CONCEPT III

ELECTRONIC ADVANCED SLIDE RULE CALCULATOR

Distributed by
Zayre Corporation
Framingham, Mass. 01701

TEXAS INSTRUMENTS

KEY INDEX

This index permits quick page location of the description (bold #) and one sample problem (light #) for each key.

IMPORTANT: A copy of the sales receipt or other proof-of-purchase date is required when calculator is returned for in-warranty service.

Toll-Free Telephone Assistance

For assistance with your calculator, call one of the following toll-free numbers:

800-527-4980 (within all contiguous United States except Texas)
800-492-4298 (within Texas)

See page 58 and back cover for further information on service.

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SECTION I
DESCRIPTION

Your Concept III slide-rule calculator is designed to assist you in solving simple arithmetic and complex technical problems. The twelve arithmetic and special function keys, plus independent memory, automatic constant and scientific notation, make the Concept III a versatile computational tool.

Features

Fully Portable – Extremely lightweight. Battery or AC operation using the AC9180 Adapter.

Long Life – Solid-state Components, integrated circuits, and light-emitting-diode display provide dependable operation and long life.

Simple Operation – Arithmetic calculations can be performed in any sequence for chain calculations. When [=] is used to obtain a final answer, a new problem can be entered without using [C].

Independent Memory – Any displayed number can be stored or summed into memory and stored numbers can be recalled without interrupting a chain calculation. Memory recall does not disturb the contents of the memory.

Constant – Automatic constant allows use of constant with any of the four arithmetic functions: addition, subtraction, multiplication and division.

Scientific Notation – Computes and displays numbers as large as $\pm 9.9999999 \times 10^{98}$ or as small as $\pm 1. \times 10^{-99}$: Automatically converts answers to scientific notation when calculated answer is greater than 10^7, smaller than 10^{-7}, or when significant digits of a decimal number would be lost.

Versatility – Performs simple arithmetic and calculates reciprocals, exponentials, roots, and logarithms, with entries accepted in standard or scientific notation.

Calculation Speed – Your calculator typically performs a calculation in less than one second. However, some special-function calculations may take up to three seconds. The display is blanked and the keyboard is locked out while a calculation is being performed.

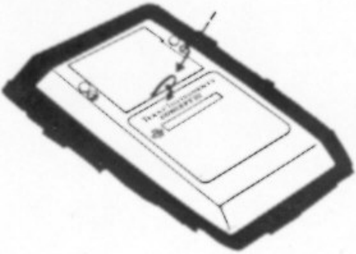
Accuracy – The Concept III calculates all answers to ten digits with the display rounded to eight digits. The two nondisplayed digits serve as guard digits to increase the accuracy of the eight displayed digits. In general, you can expect accuracy of ± 1 or better in the eighth place for arithmetic calculations, ± 2 or better in the eighth place for logarithmic functions. Power (y^x) calculations decrease one place in accuracy for each order of magnitude increase in the exponent (x). See the key descriptions in Section II for additional information.

Battery Installation and Replacement

Concept III operates on three AA non-rechargeable batteries. Because of battery self-discharge characteristics, Texas Instruments cannot ensure that factory installed batteries would be at full capacity at the time of purchase. For this reason, your calculator is supplied without batteries. It is felt that you are best served by purchasing fresh disposable batteries from your calculator dealer or other normal battery distribution channels at the time of purchase.

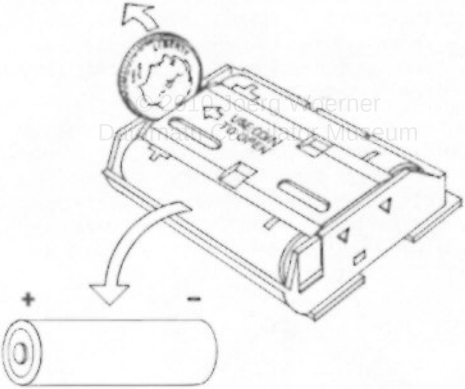
Alkaline batteries are recommended for maximum operating time (typically 15 to 20 hours). Other types of AA batteries may be used; however, they should be removed prior to a prolonged period of non-use or immediately after they fail to operate the calculator to prevent possible damage to the calculator from leakage. When batteries become discharged, the display becomes dim and may flash or show erroneous symbols and numbers before fading away.

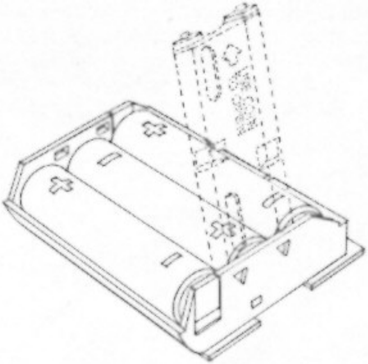
The battery pack can be quickly and simply removed from the calculator. Hold the calculator with the keys facing down. Place a small coin (penny, dime) in the slot in the bottom of the calculator. A slight prying motion with the coin will pop the slotted end of the pack out of the calculator. The pack can then be removed entirely from the calculator.



The exposed metal contacts on the battery pack are the battery terminals. Care should always be taken to prevent any metal object from coming into contact with the terminals, thereby shorting the batteries.

To install batteries, lay the battery pack on a flat surface with the open portion of the pack facing upwards. Place a small coin into the slot on the central plastic retainer. A slight prying motion with the coin will pop the slotted end of the retainer out of the pack. Install three AA non-rechargeable alkaline batteries, **paying particular attention to the proper polarity markings.** Be careful that you do not deform the battery contacts while installing new batteries.



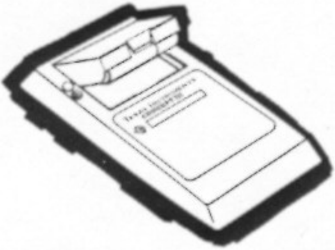


CAUTION

Improper battery installation can damage the calculator. Observe polarity markings on batteries and in case.

With the battery pack in the same position as when removing the retainer, insert the two tabbed edges of the central retainer into the right battery pack wall. While applying light pressure to the battery pack wall, gently slip the left tabs into place.

To reinsert the battery pack, place the rounded part of the pack into the pack opening so that the small step on the end of the pack fits under the edge of the calculator bottom. The slotted end of the pack will then be next to the instruction label. A small amount of pressure on the battery pack will snap it properly into position.



Spare and replacement battery-pack cases can be purchased directly from a Texas Instruments Consumer Service Facility as listed on the back cover.

IMPORTANT: When operating the calculator with the AC9180 Adapter, make sure that the adapter jack is inserted **before** switching the calculator ON. This permits proper clearing upon application of power.

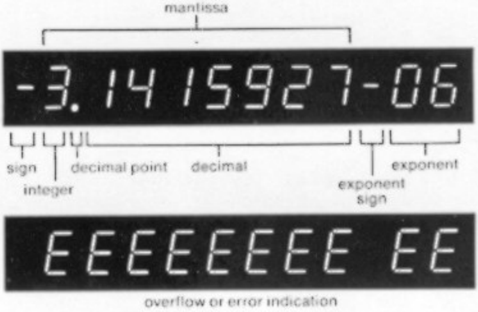
SECTION II
OPERATING INSTRUCTIONS AND EXAMPLES

Your calculator is easy to operate because of its algebraic entry format which allows entry of many problems exactly as they are written. Although many operations may be obvious, the following instructions and examples will help you develop skill and confidence in using your calculator.

On/Off Switch – Located on the top right surface of the calculator. Sliding the switch to the right turns the calculator on. Power-on condition is indicated by the presence of a lighted digit in the display. The [C] key should always be pressed to clear the calculator after turn-on and before entering any data.

Display Format

In addition to power-on indication and numerical information, the display provides indication of a negative number, decimal point, overflow and error.



Data Entry

For maximum versatility, your calculator operates in the floating decimal point mode. When entering numbers, the decimal will remain to the right of the mantissa until [•] is pressed to enter decimal numbers. Upon pressing any function key, the calculator will automatically position the entered or resultant numbers and decimal as far right as possible to eliminate all trailing zeros. Calculation results exceeding eight digits (seven digits for decimal fractions) will be displayed in scientific notation with the eight most significant digits shown by the display.

IMPORTANT: The calculator blanks the display for the short time duration (up to three seconds) it uses to process problems. Any keys pressed while the display is blanked will be ignored.

[0] **through** [9] **Digit Keys** – Enter numbers 0 through 9.

[•] **Decimal Point Key** – Enters a decimal point.

[C] **Clear Key** – Clears (erases) information in calculator and display and sets calculator to zero for the start of a new problem. The contents of the memory are not affected by this key.

[CD] **Clear Display Key** – Clears all information out of the display. This key will not interrupt a chain calculation or affect the contents of the memory.

[EE] **Enter Exponent Key** – Instructs the calculator that the following number entered is an exponent of 10. To enter a number in scientific notation, enter the mantissa, then press [EE] and enter the desired exponent of 10.

[+/−] **Change Sign Key** – Instructs the calculator to change the sign of the mantissa or exponent appearing in the display. To enter a negative number, enter the number and press [+/−]. Using [+/−] prior to [EE] changes the sign of the mantissa; if [+/−] is pressed after [EE], the sign of the exponent is changed.

[π] **Pi Key** – Enters the value of Pi rounded to eight digits.

Scientific Notation

Any number can be entered into the calculator in scientific notation — that is, as a number (mantissa) multiplied by 10 raised to some power (exponent).

Very large and very small numbers must be entered in scientific notation. For example, 120,000,000,000 is written as 1.2×10^{11}.

Enter	Press	Display
1.2	[EE]	1.2 00
11		1.2 11

NOTE: The last two digits on the right side of the display are used to indicate the exponent of 10.

In this example the exponent indicates how many places the decimal should be moved to the right. If the exponent is negative, the decimal should be moved to the left.

Example: $1.2 \times 10^{-11} = 0.000000000012$

Enter	Press	Display
	[C]	0.
1.2	[EE]	1.2 00
11	[+/−]	1.2 −11

To change the mantissa sign of an entered number after [EE] has been pressed, press [•] and [+/−] or [CD] and reenter the number. The exponent of an intermediate or final result may be changed by pressing [EE] and entering new exponent digits.

Data in scientific notation form may be entered intermixed with data in standard form. The calculator will convert the entered data for proper calculation.

Example: $3.2 \times 10^3 + 12575 + 2855 = 18630$

Enter	Press	Display
	[C]	0.
3.2	[EE]	3.2 00
3	[+]	3200.
12575	[+]	15775.
2855	[=]	18630.

The calculator will ignore any mantissa digits entered in excess of eight (seven if decimal is entered first) and will use the last two exponent digits entered as shown in the display. If a calculation result has more than eight digits before the decimal or seven digits after the decimal (numbers closer to zero than ±1), it is automatically converted to scientific notation. The calculator will maintain results in scientific notation only if significant digits would be lost in reverting to standard notation.

Example: $3 \div 7 \times 10 = .42857143 \times 10 = 4.2857143$

Enter	Press	Display
3	[÷]	3.
7	[=]	4.2857143 −01
	[×]	4.2857143 −01
10	[=]	4.2857143

Error Indication

Under any error, underflow or overflow condition, the display will read EEEEEEEE EE. When the error condition occurs, additional entries may produce erroneous results unless [C] is pressed.

The error indication will be displayed for the following reasons:

1. The results of any calculation (including summation into memory) is greater than 9.9999999×10^{98} or smaller than 1.0×10^{-99}.

2. Dividing a number by zero.

3. The mantissa is negative when either [$\sqrt{x}$], [log], [lnx], or [y^x] is pressed.

4. The mantissa is zero when [log], [lnx] or [y^x] is pressed. (The y^x function uses the natural logarithm routine which is undefined for zero or negative numbers.)

Pressing the [C] key removes an error indication and clears the calculator.

ARITHMETIC FUNCTIONS

Concept III uses up to ten digits when performing calculations with the display rounded to eight digits. Only the eight displayed digits are used by the calculator for subsequent calculations. The results of an arithmetic calculation will generally be accurate to ±1 in the eighth digit.

IMPORTANT: All calculations are not performed with the same accuracy. When calculations are mixed arithmetic and special functions, the result can at best be no more accurate than the special function with the least accuracy.

[+] **Add Key** – Completes any previously entered arithmetic or y^x function and instructs the calculator to add the next entered quantity to the displayed number.

[−] **Subtract Key** – Completes any previously entered arithmetic or y^x function and instructs the calculator to subtract the next entered quantity from the displayed number.

[×] **Multiply Key** – Completes any previously entered arithmetic or y^x function and instructs the calculator to multiply the displayed number times the next entered quantity.

[÷] **Divide Key** – Completes any previously entered arithmetic or y^x function and instructs the calculator to divide the displayed number by the next entered quantity.

[=] **Equals Key** – Completes any previously entered arithmetic or y^x function. Refer to *Calculations with a Constant* for other operations of the equals key.

It is not necessary to press [C] between problems when [=] is used to obtain a final result. Following [=] with a numeric entry automatically clears the previous result.

IMPORTANT: Repeated pressing of [=] following an arithmetic calculation is not ignored. The last arithmetic function and number entered, and the displayed number are reused by the calculator as an automatic constant calculation. See *Calculations with a Constant* examples in this section.

If the equals key is pressed immediately following an arithmetic or y^x function, the number displayed prior to pressing the equals key is assumed by the calculator as the missing entry.

Performing arithmetic calculations with your calculator is simple and direct. The following examples illustrate the operation of your calculator.

Addition and Subtraction

Example: 4.23 + 4 = 8.23

Enter	Press	Display
4.23	[+]	4.23
4	[=]	8.23

Example: 6 − 1.854 = 4.146

Enter	Press	Display
6	[−]	6.
1.854	[=]	4.146

Example: 12.32 − 7 + 1.6 = 6.92

Enter	Press	Display
12.32	[−]	12.32
7	[+]	5.32
1.6	[=]	6.92

Example: −5.35 − (−4.2) − 3.1 = −4.25

Enter	Press	Display
5.35	[+/−] [−]	−5.35
4.2	[+/−] [−]	−1.15
3.1	[=]	−4.25

Multiplication and Division

Example: 27.2 × 18 = 489.6

Enter	Press	Display
27.2	[×]	27.2
18	[=]	489.6

Example: 11.7 ÷ 5.2 = 2.25

Enter	Press	Display
11.7	[÷]	11.7
5.2	[=]	2.25

Example: 4 × 7.3 ÷ 2 = 14.6

Enter	Press	Display
4	[×]	4.
7.3	[÷]	29.2
2	[=]	14.6

Mixed Calculations

An intermediate result of a calculation is displayed when [+], [−], [×], or [÷] is pressed. It is not necessary to press [=] to obtain an intermediate result, nor is it necessary to reenter the intermediate result for further calculations.

Example: (8.3 + 2) ÷ 4 − 6.8 = −4.225

Enter	Press	Display
8.3	[+]	8.3
2	[÷]	10.3
4	[−]	2.575
6.8	[=]	−4.225

Example: (−5.2 − 3) × 4 + 55.2 ÷ 4 = 5.6

Enter	Press	Display
5.2	[+/−] [−]	−5.2
3	[×]	−8.2
4	[+]	−32.8
55.2	[÷]	22.4
4	[=]	5.6

Error Correction

Concept III has been designed to facilitate correction of errors. If any arithmetic function key – [+], [−], [×] or [÷] – is inadvertently pressed instead of another arithmetic function key, the error is corrected simply by pressing the correct function key.

An incorrect numerical entry is corrected by pressing the [CD] key and then entering the correct quantity.

Example: 6 ~~+~~ × 7 − ~~4~~ 3 = 39.

Enter	Press	Display	Comments
6	[+]	6.	Error
	[×]	6.	Correction
7	[−]	42.	
4		4.	Error
	[CD]	0.	
3		3.	Correction
	[=]	39.	Answer

CALCULATIONS WITH A CONSTANT

Your calculator has an automatic constant feature which allows you to repeat arithmetic calculations with a constant number. In all cases, the second entry is used by the calculator as the constant number.

Example: 5.3 + 1.753 = 7.053
186.075 + 1.753 = 187.828
−2.741 + 1.753 = −0.988

Enter	Press	Display
5.3	[+]	5.3
1.753	[=]	7.053
186.075	[=]	187.828
2.741	[+/−] [=]	−0.988

Example: .721 × 4.382 = 3.159422
97.211 × 4.382 = 425.9786
−.0061 × 4.382 = −0.0267302

Enter	Press	Display
.721	[×]	0.721
4.382	[=]	3.159422
97.211	[=]	425.9786
.0061	[+/−] [=]	−0.0267302

MEMORY OPERATIONS

The memory keys allow an entered number or calculated result to be stored and retrieved for additional flexibility in calculation.

[STO] **Store Key** – Instructs the calculator to store the displayed quantity in the memory. Any previously stored quantity is cleared.

[RCL] **Recall Key** – Instructs the calculator to display stored data from the memory. Use of this key does not clear the memory.

[Σ] **Sum and Store Key** – Instructs the calculator to algebraically sum the displayed number to the number in memory and store the result in memory. Use of this key does not affect the displayed quantity nor the previously calculated data.

Pressing [STO] or [Σ] terminates a number entry but does not complete any pending instruction. Following either of these operations with another number entry starts a new number in the display.

IMPORTANT: [C] does not erase the contents of the memory. Therefore, either the first quantity should be entered using [STO], or a zero should be stored before using [Σ].

Example: (3 × 6) + (1.5 × 4) – (16 × 2) = –8

Enter	Press	Display
3	[×]	3.
6	[=] [STO]	18.
1.5	[×]	1.5
4	[=] [Σ]	6.
16	[×]	16.
2	[=] [+/–]	–32.
	[Σ] [RCL]	–8.

SPECIAL FUNCTIONS

The calculator uses up to ten digits internally to perform special functions with the display rounded to eight digits. The reciprocal, square and square-root functions are accurate to ±1 in the eighth digit for most calculations. Accuracy of the y^x and logarithmic functions are given with the corresponding descriptions. Since each result is rounded to eight digits, sequential use of the special functions may cause the final accuracy to be less than the accuracy specified for a single operation. To help you become familiar with the capabilities of your calculator, each example problem is shown with the correct answer rounded to eight places for you to compare with the result displayed by the calculator.

Reciprocals

[1/x] **Reciprocal Key** – Completes any previously entered arithmetic or y^x function and divides the result or an entered number into one.

Example: 1/3.2 = 0.3125

Enter	Press	Display
3.2	[1/x]	0.3125

Example: $1/1.1 \times 10^{-18} = 9.0909091 \times 10^{17}$

Enter	Press	Display
1.1	[EE]	1.1 00
18	[+/-]	1.1-18
	[1/x]	9.0909091 17

Example: 1/(4 + 2) = 1/6 = 0.16666667

Enter	Press	Display
4	[+]	4.
2	[1/x]	1.6666667-01

When the calculated result is a decimal fraction (less than 1.0) having eight or more digits, the result will be displayed to eight digits in scientific notation.

Squares and Square Roots

[x^2] **Square Key** – Completes any previously entered arithmetic or y^x function and multiplies the result or an entered number times itself.

[$\sqrt{x}$] **Square Root Key** – Completes any previously entered arithmetic or y^x function and calculates the square root of the result or of an entered number. For very large values of x, the accuracy of [$\sqrt{x}$] may be as low as ±4 in the 7th digit.

Example: $(4.2)^2 = 17.64$

Enter	Press	Display
4.2	[x^2]	17.64

Example: $(99999999)^2 = 9.9999998 \times 10^{15}$

Enter	Press	Display
99999999	[x^2]	9.9999998 15

Example: $(2.1 \times 10^4)^2 = 4.41 \times 10^8$

Enter	Press	Display
2.1	[EE]	2.1 00
4	[x^2]	4.41 08

Example: $\sqrt{6.25} = 2.5$

Enter	Press	Display
6.25	[$\sqrt{x}$]	2.5

Example: $\sqrt{(6.2 + 5.3)^2 \times 4.5} = 24.395184$

Enter	Press	Display
6.2	[+]	6.2
5.3	[x^2] [×]	132.25
4.5	[$\sqrt{x}$]	24.395184

Y to the x Power

[y^x] **y to the x Power Key** – Completes any previously entered arithmetic or y^x function and instructs the calculator to raise the result or an entered number to a power (x) which is the next entry. Any special function, arithmetic or the equals key will complete the operation.

The number for y may be a keyboard entry, stored quantity, or calculated result; however, the number for x can only be a keyboard entry or stored quantity.

The accuracy of the y^x function decreases as the exponent (x) increases. The general worst-case accuracy limits of y^x as x increases are:

$\|x\| \leq 10$	±2 in 7th digit
$10 < \|x\| \leq 100$	±2 in 6th digit
$100 < \|x\| \leq 1000$	±2 in 5th digit

Since the y^x function uses the natural logarithm, the accuracy also changes for values at y between 1 and 1.1 as follows:

$1.1 \geq \|y\| > 1.01$	±4 in 7th digit
$1.01 \geq \|y\| > 1.001$	±4 in 6th digit
$1.001 \geq \|y\| > 1.0001$	±4 in 5th digit and so forth.

Example: $(8)^3 = 512$

Enter	Press	Display
8	[y^x]	2.0794415
3	[=]	512.

The calculator uses the natural logarithm in computing y^x; therefore ln 8 was displayed when [y^x] was pressed. You must wait until this natural logarithm value is displayed before entering the value of x. The calculator will not accept any data entry or function instructions while the display is blanked out. If the keys are pressed too rapidly, it is possible to inadvertently calculate $y^{\ln y}$ rather than y^x.

High order roots and other complex calculations can be solved using [y^x].

Example: $\sqrt[23]{3.95 \times 10^{12}} = (3.95 \times 10^{12})^{\frac{1}{23}} = 3.5292152$

Enter	Press	Display
23	[1/x] [STO]	4.3478261−02
3.95	[EE]	3.95 00
12	[y^x]	29.004737
	[RCL] [=]	3.5292152

Example: $4.2^{\ln 3.7} = 6.5375873$

Enter	Press	Display
3.7	[lnx] [STO]	1.3083328
4.2	[y^x]	1.4350845
	[RCL] [=]	6.5375871

Natural Logarithms

Natural logarithms are calculated with up to ten digits internally and the displayed result is rounded to eight digits. Accuracy will normally be better than ±2 in the eighth digit except for values of x between 1 and 1.1 as follows:

$1.1 \geq \lvert x \rvert > 1.01$	±4 in 7th digit
$1.01 \geq \lvert x \rvert > 1.001$	±4 in 6th digit
$1.001 \geq \lvert x \rvert > 1.0001$	±4 in 5th digit and so forth

The e^x function will normally be accurate to ±2 in the eighth digit except for very large values of x where accuracy may be as low as ±4 in the 7th digit.

[lnx] **Natural Logarithm Key** — completes any previously entered arithmetic or y^x function and instructs the calculator to determine the logarithm (to the base e) of the result or an entered number.

[e^x] **e to the x Power Key** — Completes any previously entered arithmetic or y^x function and instructs the calculator to raise (2.71828181) to the power of the result or of an entered number, i.e., to calculate the natural antilogarithm of the result or an entered number.

Example: $\ln 5.4 = 1.6863990$

Enter	Press	Display
5.4	[lnx]	1.686399

Example: $e^{3.8} = 44.701184$

Enter	Press	Display
3.8	[e^x]	44.701184

Example: $\ln [3.757 + e^{(2.8+1.4)}] = 4.2548086$

Enter	Press	Display
2.8	[+]	2.8
1.4	[e^x] [+]	66.686331
3.757	[lnx]	4.2548086

Common Logarithms

Common logarithms are calculated with up to ten digits internally and the displayed result is rounded to eight digits. Accuracy will normally be better than ±2 in the eighth digit except for values of x between 1 and 1.1 as follows:

$1.1 \geq \lvert x \rvert > 1.01$	±4 in 7th digit
$1.01 \geq \lvert x \rvert > 1.001$	±4 in 6th digit
$1.001 \geq \lvert x \rvert > 1.0001$	±4 in 5th digit and so forth.

[log] **Common Logarithm Key** – Completes any previously entered arithmetic or y^x function and instructs the calculator to determine the logarithm (to the base 10) of the result or of an entered number.

Example: $\log 1573 = 3.1967287$

Enter	Press	Display
1573	[log]	3.1967287

Example: Antilog (−2.3) = $10^{-2.3} = 5.0118723 \times 10^{-3}$

Enter	Press	Display
10	[y^x]	2.3025851
2.3	[+/−] [=]	5.0118723−03

Example: Antilog (2.84 × 1.73 + 3.79) = 5.0489376×10^8

Enter	Press	Display
2.84	[×]	2.84
1.73	[+]	4.9132
3.79	[=] [STO]	8.7032
10	[y^x]	2.3025851
	[RCL] [=]	5.0489376 08

Note: The antilog calculation is bound with the same accuracy limits specified for the y^x function.

For values of x < 1.0, the calculator will calculate and display the true base-10 logarithm (a negative quantity) rather than the quantity usually shown in a book of tables, which is the cologarithm for such values of x. To calculate the cologarithm, simply add 10 to the logarithm.

Example: Colog 0.8 = log 0.8 + 10

$= -9.6910013 \times 10^{-2} + 10$

$= 9.90309$

Enter	Press	Display	Comments
0.8	[log] [+]	−9.6910012-02	logarithm
10	[=]	9.90309	cologarithm

This cologarithm is frequently shown simply as 9.90309, but is more accurately stated as 9.90309 −10. The mantissa of the cologarithm is listed in tables to alleviate the necessity of manually adding positive and negative numbers. Cologarithms are not needed for calculator computations.

Mixed Calculations

When using one of the special function keys in a chain calculation, the problem should be worked such that the special function resultant begins the chain calculation sequence. Otherwise, the interim result must be stored in the memory while the special function operation is being performed.

Example: $34.7 + (8.7)^{2.6} = 311.87245$

Enter	Press	Display
8.7	[y^x]	2.163323
2.6	[+]	277.17245
34.7	[=]	311.87245

Example: $1.35 \times (e^{1.3} + 16) = 26.553551$

Enter	Press	Display
1.3	[e^x] [+]	3.6692967
16	[×]	19.669297
1.35	[=]	26.553551

When more than one special function key is used in a calculation, store the intermediate result in memory.

Example: $16 - 1/8.3 + 1.3^2 = 17.569518$

Enter	Press	Display
8.3	[1/x] [STO]	1.2048193–01
1.3	[x^2] [−]	1.69
	[RCL] [+]	1.5695181
16	[=]	17.569518

Example: $(.59 \times 6)^{\log .32} = .53496544$

Enter	Press	Display
.32	[log] [STO]	–4.9485002–01
.59	[X]	0.59
6	[y^x]	1.2641267
	[RCL] [=]	5.3496544–01

Error Correction

If an arithmetic function Key – [+], [–], [X], or [÷] is inadvertently pressed instead of any of the special function keys – [y^x], [1/x], [$\sqrt{x}$], [x^2], [lnx], [e^x], or [log] – the error can be corrected by pressing [CD] and then pressing the correct key.

Example: $(5 \not+)^2 = 25$

Enter	Press	Display	Comments
5	[+]	5.	Error
	[CD]	0.	
	[x^2]	25.	Correction

If y^x is pressed instead of an arithmetic or another special function key, the error can be corrected by entering one and then pressing the correct key.

Example: $4^{\not y} \times 3 = 12$

Enter	Press	Display	Comments
4	[y^x]	4.	Error
1	[X]	4.	Correction
3	[=]	12.	

If any special function key other than y^x is inadvertently pressed, the error can be corrected by completing the opposite function as shown below and then pressing the correct key. Due to display roundoff and inaccuracies of certain ranges of numbers, this method of error correction will not always return the exact number originally entered.

Error	Correction
[1/x]	[1/x]
[x^2]	[$\sqrt{x}$]
[$\sqrt{x}$]	[x^2]
[lnx]	[e^x]
[e^x]	[lnx]
[log]	[STO] 10 [y^x] [RCL]

Example: ~~log~~ ln 2 = 0.69314718

Enter	Press	Display	Comments
2	[log]	0.30103	Error
	[STO]	0.30103	
10	[y^x]	2.302581	
	[RCL] [lnx]	6.9314719–01	Correction

SECTION III
COMPLEX MATHEMATICAL METHODS

Many complex problems requiring interim calculations can be solved easily with the Concept III by using the memory. This convenient storage capability eliminates the need for writing down and reentering intermediate results. The memory also permits problems to be solved by conventional procedures instead of rewriting the problem for sequential operation.

Sum of Products or Quotients

Example: $(e^{11} \times 3) + (10^{4.1} \times 5) = 242568.70$

Enter	Press	Display
11	[e^x] [×]	59874.142
3	[=] [STO]	179622.43
10	[y^x]	2.3025851
4.1	[×]	12589.254
5	[=] [Σ]	62946.27
	[RCL]	242568.7

Example: $\frac{\ln 2}{5} - \frac{\ln 3}{4} = -0.13602364$

Enter	Press	Display
3	[lnx] [÷]	1.0986123
4	[=] [STO]	2.7465308-01
2	[lnx] [÷]	6.9314718-01
5	[−] [RCL] [=]	−1.3602364-01

Example: $1/(1/10 + 1/20 + 1/30) = 5.4545455$

Enter	Press	Display
10	[1/x] [STO]	0.1
20	[1/x] [Σ]	0.05
30	[1/x] [Σ]	3.3333333-02
	[RCL] [1/x]	5.4545456

Example:

$$1 + 2.5\ln 16 + \frac{(2.5\ln 16)^2}{2} + \frac{(2.5\ln 16)^3}{6} = 87.458231$$

Enter	Press	Display
1	[STO]	1.
16	[lnx] [X]	2.7725887
2.5	[=] [Σ]	6.9314718
	[x²] [÷]	48.045301
2	[=] [Σ]	24.022651
16	[lnx] [X]	2.7725887
2.5	[yˣ]	1.9360722
3	[÷]	333.02465
6	[=] [Σ]	55.504108
	[RCL]	87.458231

Example: $\frac{3\ln 2}{4\ln 3 + 6\ln 5} = 0.14799162$

Enter	Press	Display
3	[lnx] [X]	1.0986123
4	[=] [STO]	4.3944492
5	[lnx] [X]	1.6094379
6	[=] [Σ]	9.6566274
2	[lnx] [X]	6.9314718–01
3	[÷] [RCL] [=]	1.4799161–01

Product or Quotient of Sums

Example: $(e^{-1.2} + 3) \times (4 + 5^{2.6}) = 229.97174$

Enter	Press	Display
1.2	[+/–] [eˣ] [+]	3.0119421–01
3	[=] [STO]	3.3011942
5	[yˣ]	1.6094379
2.6	[+]	65.663195
4	[X] [RCL] [=]	229.97174

Example: $\frac{\log 2 - 4}{4.2^{1/2} + 6} = -0.45953419$

Enter	Press	Display
4.2	[√x] [+]	2.0493901
6	[=] [STO]	8.0493901
2	[log] [−]	0.30103
4	[÷] [RCL] [=]	−0.4595342

Example: $\frac{2 \times 3}{\ln(2 + 3)} = 3.7280096$

Enter	Press	Display
2	[+]	2.
3	[lnx]	1.6094379
	[1/x] [×]	6.2133494−01
2	[×]	1.2426699
3	[=]	3.7280096

In general, it is shorter to calculate the denominator first. In some cases, [1/x] can be used instead of the memory.

Example: $5 + 4 \ln[6 + 2 \ln(3 + 7)] = 14.445367$

Enter	Press	Display
3	[+]	3.
7	[lnx] [×]	2.3025851
2	[+]	4.6051702
6	[lnx] [×]	2.3613416
4	[+]	9.4453664
5	[=]	14.445366

A variation of the product of sums occurs in equations using nested parentheses.

Example: $\frac{[3 + (1.56)^{1/2}] \times (4 + \pi^2)}{(3^{-1.3} + 4) \times (e^{-.56} + 1)} = 8.8466217$

Enter	Press	Display
3	[y^x]	1.0986123
1.3	[+/−] [+]	2.3974103−01
4	[=] [STO]	4.239741
.56	[+/−] [e^x] [+]	5.7120907−01
1	[×] [RCL] [=] [STO]	6.6615195
1.56	[$\sqrt{x}$] [+]	1.2489996
3	[÷] [RCL] [=] [STO]	0.6378424
	[π] [x^2] [+]	9.8696047
4	[×] [RCL] [=]	8.8466219

Note that the problem is solved starting with the innermost set of parentheses and working outward. This is true regardless of the order in which the problem is stated.

Quadratic Equation

For the equation, $Ax^2 + Bx + C = 0$, the solution for x is:

$$x = \frac{-B \pm \sqrt{B^2 - 4AC}}{2A}$$

Example: Find the roots of the equation $3x^2 + 8x + 5 = 0$.

$$x = \frac{-8 \pm \sqrt{8^2 - (4 \times 3 \times 5)}}{2 \times 3}$$

Enter	Press	Display	Remarks
8	[x^2] [STO]	64.	B^2
4	[+/−] [×]	−4.	
3	[×]	−12.	
5	[+] [RCL] [$\sqrt{x}$]	2.	
	[STO] [−]	2.	Stored $\sqrt{B^2 - 4AC}$
8	[÷]	−6.	
2	[÷]	−3.	
3	[=]	−1.	Root 1
8	[+/−] [−]	−8.	
	[RCL] [÷]	−10.	
2	[÷]	−5.	
3	[=]	−1.6666667	Root 2

Trigonometric Functions

You can greatly augment the capability of the Concept III by using tables of trigonometric values, such as *C.R.C. Standard Mathematical Tables* published by Chemical Rubber Co., 18901 Cranwood Parkway, Cleveland, Ohio 44128.

However, you can also use the Concept III to *calculate* the values of these trigonometric functions. In general, values to four or five significant figures can be calculated using the recommended expression. A more complex expression is also given for cases where additional accuracy is needed.

The following expressions for the values of trigonometric functions are derived from the Taylor Series expansions, especially modified for use with the calculator. As a result, the trigonometric and inverse trigonometric functions involve angles expressed in radians. To convert degrees into radians, multiply by $\pi/180$. Conversely, to convert radians into degrees, we multiply by $180/\pi$.

Sine

$$\sin a = \left[\left(\frac{a^2}{20}+1\right)^{-1} \times 10 - 7\right]\frac{a}{3}^{*} \qquad 0 < a < \frac{\pi}{4}$$

Accuracy

a in Degrees	Error in %
0 to 30°	< 0.001%
30 to 45°	< 0.006%

$$\sin a = \cos\left(\frac{\pi}{2} - a\right) \qquad \frac{\pi}{4} < a < \frac{\pi}{2}$$

Accuracy

a in Degrees	Error in %
45 to 70°	< 0.001%
70 to 90°	< 0.0001%

*For greater accuracy

$$\sin a = \left\{\left[\left(\frac{a^2}{42}+1\right)^{-1} \times 21 - 11\right]\frac{a^2}{-60} + 1\right\} a$$

Cosine

$$\cos a = \left[\left(\frac{a^2}{30}+1\right)^{-1} \times 5 - 3\right]\frac{a^2}{-4} + 1^{**} \qquad 0 < a < \frac{\pi}{4}$$

Accuracy

a in Degrees	Error in %
0 to 20°	< 0.0001%
20 to 45°	< 0.001%

$$\cos a = \sin\left(\frac{\pi}{2} - a\right) \qquad \frac{\pi}{4} < a < \frac{\pi}{2}$$

Accuracy

a in Degrees	Error in %
45 to 60°	< 0.006%
60 to 90°	< 0.001%

**For greater accuracy

$$\cos a = \left\{\left[\left(\frac{a^2}{56}+1\right)^{-1} \times 28 - 13\right]\frac{a^2}{360} - .5\right\} a^2 + 1$$

Tangent

$$\tan a = \left[\left(-\frac{2}{5}a^2 + 1\right)^{-1} \times 5 + 1\right]\frac{a}{6}^{*} \qquad 0 < a < \frac{\pi}{4}$$

a in Degrees	Accuracy Error in %
0 to 20°	< 0.001%
20 to 35°	< 0.01%
35 to 45°	< 0.03%

$$\tan a = \tan\left(\frac{\pi}{2} - a\right)^{-1} \qquad \frac{\pi}{4} < a < \frac{\pi}{2}$$

a in Degrees	Accuracy Error in %
45 to 55°	< 0.03%
55 to 70°	< 0.01%
70 to 90°	< 0.001%

*For greater accuracy

$$\tan a = \left\{\left[\left(-\frac{17}{42}a^2 + 1\right)^{-1} \times 84 + 1\right]\frac{a^2}{255} + 1\right\} a$$

Example: Sin 25° = 0.42261826

Enter	Press	Display
25	[×]	25.
	[π]	3.1415927
	[÷]	78.539818
180	[=] [STO]	4.3633232-01
	[x²] [÷]	1.9038589-01
20	[+]	9.5192945-03
1	[1/x] [×]	9.9057047-01
10	[−]	9.9057047
7	[×] [RCL] [÷]	1.2678529
3	[=]	4.2261762-01

The above answer is correct rounded to five significant digits which is within the 0.001% error tolerance.

Inverse Trigonometric Functions

Arc Sine

$$\text{arc sin } a = \left[\left(-\frac{9}{20}a^2 + 1\right)^{-1} \times 10 + 17\right]\frac{a}{27}^{*} \quad 0 < a < \frac{1}{2}$$

Accuracy

a	Error in %
0 to 0.2	< 0.0001%
0.2 to 0.3	< 0.001%
0.3 to 0.45	< 0.01%
0.45 to 0.5	< 0.03%

$$\text{arc sin } a = \frac{-4 \text{ arc sin } b + \pi}{2} \qquad \frac{1}{2} < a < 1$$

where $b = \sqrt{\frac{1-a}{2}}$

Accuracy

a	Error in %
0.5 to 0.65	< 0.05%
0.65 to 0.75	< 0.01%
0.75 to 0.9	< 0.001%
0.9 to 1.0	< 0.0001%

*For greater accuracy

$$\text{arc sin } a = \left\{\left[\left(-\frac{25}{42}a^2 + 1\right)^{-1} \times 189 + 61\right]\frac{a^2}{1500} + 1\right\} a$$

Arc Cosine

$$\text{arc cos } a = \frac{\pi}{2} - \text{arc sin } a \qquad 0 < a < 1$$

Accuracy
Same as for arc sin

Arc Tangent

$$\text{arc tan a} = \left[\left(\frac{3a^2}{5} + 1\right)^{-1} \times 5 + 4\right] \frac{a}{9}^{*} \qquad 0 < a < 0.5$$

Accuracy

a	Error in %
0 to 0.2	< 0.0001%
0.2 to 0.3	< 0.001%
0.3 to 0.45	< 0.01%
0.45 to 0.5	< 0.02%

$$\text{arc tan a} = \text{arc tan b} + 0.4636476$$

$$\text{where b} = \left[\left(\frac{2}{a} + 1\right)^{-1} \times 5 - 1\right]/2 \qquad 0.5 < a < 1$$

Accuracy

a	Error in %
0.5 to 0.85	< 0.0001%
0.85 to 1	< 0.001%

$$\text{arc tan a} = \frac{-2\ \text{arc tan}\left(\frac{1}{a}\right) + \pi}{2} \qquad a > 1$$

Accuracy

Same as above for $\frac{1}{a}$

*For greater accuracy

$$\text{arc tan a} = \left\{\left[\left(\frac{5a^2}{7} + 1\right)^{-1} \times 21 + 4\right\} \frac{a^2}{-75} + 1\right\} a$$

Example: Arc tan 0.75 = 36.869898°

Enter	Press	Display	Remark
2	[÷]	2.	
.75	[+]	2.6666667	
1	[1/x] [X]	2.7272727–01	
5	[–]	1.3636364	
1	[÷]	3.6363635–01	
2	[=] [STO]	1.8181818–01	value of b
	[x²] [X]	3.3057851–02	
3	[÷]	9.9173553–02	
5	[+]	1.9834711–02	
1	[1/x] [X]	9.8055105–01	
5	[+]	4.9027553	
4	[X] [RCL] [÷]	1.6186828	
9	[+]	1.7985364–01	arc tan b
.4636476	[X]	6.4350124–01	arc tan a in radians
180	[÷]	115.83022	
	[π] [=]	36.869905	arc tan a in degrees

Hyperbolic Functions

Solving problems involving hyperbolic functions with the calculator is simple and straightforward.

Hyperbolic Sine (sinh) $x = 1/2(e^x - e^{-x}) = \frac{e^{2x}-1}{2e^x}$

Hyperbolic Cosine (cosh) $x = 1/2(e^x + e^{-x}) = \frac{e^{2x}+1}{2e^x}$

Hyperbolic Tangent (tanh) $x = \frac{e^x-e^{-x}}{e^x+e^{-x}} = \frac{e^{2x}-1}{e^{2x}+1}$

Example: tanh 2.99 = 0.99495511

Enter	Press	Display
2.99	[X]	2.99
2	[eˣ] [+]	395.44037
1	[=] [STO] [−]	396.44037
2	[÷] [RCL] [=]	9.9495511−01

Inverse Hyperbolic Functions

$\sinh^{-1} x = \ln(x + \sqrt{x^2+1})$

$\cosh^{-1} x = \ln(x + \sqrt{x^2-1})$

$\tanh^{-1} x = 1/2 \ln \frac{1+x}{1-x}$

Example: $\sinh^{-1}$ 86.213 = 5.1500018

Enter	Press	Display
86.213	[STO] [x²] [+]	7432.6814
1	[√x] [+]	86.2188
	[RCL] [=] [lnx]	5.1500018

SECTION IV
SAMPLE PROBLEMS

Your calculator is a versatile tool for solving simple or complex problems. The following problems have been selected from several disciplines with each solution shown in detail. It is recommended that you use your calculator to step through the sample problems in this section that relate to your discipline and interest.

Business

Accumulated Amount—If \$15,000 is invested at 7¾% interest compounded annually, what will be the accumulated amount at the end of eight years?

$$FV = PV\,(1 + i)^n$$
$$= 15{,}000\,(1 + .0775)^8$$
$$= \$27{,}253.95$$

Enter	Press	Display
1	[+]	1.
.0775	[y^x]	7.4643544−02
8	[×]	1.8169301
15000	[=]	27253.952

Present Value—What is the present value of the future amount \$35,570 in 13 years? The interest rate is 6.3% compounded quarterly.

$$PV = FV(1+i)^{-n}$$
$$= 35570\left[1 + \left(\frac{.063}{4}\right)\right]^{-(13\times 4)}$$
$$= \$15{,}782.24$$

Enter	Press	Display
4	[×]	4.
13	[=] [+/-] [STO]	−52.
.063	[÷]	0.063
4	[+]	0.01575
1	[y^x] [RCL] [×]	4.4369528−01
35570	[=]	15782.241

Loan Amortization – What is the amount of the monthly payment required to amortize (pay off) a $4550 loan or note over 36 months, if the annual percentage rate is 6½%?

$$PMT = PV\left[\frac{i}{1-(1+i)^{-n}}\right]$$

$$= 4550\left[\frac{\frac{.065}{12}}{1-\left(1+\frac{.065}{12}\right)^{-36}}\right]$$

$$= \$139.45$$

Enter	Press	Display
.065	[÷]	0.065
12	[+] [STO]	5.4166667−03
1	[y^x]	5.402042−03
36	[+/-] [=] [+/-] [+]	8.2326799−01
1	[1/x] [×]	5.6582845
	[RCL] [×]	3.0649041−02
4550	[=]	139.45314

In problems involving money, fractions of a cent are normally rounded up, i.e., 139.45313 becomes 139.46.

Time Required to Pay off a Loan or Note – How many monthly payments of 139.46 will be required to pay off a loan or note of $4550 if the Annual Percentage Rate is 6½%?

$$n = \frac{-\ln\left[1 - PV\left(\frac{i}{PMT}\right)\right]}{\ln(1+i)}$$

$$= \frac{-\ln\left[1 - 4550\left(\frac{.065}{12 \times 139.46}\right)\right]}{\ln\left[1 + \frac{.065}{12}\right]}$$

= 36 monthly payments

Enter	Press	Display
.065	[÷]	0.065
12	[+]	5.4166667–03
1	[lnx] [STO]	5.402042–03
.065	[÷]	.065
12	[÷]	5.4166667–03
139.46	[×]	3.8840289–05
4550	[=] [+/–] [+]	–1.7672331–01
1	[lnx] [+/–] [÷] [RCL] [=]	35.998043

Sinking Fund – If a fixed investment of $3500 is made at the end of each successive year for nine years at an interest rate of 7.25% compounded annually, what will be the accumulated amount of the sinking fund?

$$S = N \times \frac{(1+i)^n - 1}{i}$$

$$= 3500 \times \frac{(1 + .0725)^9 - 1}{.0725}$$

= $42,351.19

Enter	Press	Display
1.0725	[y^x]	6.9992375-02
9	[−]	1.8774817
1	[÷]	8.7748173-01
.0725	[×]	12.103196
3500	[=]	42361.187

Accumulated Amount – If a fixed investment of $1200 is made at the beginning of each year for 15 years, at 8¾% interest compounded annually, what is the value of the account at the end of the 15th year?

$$S = \frac{N \times [(1 + i)^{n+1} - 1]}{i} - N$$

$$= \frac{1200 \times [(1 + 0.0875)^{(15+1)} - 1]}{.0875} - 1200$$

$$= \$37571.47$$

Enter	Press	Display
1.0875	[y^x]	8.3881485-02
16	[−]	3.8270863
1	[×]	2.8270863
1200	[÷]	3392.5036
.0875	[−]	38771.469
1200	[=]	37571.469

Architectural Engineering

Duct System – What are the pressure losses in a 3000 fpm air duct system 145 feet long and 2.5 feet in diameter? Use values of 2.8×10^{-6} for f and 8.9×10^{-5} for C.

$$Ht = (fL/D)\ (V^2/4005) + (CV^2/4005)$$
$$= (V^2/4005)\ [(fL/D) + C]$$
$$= (3000^2/4005)\ [(2.8 \times 10^{-6} \times 145/2.5) + 8.9 \times 10^{-5}]$$
$$= 0.56494382 \text{ inches of water}$$

Enter	Press	Display
3000	[x²] [÷]	9000000.
4005	[=] [STO]	2247.191
2.8	[EE]	2.8 00
6	[+/−] [×]	0.0000028
145	[÷]	0.000406
2.5	[+]	0.0001624
8.9	[EE]	8.9 00
5	[+/−] [×]	0.0002514
	[RCL] [=]	5.6494382−01

Wind Stress—What is the direct stress D in the exterior column of a three story building caused by wind panel load? The total base width of the bent is 54 feet. The height (H) of each story and the wind load (W) for each are shown in the table.

Floor, n	H_n	w_n
1	19	153900
2	17	137700
3	17	137700

$$D = \frac{1}{a}[W_1H_1/2 + W_2(H_1/2 + H_2) + W_3(H_1/2 + H_2 + H_3)]$$

$$= \frac{1}{54}[153900 \times 19/2 + 137700(19/2 + 17) + 137700(19/2 + 17 + 17)]$$

$$= 205{,}575 \text{ lb}$$

Enter	Press	Display
19	[÷]	19.
2	[×]	9.5
153900	[=] [STO]	1462050.
19	[÷]	19.
2	[+]	9.5
17	[×]	26.5
137700	[=] [Σ]	3649050.
19	[÷]	19.
2	[+]	9.5
17	[+]	26.5
17	[×]	43.5
137700	[=] [Σ] [RCL] [÷]	11101050.
54	[=]	205575.

Civil Engineering

Soil Mechanics – Determine the vertical stress in a soil at a point 2½ feet deep and located 3½ feet horizontally from a concentrated surface load of 13,500 lb.

$$\sigma_z = \frac{3\,P}{2\,\pi\,Z^2}\left[1 + \left(\frac{r}{Z}\right)^2\right]^{5/2}$$

$$= \frac{3 \times 13500}{2\,\pi \times (2.5)^2}\left[1 + \left(\frac{3.5}{2.5}\right)^2\right]^{5/2}$$

$$= 15546.206 \text{ lb}$$

Enter	Press	Display
5	[÷]	5.
2	[=] [STO]	2.5
3.5	[÷]	3.5
2.5	[x^2] [+]	1.96
1	[y^x] [RCL] [×]	15.074027
3	[×]	45.22208
13500	[÷]	610498.07
2	[÷]	305249.04
	[π] [=] [STO]	97163.785
2.5	[x^2] [1/x] [×]	0.16
	[RCL] [=]	15546.206

Time of Concentration – The total runoff of rainfall from an area to an inlet will be maximum at the time that the water from the most remote area contributes to the flow. Determine this time if the distance from the most remote area is 1350 feet, the slope is 0.15 foot per foot, and the rain intensity is 1.7 inches per hour. Use a coefficient of 2.5 for turf.

$$t = C\left(\frac{L}{Si^2}\right)^{1/3}$$

$$= 2.5\left[\frac{1350}{.15 \times (1.7)^2}\right]^{1/3}$$

$$= 36.508016 \text{ minutes}$$

Enter	Press	Display
3	[1/x] [STO]	3.3333333-01
1.7	[x²] [×]	2.89
.15	[1/x] [×]	2.3068051
1350	[yˣ]	8.0437234
	[RCL] [×]	14.603206
2.5	[=]	36.508015

Structural Analysis – Determine the compressive stress in the extreme fibre of concrete in a rectangular concrete beam with only tensile reinforcing subjected to a bending moment of 28,500 lb-in. The width of the beam is 2.5 feet and the effective depth is 8.5 inches. Use the approximate design values of 7/8 and 1/3 for j and k respectively.

$$f_c = \frac{2M}{j\,k\,b\,d^2}$$

$$= \frac{2 \times 28500}{\frac{7}{8} \times \frac{1}{3} \times 2.5 \times (8.5)^2}$$

$$= 1081.9575 \text{ psi}$$

Enter	Press	Display
8.5	[x²] [×]	72.25
2.5	[×]	180.625
7	[÷]	1264.375
8	[÷]	158.04688
3	[1/x] [×]	1.898171-02
2	[×]	3.796342-02
28500	[=]	1081.9575

Electrical Engineering

Parallel Resistors—Three resistors of 560 ohms, 390 ohms, and 670 ohms are in parallel. What is the equivalent resistance?

$$R_{eq} = \frac{1}{1/R_1 + 1/R_2 + 1/R_3}$$

$$= \frac{1}{1/560 + 1/390 + 1/670}$$

$$= 171.16388 \text{ ohms}$$

Enter	Press	Display
560	[1/x] [STO]	1.7857142–03
390	[1/x] [Σ]	2.5641025–03
670	[1/x] [Σ] [RCL] [1/x]	171.16388

RC Network—A step voltage of 18 V is applied across a series RC network with R = 3300 ohms and C = 47 μF. What is the voltage across the capacitor at the end of 250 milliseconds?

$$Vc = Vi\left(1 - e^{-\left(\frac{t}{RC}\right)}\right)$$

$$= 18\left(1 - e^{\frac{-250 \times 10^{-3}}{3300 \times 47 \times 10^{-6}}}\right)$$

$$= 14.408721\text{V}$$

Enter	Press	Display
250	[+/–] [EE]	–250 00
3	[+/–] [÷]	–0.25
3300	[÷]	–7.5757576–05
47	[EE] [+/–]	47–00
6	[eˣ] [+/–] [+]	–1.9951551–01
1	[×]	8.0048449–01
18	[=]	14.408721

Transmission Line—A balanced three-phase transmission line has axial line spacings of $d_{12}=56$ inches, $d_{23}=96$ inches, and $d_{13}=56$ inches, with each line having a radius of r—0.3 inch. What is the self-inductance (L) per mile length of one of the lines?

$$L = 0.08047 + 0.7411 \log \frac{\sqrt[3]{d_{12}d_{23}d_{13}}}{r}$$

$$= 0.08047 + 0.7411 \log \frac{\sqrt[3]{56 \times 96 \times 56}}{0.3}$$

$$= 1.8213839 \text{ millihenrys/mi.}$$

Enter	Press	Display
3	[1/x] [STO]	3.3333333–01
56	[x²] [×]	3136.
96	[yˣ]	12.615052
	[RCL] [÷]	67.021747
.3	[log] [×]	2.3490945
.7411	[+]	1.7409139
.08047	[=]	1.8213839

Mechanical Engineering

Shaft Design—What is maximum stress in a 1.3 inch diameter circular shaft caused by a 875 in-lb. bending moment and a 1500 in-lb. torque?

$$SMAX = (16/\pi d^3)\,(Mb + \sqrt{Mb^2 + Mt^2})$$

$$= [16/(\pi \times (1.3)^3)]\,(875 + \sqrt{(875)^2 + (1500)^2})$$

$$= 6053.9567 \text{ psi}$$

Enter	Press	Display
875	[x²] [STO]	765625.
1500	[x²] [Σ] [RCL] [√x] [+]	1736.5555
875	[×]	2611.5555
16	[÷]	41784.888
	[π] [=] [STO]	13300.543
1.3	[yˣ]	2.6236427−01
3	[1/x] [×]	4.5516613−01
	[RCL] [=]	6053.9567

Moment of Inertia—Determine the moment of inertia of a hollow circular cylinder about its axis. The outer and inner radii are 1.25 ft and 0.80 ft, the length is 3.5 ft, and the material has a mass of 435 lb per cu ft.

$$I = \pi m a(r_1^4 - r_2^4)/2$$
$$= \pi \times 435 \times 3.5\,[(1.25)^4 - (0.8)^4]/2$$
$$= 4859.1407\ \text{lb/ft}^2$$

Enter	Press	Display
1.25	[yˣ]	2.2314355−01
4	[=] [STO]	2.4414062
.8	[yˣ]	−2.2314355−01
4	[=] [+/−] [Σ]	−0.4096
	[RCL] [÷]	2.0318062
2	[×]	1.0159031
3.5	[×]	3.5556609
435	[×]	1546.7125
	[π] [=]	4859.1406

Compressor Performance—What is the apparent capacity Ca of a compressor with a diameter of 2.25 in, a stroke length of 5.5 in, and a clearance of 7%? Assume a pressure ratio Rp of 9.5:1 and a specific heat ratio k of 1.8:1.

$Ca = (\pi d^2/4)\ (L)\ (1 + C - CR_p^{1/n})$
$= [\pi \times (2.25)^2/4]\ (5.5)\ [1 + .07 - .07 \times (9.5)^{1/1.8}]$
$= 18.052402$ cu in/cycle

Enter	Press	Display
1.8	[1/x] [STO]	5.5555556-01
9.5	[y^x] [RCL] [×]	3.4928488
.07	[+/−] [+]	−2.4449942-01
.07	[+]	−1.7449942-01
1	[×]	8.2550059-01
5.5	[=] [STO]	4.5402532
2.25	[x²] [×]	5.0625
	[π] [÷]	15.904313
4	[×] [RCL] [=]	18.052402

Compressor Efficiency – What is the efficiency of compression (ϵ_c) of a three-stage air compressor with a discharge pressure of 200 psia?

$$\epsilon_c = \frac{\ln \frac{P_2}{P_a}}{\frac{3n}{n-1}\left[\left(\frac{P_2}{P_a}\right)^{\frac{n-1}{3n}} - 1\right]}$$

With the value of n for this compressor specified, $n = 1.27$, and the atmospheric pressure (P_a) is 14.7 psia, then:

$$\epsilon_c = \frac{\ln \frac{200}{14.7}}{\frac{3 \times 1.27}{1.27 - 1}\left[\left(\frac{200}{14.7}\right)^{\frac{1.27-1}{3 \times 1.27}} - 1\right]} = 0.91035331$$

Enter	Press	Display
1.27	[−]	1.27
1	[÷]	0.27
3	[÷]	0.09
1.27	[=] [STO]	7.0866142−02
200	[÷]	200.
14.7	[y^x]	2.6104699
	[RCL] [−]	1.2032111
1	[×]	2.0321113−01
3	[×]	0.6096334
1.27	[=] [STO]	7.7423442−01
1.27	[−]	1.27
1	[1/x] [×]	3.7037037
	[RCL] [=] [STO]	2.8675349
200	[÷]	200.
14.7	[lnx] [÷]	2.6104699
	[RCL] [=]	9.1035331−01

Chemical Engineering

pH Solution – What is the pH of a solution if the hydronium ion concentration is 3.5×10^{-4} mole/liter?

$$pH = \log \frac{1}{(H+)}$$

$$= \log \frac{1}{3.5 \times 10^{-4}}$$

$$= 3.4559320 \text{ per liter}$$

Enter	Press	Display
3.5	[EE]	3.5 00
4	[+/−] [1/x]	2857.1429
	[log]	3.455932

Equilibrium Constant – An equilibrium mixture of H_2, I_2, and HI gases at 425°C consists of 4.1082×10^{-3} mole/liter of H_2, 6.62×10^{-4} mole/liter of I_2, and 12.189×10^{-3} mole/liter of HI. What is the equilibrium constant (K) for the system?

$$K = \frac{(HI)^2}{H_2 \times I_2}$$

$$= \frac{(12.189 \times 10^{-3})^2}{(4.1082 \times 10^{-3}) \times (6.64 \times 10^{-4})}$$

$$= 54.464873$$

Enter	Press	Display
12.189	[EE]	12.189 00
3	[+/-] [x²] [÷]	1.4857172–04
4.1082	[EE]	4.1082 00
3	[+/-] [÷]	3.6164676–02
6.64	[EE]	6.64 00
4	[+/-] [=]	54.464873

Fluid Displacement – An air-lift water pump has a running submergence (H_s) of 12 feet and a total head (H_t) of 32 feet. What is the free-air volume (V_a) required by the pump when the value of constant C is 245?

$$V_a = \frac{0.8\ H_t}{C \log\left[(H_s + 34)/34\right]}$$

$$= \frac{0.8 \times 32}{245 \log\left[(12 + 34)/34\right]}$$

$$= 0.79593738\ \text{ft}^3/\text{gal}$$

Enter	Press	Display
12	[+]	12.
34	[÷]	46.
34	[log] [×]	1.3127891–01
245	[1/x] [×]	3.1091305–02
32	[×]	9.9492176–01
.8	[=]	7.9593741–01

APPENDIX A
CONVERSIONS FACTORS

English to Metric

To Find	Multiply	By
microns	mils	**25.4**
centimeters	inches	**2.54**
meters	feet	**0.3048**
meters	yards	**0.9144**
kilometers	miles	**1.609344**
grams	ounces	28.349523
kilograms	pounds	**0.45359237**
liters	gallons	3.7854118
milliliters (cc)	fl. ounces	29.573530
sq. centimeters	sq. inches	**6.4516**
sq. meters	sq. feet	**0.0929304**
sq. meters	sq. yards	**0.83612736**
milliliters (cc)	cu. inches	**16.387064**
cu. meters	cu. feet	2.8316847×10^{-2}
cu. meters	cu. yards	0.76455486

Temperature Conversions

$$°F = \frac{9}{5}(°C) + 32$$

$$°C = \frac{5}{9}(°F - 32)$$

Boldface numbers are exact; others are rounded.

General

To Find	Multiply	By
atmospheres	feet of water @ 4°C	2.950×10^{-2}
atmospheres	inches of mercury @ 0°C	3.342×10^{-2}
atmospheres	pounds per sq. inch	6.804×10^{-2}
BTU	foot-pounds	1.285×10^{-3}
BTU	joules	9.480×10^{-4}
cu. ft.	cords	**128**
degree (angle)	radians	57.2958
ergs	foot-pounds	1.356×10^{7}
feet	miles	**5280**
feet of water @ 4°C	atmosphere	33.90
foot-pounds	horsepower-hours	1.98×10^{6}
foot-pounds	kilowatt-hours	2.656×10^{6}
foot-pounds per min.	horsepower	3.3×10^{4}
horsepower	foot-pounds per sec.	1.818×10^{-3}
inches of mercury @ 0°C	pounds per sq. inch	2.036
joules	BTU	1054.8
joules	foot-pounds	1.35582
kilowatts	BTU per min.	1.758×10^{-2}
kilowatts	foot-pounds per min.	2.26×10^{-5}
kilowatts	horsepower	.745712
knots	miles per hour	0.86897624
miles	feet	1.894×10^{-4}
nautical miles	miles	0.86897624
radians	degrees	1.745×10^{-2}
sq. feet	acres	**43560**
watts	BTU per min.	17.5796

Boldface numbers are exact; others are rounded.

APPENDIX B
VALUES OF FUNDAMENTAL PHYSICAL CONSTANTS

Constant	Symbol	Value	Units mks	Units cgs
1. Speed of Light	c	2.9979250	10^{8}msec^{-1}	10^{10}cmsec^{-1}
2. Electron Charge	e	1.6021917	10^{-19}C	10^{-20}emu
3. Avogadro Number	N	6.022169	10^{26}kmole^{-1}	10^{23}mole^{-1}
4. Electron Rest Mass	m_e	9.109558	10^{-31}kg	10^{-28}g
	m_e	5.485930	10^{-4}amu	10^{-4}amu
5. Proton Rest Mass	M_p	1.672614	10^{-27}kg	10^{-24}g
	M_p	1.00727661	amu	amu
6. Neutron Rest Mass	M_n	1.674920	10^{-27}kg	10^{-24}g
	M_n	1.00866520	amu	amu
7. Atomic Mass Unit	amu	1.660531	10^{-27}kg	10^{-24}g
8. Ratio of proton to electron rest mass	M_p/m_e	1836.109	—	—
9. Electron Charge to Mass ratio	e/M_e	1.7588028	10^{11}Ckg^{-1}	10^{7}emu g^{-1}
10. Planck Constant	h	6.626196	10^{-34}J-sec	10^{-27}erg-sec
11. Rydberg Constant	R_∞	1.09737312	10^{7}m^{-1}	10^{5}cm^{-1}
12. Gas Constant	R_0	8.31434	10^{3}J-kmole^{-1}K^{-1}	10^{7}erg-mole^{-1}-K^{-1}
13. Boltzmann Constant	k	1.380622	10^{-23}JK^{-1}	10^{-16}erg K^{-1}
14. Gravitational Constant	G	6.6732	10^{-11}N-M^{2}kg^{-2}	10^{-8}dyn-cm^{2}g^{-2}
15. Electron Volt	eV	1.6021917	10^{-19}J	10^{-12}erg
16. Magnetic Flux Quantum	Φ_0	2.0678538	10^{-15}T-m^{2}	10^{-7}G-cm^{2}
17. Bohr Magneton	μ_B	9.274096	10^{-24}JT^{-1}	10^{-21}erg G^{-1}
18. Electron Magnetic Moment	μ_e	9.284851	10^{-24}JT^{-1}	10^{-21}ergG^{-1}
19. Proton Magnetic Moment	μ_p	1.4106203	10^{-26}JT^{-1}	10^{-23}ergG^{-1}
20. Compton Wavelength of the Electron	λ_C	2.4263096	10^{-12}m	10^{-10}cm
21. Compton Wavelength of the Proton	$\lambda_{C,P}$	1.3214409	10^{-15}m	10^{-13}cm
22. Compton Wavelength of the Neutron	$\lambda_{C,n}$	1.3196217	10^{-15}m	10^{-13}cm
23. Faraday Constant	F	9.648670	10^{7}Ckmole^{-1}	10^{3}emu mole^{-1}

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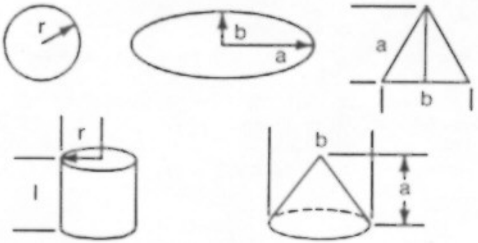
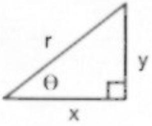
APPENDIX C
GEOMETRIC FORMULAS



Circumference:	Circle $2\pi r$	
Area:	Circle	πr^2
	Ellipse	πab
	Sphere	$4\pi r^2$
	Cylinder	$2\pi r[r+l]$
	Triangle	$\frac{1}{2}ab$
Volume:	Ellipsoid of revolution	$4/3\pi b^2 a$
	Sphere	$4/3\pi r^3$
	Cylinder	$\pi r^2 l$
	Cone	$\frac{\pi b^2 a}{12}$
Analytical:	Circle	$\frac{x^2}{r^2}+\frac{y^2}{r^2}=1$
	Ellipse	$\frac{x^2}{a^2}+\frac{y^2}{b^2}=1$
	Hyperbola	$\frac{x^2}{a^2}-\frac{y^2}{b^2}=1$
	Parabola	$y^2=\pm 2px$
	Line	$y=mx+b$

APPENDIX D
MATHEMATICAL EXPRESSIONS

Trigonometric Relations



$\sin \Theta = \frac{y}{r}$

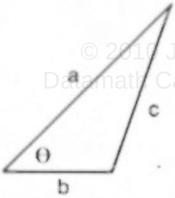
$\cos \Theta = \frac{x}{r}$

$\tan \Theta = \frac{y}{x}$

$\sin^2 \Theta + \cos^2 \Theta = 1$

$e^{i\Theta} = \cos \Theta + i \sin \Theta \qquad i = \sqrt{-1}$

Law of Cosines



$a^2 + b^2 - 2ab \cos \Theta = c^2$

Laws of Exponents

$a^x \times a^y = a^{x+y}$	$\frac{1}{a^x}\ a^{-x}$
$(ab)^x = a^x \times b^x$	$\frac{a^x}{a^y} = a^{x-y}$
$(a^x)^y = a^{xy}$	$a^0 = 1$

Laws of Logarithms

$\ln(y^x) = x \ln y$

$\ln(ab) = \ln a + \ln b$

$\ln\left(\frac{a}{b}\right) = \ln a - \ln b$

APPENDIX E
FINANCIAL EQUATIONS

Compounded Amounts

$$FV = PV\,(1+i)^n$$

$$PV = FV\,(1+i)^{-n} \qquad n = \frac{\ln\left[\frac{FV}{PV}\right]}{\ln(1+i)} \qquad i = \left[\frac{FV}{PV}\right]^{1/n} - 1$$

where

FV = Future Value
PV = Present Value
n = number of periods
i = interest per period n expressed as a decimal

Annuities

$$FV = PMT\left[\frac{((1+i)^n - 1)}{i}\right]$$

$$PMT = FV\left[\frac{i}{((1+i)^n - 1)}\right]$$

$$n = \frac{\ln\left[1 + FV\left[\frac{i}{PMT}\right]\right]}{\ln(1+i)}$$

$$PV = PMT\left[\frac{(1-(1+i)^{-n})}{i}\right]$$

$$n = \frac{-\ln\left[1 - PV\left[\frac{i}{PMT}\right]\right]}{\ln(1+i)}$$

$$PMT = PV\left[\frac{i}{1-(1+i)^{-n}}\right]$$

where

FV = Future Value
PV = Present Value
n = number of periods
i = interest per period n expressed as a decimal
PMT = Payment per period n

APPENDIX F
STATISTICAL FUNCTIONS

Mean, Variance and Standard Deviation

$$\text{Mean} = \overline{X} = \frac{\sum_{i=1}^{N} x_i}{N} \qquad \text{Variance} = \frac{\sum_{i=1}^{N} (x_i - \overline{X})^2}{N}$$

$$\text{S. Dev.} = \sqrt{\frac{\sum_{i=1}^{N} (x_i - \overline{X})^2}{N - 1}}$$

Linear Regression

$$y = mx + b$$

$$m = \frac{\frac{\sum_{i=1}^{N} x_i y_i}{N} - \overline{x}\overline{y}}{\sigma_x^2}$$

$$b = \overline{y} - m\overline{x}$$

$$\overline{x} = \text{average x value} = \frac{\sum_{i=1}^{N} x_i}{N}$$

$$\overline{y} = \text{average y value} = \frac{\sum_{i=1}^{N} y_i}{N}$$

σ_x^2 = Variance of the x values

$$\sigma_x^2 = \frac{\sum_{i=1}^{N} x_i^2}{N} - \overline{x}^2$$

APPENDIX G
SERVICE INFORMATION

In Case of Difficulty

1. If using the adapter (AC9180), check for power at AC outlet and proper insertion of plug into calculator.

   CAUTION: Use of other than the AC9180 adapter may apply improper voltage to your Concept III calculator and will cause damage.

2. Check to be sure ON/OFF switch is in the ON position. Presence of digits in the display indicates power is on.
3. If display fails to light on battery operation, check for improperly inserted or discharged batteries. See *Battery Replacement* instructions in Section I.
4. Review operating instructions to be certain calculations are performed correctly.

If none of the above procedures corrects the difficulty, return the **calculator (and adapter)** PREPAID and INSURED to the applicable SERVICE FACILITY listed on the back cover.

NOTE: The P.O. box number listed for the Texas Service Facility is for United States parcel post shipments only. If you desire to use another carrier, please call the Consumer Relations Department for the proper shipping address.

For your protection, the calculator must be sent insured; Texas Instruments cannot assume any responsibility for loss of or damage to uninsured shipments. **A copy of the sales receipt or other proof-of-purchase date MUST be enclosed with the calculator to establish the warranty status of the unit (please do not send the original document).** If proof-of-purchase date is not enclosed, service rates in effect at time of return will be charged. Please include information on the difficulty experienced with the calculator, as well as return address information including name, address, city, state, and zip code. The shipment should be carefully packaged and adequately protected against shock and rough handling.

If You Have Questions or Need Assistance

If you have questions or need assistance with your calculator, write:

Consumer Relations Department
P.O. Box 22283
Dallas, Texas 75222

or call 800-527-4980 (toll-free within all contiguous states except Texas) or 800-492-4298 (toll-free within Texas). If outside the contiguous United States, call 214-238-5461. (We regret we cannot accept collect calls at this number.)

IMPORTANT: In addition to retaining your sales receipt or other proof-of-purchase date documentation, please record the following information. Any correspondence concerning the calculator must mention the model, serial number, and date-of-purchase.

Concept III		
Model No.	Serial No.	Purchase Date

Texas Instruments reserves the right to make changes in materials & specifications without notice.

NINETY-DAY LIMITED WARRANTY

This electronic calculator from Texas Instruments is warranted to the original purchaser for a period of ninety (90) days from the original purchase date – under normal use and service – against defective materials or workmanship. **ANY IMPLIED WARRANTIES ARE ALSO LIMITED IN DURATION TO THE NINETY-DAY PERIOD FROM THE ORIGINAL PURCHASE DATE.**

This warranty is void if: (1) the calculator has been damaged by accident or unreasonable use, neglect, improper service or other causes not arising out of defects in material or workmanship, (2) the serial number has been altered or defaced.

TEXAS INSTRUMENTS SHALL NOT BE LIABLE FOR LOSS OF USE OF THE CALCULATOR OR OTHER INCIDENTAL OR CONSEQUENTIAL COSTS, EXPENSES OR DAMAGES INCURRED BY THE PURCHASER.

During the warranty period your calculator will either be repaired or it will be replaced with a reconditioned model of equivalent quality (at manufacturer's option) without charge to the purchaser, when returned prepaid and insured, with proof of purchase date, to a Texas Instruments service facility listed below. In the event of replacement with a reconditioned model, the replacement unit will continue the warranty of the original calculator or 90 days, whichever is longer.

UNITS RETURNED WITHOUT PROOF OF PURCHASE DATE WILL BE REPAIRED AT THE SERVICE RATES IN EFFECT AT THE TIME OF RETURN.

IMPORTANT: Before returning your calculator for repair, carefully review service and mailing instructions in this manual.

Texas Instruments Consumer Service Facilities

Texas Instruments Service Facility
P. O. Box 2500
Lubbock, Texas 79408

Texas Instruments Service Facility
41 Shelley Road
Richmond Hill, Ontario, Canada

Consumers in California and Oregon may contact the following Texas Instruments offices for additional assistance or information:

Texas Instruments Consumer Service
78 Town and Country
Orange, California 92668
(714) 547-2556

Texas Instruments Consumer Service
10700 Southwest Beaverton Highway
Park Plaza West, Suite 111
Beaverton, Oregon 97005
(503) 643-6758

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1014285-1