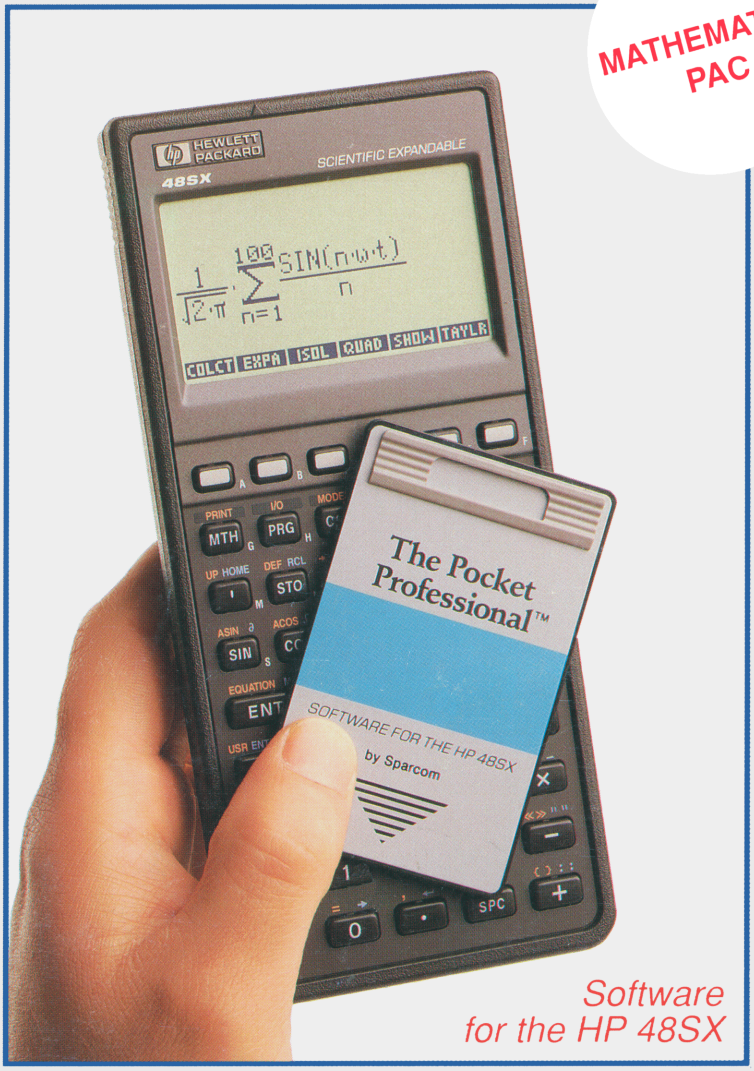
Sparcom

Pocket Professional™

OWNER'S MANUAL

MATHEMATICS PAC



Software for the HP 48SX

The Pocket Professional™

Mathematics Pac

Owner's Manual

SPARCOM®

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Notice

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Acknowledgements

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Chapter 1
Getting Started

In This Chapter

Sparcom's Pocket Professional™ software is the first of its kind, developed to provide speed, efficiency and portability to students and professionals in the technical fields. When you slide the Pocket Professional™ Mathematics Pac into your HP 48SX, your calculator is instantly transformed into an electronic "textbook," ready to efficiently solve your mathematical problems. The Pac is organized into eight separate sections: Algebra, Geometry, Trigonometry, Hyperbolics, Calculus, Linear Algebra, Transforms, and Miscellaneous... all available in an efficient, menu-driven format.

This chapter covers:

- ☐ Installing and Removing the Card
- ☐ RAM Requirements and the MATHD Directory
- ☐ Using the Main Menu
- ☐ Moving Around the Screen
- ☐ Viewing Items Too Wide for the Display
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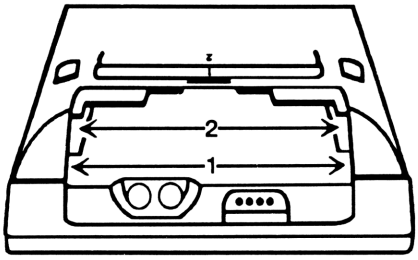
- ☐ Alpha Lock
- ☐ How to Load Data from the Stack
- ☐ System Flags

Installing and Removing the Card

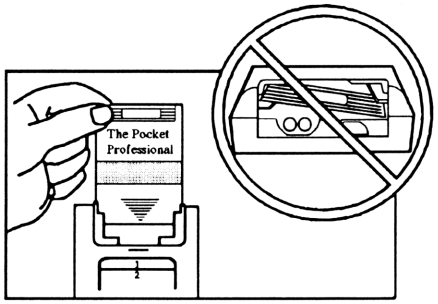
The HP 48SX has two ports for installing plug-in cards. You can install your Mathematics Pac card in either port. Be sure to **turn off the HP 48SX** while installing or removing the card. Otherwise, user memory may be erased.

To Install the Application Card

1. Turn the HP 48SX off. Do not press [ON] until you have completed the installation procedure.
2. 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:



3. Select either empty port for the Pocket Professional™ card, and position the card just outside the slot. Point the triangular arrow on the card toward the HP 48SX port opening, as shown below:

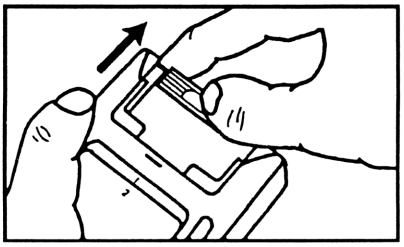


4. Slide the card firmly into the slot. After you first feel resistance, push the card about 1/4 inch further, until it is fully seated.
5. Replace the port cover.

To Remove an Application Card

1. Turn the HP 48SX off. Do not press [ON] until you have completed the removal procedure.

2. 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.
3. Press against the card's grip and slide the card out of the port, as shown below:

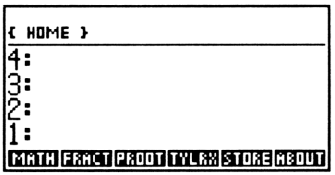


4. Replace the port cover.

Accessing the Mathematics Pac

After you turn on your HP 48SX by pressing [ON], there are three ways to start the Pac.

Method 1: Press [◄] [LIBRARY] to display all libraries available to the HP 48SX. Find and press MATH to enter the Mathematics Pac library directory. The screen displays new menukeys (softkeys) along the bottom, as shown:



Press MATH (the first softkey) to start the application. To display a screen containing the revision number and product information about the Mathematics Pac, press ABOUT (the sixth softkey). For information about the other softkeys available at this menu, see Chapter 10, "Programmable Functions."

Method 2: Type [α] [α] MATH [ENTER] to start the application.

Method 3: Add the command MATH to the CST (custom) menu. (For more information, refer to Chapter 15 of the HP 48SX *Owner's Manual*,

"Customizing the Calculator.") After the command has been added to CST, press CST MATH to start the application.

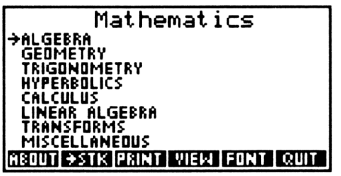
RAM Requirements and the MATHD Directory

The Mathematics Pac requires a certain amount of the RAM in your HP 48SX to be unused in order to work correctly. This RAM is used for temporary storage during menu display and calculations, and for storing global variables and user integrals in the MATHD directory. We recommend that you have at least 4000 bytes free when you operate the Mathematics Pac. In a very few cases, more RAM will be required, and in most cases, less is necessary, but if you have at least 4K free, you should have no trouble. (For more information, refer to Chapter 5 of the HP 48SX *Owner's Manual*, "Calculator Memory.")

When you execute the Mathematics Pac for the first time, the software creates the directory MATHD in the HOME directory of the HP 48SX, using a small amount of free RAM. All operations performed by the Mathematics Pac take place in the MATHD directory. It is, therefore, the only place where global variables are created or purged by the Mathematics Pac. You may purge this directory (using the command PGDIR) if you are very low on RAM, but you will lose all stored integrals and variable values. If you purge the MATHD directory, the Mathematics Pac will automatically recreate it the next time you execute the Pac. (For more information, refer to Chapter 7 of the HP 48SX *Owner's Manual*, "Directories.")

Using the Main Menu

After you start the application, the Main menu appears:



The Main menu lists the eight major subjects. A subject is selected by moving the arrow to the desired item and pressing ENTER.

Items in the Main Menu

Each item in the Main menu is briefly described below and is discussed in detail in the remainder of this manual.

Item	Description
Algebra	Demonstrates several commonly used algebraic functions.
Geometry	Includes over 150 equations describing the most useful two- and three-dimensional geometric figures.
Trigonometry	Provides quick access to 100 trigonometric identities for reference.
Hyperbolics	Provides quick access to 100 hyperbolic identities for reference.
Calculus	Spans several major areas within symbolic mathematics, including over 300 integrals, nearly 50 derivatives, and the 20 most common series in calculus.
Linear Algebra	Provides basic tools for use in matrix analysis.
Transforms	Includes over 150 reference formulas.
Miscellaneous	Contains commonly used mathematical reference data.

Summary of Operations

Key	Action
ABOUT	Displays a screen containing the revision number and product information about the Mathematics Pac. Pressing any key erases the screen and returns to the Main menu.
FONT	Toggles between the small and large fonts.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
QUIT	Quits the Mathematics Pac to the HP 48SX stack.

→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Moves down one level in the menu structure.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Moving Around the Screen

Use the ▲ and ▼ keys to move the arrow up and down in a menu. Press ◀ ▼ to move the arrow to the bottom of the screen, or to page down one screen at a time if the arrow is already at the bottom of the screen. Press ◀ ▲ to move the arrow to the top of the screen, or to page up one screen at a time. Press ▶ ▼ to move the arrow to the end of the menu or press ▶ ▲ to move the arrow to the beginning of the menu.

Viewing Items Too Wide for the Display

If the text of a menu item is too wide to fit within the display, an ellipsis (...) appears at the end of the line. On some screens, the VIEW softkey will be present – press VIEW to display the entire text of an item, up to one entire screen size. Once the full text has been displayed, press ENTER or ATTN to return to the menu. At **all** screens, including those screens where VIEW is not present, pressing ▶ VISIT will perform the same function. If an item **does** fit entirely on the screen, VIEW or ▶ VISIT will beep and do nothing.

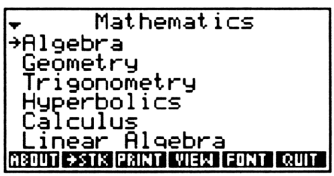
Scrolling Equations Too Wide for the Display

Equations can be viewed in EquationWriter format by moving the arrow to the desired equation and pressing ENTER. This builds and displays the EquationWriter form of the equation. If the EquationWriter form fits on the screen, pressing ENTER returns to the list of equations from which the equation was selected. If the EquationWriter form is too large for the screen, the cursor keys are activated for scrolling, and pressing ATTN returns to the list of equations from which the equation was selected. If the EquationWriter form is too tall for the screen, the help messages are not displayed, so as not to obscure any part of the equation, but the cursor keys are still activated.

WARNING: While the HP 48SX is building the EquationWriter format version of an equation, any key presses may cause strange behavior, resulting in no display of the equation. Therefore, do not press any keys until the equation has been drawn, erased, and re-drawn with the accompanying messages. If you change your mind during a long equation build, press ATTN to abort the build process and return to the equation screen.

Changing the Font Size

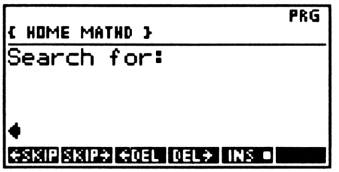
The default font for the Mathematics Pac displays information in condensed, uppercase letters only. Pressing FONT will toggle the information to a larger font, which is case-sensitive:



The font size will remain the same until FONT is pressed again.

Using the Search Mode

When menu lists are long, it is faster to locate an item using the search mode. To initiate a search, press [α] to display the following screen:



The HP 48SX is now locked in alpha-entry mode, as indicated by the alpha annunciator at the top of the screen. Alpha entry mode activates the white capital letters printed to the lower right of many keys. (For more information, see the section below entitled, "Alpha Lock," and refer to Chapter 2 of the HP 48SX *Owner's Manual*, "The Keyboard and Display.")

To perform a search, enter the first letter or letters of the desired string and press [ENTER]. The search function is case-sensitive, and will scan through all information in the current menu. To enter a lowercase letter in the alpha entry mode, precede the letter with [◄]. To abort the search, press [ATTN].

Editing Text Entries

The softkeys present at the search screen and at many data input screens are command line editing keys. They allow you to edit the search string or input data. Their functions are summarized below:

Key	Action
←SKIP	Moves the cursor to the beginning of the current word.
SKIP→	Moves the cursor to the beginning of the next word.
←DEL	Deletes all characters in the current word prior to the cursor.
DEL→	Deletes all characters in the current word between the cursor's current position and the first character of the next word.
INS	Toggles between insert and type-over modes.

ATTN	Clears the command line if there is text present, or aborts text entry if the command line is already blank.
ENTER	Accepts the current command line as the entry and returns to the previous menu or list.

(For more information, refer to Chapter 3 of the HP 48SX *Owner's Manual*, "The Stack and Command Line.")

Alpha Lock

System flag –60 controls whether or not Alpha Lock mode is set. The default setting for flag –60 is clear, which means that pressing α places the HP 48SX in alpha-entry mode for only one character, and you must press α α to lock alpha-entry mode. If flag –60 is set, however, then pressing α only once locks alpha-entry mode. The examples in this manual assume that flag –60 is clear, so that each α keystroke turns on alpha-entry mode only for the following character. (For more information, refer to Chapter 2 of the HP 48SX *Owner's Manual*, "The Keyboard and Display.")

How to Load Data from the Stack

At all data input screens, it is possible to load in values from the HP 48SX stack, even while the Mathematics Pac is executing. This is achieved through a limited version of the Interactive Stack, which operates from inside the input routine. To activate the Interactive Stack, press ▲, or if that doesn't work, press ↶ EDIT to display the EDIT menu and then press ↑STK. At this point, unless the stack is empty, the screen will display the contents of the stack. You may move the arrow up and down the stack with ▲ and ▼, and when you reach the desired value, press ECHO to copy it onto the command line for editing. To exit the Interactive Stack and return to the command line, press ENTER or ATTN. After returning to the command line, you can edit the value with the editing softkeys described above. (For more information, refer to Chapter 3 of the HP 48SX *Owner's Manual*, "The Stack and Command Line.")

System Flags

Flag Preservation

Executing the Mathematics Pac will not change the flag settings or stack depth on your HP 48SX, unless you push →STK at some point to leave results on the stack. For your convenience, most flag settings are preserved during operation of the Mathematics Pac, including the alpha-lock setting. However, for the software to operate properly, some system flags are temporarily modified during execution:

- ☐ Angle mode is set to Degrees, except for integrations
- ☐ Clock display is turned off
- ☐ Radix mark is set to "." (period)
- ☐ User Mode is turned off

When you press ATTN or QUIT to exit the Mathematics Pac to the HP 48SX stack, or when you press HALT at the solver screen to access the HP 48SX stack, all system and user flags are restored to their previous settings.

WARNING: Pressing ATTN multiple times in rapid succession may abort the Mathematics Pac without resetting the state of your HP 48SX. Do not do this! The Pac is designed to be tolerant of any user operation, including a few ATTN presses, but it cannot properly restore your stack and flag settings if you push ATTN too many times in a row.

User Flags Controlling Font Size and Units

The dispay font size is controlled by the setting of user flag 57. If flag 57 is clear, the small display font will be used; if flag 57 is set, the large display font will be used. Changes in the display font during operation of the Mathematics Pac are preserved after you quit to the HP 48SX stack.

The state of units (on or off) is controlled by the setting of user flag 61. If flag 61 is clear, units are on; if flag 61 is set, units are off. Changes in the units status during operation of the Mathematics Pac are preserved after you quit to the HP 48SX stack.

Chapter 2
Algebra

In This Chapter

Algebra demonstrates several commonly used algebraic functions.

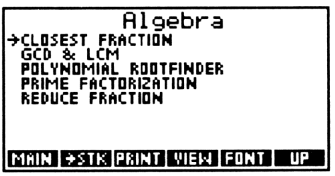
This chapter covers:

- ☐ Using Algebra
- ☐ Closest Fraction
- ☐ Greatest Common Divisor/Least Common Multiple
- ☐ Polynomial Root Finder
- ☐ Prime Factorization
- ☐ Reducing a Fraction

Using Algebra

To get to the Algebra section, follow these steps:

1. Press ↩ LIBRARY to display all libraries available to the HP 48SX.
2. Find and press MATH to enter the Mathematics Pac library directory.
3. Press the first softkey, MATH , to start the application.
4. At the Main menu, move the arrow to Algebra (by pressing ▲ and ▼) and press ENTER.



Items in the Algebra Menu

Each entry in the Algebra menu is briefly described below and is discussed in detail later in this chapter.

Item	Description
Closest Fraction	Closest Fraction takes as input a real number, a complex number, an algebraic object, or a unit object, along with a maximum denominator, and returns the closest fraction.
GCD & LCM	GCD & LCM take as input two integers and return the greatest common divisor (GCD) and least common multiple (LCM) of those two integers.
Polynomial Root Finder	Polynomial Root Finder takes as input a series of real or complex coefficients of a polynomial expression, and returns all roots – both real and complex – of that polynomial.
Prime Factorization	Prime Factorization takes as input an integer and returns a list of the prime factors that uniquely describes the integer.
Reducing a Fraction	Reducing a Fraction takes as input two integers (the numerator and denominator) and returns two integers (the reduced numerator and denominator).

Summary of Operations (Algebra)

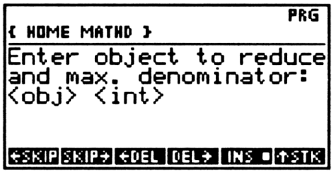
Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
UP	Moves up one level in the menu structure.

VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Executes the selected function.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Closest Fraction

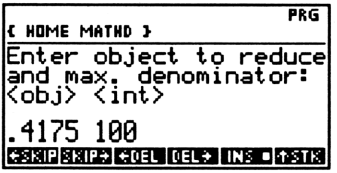
Upon choosing Closest Fraction from the Algebra menu, the following screen appears:



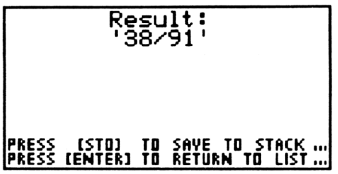
Closest Fraction takes as input a real number, a complex number, an algebraic object, or a unit object, along with a maximum denominator, and returns the closest fraction.

The '<' and '>' symbols shown in many entry prompts in the Mathematics Pac bracket the type(s) of object(s) to be entered on the command line, and are not meant to be included as a part of the entry.

Example 1: Calculate what the closest fraction to .4175 is, with a maximum denominator of 100. Type in .4175 SPC 100 as your input:

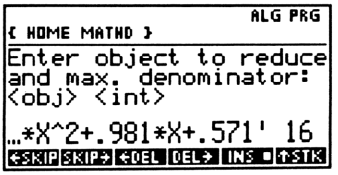


Pressing ENTER displays a "Solving..." message and then the following screen:

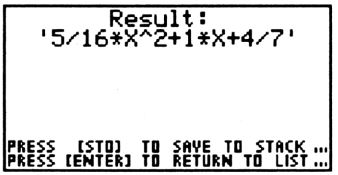


Press STO to save the result to the stack as an algebraic object, or ENTER or ATTN to return to the Algebra menu without saving the result on the stack.

Example 2: Calculate the closest fractions of all the coefficients of .321X^2+.981X+.571, with a maximum denominator of 16. Type in ' .321 * α X y^x 2 + .981 * α X + .571 ▶ SPC 16 as your input:

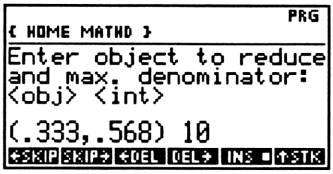


Pressing ENTER displays a "Solving..." message and then the following screen:

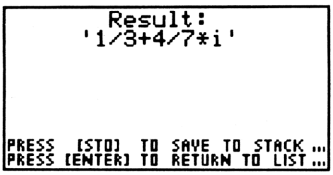


Press STO to save the result to the stack as an algebraic object, or ENTER or ATTN to return to the Algebra menu without saving the result on the stack.

Example 3: Calculate what the closest fractional components are of (.333,.568), with a maximum denominator of 10. Type ◀ ( ) .333 ◀ , .568 ▶ SPC 10 as your input:



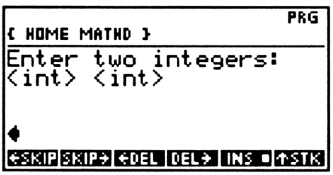
Pressing ENTER displays a "Solving..." message and then the following screen:



Press STO to save the result to the stack as an algebraic object, or ENTER or ATTN to return to the Algebra menu without saving the result on the stack.

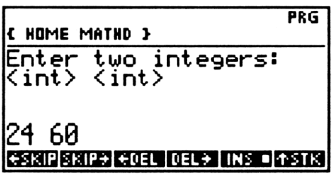
GCD & LCM

Upon choosing GCD & LCM from the Algebra menu, the following screen appears:

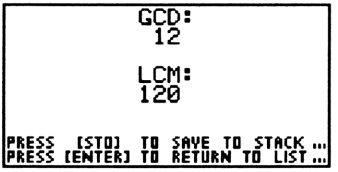


GCD & LCM take as input two integers and return the greatest common divisor (GCD) and least common multiple (LCM) of those two integers.

Example: Calculate GCD and LCM for the integers 24 and 60. Type in 24 SPC 60 as your input:



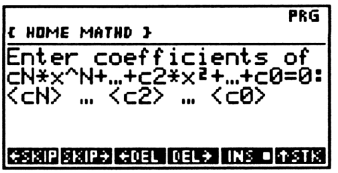
Pressing [ENTER] displays a "Solving..." message and then the following screen:



Press [STO] to save the results to the stack as tagged objects, or [ENTER] or [ATTN] to return to the Algebra menu without saving the results on the stack.

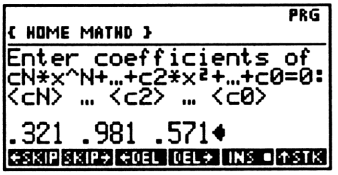
Polynomial Root Finder

Upon choosing Polynomial Root Finder from the Algebra menu, the following screen appears:

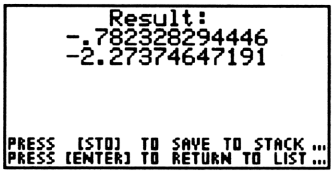


Polynomial Root Finder takes as input a series of real or complex coefficients of a polynomial expression, and returns all roots – both real and complex – of that polynomial.

Example 1: Calculate the roots of .321X ^ 2 + .981X + .571. Type in .321 [SPC] .981 [SPC] .571 as your input:

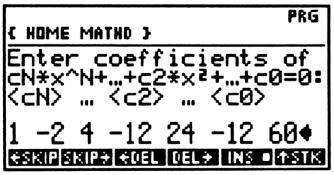


Pressing [ENTER] displays a "Solving..." message and then the following screen:

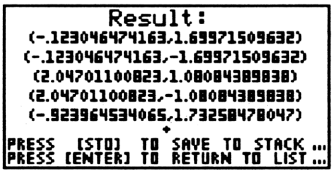


Press [STO] to save the result to the stack as a list, or [ENTER] or [ATTN] to return to the Algebra menu without saving the result on the stack.

Example 2: Calculate the roots of
X ^ 6–2*X ^ 5 + 4*X ^ 4–12*X ^ 3 + 24*X ^ 2–12*X + 60. Type in 1 [SPC] 2 [+/-] [SPC] 4 [SPC] 12 [+/-] [SPC] 24 [SPC] 12 [+/-] [SPC] 60 as your input:



Pressing [ENTER] displays a "Solving..." message and then the following screen:

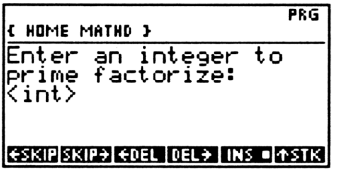


The small " + " symbol indicates that more than five roots were found. However, only five roots can be displayed here – to view the remaining roots, press [STO] to copy the result to the stack as a list, and then quit the Pac to examine them.

NOTE: For large-order polynomials, computation times may exceed one minute or more.

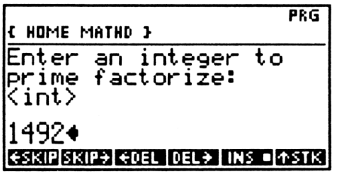
Prime Factorization

Upon choosing Prime Factorization from the Algebra menu, the following screen appears:

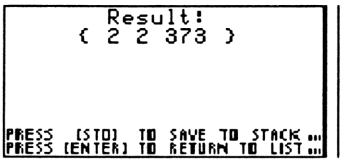


Prime Factorization takes as input an integer and returns a list of the prime factors that uniquely describe the integer.

Example: Calculate the prime factorization of 1492. Type in 1492 as your input:



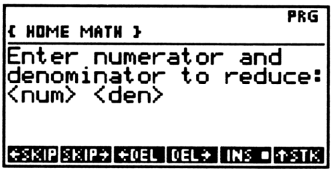
Pressing [ENTER] displays a "Solving..." message and then the following screen:



Press [STO] to save the result to the stack as a list, or [ENTER] or [ATTN] to return to the Algebra menu without saving the result on the stack.

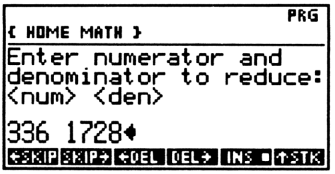
Reducing a Fraction

Upon choosing Reducing a Fraction from the Algebra menu, the following screen appears:

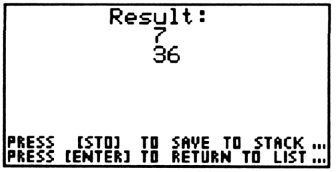


Reducing takes as input two integers (the numerator and denominator) and returns two integers (the reduced numerator and denominator).

Example: Reduce the fraction 336/1728. Type in 336 [SPC] 1728 as your input:



Pressing [ENTER] displays a "Solving..." message and then the following screen:



Press [STO] to save the result to the stack as a list, or [ENTER] or [ATTN] to return to the Algebra menu without saving the result on the stack.

Chapter 3
Geometry

In This Chapter

Geometry includes over 150 equations describing the most common and useful two- and three-dimensional geometric figures. Each of the equation sets is described in detail in Appendix C, "Geometry Reference."

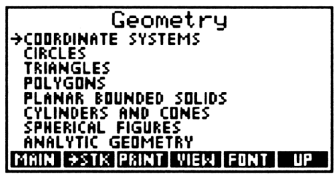
This chapter covers:

- ☐ Using Geometry
- ☐ Solving a Single Equation
- ☐ Managing Units and Solving
- ☐ Solving Multiple Equations
- ☐ Plotting One Equation
- ☐ The Graphics Environment
- ☐ Managing Units and Plotting
- ☐ Multiple Plots of an Equation
- ☐ What You Should Know About the Solver

Using Geometry

To get to the Geometry section, follow these steps:

1. Press ◀ LIBRARY to display all libraries available to the HP 48SX.
2. Find and press MATH to enter the Mathematics Pac library directory.
3. Press the first softkey, MATH, to start the application.
4. At the Main menu, move the arrow to Geometry (by pressing ▲ and ▼) and press ENTER.



Items in the Geometry Menu

Each of the eight categories in the Geometry menu is briefly described below and is discussed in detail in Appendix C, "Geometry Reference."

Item	Description
Coordinate Systems	Equations describing the relationships between Cartesion, polar, cylindrical, and spherical coordinates.
Circles	Equations describing circles, sectors, and segments.
Triangles	Equations describing triangles, including the laws of sines, cosines, and tangents.
Polygons	Equations describing common quadrilaterals and regular polygons.
Planar Bounded Solids	Equations describing planar bounded solids, including inscribed and circumscribed sphere radii.
Cylinders and Cones	Equations describing right circular cylinders and cones.
Spherical Figures	Equations describing spherical figures, including zones and segments of spheres.
Analytic Geometry	Equations describing analytic geometry figures.

Summary of Operations (Geometry)

Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.

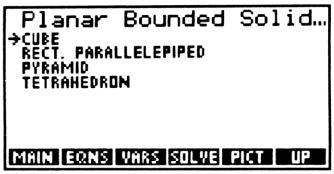
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Moves down one level in the menu structure.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Choosing a Category from the Geometry Menu

Each of the eight categories of equations contains a series of related topics. Each topic includes a title, an equation or set of equations, a complete list of variables and descriptions, a default set of units for all variables, and (usually) a picture to illustrate the topic.

Example: Investigate the category of Planar Bounded Solids. To examine this category, move the arrow to Planar Bounded Solids and press ENTER:



Items in a Category Menu

Each entry in the Planar Bounded Solids category menu is briefly described below and is discussed in detail in Appendix C, "Geometry Reference."

Item	Description
Cube	Equations describing cubes.
Rect. Parallelepiped	Equations describing rectangular parallelepipeds.
Pyramid	Equations describing pyramids.

Tetrahedron	Equations describing tetrahedrons.

Summary of Operations (Category)

Key	Action
EQNS	Displays the equation screen for the current topic.
MAIN	Returns to the Main menu.
FONT	Toggles between the small and large fonts.
PICT	Displays a picture for the current item, if one exists.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
SOLVE	Displays the solver screen of the current topic.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack.
UP	Moves up one level in the menu structure.
VARS	Displays the variable screen for the current topic, including descriptions and default units.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Displays the equation screen for the current topic.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Choosing a Topic from a Category Menu

Once you have chosen a category, as described above, then a menu of topics will be displayed.

Example (cont.): We have just chosen Planar Bounded Solids from the Geometry menu. A topic is selected by moving the arrow to the desired item and pressing ENTER. Let's investigate the equation set describing a

Tetrahedron. To do this, move the arrow to Tetrahedron and press ENTER or EQNS. After the "Loading data..." message, this screen will be displayed:

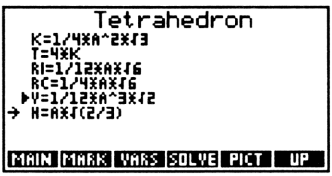
This screen displays the six equations that describe a Tetrahedron.

Solving a Single Equation

Example (cont.): Calculate the volume of a tetrahedron with side length 2.

Marking the Equation

The first step in solving this problem is to select the equation necessary to solve it. Since we are interested in only the volume, it makes sense to only solve that one equation. To do this, mark the volume equation by moving the arrow down to the second-to-last equation and pressing MARK. Observe that after marking an equation, the arrow is automatically incremented one location for convenience, so that more than one equation can easily be marked:



To make sure this is the equation we want, we can display it in the EquationWriter format. To do this, move the arrow back to the marked equation by pressing ▲. Press ENTER to display the equation in EquationWriter format. After the "Building equation..." message and a brief pause, you will see the equation. When you have finished viewing the equation, press ENTER or ATN to return to the equation screen.

Listing the Variables

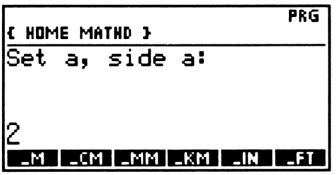
Before solving the equation, let's check the variable screen. Press VARS to display all the variables used in the current set of equations. After the "Updating subset..." message, the following screen is displayed:

Note that only variables contained in the marked equations will be shown at the variable screen.

Now, let's solve the equation. First, press SOLVE to go to the solver level:

Entering a Value

By default, no units are present, which is what we want. Now, set the value of A to 2. Make sure the arrow is pointing at A, and press ENTER. Enter the value for A by typing 2 (don't press any of the unit softkeys; those will be covered in the next section):



Press ENTER to accept the value and return to the solver screen:

The triangular tag next to A indicates that the value is user-defined, or known.

NOTE: Some variables are uppercase letters, while others are lowercase letters; however, when displayed in the small font, all variables appear as uppercase. For this reason, the lowercase and uppercase versions of a letter are never both used, because it would be impossible to tell them apart. (Both r and R would appear as R in the small font.) Most pictures in this manual were captured in the small display font, so all variables are referenced as if they were uppercase.

Solving the Equation

Press CALC to solve the equation. After the "Storing values..." message and the "Updating knowns..." message, you will see an informational message describing which equation is being solved for which variable. Then the found value will be displayed, and the solver screen will reappear:

The asterisk (*) tag next to V indicates that its value was just found in the last calculation.

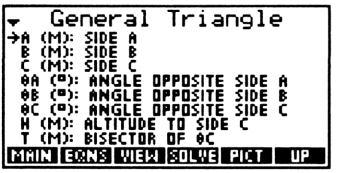
Solving Multiple Equations

Example: Calculate the radius of the circle circumscribing a triangle about which you know only the lengths of the three sides: 2_cm, 1_in, and √3_cm.

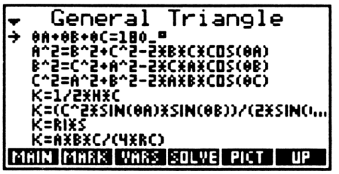
The first step in solving this problem is to find the equations necessary to solve it. Starting at the Main menu, execute the following steps:

Listing the Variables

Move the arrow to Geometry and press ENTER. Then move the arrow to Triangles and press ENTER. Then move the arrow to General Triangle and press VARS to examine the variables. After the "Loading data..." message, this screen will be displayed:

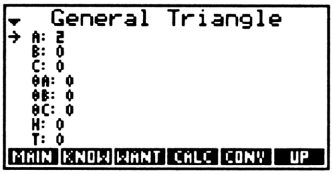


Scroll down in the list to find the variable RC, the circumscribed circle radius. This is the variable for which we will be solving. Now press EQNS to view the equation set:



Marking the Equations

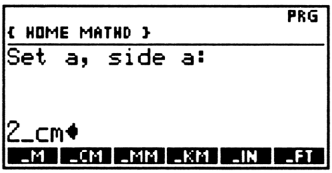
This screen makes evident the advantage of the solver: we don't know which equations are necessary to find RC from A, B, and C, so we simply use all of them and let the solver do the work. Therefore, press SOLVE to go to the solver level:



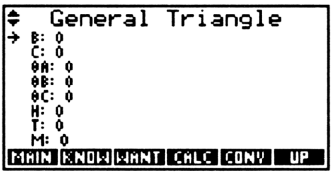
Note that A has the value 2 already stored in it; this is a remnant of the previous example, but does not affect the current problem.

Entering the Values

By default, no units are present, which is what we want. Set the value of A by moving the arrow to A and pressing [ENTER]. Clear the current value of 2 by pressing [ATTN] and then enter a new value for A by typing 2 and pressing _CM to append units of centimeters:



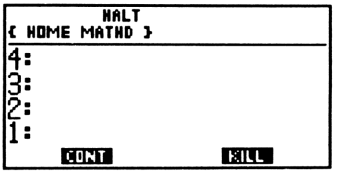
Press [ENTER] to accept the value and return to the solver screen:



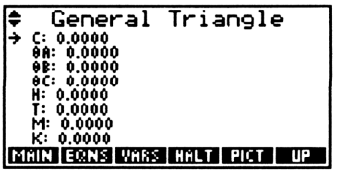
The arrow is automatically moved down one location for convenience, although this means that the specified value for A has been scrolled up off the screen. Press [▲] to look at A. Since units are off, the value for A was converted to the default unit of meters, and therefore displays as .02. The triangular tag next to A indicates that the value is user-defined, or known. Set the value for B (1_in) in a similar fashion; it will display as .0254.

Using the HP 48SX Stack for Calculations

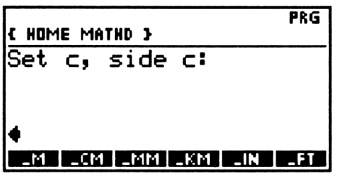
To enter the value of √3_cm for C, we must first evaluate the square root. This cannot be done inside the Mathematics Pac, so press [NXT] HALT to temporarily suspend execution:



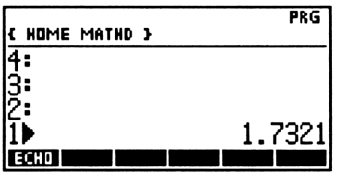
Now we have full use of the HP 48SX stack and functions, so type 3 and press [√]. While we are at the stack, we can also perform other operations, such as changing the display notation. Change it to FIX 4 by typing 4 [SPC] [α] [α] FIX [ENTER]. Then press CONT to continue operation:



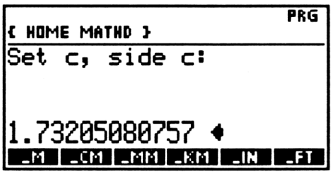
Make sure the arrow is pointing at C and press [ENTER]:



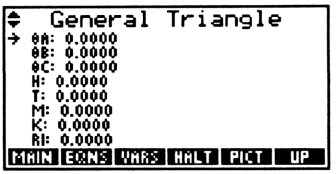
Press [▲] to access the Interactive Stack:



Press ECHO to copy the value in stack level 1 onto the command line for editing. Then press [ENTER] or [ATTN] to exit the Interactive Stack and return to the command line to finish entering the value for C:



Press ← to remove the extra space, and press _CM to append units of centimeters to the value. Then press ENTER to return to the solver screen:

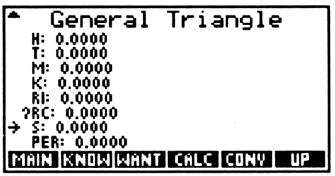


The value for C will display as .0173.

Using the Wanted Feature

Now, we could press CALC to solve the equations. However, the solver would systematically search through all the equations, and would continue solving past the point at which it had found a value for RC. Therefore, to expedite the process, mark RC as a wanted variable. The solver will terminate immediately upon finding values for all wanted variables.

Move the arrow down to RC (by pressing ↑ ▼ ▼) and press NXT NXT NXT WANT :



The question mark (?) tag next to RC indicates it is wanted. The WANT key is a toggle, just like the KNOW key, so pressing it again when the arrow is pointing to RC would remove the question mark (?) tag.

Solving the Equations

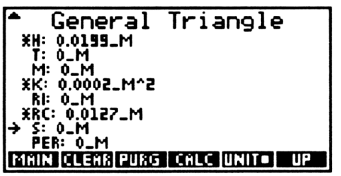
Now, press CALC to solve the equation set. After the "Storing values..." message and the "Updating knowns..." message, you will begin to see a series of informational messages describing which equation is being solved for which variable. In each case, the found value will be briefly displayed, and the solver will continue systematically searching for new equations to solve, until RC has been found. (In this example, values for θA, θB, θC, K, and H will be found before RC is calculated.)

The asterisk (*) tags next to several variables indicate that their values were just found in the last calculation.

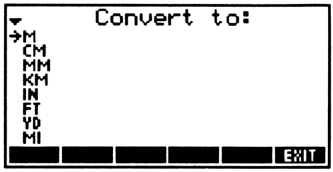
You may note that a value of 805.46 was found for θB, which is not the principal value. To fix this, copy the value of θB to the stack, halt and do a 360 MOD operation on θB, return to the Pac, and load the value back into θB by using the Interactive Stack. An alternative to this cumbersome process is to seed θB with a guess, as expained in a later section in this chapter entitled, "What You Should Know About the Solver."

Converting a Value

Now, let's find out what the value of RC is in millimeters. Turn units on by pressing NXT NXT NXT UNITS :



Move the arrow up to point at RC by pressing ▲ and then press NXT CONV :



This is a list of all the dimensionally consistent units to which you can convert the value of RC. Move the arrow down to the MM choice and press ENTER. After the "Converting value..." message, the following screen will be displayed:

Copying a Result to the Stack

To copy the final result to the stack, make sure the arrow is pointing at RC and press NXT NXT →STK :

Select ONE to copy only the value of RC to the stack, tagged with the variable name. When you quit the Pac later, you will see both the value we placed there earlier, when finding √3, and also the value of RC, tagged with the variable name.

Managing Units and Solving

The solver can work either with units or without units. In general, the solving operations work much faster when units are off, but you may want to work with units in order to view answers in the desired units. There are several important points to the behavior of the unit manager as it relates to the solver:

1. When units are on, values can be entered in any unit, as chosen from the menu presented at the entry screen. The default SI unit is always the first softkey, and entering a value without appending a unit will cause the default unit to be appended.
2. When units are off, all values are considered to be SI units, so that equations can be solved without yielding inaccurate results. If a value is entered with a unit from the entry screen, the value is automatically converted to the default SI units, and then the unit is stripped. Thus, if units are off, and 2_cm is entered for a variable, you will see .02 at the solver screen, because the value has been converted to meters.
3. When units are on, the units of a desired or wanted variable can be specified in advance, in a manner similar to specifying a guess. Simply enter a value in the desired units into the variable. Then press KNOW to toggle the variable back to an unknown state, or press WANT to mark the variable as wanted. Then press CALC to solve for the variable; the answer will be returned in the specified units. The alternative to this process is to press CONV to convert the found value to the desired units, after solving has been completed.
4. When CALC is pressed, all the values in the variables are stored in global copies of the variables, inside the MATHD directory. Therefore, after many uses of the Mathematics Pac, you may begin to notice that variables already seem to contain values when you go to solve equations. This is normal – the Pac is automatically loading in existing values from the global variables for convenience, if the units are dimensionally consistent with the units required for the variable.
5. Once solving with units takes a noticeably longer time, the following procedure is recommended to yield the quickest results. This procedure assumes that there is only one, or possibly two, variables in which you are interested, and that the units on the other known variables are irrelevant. Start with units turned off (i.e., the softkey appears as UNITS, not as UNIT▪). Enter all known values in the correct units by making use of the automatic conversion feature. This means that many of the values will look strange, but this is not important, since they are all consistent. Then solve for the desired variable(s). After the solver has completed, turn units on, to append default SI units to all variables. Then, select the desired variable(s), and press CONV to convert them to the final units. This procedure gives the best of both worlds: no units for fast solving, but units for convenient results.

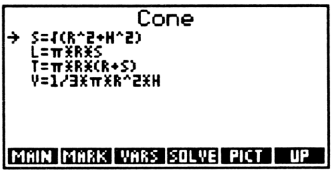
Plotting One Equation

Example: Plot how the volume of a right circular cone varies with the radius of the base for a cone with altitude 7.

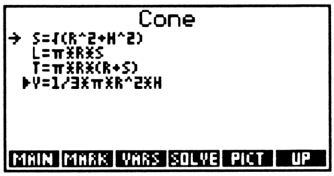
The first step in solving this problem is to find the equation necessary to solve it. Starting at the Main menu, execute the following steps:

Choosing the Equation

Move the arrow to Geometry and press ENTER. Then move the arrow to Cylinders and Cones and press ENTER. Then move the arrow to Cone and press ENTER or EQNS to display the equations. After the "Loading data..." message, this screen will be displayed:

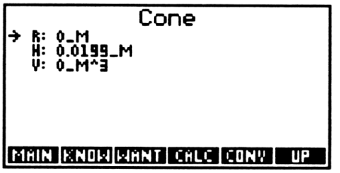


Since we are interested in the variation of volume with base radius, the equation to plot is the last one. We have decided that the independent variable is the base radius (although it could be the altitude), so we must enter a value for the altitude, so it can be held constant while the base radius varies. This must be done at the solver screen. Before pressing SOLVE, first move the arrow down to the volume equation (the last one) and press MARK:

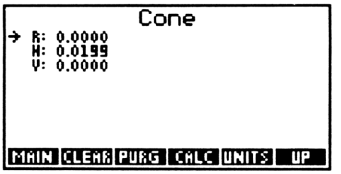


Holding Other Variables Constant for Plotting

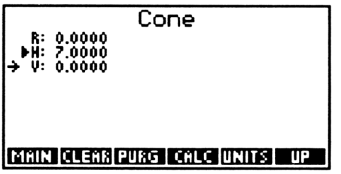
Marking the volume equation will prevent the unneeded variables S, L, and T from appearing at the solver screen. Now, press SOLVE. After the "Updating subset..." message, the following screen will be displayed:



If you have been following step-by-step through this chapter, units will currently be turned on. Turn them off by pressing NXT NXT NXT UNIT. After the "Removing units..." message, the following screen will be displayed:



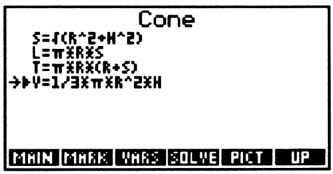
Set the value of H by moving the arrow to H and pressing ENTER. Press ATTN to clear the previous value and type 7 as your input (don't press any of the unit softkeys); then press ENTER to accept that value and return to the solver screen:



Now, we are ready to plot the equation, because a value for H has been entered.

NOTE: What is important at the solver screen is that H be marked as a known variable. It is also critical that R be an unknown variable—if R is marked as known, it will not be allowed to vary as the independent variable by the plotter. In a complex equation, it must be the case that all but one of the variables on the right-hand side of the equation be marked as known at the solver screen before plotting.

Return to the equation screen by pressing NXT NXT EQNS, and move the arrow down so it points at the volume equation (the last one):



NOTE: Pressing PLOT will plot the equation currently selected by the arrow, not necessarily the marked equation. The reason for this is that none, one, some, or all of the equations may be marked at any one time.

Plotting an Equation

To begin the plotting process, press NXT NXT PLOT. After the "Processing..." message, the following screen will be displayed:

For this example, we are starting a new plot, so press YES to clear the graphics screen, PICT, before beginning the plot. If you should decide to abort the plotting process here, pressing ATTN would return to the equation screen. After the "Purging variables..." and "Storing values..." messages, the following screen will be displayed:

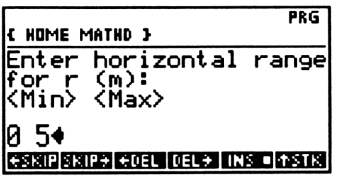
Specifying the X and Y Axes Ranges

Now, you must choose the range for the X axis (the R axis in this case). You are required to enter both a minimum and a maximum value for the independent variable.

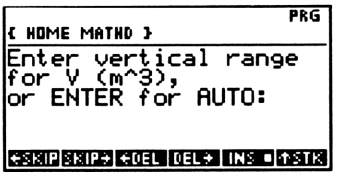
NOTE: If units are off, the range values you enter are assumed to be in SI units and should not be entered as unit objects. For example, type 3 for 3_m and .03 for 3_cm. When units are off, it is not possible to enter plot ranges in units other than default SI units.

NOTE: If units are on, the range values you enter are assumed to be in the units of the independent variable. For example, if R contained a value in centimeters, the X axis prompt would assume the axis ranges you entered were in centimeters. (For more information, see a later section entitled, "Managing Units and Plotting.")

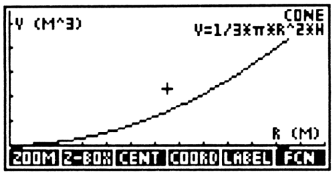
Let's vary the base radius of the cone from 0 to 5. Separate the values by pressing [SPC]:



Press [ENTER] to accept the X range values. The following screen will be displayed:



Now, you must choose the range for the Y axis (the V axis in this case). You are given a choice between fixing the Y axis and having the HP 48SX autoscale it for you. If you fix the axis, you are required to enter both a minimum and a maximum value for the dependent value. If you decide on autoscaling, simply press ENTER at this screen. For our example, press ENTER to autoscale. After the "Autoscaling plot..." and "ATTN to exit plot..." messages, the plot will begin. At any time, you can press ATTN to abort the plotting process. After the plot is complete, the Graphics environment of the HP 48SX will be activated:



The "ATTN to exit plot..." message was to remind you that pressing ATTN will return to the equation screen when you have finished examining the plot.

The Graphics Environment

The HP 48SX Graphics environment provides extremely useful functions for graphically analyzing functions. Explaining in detail the functionality of the Graphics environment is beyond the scope of this manual, but the behavior of selected, useful softkeys at the Graphics environment and the Function menu is explained below. For a complete description of all the softkeys available, refer to Chapter 18 of the HP 48SX *Owner's Manual*, "Basic Plotting and Function Analysis.

WARNING: The SLOPE and F' softkeys at the Function menu will only work correctly when the plot was made with units turned off, because the HP 48SX has difficulty taking derivatives of variables containing unit objects. When units are turned off, these functions work correctly.

Summary of Operations (Graphics Environment)

Key	Action
CENT	Redraws the plot with the cursor position at the center of the screen.
COORD	Displays the coordinates of the cursor position.
FCN	Displays the Function menu for analyzing function plots.
KEYS	Toggles display of the softkeys on and off.
LABEL	Unnecessary in the Mathematics Pac.
MARK	Places a mark (X) at the cursor location.
REPL	Pastes in a graphics object (GROB) from the stack at the cursor location.
SUB	Copies the rectangle bounded by the mark and the cursor location to the stack as a graphics object (GROB).
Z-BOX	Zooms in on the rectangle defined by the mark and the cursor.
ZOOM	Displays the ZOOM menu, which rescales and recenters the plot.
ATTN	Exits the Graphics environment and returns to the equation screen.
ENTER	Copies the coordinates of the cursor position to the stack.
ON-MTH	Dumps the current screen to an IR printer.
◀ ▼	Temporarily displays the plot status menu, including the axis ranges, until ▼ is released.
STO	Copies PICT (the plot) to the stack.

Summary of Operations (Function Menu)

Key	Action
AREA	Displays the area under the function defined by the X axis value of the mark and cursor.
EXIT	Returns to the Graphics environment menu.

EXTR	Moves the cursor to the nearest extremum on the function.
F'	Plots the first derivative of the function.
F(X)	Displays the function value at the X axis value of the cursor, and moves the cursor to that point on the function.
NXEQ	Unneeded in the Mathematics Pac.
ROOT	Moves the cursor to the nearest root and displays the coordinate of the root.
SLOPE	Displays the slope of the function at the X axis value of the cursor, and moves the cursor to the point at which the slope was calculated.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Managing Units and Plotting

The plotter can work either with units or without units. In general, plotting works much faster when units are off, but you may want to work with units in order to simplify plotting. There are several important points to the behavior of the unit manager as it relates to the plotter that you should understand:

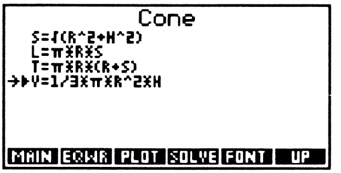
1. When units are on, X and Y axis range values are entered in the units of the independent and dependent variables, as set at the solver screen. For example, to enter 0_cm to 3_cm as the X axis range, set the units of the independent variable to centimeters at the solver screen, toggle the variable back to unknown by pressing KNOW, and later enter 0 SPC 3 at the X axis range prompt.
2. When units are off, X and Y axis range values are entered in the default SI units of the independent and dependent variables. For example, to enter 0_cm to 3_cm as the X axis range, type 0 SPC .03 at the prompt, since the default units for the independent variables will be meters.

3. Plotting with units may take up to 10 times as long as plotting without units. Therefore, in cases where only the qualitative shape of the plot is important, it is recommended that you plot without units so that you get your results faster. In cases where the Graphics environment will be utilized to analyze a plot, it may be necessary to plot with units, so that the coordinates are in the desired units. (The coordinates will always be in default SI units for plots done with units off, and this may be inconvenient in some cases.)

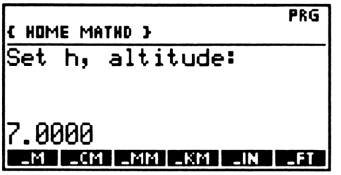
Multiple Plots of an Equation

Example (cont.): Plot how the volume of a right circular cone varies with the radius of the base for a cone with altitude 21, and compare to the result for a cone with altitude 7.

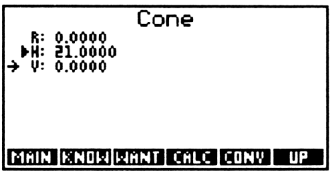
We have already selected the appropriate equation, but to make the new plot for an altitude of 21, we must change the value stored in H. First, we must leave the Graphics environment, where we were examining the plot for a cone with altitude 7. Press [ATTN] to return to the equation screen:



Press [SOLVE] to return to the solver screen, move the arrow down to H, and press [ENTER] to edit the value of 7 stored there:

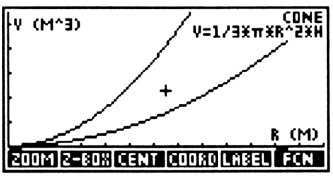


Press [ATTN] to clear the value of 7 from the command line, type 21, and press [ENTER] to accept that value:



Press NXT EQNS to return to the equation screen, and move the arrow down so it points at the volume equation (the last one), and press NXT NXT PLOT to plot that equation. After the "Processing..." message, the following screen will be displayed again:

This time, press NO so that the previous plot is not erased from PICT. Since we are choosing to overlay this plot on any previous plots in PICT, it is not necessary to change the X and Y axes, because they have already been specified. Therefore, after the "Purging variables...", "Storing values...", and "ATTN to exit plot..." messages, the new plot will begin. At any time, you can press ATTN to abort the plotting process. After the plot is complete, the Graphics environment of the HP 48SX will be activated:



The "ATTN to exit plot..." message was to remind you that pressing ATTN will return to the equation screen when you have finished examining the plot.

What You Should Know About the Solver

As you have seen in the examples given above, the solver allows you to easily specify the values and units of your equation or set of equations before sending the data to the HP 48SX numerical root-finder. For the selected set

of equations, the solver screen lists all the variables, shows whether they are known, unknown, wanted, or just calculated, and whether units are on or off.

What Does Multiple Equation Solver Mean?

The Sparcom solver is a **systematic** solver, not a **simultaneous** one. For example, it can solve this set of equations, provided it is given a user-specified value of either x or y:

$$x + y + z = 5$$

$$x + y = 3$$

However, it cannot solve this set of equations, when neither x or y is known in advance:

$$x + y = 2$$

$$x - y = 0$$

It iterates through a set of equations, searching for an equation with only one unknown variable. When an equation satisfying this requirement is found, it utilizes the HP 48SX root-finder (programmable command ROOT) 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 four conditions occurs:

1. All equations are solved, and all variables found.
2. All variables marked as wanted are found.
3. No more equations can be solved, because all remaining unsolved equations have more than one unknown variable.
4. A solving error occurs, such as Divide By Zero or Bad Guess(es).

All variables for which values are found in a solving operation are marked with an asterisk (*) tag at the solver screen. If a variable is not marked with an asterisk (*), then it was either not marked as wanted, or a value for it was not found because of too many unknowns.

Speeding Up Computing Time

Pressing CALC activates the HP 48SX root-finder to calculate the solution(s). The root-finder requires an initial value on which to base its search. You an provide a guess for the HP 48SX to use; if you don't do so, the solver will supply a guess of 1. The root-finder then generates pairs of intermediate values and interpolates between them to find the solution. The

time required to find the root depends on how close the initial guess is to the actual solution.

You can speed up computing time by providing a guess close to the expected solution. At the solver screen, enter your guess into the variable. Upon returning to the solver screen, the variable will be marked as known; press KNOW to toggle the variable back to unknown. Then press CALC, and the HP 48SX will use the stored value for the variable as its initial starting point.

"Bad Guess(es)" Message

If the HP 48SX displays the "Bad Guess(es)" message, it indicates an error has been made in setting up the problem. Go back through the setup process and check for error in specifying data, such as physically impossible triangle dimensions, etc. (For more information, refer to Chapter 17 of the HP 48SX *Owner's Manual*, "The HP Solve Application.")

Summary of Operations (Equations Screen)

Key	Action
EQWR	Displays the selected equation in the EquationWriter.
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
MARK	Toggles the selected equation between marked and unmarked status, adding or removing a triangular tag. Only variables in the marked set of equations will appear in the solver and variable screens. If no equations are marked, all will be used.
PLOT	Plots the selected equation, prompting for x-axis and y-axis values. Plotting is only allowed for equations of the form y=f(a,b,...), where all but one of the variables on the right-hand side of the equation are held constant (i.e., known).
PICT	Displays a picture for the current item, if one exists.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
SOLVE	Displays the solver screen of the current topic.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack.
UP	Moves up one level in the menu structure.
VARS	Displays the variable screen for the current topic, including descriptions and default units.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Builds and displays the EquationWriter form of the equation.
ON-MTH	Dumps the current screen to an IR printer.
→ VISIT	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. Once the full text has been displayed, pressing ENTER or ATTN returns to the menu. If the item fits on the screen, this key is non-functional.

Summary of Operations (Variable Screen)

Key	Action
EQNS	Displays the equation screen for the current topic.
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PICT	Displays a picture for the current item, if one exists.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
SOLVE	Displays the solver screen of the current topic.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Displays the topic, the variable name (with default units), and the full description, all expanded to one screen. Press STO to save the variable
ON-MTH	Dumps the current screen to an IR printer.

Summary of Operations (Solver Screen)

Key	Action
CALC	Stores variable values and systematically iterates through the set of marked equations in an attempt to find values for all wanted variables. Also, stores the known and found values into global variables in the MATHD directory.
CLEAR	Resets values of all current variables to zero
CONV	Converts a variable to different units, if units are on.
EQNS	Displays the equation screen for the current topic.
FONT	Toggles between the small and large fonts.
HALT	Halts the Pac so that operations can be performed on the HP 48SX stack. Pressing CONT or ↩ ON returns to the Pac, while pressing KILL terminates the Pac.
KNOW	Toggles the selected variable between known and unknown status, adding or removing a triangular tag.
MAIN	Returns to the Main menu.
PICT	Displays a picture for the current item, if one exists.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
PURG	Purges the global copies (in the MATHD directory) of the current set of variables, but does not change the values currently set inside the Pac.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack.
UNIT▪	Indicates that units are currently turned on. Pressing this key turns off units, automatically converting all variable values to SI units and then stripping the units.
UNITS	Indicates that units are currently turned off. Pressing this key turns on units, automatically appending standard SI units to the values.
UP	Moves up one level in the menu structure.
VARS	Displays the variable screen for the current topic, including descriptions and default units.

WANT	Toggles the selected variable between wanted and unwanted status, adding or removing a question mark tag.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Prompts for a value for the variable.
ON - MTH	Dumps the current screen to an IR printer.
→ VISIT	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. Once the full text has been displayed, pressing ENTER or ATTN returns to the menu. If the item fits on the screen, this key is non-functional.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Notes:

Chapter 4
Trigonometry

In This Chapter

Trigonometry provides quick access to 100 trigonometric identities for reference.

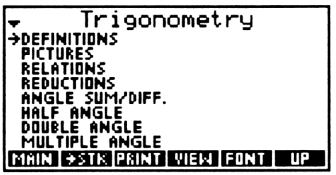
This chapter covers:

- ☐ Using Trigonometry
- ☐ Trigonometry Sections

Using Trigonometry

To get to the Trigonometry section, follow these steps:

1. Press ◀ LIBRARY to display all libraries available to the HP 48SX.
2. Find and press MATH to enter the Mathematics Pac library directory.
3. Press the first softkey, MATH, to start the application.
4. At the Main menu, move the arrow to Trigonometry (by pressing ▲ and ▼) and press ENTER.



Items in the Trigonometry Menu

Each entry in the Trigonometry menu is briefly described below and is discussed in detail later in this chapter.

Item	Description
Definitions	Definitions of the basic trigonometric formulas.
Pictures	Graphs of the basic trigonometric formulas.
Relations	Fifteen relations.
Reductions	Twelve reductions.
Angle Sum/Diff.	Eight angle sum and angle difference formulas.
Half Angle	Six half-angle formulas, along with the quadrants in which each formula is valid.
Double Angle	Eight double angle formulas.
Multiple Angle	Nine multiple angle formulas.
Function Product	Three function product formulas.
Function Sum/Diff.	Twelve function sum and difference formulas.
Power Relations	Seven power relations.
Exponential Relations	Five exponential relations.
Quadrant Signs	Variation of the signs of the trigonometric functions in each of the quadrants.

Summary of Operations (Trigonometry)

Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.

ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Moves down one level in the menu structure.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Trigonometry Sections

All of the Trigonometry sections except Definitions, Pictures, and Quadrant Signs behave identically. The other ten sections contain reference formulas which can be browsed, viewed in text format (by pressing VIEW), viewed in EquationWriter format (by pressing ENTER), or copied to the stack as algebraics for later use.

Definitions is different in that you can access a picture (by pressing PICT).

Pictures is different in that the data consists of pictures, so pressing ENTER simply displays the selected entry as a picture on the screen. Note that PRINT does **not** print the picture – the only way to capture the pictures as hardcopy is to press ON-MTH to trigger a screen dump to an IR printer.

Quadrant Signs is different in that the data does not consist of equations, so pressing ENTER displays the selected item expanded to fill the screen. You can also access the same picture as from Definitions.

Summary of Operations (Trigonometry sections)

Key	Action
FONT	Toggles between the small and larger fonts.
MAIN	Returns to the Main menu.
PICT	Displays a picture for the current item, if one exists.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	For equation data, ENTER builds and displays the Equation-Writer form of the equation. (For more information, see the section in Chapter 1 entitled, "Scrolling Equations Too Wide for the Display.") For picture data, ENTER displays the picture. For text, ENTER displays the screen title, the item label, and the item, all expanded to one screen.
ON-MTH	Dumps the current screen to an IR printer.

Chapter 5
Hyperbolics

In This Chapter

Hyperbolics provides quick access to 100 hyperbolic identities for reference.

This chapter covers:

- ☐ Using Hyperbolics
- ☐ Hyperbolics Sections

Using Hyperbolics

To get to the Hyperbolics section, follow these steps:

1. Press ◀ LIBRARY to display all libraries available to the HP 48SX.
2. Find and press MATH to enter the Mathematics Pac library directory.
3. Press the first softkey, MATH, to start the application.
4. At the Main menu, move the arrow to Hyperbolics (by pressing ▲ and ▼) and press ENTER.

Items in the Hyperbolics Menu

Each entry in the Hyperbolics menu is briefly described below and is discussed in detail later in this chapter.

Item	Description
Definitions	Definitions of the basic hyperbolic formulas.
Pictures	Graphs of the basic hyperbolic formulas.
Relations	Sixteen relations.
Angle Sum/Diff.	Eight angle sum and angle difference formulas.
Half Angle	Seven half-angle formulas.
Double Angle	Seven double angle formulas.
Multiple Angle	Eight multiple angle formulas.
Function Product	Three function product formulas.
Function Sum/Diff.	Ten function sum and difference formulas.
Power Relations	Eight power relations.
Complex Arguments	Twelve complex argument relations.

Summary of Operations (Hyperbolics)

Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Moves down one level in the menu structure.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Hyperbolics Sections

All of the Hyperbolics sections except Pictures behave identically. The other ten sections contain reference formulas which can be browsed, viewed in text format (by pressing VIEW), viewed in EquationWriter format (by pressing ENTER), or copied to the stack as algebraics for later use.

Pictures is different in that the data consists of pictures, so pressing ENTER simply displays the selected entry as a picture on the screen. Note that PRINT does **not** print the picture – the only way to capture the pictures as hardcopy is to press ON-MTH to trigger a screen dump to an IR printer.

Summary of Operations (Hyperbolics)

Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	For equation data, ENTER builds and displays the EquationWriter form of the equation. (For more information, see the section in Chapter 1 entitled, "Scrolling Equations Too Wide for the Display.") For picture data, ENTER displays the picture.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Chapter 6
Calculus

In This Chapter

Calculus spans several major areas within symbolic mathematics, including 300 integrals, nearly 50 derivatives, over 20 series, and a section on vector analysis.

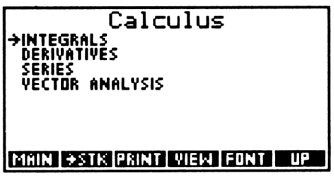
This chapter covers:

- ☐ Integrals
- ☐ Derivatives
- ☐ Series
- ☐ Vector Analysis

Using Calculus

To get to the Calculus section, follow these steps:

1. Press ↩ LIBRARY to display all libraries available to the HP 48SX.
2. Find and press MATH to enter the Mathematics Pac library directory.
3. Press the first softkey, MATH to start the application.
4. At the Main menu, move the arrow to Calculus (by pressing ▲ and ▼) and press ENTER.



Items in the Calculus Menu

Each entry in the Calculus menu is briefly described below and is discussed in detail later in this chapter.

Item	Description
Integrals	Provides reference to over 300 integrals, along with solving capabilities.
Derivatives	Provides reference to over 50 derivatives, along with solving capabilities.
Series	Provides reference to over 20 series, including binomial and Taylor series, along with solving capabilities.
Vector Analysis	Provides reference to div, grad, and curl, in Cartesian, cylindrical, and spherical coordinates.

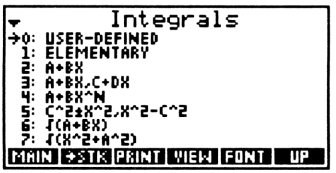
Summary of Operations (Calculus)

Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Moves down one level in the menu structure.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Integrals

Upon choosing Integrals from the Calculus menu, the following screen appears:



This menu includes the eighteen sections of integrals in the Mathematics Pac. To find a particular integral, you should browse through the list of sections until you find the general form of the integral you wish to look up or solve. If you cannot find the integral you wish to look up or solve, you can easily enter it into the user-defined section, as described in the section in Chapter 10 entitled, "Calculus Functions."

Choosing a Section from the Integral Menu

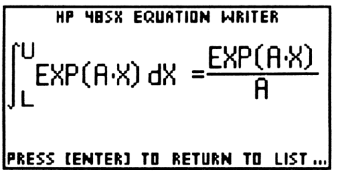
Each of the eighteen sections of integrals contains a group of related integrals. Each integral can be displayed in EquationWriter or text format, copied to the stack, or solved, indefinitely or definitely. You can also search for a specific integral using the search mode described in the section in Chapter 1 entitled, "Using the Search Mode." The user-defined integral section behaves identically to all other sections, once you have entered your own integrals, as described in the section in Chapter 10 entitled, "Calculus Functions."

Example: Investigate the section of integrals with forms containing exponentials. To examine this section, move the arrow to Exponential by pressing ▶ ▼ ▲ and then press ENTER:

This particular section contains ten integrals.

Viewing an Integral in EquationWriter Format

Let's view the first integral in this section in EquationWriter format. To do this, press ENTER. After a "Building equation..." message, the screen will blank for a few moments. Then, the integral will be drawn in EquationWriter format:



When you have finished viewing the integral, press ENTER to return to the list. Many integrals are too large for the screen, and will be displayed with the cursor keys activated for scrolling purposes. (For more information, refer to the section in Chapter 1 entitled, "Scrolling Equations Too Wide for the Display.")

WARNING: While the HP 48SX is building the EquationWriter format version of an integral, any key presses may cause strange behavior, resulting in no display of the equation. Therefore, do not press any keys until the integral has been drawn, erased, and re-drawn with the accompanying messages. If you change your mind during a long integral build, press ATN to abort the build process and return to the integral screen.

Now, solve the first integral.

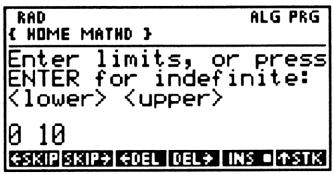
Solving an Integral

The integral solving process is one of substitution and algebraic simplification. To solve the first integral, make sure the arrow is pointing to it and press SOLVE. The first step in solving the integral is specifying the limits of integration. You can either perform a definite integration by entering a lower and an upper limit, or an indefinite integration by pressing

ENTER with a blank command line. If you choose to perform an indefinite integration, then a constant of integration will be added to the final result.

Entering Limits of Integration

For this example, enter limits of integration. Limits can either be real numbers, names (variables), or algebraic expressions. This means you can integrate from 0 to 1, or from A to B, or even from SIN(t) to COS(t + u), providing that none of the variables used in the limits are identical to the variable of integration, X. For this example, integrate from 0 to 10, so type 0 SPC 10 as your input:

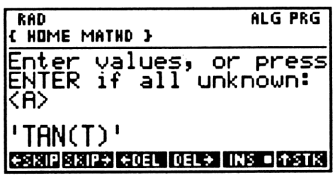


Press ENTER to accept that input.

Entering Values of Constants

After the "Processing..." message, you will be prompted to enter values for all the unknown constants in the integral. This does not include the variable of integration, for which you do not enter a value. The constants are precisely that – constant with respect to the variable of integration, X. However, as in the case of the limits of integration, constants can either be real numbers, names (variables), or algebraic expressions.

For this example, set the value of A to be TAN(T), where T is a constant. Type ' TAN α T as your input:

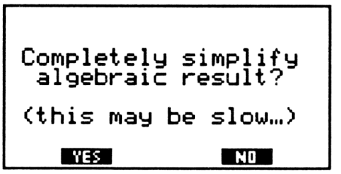


Press ENTER to accept that input.

NOTE: If you wish to enter a name (variable) as a limit or a constant, the tic marks surrounding the name are optional. For example, T can be entered as 'T' or T.

Simplifying the Result

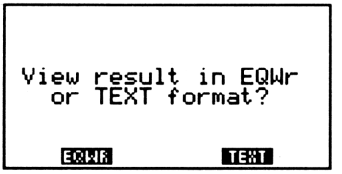
After the "Storing values..." and the "Solving..." message, the following screen will appear:



This prompt only appears when the current result of the integration process is an algebraic expression. When that is the case, you have the option of completely simplifying the expression, through a series of algebraic expansions and collections by the HP 48SX. If the current result is numeric, this prompt is bypassed because no simplification is necessary.

Answering YES will simplify the expression, although it may take a few minutes for complex expressions, while answering NO will cause subsequent displays of the result to appear unsimplified.

For this example, press YES . After the "Processing..." message, the following screen will be displayed:

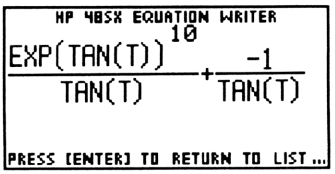


Viewing the Result

This prompt only appears when the final result of the integration process is an algebraic expression. When that is the case, you have the option of displaying the result in either EquationWriter format or text format. If the

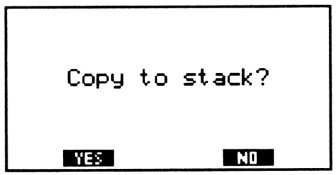
final result is numeric, this prompt is bypassed because the EquationWriter display format is not appropriate.

For this example, press EQWR. After a "Building equation..." message, the screen will blank for a few moments. Then, the integral will be drawn in EquationWriter format:



When you have finished viewing the integral, press ENTER to proceed to the next prompt. Many integrals are too large for the screen, and will be displayed with the cursor keys activated for scrolling purposes. (For more information, refer to the section in Chapter 1 entitled, "Scrolling Equations Too Wide for the Display.")

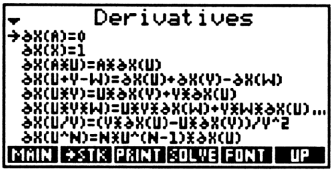
After pressing ENTER, the following screen will be displayed:



Choosing YES will leave a copy of the result on the stack as an algebraic object for further use after you quit the Mathematics Pac, while choosing NO will not. After you make a choice here, you will be returned to the list of integrals.

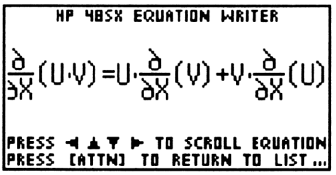
Derivatives

Upon choosing Derivatives from the Calculus menu, the following screen appears:



This menu includes all of the derivatives in the Mathematics Pac. To find a particular derivative, you should browse through the list until you find the general form of the derivative you wish to look up or solve. Each derivative formula can be displayed in EquationWriter or text format, copied to the stack, or solved. You can also search for a specific derivative formula using the search mode described in the section in Chapter 1 entitled, "Using the Search Mode."

Example: Find the derivative of SIN(X)*COS(X). To use the table of derivatives, you must first recognize the form of the derivative, which in this case is U*V. Therefore, move the arrow down to the fifth derivative formula by pressing ▼ four times. To make sure this is the desired form, press ENTER to view it in EquationWriter format:



Since this formula is slightly wider than the screen, the cursor keys are activated for scrolling. When you have finished viewing the formula, press ATTN to return to the list of derivative formulas.

Solving a Derivative

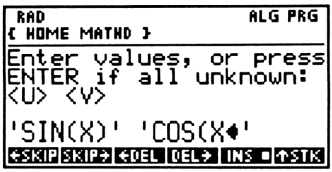
Now that we have selected the correct derivative formula, press SOLVE . After a "Processing..." message, you will be prompted to enter values for the unknowns in the formula.

Entering Functions and Constants

You must enter values for all the unknown functions and constants in the derivative formula. The functions must be functions of the independent variable, X. The constants must be constant with respect to the independent

variable, X. You can easily tell the difference between what must be a function and what must be a constant by the letter: U, V, and W are functions, while A, B, and all other letters represent constants with respect to X.

For this example, the value of U is SIN(X) and the value of V is COS(X), so type ' SIN ∂ X ▶ ▶ SPC ' COS ∂ X as your input:

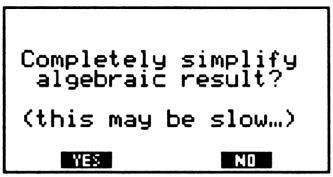


Press ENTER to accept that input.

> **NOTE: If you wish to enter a name (variable) as a limit or a constant, the tic marks surrounding the name are optional. For example, X can be entered as 'X' or X.**

Simplifying the Result

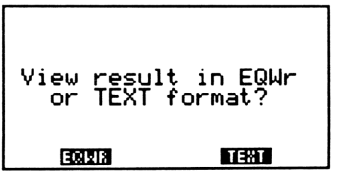
After the "Storing values..." and the "Solving..." message, the following screen will appear:



This prompt only appears when the current result of the derivation process is an algebraic expression. When that is the case, you have the option of completely simplifying the expression, through a series of algebraic expansions and collections by the HP 48SX. If the current result is numeric, this prompt is bypassed because no simplification is necessary.

Answering YES will simplify the expression, although it may take a few minutes for complex expressions, while answering NO will cause subsequent displays of the result to appear unsimplified.

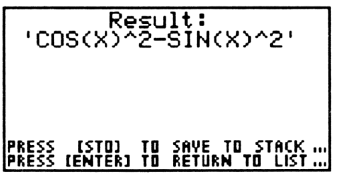
For this example, press YES . After a "Processing..." message, the following screen will be displayed:



Viewing the Result

This prompt only appears when the final result of the derivation process is an algebraic expression. When that is the case, you have the option of displaying the result in either EquationWriter format or text format. If the final result is numeric, this prompt is bypassed because the EquationWriter display format is not appropriate.

For this example, press TEXT . The following screen will be displayed:



Press STO to save the result to the stack as an algebraic object, or ENTER or ATTN to return to the derivatives screen without saving the result on the stack.

Series

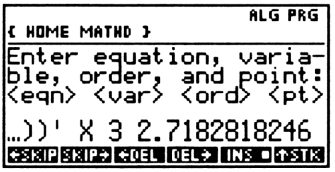
Upon choosing Series from the Calculus menu, the following screen appears:

Taylor Series

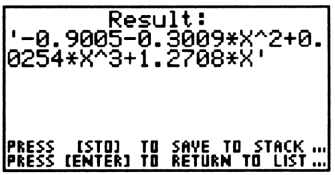
Example: Find the Taylor series of the function SIN(LN(X)) about the point X = e, to the third order.

> **NOTE: This is quite a lengthy example, but most complex Taylor series expansions and algebraic simplifications will take several minutes.**

To do this, select Taylor from the Series menu. Then press SOLVE, and type in ' SIN → 1/x α X ▶▶ ▶ SPC α X SPC 3 SPC 2.7182818246 as your input:



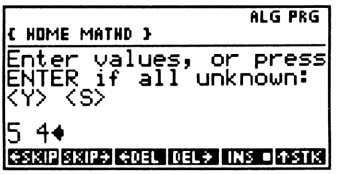
Press ENTER to accept that input. After a lengthy "Solving..." message, you will be prompted for simplification. Choose YES if you want to simplify the result before you display it, or NO if you want to quickly view the result without further simplification. For this example, press YES to simplify the result. After another lengthy "Processing..." message, you will be prompted for what type of display you want. Choose EQWR to view the result in EquationWriter format, or TEXT to view the result quickly in a text format. For this example, choose TEXT, and the following screen will be displayed:



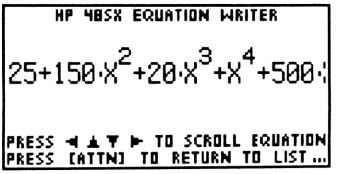
Press STO to save the result to the stack as an algebraic object, or ENTER or ATTN to return to the Taylor series screen without saving the result on the stack.

Binomial Series

Example: Find the binomial expansion of $(X+5)\wedge 4$. To do this, select Binomial from the Series menu. Then press SOLVE, and type 5 SPC 4 as your input, since $Y=5$ and $S=4$ in the general form $(X+Y)\wedge S$:



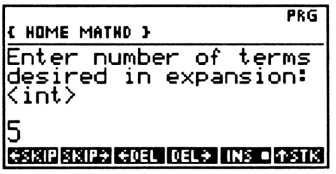
Press ENTER to accept that input, and after a "Storing values..." and a "Solving..." message, you will be prompted for algebraic simplification. Choose YES to simplify the result, and then select EQWR to view the result in EquationWriter format. After these choices, the following screen will be displayed:



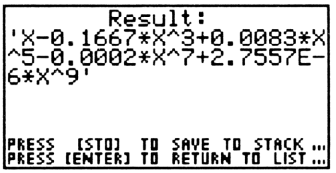
When you have finished viewing the result, press ATTN to continue on to the final prompt, which asks if you wish to copy the result to the stack. Choosing YES will leave a copy of the result on the stack as an algebraic object for further use after you quit the Mathematics Pac. After you make a choice here, you will be returned to the binomial series screen.

Other Series

Example: Evaluate the series expansion of SIN(X) to five terms. To do this, select Trig. & Hyperbolic from the Series menu. Then, since the arrow is already pointing at the series for SIN(X), press SOLVE, and after a "Processing..." message, enter the number of terms desired by typing 5 as your input:



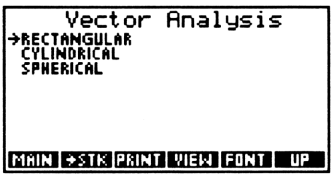
Press ENTER to accept that input. After the "Processing..." message, you will be prompted for algebraic simplification and for display type. The fastest way to view the results is no simplification, text format. To do this, press NO and then TEXT at the next prompt. After these choices, the following screen will be displayed:



Press STO to save the result to the stack as an algebraic object, or ENTER or ATTN to return to the Trig. & Hyperbolics series screen without saving the result on the stack.

Vector Analysis

Upon choosing Vector Analysis from the Calculus menu, the following screen appears:



These are the available coordinate systems. Choose any one of these by moving the arrow to the appropriate selection and pressing ENTER to view the equations for that coordinate system. Once you have chosen a coordinate system, you can view the equations for gradient, divergence, curl, and Laplacian in EquationWriter or text format, or copy them to the stack for further reference.

NOTE: The divergence and gradient operators, and the dot and cross products in the formulas are not valid HP 48SX functions—these formulas are included solely for reference.

Summary of Operations (Calculus Sections)

Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
SOLVE	Starts an item-specific solving process.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	For equation data, ENTER builds and displays the Equation-Writer form of the equation. (For more information, see the section in Chapter 1 entitled, "Scrolling Equations Too Wide for the Display.") For picture data, ENTER displays the picture. For text, ENTER displays the screen title, the item label, and the item, all expanded to one screen.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Chapter 7
Linear Algebra

In This Chapter

Linear Algebra provides basic tools for use in matrix analysis.

This chapter covers:

- ☐ Using Linear Algebra
- ☐ Enter or Edit Matrix
- ☐ Characteristic Polynomial
- ☐ Determinant
- ☐ Eigenvalues
- ☐ Trace

Using Linear Algebra

To get to the Linear Algebra section, follow these steps:

1. Press ◀ LIBRARY to display all libraries available to the HP 48SX.
2. Find and press MATH to enter the Mathematics Pac library directory.
3. Press the first softkey, MATH, to start the application.
4. At the Main menu, move the arrow to Linear Algebra (by pressing ▲ and ▼) and press ENTER.

Items in the Linear Algebra Menu

Each entry in the Linear Algebra menu is briefly described below and is discussed in detail later in this chapter.

Item	Description
Enter or Edit Matrix	Controls entry and editing of the matrix on which all other operations will be performed.
Characteristic Polynomial	Finds the characteristic polynomial of a square matrix.
Determinant	Finds the determinant of a square matrix.
Eigenvalues	Finds the eigenvalues of a square matrix by applying the polynomial root-finder to the characteristic polynomial.
Trace	Finds the trace of a square matrix.

Summary of Operations (Linear Algebra)

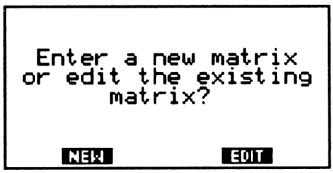
Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Moves down one level in the menu structure.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Enter or Edit Matrix

Enter or Edit Matrix makes use of the command line to enter or edit a square matrix. When a matrix is entered, it is stored in the global variable MATR in the MATHD directory. Once a matrix has been specified, all other functions in the Linear Algebra section will operate on that matrix. To enter a new matrix or to edit the existing matrix, simply choose Enter or Edit Matrix again.

Usually, choosing Enter or Edit Matrix displays the following screen:



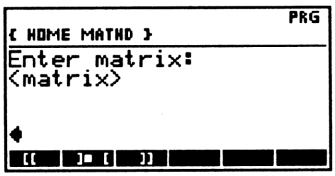
At this point, select NEW to enter a new matrix (overwriting MATR) on a blank command line, select EDIT to edit the matrix previously stored in MATR, or press ATN to abort the process and return to the Linear Algebra menu.

If the variable MATR does not exist (which happens the first time Enter or Edit Matrix is selected), then the New/Edit question is bypassed and you are taken directly to the new matrix entry screen, as described below.

NOTE: All operations in Linear Algebra take only square matrices as arguments, so the Enter or Edit Matrix function will not allow entry of non-square matrices.

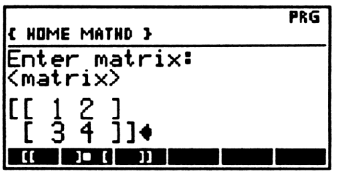
Entering a New Matrix

Selecting NEW brings up the following screen:



The first softkey in the menu begins a matrix. The second softkey is pressed after each row of data, in order to end that row and begin a new row. And the third softkey ends the matrix. Pressing ENTER accepts the entry.

Example: Enter the matrix [[1 2] [3 4]]. First, select NEW . Then type in [[1 SPC 2][3 SPC 4]] as your input:

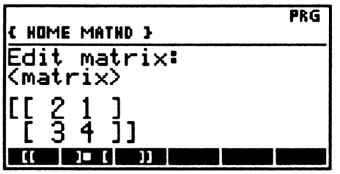


Pressing ENTER stores that matrix into MATR and returns to the Linear Algebra screen.

Editing an Existing Matrix

Selecting EDIT brings up a screen with the current contents of MATR loaded onto the command line for editing. (For more information, refer to the section in Chapter 1 entitled, "Editing Text Entries.")

Example (cont.): Edit the matrix [[1 2] [3 4]], changing it to [[2 1] [3 4]]. First, select EDIT . Then type DEL DEL ▶ ▶ 1 SPC as your input:



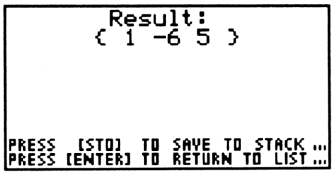
Pressing ENTER stores that matrix into MATR (overwriting the previous contents) and returns to the Linear Algebra screen.

Characteristic Polynomial

Upon choosing Char. Polynomial from the Linear Algebra menu, the characteristic polynomial of the matrix stored in MATR is automatically calculated and displayed.

Example (cont.): Calculate the characteristic polynomial of the matrix [[2 1] [3 4]]. To do this, simply choose Char. Polynomial from the Linear

Algebra menu. This displays a "Solving..." message and then the following screen:

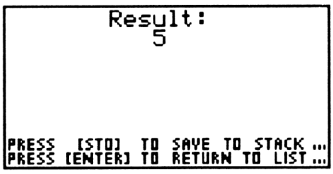


Press STO to save the result to the stack as a list, or ENTER or ATTN to return to the Linear Algebra menu without saving the result on the stack.

Determinant

Upon choosing Determinant from the Linear Algebra menu, the determinant of the matrix stored in MATR is automatically calculated and displayed.

Example (cont.): Calculate the determinant of the matrix [[2 1] [3 4]]. To do this, simply choose Determinant from the Linear Algebra menu. This displays a "Solving..." message and then the following screen:

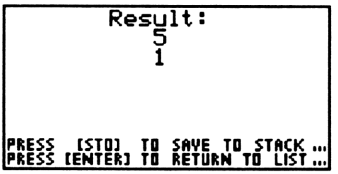


Press STO to save the result to the stack as a number, or ENTER or ATTN to return to the Linear Algebra menu without saving the result on the stack.

Eigenvalues

Upon choosing Eigenvalues from the Linear Algebra menu, the eigenvalues of the matrix stored in MATR are automatically calculated and displayed.

Example (cont.): Calculate the eigenvalues of the matrix [[2 1] [3 4]]. To do this, simply choose Eigenvalues from the Linear Algebra menu. This displays a "Solving..." message and then the following screen:



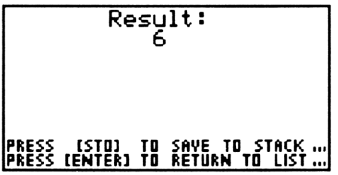
Press STO to save the result to the stack as a list, or ENTER or ATTN to return to the Linear Algebra menu without saving the result on the stack.

If the matrix has more than five eigenvalues, then a small " + " symbol will be displayed. However, only five roots can be displayed here – to view the remaining roots, press STO to copy the results to the stack, and then quit the Pac to examine the returned list.

Trace

Upon choosing Trace from the Linear Algebra menu, the trace of the matrix stored in MATR is automatically calculated and displayed.

Example (cont.): Calculate the trace of the matrix [[2 1] [3 4]]. To do this, simply choose Trace from the Linear Algebra menu. This displays a "Solving..." message and then the following screen:



Press STO to save the result to the stack as a number, or ENTER or ATTN to return to the Linear Algebra menu without saving the result on the stack.

Chapter 8
Transforms

In This Chapter

Transforms includes over 150 reference formulas.

This chapter covers:

- ☐ Using Transforms
- ☐ Transforms Sections

Using Transforms

To get to the Transforms section, follow these steps:

1. Press ↩ LIBRARY to display all libraries available to the HP 48SX.
2. Find and press MATH to enter the Mathematics Pac library directory.
3. Press the first softkey, MATH, to start the application.
4. At the Main menu, move the arrow to Transforms (by pressing ▲ and ▼) and press ENTER.

Items in the Transforms Menu

Each entry in the Transforms menu is briefly described below and is discussed in detail later in this chapter.

Item	Description
Definitions	Definitions of the included transforms.
Fourier Transforms	Nearly 50 finite sine, finite cosine, Fourier sine, Fourier cosine, and Fourier transforms.
Laplace Transforms	Over 75 Laplace transform pairs.
Z Transforms	Over 25 Z transform pairs.

Summary of Operations (Transforms)

Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Moves down one level in the menu structure.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

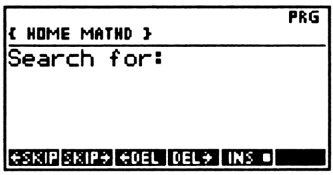
Transforms Sections

All of the Transforms sections behave identically. They all contain reference formulas which can be browsed, viewed in text format (by pressing VIEW), viewed in EquationWriter format (by pressing ENTER), or copied to the stack as algebraics for later use.

Since some of the lists of equations are quite long (e.g., Laplace Transforms contains 76 formulas), an example demonstrating use of the search mode to find a particular formula will be useful. (For more information, refer to the section in Chapter 1 entitled, "Using the Search Mode.")

Example: Locate the Laplace transform for the function 1/(S ^ 4–A ^ 4). To find this formula, move the arrow to Laplace Transforms and press ENTER:

To invoke the search mode, press α:



Now, you must type in the search string. It must **exactly** match the formula for which we are looking, although it may be a substring. Note also that the search function is case-sensitive, so the S and A in the formula must be uppercase. To enter the search string, type:

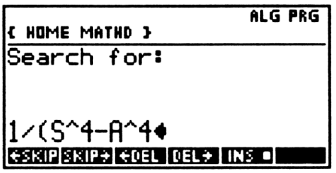
1 ÷ ↶ ( ) S

α → α

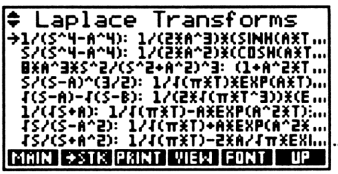
y^x 4 − α A

y^x 4

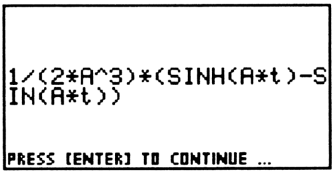
At this point, the screen should look like:



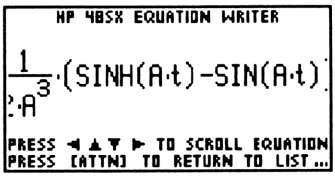
If it doesn't match exactly, use the editing softkeys and the cursor keys to correct the search string. (For more information, refer to the sections in Chapter 1 entitled, "Editing Text Entries," and "Alpha Lock.") When the search string is correct, press ENTER. After a pause, you will see:



This is the desired formula. To view it quickly in text format, press VIEW :



Press ENTER to return to the list of transforms, and press ENTER again to view the transform in EquationWriter format:



This formula is slightly wider than the screen, so the cursor keys are activated for scrolling purposes. When you have finished viewing the equation, press ATTN to return to the list of transforms.

Summary of Operations (Transforms Sections)

Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Builds and displays the EquationWriter form of the equation. (For more information, see the section in Chapter 1 entitled, "Scrolling Equations Too Wide for the Screen.")
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Notes:

Chapter 9
Miscellaneous

In This Chapter

Miscellaneous contains commonly used mathematical reference data.

This chapter covers:

- ☐ Using Linear Algebra
- ☐ Constants Library
- ☐ Common Prefixes
- ☐ Greek Alphabet
- ☐ Quadric Surfaces

Using Miscellaneous

To get to the Miscellaneous section, follow these steps:

1. Press ↩ LIBRARY to display all libraries available to the HP 48SX.
2. Find and press MATH to enter the Mathematics Pac library directory.
3. Press the first softkey, MATH , to start the application.
4. At the Main menu, move the arrow to Miscellaneous (by pressing ▲ and ▼) and press ENTER.

Items in the Miscellaneous Menu

Each entry in the Miscellaneous menu is briefly described below and is discussed in detail later in this chapter.

Item	Description
Constants Library	Commonly used mathematical constants.
Common Prefixes	Commonly used prefixes.
Greek Alphabet	Uppercase and lowercase Greek letters.
Quadric Surfaces	All types of quadric surfaces and their equations.

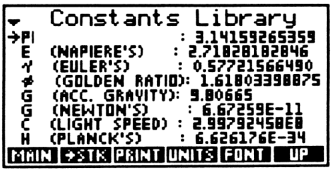
Summary of Operations (Miscellaneous)

Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	Moves down one level in the menu structure.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

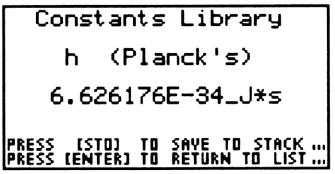
Constants Library

Upon choosing Constants Library from the Miscellaneous menu, the following screen appears:



NOTE: The values are unjustified because the small font is proportionally spaced; switching to the large font will align the numerical data in the same column.

Example: Look up the value of Planck's constant. First, move the arrow down to H by pressing ◀ ▼. Now, press UNITS to turn on units. Finally, although you can see most of the value of H on the display, press ENTER to view the full value of the constant:



Press STO to save the constant to the stack as a tagged object, or ENTER or ATTN to return to the Constants Library menu without saving the constant on the stack.

NOTE: Toggling units at the Constants Library screen changes the same user flag as does toggling units at the solver screen, so changes to the units setting here will persist if you later return to the solver screen.

Greek Alphabet

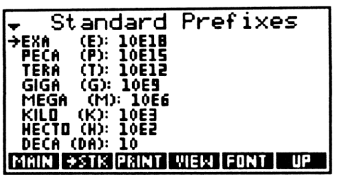
Upon choosing Greek Alphabet from the Miscellaneous menu, the following screen appears:

This screen is a picture displaying representations of all of the uppercase and lowercase Greek letters. Many of these characters are available from the HP 48SX keyboard, but not all of them. To get a printed copy of this screen, press [ON]-[MTH] now. Press [ENTER] to return to the Miscellaneous menu.

> **NOTE: The uppercase and lowercase letters alternate columns, due to limitations of the pixel resolution of the HP 48SX screen.**

Standard Prefixes

Upon choosing Standard Prefixes from the Miscellaneous menu, the following screen appears:



The only difference in behavior between Standard Prefixes and Constants Library is that units are not relevant to the prefixes, so UNITS has been replaced with VIEW.

Quadric Surfaces

Upon choosing Quadric Surfaces from the Miscellaneous menu, the following screen appears:

This section contains reference formulas for the seventeen types of quadric surfaces. These equations can be viewed in text format by pressing VIEW, viewed in EquationWriter format by pressing ENTER, or copied to the stack as algebraics by pressing →STK.

Summary of Operations (Miscellaneous Sections)

Key	Action
FONT	Toggles between the small and large fonts.
MAIN	Returns to the Main menu.
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack.
UNIT•	Indicates that units are currently turned on. Pressing this key turns off units, automatically stripping units from all constants.
UNITS	Indicates that units are currently turned off. Pressing this key turns on units, automatically appending units to all constants.
UP	Moves up one level in the menu structure.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
ATTN	Quits the Mathematics Pac to the HP 48SX stack.
ENTER	For equation data, ENTER builds and displays the Equation-Writer form of the equation. (For more information, see the section in Chapter 1 entitled, "Scrolling Equations Too Wide for the Display.") For picture data, ENTER displays the picture. For text, ENTER displays the screen title, the item label, and the item, all expanded to one screen.
ON-MTH	Dumps the current screen to an IR printer.

A complete summary of operations is given in Appendix B, "Summary of Operations."

Chapter 10
Programmable Functions

In This Chapter

Programmable Functions describes the syntax and behavior of the commands located in the MATH directory in the Library menu. Most of the programmable commands are also functions, which can be used in algebraic expressions, and all can be included as a part of user-language RPL programs.

This chapter includes:

- ☐ Algebra Functions
- ☐ Trigonometry Functions
- ☐ Hyperbolics Functions
- ☐ Calculus Functions
- ☐ Transforms Functions
- ☐ Linear Algebra Functions
- ☐ Utilities

Algebra Functions

This section describes the syntax and behavior of FRACT, GCD, LCM, PROOT, PRIME, and REDUC.

FRACT

FRACT is a function that performs the closest fraction algorithm. It is identical to the Closest Fraction function described in Chapter 2, except that FRACT can also take lists of objects and tagged objects as valid arguments. FRACT also requires a maximum denominator, which must be an integer. FRACT returns the input object, but with all numerical parts changed to algebraic expressions representing the closest fraction.

Input Level 2	Input Level 1	Output Level 1
'algebraic'	integer (denominator)	'algebraic'
complex	integer (denominator)	complex
list	integer (denominator)	list
real	integer (denominator)	real
tagged	integer (denominator)	tagged
unit	integer (denominator)	unit

GCD

GCD is a function that performs the greatest common divisor function. It is identical to the GCD function described in Chapter 2.

Input Level 2	Input Level 1	Output Level 1
integer	integer	integer (GCD)

LCM

LCM is a function that performs the least common multiple function. It is identical to the LCM function described in Chapter 2.

Input Level 2	Input Level 1	Output Level 1
integer	integer	integer (LCM)

PROOT

PROOT is a command that performs the polynomial root finder function. PROOT is not a function because it takes a list as input, but it can be used as a command. It is identical to the PROOT function described in Chapter 2.

Input Level 1	Output Level 1
list of integers (coefficients)	list of real or complex (roots)

PRIME

PRIME is a function that performs the prime factorization function. It is identical to the prime factorization function described in Chapter 2.

Input Level 1	Output Level 1
integer	list of integers (prime factors)

REDUC

REDUC is a function that performs the reduce function. It is identical to the reduce function described in Chapter 2.

Input Level 1	Output Level 1
integer	list (numerator and denominator)

Trigonometry Functions

This section describes the syntax and behavior of COT, SEC, CSC, ACOT, ASEC, and ACSC.

COT, SEC, CSC, ACOT, ASEC, ACSC

These are all standard trigonometric functions, and all allow the same types of arguments and give corresponding results. The syntax table is shown only for COT.

Input Level 1	Output Level 1
'algebraic'	'COT(algebraic)'
complex	COT(complex)
'name'	'COT(name)'

real	COT(real)

Hyperbolic Functions

This section describes the syntax and behavior of COTH, SECH, CSCH, ACOTH, ASECH, and ACSCH.

COTH, SECH, CSCH, ACOTH, ASECH, ACSCH

These are all standard hyperbolic functions, and all allow the same types of arguments and give corresponding results. The syntax table is shown only for COTH.

Input Level 1	Output Level 1
'algebraic'	'COTH(algebraic)'
complex	COTH(complex)
'name'	'COTH(name)'
real	COTH(real)

Calculus Functions

This section describes the syntax and behavior of BINO, STORE, and TYLRX.

BINO

BINO is a function that finds binomial coefficients. It is used in the binomial series formula described in Chapter 6. It differs from the HP 48SX command, COMB, in that BINO allows the level 2 integer to be negative.

Input Level 2	Input Level 1	Output Level 1
integer	integer	integer (binomial coefficient)

STORE

STORE is a function that stores an integral into the user-defined integrals section of the integral tables inside the Calculus section of the Mathematics Pac.

There are several important points to understand about how STORE works and about the required format of the integral to be stored:

1. The integral should be an algebraic expression, and therefore can be entered by way of the HP 48SX EquationWriter and copied to the stack. (For more information, refer to Chapter 16 of the HP 48SX Owner's Manual, "The EquationWriter Application.")
2. The limits of the integral will be ignored, and the integral will be stored as an indefinite integral.
3. The variable of integration should be X, and the case is important—it should be an uppercase X. If you already have an integral that you do not want to be forced to edit, STORE will automatically convert all occurrences of the variable of integration to X. However, this means that if X appears elsewhere in the original integral, that integral cannot be used.
4. If you want the integral to appear with a label on the left side containing conditions like A = 1, then you should enter the integral as an algebraic, enter the condition as a string, and then tag the integral with the string.

Input Level 1	Output Level 1
algebraic (integral)	empty
tagged (integral with label)	empty

TYLRX

TYLRX is a function that finds the Taylor series expansion of an arbitrary function of an arbitrary variable about an arbitrary point. It expands the functionality of the HP 48SX function TAYLR by allowing specification of the point about which to expand the series.

In Level 4	In Level 3	In Level 2	In Level 1	Out Level 1
algebraic	name	integer	real (point)	algebraic

Transforms Functions

This section describes the syntax and behavior of ERF, ERFC, J0, and J1.

ERF

ERF is a function that finds the error function. It is used in some of the transforms.

Input Level 1	Output Level 1
'algebraic'	'ERF(algebraic)'
'name'	'ERF(name)'
real	ERF(real)

ERFC

ERFC is a function that finds the complementary error function. It is used in some of the transforms.

Input Level 1	Output Level 1
'algebraic'	'ERFC(algebraic)'
'name'	'ERFC(name)'
real	ERFC(real)

J0

J0 is a function that finds the zeroth order Bessel function. It is used in some of the transforms.

Input Level 1	Output Level 1
'algebraic'	'J0(algebraic)'
'name'	'J0(name)'
real	J0(real)

J1

J1 is a function that finds the first order Bessel function. It is used in some of the transforms.

Input Level 1	Output Level 1
'algebraic'	'J1(algebraic)'
'name'	'J1(name)'
real	J1(real)

Linear Algebra Functions

This section describes the syntax and behavior of CPOLY, EIVAL, and TRACE.

CPOLY

CPOLY is a command that performs the characteristic polynomial function. CPOLY is not a function because it takes a matrix as input, but it can be used as a command. It is identical to the characteristic polynomial function described in Chapter 7.

Input Level 1	Output Level 1
matrix (square)	list of real or complex (coefficients)

EIVAL

EIVAL is a command that performs the eigenvalues function. EIVAL is not a function because it takes a matrix as input, but it can be used as a command. It is identical to the eigenvalues function described in Chapter 7.

Input Level 1	Output Level 1
matrix (square)	list of real or complex (eigenvalues)

TRACE

TRACE is a command that performs the trace function. TRACE is not a function because it takes a matrix as input, but it can be used as a command. It is identical to the trace function described in Chapter 7.

Input Level 1	Output Level 1
matrix (square)	integer (trace)

Utilities

This section describes the syntax and behavior of derUBASE, FLAG, TORAD, and SLVINTEG. None of these functions is designed to be useful to the user, but they all must be present in the Library menu in order for proper operation of the Mathematics Pac.

derUBASE

derUBASE is the user-defined derivative of the HP 48SX UBASE function. derUBASE is necessary for proper operation of the SLOPE function in the Graphics Environment when the equation being plotted contains a UBASE call.

FLAG

FLAG is a function that returns the setting of a flag. FLAG is necessary for proper evaluation of certain geometry equations that include angle constants like 180_°. Depending on the setting of the units flag, the angle constant must be either 180 or 180_°.

TORAD

TORAD is a function that converts a value with angle units or without units to radians, assuming that all values without units are in degrees. TORAD is necessary for proper evaluation of certain geometry equations that include angles with assumed units of radians.

SLVINTEG

SLVINTEG is a program that calls the integral solver. SLVINTEG is necessary for proper solving of user-defined integrals from inside the Mathematics Pac, because the program name SLVINTEG must be present in the user variable USRINTEG.

Notes:

Appendix A
Warranty and Service

Pocket Professional Support

You can get answers to your questions about using your Pocket Professional card from Sparcom. If you don't find the information in this manual or in the HP 48SX *Owner's Manual*, contact us in writing, at :

Sparcom Corporation
Attn: Technical Support Dept.
897 NW Grant Avenue, Corvallis, OR 97330, U.S.A. (503) 757-8416

or send E-mail:

from **Internet:**	support@sparcom.com
from **Compuserve:**	>Internet:support@sparcom.com
from **FidoNet:**	To:support@sparcom.com

Limited One-Year Warranty

What Is Covered

The Pocket Professional is warranted by Sparcom Corporation against defects in material and workmanship for one year from the date of original purchase. If you sell your card or give it as a gift, the warranty is automatically transferred to the new owner and remains in effect for the original one-year 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.

What Is Not Covered

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. The repair or replacement of a product is your exclusive remedy. ANY OTHER IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS IS LIMITED TO THE ONE-YEAR DURATION OF THIS WRITTEN WARRANTY. IN NO EVENT SHALL SPARCOM CORP. BE LIABLE FOR CONSEQUENTIAL DAMAGES. Products are sold on the basis of specifications applicable at the time of manufacture. Sparcom shall have no obligation to modify or update products, once sold.

If the Card Requires Service

Sparcom 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.

Service Charge

There is a fixed charge for standard out-of-warranty repairs. This charge is subject to the customer's local sales or value-added tax, wherever applicable. Cards damaged by accident or misuse are not covered by fixed charges. These charges are individually determined based on time and material.

Shipping Instructions

If your card requires service, ship it to Sparcom Corporation, 897 NW Grant Avenue, Corvallis, OR 97330, U.S.A.

- Include your return address and a description of the problem.
- Include proof-of-purchase date if the warranty has not expired.
- Include a purchase order, along with a check, or credit card number and expiration date (VISA or MasterCard) to cover the standard repair charge.
- Ship your card, postage prepaid, in adequate protective packaging to prevent damage. Shipping damage is not covered by the warranty, so insuring the shipment is recommended.

Cards are usually serviced and reshipped within five working days.

Environmental Limits

The reliability of the Pocket Professional depends upon the following temperature and humidity limits:

- Operating temperature: 0 to 45 °C (32 to 113 °F).
- Storage temperature: -20 to 60 °C (-4 to 140 °F).
- Operating and storage humidity: 90% relative humidity at 40 °C (104 °F) maximum.

Notes:

Appendix B
Summary of Operations

Key	Action
ABOUT	Displays a screen containing the revision number and product information about the Mathematics Pac. Pressing any key erases the screen and returns to the previous menu or to the HP 48SX stack.
AREA	Displays the area under the function defined by the X axis value of the mark and cursor.
CALC	Stores variable values and systematically iterates through the set of marked equations in an attempt to find values for all wanted variables. Also, stores the known and found values into global variables in the MATHD directory.
CENT	Redraws the plot with the cursor position at the center of the screen.
CLEAR	Resets values of the current variables to zero, but does not change the global copies, which only change during CALC operations.
CONV	Converts a variable to different units, if units are on.
COORD	Displays the coordinates of the cursor position.
EQNS	Displays the equation screen for the current topic.
EQWR	Displays the selected equation in the EquationWriter.
EXIT	Returns to the Graphics environment menu.
EXTR	Moves the cursor to the nearest extremum on the function.
F'	Plots the first derivative of the function.
F(X)	Displays the function value at the X axis value of the cursor, and moves the cursor to that point on the function.
FCN	Displays the Function menu for analyzing function plots.
FONT	Toggles between the small and large fonts.

HALT	Halts the Pac so that operations can be performed on the HP 48SX stack. Pressing CONT or ◀ ON returns to the Pac, while pressing KILL or PRG CTRL KILL terminates the Pac.
KEYS	Toggles display of the softkeys on and off.
	Toggles the selected variable between known and unknown status, adding or removing a triangular tag.
LABEL	Unnecessary in the Mathematics Pac.
MAIN	Returns to the Main menu.
MARK	If at the equations screen, toggles the selected equation between marked and unmarked status, adding or removing a triangular tag. Only variables in the marked set of equations will appear in the solver and variable screens. If no equations are marked, all will be used. If in the Graphics environment, places a mark (X) at the cursor location.
NXEQ	Unneeded in the Mathematics Pac.
PICT	Displays a picture for the current item, if one exists.
PLOT	Plots the selected equation, prompting for x-axis and y-axis values. Plotting is only allowed for equations of the form $y = f(a,b,\ldots)$, where all but one of the variables on the right-hand side of the equation are held constant (i.e., known).
PRINT	Prompts for ONE or ALL to select items, and then sends those items to an IR printer.
PURG	Purges the global copies (in the MATHD directory) of the current set of variables, but does not change the values currently set inside the Pac.
QUIT	Quits the Mathematics Pac to the HP 48SX stack.
REPL	Pastes in a graphics object (GROB) from the stack at the cursor location.
ROOT	Moves the cursor to the nearest root and displays the coordinate of the root.
SLOPE	Displays the slope of the function at the X axis value of the cursor, and moves the cursor to the point at which the slope was calculated.

SOLVE	Displays the solver screen of the current topic for Geometry, or starts an item-specific solving process for other sections.
→STK	Prompts for ONE or ALL to select items, and then copies those items to the stack. The items are placed in a list if ALL was chosen.
SUB	Copies the rectangle bounded by the mark and the cursor location to the stack as a graphics object (GROB).
UNIT•	Indicates that units are currently turned on. Pressing this key turns off units, automatically converting all variable values to SI units and then stripping the units. For the Constants Library, no conversion is necessary.
UNITS	Indicates that units are currently turned off. Pressing this key turns on units, automatically appending standard SI units to the values or constants.
UP	Moves up one level in the menu structure.
VARS	Displays the variable screen for the current topic, including descriptions and default units.
VIEW	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. If the item fits on the screen, this key is non-functional.
WANT	Toggles the selected variable between wanted and unwanted status, adding or removing a question mark tag.
Z-BOX	Zooms in on the rectangle defined by the mark and the cursor.
ZOOM	Displays the ZOOM menu, which rescales and recenters the plot.
[α]	Enters the search screen mode, whereby the user can search the current menu for a particular string. Pressing [ATTN] aborts the search operation.
[ATTN]	If pressed at a menu, [ATTN] quits the Mathematics Pac to the HP 48SX stack. If pressed at most other times, [ATTN] aborts the current operation and returns to the last menu displayed.

ENTER	In general, ENTER "zooms in" on the selected item. For equations, ENTER builds and displays the EquationWriter form of the equation. For functions, ENTER executes the selected function. For menu choices, ENTER moves down one level in the menu structure. For pictures, ENTER displays the picture. For text, ENTER displays the screen title, the item label, and the item, all expanded to one screen. For variables, ENTER prompts for a value for the variable.
ON - MTH	Dumps the current screen to an IR printer.
→ VISIT	Displays the entire text of an item too wide to fit on the screen, up to one entire screen size. Once the full text has been displayed, pressing ENTER or ATTN returns to the menu. If the item fits on the screen, this key is non-functional.

Appendix C
Geometry Reference

Geometry Reference lists the categories and topics contained in the Mathematics Pac:

- ☐ Categories and Topics
- ☐ Coordinate Systems
- ☐ Circles
- ☐ Triangles
- ☐ Polygons
- ☐ Planar Bounded Solids
- ☐ Cylinders and Cones
- ☐ Spherical Figures
- ☐ Analytic Geometry

Categories and Topics

Category/Topics	# Eqns	# Vars	Picture?	Page #
Coordinate Systems				
XY <-> Polar	4	4	Yes	C-3
XYZ <-> Cylindrical	5	5	Yes	C-3
XYZ <-> Spherical	6	6	Yes	C-4
Circles				
Circle	3	4	No	C-5
Sector/Segment	8	8	Yes	C-5
Triangles				
Right Triangle	10	12	Yes	C-7
Equilateral Triangle	5	6	No	C-8
General Triangle	17	14	Yes	C-8
Laws of SIN,COS,TAN	4	6	Yes	C-10

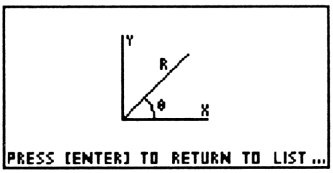
Polygons				
Rectangle	3	5	No	C-11
Parallelogram	7	9	Yes	C-12
Rhombus	3	5	Yes	C-12
Trapezoid	3	5	Yes	C-13
General Quadrilateral	8	12	Yes	C-14
Regular Polygons	5	7	Yes	C-15
Planar Bound Solids				
Cube	7	8	Yes	C-16
Rect. Parallelepiped	3	6	Yes	C-17
Pyramid	1	3	No	C-17
Tetrahedron	6	7	Yes	C-17
Cylinders & Cones				
Cylinder	5	5	Yes	C-19
Cone	4	6	Yes	C-19
Frustum of Cone	4	7	Yes	C-20
Spherical Figures				
Sphere	3	4	No	C-21
Zone/Seg., 1 Base	5	7	Yes	C-21
Zone/Seg., 2 Bases	4	7	Yes	C-22
Ellipsoid	1	4	Yes	C-23
Circular Torus	2	4	Yes	C-23
Analytic Geometry				
Parabolas ($e = 1$)	3	6	Yes	C-24
Ellipses ($e < 1$)	8	10	Yes	C-24
Hyperbolas ($e > 1$)	5	7	Yes	C-25

Coordinate Systems

In this category, equations describing the relationships between Cartesion, polar, cylindrical, and spherical coordinates are contained in the following topics:

- ☐ XY <-> Polar
- ☐ XYZ <-> Cylindrical
- ☐ XYZ <-> Spherical

XY <-> Polar



$$x = r \cdot COS(\theta)$$

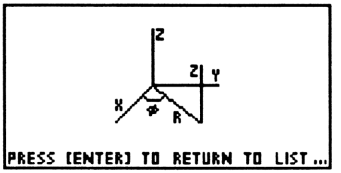
$$y = r \cdot SIN(\theta)$$

$$r = \sqrt{x^2 + y^2}$$

$$\theta = ATAN\left(\frac{y}{x}\right)$$

Variables	Descriptions	Units
x	abscissa	—
y	ordinate	—
r	radial distance	—
θ	polar angle	°

XYZ <-> Cylindrical



$$x = r \cdot COS(\varphi)$$

$$y = r \cdot SIN(\varphi)$$

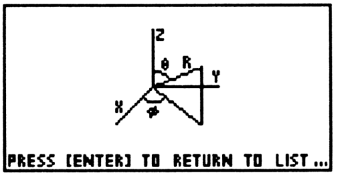
$$z = z$$

$$r = \sqrt{x^2 + y^2}$$

$$\varphi = ATAN\left(\frac{y}{x}\right)$$

Variables	Descriptions	Units
x	abscissa	—
y	ordinate	—
z	z-axis distance	—
r	radial distance	—
ϕ	polar angle	°

XYZ <-> Spherical



$$x = r \cdot COS(\varphi) \cdot SIN(\theta)$$

$$y = r \cdot SIN(\varphi) \cdot SIN(\theta)$$

$$z = r \cdot COS(\theta)$$

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

$$\varphi = ATAN\left(\frac{y}{x}\right)$$

$$r = \sqrt{x^2 + y^2 + z^2}$$

Variables	Descriptions	Units
x	abscissa	—
y	ordinate	—
z	z-axis distance	—
r	radial distance	—
ϕ	polar angle	°
θ	azimuthal angle	°

Circles

In this category, equations describing circles, sectors, and segments are contained in the following topics:

- ☐ Circle
- ☐ Sector/Segment

Circle

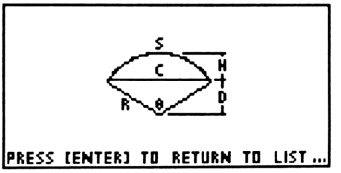
$$d = 2 \cdot r$$

$$c = 2 \cdot \pi \cdot r$$

$$K = \pi \cdot r^2$$

Variables	Descriptions	Units
c	circumference	m
d	diameter	m
r	radius	m
K	area	m^2

Sector/Segment



$$h = r - d$$

$$s = r \cdot \theta$$

$$d = r \cdot COS\left(\frac{\theta}{2}\right)$$

$$d = \frac{1}{2} \cdot \sqrt{4 \cdot r^2 - c^2}$$

$$c = 2 \cdot r \cdot SIN\left(\frac{\theta}{2}\right)$$

$$c = \sqrt{4 \cdot h \cdot (2 \cdot r - h)}$$

$$Ksec = \frac{1}{2} \cdot r \cdot s$$

$$Kseg = \frac{1}{2} \cdot r^2 \cdot (\theta - SIN(\theta))$$

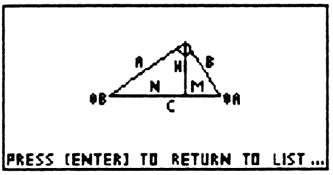
Variables	Descriptions	Units
c	segment base	m
d	sector height	m
h	segment height	m
r	radius	m
s	arc length	m
θ	angle	°
Ksec	sector area	m^2
Kseg	segment area	m^2

Triangles

In this category, equations describing triangles, including the laws of sines, cosines, and tangents, are contained in the following topics:

- ☐ Right Triangle
- ☐ Equilateral Triangle
- ☐ General Triangle
- ☐ Laws of SIN, COS, TAN

Right Triangle



$$c^2 = a^2 + b^2$$

$$K = \frac{1}{2} \cdot a \cdot b$$

$$per = a + b + c$$

$$ri = \frac{a \cdot b}{a + b + c}$$

$$rc = \frac{1}{2} \cdot c$$

$$h = \frac{a \cdot b}{c}$$

$$m = \frac{b^2}{c}$$

$$n = \frac{a^2}{c}$$

$$a = c \cdot SIN(\theta a)$$

$$\theta a + \theta b = 90\_^\circ$$

Variables	Descriptions	Units
a	side a	m
b	side b	m
c	side c	m
h	altitude	m
m	distance to vertex	m
n	distance to vertex	m
per	perimeter	m
rc	circumscribed circle radius	m
ri	inscribed circle radius	m
K	area	m^2
θa	angle opposite side a	°
θb	angle opposite side b	°

Equilateral Triangle

$$K = \frac{1}{4} \cdot a^2 \cdot \sqrt{3}$$

$$per = 3 \cdot a$$

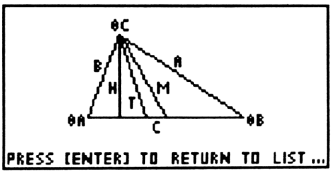
$$ri = \frac{1}{6} \cdot a \cdot \sqrt{3}$$

$$rc = \frac{1}{3} \cdot a \cdot \sqrt{3}$$

$$h = \frac{1}{2} \cdot a \cdot \sqrt{3}$$

Variables	Descriptions	Units
a	side a	m
h	altitude	m
per	perimeter	m
rc	circumscribed circle radius	m
ri	inscribed circle radius	m
K	area	m^2

General Triangle



$\theta a + \theta b + \theta c = 180\_^{\circ}$

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

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

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

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

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

$K = ri \cdot s$

$K = \frac{a \cdot b \cdot c}{4 \cdot rc}$

$s = \frac{1}{2} \cdot (a + b + c)$

$per = 2 \cdot s$

$K^2 = s \cdot (s - a) \cdot (s - b) \cdot (s - c)$

$ri = 4 \cdot rc \cdot SIN\left(\frac{\theta a}{2}\right) \cdot SIN\left(\frac{\theta b}{2}\right) \cdot SIN\left(\frac{\theta c}{2}\right)$

$rc = \frac{c}{2 \cdot SIN\,(\theta c)}$

$h = a \cdot SIN\,(\theta b)$

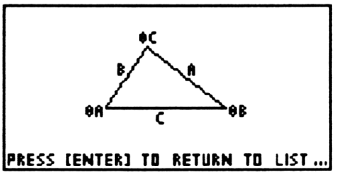
$h = b \cdot SIN\,(\theta a)$

$t = 2 \cdot \left(\frac{a \cdot b}{a + b}\right) \cdot COS\left(\frac{\theta c}{2}\right)$

$$m^2 = \frac{a^2}{2} + \frac{b^2}{2} - \frac{c^2}{4}$$

Variables	Descriptions	Units
a	side a	m
b	side b	m
c	side c	m
h	altitude to side c	m
m	median to side c	m
per	perimeter	m
rc	circumscribed circle radius	m
ri	inscribed circle radius	m
s	semiperimeter	m
t	bisector of θc	m
K	area	m^2
θa	angle opposite side a	°
θb	angle opposite side b	°
θc	angle opposite side c	°

Laws of SIN, COS, TAN



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

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

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

$$\frac{a+b}{a-b} = \frac{TAN\left(\frac{1}{2} \cdot (\theta a + \theta b)\right)}{TAN\left(\frac{1}{2} \cdot (\theta a - \theta b)\right)}$$

Variables	Descriptions	Units
a	side a	m
b	side b	m
c	side c	m
θa	angle opposite side a	°
θb	angle opposite side b	°
θc	angle opposite side c	°

Polygons

In this category, equations describing common quadrilaterals and regular polygons are contained in the following topics:

- ☐ Rectangle
- ☐ Parallelogram
- ☐ Rhombus
- ☐ Trapezoid
- ☐ General Quadrilateral
- ☐ Regular Polygons

Rectangle

$$K = a \cdot b$$

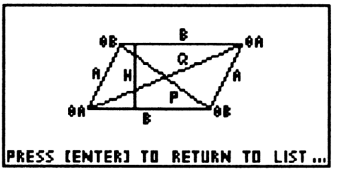
$$p^2 = a^2 + b^2$$

$$per = 2 \cdot a + 2 \cdot b$$

Variables	Descriptions	Units
a	side a	m
b	side b	m
p	diagonal	m

per	perimeter	m
K	area	m^2

Parallelogram



$K = b \cdot h$

$K = a \cdot b \cdot SIN\ (\theta a)$

$h = a \cdot SIN\ (\theta a)$

$per = 2 \cdot a + 2 \cdot b$

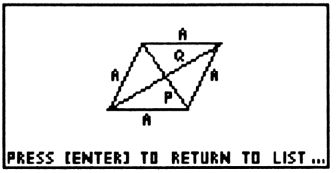
$p^2 = a^2 + b^2 - 2 \cdot a \cdot b \cdot COS\ (\theta a)$

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

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

Variables	Descriptions	Units
a	side a	m
b	side b	m
h	altitude	m
p	short diagonal	m
q	long diagonal	m
per	perimeter	m
K	area	m^2
θa	angle θa	°
θb	angle θb	°

Rhombus



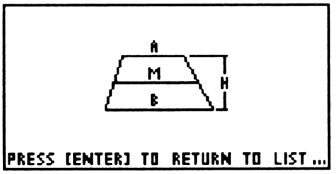
$$K = \frac{1}{2} \cdot p \cdot q$$

$$per = 4 \cdot a$$

$$p^2 + q^2 = 4 \cdot a^2$$

Variables	Descriptions	Units
a	side a	m
p	short diagonal	m
q	long diagonal	m
per	perimeter	m
K	area	m^2

Trapezoid



$$K = \frac{1}{2} \cdot (a + b) \cdot h$$

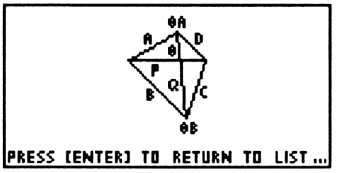
$$K = m \cdot h$$

$$m = \frac{1}{2} \cdot (a + b)$$

Variables	Descriptions	Units
a	side a	m

b	side b	m
h	altitude	m
m	median	m
K	area	m^2

General Quadrilateral



$$s = \frac{1}{2} \cdot (a + b + c + d)$$

$$per = 2 \cdot s$$

$$K = \frac{1}{2} \cdot p \cdot q \cdot SIN(\theta)$$

$$K = \frac{1}{4} \cdot (b^2 + d^2 - a^2 - c^2) \cdot TAN(\theta)$$

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

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

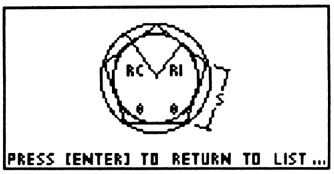
$$p^2 = a^2 + d^2 - 2 \cdot a \cdot d \cdot COS(\theta a)$$

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

Variables	Descriptions	Units
a	side a	m
b	side b	m
c	side c	m
d	side d	m
q	diagonal from θa to θb	m

p	other diagonal	m
per	perimeter	m
s	semiperimeter	m
K	area	m^2
θ	angle between diagonals	°
θa	angle θa	°
θb	angle θb	°

Regular Polygons



$$a = 2 \cdot ri \cdot TAN\left(\frac{180\,°}{n}\right)$$

$$a = 2 \cdot rc \cdot SIN\left(\frac{180\,°}{n}\right)$$

$$per = n \cdot a$$

$$K = n \cdot ri^2 \cdot TAN\left(\frac{180\,°}{n}\right)$$

$$\theta = \frac{n-2}{n} \cdot 180\_°$$

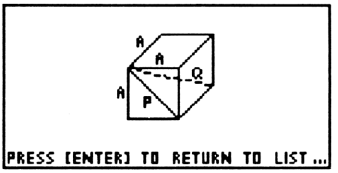
Variables	Descriptions	Units
a	side a	m
n	number of sides	–
rc	circumscribed circle radius	m
ri	inscribed circle radius	m
per	perimeter	m
K	area	m^2
θ	vertex angle	°

Planar Bounded Solids

In this category, equations describing planar bounded solids, including inscribed and circumscribed sphere radii, are contained in the following topics:

- ☐ Cube
- ☐ Rect. Parallelepiped
- ☐ Pyramid
- ☐ Tetrahedron

Cube



$K = a^2$

$T = 6 \cdot K$

$ri = \frac{1}{2} \cdot a$

$rc = \frac{1}{2} \cdot a \cdot \sqrt{3}$

$V = a^3$

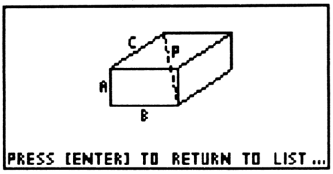
$p = a \cdot \sqrt{2}$

$q = a \cdot \sqrt{3}$

Variables	Descriptions	Units
a	side a	m
p	face diagonal	m
q	cube diagonal	m
rc	circumscribed sphere radius	m
ri	inscribed sphere radius	m

K	face area	m^2
T	total surface area	m^2
V	volume	m^3

Rect. Parallelepiped



$T = 2 \cdot (a \cdot b + b \cdot c + c \cdot a)$

$V = a \cdot b \cdot c$

$p = \sqrt{a^2 + b^2 + c^2}$

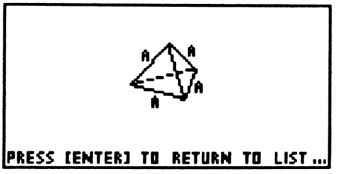
Variables	Descriptions	Units
a	side a	m
b	side b	m
c	side c	m
p	diagonal	m
T	total surface area	m^2
V	volume	m^3

Pyramid

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

Variables	Descriptions	Units
h	altitude	m
B	base area	m^2
V	volume	m^3

Tetrahedron



$$K = \frac{1}{4} \cdot a^2 \cdot \sqrt{3}$$

$$T = 4 \cdot K$$

$$ri = \frac{1}{12} \cdot a \cdot \sqrt{6}$$

$$rc = \frac{1}{4} \cdot a \cdot \sqrt{6}$$

$$V = \frac{1}{12} \cdot a^3 \cdot \sqrt{2}$$

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

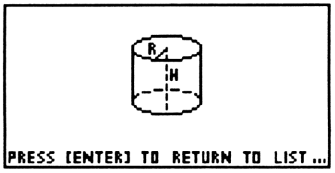
Variables	Descriptions	Units
a	side a	m
h	altitude	m
rc	circumscribed sphere radius	m
ri	inscribed sphere radius	m
K	face area	m^2
T	total surface area	m^2
V	volume	m^3

Cylinders and Cones

In this category, equations describing right circular cylinders and cones are contained in the following topics:

- ☐ Cylinder
- ☐ Cone
- ☐ Frustum of Cone

Cylinder



$$L = 2 \cdot \pi \cdot r \cdot h$$

$$T = 2 \cdot \pi \cdot r \cdot (r + h)$$

$$V = \pi \cdot r^2 \cdot h$$

$$L = \frac{T}{2 \cdot \pi \cdot r} - r$$

$$T = L \cdot \left(\frac{L}{2 \cdot \pi \cdot h^2} + 1\right)$$

Variables	Descriptions	Units
h	altitude	m
r	base radius	m
L	lateral surface area	m^2
T	total surface area	m^2
V	volume	m^3

Cone

$$s = \sqrt{r^2 + h^2}$$

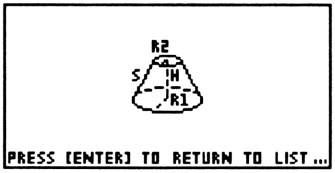
$$L = \pi \cdot r \cdot s$$

$$T = \pi \cdot r \cdot (r + s)$$

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

Variables	Descriptions	Units
h	altitude	m
r	base radius	m
s	slant height	m
L	lateral surface area	m^2
T	total surface area	m^2
V	volume	m^3

Frustum of Cone



$$s = \sqrt{(r1 - r2)^2 + h^2}$$

$$L = \pi \cdot (r1 + r2) \cdot s$$

$$T = \pi \cdot \left(r1^2 + r2^2 + (r1 + r2) \cdot s\right)$$

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

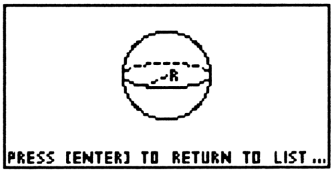
Variables	Descriptions	Units
h	altitude	m
r1	lower base radius	m
r2	upper base radius	m
s	slant height	m
L	lateral surface area	m^2
T	total surface area	m^2
V	volume	m^3

Spherical Figures

In this category, equations describing spherical figures, including zones and segments of spheres, are contained in the following topics:

- ☐ Sphere
- ☐ Zone/Segment, 1 Base
- ☐ Zone/Segment, 2 Bases
- ☐ Ellipsoid
- ☐ Circular Torus

Sphere



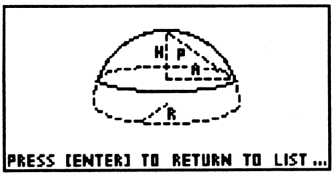
$$d = 2 \cdot r$$

$$S = 4 \cdot \pi \cdot r^2$$

$$V = \frac{4}{3} \cdot \pi \cdot r^3$$

Variables	Descriptions	Units
d	diameter	m
r	radius	m
S	surface area	m^2
V	volume	m^3

Zone/Segment, 1 Base



$$d = 2 \cdot r$$

$$S = 2 \cdot \pi \cdot r \cdot h$$

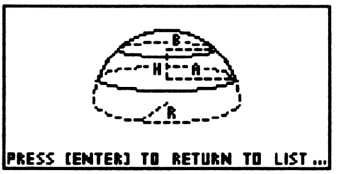
$$S = \pi \cdot p^2$$

$$V = \frac{1}{3} \cdot \pi \cdot h^2 \cdot (3 \cdot r - h)$$

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

Variables	Descriptions	Units
a	zone base radius	m
d	sphere diameter	m
h	zone altitude	m
p	zone diagonal	m
r	sphere radius	m
S	zone surface area	m^2
V	zone volume	m^3

Zone/Segment, 2 Bases



$$d = 2 \cdot r$$

$$S = 2 \cdot \pi \cdot r \cdot h$$

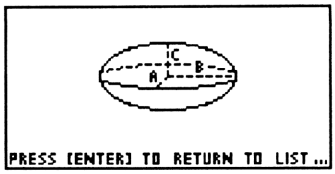
$$V = \frac{1}{6} \cdot \pi \cdot h \cdot \left(3 \cdot a^2 + 3 \cdot b^2 + h^2\right)$$

$$h = \sqrt{r^2 - b^2} - \sqrt{r^2 - a^2}$$

Variables	Descriptions	Units
a	zone base radius	m
b	zone ceiling radius	m

d	sphere diameter	m
h	zone altitude	m
r	sphere radius	m
S	zone surface area	m^2
V	zone volume	m^3

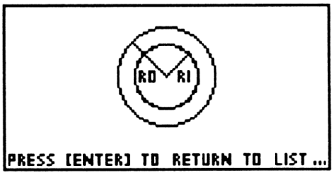
Ellipsoid



$$V = \frac{4}{3} \cdot \pi \cdot a \cdot b \cdot c$$

Variables	Descriptions	Units
a	semiaxis a	m
b	semiaxis b	m
c	semiaxis c	m
V	zone volume	m^3

Circular Torus



$$S = \pi^2 \cdot \left(ro^2 - ri^2\right)$$

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

Variables	Descriptions	Units
ri	inner radius	m

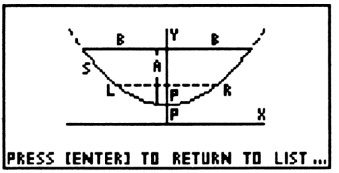
ro	outer radius	m
S	surface area	m^2
V	zone volume	m^3

Analytic Geometry

In this category, equations describing analytic geometry figures are contained in the following topics:

- ☐ Parabolas (e = 1)
- ☐ Ellipses (e)
- ☐ Hyperbolas (e1)

Parabolas (e = 1)



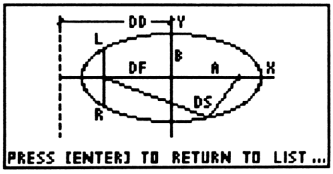
$$lr = 4 \cdot p$$

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

$$Kseg = \frac{4}{3} \cdot a \cdot b$$

Variables	Descriptions	Units
a	vertex to segment edge	m
b	bisector to parabola	m
lr	latus rectum	m
p	vertex to focus	m
s	arc length	m
Kseg	segment area	m^2

Ellipses (e < 1)



$$K = \pi \cdot a \cdot b$$

$$aper = 2 \cdot \pi \cdot \left(\frac{a^2 + b^2}{2} \right)^{1/2}$$

$$per = 4 \cdot a \cdot \int_0^{\pi/2} \sqrt{1 - \left(1 - \frac{b^2}{a^2}\right) \cdot SIN(\theta)^2}\, d\theta$$

$$E = \frac{\sqrt{a^2 - b^2}}{a}$$

$$lr = \frac{2 \cdot b^2}{a}$$

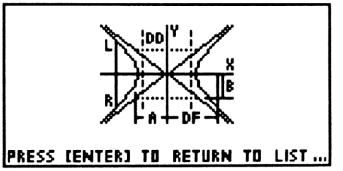
$$df = \sqrt{a^2 - b^2}$$

$$dd = \frac{a}{E}$$

$$ds = 2 \cdot a$$

Variables	Descriptions	Units
E	eccentricity	–
a	semimajor axis	m
b	semiminor axis	m
dd	center to directrix	m
df	center to focus	m
ds	sum of foci to point	m
lr	latus rectum	m
aper	approximate perimeter	m
per	exact perimeter	m
K	area	m^2

Hyperbolas (e > 1)



$$E = \frac{\sqrt{a^2 + b^2}}{a}$$

$$lr = \frac{2 \cdot b^2}{a}$$

$$df = \sqrt{a^2 + b^2}$$

$$dd = \frac{a}{E}$$

$$ds = 2 \cdot a$$

Variables	Descriptions	Units
E	eccentricity	—
a	semitransverse axis	m
b	semiconjugate axis	m
dd	center to directrix	m
df	center to focus	m
ds	difference of foci to point	m
lr	latus rectum	m

Appendix D
Calculus Reference

What follows are lists of the left-hand sides of all the integrals available in Calculus, along with the conditions required for validity.

Section 1: Elementary

$\int A\,dX$

$\int X^N dX \quad (N \neq -1)$

$\int \frac{1}{X}\,dX$

$\int EXP\,(A \cdot X)\,dX$

$\int B^{A \cdot X}\,dX \quad (B > 0)$

$\int LN\,(X)\,dX$

$\int A^X \cdot LN\,(A)\,dX \quad (A > 0)$

$\int \frac{1}{A^2 + X^2}\,dX$

$\int \frac{1}{A^2 - X^2}\,dX \quad (A^2 > X^2)$

$\int \frac{1}{X^2 - A^2}\,dX \quad (X^2 > A^2)$

$\int \frac{1}{\sqrt{A^2 - X^2}}\,dX \quad (A^2 > X^2)$

$\int \frac{1}{\sqrt{X^2 + A^2}}\,dX$

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

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

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

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

Section 2: A + BX

$\int (A + B \cdot X)^N\,dX \quad (N \neq -1)$

$\int X \cdot (A + B \cdot X)^N\,dX \quad (N \neq -1, -2)$

$\int X^2 \cdot (A + B \cdot X)^N\,dX \quad (N \neq -1, -2, -3)$

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

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

$$\int \frac{X}{A + B \cdot X}\, dX$$

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

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

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

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

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

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

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

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

Section 3: A + BX and C + DX

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

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

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

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

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

$$\int \frac{A + B \cdot X}{C + D \cdot X}\, dX$$

Section 4: A + BX^N

$$\int \frac{1}{A + B \cdot X^2}\, dX \quad (A \cdot B > 0)$$

$$\int \frac{1}{A + B \cdot X^2}\, dX \quad (A \cdot B < 0)$$

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

$$\int \frac{X^2}{A + B \cdot X^2}\, dX \quad (A \cdot B > 0)$$

$$\int \frac{X^2}{A + B \cdot X^2}\, dX \quad (A \cdot B < 0)$$

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

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

$$\int \frac{1}{A + B \cdot X^3}\, dX$$

$$\int \frac{X}{A + B \cdot X^3}\, dX$$

$$\int \frac{X^2}{A + B \cdot X^3}\, dX$$

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

Section 5: C^2(+/-)X^2, X^2-C^2

$$\int \frac{1}{C^2 + X^2}\, dX$$

$$\int \frac{1}{C^2 - X^2}\, dX \quad (C^2 > X^2)$$

$$\int \frac{1}{X^2 - C^2}\, dX \quad (X^2 > C^2)$$

$$\int \frac{X}{C^2 + X^2}\, dX$$

$$\int \frac{X}{C^2 - X^2}\, dX$$

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

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

$$\int \frac{X}{X^2 - C^2}\, dX$$

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

Section 6: the SQRT(A+BX)

$$\int \sqrt{A + B \cdot X}\, dX$$

$$\int X \cdot \sqrt{A + B \cdot X}\, dX$$

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

$$\int \frac{\sqrt{A + B \cdot X}}{X}\, dX \quad (A > 0)$$

$$\int \frac{\sqrt{A + B \cdot X}}{X}\, dX \quad (A < 0)$$

$$\int \frac{\sqrt{A + B \cdot X}}{X^2}\, dX \quad (A > 0)$$

$$\int \frac{\sqrt{A + B \cdot X}}{X^2}\, dX \quad (A < 0)$$

$$\int \frac{1}{\sqrt{A + B \cdot X}}\, dX$$

$$\int \frac{X}{\sqrt{A + B \cdot X}}\, dX$$

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

$$\int \frac{1}{X \cdot \sqrt{A + B \cdot X}}\, dX \quad (A > 0)$$

$$\int \frac{1}{X \cdot \sqrt{A + B \cdot X}}\, dX \quad (A < 0)$$

$$\int \frac{1}{X^2 \cdot \sqrt{A + B \cdot X}}\, dX \quad (A > 0)$$

$$\int \frac{1}{X^2 \cdot \sqrt{A + B \cdot X}}\, dX \quad (A < 0)$$

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

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

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

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

Section 7: the SQRT(X^2+A^2)

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

$$\int \frac{1}{\sqrt{X^2 + A^2}}\, dX$$

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

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

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

$$\int X \cdot \sqrt{X^2 + A^2}\, dX$$

$$\int \sqrt{(X^2 + A^2)^3}\, dX$$

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

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

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

$$\int X^2 \cdot \sqrt{X^2 + A^2}\, dX$$

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

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

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

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

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

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

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

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

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

Section 8: the SQRT(X ^ 2 - A ^ 2)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Section 9: the SQRT(A ^ 2 - X ^ 2)

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Section 10: SIN (X)

$$\int SIN\,(A \cdot X)\, dX$$

$$\int SIN\,(A \cdot X)^2\, dX$$

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

$$\int SIN\,(M \cdot X) \cdot SIN\,(N \cdot X)\,dX \quad (M^2 \neq N^2)$$

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

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

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

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

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

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

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

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

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

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

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

$$\int X \cdot SIN\,(A \cdot X)\,dX$$

$$\int X^2 \cdot SIN\,(A \cdot X)\,dX$$

$$\int X \cdot SIN\,(A \cdot X)^2\,dX$$

$$\int X^2 \cdot SIN\,(A \cdot X)^2\,dX$$

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

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

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

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

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

Section 11: COS (X)

$$\int COS\,(A \cdot X)\,dX$$

$$\int COS\,(A \cdot X)^2\,dX$$

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

$$\int COS\,(M \cdot X) \cdot COS\,(N \cdot X)\,dX \quad (M^2 \neq N^2)$$

$$\int \frac{1}{1 + COS\,(A \cdot X)}\,dX$$

$$\int \frac{1}{1 - COS\,(A \cdot X)}\,dX$$

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

$$\int \frac{COS\,(A \cdot X)}{1 + COS\,(A \cdot X)}\,dX$$

$$\int \frac{COS\,(A \cdot X)}{1 - COS\,(A \cdot X)}\,dX$$

$$\int \frac{1}{COS\,(A \cdot X) \cdot (1 + COS\,(A \cdot X))}\,dX$$

$$\int \frac{1}{COS\,(A \cdot X) \cdot (1 - COS\,(A \cdot X))}\,dX$$

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

$$\int \frac{1}{(1 - COS\,(A \cdot X))^2}\,dX$$

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

$$\int \frac{COS\,(A \cdot X)}{(1 - COS\,(A \cdot X))^2}\,dX$$

$$\int X \cdot COS\,(A \cdot X)\,dX$$

$$\int X^2 \cdot COS\,(A \cdot X)\,dX$$

$$\int X \cdot COS\,(A \cdot X)^2\,dX$$

$$\int X^2 \cdot COS\,(A \cdot X)^2\,dX$$

$$\int \frac{X}{1 + COS\,(A \cdot X)}\,dX$$

$$\int \frac{X}{1 - COS\,(A \cdot X)}\,dX$$

$$\int \sqrt{1 - COS\,(A \cdot X)}\,dX$$

$$\int \sqrt{1 + COS\,(A \cdot X)}\,dX$$

$$\int \frac{X}{COS\,(A \cdot X)^2}\,dX$$

Section 12: SIN (X) and COS (X)

$$\int SIN\,(A \cdot X) \cdot COS\,(A \cdot X)\,dX$$

$$\int SIN\,(M \cdot X) \cdot COS\,(N \cdot X)\,dX \quad (M^2 \neq N^2)$$

$$\int SIN\,(A \cdot X)^2 \cdot COS\,(A \cdot X)^2\,dX$$

$$\int SIN\,(A \cdot X) \cdot COS\,(A \cdot X)^M\,dX$$

$$\int SIN\,(A \cdot X)^M \cdot COS\,(A \cdot X)\,dX$$

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

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

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

$$\int \frac{1}{SIN\,(A \cdot X) \cdot COS\,(A \cdot X)}\,dX$$

$$\int \frac{SIN\,(X)^2}{A + B \cdot COS\,(X)^2}\,dX \quad A \cdot B > 0 \text{ or } ABS\,(A) > ABS(B)$$

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

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

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

$$\int \frac{COS\,(C \cdot X)}{A \cdot COS\,(C \cdot X) + B \cdot SIN\,(C \cdot X)}\,dX$$

$$\int \frac{SIN\,(C \cdot X)}{A \cdot SIN\,(C \cdot X) + B \cdot COS\,(C \cdot X)}\,dX$$

$$\int \frac{SIN\,(A \cdot X)}{1 + COS(A \cdot X)}\,dX$$

$$\int \frac{SIN\,(A \cdot X)}{1 - COS(A \cdot X)}\,dX$$

$$\int \frac{COS\,(A \cdot X)}{1 + SIN\,(A \cdot X)}\,dX$$

$$\int \frac{COS\,(A \cdot X)}{1 - SIN\,(A \cdot X)}\,dX$$

$$\int \frac{SIN\,(A \cdot X)}{COS\,(A \cdot X) \cdot (1 + COS\,(A \cdot X))}\,dX$$

$$\int \frac{SIN\,(A \cdot X)}{COS\,(A \cdot X) \cdot (1 - COS\,(A \cdot X))}\,dX$$

$$\int \frac{COS\,(A \cdot X)}{SIN\,(A \cdot X) \cdot (1 + SIN\,(A \cdot X))}\,dX$$

$$\int \frac{COS\,(A \cdot X)}{SIN\,(A \cdot X) \cdot (1 - SIN\,(A \cdot X))}\,dX$$

$$\int \frac{1}{SIN\,(A \cdot X) + COS\,(A \cdot X)}\,dX$$

$$\int \frac{1}{SIN\,(A \cdot X) - COS\,(A \cdot X)}\,dX$$

$$\int \frac{1}{1 + COS\,(A \cdot X) + SIN\,(A \cdot X)}\,dX$$

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

$$\int \frac{1}{A^2 \cdot COS\,(C \cdot X)^2 - B^2 \cdot SIN\,(C \cdot X)^2}\,dX$$

$$\int \frac{X + SIN\,(X)}{1 + COS\,(X)}\,dX$$

$$\int \frac{X - SIN\,(X)}{1 - COS\,(X)}\,dX$$

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

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

Section 13: Other Trigonometric Functions

$$\int TAN\,(A \cdot X)\,dX$$

$$\int COT\,(A \cdot X)\,dX$$

$$\int SEC\,(A \cdot X)\,dX$$

$$\int CSC\,(A \cdot X)\,dX$$

$$\int TAN\,(A \cdot X)^2\,dX$$

$$\int COT\,(A \cdot X)^2\,dX$$

Section 14: Inverse Trigonometric Functions

$$\int ASIN\,(A \cdot X)\,dX$$

$$\int ACOS\,(A \cdot X)\,dX$$

$$\int ATAN\,(A \cdot X)\,dX$$

$$\int ACOT\,(A \cdot X)\,dX$$

$$\int ASEC\,(A \cdot X)\,dX$$

$$\int ACSC\,(A \cdot X)\,dX$$

$$\int X \cdot ASIN\,(A \cdot X)\,dX$$

$$\int X \cdot ACOS\,(A \cdot X)\,dX$$

$$\int X \cdot ATAN\,(A \cdot X)\,dX$$

$$\int X \cdot ACOT\,(A \cdot X)\,dX$$

$$\int X \cdot ASEC\,(A \cdot X)\,dX$$

$$\int X \cdot ACSC\,(A \cdot X)\,dX$$

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

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

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

$$\int \frac{ACOT\,(A \cdot X)}{X^2}\,dX$$

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

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

Section 15: Logarithmic Forms

$$\int LN\,(A \cdot X + B)\,dX$$

$$\int X^N \cdot LN\,(A \cdot X)\,dX$$

$$\int LN\,(X)^N\,dX$$

$$\int \frac{LN\,(X)^N}{X}\,dX$$

$$\int \frac{1}{X \cdot LN\,(X)}\,dX$$

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

$$\int X^M \cdot LN\,(X)^N\,dX$$

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

$$\int LN\left(\frac{X + A}{X - A}\right)\,dX$$

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

$$\int LN\left(X^2 + A^2\right)\,dX$$

$$\int LN\left(X^2 - A^2\right)\,dX$$

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

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

Section 16: Exponential Forms

$$\int EXP\,(A \cdot X)\,dX$$

$$\int X \cdot EXP\,(A \cdot X)\,dX$$

$$\int X^M \cdot EXP\,(A \cdot X)\,dX$$

$$\int \frac{1}{1 + EXP\,(X)}\,dX$$

$$\int A^X - A^{-X}\,dX$$

$$\int \frac{EXP\,(A \cdot X)}{B + C \cdot EXP\,(A \cdot X)}\,dX$$

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

$$\int X \cdot EXP\,(-X^2)\,dX$$

$$\int EXP\,(A \cdot X) \cdot SIN\,(B \cdot X)\,dX$$

$$\int EXP\,(A \cdot X) \cdot COS\,(B \cdot X)\,dX$$

Section 17: Hyperbolic Forms

$\int SINH\ (X)\ dX$

$\int COSH\ (X)\ dX$

$\int TANH\ (X)\ dX$

$\int COTH\ (X)\ dX$

$\int SECH\ (X)\ dX$

$\int CSCH\ (X)\ dX$

$\int X \cdot SINH\ (X)\ dX$

$\int X \cdot COSH\ (X)\ dX$

$\int SECH\ (X) \cdot TANH\ (X)\ dX$

$\int CSCH\ (X) \cdot COTH\ (X)\ dX$

$\int SINH\ (X)^2\ dX$

$\int COSH\ (X)^2\ dX$

$\int TANH\ (X)^2\ dX$

$\int COTH\ (X)^2\ dX$

$\int SECH\ (X)^2\ dX$

$\int CSCH\ (X)^2\ dX$

$\int ASINH\left(\frac{X}{A}\right) dX \quad (A > 0)$

$\int ACOSH\left(\frac{X}{A}\right) dX \quad \left(ACOSH\left(\frac{X}{A}\right) > 0,\ A > 0\right)$

$\int ACOSH\left(\frac{X}{A}\right) dX \quad \left(ACOSH\left(\frac{X}{A}\right) < 0,\ A > 0\right)$

$$\int ATANH\left(\frac{X}{A}\right) dX \quad (ABS\left(\frac{X}{A}\right) < 1)$$

$$\int ACOTH\left(\frac{X}{A}\right) dX \quad (ABS\left(\frac{X}{A}\right) > 1)$$

$$\int ASECH\ (X)\ dX$$

$$\int ACSCH\ (X)\ dX$$

$$\int X \cdot ASINH\left(\frac{X}{A}\right) dX \quad (A > 0)$$

$$\int X \cdot ACOSH\left(\frac{X}{A}\right) dX$$

$$\int X \cdot ATANH\left(\frac{X}{A}\right) dX \quad (ABS\left(\frac{X}{A}\right) < 1)$$

$$\int X \cdot ACOTH\left(\frac{X}{A}\right) dX \quad (ABS\left(\frac{X}{A}\right) > 1)$$

$$\int X \cdot ASECH\ (X)\ dX$$

$$\int X \cdot ACSCH\ (X)\ dX$$

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