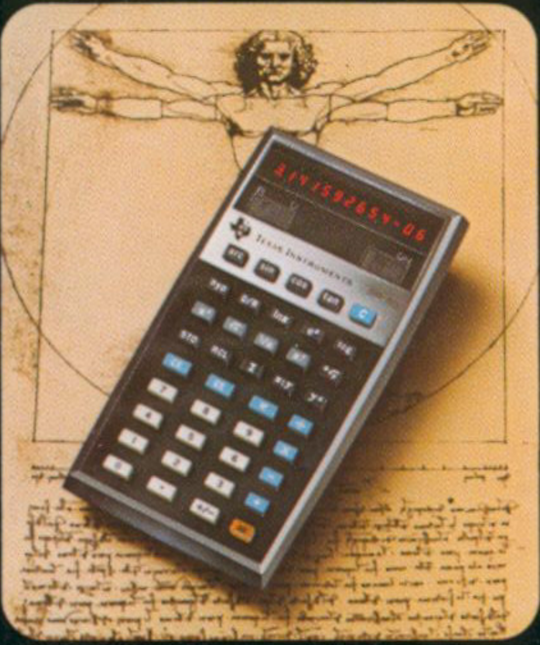
Texas Instruments
slide rule calculator
SR-50



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SECTION 1
DESCRIPTION

Your SR-50 Slide Rule Calculator is designed for use by scientists, engineers, and students who require accuracy and reliability in a portable scientific calculator. The SR-50 is a powerful computational tool capable of processing a wide range of problems from simple arithmetic to complex scientific calculations. Your SR-50 has been designed with state-of-the-art MOS solid state circuitry, constructed with high quality components throughout, and assembled with precise workmanship.

Features

Algebraic Entry – The SR-50 uses the algebraic entry method to simplify data entry into the calculator. For simple problems, the numbers and algebraic functions are entered into the calculator in the same sequence as they are stated algebraically. For example, the problem of adding 15 to 25 and then subtracting 30 is normally stated as:

$$25 + 15 - 30 = 10$$

and is entered into the SR-50 as:

25 [+] 15 [−] 30 [=] 10

Toll-Free Telephone Assistance

For assistance with your SR-50 calculator, call one of the following toll-free numbers if necessary:

800-527-4980 (within all continental states except Texas)
800-492-4298 (within Texas)

See inside back and back cover for further information on service.

Cover photo background courtesy of The Bettmann Archive, Inc.

Sum of Products – The SR-50 provides sum-of-product capability without use of special keys. For example, the expression:

$$(2 \times 3) + (4 \times 5) + (6 \times 7) = 68$$

is entered into the SR-50 as:

2 [×] 3 [+] 4 [×] 5 [+] 6 [×] 7 [=] 68

Similar calculations, such as sum (or difference) of quotients, powers, roots, factorials, etc., are entered in the same straightforward manner.

Accuracy – Calculates answers to 13 significant digits and displays answers rounded off to 10 significant digits. The displayed number is accurate to within ±1 in the tenth displayed digit. For maximum accuracy, the SR-50 uses all 13 significant digits for subsequent calculations.

Versatility – Performs simple arithmetic, reciprocals, factorials, exponentiation, roots, trigonometric, hyperbolic, and logarithmic functions, all in full floating decimal point or in scientific notation.

Scientific Notation – Computes and displays numbers as large as $\pm 9.999999999 \times 10^{99}$ and as small as $\pm 1.000000000 \times 10^{-99}$. Automatically converts answers to scientific notation when the calculated answer is greater than 10^{10} or less than 10^{-10}.

Automatic Clearing – The SR-50 calculator automatically clears itself. When the [=] key is pressed to complete the evaluation of an expression, the calculation is completed, the answer is displayed, and the calculator is cleared for the start of a new problem. It is not necessary to press the clear key between problems.

Calculation Time – Most calculations except large factorials are performed in less than a tenth of a second.

Memories — Three data registers for data calculation and one memory register for data storage.

Fully Portable — Extremely lightweight. Battery or AC operated.

Long Life — Solid state components, integrated circuits, and light emitting diode displays provide dependable operation and long life.

Battery Pack — The SR-50 comes complete with a *fast-charge* rechargeable battery pack, model BP-1. Under normal use, the battery pack will provide 4 to 6 hours of operation without recharging. About 3 hours of recharging will restore full charge. Spare and replacement battery packs can be purchased directly from a Texas Instruments Consumer Services Facility as listed on the back cover.

AC Adapter/Charger — Battery pack recharge or direct operation from standard voltage outlets is easily accomplished with the AC Adapter/Charger model AC9200 included with the SR-50 (also used with the SR-10 and SR-11). The SR-50 cannot be overcharged; it can be operated indefinitely with the adapter/charger connected.

Display Description

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

Minus Sign – Appears to the left of the 10-digit mantissa to indicate negative numbers, and appears to the left of the exponent (right of mantissa) to indicate negative exponents.

Decimal Point – Automatically assumed to be to the right of any number entered unless placed in another position with the [•] key. When entering numbers, the decimal will not appear until [•] is pressed.

Overflow and Error Indication – The display will flash for the following reasons:

1. Entry or calculation result outside the range of the calculator, $\pm 1. \times 10^{-99}$ to $\pm 9.999999999 \times 10^{99}$.

2. Factorial of any value except a positive integer.

3. Inverse of a trig function with a nonvalid value for the argument, such as arcsin n with n greater than 1.

4. Square root or logarithm of a negative number.

5. The SR-50 uses the logarithm equation $\log y^x = x \log y$ in processing the [y^x] and [$\sqrt[x]{y}$] functions. Since the log of a negative number is invalid, the SR-50 considers as invalid raising a negative number to any power or taking the root of a negative number.

Indication Removal – The flashing display caused by overflow or error will continue during subsequent calculation until the [C] key is pressed.

Battery Operation

The *fast-charge* nickel-cadmium battery pack BP-1 furnished with the SR-50 calculator was fully charged at the factory before shipping. However, due to shelf life discharging, it may require charging before initial operation.

With the battery pack properly installed in the bottom of the SR-50, charging is accomplished by plugging the AC Adapter/Charger AC9200 into a convenient outlet and plugging the attached cord into the SR-50 socket. The SR-50 can be used while it is being charged. A full charge requires about 3 hours with the power switch off and about 6 hours with the switch on for normal operation.

Do not attempt to operate the SR-50 with the charger plugged in *unless* the battery pack is in place or the calculator operation will be erratic.

Note: When batteries become discharged, calculator operation may become erratic with random flashing of display digits shortly before display fades away. Attach SR-50 to charger and allow batteries to recharge for a moment before resuming use.

If the SR-50 is left on for an extended period of time after the batteries become discharged, one of the batteries may be driven into reverse charge. This condition is indicated by failure of the calculator to operate after being recharged for a few minutes. The battery can usually be restored to operating condition by charging the calculator overnight. Repeated reverse charging will permanently damage batteries.

SECTION 2
DATA ENTRY

On/Off Switch – Located on the top right front surface of the calculator. Sliding it to the right applies power, and sliding it to the left removes power from the calculator. The power-on condition is indicated by a number in the display.

Note: After turning the calculator on and before performing the first calculation, press the [C] key.

[0] through [9] **Digit Keys** – Enter numbers 0 through 9 to a limit of a 10-digit mantissa and a 2-digit exponent.

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

[π] **Pi Key** – Enters the value of pi (π) to 13 significant digits (3.141592653590); display indicates value rounded off to 10 significant digits (3.141592654).

[EE] **Enter Exponent Key** – Instructs the calculator that the subsequent number is to be entered as an exponent of 10. After the [EE] key has been pressed, the calculator will display all further results in scientific notation until the [C] key is pressed.

[+/–] **Change Sign Key** – Changes the sign of the number appearing in the display.

[CE] **Clear Entry Key** – Clears the last keyboard entry.

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

Negative Number Entry

A negative sign is assigned to a number by pressing the [+/-] key directly after entering the number. For example, to enter −125:

Enter	Press	Display
125	[+/-]	−125

Scientific Notation

Any number can be entered into the SR-50 in scientific notation — that is, as a number (mantissa) multiplied by 10 raised to some power (exponent). For example 1000 can be written as $1. \times 10^3$.

Enter	Press	Display
1	[EE]	1 00
3		1 03

Note: The last two digits on the right side of the display are used to indicate exponents.

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

In both these examples, 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*. For example $1.2 \times 10^{-11} = 0.000000000012$.

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

To change the mantissa or its sign after the [EE] key has been pressed, simply press the [•] key and make the appropriate entry on the keyboard. To change the exponent or its sign, simply press the [EE] key again and make the appropriate entry.

Enter	Press	Display	Remarks
1.327	[EE]	1.327 00	
21		1.327 21	
	[•]	1.327 21	To change mantissa
65	[+/−]	−1.32765 21	
	[EE]	−1.32765 21	To change exponent
22	[+/−]	−1.32765 −22	

Data in scientific notation form may be entered intermixed with data in normal form. The calculator will convert the entered data for proper calculation. For example:
$12575 + 3.2 \times 10^3 + 2855 = 1.863 \times 10^4$.

Enter	Press	Display
12575	[+]	12575.
3.2	[EE]	3.2 00
3	[+]	3.2 03
2855	[=]	1.863 04

Error Correction

Incorrect number key entries are corrected by pressing the [CE] key before pressing the next function key in the calculation.

Example: 3 X ~~4~~ 5 = 15

Enter	Press	Display	Remarks
3	[X]	3.	
4		4.	Error
	[CE]	0.	Correction
5	[=]	15.	

Pi is entered as a calculated value and is not cleared by this key. If the [π] key is inadvertently pressed, it can be nullified by simply entering the correct number. For example, in entering 2.395, the [π] key might be pressed accidentally instead of the [9] key.

Enter	Press	Display	Remarks
2.3		2.3	
[π]		3.141592654	Error
2.395		2.395	Correction

ARITHMETIC OPERATIONS

[+] **Add Key** – Adds to the previous entry or result the next entered quantity.

[-] **Subtract Key** – Subtracts from the previous entry or result the next entered quantity.

[×] **Multiply Key** – Multiplies the previous entry or result by the next entered quantity.

[÷] **Divide Key** – Divides the previous entry or result by the next entered quantity.

[=] **Equals Key** – Completes the calculation of all the previously entered data and algebraic functions. This key is used to obtain both intermediate results and final results.

Performing arithmetic calculations with your SR-50 calculator is simple and direct. Numbers and functions are entered in the same sequence as the expression is written. The following examples illustrate the operation of the calculator.

Addition and Subtraction

Example: 12.32 – 7 + 1.6 = 6.92

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

Multiplication and Division

Example: $(4 \times 7.3) \div 2 = 14.6$

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

Error Correction

The SR-50 has been designed to facilitate correction of the most common function key errors. If a [+] key is inadvertently pressed instead of a [−] key (or vice versa), the error is corrected by simply pressing the correct function key.

Example: 5 ~~+~~ − 2 = 3

Enter	Press	Display	Remarks
5	[+]	5.	Error
	[−]	5.	Correction
2	[=]	3.	

The calculator automatically inserted a zero to complete the erroneous function key entry. Thus, the above key sequence is calculated as 5 + 0 − 2 = 3. The sequence 5 [−] [+] 2 [=] is calculated as 5 − 0 + 2 = 7.

If a [X] or [÷] key is pressed instead of any other arithmetic operator key, the error is corrected simply by pressing the correct key.

Example: 5 ÷̸ + 2 = 7

Enter	Press	Display	Remarks
5	[÷]	5.	Error
	[+]	5.	Correction
2	[=]	7.	

In this case, the calculator completes the erroneous function by inserting a one before entering the [+] function. Thus, this key sequence is calculated as (5 ÷ 1) + 2 = 7. The key sequence 5 [X] [+] 2 [=] is calculated as (5 X 1) + 2 = 7.

Note: An accidental double entry of any arithmetic operation key is automatically corrected because the SR-50 inserts a zero between two [+] or [-] operations and a one between two [X] or [÷] operations.

If a [+] or [-] key is inadvertently pressed instead of a [X] or [÷] key, you can correct the error by pressing the [=] key and then the correct function key.

Example: 5 +̸ X 2 = 10

Enter	Press	Display	Remarks
5	[+]	5.	Error
	[=] [X]	5.	Correction
2	[=]	10.	

Again the calculator automatically inserts a zero after the [+] key but the [=] has to be pressed to complete the erroneous [+] function because of the sum of products capability. Thus, the above sequence is calculated as (5 + 0) X 2 = 10. If the [=] key had been omitted, the calculator would have calculated the data as 5 + (0 X 2) = 5.

Pressing the [=] key immediately after any arithmetic operation key effectively replaces the arithmetic operation by an [=] function. Thus, 5 [+] 2 [+] [=] is calculated as 5 + 2 + 0 = 7 and 5 [X] 2 [X] [=] is calculated as 5 X 2 X 1 = 10. Thus, the [=] key can be used to complete any arithmetic operation key that was erroneously pressed.

SPECIAL FUNCTIONS

The special function keys operate only on the quantity displayed, either a number entry or a calculated result. They do not complete any previously entered function.

[x^2] **Square Key** — Finds the square of the number displayed (that is, multiplies the number displayed by itself).

[$\sqrt{x}$] **Square Root Key** — Finds the square root of the number displayed (that is, finds the number which multiplied by itself, equals the number displayed).

[1/x] **Reciprocal Key** — Finds the reciprocal of the number displayed (that is, divides the number displayed into 1).

[x!] **Factorial Key** — Finds the factorial of the number displayed (that is, the product of all integer numbers from one through the integer value displayed). The largest factorial the SR-50 can compute without an overflow condition is 69!

Squares

Example: $(4.2)^2 = 17.64$

Enter	Press	Display
4.2	[x^2]	17.64

Square Roots

Example: $\sqrt{6.25} = 2.5$

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

Example: $\sqrt{4} + \sqrt{9} = 5$

Enter	Press	Display
4	[$\sqrt{x}$] [+]	2.
9	[$\sqrt{x}$]	3.
	[=]	5

Reciprocals

Example: $\frac{1}{3.2} = 0.3125$

Enter	Press	Display
3.2	[1/x]	0.3125

Factorials

Example: $7! = 5040$

Enter	Press	Display
7	[x!]	5040.

Example: $\frac{60}{4!} = 2.5$

Enter	Press	Display
60	[÷]	60.
4	[x!]	24.
	[=]	2.5

When the factorial of a noninteger number is computed, only the whole number is considered and the display flashes indicating the fractional part was ignored. The [C] key must be pressed to remove the flashing condition of the display.

Example: 7.3! = 5040

Enter	Press	Display	Remarks
7.3	[x!]	5040.	Flashing display

The 13 internal digits of a calculated result are rounded off for the displayed 10 digits. This means that a displayed integer may actually have a rounded off fractional portion. Because of this, if the [x!] key is to be used on a calculated result, the [EE] key should be pressed immediately before the [x!] key. After the [EE] key is pressed only the 10 displayed digits will be processed by the factorial function, and not the full 13 internal digits.

Example: $(\sqrt{9})! = 6$

Enter	Press	Display
9	[√x]	3.
	[EE]	3 00
	[x!]	6. 00

TRIGONOMETRIC AND HYPERBOLIC CALCULATIONS

The [sin], [cos], [tan], and [arc] keys are used in determining both trigonometric and hyperbolic functions. These keys operate on the displayed data as soon as the key is pressed. They do not affect any other previously calculated result.

To obtain a trig function, the argument is entered (through the keyboard or as a prior calculated result) and then the function key is pressed. The angle for trig functions is selected as degrees or radians by the setting of the Deg/Rad switch.

Deg/Rad Switch – Located on the top left front surface of the calculator. The calculator interprets a displayed angle as being in degrees if the switch is to the right (D) and in radians if it is to the left (R).

[D/R] **Angle Change Key** – If the Deg/Rad switch is set for degrees, pressing the [D/R] key instructs the calculator to convert the displayed angle from radians to degrees. If the switch is set for radians, pressing this key instructs the calculator to convert the displayed angle from degrees to radians. (If the key is pressed a second time the calculator will assume that the displayed radian quantity is in degrees and will convert this quantity to radians. To switch back to degrees, set the Deg/Rad switch back to D and press the [D/R] key.)

[sin] **Sine Key** – Determines the sine of the displayed angle.

[cos] **Cosine Key** – Determines the cosine of the displayed angle.

[tan] **Tangent Key** – Determines the tangent of the displayed angle.

[hyp] **Hyperbolic Function Key** – Determines the hyperbolic function of the displayed quantity when pressed before the [sin], [cos], or [tan] key.

[arc] **Inverse Trigonometric and Hyperbolic Key** – Determines the angle of the selected trig function whose value is the displayed quantity, when pressed before the [sin], [cos] or [tan] key. When both the [arc] and [hyp] keys are pressed before the [sin], [cos] or [tan] keys, they instruct the calculator to determine the inverse hyperbolic function of the displayed quantity.

Trig Function Calculation

The SR-50 will calculate trig values for angles greater than 360 degrees (2π radians) or less than −360 degrees (-2π radians). As long as the trig function is displayed in normal form rather than in scientific notation, all 10 displayed digits are accurate for the range of −36000 to 36000 degrees (-200π to 200π radians). In general, the accuracy decreases one digit for each decade outside this range. If the magnitude of the angle is 1.001×10^{14} degrees or larger, the SR-50 interprets it as 0 degrees.

The value of pi entered by the [π] key or used in converting from degrees to radians is correct to 13 digits only. As a result, inaccuracies in the 3 nondisplayed digits can occur that result in trigonometric values closer to zero than 10^{-10}. Any answer less than 10^{-10} should be interpreted as zero.

Throughout the manual, the notation Angle:Deg means set the Deg/Rad switch to D and Angle:Rad means set the Deg/Rad switch to R.

Example: $\sin 30^\circ = 0.5$
Angle:Deg

Enter	Press	Display
30	[sin]	0.5

Example: $\cos \frac{\pi}{3} = 0.5$

Angle: Deg

Enter	Press	Display
[π]	[÷]	3.141592654
3	[=]	1.047197551
	[D/R]	60.
	[cos]	0.5

Example: 14.3 tan 1.385 = 76.0783255

Angle: Rad

Enter	Press	Display
14.3	[×]	14.3
1.385	[tan] [=]	76.0783255

Example: arcsin 0.5 = 30°

Angle: Deg

Enter	Press	Display
0.5	[arc] [sin]	30.

Example: $\frac{\pi}{4}$ + arctan 1 = 1.570796321

Angle: Rad

Enter	Press	Display
[π]	[÷]	3.141592654
4	[+]	.7853981634
1	[arc] [tan] [=]	1.570796327

Hyperbolic Function Calculations

Example: tanh 6.43 = 0.9999948

Enter	Press	Display
6.43	[hyp] [tan]	0.9999948

To calculate inverse hyperbolic functions, the relative order of pressing the [arc] and [hyp] does not matter, but both must be pressed before the [sin], [cos], or [tan] key.

Example: arcsinh .886 = 0.7984245338

Enter	Press	Display
.886	[arc] [hyp] [sin]	0.7984245338

Alternate method:

Enter	Press	Display
.886	[hyp] [arc] [sin]	0.7984245338

LOGARITHMIC CALCULATIONS

The logarithmic function keys provide for processing of logarithmic quantities to base e or base 10. The log keys process only the displayed number, either an entered quantity or a calculated result.

[log] **Common Logarithm Key** — Determines the logarithm to the base 10 of the displayed number.

[lnx] **Natural Logarithm Key** — Determines the logarithm to the base e of the displayed number.

[e^x] **e to the x Power** — Raises the value of e to the displayed power.

Example: ln 5.4 = 1.686398954

Enter	Press	Display
5.4	[lnx]	1.686398954

Example: 31.78 + 4 ln 19.3 = 43.62042038

Enter	Press	Display
31.78	[+]	31.78
4	[X]	4.
19.3	[lnx]	2.960105096
	[=]	43.62042038

Example: $e^{3.8}$ = 44.70118449

Enter	Press	Display
3.8	[e^x]	44.70118449

Example: log 1573 = 3.196728723

Enter	Press	Display
1573	[log]	3.196728723

The antilog of a number can be easily calculated using the [y^x] key described below since antilog x = 10^x.

POWERS AND ROOTS

These two-variable function keys process two numbers in a single operation. The numbers can be a keyboard entry, a calculated result, a stored quantity, or a combination of these.

[y^x] **Y to the X Power Key** — Raises a number to a power.

[$\sqrt[x]{y}$] **The X^{th} Root of Y Key** – Finds the root of a number.

[x:y] **Exchange Key** – Exchanges the x and y values entered for the functions [y^x] and [$\sqrt[x]{y}$]. The [x:y] key also exchanges the two operands in division.

In both [y^x] and [$\sqrt[x]{y}$] the first quantity entered is the value assigned to y. The second value is entered as the value of x. After the second value is entered, the values for x and y can be exchanged by pressing the [x:y] key.

Powers

Example: $(8)^3 = 512$

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

Example: $(2)^{3+4} = (2)^7 = 128$

Enter	Press	Display	Remarks
3	[+]	3.	
4	[=] [y^x]	7.	
2		2	
	[x:y]	7.	Exchange x and y
	[=]	128.	

Example: Antilog $3.19673 = 10^{3.19673} = 1573.004626$

Enter	Press	Display
10	[y^x]	10
3.19673	[=]	1573.004627

To determine the antilog of a calculated quantity (already in the display), the [y^x] and [x:y] keys are used:

Enter	Press	Display
		3.19673
	[y^x]	3.19673
10	[x:y]	3.19673
	[=]	1573.004627

Example: $34.7 + (8.7)^{2.6} = 311.8724475$

Enter	Press	Display
34.7	[+]	34.7
8.7	[y^x]	8.7
2.6	[=]	311.8724475

The following complex functions can be calculated easily with the SR-50: $y^{1/x}$, $y^{\sqrt{x}}$, $y^{\sin x}$, $y^{\ln x}$, etc.

Example: $4.2^{\ln 3.7} = 6.537587302$

Enter	Press	Display
4.2	[y^x]	4.2
3.7	[lnx]	1.30833282
	[=]	6.537587302

Roots

Example: $\sqrt[1.3]{4.8} = 3.342194507$

Enter	Press	Display
4.8	[$\sqrt[x]{y}$]	4.8
1.3	[=]	3.342194507

Example: $\sqrt[4.7]{215} + 5.86 = 8.995187378$

Enter	Press	Display
215	[$\sqrt[x]{y}$]	215.
4.7	[+]	3.135187378
5.86	[=]	8.995187378

MEMORY USE

The memory keys allow data to be stored and retrieved for additional flexibility in calculation.

[STO] **Store Key** — Stores the displayed quantity in the memory. Any previously stored quantity is cleared.

[RCL] **Recall Key** — Retrieves stored data from the memory. The [RCL] key does not clear the memory.

[Σ] **Sum and Store Key** — Algebraically sums the displayed number to the number in memory, and stores the result in memory. The use of this key does not affect the displayed quantity nor the previously calculated data.

The memory may be used to store a constant for iterative calculation, or to store a calculated result for subsequent additional calculation.

Example: $3.7 (2.14396)^3 + 9.7 (2.14396)^2 + 13.3 = 94.3496219$

Enter	Press	Display
2.14396	[STO] [y^x]	2.14396
3	[×]	9.854850386
3.7	[+] [RCL]	2.14396
	[x^2] [×]	4.596564482
9.7	[+]	81.0496219
13.3	[=]	94.3496219

The memory is used to store the results of the [Σ] key. This result can then be recalled for subsequent calculation. The [C] key does not erase the contents of the memory. Therefore, either the first quantity should be entered using the [STO] key, or a zero should be stored before entering the first quantity using the [Σ] key.

Example: $-19.95 + 118.80 - 13.94 - 37.50 - 2.98 + 15.35 - 44.29 = 134.15 - 118.66 = 15.49$

In order to retain the credit and debit amounts, each positive item will be summed to memory as the items are entered to be algebraically accumulated. This summed credit amount will then be subtracted from the net amount to yield the debit amount.

Enter	Press	Display	Remarks
19.95	[+/-] [+]	−19.95	
118.80	[STO] [−]	98.85	
13.94	[−]	84.91	
37.50	[−]	47.41	
2.98	[+]	44.43	
15.35	[Σ] [−]	59.78	
44.29	[=]	15.49	Net amount
	[−] [RCL]	134.15	Credit amount
	[=]	−118.66	Debit amount

To sum a negative quantity to the above credit amount, enter the number, press [+/-] key, and then press [Σ] key.

Example: Reduce the above credit amount by 50.10.

Enter	Press	Display	Remarks
50.10	[+/-]	−50.10	Change sign
	[Σ]	−50.10	Sum
	[RCL]	84.05	Check result

SECTION 3
COMPLEX CALCULATIONS

Sum of Products

The SR-50 has been designed to calculate sum of products and similar problems in a straightforward manner. Included in this category are sum and difference of products, quotients, powers and roots. Calculations such as these are the most common applications of a calculator memory. In the SR-50, a separate register (the Z register) has been dedicated to this use. This permits computation of this type of problem without use of special memory keys.

Example: 2 X 3 + 4 X 5 = 26

Enter	Press	Display
2	[X]	2.
3	[+]	6.
4	[X]	4.
5	[=]	26.

Example: 1/2 – 3/4 = –0.25

Enter	Press	Display
1	[÷]	1.
2	[–]	0.5
3	[÷]	3.
4	[=]	–0.25

Example: $2^5 - 2^3 = 24$

Enter	Press	Display
2	[y^x]	2.
5	[−]	32.
2	[y^x]	2.
3	[=]	24.

Example: $\sqrt[3]{8} + \sqrt[4]{625} = 7$

Enter	Press	Display
8	[$\sqrt[x]{y}$]	8.
3	[+]	2.
625	[$\sqrt[x]{y}$]	625.
4	[=]	7.

All of the single function keys on the SR-50 (logarithmic, trigonometric, factorial, etc.) operate only on the displayed quantity; they do not complete any prior instruction. Thus, the sum of products capability can be extended to these functions.

Example: sin 30 cos 60 + cos 30 sin 60 = 1

Angle: Deg

Enter	Press	Display
30	[sin] [×]	0.5
60	[cos] [+]	0.25
30	[cos] [×]	.8660254038
60	[sin] [=]	1.

Example: $2^2 \times 3^2 + 4^2 \times 5^2 = 436$

Enter	Press	Display
2	[x^2] [×]	4.
3	[x^2] [+]	36.
4	[x^2] [×]	16.
5	[x^2] [+]	436.

Although all of the preceding examples have used the minimum number of quantities (4) for illustration pruposes, the sum of products capability of the SR-50 is not limited to these simple applications.

Example: $\frac{2 \times 3}{4} + \frac{2^3 \times 4}{5} + \frac{\sqrt[4]{81} \times 5}{10} = 9.4$

Enter	Press	Display
2	[×]	2.
3	[÷]	6.
4	[+]	1.5
2	[y^x]	2.
3	[×]	8.
4	[÷]	32.
5	[+]	7.9
81	[$\sqrt[x]{y}$]	81.
4	[×]	3.
5	[÷]	15.
10	[=]	9.4

Intermediate Results

In the preceding problems; the [+] or [−] key always completes a prior [X], [÷], [y^x] or [$\sqrt[x]{y}$] command, but the reverse is not true. Thus to calculate

$$(2 \times 3 + 4) \times 5 = 50$$

it is necessary to complete the expression within the parenthesis — just as you would do to solve the problem manually. This is done by pressing the [=] key.

Enter	Press	Display
2	[X]	2.
3	[+]	6.
4	[=] [X]	10.
5	[=]	50.

Notice that it is necessary to use parentheses to write this problem in a single line. The [=] key essentially performs the close parenthesis function.

A general rule of when the [=] key should be pressed to obtain an intermediate result is:

> **Write the expression in a single line (no complex fractions) using parentheses. Press the [=] key for every close parenthesis.**

With a little practice, it is easy to learn when the [=] key does not have to be pressed for a close parenthesis (such as when the next function is a [+] or [−] key).

Examples of when the [=] key should be used include: sin (a + b), cosh (a X b), $(a - b)^2$, and $\sqrt{a/b}$. Note that the last example involves the quantity a divided by b even though the expression is usually written without parentheses. Similarily, the expression (2 X 3 + 4)/5 is frequently written on two lines without parenthesis as:

$$\frac{2 \times 3 + 4}{5}$$

Again, with a little practice, it often is not necessary to rewrite the expression to determine when the [=] key should be used to obtain an intermediate result.

Product of Sums

As mentioned previously, the SR-50 was designed to facilitate calculation of the frequently encountered sum of products type of problem. As a result, solving the much rarer product of sums is not as direct and requires use of the memory.

Example: (2 + 3) X (4 + 5) = 120

Enter	Press	Display
2	[+]	2.
3	[=] [STO]	5.
4	[+]	4.
5	[=] [X]	9.
	[RCL] [=]	45.

Example: $\frac{2-4}{4+6} = -0.2$

Enter	Press	Display
4	[+]	4.
6	[=] [STO]	10.
2	[−]	2.
4	[=] [÷]	−2.
	[RCL] [=]	−0.2

In this problem, the numerator could have been calculated first and stored in the memory, but another step would be required. The [x:y] key would have to be pressed before the final [=] key.

Alternate solution

Enter	Press	Display
2	[−]	2.
4	[=] [STO]	−2.
4	[+]	4.
6	[=] [÷]	10.
	[RCL] [x:y] [=]	−0.2

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

$$\frac{2 \times 3}{2+3} = 1.2$$

Enter	Press	Display
2	[+]	2.
3	[=]	5.
	[1/x] [×]	0.2
2	[×]	0.4
3	[=]	1.2

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

Example: ((3 + 7) 2 + 6) 4 + 5 = 109

Enter	Press	Display
3	[+]	3.
7	[=] [×]	10.
2	[+]	20.
6	[=] [×]	26.
4	[+]	104.
5	[=]	109.

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. For example, the preceding problem can be written as:

$$5 + 4\ (6 + 2\ (3 + 7)) = 109$$

The problem would obviously be solved in the same order as shown above.

Calculation Examples

Example: $\frac{2 \times 3 + 4 \times 5}{3 \times 4 + 5 \times 6} = 0.619047619$

Enter	Press	Display
3	[X]	3.
4	[+]	12.
5	[X]	5.
6	[=] [STO]	42.
2	[X]	2.
3	[+]	6.
4	[X]	4.
5	[=] [÷]	26.
	[RCL] [=]	0.619047619

Example: $\frac{(2+3) \times (4+5)}{(3+4) \times (5+6)} = 0.5844155844$

Enter	Press	Display
3	[+]	3.
4	[=] [STO]	7.
5	[+]	5.
6	[=] [X]	11.
	[RCL] [=] [STO]	77.
2	[+]	2.
3	[=] [÷]	5.
	[RCL] [=] [STO]	.0649350649
4	[+]	4.
5	[=] [X]	9.
	[RCL] [=]	.5844155844

SECTION 4
SAMPLE PROBLEMS

Your SR-50 calculator is a useful and versatile problem-solving tool. To improve your understanding of its versatility, it is recommended that you use your SR-50 to step through the sample problems in this section. A wide range of problems from several disciplines has been included.

Several problems are included to illustrate certain data manipulation and procedural techniques that are quite useful in problem solving. An understanding of the steps as presented can aid you in solving other problems.

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?

$$An = P\,(1 + i)^n$$

$$= 15{,}000\,(1 + .0775)^8$$

$$= \$27{,}253.95$$

Enter	Press	Display
1	[+]	1.
.0775	[=] [y^x]	1.0775
8	[×]	1.816930146
15000	[=]	27253.95219

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

$$P = \frac{A}{\left(1 + \frac{i}{q}\right)^{nq}}$$

$$= \frac{35570}{\left(1 + \frac{.063}{4}\right)^{13 \times 4}}$$

$$= \$15,782.24$$

Enter	Press	Display
1	[+]	1.
.063	[÷]	0.063
4	[=] [y^x]	1.01575
13	[y^x]	1.225261544
4	[=] [1/x] [X]	.4436952589
35570	[=]	15782.24036

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?

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

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

$$= \$42,361.18$$

Enter	Press	Display
1.0725	[y^x]	1.0725
9	[-]	1.877481679
1	[=] [÷]	.8774816789
.0725	[×]	12.10319557
3500	[=]	42361.1845

Investment Decisions – A decision must be made for a capital equipment investment. What is the maximum recommended purchase price Q of a machine with projected earnings for five years of $1200, $1500, $1750, $1300, and $900. Assume a value of zero after five years. Use an interest rate of 6.25%.

$$Q_{max} = \frac{R1}{(1+r)} + \frac{R2}{(1+r)^2} + \frac{R3}{(1+r)^3}$$

$$+ \frac{R4}{(1+r)^4} + \frac{R5}{(1+r)^5}$$

$$= \frac{1200}{(1.0625)} + \frac{1500}{(1.0625)^2} + \frac{1750}{(1.0625)^3}$$

$$+ \frac{1300}{(1.0625)^4} + \frac{900}{(1.0625)^5}$$

$$= \$5601.84$$

Please note the use of the [x:y] exchange key in the processing of this example. Each denominator is processed before division is performed. The numerator of each quotient is entered as the divisor. Pressing the [x:y] key prior to the next function key exchanges the numerator and denominator values before the division is performed.

Enter	Press	Display
1.0625	STO ÷	1.0625
1200	x⇄y +	1129.411765
	RCL x^2 ÷	1.12890625
1500	x⇄y +	2458.131488
	RCL y^x	1.0625
3	÷	1.199462891
1750	x⇄y +	3917.117851
	RCL y^x	1.0625
4	÷	1.274429321
1300	x⇄y +	4937.182265
	RCL y^x	1.0625
5	÷	1.354081154
900	x⇄y =	5601.839622

Boating

Sailboat Ratings – What are the measured rating, MR, and the rating, R, of a boat with the dimensions given below?

sail area,	S = 256.8 sq. ft.
length,	L = 22.375 ft.
beam,	B = 7.917 ft.
draft,	D = 3.750 ft.
draft correction,	DC = 0.350 ft.
freeboard correction,	FC = 0.275 ft.
engine and propeller factor,	EPF = 0.9975
center of gravity factor,	CGF = 1.0125

Measured rating,

$$MR = \frac{0.13\ L\ \sqrt{S}}{\sqrt{B \times D}} + 0.25\ L + 0.20\ \sqrt{S} + DC + FC$$

$$= \frac{0.13 \times 22.375 \times \sqrt{256.8}}{\sqrt{7.917 \times 3.750}} + 0.25 \times 22.375$$

$$+ 0.20 \times \sqrt{256.8} + 0.350 + 0.275$$

= 17.979 feet

Enter	Press	Display
7.917	[×]	7.917
3.75	[=] [√x] [1/x] [×]	.1835287234
.13	[×]	0.023858734
22.375	[×]	.5338391741
256.8	[√x] [+]	8.554762355
.25	[×]	0.25
22.375	[+]	14.14851235
.2	[×]	0.2
256.8	[√x] [+]	17.35350845
.35	[+]	17.70350845
.275	[=]	17.97850845

Rating,

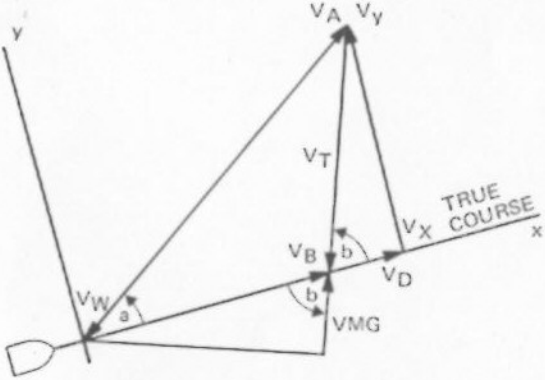
R = MR X EPF X CGF

= 17.979 X .9975 X 1.0125

= 18.158 feet

Enter	Press	Display
17.979	[×]	17.979
.9975	[×]	17.9340525
1.0125	[=]	18.15822816

Velocity Made Good – A sail boat sails an effective course into the wind by tacking back and forth at an angle to the wind. If the wind velocity and boat velocity are drawn as vectors, the component of boat velocity directly into the wind is the velocity made good, VMG. Using the vector diagram and quantities shown, determine the VMG of the boat.



V_W = apparent wind velocity, 17 knots

V_B = boat's true speed, 9 knots

a = apparent angle of wind, 28°

This problem can be solved using vector equations. Each upper case V represents a vector and each lower case v represents a vector magnitude.

$$V_A = -V_W$$

$$V_x + V_y = V_A$$

$$v_x + j\, v_y = V_A$$

$$v_y = v_a \sin a$$

$$= 17 \sin 28$$

$$= 7.981016567$$

$$v_x = v_a \cos a$$

$$= 17 \cos 28$$

$$= 15.01010908$$

$$v_D = v_x - v_B$$

$$= 15.01010908 - 9$$

$$= 6.010109079$$

$$V_T = v_D + j v_y = v_T \angle b$$

$$= 6.010109079 + j\, 7.981016567$$

$$= \sqrt{(6.010109079)^2 + (7.981016567)^2} \;\; \angle \arctan \frac{7.981016567}{6.010109079}$$

$$= 9.990897687 \;\; \angle 53.01840377^\circ$$

$$VMG = v_B \cos b$$

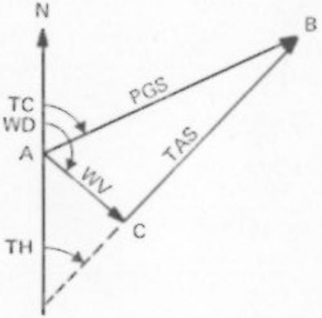
$$= 9 \cos 53.01840377$$

$$= 5.414026187 \text{ knots}$$

Enter	Press	Display	Remarks
17	[×]	17.	
28	[sin] [=] [STO]	7.981016567	v_y
17	[×]	17.	
28	[cos] [=] [−]	15.01010908	v_x
9	[=]	6.010109079	v_D
	[x^2] [+] [RCL]	7.981016567	
	[x^2] [=] [$\sqrt{x}$]	9.990897687	v_T
	[RCL] [÷]	7.981016567	
6.010109079	[=] [arc] [tan]	53.01840377	θ
	[cos] [×]	.6015584653	
9	[=]	5.414026187	VMG

Navigation

The wind triangle used in flight planning problems consists of three vectors and six factors as shown in the following diagram.



Vector	Heading	Velocity
AB	TC, True Course	PGS, Predicted Ground Speed
AC	WD, Wind Direction	WV, Wind Velocity
CB	TH, True Heading	TAS, True Air Speed

In preflight plans, the known data are true course, wind direction, wind velocity, and true air speed.

True Heading — Find the true heading of a planned flight if the following data are known: TC = 40°, WD = 105°, TAS = 120 mph, WV = 47 mph.

$$\begin{aligned} TH &= TC - \arcsin\,[WV \sin(WD - TC)/TAS] \\ &= 40 - \arcsin\,[47 \sin(105 - 40)/120] \\ &= 19.20836054^\circ \end{aligned}$$

Angle: Deg

Enter	Press	Display
105	[−]	105.
40	[=] [sin] [×]	0.906307787
47	[÷]	42.59646599
120	[=] [arc] [sin] [+/−] [+]	−20.79163946
40	[=]	19.20836054

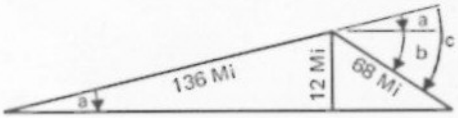
Predicted Ground Speed — For the flight plan in the previous problem, determine the predicted ground speed.

$$\begin{aligned} PGS &= WV \cos(WD - TC) \\ &\quad + \sqrt{[WV \cos(WD - TC)]^2 - (WV)^2 + (TAS)^2} \\ &= 47 \cos(105 - 40) \\ &\quad + \sqrt{[47 \cos(105 - 40)]^2 - (47)^2 + (120)^2} \\ &= 132.0483563 \text{ mph} \end{aligned}$$

Angle: Deg

Enter	Press	Display
105	[−]	105
40	[=] [cos] [X]	.4226182617
47	[=] [STO] [x^2] [−]	394.5410851
47	[x^2] [+]	−1814.458915
120	[x^2] [=] [$\sqrt{x}$] [+] [RCL] [=]	132.0483563

Drift Correction — During a flight it is determined that the plane is 12 miles off course. If the distance flown is 136 miles and the remaining distance is 68 miles, determine the angle for a parallel course, the correction angle to coverge at destination, and the total correction to converge on the destination.



Parallel course,

$$a = \text{arc sin } \frac{12}{136}$$
$$= 5.062092964^\circ$$

Angle:Deg

Enter	Press	Display
12	[÷]	12.
136	[=] [arc] [sin] [STO]	5.062092964

Correction angle,

$$b = \text{arc sin}\ \frac{12}{68}$$
$$= 10.16424862^\circ$$

Angle:Deg

Enter	Press	Display
12	[÷]	12.
68	[=] [arc] [sin]	10.16424862

Total correction

$$c = b + a$$
$$= \text{arc sin}\ \frac{12}{68} + \text{arcsin}\ \frac{12}{136}$$
$$= 10.16424862 + \text{RCL}$$
$$= 15.22634159^\circ$$
$$= 15^\circ\ 13'\ 35''$$

The decimal degrees can be converted to minutes by multiplying the fractional portion of the degrees by 60. The resulting decimal minutes can be converted to seconds by multiplying the fractional portion of the minutes by 60.

Enter	Press	Display	Remarks
10.16424862	[+] [RCL] [−]	15.22634159	Degrees
15	[=] [×]	.226341586	
60	[−]	13.58049516	Minutes
13	[=] [×]	.5804951576	
60	[=]	34.82970946	Seconds

Combinations – Find the number of ways in which six differently colored blocks can be arranged using any number at a time.

$$D = n! \left[1 + \frac{1}{1!} + \frac{1}{2!} + \frac{1}{3!} + \ldots + \frac{1}{(n-1)!}\right]$$

$$D = 6! \left[1 + \frac{1}{1!} + \frac{1}{2!} + \frac{1}{3!} + \frac{1}{4!} + \frac{1}{5!}\right]$$

$$= 1956$$

Enter	Press	Display
1	[+]	1.
1	[x!] [1/x] [+]	2.
2	[x!] [1/x] [+]	2.5
3	[x!] [1/x] [+]	2.666666667
4	[x!] [1/x] [+]	2.708333333
5	[x!] [1/x] [=] [X]	2.716666667
6	[x!] [=]	1956.

Combinations With Fixed Arrangements – What is the number of combinations of 35 marbles taken 6 at a time?

$$c\ (n, r) = \frac{n!}{r!\ (n-r)!}$$

$$c\ (35, 6) = \frac{35!}{6!\ (35-6)!}$$

$$= 1{,}623{,}160$$

Enter	Press	Display
35	[-]	35
6	[=] [x!] [X]	8.841761994 30
6	[x!] [÷]	6.366068635 33
35	[x!] [x:y] [=]	1623160

Mean Variance, and Standard Deviation – Find the mean, variance, and standard deviation for the values 3, 5, 3, 7, 4.

Mean

$$\bar{X} = \frac{1}{N}\sum_{i=0}^{n} X_i = \frac{\Sigma x}{N}$$

$$= \frac{1}{5}(3 + 5 + 3 + 7 + 4)$$

$$= 4.4$$

Variance (unbiased)

$$\sigma^2 = \frac{\Sigma X^2 - N\bar{X}^2}{N-1} = \frac{\Sigma X^2 - N\left(\frac{\Sigma X}{N}\right)^2}{N-1}$$

$$= \frac{(3^2 + 5^2 + 3^2 + 7^2 + 4^2) - 5\left(\frac{3+5+3+7+4}{5}\right)^2}{4}$$

$$= 2.8$$

Standard Deviation (unbiased)

$$\sigma = \sqrt{\sigma^2}$$

$$= \sqrt{2.8}$$

$$= 1.673320053$$

All three of these values can be determined in a single calculation. The values of x are summed in the memory and the values of x^2 are summed in the z register.

Enter	Press	Display	Remarks
3	[STO] [x^2] [+]	9.	
5	[Σ] [x^2] [+]	34.	
3	[Σ] [x^2] [+]	43.	
7	[Σ] [x^2] [+]	92.	
4	[Σ] [x^2] [=]	108.	
	[RCL] [x:y] [STO]	22.	Exchange x
	[x:y] [÷]		with memory
5	[=]	4.4	Mean
	[x^2] [+/−] [×]	−19.36	
5	[+] [RCL] [=] [÷]	11.2	
4	[=]	2.8	Variance
	[$\sqrt{x}$]	1.673320053	Standard deviation

To calculate the biased variance and standard deviation, the denominator of the variance equation is N instead of N − 1. In this example, 11.2 would be divided by 5 to yield a biased variance of 2.24 and a biased standard deviation of 1.496662955. The biased and unbiased expressions converge, of course, for large values of N.

Poisson Distribution – If the average value of occurrences of an event during time interval T is 2.5, find the probability of 5 occurrences during T.

$$P(a) = e^{-m}\left[\frac{m^a}{a!}\right]$$

$$P(5) = e^{-2.5}\left[\frac{(2.5)^5}{5!}\right]$$

$$P(5) = .06680 \text{ or } 6.68\%$$

Enter	Press	Display
2.5	[y^x]	2.5
5	[÷]	97.65625
5	[$x!$]	120
	[×]	.8138020833
2.5	[+/−] [e^x] [=]	.0668009428

Physics

Thrown Object – If a ball is thrown upward with a velocity of 86 feet per second, what is its velocity and height at the end of 1.75 seconds? Use g = 32.2 feet per sec^2.

Velocity,

$$v = v_o - gt$$

$$= 86 - (32.2)(1.75)$$

$$= 29.65 \text{ ft/sec}$$

Enter	Press	Display
86	[−]	86.
32.2	[×]	32.2
1.75	[=]	29.65

Height,

$$s = v_0 t - \frac{1}{2} g t^2$$

$$= (86)\ (1.75) - \frac{1}{2}\ (32.2)\ (1.75)^2$$

$$= 101.19 \text{ feet}$$

Enter	Press	Display
86	[X]	86.
1.75	[−]	150.05
32.2	[X]	32.2
1.75	[x^2] [÷]	98.6125
2	[=]	101.19375

Gas Pressure – The internal pressure of a tank of gas is 1300 psi at room temperature. What is the internal pressure if the temperature rises by 25°C (from 298°K to 323°K)?

$$P_2 = \frac{P_1 T_2}{T_1}$$

$$= \frac{1300 \times 323}{298}$$

$$= 1409.060403 \text{ psi}$$

Enter	Press	Display
1300	[X]	1300.
323	[÷]	419900.
298	[=]	1409.060403

Density of Gas – What is the density of helium gas in a tank at a pressure of 125 atm at room temperature, 298°K? The universal gas constant is 8317 nt m/kg°K, the atomic mass of helium is 4.004, and 1 atm = 1.013×10^5 nt/m^2.

$P = 125$ atm
$M = 4.004$

$R = 8317$ nt m/kg°K
$T = 298°K$

$$\rho = \frac{PM}{RT}$$

$$= \frac{125 \times 1.013 \times 10^5 \times 4.004}{8317 \times 298}$$

$$= 20.4564638 \text{ Kg per m}^2$$

Enter	Press	Display
125	[X]	125.
1.013	[EE]	1.013 00
5	[X]	1.26625 07
4.004	[÷]	5.070065 07
8317	[÷]	6.096026211 03
298	[=]	2.04564638 01

Coordinate Conversion – Convert the rectangular coordinates x = 35.6, y = 18.4 to the polar form $A \angle \theta$.

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

$$= \sqrt{(35.6)^2 + (18.4)^2}$$

$$= 40.1$$

$$\theta = \arctan \frac{y}{x}$$

$$= \arctan \frac{18.4}{35.6}$$

$$= 27.3°$$

Angle: Deg

Enter	Press	Display	Remarks
35.6	[x^2] [+]	1267.36	
18.4	[x^2] [=] [$\sqrt{x}$]	40.07393168	A
18.4	[÷]	18.4	
35.6	[=] [arc] [tan]	27.33235949	θ

Convert the polar coordinates 141 $\angle 76.5°$ to the rectangular form (x, y).

$$x = A \cos \theta$$

$$= 141 \cos 76.5$$

$$= 32.9157963$$

$$y = A \sin \theta$$

$$= 141 \sin 76.5$$

$$= 137.1041588$$

Angle: Deg

Enter	Press	Display
76.5	[STO] [cos] [×]	.2334453639
141	[=]	32.9157963
141	[×] [RCL] [sin] [=]	137.1041588

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.

$$Ht = (fL/D)(V^2/4005) + (CV^2/4005)$$

$$= (2.8 \times 10^{-6} \times 145/2.5)\,[(3000)^2/4005]$$

$$+ [8.9 \times 10^{-5}\,(3000)^2/4005]$$

$$= 0.5649438202 \text{ inches of water}$$

Enter	Press	Display
2.8	[EE]	2.8 00
6	[+/−] [×]	2.8 −06
145	[÷]	4.06 −04
2.5	[×]	1.624 −04
3000	[x^2] [÷]	1.4616 03
4005	[+]	3.649438202 −01
8.9	[EE]	8.9 00
5	[+/−] [×]	8.9 −05
3000	[x^2] [÷]	8.01 02
4005	[=]	5.649438202 −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 for each are shown in the table.

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

$$D = \frac{1}{a} [W_1 H_1/2 + W_2 (h_1/2 + h_2)$$

$$+ W_3 (h_1/2 + h_2 + h_3)]$$

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

$$+ 137700 (19/2 + 17 + 17)]$$

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

Enter	Press	Display
19	[÷]	19.
2	[×] [STO]	19.5
153900	[+]	1462050.
17	[Σ] [RCL] [×]	26.5
137700	[+]	5111100.
17	[Σ] [RCL] [×]	43.5
137700	[=] [÷]	11101050.
54	[=]	205575.

Girder Design — What is the total bending moment M in a 19.7 foot simply supported girder with a total uniform load W of 55,000 pounds and a wind load M_W of 110,000 ft lb?

The moment will occur at a point p feet from one end.

$$p = \frac{2 \times 110{,}000}{55{,}000} = 4 \text{ feet}$$

$$M = \left(\frac{W}{2L}\right)\left(\frac{L}{2} - p\right)\left(\frac{L}{2} + p\right) + \frac{p\,M_W}{L/2}$$

$$= \frac{WL}{8} - \frac{Wp^2}{2L} + \frac{2p\,M_W}{L}$$

$$= \left(\frac{55000 \times 19.7}{8}\right) - \left(\frac{55000 \times (4)^2}{2 \times 19.7}\right) + \left(\frac{2 \times 4 \times 110000}{19.7}\right)$$

$$= 157{,}772.5254 \text{ ft lb}$$

Enter	Press	Display
55000	[×]	55000.
19.7	[÷]	1083500.
8	[−]	135437.5
55000	[×]	55000.
4	[x^2] [÷]	880000.
2	[÷]	440000.
19.7	[+]	113102.4746
2	[×]	2.
4	[×]	8.
110000	[÷]	880000.
19.7	[=]	157772.5254

Shape Factor – What is the shape factor for heat transfer by radiation between two parallel disks 1.5 feet apart? The radii of the disks are 2.75 feet and 3.6 feet.

$$F = \frac{1}{2a^2}\left[L^2 + a^2 + b^2 - \sqrt{(L^2 + a^2 + b^2)^2 - 4a^2 \times b^2}\right]$$

$$= \frac{1}{2 \times (2.75)^2}\left[(1.5)^2 + (2.75)^2 + (3.6)^2\right.$$

$$\left. - \sqrt{[(1.5)^2 + (2.75)^2 + (3.6)^2]^2 - 4 \times (2.75)^2 \times (3.6)^2}\right]$$

$$= 0.7618644459$$

Enter	Press	Display
1.5	[x^2] [+]	2.25
2.75	[x^2] [+]	9.8125
3.6	[x^2] [=] [STO] [x^2] [−]	518.5867563
4	[×]	4.
2.75	[x^2] [×]	30.25
3.6	[x^2] [=] [$\sqrt{x}$] [+/−]	−11.24930026
	[+] [RCL] [=] [÷]	11.52319974
2	[÷]	5.761599872
2.75	[x^2] [=]	.7618644459

Heat Transfer – What is the surface coefficient of heat transfer for a 50% solution of sodium hydroxide at 200°F in a 0.08 foot diameter nickel boiler tube if the Reynolds number is 20,000? The thermal conductivity of the solution is 0.423, the specific heat is 0.76, and its viscosity is 10.16.

$$h = 0.023\ \frac{K}{D}\ (R)^{0.8}\ \left(\frac{C\mu}{R}\right)^{0.4}$$

$$= .023 \times \frac{.423}{.08} \times (20{,}000)^{0.8}\ \left(\frac{.76 \times 10.16}{.423}\right)^{0.4}$$

$$= 1072.380692$$

Enter	Press	Display
.76	[×]	.76
10.16	[÷]	7.7216
.423	[y^x]	18.25437352
.4	[=] [STO]	3.195558505
20000	[y^x]	20000.
.8	[×]	2759.459323
.423	[×]	1167.251294
.023	[÷]	26.84677975
.08	[×] [RCL] [=]	1072.380692

Fluid Flow – What is the amount of flow of fluid across a weir with a V-shaped notch? The angle of the notch is 35° and the height of the liquid from the bottom edge of the weir is 4.5 feet.

$$Q = 2.505\ \left(\tan \frac{\alpha}{2}\right)\ H^{2.47}$$

$$= 2.505\ \left(\tan \frac{35}{2}\right) \times (4.5)^{2.47}$$

$$= 32.43134362 \text{ cu ft per sec}$$

Angle: Deg

Enter	Press	Display
4.5	[y^x]	4.5
2.47	[×]	41.06150933
17.5	[tan] [×]	12.94664416
2.505	[=]	32.43134362

Civil Engineering

Surveying – Determine the temperature correction and the slope correction for a steel tape used at a temperature of 85°F. The tape standardized temperature is 70°F, the measured length is 1275 feet, and the slope angle is 5.4°.

Temperature correction,

$$C_t = 0.0000065\ S\ (T - T_o)$$

$$= 0.0000065 \times 1275 \times (85 - 70)$$

$$= 0.1243125$$

Enter	Press	Display
85	[−]	85.
70	[=] [×]	15.
65	[EE] [+/−]	65. −00
7	[×]	9.75 −05
1275	[=]	1.243125 −01

Slope correction,

$$C_h = S\ (1 - \cos\theta)$$

$$= 1275\ (1 - \cos 5.4^\circ)$$

$$= 5.658495129$$

Angle: Deg

Enter	Press	Display
1	[−]	1.
5.4	[cos] [=] [×]	.0044380353
1275	[=]	5.658495129

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.

$$\sigma_z = \frac{3P}{2\pi Z^2}\left[1 + \left(\frac{r}{Z}\right)^2\right]^{2.5}$$

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

= 15546.20589 lb

Enter	Press	Display
3.5	[÷]	3.5
2.5	[=] [x^2] [+]	1.96
1	[=] [y^x]	2.96
2.5	[×]	15.07402661
3	[×]	45.22207984
13500	[÷]	610498.0778
2	[÷]	305249.0389
π	[÷]	97163.78683
2.5	[x^2] [=]	15546.20589

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 contribures 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.

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

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

$$= 36.50801589 \text{ minutes}$$

Enter	Press	Display
1350	[÷]	1350.
.15	[÷]	9000.
1.7	[x^2] [$\sqrt[x]{y}$]	3114.186851
3	[×]	14.60320636
2.5	[=]	36.50801589

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.

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

$$= \frac{2 \times 28500}{.875 \times .333 \times 2.5 \times (8.5)^2}$$

$$= 1083.040529 \text{ psi}$$

Enter	Press	Display
2	[×]	2.
28500	[÷]	57000.
.875	[÷]	65142.85714
.333	[÷]	195624.1956
2.5	[÷]	78249.67825
8.5	[x^2] [=]	1083.040529

Electrical Engineering

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

$$\text{Req} = \frac{1}{1/R_1 + 1/R_2 + 1/R_3}$$

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

$$= 171.1638788 \text{ ohms}$$

Enter	Press	Display
560	[1/x] [+]	.0017857142
390	[1/x] [+]	.0043498168
670	[1/x] [=] [1/x]	171.1638788

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 millisec?

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

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

$$= 14.40872087 \text{ V}$$

Enter	Press	Display
250	[+/−] [EE]	−250 00
3	[+/−] [÷]	−2.5 −01
3300	[÷]	−7.575757576 −05
47	[EE] [+/−]	47 −00
6	[=] [e^x] [+/−] [+]	−1.995155075 −01
1	[=] [X]	8.004844925 −01
18	[=]	1.440872087 01

RL Equivalent Impedance — What is the equivalent impedance of a 560 ohm resistor and a 25.5 millihenry inductor at a frequency of 2500 hertz?

$$Z_{eq} = R + j\,X_L = 560 + j\,400$$

or $$Z_{eq} = A \underline{/\theta} = 687.5569736 \underline{/35.6^\circ}$$

where $$\theta = \arctan \frac{X_L}{R}$$

and $$A = \frac{X_L}{\sin \theta}$$

and $$X_L = 2\pi f L$$

$$= 2\pi \times 2500 \times .0255$$

Angle:Deg

Enter	Press	Display	Remarks
2	[X]	2.	
[π]	[X]	6.283185307	
2500	[X]	15707.96327	
.0255	[÷] [STO]	400.5530633	XL
560	[=] [arc] [tan]	35.57512944	θ
	[sin] [1/x] [X]	1.718892434	
	[RCL] [=]	688.50763	

Four Terminal Networks – Find α the attenuation constant for a symmetrical four-terminal network such that the ratio of the short circuit and open circuit impedances is 0.955 /24.3° ohms.

Convert 0.955 /24.3° to the rectangular form, R + jX.

$$C = R = .955 \cos 24.3^\circ = .8703901292$$

$$D = X = .955 \sin 24.3^\circ = .3929962125$$

Angle:Deg

Enter	Press	Display	Remarks
.955	[X]	0.955	
24.3	[cos] [=] [STO]	.8703901292	R value
.955	[X]	.955	
24.3	[sin] [=]	.3929962125	X value
	[x²] [+]	0.154446023	
	[RCL] [x²] [+]	0.912025	
1	[=] [1/x] [X]	.5230057138	
2	[X] [RCL] [=]	.9104380217	
	[arc] [hyp] [tan] [÷]	1.530078472	
2	[=]	.7650392361	

$$\tanh 2\alpha = \frac{2C}{1 + C^2 + D^2}$$

$$\tanh 2\alpha = \frac{2 \times .8703901292}{1 + (.8703901292)^2 + (.3929962125)^2}$$

$$\tanh 2\alpha = .9104380207$$

$$2\alpha = 1.530078472$$

$$\alpha = .7650392361 \text{ neper/section}$$
(1 neper = 8.668 dB)

Mechanical Engineering

Brake Horsepower – As measured on a prony brake, what is the brake horsepower of an engine with a 2.5 foot brake arm and a force of 1050 lb at 250 rpm?

$$BHP = 2\pi LFN/33000$$

$$= 2\pi \times 2.5 \times 1050 \times 250/33000$$

$$= 124.9497078 \text{ hp}$$

Enter	Press	Display
2	[×]	2.
[π]	[×]	6.283185307
2.5	[×]	15.70796327
1050	[×]	16493.36143
250	[÷]	4123340.358
33000	[=]	124.9497078

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

$$S_{MAX} = (16/\pi d^3)\ (M_b + \sqrt{M_b{}^2 + M_t{}^2})$$

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

$$= 6053.95673 \text{ psi}$$

Enter	Press	Display
875	[x^2] [+]	765625.
1500	[x^2] [=] [$\sqrt{x}$] [+]	1736.555499
875	[=] [×]	2611.555499
16	[÷]	41784.88798
[π]	[=] [STO]	13300.54294
1.3	[y^x]	1.3
3	[÷] [RCL] [x:y] [=]	6053.95673

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.

$$I = \pi ml\,(r_1{}^4 - r_2{}^4)/2$$

$$= \pi \times 435 \times 3.5\,[(1.25)^4 - (0.8)^4]/2$$

$$= 4859.140652 \text{ lb/ft}^2$$

Enter	Press	Display
1.25	[y^x]	1.25
4	[−]	2.44140625
.8	[y^x]	.8
4	[=] [÷]	2.03180625
2	[×]	1.015903125
[π]	[×]	3.191553794
435	[×]	1388.3259
3.5	[=]	4859.140652

Compressor Performance — What is the apparent capacity C_a 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 R_p of 9.5:1 and a specific heat ratio k of 1.8:1.

$$C_a = (\pi d^2/4)\ (L)\ (1 + C - CR_p{}^{1/k})$$

$$= [\pi \times (2.25)^2/4]\ (5.5)\ [1 + .07 - .07 \times (9.5)^{1/1.8}]$$

$$= 18.0524019 \text{ cu in/cycle}$$

Enter	Press	Display
9.5	[y^x]	9.5
1.8	[1/x] [×]	3.492848757
.07	[+/−] [+]	−.244499413
1.07	[=] [×]	.825500587
5.5	[×]	4.540253229
[π]	[×]	14.26362619
2.25	[x^2] [÷]	72.20960758
4	[=]	18.0524019

Rod Deflection — What is the deflection of the end of a metal rod due to a force of 20,000 pounds? The length of the rod is 2.5 feet and the cross sectional area is 0.385 square feet. E, the elastic modulus, is 30×10^6 psi.

$$d = \frac{PL}{AE}$$

$$= \frac{20{,}000 \times 2.5 \times 12}{.385 \times 144 \times 30 \times 10^6}$$

$$= 3.607503608 \times 10^{-4} \text{ inches}$$

Enter	Press	Display
.385	[×]	0.385
144	[×]	55.44
30	[EE]	30 00
6	[=]	1.6632 09
	[1/x] [×]	6.012506013 −10
20	[EE]	20 00
3	[×]	1.202501203 −05
2.5	[×]	3.006253006 −05
12	[=]	3.607503608 −04

Metric Unit Conversions

Inches to Centimeters – Convert 8.5 inches to centimeters. Use the factor given in the conversion factors table in Appendix A.

$$d = \text{inches} \times 2.54$$

$$= 8.5 \times 2.54$$

$$= 21.59 \text{ cm}$$

Enter	Press	Display
8.5	[X]	8.5
2.54	[=]	21.59

Kilometers to Miles – What is the length in miles of a 128-kilometer trip?

$$d = \text{kilometers} \times .6213711922$$

$$= 128 \times .6213711922$$

$$= 79.5355126 \text{ miles}$$

Enter	Press	Display
128	[X]	128.
.6213711922	[=]	79.5355126

Liters to Gallons – How many gallons of gas are required to fill a 60-liter tank?

$$q = \text{liters} \times .2641720524$$

$$= 60 \times .2641720524$$

$$= 15.85032314 \text{ gallons}$$

Enter	Press	Display
60	[X]	60
.2641720524	[=]	15.85032314

Square Yards to Square Meters — A 100-yard by 53-yard football field contains how many square meters?

$$a = \text{square yards} \times .83612736$$

$$= 100 \times 53 \times .83612736$$

$$= 4431.475008 \text{ square meters}$$

Enter	Press	Display
100	[X]	100.
53	[X]	5300
.83612736	[=]	4431.475008

Cubic Centimeters to Cubic Inches — A 1700-cc engine has a displacement of how many cubic inches?

$$v = \text{cubic centimeters} \times 6.102374409 \times 10^{-2}$$

$$= 1700 \times 6.102374409 \times 10^{-2}$$

$$= 103.74036502 \text{ cubic inches}$$

Enter	Press	Display
1700	[X]	1700.
6.102374409	[EE]	6.102374409 00
2	[+/−] [=]	1.03740365 02

APPENDIX A
CONVERSION TABLES

Conversion Factors – Metric to English

To Find	Multiply	By
inches	centimeters	0.3937007874
feet	meters	3.280839895
yards	meters	1.093613298
miles	kilometers	0.6213711922
ounces	grams	$3.527396195 \times 10^{-2}$
pounds	kilograms	2.204622622
gallons	liters	0.2641720524
fl. ounces	milliliters (cc)	$3.381402270 \times 10^{-2}$
sq. inches	sq. centimeters	0.1550003100
sq. feet	sq. meters	10.76391042
sq. yards	sq. meters	1.195990046
cu. inches	milliliters (cc)	$6.102374409 \times 10^{-2}$
cu. feet	cu. meters	35.31466672
cu. yards	cu. meters	1.307950619

Conversion 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**

Boldface numbers are exact; others are given to ten significant figures.

grams	ounces	28.34952313
kilograms	pounds	0.45359237
liters	gallons	3.785411784
milliliters (cc)	fl. ounces	29.57352956
sq. centimeters	sq. inches	6.4516
sq. meters	sq. feet	0.09290304
sq. meters	sq. yards	0.83612736
milliliters (cc)	cu. inches	16.387064
cu. meters	cu. feet	$2.831684659 \times 10^{-2}$
cu. meters	cu. yards	0.764554858

Temperature Conversions

$$°F = \frac{9}{5}(°C) + 32$$

$$°C = \frac{5}{9}(°F - 32)$$

Conversion Factors — General

To Find	Multiply	By
atmospheres	feet of water @ 4°C	2.950×10^{-5}
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}
cords	cu ft	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	2.655×10^{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

APPENDIX B
GENERAL FORMULAS

Quadratic Equation

If $ax^2 + bx + C = 0 \qquad a \neq 0$

then $x = \dfrac{-b \pm \sqrt{b^2 - 4ac}}{2a}$

Law of Exponents

$a^x \times a^y = a^{x+y} \qquad a^{-x} = \dfrac{1}{a^x}$

$(ab)^x = a^x \times b^x \qquad \dfrac{a^x}{a^y} = a^{x-y}$

$(a^x)^y = a^{xy} \qquad a^0 = 1 \quad a \neq 0$

Geometry

Triangle

area $= \dfrac{1}{2}$ bh   where b = base
h = altitude

Rectangle

area = bh

Parallelogram (opposite sides parallel)

area = bh
= ab sin θ a & b: sides
θ: angle between sides

Circle

$$\text{circumference} = 2\pi R \qquad R\text{: radius}$$
$$= \pi D \qquad D\text{: diameter}$$

$$\text{area} = \pi R^2$$
$$= \frac{1}{4}\pi D^2$$

Sphere

$$\text{area} = 4\pi R^2$$
$$= \pi D^2$$

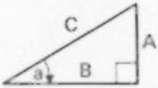
$$\text{volume} = \frac{4}{3}\pi R^3$$
$$= \frac{1}{6}\pi D^3$$

APPENDIX C
SPECIAL FORMULAS

The following is a very brief review of trigonometric, logarithmic, and hyperbolic functions.

Trigonometric Functions

Trigonometric functions can be defined geometrically in terms of a right triangle.



$$C^2 = A^2 + B^2$$

If the angle a is opposite side A, b is opposite B, and c opposite C, then

$$\sin a = A/C, \cos a = B/C, \tan a = A/B$$

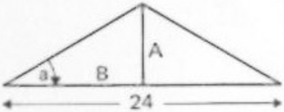
Example: If you are building a roof on a tool shed 24 feet wide, and want to have an angle of 30° to provide drainage then B = 12 feet and a = 30°

$A = B \tan a$

$A = 12 \times \tan 30$

$= 12 \times .5773502692$

$= 6.92820323$ feet



Basic relations for the trigonometric functions are:

$$\sin a = \frac{1}{\csc a}, \cos a = \frac{1}{\sec a}, \tan a = \frac{1}{\text{cotan } a}$$

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

Valid also for any plane triangle

$$A/\sin a = B/\sin b = C/\sin c$$

$$C^2 = A^2 + B^2 - 2\,AB\cos c$$

From calculus the functions can be defined as a series expansion

$$\sin a = a - \frac{a^3}{3!} + \frac{a^5}{5!} - \frac{a^7}{7!} + \ldots$$

$$\cos a = 1 - \frac{a^2}{2!} + \frac{a^4}{4!} - \frac{a^6}{6!} + \ldots$$

$$\tan a = a + \frac{a^3}{3} + \frac{2a^5}{15} + \frac{17a^7}{315}$$

$$+ \frac{62a^9}{2835} \ldots \quad (a^2 < \pi^2/4)$$

where the angle a is expressed in radians.

Inverse Trigonometric Functions

Each function returns the value of the angle if the ratio for that two sides of the triangle is known.

$$a = \text{arc sin } (A/C) = \text{arc cos } (B/C) = \text{arc tan } (A/B)$$

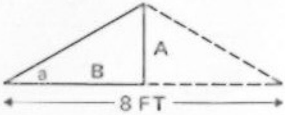
The value of the argument for sin and cos functions must be in the interval $-1 \leqslant R \leqslant 1$ for arcsin and arccos to be defined, and the value of function will always be between $-\pi/2 \leqslant a \leqslant \pi/2$, or $-90^\circ \leqslant a \leqslant 90^\circ$. The value for the tan function is the interval $-\infty < R < \infty$.

Example: A tool shed has a width of 8 feet and a height of 3 feet. Find the angle a of the roof. A = 3, B = 4.

$a = \arc\tan (A/B)$

$= \arc\tan (3/4)$

$= 36.86989765°$



Logarithms

Any positive number can be represented by another positive number, called a base, raised to an appropriate power, an exponent, $x = b^y$. The exponent to which the base must be raised is called the logarithm of the number, x, for that specific base, b. Or, $y = \log_b x$.

Two bases normally used are 10. and e = 2.718281828. The relationship between these bases can be expressed as:

$$\log_{10} x = \frac{\log_e x}{\log_e 10}$$

$$= \frac{\ln x}{\ln 10}$$

$$= \frac{\ln x}{2.302585093}$$

Base 10 logarithms are called common logarithms, and base e logarithms are called natural logarithms. Logarithms for negative numbers are undefined.

Example: Determine the time it requires for a radioisotope to decay to 0.1 its present value

$t = k \ln (X/Xo)$ where $k = -1.386/\text{year}$

$t = -1.386 (\ln .1)$ $X/Xo = 0.1$

$= -1.386X (-2.302585093)$

$= 3.191382939$ years

Exponential Functions

Exponential functions occur frequently in the mathmatical problems of biology, physics, chemistry, and engineering. The value of e^X given by the series expansion is:

$$e^X = 1 + X + \frac{X^2}{2!} + \frac{X^3}{3!} + \frac{X^4}{4!} + \ldots$$

The value of e can be evaluated by allowing X = 1; e = 2.718281828. Trigonometric functions can be expressed as functions of e^X.

$$\sin x = \frac{1}{2i}(e^{ix} - e^{-ix}), \cos x = \frac{1}{2}(e^{ix} + e^{-ix}),$$

$$\tan x = \frac{(e^{ix} - e^{-ix})}{i\,(e^{ix} + e^{-ix})}$$

Hyperbolic Functions

Hyperbolic functions may be defined as functions of exponentials

$$y = \sinh x = \frac{e^x - e^{-x}}{2}, y = \cosh x = \frac{e^x + e^{-x}}{2},$$

$$y = \tanh x = \frac{e^x - e^{-x}}{e^x + e^{-x}}$$

The function y = a cosh (x/b) is known as a catenary and describes the way a power cable, chain, or clothes line supported only by the ends will hang.

Example: The length of a uniform power cable strung between two utility poles of equal height is given by the expression

$$L = (2\ T/W)\ \sinh\ (WX/T)$$

where 2X is the distance between poles, W is the weight/ft of cable, and T is the tension at the lowest point. If X = 45, W = 0.78 lbs/ft and T = 62 lbs

$$L = (2)\ (62)/(.78)\ \sinh\ [(0.78)\ (45)/(62)]$$
$$= 94.88516293 \text{ ft}$$

Basic relations for the hyperbolic functions are:

$$\operatorname{csch} x = 1/\sinh x,\ \operatorname{sech} x = 1/\cosh x,$$

$$\tanh x = \sinh x/\cosh x = 1/\coth x$$

$$\cosh^2 x - \sinh^2 x = 1$$

$$\sinh x = -\sinh -x,\ \cosh x = \cosh -x,$$

$$\tanh x = -\tanh -x$$

The power series definition of the hyperbolic functions are:

$$\sinh x = x + x^3/3! + x^5/5! + \ldots$$

$$\cosh x = 1 + x^2/2! + x^4/4! + x^6/6! + \ldots$$

$$\tanh x = x - x^3/3 + 2x^5/15 - 17x^7/315$$
$$+ \ldots\ (x^2 < \pi^2/4)$$

Inverse Hyperbolic Functions

The relationship between hyperbolic and inverse hyperbolic functions are given by the following expressions:

If $y = \sinh x$, then $x = \text{arcsinh } y$

Example: Determine the distance 2X between the supports for a power cable where W = 0.78 lbs/ft, T = 62 lbs. and the sag in the line is S = 13.082 ft.

$$2X = 2\ T/W \text{ arccosh } (WS/T + 1)$$

$$= [(2)\ (62)/.78]\ \text{arccosh } [(.78)\ (13.082)/62 + 1]$$

$$= 90.00077378 \text{ ft.}$$

The base relations and identities for the inverse hyperbolic function are:

$$\text{arcsinh } x = \ln (x + \sqrt{x^2 + 1}) = \text{arccosh } \sqrt{x^2 + 1}$$

$$\text{arccosh } x = \ln (x + \sqrt{x^2 - 1}) = \text{arcsinh } \sqrt{x^2 - 1}$$

$$\text{arctanh } x = 1/2 \ln [(1 + x)/(1 - x)]$$

APPENDIX D
REGISTER LEVEL PROCESSING

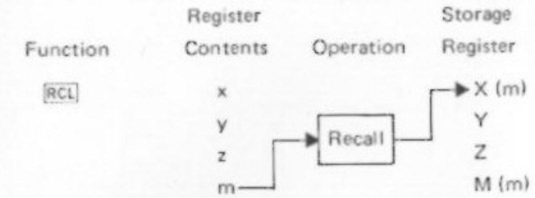
In order to provide additional insight in the data processing of the SR-50, the following discussion is included to show the details of processing at the register level. These registers are electronic elements used to store data while it is being displayed, being processed, or waiting to be processed. Please note that your SR-50 relieves you of the burden of keeping track of the contents of the registers and assigning functions. With the straightforward approach of algebraic notation entry and defined sequence of processing, the calculator automatically controls the register and function assignment.

The SR-50 uses three registers for processing. Upper case letters are used to indicate the register, while lower case letters are used to indicate the contents of each register; x in X register, y in Y register, and z in Z register. A separate register, M, is used as the memory location.

The X register is the input register. The value of x is the quantity shown on the display. This value of x is always the operand for immediate functions; it is processed and returned to X without changing the Y or Z registers. One operand for multiplication or division, and one operand for two-variable functions is always stored in the X register. The Y register is the process register. A quantity pending completion of any processing (except immediate functions) is always stored in the Y register. The Z register is the cumulative register for addition and subtraction. The M register is used as the memory location for storage and for summing to memory. It is never used for processing, so stored data does not get displaced during the processing of functions.

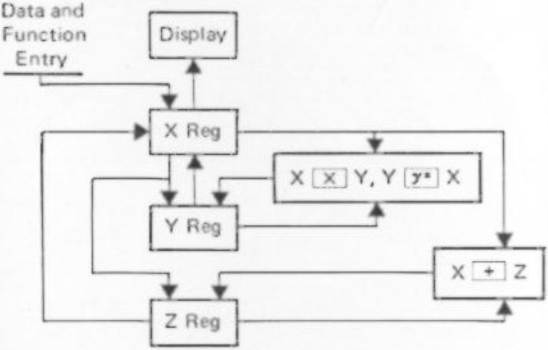
The following diagrams illustrate the transfer of data between registers for the various functions. The contents of each register after the processing is completed is shown.

Function	Register Contents	Operation	Storage Register
[+]	x	$z + x$	X $(z + x)$
	y		Y
	z		Z $(z + x)$
[−]	x	$z - x$	X $(z - x)$
	y		Y
	z		Z $(z - x)$
[×]	x	$y \times x$	X $(y \times x)$
	y		Y $(y \times x)$
	z		Z
[÷]	x	$y \div x$	X $(y \div x)$
	y		Y $(y \div x)$
	z		Z
[x^2]	x	x^2	X (x^2)
	y		Y
	z		Z
[y^x]	x	y^x	X (y^x)
	y		Y (y^x)
	z		Z
[STO]	x	Store	X (x)
	y		Y
	z		Z
	m		M (x)



Sequence of Processing

The SR-50 Data Flow Block Diagram below shows the interconnections between the registers, the processors, and the display. For simplification, the various functions have been shown simply as [+], [×], and [y^x]. The [−] function would cause the same processing sequence as the [+] function, with the [+] changed to [−]. Similarly, the [÷] function would cause the same processing sequence as the [×] function, with the [×] changed to [÷], and [$\sqrt[x]{y}$] would cause the same sequence as [y^x]. If an immediate function is entered, the data in the X register is processed, and the results stored in X without changing Y or Z registers.



SR-50 Data Flow Block Diagram

Data for a simple expression is entered into the SR-50 in the same mathematical sequence that it is written on paper. This sequence, then, will have the form:

Data, Function, Data, Function, . . . , Data =

For example, the sequence 5 X 4 X 3 = will yield 60 for an answer.

As the data are entered, they are stored in data registers X, Y, and Z. As functions are entered, they are stored in function registers associated with the X, Y, and Z data registers. The processing of the data is controlled by the stored functions, and is started when a function is entered.

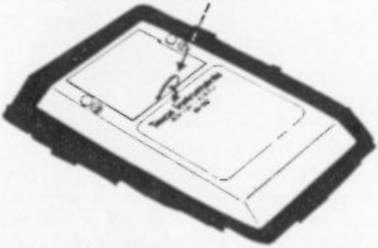
When the initial data is entered, it is stored in X register until the first function key is pressed. If the function key pressed is [+], the data is transferred to Z register. If the function key pressed is [X] or [y^x], the X data is transferred to Y register. After the transfer, the data is also still stored in X register for display. The next data is then entered into X register. The decision for the processing to be accomplished is made when the next function key is pressed, and depends upon the prior functions still stored.

After the next data is entered, any function then entered will again form one of the combinations shown. With the three process registers any sequence or combination of functions can be processed without overflowing the registers or losing data.

SERVICE INFORMATION

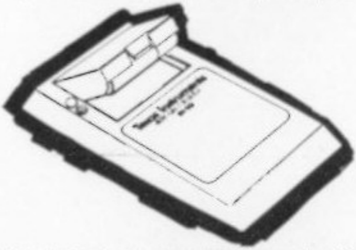
Battery Pack Replacement

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 and shorting the batteries.

To re-insert 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 packs can be purchased directly from a Texas Instruments Consumer Services Facility as listed on the back cover.

In Case of Difficulty

1. Check to be sure calculator is correctly plugged into a proper outlet that has power and that the AC Adapter/Charger voltage switch is set on the correct voltage.
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, recharge batteries.
4. Review operating instructions to be certain calculations are performed correctly.

If none of these corrects the difficulty, return the unit and charger prepaid for repair to your nearest Texas Instruments Consumer Service Facility listed on following page. Please include information on your difficulty as well as return information of name, address, city, state and zip code.

CAUTION: Use of other than the AC Adapter/Charger AC9200 may apply improper voltage to your SR-50 calculator and will cause damage.

If you have questions or need assistance with your calculator, write the Consumer Relations Department at:

Texas Instruments Incorporated
P.O. Box 22283
Dallas, Texas 75222

or call 800-527-4980 (toll-free within all continental states except Texas) or 800-492-4298 (toll-free within Texas). If outside continental United States call 214-238-2741. (We regret that we cannot accept collect calls at this number.)

Warranty Registration

To protect your warranty, complete and mail the attached Warranty Registration Card within 10 days of purchase or receipt as a gift. Also record the serial number of your calculator below. Any correspondence concerning your calculator must include both model and serial number.

Model No.	Serial No.	Purchase Date
SR-50		

Texas Instruments
slide rule calculator
SR-50

ONE YEAR WARRANTY

The SR-50 electronic calculator from Texas Instruments is warranted to the original purchaser for a period of one year from the original purchase date — under normal use and service against defective materials or workmanship.

Defective parts will be repaired, adjusted and/or replaced at no charge when the calculator is returned prepaid to a Texas Instruments Consumer Service Facility listed below.

The warranty is void if the calculator has been visibly damaged by accident or misuse, if the serial number has been altered or defaced, or if the calculator has been serviced or modified by any person other than a Texas Instruments Consumer Service Facility.

This warranty contains the entire obligation of Texas Instruments Incorporated and no other warranties expressed, implied, or statutory are given.

The warranty is void unless the attached Warranty Registration Card has been properly completed and mailed to Texas Instruments Incorporated within 10 days of purchase.

Texas Instruments Consumer Services Facilities

Mailing Address:	**Texas Instruments Service Facility** P.O. Box 22283 Dallas, Texas 75222
Canadian Address:	**Texas Instruments Service Facility** 255 Centre St. East Richmond Hill, Ontario, Canada

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