands in the Math•*Pro* library menu.

Name	Description	Input(s)	Output
MATH	Run Math•*Pro*	–	–
ABOUTMATH	About Math•*Pro*	–	–
CMDSMATH	Math•*Pro* Commands	–	–
GOMATH	Go Math•*Pro*	{list}	–
CONS	Constants	'name'	x_unit

GOMATH: Go Math•*Pro*

For more information, see Chapter 32, "Programmable Screens."

CONS: Constants

This command provides programmable access to the values of the constants in the Constants reference table. The value of the constant will be returned with units if user flag 61 is clear or without units if user flag 61 is set. (For more information, see Appendix C, "User Flags.") CONS can be used in an algebraic expression, such as 'CONS(h)', or in a user program, such as « 'h' CONS ». CONS is also affected by system flags -2 and -3, which control symbolic constants and numeric results—if either flag -2 or -3 is set, 'h' CONS will return a numeric value, but if both are clear, 'h' CONS will return 'CONS(h)', which will only evaluate to a numeric value after →NUM. To replace a built-in constant with a different value, you can place an override constant in a variable named "$" followed by the constant name, such as '$h'.

Example: *Create an equation with a constant.* The mass-energy relation is . To write this as an HP 48 equation which accesses the speed of light constant included in Math•*Pro*, use the equation:

```
'E=m*CONS(c)^2'
```

This equation will call the command CONS to access the value of the speed of light constant, *c*. The value of *c* will be returned as 299792458_m/s if flag 61 is clear (units on), or as 299792458 if flag 61 is set (units off).

Example: *Override a built-in constant.* To solve gravitational problems on the moon (instead of the Earth), the acceleration of gravity, *g*, must be overridden. To override the built-in value of 9.80665 m/s (the gravitational acceleration at the surface of the Earth), store the value 1.55 m/s into the variable '$g'. The value of *g* will now be returned by CONS as 1.55 m/s. To return to the original value, purge the variable '$g' from user memory.

Algebraic Functions

These commands are found in the CMDS ALGB menu.

Name	Description	Input(s)	Output
DELTA	Delta Function	'symb$_1$' 'symb$_2$'	T/F
PFEC	Partial Fraction Expansion, Coefs	[array$_1$] [array$_2$]	'symb'
PFER	Partial Fraction Expansion, Roots	[array$_1$] [array$_2$]	'symb'
POLYC	Polynomial Coefficients	[array$_1$]	[array$_2$]
POLYE	Polynomial Equation	[array] 'name'	'symb'
POLYR	Polynomial Roots	[array$_1$]	[array$_2$]
PWISE	Piecewise Functions	–	–
SIMPL	Symbolic Simplification	'symb$_1$'	'symb$_2$'
TYLRA	Taylor Polynomial	'symb$_1$' 'name' x y	'symb$_2$'

For more information, see Chapter 3, "Algebraic Functions."

Arithmetic Functions

These commands are found in the CMDS ARTH menu.

Name	Description	Input(s)	Output
FRACT	Closest Fraction	$'symb_1'$ m	$'symb_2'$
GCD	Greatest Common Divisor	m_1 m_2	n
LCM	Least Common Multiple	m_1 m_2	n
LOGA	Logarithm, Any Base	'symb' z_1	z_2
NROOT	Nth Roots of a Number	z n	{list}
PRIME	Prime Factorization	n	{list}
REDUC	Reduce Fraction	m_1 n_1	m_2 n_2

For more information, see Chapter 4, "Arithmetic Functions."

Curve Fitting Functions

These commands are found in the CMDS CURV menu.

Name	Description	Input(s)	Output
PINTR	Polynomial Interpolation	[$array_1$]	[$array_2$]
PTSLP	Point-Slope Fit	(x,y) a	[array]
SPLIN	Cubic Spline Fit	(x_1,y_1) a (x_2,y_2) b	[array]

For more information, see Chapter 5, "Curve Fitting Functions."

Hyperbolic Functions

These commands are found in the CMDS HYPR menu.

Name	Description	Input(s)	Output
COTH	Hyperbolic Cotangent	z_1	z_2
SECH	Hyperbolic Secant	z_1	z_2
CSCH	Hyperbolic Cosecant	z_1	z_2
ACOTH	Inverse Hyperbolic Cotangent	z_1	z_2
ASECH	Inverse Hyperbolic Secant	z_1	z_2
ACSCH	Inverse Hyperbolic Cosecant	z_1	z_2

For more information, see Chapter 6, "Hyperbolic Functions."

Integration Functions

These commands are found in the **CMDS** **INTG** menu.

Name	Description	Input(s)	Output
LEFT	Left Rectangles	a b 'symb' m	c
RIGHT	Right Rectangles	a b 'symb' m	c
MIDPT	Midpoint Rectangles	a b 'symb' m	c
TRAPZ	Trapezoidal Method	a b 'symb' m	c
SIMPS	Simpson's Rule	a b 'symb' m	c

For more information, see Chapter 7, "Integration Functions."

Special Functions

These commands are found in the **CMDS** **SPEC** menu.

Name	Description	Input(s)	Output
BETA	Beta Function	a b	c
ERF	Error Function	x	y
ERFC	Complementary Error Function	x	y
GAMMA	Gamma Function	x	y
J0	J0 Bessel Function	x	y
J1	J1 Bessel Function	x	y
JN	JN Bessel Function	x n	y
Y0	Y0 Bessel Function	x	y
Y1	Y1 Bessel Function	x	y
YN	YN Bessel Function	x n	y

For more information, see Chapter 8, "Special Functions."

Trigonometric Functions

These commands are found in the **CMDS** **TRIG** menu.

Name	Description	Input(s)	Output
COT	Cotangent	z_1	z_2
SEC	Secant	z_1	z_2
CSC	Cosecant	z_1	z_2
ACOT	Inverse Cotangent	z_1	z_2
ASEC	Inverse Secant	z_1	z_2
ACSC	Inverse Cosecant	z_1	z_2

For more information, see Chapter 9, "Trigonometric Functions."

Chapter 32

Programmable Screens

Math•*Pro* is designed to allow you to jump directly to any Analysis, Equation, or Reference screen from the HP 48 stack with the GOMATH command.

This chapter covers programming with Math•*Pro* and includes a summary of the screens in Math•*Pro*. For more information about programming, see Chapter 31, "Programmable Commands" and the HP 48 manual.

This chapter covers:

- ❏ GOMATH: Go Math•*Pro*
- ❏ Analysis Screens
- ❏ Equations Screens
- ❏ Reference Screens

GOMATH: Go Math•*Pro*

This command provides programmable access to the Math•*Pro* screens. The input to GOMATH is a path list indicating which screen to display.

Example: *Browse Constants from the HP 48 stack.* To go directly to the Constants reference table from the HP 48 stack, type [←] [{}] 3 [SPC] 1 [ENTER] to put the list { 3 1 } on the stack. Then press (HP 48GX) [→] [LIBRARY] or (HP 48SX) [←] [LIBRARY] and [MATH] [GOMA] and the Constants screen will appear.

Example: *Browse Constants from a user program.* To make a program which goes directly to the Constants reference table from the HP 48 stack, type [←] [«»] [←] [{}] 3 [SPC] 1 [►] [SPC] [←] [LIBRARY] [MATH] [GOMA] [ENTER] to put the program « { 3 1 } GOMATH » on the stack. Then type ['] [α] [α] GOCONS [ENTER] to put the name 'GOCONS' on the stack. Finally, press [STO] to store the program into GOCONS. To execute GOCONS from the HP 48 stack, press [VAR] [GOCO] and the Constants screen will appear. The program could also be stored in your custom menu for quick access. For more information, see the HP 48 manual.

Analysis Screens

This is a summary of the Math•*Pro* Analysis screens and their corresponding path lists for use with the GOMATH command.

Menu Item	Path
Home	{ }
Analysis	{ 1 }
Algebraic Functions	{ 1 1 }
Delta Function	{ 1 1 1 }
Partial Fraction Expansion	{ 1 1 2 }
Piecewise Functions	{ 1 1 3 }
Polynomial Coefficients	{ 1 1 4 }
Polynomial Equation	{ 1 1 5 }
Polynomial Roots	{ 1 1 6 }
Symbolic Simplification	{ 1 1 7 }
Taylor Polynomial	{ 1 1 8 }
Arithmetic Function	{ 1 2 }
Closest Fraction	{ 1 2 1 }
Greatest Common Divisor	{ 1 2 2 }
Least Common Multiple	{ 1 2 3 }
Logarithm, Any Base	{ 1 2 4 }
Nth Roots of a Number	{ 1 2 5 }
Prime Factorization	{ 1 2 6 }
Reduce Fraction	{ 1 2 7 }
Curve Fitting Functions	{ 1 3 }
Polynomial Interpolation	{ 1 3 1 }
Point-Slope Fit	{ 1 3 2 }
Cubic Spline Fit	{ 1 3 3 }
Hyperbolic Functions	{ 1 4 }
Integration Functions	{ 1 5 }
Special Functions	{ 1 6 }
Bessel Functions	{ 1 6 1 }
Beta Function	{ 1 6 2 }
Error Functions	{ 1 6 3 }
Gamma Function	{ 1 6 4 }
Trigonometric Functions	{ 1 7 }

Equations Screens

This is a summary of the Math•*Pro* Equations screens and their corresponding path lists for use with the GOMATH command.

Menu Item	Path
Home	{ }
Equations	{ 2 }
Analytic Geometry	{ 2 1 }
Parabola	{ 2 1 1 }
Ellipse	{ 2 1 2 }
Hyperbola	{ 2 1 3 }
Circles	{ 2 2 }
Circle	{ 2 2 1 }
Sector and Segment	{ 2 2 2 }
Circular Ring	{ 2 2 3 }
Semicircle	{ 2 2 4 }
Coordinate Systems	{ 2 3 }
XY ↔ Polar	{ 2 3 1 }
XYZ ↔ Cylindrical	{ 2 3 2 }
XYZ ↔ Spherical	{ 2 3 3 }
Cylinders and Cones	{ 2 4 }
Right Circular Cylinder	{ 2 4 1 }
Thin Cylindrical Shell	{ 2 4 2 }
Thick Cylindrical Shell	{ 2 4 3 }
Uniform Thin Rod	{ 2 4 4 }
Right Circular Cone	{ 2 4 5 }
Frustum of Cone	{ 2 4 6 }
Planar Bounded Solids	{ 2 5 }
Cube	{ 2 5 1 }
Rectangular Parallelepiped	{ 2 5 2 }
Pyramid	{ 2 5 3 }
Tetrahedron	{ 2 5 4 }
Polygons	{ 2 6 }
Rectangle	{ 2 6 1}
Parallelogram	{ 2 6 2 }
Rhombus	{ 2 6 3 }
Trapezoid	{ 2 6 4 }
General Quadrilateral	{ 2 6 5 }
Regular Polygons	{ 2 6 6 }
Spherical Figures	{ 2 7 }
Sphere	{ 2 7 1 }

Hemisphere	{ 2 7 2 }
Thin Spherical Shell	{ 2 7 3 }
Thick Spherical Shell	{ 2 7 4 }
Zone and Segment of 1 Base	{ 2 7 5 }
Zone and Segment of 2 Bases	{ 2 7 6 }
Ellipsoid	{ 2 7 7 }
Circular Torus	{ 2 7 8 }
Triangles	{ 2 8 }
Right Triangle	{ 2 8 1}
Equilateral Triangle	{ 2 8 2 }
General Triangle	{ 2 8 3 }
Laws of SIN, COS, TAN	{ 2 8 4 }

Reference Screens

This is a summary of the Math•*Pro* Reference screens and their corresponding path lists for use with the GOMATH command.

Menu Item	Path
Home	{ }
Reference	{ 3 }
Constants	{ 3 1 }
Derivatives	{ 3 2 }
Greek Alphabet	{ 3 3 }
Hyperbolics	{ 3 4 }
Definitions	{ 3 4 1 }
Pictures	{ 3 4 2 }
Relations	{ 3 4 3 }
Angle Sum/Difference	{ 3 4 4 }
Half Angle	{ 3 4 5 }
Double Angle	{ 3 4 6 }
Multiple Angle	{ 3 4 7 }
Function Product	{ 3 4 8 }
Function Sum/Difference	{ 3 4 9 }
Power Relations	{ 3 4 10 }
Complex Arguments	{ 3 4 11 }
Integrals	{ 3 5 }
0: User-Defined	{ 3 5 1 }
1: Elementary	{ 3 5 2 }
2: A+BX	{ 3 5 3 }
3: A+BX,C+DX	{ 3 5 4 }
4: A+BX^N	{ 3 5 5 }
5: C^2±X^2,X^2-C^2	{ 3 5 6 }
6: √(A+BX)	{ 3 5 7 }
7: √(X^2+A^2)	{ 3 5 8 }
8: √(X^2-A^2)	{ 3 5 9 }
9: √(A^2-X^2)	{ 3 5 10 }
10: Trig. (SIN)	{ 3 5 11 }
11: Trig. (COS)	{ 3 5 12 }
12: Trig. (SIN and COS)	{ 3 5 13 }
13: Trig. (Other)	{ 3 5 14 }
14: Inverse Trigonometric	{ 3 5 15 }
15: Logarithmic	{ 3 5 16 }
16: Exponential	{ 3 5 17 }
17: Hyperbolic	{ 3 5 18 }

18: Definite	{ 3 5 19 }
Quadric Surfaces	{ 3 6 }
Series	{ 3 7 }
Taylor	{ 3 7 1 }
Binomial	{ 3 7 2 }
Exponential/Logarithmic	{ 3 7 3 }
Trigonometric/Hyperbolic	{ 3 7 4 }
SI Prefixes	{ 3 8 }
Transforms	{ 3 9 }
Definitions	{ 3 9 1 }
Fourier Finite Sine	{ 3 9 2 }
Fourier Finite Cosine	{ 3 9 3 }
Fourier Sine	{ 3 9 4 }
Fourier Cosine	{ 3 9 5 }
Fourier Transforms	{ 3 9 6 }
Laplace Transforms	{ 3 9 7 }
Z Transforms	{ 3 9 8 }
Trigonometry	{ 3 10 }
Definitions	{ 3 10 1 }
Pictures	{ 3 10 2 }
Relations	{ 3 10 3 }
Reductions	{ 3 10 4 }
Angle Sum/Difference	{ 3 10 5 }
Half Angle	{ 3 10 6 }
Double Angle	{ 3 10 7 }
Multiple Angle	{ 3 10 8 }
Function Product	{ 3 10 9 }
Function Sum/Difference	{ 3 10 10 }
Power Relations	{ 3 10 11 }
Exponential Relations	{ 3 10 12 }
Quadrant Signs	{ 3 10 13 }
Vectors	{ 3 11 }
Dot Products	{ 3 11 1 }
Cross Products	{ 3 11 2 }
Del Operator	{ 3 11 3 }
Gradient	{ 3 11 4 }
Divergence	{ 3 11 5 }
Curl	{ 3 11 6 }
Laplacian	{ 3 11 7 }

Chapter 33

Advanced Use of the Solver

This chapter covers advanced use of the solver in the Equations section.

- ❑ Creating a Working Directory
- ❑ How are Multiple Equations Solved?
- ❑ Using Guesses to Improve Solving
- ❑ Solver Icons

Creating a Working Directory

Every time the solver solves an equation, it stores the variable values into your HP 48 user memory, in the directory you were at when you ran Math•*Pro*. If you would prefer to organize the equation variables into a specific subdirectory in your HP 48 user memory, follow these steps:

❶ Quit Math•*Pro* to the HP 48 stack.
❷ Press [↱][HOME] to go to the HOME directory of your HP 48.
❸ Press [VAR] to display the variables in the HOME directory.
❹ Decide on a name for the work subdirectory (e.g., WORK).
❺ Type ['][α][α] WORK [ENTER] to put the name on the stack.
❻ Type [α][α] CRDIR [ENTER] to create the subdirectory 'WORK' in your HOME directory. It should appear in the variable menu as WORK.

You have now created the subdirectory { HOME WORK }. In order to store all equation variables created by Math•*Pro* in { HOME WORK }, each time you run the software, first follow these steps:

❶ Press [↱][HOME] to go to the HOME directory of your HP 48.
❷ Press [VAR] to display the variables in the HOME directory.
❸ Press WORK to switch to the { HOME WORK } subdirectory.
❹ Start Math•*Pro*, as described in Chapter 1, "Getting Started."

For more information on directories, see the HP 48 manual.

How are Multiple Equations Solved?

The solver in the Equations section of Math•*Pro* is a *systematic* solver, not a *simultaneous* one. For example, the solver can solve this set of equations, provided it is given a known value of either x or y:

$$x + y + z = 5$$
$$x + y = 3$$

However, the solver cannot solve this set of equations, when neither x or y is known in advance:

$$x + y = 2$$
$$x - y = 0$$

The solver iterates through a set of equations, searching for an equation with only one unknown variable. When an equation satisfying this requirement is found, the solver uses the built-in HP 48 root-finder to solve for the unknown variable. After the value is found, that variable is marked as found, and the solver continues to search. The solver does not terminate its search until one of three conditions occurs:

❶ All equations are solved, and all unknown variables are found.

❷ All variables marked as wanted are found.

❸ No more equations can be solved, because all remaining unsolved equations have more than one unknown variable.

All variables for which values are found in a solving operation are marked with a shaded circle at the solver screen.

Using Guesses to Improve Solving

Pressing **SOLVE** calls the built-in HP 48 root-finder to solve each equation. The root-finder requires an initial value on which to base its search for the solution. If no value exists, the solver uses a default guess of 1, but you can provide a guess to override that value. The root-finder then generates pairs of intermediate values and interpolates between them to find the solution. The time required to find the solution (the root) depends on how close the initial guess is to the actual solution.

You can shorten the solution time by providing a guess close to the expected solution. Go to the solver screen and move the highlight bar to the variable in question, and enter a guess. The variable will automatically be marked as known, so move the highlight bar back to the variable and press KNOW or +/- to unmark the variable as known, so it will be calculated by the solver. Then press SOLVE and the solver will use the current value as the initial guess for the variable.

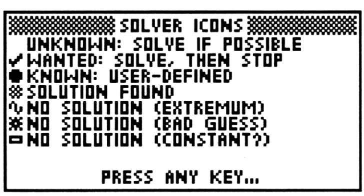
There is another advantage to using a guess, which is that you can help the solver find a specific solution to an equation which may have multiple valid solutions or roots.

Example: Imagine solving the equation $x^2 = 9$. Possible solutions include 3 and -3. Both of these solutions are right, but which one do you want? If you enter a guess of -1 for x, the solver will find the -3 solution, but if you enter a guess of 1 for x (which is the default guess), the solver will find the 3 solution. Depending on which solution you want, you may have to enter a guess for x.

Solver Icons

At the Solver screen, the status of variables is indicated by icons which appear to the left of the variable name. You control the presence of some of the icons, and the solver controls the presence of the other icons.

To display the icon screen from the Solver screen, press ICONS.



Press any key to return to the previous screen.

User-Controlled Icons

You control the presence of unknown (blank icon), known, and wanted icons by pressing KNOW or WANT.

- **UNKNOWN:** *Solve if possible.* The solver will calculate the values of all unknown variables, unless it first stops because all wanted variables have been found. As a result of a calculation, the solver may change the status of unknown variables to solution found or no solution. However, if there are not enough known variables to solve for the unknown variable, the status will remain unchanged as unknown.

- **KNOWN:** *User-defined.* The values of the known variables are used to calculate the values of the unknown and wanted variables. The solver will not change the status of known variables.

- **WANTED:** *Solve, then stop.* The solver will calculate the values of all wanted variables and then stop. While solving for the wanted variables, the solver may also have to calculate the values of some unknown variables in order to find solutions to the wanted variables. As a result of a calculation, the solver may change the status of wanted variables to solution found or no solution. However, if there are not enough known variables to solve for the wanted variable, the status will remain unchanged as wanted.

Solver-Controlled Icons

The solver controls the presence of solution found and no solution icons. Each time you change a value or press SOLVE to start a new calculation, the solution found and no solution icons are all removed and the variables reset to unknown.

- **SOLUTION FOUND:** *Solution found.* A solution found icon indicates a solution has been found for the variable. Solutions may be indicated either as *zeros* or *sign reversals*, both of which are accurate solutions.

- **NO SOLUTION:** *Extremum.* An extremum icon indicates a solution has not been found for the variable. This occurs when the solver finds a point where the value of the variable being solved approximates a local minimum or maximum, or when the largest (MAXR) or smallest (–MAXR) range of numbers is encountered.

- **NO SOLUTION:** *Bad guess.* A bad guess icon indicates a solution has not been found for the variable. This occurs when the initial guess for the variable is outside the domain of the equation. An example of this is a negative value inside a square root, which will cause a bad guess error, because the solver does not support complex numbers.

- **NO SOLUTION:** *Constant?* A constant icon indicates a solution has not been found for the variable. This occurs when the value of the variable is the same at every point sampled across the domain of the equation.

For more information, see Chapter 10, "Equation Tutorial."

Chapter 34

Advanced Use of the Plotter

This chapter covers advanced use of the plotter in the Equations section.

- ❑ How are Equations Plotted?

How are Equations Plotted?

To plot an equation, it must be in the form $y = f(x)$, where x represents the independent variable and y the dependent variable. The plotter must be able to isolate the dependent variable on the left side of the equation before plotting. For this reason, there are equations in which certain variables should not be selected as the dependent variable, because they cannot be isolated.

Example: *How can the law of Cosines be plotted?* The equation is:

$$a^2 = b^2 + c^2 - 2bc\cos(\theta a)$$

where **a**, **b**, and **c** are the three triangle sides and **θa** is the angle opposite side **a**.

In this equation, any variable can be selected as the independent variable, but only **a** and **θa** should be selected as the dependent variable, because **b** and **c** appear more than once in the equation.

This table shows the possible combinations of the independent and dependent variables for the law of Cosines equation and shows exactly what form the equation takes for plotting in each case.

Dependent	Independent	Isolated Equation
a	b	$a = f(b) = \sqrt{b^2 + c^2 - 2bc\cos(\theta a)}$
a	c	$a = f(c) = \sqrt{b^2 + c^2 - 2bc\cos(\theta a)}$
a	**θa**	$a = f(\theta a) = \sqrt{b^2 + c^2 - 2bc\cos(\theta a)}$
b	a	Cannot isolate **b**
b	c	Cannot isolate **b**
b	**θa**	Cannot isolate **b**
c	a	Cannot isolate **c**
c	b	Cannot isolate **c**
c	**θa**	Cannot isolate **c**
θa	a	$\theta a = f(a) = \cos^{-1}\left(\dfrac{a^2 - b^2 - c^2}{-2bc}\right)$
θa	b	$\theta a = f(b) = \cos^{-1}\left(\dfrac{a^2 - b^2 - c^2}{-2bc}\right)$
θa	c	$\theta a = f(c) = \cos^{-1}\left(\dfrac{a^2 - b^2 - c^2}{-2bc}\right)$

When isolating **a** or **θa**, the plotter also automatically selects the principal value (or branch) of the solution, if there are multiple solutions. Observe that the first three equations also have a negative solution to the square root, but the principal solution is the positive one, so that is what is used for plotting.

After plotting an equation, to examine the form of the actual equation which was plotted, quit Math•*Pro* and look at the variable 'EQ' in the user memory of your HP 48. (Note: 'EQ' is not created until the plot is drawn.)

Appendixes and Index

Appendix A

Warranty and Service

This appendix covers:

- ❑ PocketProfessional Support
- ❑ Limited 60 Day Warranty
- ❑ If a Card Requires Service
- ❑ Environmental Limits

PocketProfessional Support

If you have questions about using your PocketProfessional software and cannot find the answers in this manual or your HP 48 manual, contact Sparcom Corporation in one of the following ways:

❶ **E-Mail**
From Internet: support@sparcom.com
From Compuserve: >Internet:support@sparcom.com
From FidoNet: To:support@sparcom.com

❷ **Standard Mail**
Sparcom Corporation
Attn: Technical Support
897 NW Grant Avenue
Corvallis, OR 97330, USA

❸ **Telephone**
(503) 757–8416, Monday to Friday, 9 a.m. to 5 p.m., Pacific Time

❹ **Facsimile**
(503) 753–7821

Limited Sixty Day Warranty

A PocketProfessional plug-in card is warranted by Sparcom Corporation against defects in material and workmanship for sixty days from the date of original purchase. The warranty is transferable and remains in effect for the original sixty day period. During the warranty period, we will repair or replace (at no charge) a product that proves to be defective, provided you return the product and proof of purchase, shipping prepaid, to Sparcom Corporation.

This warranty does not apply if the product has been damaged by accident or misuse or as the result of service or modification by any entity other than Sparcom Corporation. No other warranty is given. Products are sold on the basis of specifications applicable at the time of manufacture. Sparcom Corporation has no obligation to modify or update products, once sold.

If a Card Requires Service

Sparcom Corporation will repair a card, or replace it with the same model or one of equal or better functionality, whether it is under warranty or not. Cards are usually serviced and re-shipped within five working days.

Service Charge

There is a fixed charge for out-of-warranty repairs, subject to the customer's applicable local sales or value-added tax, and is individually determined.

Shipping Instructions

If your card requires service, call Sparcom Corporation for a Return Merchandise Authorization number (RMA). Also:

❶ Include your return address and a description of the problem.

❷ Include your RMA number with the merchandise.

❸ Include a proof of purchase date if the warranty has not expired.

❹ Include a purchase order, along with a check or credit card number and expiration date (VISA or MasterCard), to cover the standard repair charge, if applicable.

❺ Ship your card, postage prepaid, in protective packaging adequate to prevent damage. Shipping damage is not covered by the warranty, so insuring the shipment is recommended. Ship the package to:

Sparcom Corporation
RMA #_______
897 NW Grant Avenue
Corvallis, OR 97330, USA

Environmental Limits

The reliability of a PocketProfessional plug-in card depends upon the following temperature and humidity limits:

❶ **Operating Temperature:** 0 to 45° C (32 to 113° F).

❷ **Storage Temperature:** –20 to 60° C (–4 to 140° F).

❸ **Operating and Storage Humidity:** 90% relative humidity at 40° C (104° F) maximum.

Appendix B

Key Summary

This appendix covers:

- Options Menu Key Summary
- Home Screen Key Summary
- Analysis Screen Key Summary
- Equation Screen Key Summary
- Solver Screen Key Summary
- Plotter Screen Key Summary
- Reference Screen Key Summary

Options Menu Key Summary

Key	Action
SPD:▪	Changes the scrolling speed of the highlight bar.
UNIT▪	Toggles units on or off.
HELP▪	Toggles display of help text at the bottom of the screen.
FONT	Toggles font size between large and small.
DESC▪	Toggles positions of data and help text (if appropriate).
→STK	Copies one or all of the items shown to the HP 48 stack.
VIEW	Displays the highlighted item in a text view. Press ⮫ or ⮨ VIEW to show the item in a graphics view.
FIND	Searches for the specified character or string.
PRINT	Prints one or all of the items shown to an HP 48 printer.
PATH	Displays screens chosen to reach the current screen.
EXIT	Leaves the options menu.

Home Screen Key Summary

Key	Action
ABOUT	Displays product information and software revision.
VIEW	Displays the highlighted item in a text view.
FIND	Searches for the specified character or string.
OPTS	Displays the options menu.
PATH	Displays screens chosen to reach the current screen.
QUIT	Quits Math•*Pro* and returns to the HP 48 stack.
HOME	Goes to the home screen.
UP	Goes to the previous screen.

Key	Action
▲ or ▼	Moves the highlight bar up or down one item.
↰ ▲ or ↰ ▼	Moves the highlight bar to top or bottom of screen.
↱ ▲ or ↱ ▼	Moves the highlight bar to top or bottom of list.
◄ or ↰ UP	Goes to the previous screen.
↱ ◄ or ↱ HOME	Goes to the home screen.
ENTER or ►	Enters the highlighted section.
NXT or ↰ PREV	Goes to the next or previous menu row (if appropriate).
CST	Goes to the custom settings screen.
↰ CST or ↱ CST	Goes to the first or second page of the options menu.
↱ CMD	HP 48GX: Displays the highlighted item in a text view.
↱ VISIT	HP 48SX: Displays the highlighted item in a text view.
ON	Quits Math•*Pro* to the HP 48 stack.

Analysis Screen Key Summary

Key	Action
OPTS	Displays the options menu.
SOLVE	Performs a calculation using the displayed values.
EDIT	Edits the highlighted item for an edit field.
STACK	Copies the highlighted item to the HP 48 stack and temporarily goes to the HP 48 stack environment.
TYPES	Displays the allowed object types for an edit field.
CHOOS	Displays the possible choices for a choose field.
→STK	Copies one or all of the items shown to the HP 48 stack.
VIEW	Displays the highlighted item in a text view. Press ⮫ or ⮨ VIEW to show the item in a graphics view.

Key	Action
▲ or ▼	Moves the highlight bar up or down one item.
⮨ ▲ or ⮨ ▼	Moves the highlight bar to top or bottom of screen.
⮫ ▲ or ⮫ ▼	Moves the highlight bar to top or bottom of list.
◄ or ⮨ UP	Goes to the previous screen.
⮫ ◄ or ⮫ HOME	Goes to the home screen.
ENTER or ►	Enters the highlighted section (for a screen). Edits the highlighted item (for an edit field). Displays the possible choices (for a choose field). Copies item(s) shown to the stack (for a result field).
NXT or ⮨ PREV	Goes to the next or previous menu row (if appropriate).
CST	Goes to the custom settings screen.
⮨ CST or ⮫ CST	Goes to the first or second page of the options menu.
⮫ CMD	HP 48GX: Displays the highlighted item in a text view.
⮫ VISIT	HP 48SX: Displays the highlighted item in a text view.
ON	Quits Math•*Pro* to the HP 48 stack.

Equation Screen Key Summary

Key	Action
✓CHK	Checks or unchecks the highlighted equation.
EQWR	Displays the highlighted equation in a graphics view.
PICT	Displays a picture.
OPTS	Displays the options menu.
PLOTR	Goes to the Plotter screen.
SOLVR	Goes to the Solver screen.

Key	Action
▲ or ▼	Moves the highlight bar up or down one item.
⬅ ▲ or ⬅ ▼	Moves the highlight bar to top or bottom of screen.
➡ ▲ or ➡ ▼	Moves the highlight bar to top or bottom of list.
◄ or ⬅ UP	Goes to the previous screen.
➡ ◄ or ➡ HOME	Goes to the home screen.
ENTER or ►	Enters the highlighted section (for a screen). Checks or unchecks the highlighted equation.
+/-	Checks or unchecks the highlighted equation.
NXT or ⬅ PREV	Goes to the next or previous menu row (if appropriate).
CST	Goes to the custom settings screen.
⬅ CST or ➡ CST	Goes to the first or second page of the options menu.
➡ CMD	HP 48GX: Displays the highlighted item in a text view.
➡ VISIT	HP 48SX: Displays the highlighted item in a text view.
ON	Quits Math•*Pro* to the HP 48 stack.

Solver Screen Key Summary

Key	Action
EDIT	Edits the highlighted variable.
STACK	Copies the highlighted variable to the HP 48 stack and temporarily goes to the HP 48 stack environment.
PICT	Displays a picture.
OPTS	Displays the options menu.
CONV	Displays the convert menu for the highlighted variable.
SOLVE	Solves the equation(s) using the displayed values.
KNOW	Marks or unmarks the highlighted variable as *known*.
WANT	Marks or unmarks the highlighted variable as *wanted*.
RESET	Resets one or all of the variables.
ICONS	Displays the icons used to indicate variable status.
PLOTR	Goes to the Plotter screen.
EQNS	Goes to the Equation screen.

Key	Action
[▲] or [▼]	Moves the highlight bar up or down one item.
[↰][▲] or [↰][▼]	Moves the highlight bar to top or bottom of screen.
[↱][▲] or [↱][▼]	Moves the highlight bar to top or bottom of list.
[◄] or [↰][UP]	Goes to the previous screen.
[↱][◄] or [↱][HOME]	Goes to the home screen.
[ENTER] or [►]	Edits the highlighted variable.
[+/-]	Marks or unmarks the highlighted variable as *known*.
[NXT] or [↰][PREV]	Goes to the next or previous menu row (if appropriate).
[CST]	Goes to the custom settings screen.
[↰][CST] or [↱][CST]	Goes to the first or second page of the options menu.
[VAR]	Toggles positions of variable values and descriptions.
[DEL]	Resets one or all of the variables.
[↰][UNITS] or [↱][UNITS]	Toggles units on or off.
[↱][CMD] or [↱][VISIT]	Displays the highlighted item in a text view.
[ON]	Quits Math•*Pro* to the HP 48 stack.

Plotter Screen Key Summary

Key	Action
PICT	Displays a picture.
OPTS	Displays the options menu.
ERASE	Erases any previous plots.
DRAW	Plots the current equation.
EQNS	Goes to the Equation screen.
SOLVR	Goes to the Solver screen.
EDIT	Edits the highlighted item for an edit field.
STACK	Copies the highlighted item to the HP 48 stack and temporarily goes to the HP 48 stack environment.
CHOOS	Displays a list of possible values for a choose field.
✓CHK	Toggles a check mark for a check field.

Key	Action
▲ or ▼	Moves the highlight bar up or down one item.
← ▲ or ← ▼	Moves the highlight bar to top or bottom of screen.
→ ▲ or → ▼	Moves the highlight bar to top or bottom of list.
◄ or ← UP	Goes to the previous screen.
→ ◄ or → HOME	Goes to the home screen.
ENTER or ►	Edits the highlighted item (for an edit field). Displays the possible choices (for a choose field). Checks or unchecks highlighted item (for check field).
+/-	Displays the possible choices (for a choose field). Checks or unchecks highlighted item (for check field).
NXT or ← PREV	Goes to the next or previous menu row (if appropriate).
CST	Goes to the custom settings screen.
← CST or → CST	Goes to the first or second page of the options menu.
← UNITS or → UNITS	Toggles units on or off.
→ CMD	HP 48GX: Displays the highlighted item in a text view.
→ VISIT	HP 48SX: Displays the highlighted item in a text view.
ON	Quits Math•*Pro* to the HP 48 stack.

Reference Screen Key Summary

Key	Action
→STK	Copies one or all of the items shown to the HP 48 stack.
VIEW	Displays the highlighted item in a text view.
PICT	Displays a picture (if appropriate).
OPTS	Displays the option menu.
DESC▪	Toggles positions of data and help text (if appropriate).
SOLVE	Activates the custom solving routine (if appropriate).

Key	Action
▲ or ▼	Moves the highlight bar up or down one item.
◀ ▲ or ◀ ▼	Moves the highlight bar to top or bottom of screen.
▶ ▲ or ▶ ▼	Moves the highlight bar to top or bottom of list.
◄ or ◀ UP	Goes to the previous screen.
▶ ◄ or ▶ HOME	Goes to the home screen.
ENTER or ►	Enters the highlighted section (for a screen). Edits the highlighted item (for an edit field). Activates the custom solving routine (if appropriate). Copies item(s) shown to the stack (for a result field).
NXT or ◀ PREV	Goes to the next or previous menu row (if appropriate).
CST	Goes to the custom settings screen.
◀ CST or ▶ CST	Goes to the first or second page of the options menu.
VAR	Toggles positions of data and help text (if appropriate).
◀ UNITS or ▶ UNITS	Toggles units on or off.
▶ CMD	HP 48GX: Displays the highlighted item in a text view.
▶ VISIT	HP 48SX: Displays the highlighted item in a text view.
ON	Quits Math•*Pro* to the HP 48 stack.

Appendix C

User Flags

This appendix covers:

- ❑ Flag 57: Font Size
- ❑ Flag 58: Help Text
- ❑ Flag 61: Units
- ❑ User Flag Summary

Flag 57: Font Size

The display font size is controlled by the setting of user flag 57:

- ❑ **Flag 57 Clear:** *Small display font.* The small font contains 3x5 uppercase letters and fits eight vertical lines of text on the screen (without help text).

- ❑ **Flag 57 Set:** *Large display font.* The large font contains 5x7 uppercase and lowercase letters and fits six vertical lines of text on the screen (without help text).

To change the font size while using Math•*Pro*, press FONT.

To change the font size from the HP 48 stack, type 57 SF or 57 CF.

Flag 58: Help Text

The presence of context-sensitive help text along the bottom of the screen is controlled by the setting of user flag 58.

- ❑ **Flag 58 Clear:** *Help text on.* Help text is displayed at the bottom of the HP 48 screen, directly above the menu keys. Help text is always displayed in the small font, regardless of the setting of flag 57.

- ❑ **Flag 58 Set:** *Help text off.* When help text is off, one more line is available on the screen for displaying information.

To toggle help text while using Math•*Pro*, press HELP.

To toggle help text from the HP 48 stack, type 58 SF or 58 CF.

Flag 61: Units

The presence of units is controlled by the setting of user flag 61.

- ❑ **Flag 61 Clear:** *Units on.* Equations can be solved and plotted with or without units, and Reference tables can be displayed with or without units. When units are on, equation solving and plotting may take longer.

- ❑ **Flag 61 Set:** *Units off.* When units are off, equation solving and plotting will be faster than when units are on.

To toggle units while using Math•*Pro*, press UNITS.

To toggle units from the HP 48 stack, type 61 SF or 61 CF.

User Flag Summary

Flag	Affects	Clear	Set
57	Font Size	Small font (default)	Large font
58	Help Text	Help text on (default)	Help text off
61	Units	Units on	Units off (default)

Appendix D

Questions and Answers

This appendix lists the most common questions about Math•*Pro*. Scan this list before you call customer support—you might save yourself a phone call!

This appendix covers:

- ❑ General Questions
- ❑ Analysis Questions
- ❑ Equations Questions
- ❑ Reference Questions

General Questions

These are the most commonly asked questions about general features of Math•*Pro*. For more information, see Chapter 1, "Getting Started."

Q Why is there a 'SPARCOM' directory in my HP 48 user memory? (It appears as SPARC when you press VAR to display the variable menu.)

A Special parameter variables are stored in the 'SPARCOM' directory by Math•*Pro*. One of those variables is 'MATHPAR', which contains information about which screen you were at when you quit Math•*Pro*, so that screen will re-appear the next time you run the software. Another variable is 'INTEG', which contains any user-defined integrals you enter in the Integrals section.

Note that variables created during equation solving and plotting are *not* necessarily stored in the 'SPARCOM' directory, but in whatever directory you were at when you ran the software. This is so that you can create working subdirectories to organize your sets of variables if you commonly solve different sets of equations.

Q What do the three dots (...) mean at the end of an item on the screen?

A The three dots (an ellipsis) indicate the item is too wide to fit on the screen. To display the item in a text view, move the highlight bar to it and press VIEW or ⮫ CMD (HP 48GX) or ⮫ VISIT (HP 48SX).

Q I solved a problem a long time ago, and I want to find those values again for a problem I'm working on now, but I can't find them. Where are they?

A Values entered in Analysis calculations are never remembered by Math•*Pro*, because they are not stored in user memory. However, values entered in Equations calculations *are* stored in variables in user memory. Those variables will remain in whatever directory you were at when you solved the problem, unless you have cleared your HP 48 memory or reset the variables since you originally solved the problem.

Q I'm trying to find something which I know is in Math•*Pro* somewhere, but the find operation keeps telling me, "String Not Found."

A The find feature only searches information in the current screen. It cannot find an item if it is not displayed on the current screen. If you need to find out where a feature is located in Math•*Pro*, use the table of contents or index of this manual.

Analysis Questions

These are the most commonly asked questions about the Analysis section of Math•*Pro*. For more information, see Chapter 2, "Analysis Tutorial" and your HP 48 manual.

Q The result isn't the value I expected. What could be wrong?

> **A** Your HP 48 may be in an incorrect mode. Press CST to display the custom settings screen, and check the angle and result modes.

Q When I press SOLVE, the result is an expression, not a number. Why?

> **A** Your HP 48 may be in symbolic results mode instead of numeric results mode. Press CST to display the custom settings screen, change the result mode to Numeric, and re-solve.

Q When I press SOLVE, I get the message, "Undefined Name." Why?

> **A** Your HP 48 may be in numeric results mode instead of symbolic results mode. Press CST to display the custom settings screen, change the result mode to Symbolic, and re-solve.

Equations Questions

These are the most commonly asked questions about the Equations section of Math•*Pro*. For more information, see Chapter 10, "Equation Tutorial" and your HP 48 manual.

Q I turned units off and all my values changed. What happened?

A When units are on, values can be entered and saved in any unit. When units are off, values can be entered in any unit, but the values will automatically be used and displayed in SI units after entry. This is necessary so that when you press SOLVE to solve the equation, all the values will be consistent with each other and your answer will be correct. If you don't want to be restricted to SI units, turn units back on.

Q I entered values for some variables and pressed SOLVE, but I get the message, "Too many unknowns to finish solving." Why?

A Sometimes the solver doesn't have enough information (i.e., enough known variables) to solve for all the remaining, unknown variables. If you don't yet have an answer to your problem, then you will have to enter more known values and re-solve.

Q There are already values stored in some of my variables. How do I clear those values?

A The values remain from previous solving operations. It is okay to ignore the values, because as long as they aren't marked as known, they will be overwritten by new solutions. If you want to reset the variables, press RESET or [DEL] to clear one or all of the variables.

Q I entered values for some variables and pressed SOLVE, but I get the message, "Bad Guess(es)". Why?

A There are several possibilities, but in all cases, the solver has encountered trouble while trying to solve for a particular variable. The problem variable is marked with an icon indicating a bad guess error occurred while solving for that variable.

Q The solution to my problem is clearly wrong! (A triangle area or angle might be negative.) Why?

A This is most likely to happen when angles are involved in the equation(s) you are solving. What has happened is that the HP 48 has found a non-principal solution to your equation.

Example: Imagine solving the equation $\sin(x) = 0.5$. Solutions include: 30°, 390°, -330°, 750°, etc., but the *principal* solution is 30°.

If a non-principal solution is found, it may then be used to solve other equations, leading to strange results.

Example (cont.): Now imagine solving the equation $x + y = 90°$. If x is 30°, then y should be 60°. But if a non-principal solution for x was found, such as 750°, then the value of y will be -660°, which although technically correct, is also not a principal solution.

The way to fix this problem is to put in an initial guess for angle variables.

Example (cont.): Before solving for x, enter the value 45° for x and then press KNOW or +/- to unmark x as known. Now, when you press SOLVE to solve for x, the guess of 45° will be used, and it is close enough to the principal solution of 30° that the solver is very likely to find the principal solution.

Q I tried plotting an equation and got the message, "Undefined Name." Why?

A When plotting, all variables other than the independent and dependent variables must have values. Go to the Solver screen and enter values for the other variables in the equation you are plotting and re-plot.

Q I tried plotting an equation and got the message, "Unable to Isolate." Why?

A The variable you have selected as the dependent variable occurs more than once in the equation, which means it can't be isolated. This means that you can't plot the equation with that variable as the dependent variable.

Reference Questions

These are the most commonly asked questions about the Reference section of Math•*Pro*. For more information, see Chapter 19, "Reference Tutorial" and your HP 48 manual.

Q I tried solving a derivative or integral and got a number as the result, not an expression. Why?

> **A** All derivatives and integrals in Math•*Pro* are written with respect to the variable 'X'. It is likely that the variable 'X' exists in your HP 48 user memory, which means the value of 'X' is being inserted into the derivative or integral result, which is then being evaluated to a number. To prevent this from occurring, quit Math•*Pro* and purge 'X' from the user memory of your HP 48. 'X' is most likely to be in the HOME directory.

Q I tried solving a derivative or integral and got an expression with $\pi/180$ in it. What does that mean?

> **A** Your HP 48 may be in Degrees mode and the derivative or integral may involve a trigonometric function, so the result includes the correction factor $\pi/180$ to convert between degrees and radians. Set your HP 48 to Radians mode, and the trigonometric derivatives or integrals will be calculated without this correction factor.

Q How do I solve an integral which isn't in Math•*Pro*?

> **A** Enter the general form of the integral and its solution into the User-Defined section of Integrals. Then, you will be able to solve it in the same manner as the built-in integrals.

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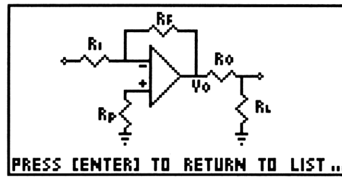
PocketProfessional® Series

The PocketProfessional series of software includes over 14 different software programs for the HP 48GX and HP 48SX calculators. Ask your authorized Sparcom Corporation dealer or distributor for any of the products listed below.

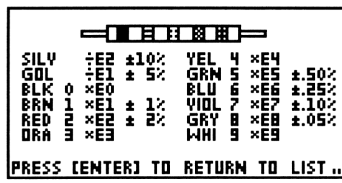
Electrical Engineering Pac PN 10051-1A

Over 300 equations in circuit elements, DC circuits, RL and RC circuits, RLC circuits, OpAmp circuits, solid state devices and more. Analysis sections include simple AC circuits, Fourier and Laplace transforms, ladder network analysis, and two-port networks.



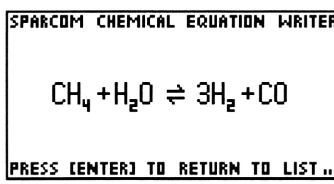
Electrical Engineering Reference Pac PN 10061-1A

Turn your HP 48GX or HP 48SX into an EE reference manual. Over 3000 entries from seven subject areas. Resistor color chart. Standard inductor and capacitor values.



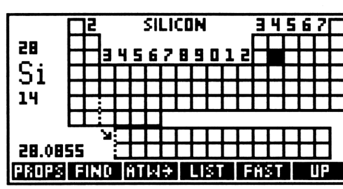
General Chemistry Pac PN 10052-1A

Over 150 equations from kinetics, acids/bases, gases, precipitation and more. Periodic table includes 14 properties of each element. Chemical equation writer calculates theoretical yields, limiting reagents, and checks balance. Molecular weight calculator. Plot pH titration curves.



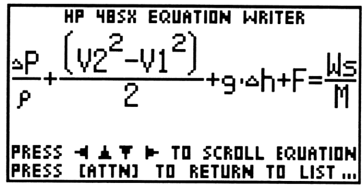
General Chemistry Reference Pac PN 10062-1A

Turn your HP 48GX or HP 48SX into a Chemistry reference manual. Over 3000 entries in eleven subject areas. Periodic table includes 20 different properties of each element.



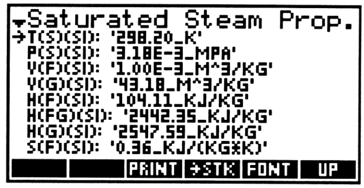
Mechanical Engineering Pac PN 10053-1A

Over 300 equations from fluid mechanics, heat transfer, gases, beams, stress analysis, machine design, and more. Analysis sections include steam tables, thermocouples and vector analysis.



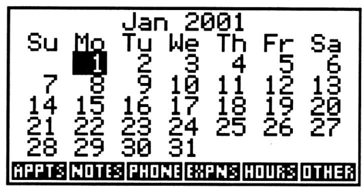
Mechanical Engineering Reference Pac PN 10063-1A

Turn your HP 48GX or HP 48SX into a ME reference manual. Over 3000 entries from nine subject areas. Steam tables. Composition of metals. Thermal Conductivities.



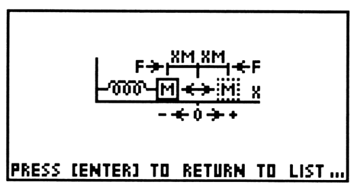
Personal Information Manager PN 10081-1A

Turns the HP 48SX into an electronic organizer. Interactive calendar and appointment book take care of your schedule. Phone directory. Expense accountant and time manager. Report generator compiles itemized lists to make expense reports.



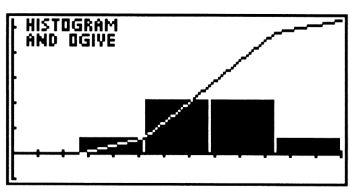
Physics Pac PN 10091-1A

Over 250 equations in angular mechanics, electrical circuits, electric fields, force/energy/work, gravitation, linear mechanics, magnetism, optics, oscillations, special relativity and waves. Taylor expansion, vector analysis, integral tables, and reference data.



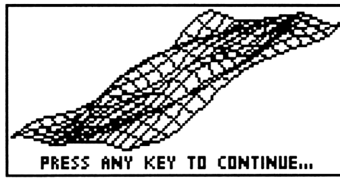
Statistics Pac PN 10101-1A

This pac includes basic statistics, probability distributions, estimation, plotting manager, and regression analysis. Load tab or comma delimited data files from a PC or Mac directly into the HP 48SX.



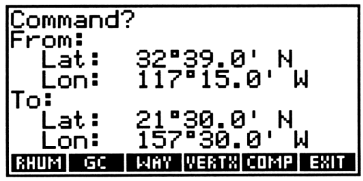
Calculus Pac PN 10111-1A

Access curve fitting routines. Integrate by left, right, and midpoint rectangles, trapezoids, and Simpson's rule. Access integral tables, plus add your own. Graphics include 2D and 3D, including hidden-line removal. Symbolic vector and differential equation solving.



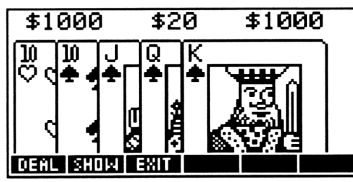
Celestial Navigation Pac PN 10121-1A

Celestial navigation is now made easy on the HP 48GX or HP 48SX. Route planning by Great Circle, Rhumb line or Composite methods. Compute position fix and display the result. The almanac is good to the year 2030. Messier objects.



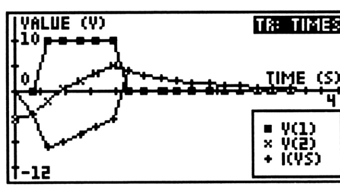
Games48 PN 10131-1A

Tests of reflexes, thinking power and casino skills is all included in the Games48 Pac. Ten games including: Blackjack, Diamonds, Keno, Poker, Reversi, Roulette, Slots, Skunk, and Sokoban.



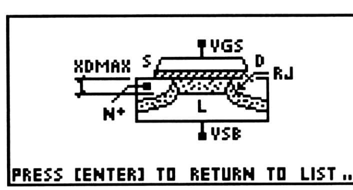
Spice48 PN 10511-1A

This self-contained circuit analysis tool is used to calculate and view the complete response of linear circuits. SPICE48 is based on the work of the CAD Group, University of California at Berkeley. SPICE has emerged as the *industry standard* for analog circuit analysis.



Solid State Electronics Pac PN 10501-1A

Over 350 equations describing characteristics of devices such as MOS transistors, MOS inverter design, bipolar transistors, PN junctions, microwave, optoelectronic devices and IC process engineering. Extensive functions provided to compute IC yields and lifetime calculations.



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