Texas Instruments

electronic slide-rule calculator

SR-16

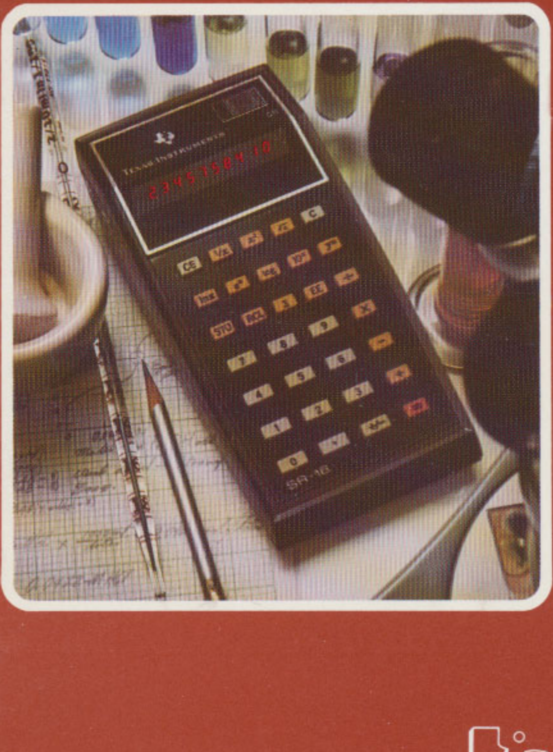


TABLE OF CONTENTS

Section *Page*

Toll-Free Telephone Assistance

For assistance with your SR-16 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 page 48 and back cover for further information on service.

SECTION 1
DESCRIPTION

Your SR-16 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 and scientific notation, make the SR-16 a versatile computational tool.

Features

Fully Portable – Extremely lightweight. Battery or AC operated.

Easy Operation – Arithmetic calculations may be performed in any sequence for chain calculations. When [=] is used to obtain a final answer, a new problem may be entered without using [C]. Special function keys operate only on the quantities displayed.

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

Versatility – Performs simple arithmetic, reciprocals, exponentiation, roots, and logarithmic functions, with entries accepted in standard or scientific notation.

Scientific Notation – Computes and displays numbers as large as $\pm 9.9999999 \times 10^{99}$ and as small as $\pm 1.0000000 \times 10^{-99}$. Automatically converts answers to scientific notation when the calculated answer is 10^{8} or greater, or when significant digits of a decimal number answer would be lost.

Accuracy — Logarithmic and Y^x functions are calculated to six places with excess digits truncated. All other functions are calculated to eight places with excess digits truncated.

Long Life — Solid-state components, integrated circuits, and light emitting diode display provides dependable operation and long life.

Rechargeable Batteries — The SR-16 calculator comes complete with *fast-charge* nickel-cadmium batteries which will provide 6 to 12 hours of operation without recharging under normal use. About 3 hours of recharging will restore full charge to the batteries.

AC Adapter/Charger — Battery recharge or direct operation from standard voltage outlets is easily accomplished with the AC Adapter/Charger model AC9200 included with the SR-16 (also used with the SR-10, SR-11, and SR-50). The SR-16 cannot be overcharged; it can be operated indefinitely with the adapter/charger connected.

Battery Operation

The *fast-charge* nickel-cadmium batteries furnished with the SR-16 calculator were fully charged at the factory before shipping. However, due to shelf-life discharging, they may require charging before initial operation.

Charging the batteries in the SR-16 is accomplished by plugging the AC Adapter/Charger AC9200 into a convenient outlet and plugging the attached cord into the SR-16 socket. The SR-16 can be used while it is being charged. A full charge requires about 3 hours with the power switch off and about 4 hours with the switch on for normal operation.

When batteries become discharged, calculator operation may become erratic with random flashing of display digits shortly before display fades away. Attach the SR-16 to its charger and allow batteries to recharge for a moment before resuming use.

If the SR-16 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 may permanently damage batteries.

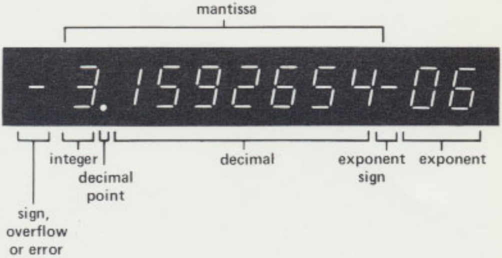
SECTION 2
OPERATING INSTRUCTIONS AND EXAMPLES

The algebraic entry format of problems makes your SR-16 easy to operate. While operation of many functions may be obvious, the operating instructions and examples will help you develop expertise and confidence in using your SR-16.

On/Off Switch – Located on the top right surface of the calculator. Sliding the switch to the right turns the calculator on. When the calculator is turned on, all registers (including memory), signs, and operating sequences should be cleared which results in a zero displayed in the right-most digit of the display mantissa. If a zero is not displayed, press [C] to clear calculator for operation.

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 SR-16 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 will be displayed in scientific notation with the eight most significant digits shown by the display.

The calculator blanks the display for the short time duration it uses to process problems. Any data entry 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.

[CE] **Clear Entry Key** – Clears the last number and sign entered manually on the keyboard.

[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. The [EE] can not be used to change the exponent of an intermediate result, final result, or a number recalled from memory.

[+/−] **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 the change sign key prior to [EE] changes the sign of the mantissa. If [+/−] is pressed after [EE] , the sign of the exponent is changed.

Scientific Notation

Any number can be entered into the SR-16 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: 1.2×10^{-11} = 0.000000000012

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

To change the mantissa or its sign after [EE] has been pressed, press [CE] and reenter the number. If a chain calculation is not in progress, the sign of the mantissa may be changed by pressing [=] and [+/−].

Data in scientific notation form may be entered intermixed with data in standard form. The calculator will convert the entered data for proper calculation. For example: $12575 + 3.2 \times 10^3 + 2855 = 18630$.

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

The calculator will maintain results in scientific notation only if significant digits would be lost in reverting to standard notation. For example:

Enter	Press	Display
3	[EE]	3. 00
5	[1/x]	3.3333333 −06
2	[EE]	2. 00
5	[1/x]	0.000005

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 is more than eight digits before the decimal or seven digits after the decimal, it is automatically converted to scientific notation.

Error Indication

Under any error, underflow, or overflow condition, the mantissa sign position of the display will read E, and a 0. will appear in the right-hand digit of the mantissa. When the error condition occurs, all data and function key entries are locked out.

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^{99} or smaller than 1.0×10^{-99}.

2. The mantissa is negative when either [√x], [log], [ln x], or [y^x] is pressed.

3. The mantissa is zero when either [log] or [ln x] is pressed.

4. Dividing a number by zero.

Pressing [C] removes an error indication.

ARITHMETIC FUNCTIONS

[+] **Add Key** – Instructs the calculator to add the next entered quantity to the previous number or result.

[−] **Subtract Key** – Instructs the calculator to subtract the next entered quantity from the previous number or result.

[×] **Multiply Key** – Instructs the calculator to multiply the previous number or result by the next entered quantity.

[÷] **Divide Key** – Instructs the calculator to divide the previous number or result by the next entered quantity.

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

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

Performing arithmetic calculations with your SR-16 calculator is simple and direct. The following examples illustrate the operation of your calculator.

Repeated pressing of the function keys is not ignored. If a keyboard number entry or memory recall is not made between function key entries, the calculator assumes that the displayed number is the entry each time a function key is pressed.

Example:

Enter	Press	Display
5	[+]	5.
	[+]	10.
	[+]	20.
	[=]	40.
5	[×] [×] [×] [=]	390625.
5	[÷] [=]	1.
5	[−] [=]	0.

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: $27.2 \times 18 = 489.6$

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

Example: $11.7 \div 5.2 = 2.25$

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

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

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

Mixed Calculations

An intermediate result of a calculation is displayed when [+], [–], [X], 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) X 4 + 55.2 ÷ 4 = 5.6

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

MEMORY OPERATIONS

The memory keys allow data 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. The [RCL] 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. The use of this key does not affect the displayed quantity nor the previously calculated data.

The [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 entering the first quantity using [Σ] .

The memory may be used to store a constant for repeated calculations, or to store a calculated result for future use.

Example: 16 X .253 = 4.048
136 X .253 = 34.408

Enter	Press	Display
16	[X]	16.
.253	[STO] [=]	4.048
136	[X] [RCL] [=]	34.408

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

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

SPECIAL FUNCTIONS

[1/x] **Reciprocal Key** – Instructs the calculator to find the reciprocal of the number displayed.

[x^2] **Square Key** – Instructs the calculator to find the square of the number displayed.

[$\sqrt{x}$] **Square Root Key** – Instructs the calculator to find the square root of the number displayed.

[y^x] **Y to the x Power Key** – Instructs the calculator to raise a number to a power. The displayed number prior to pressing [y^x] is assumed as Y. The number entered immediately after pressing [y^x] is assumed as x. Pressing [=] 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.

[log] **Common Logarithm Key** – Instructs the calculator to determine the logarithm to the base 10 of the displayed number.

[10^x] **10 to the x Power** – Instructs the calculator to raise the number 10 to the displayed power.

[ln x] **Natural Logarithm Key** – Instructs the calculator to determine the logarithm to the base e of the displayed number.

[e^x] **e to the x Power** – Instructs the calculator to raise the value of e to the displayed power.

The special function keys process only the displayed quantity; either an entered number, a calculated result, or a number recalled from memory.

Functions [y^x], [log], [10^x], [lnx], and [e^x] provide results to six significant digits. All other functions are calculated to eight significant digits.

Reciprocals

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

Enter	Press	Display
3.2	[1/x]	0.3125

Example: $\frac{1}{1.1 \times 10^{-18}} = 9.090909 \times 10^{17}$

Enter	Press	Display
1.1	[EE]	1.1 00
18	[+/-]	1.1 -18
	[1/x]	9.090909 17

Squares

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

Square Roots

Example: $\sqrt{6.25} = 2.5$

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

Example: $\sqrt{1.1 \times 10^8} = 10488.088$

Enter	Press	Display
1.1	[EE]	1.1 00
8	[$\sqrt{x}$]	10488.088

Two-Variable Function (Y^x)

Example: $(8)^3 = 512$

Enter	Press	Display
8	[y^x]	0.903089
3	[=]	511.999

The SR-16 uses the common logarithm in computing Y^x, therefore the Log of 8 was displayed when [y^x] was pressed.

Two-variable roots and other complex calculations can be solved using [y^x] .

Example: $\sqrt[23]{3.95 \times 10^{12}} = (3.95 \times 10^{12})^{1/23} = 3.52921$

Enter	Press	Display
23	[1/x] [STO]	4.347826 –02
3.95	[EE]	3.95 00
12	[y^x]	12.5965
	[RCL] [=]	3.52921

Common Logarithms

Example: log 1573 = 3.19672

Enter	Press	Display
1573	[log]	3.19672

Example: Antilog (−2.3) = $10^{-2.3}$ = 5.01187 X 10^{-3}

Enter	Press	Display
2.3	[+/−] [10^x]	5.01187 −03

Natural Logarithms

Example: ln 5.4 = 1.68639

Enter	Press	Display
5.4	[lnx]	1.68639

Example: $e^{3.8}$ = 44.7011

Enter	Press	Display
3.8	[e^x]	44.7011

Mixed Calculations

When using one of the special function keys in a chain calculation, enter the problem such that the special function resultant begins the chain calculation sequence.

Example: $34.7 + (8.7)^{2.6} = 311.872$

Enter	Press	Display
8.7	[y^x]	0.939519
2.6	[=] [+]	277.172
34.7	[=]	311.872

Example: $1.35 \times (e^{1.3} + 16) = 26.55355$

Enter	Press	Display
1.3	[e^x] [+]	3.66929
16	[X]	19.66929
1.35	[=]	26.553541

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]	1.2048192 –01
1.3	[x^2] [–]	1.69
	[RCL] [+]	1.569518
16	[=]	17.569518

Example: $4.2^{\ln 3.7} = 6.53758$

Enter	Press	Display
3.7	[$\ln x$] [STO]	1.30833
4.2	[y^x] [RCL] [=]	6.53756

SECTION 3
COMPLEX MATHEMATICAL METHODS

Many complex problems requiring interim calculations can be solved easily with the SR-16 by using the memory. This convenient storage capability eliminates the need for writing down and reentering interim results. The memory also permits problems to be solved by conventional procedures instead of rewriting the problems for sequential operation.

Sum of Products or Quotients

Example: $(e^{11} \times 3) + (10^{4.1} \times 5) = 242568.7$

Enter	Press	Display
11	[e^x] [×]	59874.1
3	[=] [STO]	179622.3
4.1	[10^x] [×]	12589.2
5	[=] [Σ]	62946.
	[RCL]	242568.3

Example: $\frac{\ln 2}{5} - \frac{\ln 3}{4} = -0.1360236$

Enter	Press	Display
3	[ln x] [÷]	1.09861
4	[=] [STO]	0.2746525
2	[ln x] [÷]	0.693147
5	[−] [RCL] [=]	−0.1360231

Example: 1/(1/10 + 1/20 + 1/30) = 5.4545454

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]	5.4545455

Example:

$$1 + 2.5 \ln 16 + \frac{(2.5 \ln 16)^2}{2} + \frac{(2.5 \ln 16)^3}{6} = 87.4582$$

Enter	Press	Display
1	[STO]	1.
16	[lnx] [×]	2.77258
2.5	[=] [Σ]	6.93145
	[x²] [÷]	48.044999
2	[=] [Σ]	24.022499
16	[lnx] [×]	2.77258
2.5	[=] [yˣ]	0.840824
3	[=] [÷]	333.021
6	[=] [Σ]	55.5035
	[RCL]	87.457449

Example: $\frac{3 \ln 2}{4 \ln 3 + 6 \ln 5} = 0.1479916$

Enter	Press	Display
3	[lnx] [X]	1.09861
4	[=] [STO]	4.39444
5	[lnx] [X]	1.60943
6	[=] [Σ]	9.65658
2	[lnx] [X]	0.693147
3	[÷] [RCL] [=]	1.4799217 –01

Product or Quotient of Sums

Example: $\left(\frac{1}{e^{1.2}} + 3\right) \times (4 + 5^{2.6}) = 229.9717$

Enter	Press	Display
1.2	[+/–] [e^x] [+]	0.301194
3	[=] [STO]	3.301194
5	[y^x]	0.698969
2.6	[=] [+]	65.6631
4	[X] [RCL] [=]	229.9714

Example: $\frac{\log 2 - 4}{4.2^{1/2} + 6} = -0.4595341$

Enter	Press	Display
4.2	[$\sqrt{x}$] [+]	2.0493901
6	[=] [STO]	8.0493901
2	[log] [–]	0.301029
4	[÷] [RCL] [=]	–4.5953431 –01

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

Example: $\frac{2 \times 3}{\ln(2+3)} = 3.728009$

Enter	Press	Display
2	[+]	2.
3	[=] [lnx]	1.60943
	[1/x] [×]	6.2133798 −01
2	[×]	1.2426759
3	[=]	3.7280277

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

Example: $5 + 4 \ln[6 + 2 \ln(3 + 7)] = 14.44536$

Enter	Press	Display
3	[+]	3.
7	[=] [lnx] [×]	2.30258
2	[+]	4.60516
6	[=] [lnx] [×]	2.36134
4	[+]	9.44536
5	[=]	14.44536

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.

Example: $$\frac{[3+(1.56)^{1/2}] \times [4+(3.14)^2]}{(3^{-1.3}+4) \times (e^{-.56}+1)} = 8.8402405$$

Enter	Press	Display
3	[y^x]	0.477121
1.3	[+/−] [=] [+]	0.239741
4	[=] [STO]	4.239741
.56	[+/−] [e^x] [+]	0.571209
1	[X] [RCL] [=] [STO]	6.6615192
1.56	[$\sqrt{x}$] [+]	1.2489995
3	[÷] [RCL] [=] [STO]	6.3784241 −01
3.14	[x^2] [+]	9.8596
4	[X] [RCL] [=]	8.8402406

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	[=] [Σ] [RCL]	4.	$B^2 - 4\ AC$
	[$\sqrt{x}$] [STO] [−]	2.	Stored $\sqrt{B^2 - 4AC}$
8	[÷]	−6.	
2	[÷]	−3.	
3	[=]	−1.	Root 1
8	[+/−] [−]	−8.	
	[RCL] [÷]	−10.	
2	[÷]	−5.	
3	[=]	−1.6666666	Root 2

Trigonometric Functions

You can greatly augment the capability of the SR-16 by using tables of trigonometric values, such as *C.R.C. Standard Mathematical Tables* published by Checmical Rubber Co., 18901 Cranwood Parkway, Cleveland, Ohio 44128.

However, you can also use the SR-16 to *calculate* the value 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 SR-16 calculator. As a result, the trigonometric and inverse trigonometric functions involve angles expressed in radians. To convert degrees into radians, multiply by $\pi/180$ or $355/(113 \times 180)$. Conversely, to convert radians into degrees, we multiply by $180/\pi$ or $180 \times 113/355$.

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%

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

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

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

Accuracy

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

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

Accuracy	
a in Degrees	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.
355	[÷]	8875.
113	[÷]	78.539823
180	[=] [STO]	4.3633235 –01
	[x^2] [÷]	1.9038591 –01
20	[+]	9.5192955 –03
1	[=] [1/x] [×]	9.9057056 –01
10	[–]	9.9057056
7	[×] [RCL] [÷]	1.2678533
3	[=]	4.2261776 –01

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

Inverse Trigonometric Functions

Arc Sine

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

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	$<0.03\%$

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

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

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

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

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%

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

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

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 = 36.869897°

Enter	Press	Display	Remark
2	÷	2.	
.75	+	2.6666666	
1	= 1/x ×	2.7272727 –01	
5	−	1.3636363	
1	÷	0.3636363	
2	= STO	1.8181815 –01	value of b
	x^2 ×	3.3057839 –02	
3	÷	9.9173517 –02	
5	+	1.9834703 –02	
1	= 1/x ×	9.8055106 –01	
5	+	4.9027553	
4	× RCL ÷	1.6186824	
9	+	0.1798536	arc tan b
.4636476	×	0.6435012	arc tan a in radians
180	×	115.83021	
113	÷	13088.813	
355	=	36.869895	arc tan a in degrees

Hyperbolic Functions

Solving problems involving hyperbolic functions with the SR-16 is simple and straightforward.

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

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

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

Example: tanh 2.99 = 0.9949551

Enter	Press	Display
2.99	[×]	2.99
2	[=] [e^x] [+]	395.44
1	[=] [STO] [−]	396.44
2	[÷] [RCL] [=]	0.9949551

Inverse Hyperbolic Functions

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

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

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

Example: $\sinh^{-1}$ 86.213 = 5.15

Enter	Press	Display
86.213	[STO] [x^2] [+]	7432.6813
1	[=] [$\sqrt{x}$] [+]	86.218798
	[RCL] [=] [ln x]	5.15

SECTION 4
SAMPLE PROBLEMS

Your SR-16 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 SR-16 to step through the sample problems in this section that relate to your disciplines and interests.

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]	0.0324172
8	[=] [×]	1.81692
15000	[=]	27253.8

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
4	[×]	4.
13	[=] [STO]	52.
.063	[÷]	0.063
4	[+]	0.01575
1	[=] [y^x] [RCL] [=] [1/x] [×]	4.4369706 –01
35570	[=]	15782.304

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]	0.0303972
9	[=] [−]	1.87748
1	[÷]	0.87748
.0725	[X]	12.103172
3500	[=]	42361.102

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.

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

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

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

$$= 0.56494382 \text{ inches of water}$$

Enter	Press	Display
3000	[x^2] [÷]	9000000.
4005	[X]	2247.191
2.8	[EE]	2.8 00
6	[+/−] [X]	6.2921348 −03
145	[÷]	9.1235954 −01
2.5	[=] [STO]	3.6494381 −01
3000	[x^2] [X]	9000000.
8.9	[EE]	8.9 00
5	[+/−] [÷]	801.
4005	[=] [Σ] [RCL]	5.6494381 −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	×	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.

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

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

$$= 15546.205 \text{ lb}$$

Enter	Press	Display
5	[÷]	5.
2	[=] [STO]	2.5
3.5	[÷]	3.5
2.5	[=] [x^2] [+]	1.96
1	[=] [y^x] [RCL]	2.5
	[=] [×]	15.074
3	[×]	45.222
13500	[÷]	610497.
2	[÷]	305248.5
3.1416	[=] [STO]	97163.388
2.5	[x^2] [1/x] [×]	0.16
	[RCL] [=]	15546.142

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.

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

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

$$= 36.508015 \text{ minutes}$$

Enter	Press	Display
3	[1/x] [STO]	3.3333333 −01
1.7	[x^2] [×]	2.89
.15	[=] [1/x] [×]	2.306805
1350	[=] [y^x]	3.49334
	[RCL] [=] [×]	14.6031
2.5	[=]	36.50775

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.

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

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

$$= 1081.9574 \text{ psi}$$

Enter	Press	Display
8.5	[x^2] [×]	72.25
2.5	[×]	180.625
7	[÷]	1264.375
8	[÷]	158.04687
3	[=] [1/x] [×]	1.898171 −02
2	[×]	3.796342 −02
28500	[=]	1081.9574

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?

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

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

$$= 14.40872 \text{ V}$$

Enter	Press	Display
250	[+/-] [EE]	−250. 00
3	[+/-] [÷]	−0.25
3300	[÷]	−7.5757575 −05
47	[EE] [+/-]	47.−00
6	[=] [e^x] [+/-] [+]	−0.199515
1	[×]	0.800485
18	[=]	14.40873

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?

$$L = 0.08047 + 7411 \log \frac{\sqrt[3]{d_{12}d_{23}d_{13}}}{r}$$

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

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

Enter	Press	Display
3	[1/x] [STO]	3.3333333 −01
56	[x^2] [×]	3136.
96	[=] [y^x]	5.47864
	[RCL] [=] [÷]	67.0217
.3	[=] [log] [×]	2.34909
.7411	[+]	1.7409105
.08047	[=]	1.8213805

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] [+] [RCL]	765625.
	[=] [√x] [+]	1736.5554
875	[×]	2611.5554
16	[÷]	41784.886
355	[×]	117.7039
113	[=] [STO]	13300.54
1.3	[yˣ]	0.113943
3	[=] [1/x] [×]	0.4551682
	[RCL] [=]	6053.9828

Note that the value of π was approximated by equating to 355/113.

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.

$$I = \pi ma\,(r_1^4 - r_2^4)/2$$

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

$$= 4859.1406 \text{ lb/ft}^2$$

Enter	Press	Display
1.25	[y^x]	0.09691
4	[=] [STO]	2.4414
.8	[y^x]	–0.09691
4	[=] [+/–] [Σ]	–0.4096
	[RCL] [÷]	2.0318
2	[×]	1.0159
355	[÷]	360.6445
113	[×]	3.1915442
435	[×]	1388.3217
3.5	[=]	4859.1259

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

$$Ca = (\pi d^2/4)\,(L)\,(1 + C - CR_p{}^{1/R})$$

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

$$= 18.052401 \text{ cu in/cycle}$$

Enter	Press	Display
1.8	[1/x] [STO]	5.5555555 –01
9.5	[y^x] [RCL] [=] [×]	3.49284
.07	[+/–] [+]	–0.2444988
.07	[+]	–0.1744988
1	[×]	0.8255012
5.5	[×]	4.5402566
355	[÷]	1611.791
113	[÷]	14.263637
4	[=] [STO]	3.5659092
2.25	[x^2] [×] [RCL] [=]	18.052415

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

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

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

$$\epsilon_c = \frac{\ln \dfrac{200}{14.7}}{\dfrac{3 \times 1.27}{1.27-1}\left[\left(\dfrac{200}{14.7}\right)^{\frac{1.27-1}{3 \times 1.27}} - 1\right]} = 0.9103533$$

Enter	Press	Display
1.27	[−]	1.27
1	[÷]	0.27
3	[÷]	0.09
1.27	[=] [STO]	7.0866141 −02
200	[÷]	200.
14.7	[=] [y^x]	1.13371
	[RCL] [=] [−]	1.20321
1	[×]	0.20321
3	[×]	0.60963
1.27	[=] [STO]	0.7742301
1.27	[−]	1.27
1	[=] [1/x] [×]	3.7037037
	[RCL] [=] [STO]	2.8675188
200	[÷]	200.
14.7	[=] [lnx] [÷]	2.61046
	[RCL] [=]	9.1035497 −01

Chemical Engineering

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

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

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

$$= 3.45593 \text{ per liter}$$

Enter	Press	Display
3.5	[EE]	3.5 00
4	[+/-] [1/x]	2857.1428
	[log]	3.45593

Equilibrium Constant – An equilibrium mixture of H_2, I_2, and HI gases at 425°C consists of 4.1082 X 10^{-3} mole/liter of H_2, 6.64 X 10^{-4} mole/liter of I_2, and 12.189 X 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	+/− x^2 ÷	1.4857172 −04
4.1082	EE	4.1082 00
3	+/− ÷	3.6164675 −02
6.64	EE	6.64 00
4	+/− =	54.464871

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.

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

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

$$= 0.795937\ ft^3/gal$$

Enter	Press	Display
12	+	12.
34	÷	46.
34	= log ×	0.131278
245	= 1/x ×	3.109152 −02
32	×	9.9492864 −01
.8	=	7.9594291 −01

NOTES

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 calculator **and charger** prepaid for repair to your nearest Texas Instruments Consumer Service Facility listed on back cover. 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-16 calculator and will cause damage.

If You Have Questions or Need Assistance

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 Consumer Relations at 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 214-238-5461. (We regret that we cannot accept collect calls at this number.)

Warranty Registration
Owner's Copy

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.

SR-16

Model No. **Serial No.** **Purchase Date**

Texas Instruments
electronic slide-rule calculator
SR-16

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The SR-16 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 caluclator has been serviced or modified by any person other than a Texas Instruments Consumer Service Facility.

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