Texas Instruments
engineering desk calculator
SR-20

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SECTION 1
DESCRIPTION OF YOUR SR-20

Your SR-20 Engineering Desk Calculator is designed especially for use by scientists, engineers, and students who require a compact, highly accurate, and reliable computation tool. The SR-20 is capable of solving a wide range of complex scientific problems; it will also solve the simplest arithmetic problem. Designed with state-of-the-art MOS solid-state circuitry, constructed with high quality components throughout, and assembled with precise workmanship, your SR-20 should provide years of reliable service.

Features of Your SR-20

Accuracy — Calculates answers to 13 significant digits; display indicates answers rounded off to 10 significant digits. For maximum accuracy, the SR-20 electronic calculator uses all 13 significant digits for subsequent calculations.

Versatility — Performs addition, subtraction, multiplication, division, and special functions including reciprocals, factorials, squares, square roots and integers, all in full floating decimal point or in scientific notation, and provides keys for constants π (pi) and e (epsilon).

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 — a number (mantissa) times 10 raised to a power (exponent) — when the calculated answer is greater than 10^{10} or less than 10^{-10}.

Ease of Operation — Operations are performed in the same order as with classical slide rules. For simple arithmetic operations, just touch the numbers and functions as you would write them on paper. Automatic clearing — no need to touch clear key between problems.

Convenient Size, Light Weight — Conveniently styled for minimum desk top area, the SR-20 weighs less than two (2) pounds and fits neatly into briefcase or suitcase.

Long Life — Solid-state components, integrated circuits, and the gas discharge display provide dependable operation and long life. High impact molded plastic case resists scratching and smudging.

Convenient AC Operation — Operates directly from household current through the detachable 5-1/2 foot AC line cord.

Display Readability — Large 12-digit display allows hours of fatigue-free operation. The display shows all numerals, floating decimal point, negative signs, and calculation overflow indication (blinking display).

SECTION 2
OPERATING INSTRUCTIONS

On/Off Switch and Power Requirements

The on/off switch is located on the right side surface of the calculator. It is a horizontally operated slide switch which applies power when pushed away from the operator, and removes power when moved toward the operator. The power-on condition is indicated by illumination of the first digit in the mantissa on the right of the display.

Normal household 110 V AC, 60 Hz power operates the calculator. The calculator is designed to operate on widely varying line voltages and will be essentially immune to both high and low voltage fluctuations.

Keyboard Description

The keyboard consists of 27 keys, which may be classified as data entry keys, basic function keys, and special function keys.

Data Entry Keys

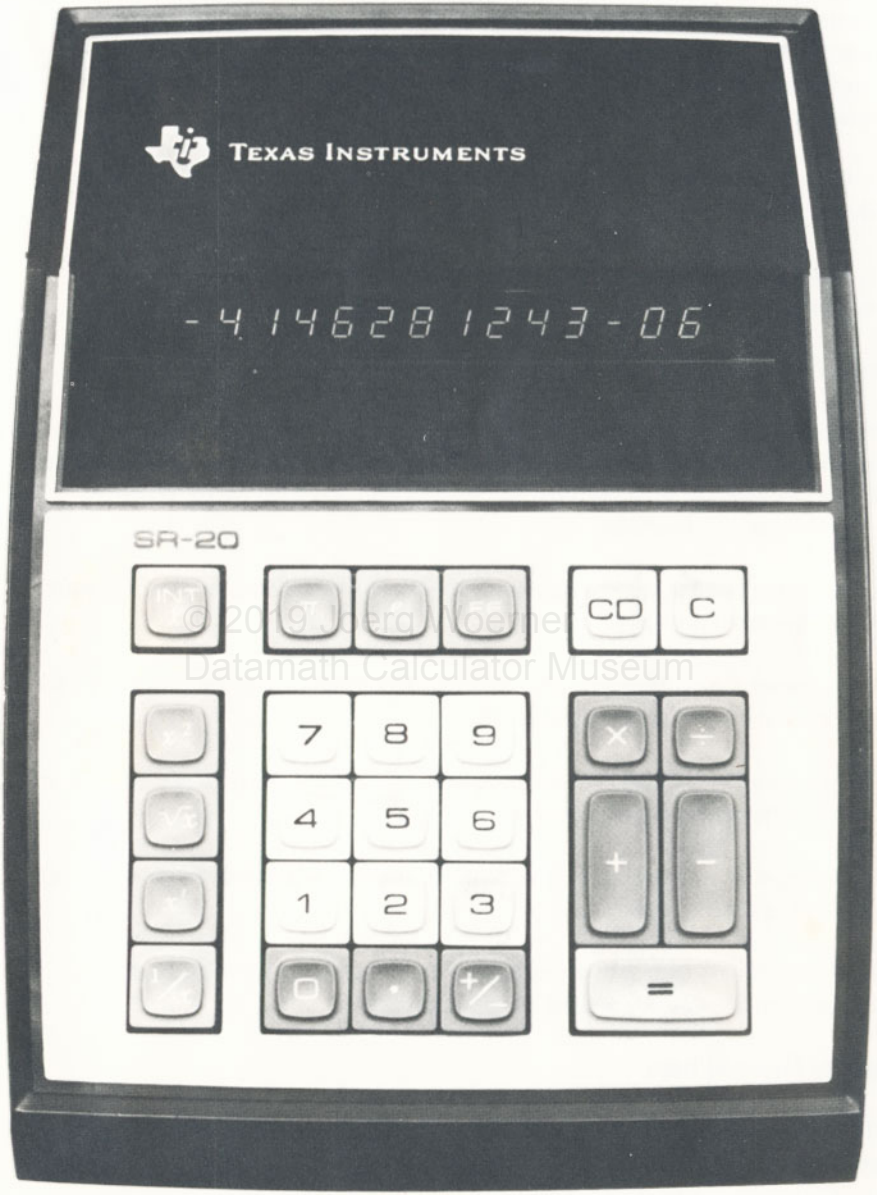
[0] **through** [9] **Digit Keys** – Enters numbers 0 through 9 to a limit of a 10-digit mantissa and a 2-digit exponent.

[·] **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).

[e] **Epsilon Key** – Enters the value of epsilon (e) to 13 significant digits (2.718281828459). Display indicates value rounded off to 10 significant digits (2.718281828).

[EE] **Enter Exponent Key** – Instructs the calculator that the subsequent number is to be entered as an exponent of 10. To enter a number in scientific notation, first enter the mantissa, press [EE] and enter the desired 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 — Instructs the calculator to change the sign of the mantissa or exponent appearing in the display. To enter a negative number, first enter the number and then press the key. Using this change sign key prior to using the EE key changes the sign of the mantissa. If the key is pressed after the EE key, the sign of the exponent is changed.

Clear Key — Clears (erases) information in calculator and display and sets calculator to zero for start of new problem.

Clear Display Key — Clears the last number entered manually in the keyboard or the last calculated result, whichever is displayed.

Basic Functions Keys

The four basic function keys — + , − , × , and ÷ — complete any previous calculation instructions before instructing the calculator what the next calculation will be. In essence, they perform an = function and then perform the + , − , × , or ÷ function.

Add Key — Instructs the calculator to add to the previous number or result the next entered quantity.

Subtract Key — Instructs the calculator to subtract from the previous number or result the next entered quantity.

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 previously entered operation to provide the desired calculation result.

Special Function Keys

The special functions keys operate on the displayed quantity and do not complete any previous calculation instructions.

Reciprocal Key — Instructs the calculator to find the reciprocal of the number displayed (that is, to divide the number displayed into 1).

[x!] **Factorial Key** – Instructs the calculator to find the factorial of the number displayed (that is, the product of all integer numbers from one through the integer value displayed).

[√x] **Square Root Key** – Instructs the calculator to find the square root of the number displayed (that is, to find the number which multiplied by itself, equals the number displayed).

[x²] **Square Key** – Instructs the calculator to find the square of the number displayed (that is to multiply the number displayed by itself).

[INT x] **Integer Key** – Instructs the calculator to truncate the decimal portion of the number being displayed leaving only the integer portion of the number in the display to be used for further calculations.

Display Description

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

Minus Sign – Appears to the left of the 10-digit mantissa to indicate negative numbers, and appears on 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 positioned in another sequence by use of [.] key. When entering numbers, the decimal will not appear until [.] is pressed.

Overflow Indication – The largest number that can be entered in the calculator is $\pm 9.999999999 \times 10^{99}$ without an overflow indication when a function key is pressed. If a calculation result is larger than this value, the calculator display will flash 9.999999999 99 or –9.999999999 99.

Underflow Indication – If a number closer to zero than $\pm 1. \times 10^{-99}$ is entered in the calculator, the calculator will flash 1. –99 or –1. –99 when a function key is pressed. If a calculation result is closer to zero than $\pm 1. \times 10^{-99}$ the calculator will flash 1. –99, –1. –99, or 0. 00.

Error Indication – The SR-20 calculator always attempts to give the most accurate results. For several invalid operations, the SR-20 will perform an assumed valid operation and flash the calculated result. If the calculator is instructed to find the square root of a negative value, it will calculate the square root of the positive value and the display will flash on and off with this calculated result. Similarly, if the calculator is instructed to find the factorial of a value not an integer, it will calculate the factorial of the integer of the value and the display will flash on and off with this calculated result.

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

Other Calculator Features

Automatic Clearing – The SR-20 calculator automatically clears itself between most calculations. Any prior calculation result is cleared if a number key is pressed without having had a basic function key other than [=] pressed beforehand.

Calculation Time – All calculations except large factorials are performed in less than a tenth of a second. The largest factorial the SR-20 can compute without an overflow condition is 69!.

Scientific Notation – Any number can be entered into the SR-20 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, 110,000,000,000 is written as 1.1×10^{11}.

Enter	Press	Display
1.1	[EE]	1.1 00
11		1.1 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 $1.1 \times 10^{-11} = 0.000000000011$

Enter	Press	Display
1.1	EE	1.1 00
11	+/-	1.1 −11

Note: The negative sign for the exponent appears immediately to the left of the exponent (to the right of the mantissa).

By using scientific notation, you can retain 10 significant digit accuracy even on numbers less than unity (1). If you use the EE key in a calculation, all results will remain in scientific notation until you press the C key.

If the EE key has been depressed but the operator wants to change the mantissa; such as adding more digits for greater accuracy or changing the sign of the mantissa, he may do so by simply pressing the . key and making the appropriate entry on the keyboard. Also, if the operator wants to change the exponent and/or its sign, he may do so by simply pressing the EE key again and making the appropriate entry on the keyboard. Example: -1.32765×10^{-21}.

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		To change exponent
22	+/-	−1.32765 −22	

SECTION 3
OPERATING EXAMPLES

Performing calculations with your SR-20 calculator is easy. Numbers and functions are entered in the same sequence as the expression is written on paper. The following examples should help in learning to properly operate the calculator.

Addition and Subtraction

Example: 4.23 + 4 = 8.23

Enter	Press	Display
4.23	+	4.23
4	=	8.23

Example: 6 − 1.854 = 4.146

Enter	Press	Display
6	−	6.
1.854	=	4.146

Example: 12.32 − 7 + 1.6 = 6.92

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

Example: −5.35 − (−4.2) − 3.1 = −4.25

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

Multiplication and Division

Example: 27.2 X 18 = 489.6

Enter	Press	Display
27.2	×	27.2
18	=	489.6

Example: 11.7 ÷ 5.2 = 2.25

Enter	Press	Display
11.7	÷	11.7
5.2	=	2.25

Example: (4 X 7.3) ÷ 2 = 14.6

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

Example: C = 2 πr = 2 X π X 3.5 = 21.99114858

Enter	Press	Display
2	×	2.
π	×	6.283185307
3.5	=	21.99114858

Note: Intermediate result of multiplication is displayed when next × or ÷ key is pressed; it is not necessary to press the = key to obtain the intermediate result. Nor is it necessary to re-enter the intermediate result for further calculations.

Positive and Negative Number Calculations

A negative sign is assigned to a number by pressing the [+/-] key directly after entering the number.

Example: 7 X −18.5 = −129.5

Enter	Press	Display
7	[×]	7.
18.5	[+/-] [=]	−129.5

Example: −125 ÷ 5 = −25

Enter	Press	Display
125	[+/-] [÷]	−125.
5	[=]	−25.

Alternate Methods:

Enter	Press	Display
	[C]	0
	[+/-]	−0
125	[÷]	−125.
5	[=]	−25.

Enter	Press	Display
	[C]	0
	[−]	0.
125	[÷]	−125.
5	[=]	−25.

Note: When a negative number is to be the first number in a calculation the [−] key or the [+/-] key can be used as long as the [C] key is pressed beforehand to clear the calculator.

Mixed Calculations

Example: $(8.3 + 2) \div 4 - 6.8 = -4.225$

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

Example: $(-5.2 - 3) \times 4 + 55.2 \div 4 = 5.6$

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

Reciprocals

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

Enter	Press	Display
3.2	1/x	0.3125

Example: $5.3 \div (3.1 + 4.3) = 0.7162162162$

Enter	Press	Display
3.1	+	3.1
4.3	=	7.4
	1/x ×	.1351351351
5.3	=	.7162162162

Note: When operating on an expression containing functions enclosed in parenthesis, it is necessary to complete the calculation within the parenthesis first to avoid re-entering intermediate results.

Example: $12\left(1-\frac{1}{e}\right) = 7.585446706$

Enter	Press	Display
1	−	1.
e	1/x ×	.6321205588
12	=	7.585446706

Squares

Example: $(4.2)^2 = 17.64$

Enter	Press	Display
4.2	x²	17.64

Example: $(4.2)^2 + (23.3 - 20.3)^2 = 26.64$

Enter	Press	Display
23.3	−	23.3
20.3	=	3.
	x² +	9.
4.2	x²	17.64
	=	26.64

Square Roots

Example: $\sqrt{6.25} = 2.5$

Enter	Press	Display
6.25	√x	2.5

Example: $\sqrt{(2.3+5.1)^2 + (3.1)^2} = 8.023091673$

Enter	Press	Display
2.3	+	2.3
5.1	=	7.4
	x² +	54.76
3.1	x²	9.61
	=	64.37
	√x	8.023091673

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

Enter	Press	Display
4	√x [+]	2.
9	√x	3.
	=	5

Factorials

Example: 7! = 5040

Enter	Press	Display
7	x!	5040.

Example: 7.3! = 5040

Enter	Press	Display
7.3	x!	5040. Flashing

Note: 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 clear key must be pressed to remove the flashing condition of the display.

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

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

Integers

Example: [3.13] = 3

Enter	Press	Display
3.13	INT x	3.

Note: [x] = Integer of x

Example: [23.2 X 2.6] = 60

Enter	Press	Display
23.2	×	23.2
2.6	=	60.32
	INT×	60.

Example: [10 X 73.42 X 10^2] = 7.342 X 10^4 = 73,420

Enter	Press	Display
73.42	EE	73.42 00
2		73.42 02
	×	7.342 03
10	=	7.342 04
	INT×	7.342 04

Note: No display change after INT× operation since the number is already an integer value expressed in scientific notation.

Error Corrections

If a wrong key is accidentally pressed during a calculation (particularly a long one), it is often desirable to correct the error rather than to clear the calculator and begin again.

Corrections can be made to numerical errors in a series of mixed calculations only if the CD key is pressed before the next function key in the sequence is pressed.

Example: 3.2 X 4.4 ÷ 5 = 2.816

Enter	Press	Display	Remarks
3.2	×	3.2	
4.3		4.3	Error
	CD	0	Correction
4.4	÷	14.08	
5	=	2.816	

A basic function error made in a series of mixed calculations can be corrected through use of the CD and 1 keys.

If an error is made by erroneously pressing the [+] or [−] key, you need only clear the display by pressing the [CD] key and then pressing the correct key.

Example: 5 + 9.7 ~~+~~ − 2.3 = 12.4

Enter	Press	Display	Remarks
5.	[+]	5.	
9.7	[+]	14.7	Error
	[CD] [−]	14.7	Correction
2.3	[=]	12.4	

Note: In essence, this method adds zero to (or subtracts zero from) the previous number or result.

If an error is made by erroneously pressing the [×] or [÷] key, it is corrected by multiplying or dividing the interim result by unity.

Example: 4.1 X 3.2 ~~X~~ ÷ 2 = 6.56

Enter	Press	Display	Remarks
4.1	[×]	4.1	
3.2	[×]	13.12	Error
1	[÷]	13.12	Correction
2	[=]	6.56	

Example: 4.1 X 3.2 ~~X 2~~ ÷ 2 = 6.56

Enter	Press	Display	Remarks
4.1	[×]	4.1	
3.2	[×]	13.12	Error
2	[CD]	0	Display Cleared
1	[÷]	13.12	Correction
2	[=]	6.56	

Note: If a number has been entered after the erroneous function key, it is necessary to clear the display before entering unity into the calculator.

Order of Operations

Many complex engineering problems require multiple steps of processing in obtaining a solution. At times, these steps must be arranged in a particular order since the sequence of operations can determine the final results. For example, the result of 3 X 2 + 5 is 11 if the sequence of operations is performed in the order shown. If the required operation is 3 times the sum of 2 plus 5, the proper value of 21 can be obtained by changing the sequence of operations to 2 + 5 X 3. To select a proper sequence for solving a problem, the process steps that occur when a function key is pressed need to be considered.

Basic Function Keys – As previously described, when one of the basic function keys is pressed, all previously entered quantities are processed and the result then displayed. In the above example problem the sequence 3 X 2 + 5 will yield 3 X 2 with a 6 displayed when the [+] key is pressed. The subsequently entered 5 will then be added to the result; 6 + 5 = 11. The sequence 2 + 5 X 3 will yield 2 + 5 with a 7 displayed when the [×] key is pressed. The result of 7 X 3 can then be obtained.

Special Function Keys – The special function keys process only the displayed quantity. In a multi-step process, the use of a special function key will not effect a previous result. For example, in the sequence 5 X 3 + $1/(2)^2$ X 4, the result of 15 is obtained when the [+] key is pressed. A 2 entered through the Data Entry keys becomes the displayed quantity. The sequence of keys [x^2] and [1/x] will process the displayed 2 and yield .25. When [×] is pressed for the subsequent multiplication by 4, the displayed quantity .25 is added to the previous result 15 which has remained unchanged during the processing by the special function keys.

SECTION 4
SAMPLE PROBLEMS

Your SR-20 calculator is a useful and versatile problem-solving tool. In order to improve your understanding of its versatility, it is recommended that you use your SR-20 to step through the sample problems in this section. A wide range of problems from several disciplines has been included with the steps in each solution shown in detail for your instruction.

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 processing other problems.

Geometry

Area of a Triangle – Find the area of a triangle with a base of 4 inches and a height of 3 inches.

$$A = \frac{1}{2} b h$$

$$= \frac{1}{2} \times 4 \times 3$$

$$= 6 \text{ sq in}$$

Enter	Press	Display
.5	×	0.5
4	×	2.0
3	=	6.

Diagonal of a Rectangle – Find the diagonal of a rectangle with a base of 4.2 inches and a height of 6.3 inches.

$$d = \sqrt{b^2 + h^2}$$

$$= \sqrt{(4.2)^2 + (6.3)^2}$$

$$= 7.57 \text{ in}$$

Enter	Press	Display
4.2	x^2 +	17.64
6.3	x^2	39.69
	=	57.33
	$\sqrt{x}$	7.571657678

Circle – For a circle with a 3.85 inch radius, find the circumference and the area of a sector subtended by 35°.

Circumference, $C = 2\pi R$

$= 2 \times \pi \times 3.85$

$= 24.19$ in

Enter	Press	Display
2	×	2
π	×	6.283185307
3.85	=	24.19026343

Area of Sector, $A_S = \frac{1}{2} r^2 \theta$ where $\theta = \frac{\text{degrees}}{180} \times \pi$

$$= \frac{1}{2} \times (3.85)^2 \times \frac{35}{180} \times \pi$$

$$= 4.527 \text{ sq in}$$

Enter	Press	Display
.5	×	0.5
3.85	x^2	14.8225
	×	7.41125
35	×	259.39375
π	÷	814.9094994
180	=	4.527274997

Sphere – Find the volume of a sphere with a radius of 3.7 inches.

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

$$= \frac{4}{3} \times \pi \times (3.7)^3$$

$$= 212.17 \text{ cu in}$$

Enter	Press	Display
3.7	×	3.7
	x^2	13.69
	= ×	50.653
4	÷	202.612
3	×	67.5373333
π	=	212.1747902

Algebra

Quadratic Equation – Find the roots of the equation $3X^2 + 7X + 4 = 0$

$$X = \frac{-b \pm \sqrt{b^2 - 4\,ac}}{2\,a}$$

$$= \frac{-(7) \pm \sqrt{(7)^2 - 4\,(3 \times 4)}}{2 \times 3}$$

$X = -1$ or $X = -1.33$

Enter	Press	Display	Remarks
	C −	.0	
4	×	−4.	
3	×	−12.	
4	+	−48.	
7	x^2	49.	
	=	1.	
	$\sqrt{x}$	1.	Intermediate Answer
	−	1.	
7	÷	−6.	
2	÷	−3.	
3	=	−1.	First Answer

Enter	Press	Display	Remarks
1	±/−	−1.	Re-enter Intermediate Answer
7	÷	−8.	
2	÷	−4.	
3	=	−1.333333333	Second Answer

Powers – Find a^n where n = 1, 2, 3, . . . 10.

Note: In order to simplify this example, the intermediate display results, which are shown in previous examples, are omitted.

Let a = 2

		Enter	Press	Display
(a)	2^2	2	x^2	4.
(b)	$2^3 = 2 \times 2^2$	2	× x^2 =	8.

		Enter	Press	Display
(c)	$2^4 = 2^2 \times 2^2$	2	x^2 x^2	16.
(d)	$2^5 = 2 \times (2^2)^2$	2	× x^2 x^2 =	32.
(e)	$2^6 = (2 \times 2^2)^2$	2	× x^2 = x^2	64.
(f)	$2^7 = \frac{1}{2} \times 2^8$	2	1/x × 1/x x^2 x^2 x^2 =	128.
(g)	$2^8 = [(2^2)^2]^2$	2	x^2 x^2 x^2	256.
(h)	$2^9 = 2 \times 2^8$	2	× x^2 x^2 x^2 =	512.
(i)	$2^{10} = 2^2 \times 2^8$	2	x^2 × x^2 x^2 =	1024.

Roots – An approximation for the n^{th} root of a number can be found by using the formulas shown below. This approximation can then be re-inserted in the formula to find a closer approximation. By continuing the process the desired accuracy can be obtained. Find $\sqrt[n]{X}$ for n = 2, 3, 4 . . . 10.

Square root – a function key, $\sqrt{X}$

Cube root $\sqrt[3]{X} = \frac{a}{3}\left(2 + \frac{X}{a^3}\right)$, where "a" is the first approximation.

For example, find $\sqrt[3]{27}$. First approximation, a = 2.5.

Enter	Press	Display	Remarks
2.5	× x^2 =	15.625	
	1/x ×	0.064	
27	+	1.728	
2	×	3.728	
2.5	÷	9.32	
3	=	3.106666667	Second Approximation
	× x^2 =	29.98361363	
	1/x ×	.0333515503	
27	+	.9004918598	
2	×	2.90049186	
3.106666667	÷	9.010861379	Re-enter Second Approximation
3	=	3.00362046	Third Approximation
	× x^2 =	27.09787042	Cube, Check Accuracy

Fourth root – press $\sqrt{x}$ twice.

Fifth root $\sqrt[5]{X} = \frac{a}{5}\left(4 + \frac{X}{a^5}\right)$

For example, find $\sqrt[5]{10{,}000}$. First approximation, a = 6.

Enter	Press	Display	Remarks
6	× x^2 x^3 =	7776.	
	$1/x$ ×	.0001286008	
10000	+	1.28600823	
4	×	5.28600823	
6	÷	31.71604938	
5	=	6.343209877	Second Approximation
	× x^2 x^3 =	10269.40792	
	$1/x$ ×	.0000973765	
10000	+	.9737659733	
4	×	4.973765973	
6.343209877	÷	31.54964145	Re-enter Second Approximation
5	=	6.30992829	Third Approximation
	× x^2 x^3 =	10002.81227	Cube, Check Accuracy

Sixth root $\sqrt[6]{X} = \frac{a}{6}\left(5 + \frac{X}{a^6}\right)$

Seventh root $\sqrt[7]{X} = \frac{a}{7}\left(6 + \frac{X}{a^7}\right)$

Eighth root – press $\sqrt{x}$ three times

Ninth root $\sqrt[9]{X} = \frac{a}{9}\left(8 + \frac{X}{a^9}\right)$

Tenth root $\sqrt[10]{X} = \frac{a}{10}\left(9 + \frac{X}{a^{10}}\right)$

Calculus

Series, e^X – Find the value of $e^{.35}$.

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

Or, by reversing the order of the terms and collecting terms,

$$e^X = \left\{\left[\left(\frac{X}{3} + 1\right)\frac{X}{2} + 1\right] X + 1\right\}$$

$$e^{.35} = \left\{\left[\left(\frac{.35}{3} + 1\right)\frac{.35}{2} + 1\right] .35 + 1\right\}$$

$$= 1.42$$

Enter	Press	Display
.35	÷	0.35
3	+	.1166666667
1	×	1.116666667
.35	÷	.3908333333
2	+	.1954166667
1	×	1.1954166667
.35	+	.4183958333
1	=	1.418395833

Note: The above answer, which was obtained by using four terms in the series, is accurate to two decimal places. Greater accuracy can be obtained by using five or more terms.

Find the value of $e^{3.6}$

Use the relation $e^{3.6} = e^3 \times e^{.6}$. Determine values for e^3 and $e^{.6}$, and multiply

$$e^{3.6} = e^3 \times e^{.6}$$

$$= e^3 \times \left[\left(\left\{\left[\left(\frac{.6}{5} + 1\right)\frac{.6}{4} + 1\right]\frac{.6}{3} + 1\right\}\frac{.6}{2} + 1\right).6 + 1\right]$$

$$= 36.597$$

Enter	Press	Display
.6	÷	0.6
5	+	0.12
1	×	1.12
.6	÷	0.672
4	+	0.168
1	×	1.168
.6	÷	0.7008
3	+	0.2336
1	×	1.2336
.6	÷	0.74016
2	+	0.37008
1	×	1.37008
.6	+	0.822048
1	×	1.822048
e	×	4.952839969
e	x^2 =	36.59681238

Series, sin X – Find the value of $\sin \frac{\pi}{4}$.

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

$$= \left\{\left[\left(-\frac{X^2}{7!} + \frac{1}{5!}\right)X^2 - \frac{1}{3!}\right]X^2 + 1\right\}X$$

$$\sin \frac{\pi}{4} = \sin .7854 = \left(\left\{\left[-\frac{(.7854)^2}{7!} + \frac{1}{5!}\right](.7854)^2 - \frac{1}{3!}\right\}(.7854)^2 + 1\right)(.7854)$$

$$= .707108$$

Enter	Press	Display
.7854	x^2 ÷	0.61685316
7	$x!$ $\frac{1}{x}$ +	−.0001223915
5	$x!$ $\frac{1}{x}$ ×	.0082109418
.7854	x^2 −	.0050649453
3	$x!$ $\frac{1}{x}$ ×	−.1616017213
.7854	x^2 +	−.0996845324
1	×	.9003154676
.7854	=	.7071077682

Series, cos X — The value of cos X can be determined by processing the series,

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

$$= \left[\left(\frac{-X^2}{6!} + \frac{1}{4!}\right) X^2 - \frac{1}{2!}\right] X^2 + 1$$

Series, ln (1 + X) — The value of ln (1 + X) can be determined by processing the series

$$\ln (1 + X) = X - \frac{X^2}{2} + \frac{X^3}{3} - \frac{X^4}{4} + \ldots$$

$$= \left\{\left[\left(\frac{-X}{4} + \frac{1}{3}\right) X - \frac{1}{2}\right] X + 1\right\} X$$

Statistics

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] [×]	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!] [×]	8.841761994 30
6	[x!] [=]	6.366068635 33
	[1/x] [×]	1.570828179 −34
35	[x!] [=]	1623160

Mean Value – Find the mean for the values 3, 5, 3, 7, 4.

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

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

$$= 4.4$$

Enter	Press	Display
3	[+]	3
5	[+]	8
3	[+]	11
7	[+]	18
4	[×]	22
5	[1/x] [=]	4.4

Variance and Standard Deviation – Find the variance and standard deviation for the values given in the previous example.

Variance, $\sigma^2 = \frac{1}{n} \sum_{i=0}^{n} X_i^2 - \bar{X}^2$

$$= \frac{1}{5} [(3)^2 + (5)^2 + (3)^2 + (7)^2 + (4)^2] - (4.4)^2$$

$$= 2.24$$

Enter	Press	Display
3	[x²] [+]	9
5	[x²] [+]	34
3	[x²] [+]	43
7	[x²] [+]	92
4	[x²] [÷]	108
5	[−]	21.6
4.4	[x²] [=]	2.24

Standard Deviation, $\sigma = \sqrt{\sigma 2}$

$= \sqrt{2.24}$

$= 1.496662955$

Enter	Press	Display
2.24	$\sqrt{x}$	1.496662955

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.

$$P(a) = e^{-m}\frac{m^a}{a!}$$

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

For $e^{-2.5}$, use the relationship $e^{-2.5} = e^{-2} \times e^{-.5}$.

$P(5) = .06680$ or 6.68%

Enter	Press	Display
2.5	× x^2 x^3	39.0625
	÷	97.65625
5	$x!$	120
	×	.8138020833
e	x^2 $1/x$	.1353352832
	×	.1101361354
e	$\sqrt{x}$ $1/x$	.6065306597
	=	.0668009428

Physics

Thrown Object – If a ball is thrown upward with a velocity of 86 feet per second, what is its velocity at the end of 1.75 seconds? What will be its height above the starting point at the end of 3.25 seconds? Use g = 32.2 feet per sec^2.

Velocity, $v = v_o - gt$

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

$= 29.65$ ft/sec

Enter	Press	Display
32.2	×	32.2
1.75	+/- +	−56.35
86	=	29.65

Height, $s = v_o\, t - \frac{1}{2}\, gt^2$

$= (86)\ (3.25) - \frac{1}{2}\ (32.2)\ (3.25)^2$

$= 3.25 \left[86 - \frac{1}{2}\ (32.2)\ (3.25)\right]$

$= 109.44$ ft

Enter	Press	Display
2	1/x ×	.5
32.2	×	16.1
3.25	=	52.325
	+/- +	−52.325
86	×	33.675
3.25	=	109.44375

Dropped Object – If a stone is dropped from a balloon 1175 feet above ground, how long will it take to reach the ground, and at what velocity?

Time, $s = v_o t + \frac{1}{2} gt^2$

$\therefore t = \sqrt{\frac{2s}{g}}$ since v_o, initial velocity, is equal to zero

$t = \sqrt{\frac{2 \times 1175}{32.2}}$

$= 8.54$ sec

Enter	Press	Display
2	×	2
1175	+	2350
32.2	=	72.98136646
	√x	8.54291323

Velocity, $v = v_o + gt$

$= 0 + (32.2 \times 8.54)$

$= 274.988$ ft per sec

Enter	Press	Display
32.2	×	32.2
8.54	=	274.988

Solar Heat Equivalence – How many tons of coal would be required to produce an amount of heat equivalent to solar energy falling on one square mile of earth in the vicinity of the equator? Solar energy falls at 7 BTU per square foot per minute on a clear day, and the heat of combustion of coal is 12,000 BTU per pound.

Weight of coal, in tons per sec = $\frac{\text{total solar heating per sec}}{\text{heating of coal per ton}}$

$$W = \frac{\text{area in sq ft X rate}}{2000 \text{ X heating of coal per lb}}$$

$$= \frac{(5280)^2 \text{ X } 7}{2000 \text{ X } 12000}$$

$$= 8.1312 \text{ tons per minute}$$

Enter	Press	Display
2	EE	2 00
3	×	2 03
12	EE	12 00
3	=	2.4 07
	1/x ×	4.166666667 –08
5280	x² ×	1.1616 00
7	=	8.1312 00

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)?

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

$$= \frac{1300 \text{ X } 323}{298}$$

$$= 1409.06 \text{ psi}$$

Enter	Press	Display
1300	×	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 $R = 8317$ nt m/kg° K
$M = 4.004$ $T = 298$° K

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

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

$$= 20.436 \text{ Kg per } m^2$$

Enter	Press	Display
125	×	125
1.013	EE	1.013 00
5	×	1.013 05
		1.26625 07
4.004	÷	5.070065 07
8317	÷	6.096026211 03
298	=	2.04564638 01

Electrical Engineering

Mechanical Work to Charge a Capacitor — How much mechanical work must be done to charge a 750 μF capacitor to a potential difference of 700 volts, assuming an efficiency of 68 percent in the process?

Stored energy, $E = \frac{1}{2}CV^2$

$$= \frac{1}{2} \times 750 \times 10^{-6} \times (675)^2$$

$$= 1.85432 \times 10^2 \text{ joules or watt-sec}$$

Enter	Press	Display	Remarks
.5	×	.5	
750	EE +/−	750 −00	
6	×	3.75 −04	
675	x² =	1.70859375 02	Intermediate Answer

$$\text{Work required} = \frac{\text{Stored energy}}{\text{Efficiency}} \times 0.738 \text{ ft-lbs/joule}$$

$$= \frac{170.859}{.68} \times 0.738 = 1.854322676 \times 10^2 \text{ ft-lbs}$$

Enter	Press	Display
1.70859 02	÷	1.70859 02
.68	×	2.512632353 02
.738	=	1.854322676 02

Parallel Plate Capacitor – What is the equivalent capacitance of a 12-plate parallel plate tuning capacitor if the area of each side of a plate is 15 square cm and the plates are separated by 0.2 mm?

$$C = \frac{(n-1)\,A}{36\,\pi \times 10^9 \times d}$$

$$= \frac{(12-1)\,(15 \times 10^{-4})}{36\,\pi \times 10^9 \times (.2 \times 10^{-3})}$$

$$= 7.2946 \times 10^{-10}$$

$$= 729.46 \text{ pF}$$

Enter	Press	Display
36	×	36
π	EE	3.141592654 00
9	×	1.130973355 11
.2	EE +/−	0.2 −00
3	=	2.261946711 07
	1/x ×	4.420970641 −08
11	×	4.863067705 −07
15	EE +/−	15 −00
4	=	7.294601557 −10

Parallel Resistance – Three resistors of 40 ohms, 20 ohms, and 8 ohms are connected in parallel. What is the equivalent resistance by the reciprocal method?

$$R_T = \frac{1}{1/R_1 + 1/R_2 + 1/R_3 + \ldots}$$

$$= \frac{1}{1/40 + 1/20 + 1/8}$$

$$= 5\ \Omega$$

Enter	Press	Display
40	1/x +	0.025
20	1/x +	0.075
8	1/x =	0.2
	1/x	5.

Heat Generated by a Light Bulb — How much heat is generated per minute by a 75 watt incandescent light bulb? One watt = 3.413 BTU per hour.

$$P = 75 \text{ watts} \times 3.413 \text{ BTU/hr} \div 60 \text{ min/hr} = 4.3 \text{ BTU/min}$$

Enter	Press	Display
75	×	75.
3.413	÷	255.975
60	=	4.26625

Voltage, Power, Resistance — What voltage is required to operate the bulb at 75 W if the bulb resistance is 161 Ω?

$$V = \sqrt{PR} = \sqrt{75 \times 161} = 109.9 \text{ volts}$$

Enter	Press	Display
75	×	75.
161	=	12075.
	$\sqrt{x}$	109.8863049

Coordinate Conversion — Convert the polar coordinate $3.2 \times 10^{-3} e^{j\pi/8}$ to rectangular coordinates.

$$Re^{j\theta} = R \cos\theta + j\, R \sin\theta$$

$$\frac{\pi}{8} = .3927$$

$$\cos .3927 = \left\{\left[\frac{-(.3927)^2}{6!} + \frac{1}{4!}\right](.3927)^2 - \frac{1}{2!}\right\}(.3927)^2 + 1$$

$$= .92388$$

Enter	Press	Display
.3927	x^2 +	0.15421329
6	$x!$ $1/x$ +	−.0002141851
4	$x!$ $1/x$ ×	.0414524815
.3927	x^2 −	.0063925235
2	$x!$ $1/x$ ×	−.4936074764
.3927	x^2 +	−.0761208329
1	=	.9238791671

$$\sin .3927 = \left(\left\{ \left[\frac{-(.3927)^2}{7!} + \frac{1}{5!} \right] (.3927)^2 - \frac{1}{3!} \right\} (.3927)^2 + 1 \right) .3927$$

$$= .38268$$

Enter	Press	Display
.3927	x^2 +	0.15421329
7	$x!$ $+/-$ +	−.0000305978
5	$x!$ $1/x$ ×	.0083027354
.3927	x^2 −	.0012803921
3	$x!$ $1/x$ ×	−.1653862745
.3927	x^2 +	−.0255047615
1	×	.9744952385
.3927	=	.3826842802

Then

$$3.2 \times 10^{-3}\, e^{-j\,\pi/8} = (3.2 \times 10^{-3})\,(.92388) + j\,(3.2 \times 10^{-3})\,(.38268)$$

$$= 2.956416 \times 10^{-3} + j\,1.224576 \times 10^{-3}$$

Enter	Press	Display
3.2	EE	3.2 00
3	$+/-$ ×	3.2 −03
.92388	=	2.956416 −03
3.2	EE	3.2 00
3	$+/-$ ×	3.2 −03
.38626	=	1.224576 −03

A total of 4 terms in the series provides five significant digit accuracy for angles up to and including 45°. If the angle is greater than 45° the complement of the angle should be used to retain the same accuracy with the total of four terms used in the series.

For example:

$$\cos 70^\circ = \sin (90^\circ - 70^\circ) = \sin 20^\circ$$

$$\sin 70^\circ = \cos (90^\circ - 70^\circ) = \cos 20^\circ$$

Therefore, solve for

$$R\, e^{j\, 70^\circ} = R \sin 20^\circ + j\, R \cos 20^\circ$$

rather than

$$R\, e^{j\, 70^\circ} = R \cos 70^\circ + j\, R \sin 70^\circ.$$

Mechanical Engineering

Acceleration, Speed – What is the acceleration in ft/sec^2 of an automobile when its speed changes from 75 mph to 45 mph in 4 seconds?

$$a = \frac{V_f - V_o}{t}$$

$$= \frac{45 \text{ mph} - 75 \text{ mph}}{4 \text{ sec}} \times 5280 \text{ ft/mile} \times \frac{1}{3600 \text{ sec/hr}}$$

$$= -11 \text{ ft/sec}^2$$

Enter	Press	Display
45	[−]	45.
75	[+]	−30.
4	[×]	−7.5
5280	[÷]	−39600.
3600	[=]	−11.

Horsepower – If the mass of the car in the previous example is 110 slugs, what hp was exerted by the brakes in decelerating the car? Use 1 ft-lb/sec = 1/550 hp.

$$P = F\,v, \text{ but } F = ma \text{ and } v = at$$

$$\therefore P = (ma)\,(at) \text{ ft-lb/sec}$$

$$P = \frac{1}{550}\, ma^2 t \text{ hp}$$

$$= \frac{1}{550} \times 115 \times (-11)^2 \times (4)$$

$$= 101.2 \text{ hp}$$

Enter	Press	Display
115	[×]	115
11	[+/−] [x^2]	121
	[×]	13915
4	[÷]	55660
550	[=]	101.2

Transmitting Torque — What is the transmitting torque of a 165-hp engine operating at 1800 rpm?

$$T = \frac{63000\ hp}{N}$$

$$= \frac{63000 \times 165}{1800}$$

$$= 5.775 \times 10^3\ \text{in-lb}$$

Enter	Press	Display
63	EE	63 00
3	×	6.3 04
165	÷	1.0395 07
1800	=	5.775 03

Load Pressure — If a 5.5 X 5.5 X 5.5 ft concrete bridge pier is loaded uniformly with a load of 625 lb per sq ft, what is the pressure of the pier on the ground below it? Concrete weighs 150 lb per cu.ft.

$$F_t = W_{load} + W_{pier}$$

$$= 625\ (5.5)^2 + 150\ (5.5)^3$$

$$= (5.5)^2\ [625 + 150\ (5.5)]$$

$$= 43862.5\ \text{lb}$$

$$P = \frac{F_t}{A}$$

$$= \frac{1}{(5.5)^2}\ (43862.5)$$

$$= 1450\ \text{lb/ft}^2$$

Enter	Press	Display
150	×	150.
5.5	+	825.
625	×	1450.
5.5	x^2 =	43862.5
	÷	43862.5
5.5	x^2 =	1450

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

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

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

$$= 5.19 \times 10^{-2} \text{ inches}$$

Enter	Press	Display
.385	×	.385
30	EE	30 00
6	=	1.155 07
	1/x ×	8.658008658 –08
20	EE	20 00
3	×	1.731601732 –03
2.5	×	4.329004329 –03
12	=	5.194805195 –02

Civil Engineering

Surveying – Determine the temperature correction and the approximate slope correction for a steel tape used at a temperature of 85° F. The tape standardized temperature is 70° F, the measured length is 12,750 feet, and the difference in elevation is 13 feet.

Temperature correction, $C_t = 0.0000065\ S\ (T - T_o)$

$= 0.0000065 \times 12750 \times (85 - 70)$

$= 1.243125$

$= 1.243125$

Enter	Press	Display
85	[−]	85
70	[×]	15
65	[EE] [+/−]	65 −00
7	[×]	9.75 −05
12750	[=]	1.243125 00

Slope Correction, $C_h = \frac{h^2}{2S}$

$= \frac{1}{2 \times 12750} (13)^2$

$= 0.00662745$

Enter	Press	Display
2	[×]	2
12750	[=] [1/x] [×]	.0000392156
13	[x²]	169
	[=]	.0066274509

Soil Mechanics – Determine the vertical stress in a soil at a point 2-1/2 feet deep and located 3-1/2 feet horizontally from a concentrated surface load of 13,500 lb.

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

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

$$= 15546.205 \text{ lb}$$

Enter	Press	Display
3.5	÷	3.5
2.5	= x² +	1.96
1	=	2.96
	√x	1.720465053
	× x² x² ×	15.07402661
3	×	45.22207983
13500	÷	610498.0778
2	÷	305249.0389
π	÷	97163.78683
2.5	x²	6.25
	=	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 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.

$$t = 2.5\left(\frac{L}{S\,i^2}\right)^{1/3}$$

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

$$= 2.5\,[934.256]^{1/3}$$

$$= 2.5 \times 14.603206$$

$$= 36.508015 \text{ minutes}$$

Enter	Press	Display
1.7	x^2 ×	2.89
.15	=	.4335
	$1/x$ ×	2.306805075
1350	=	3114.186851

Use of the previously described technique yields

$$(3114.186851)^{1/3} = 14.603206$$

14.603206	×	14.603206
2.5	=	36.508015

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

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

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

$$= 1083.04 \text{ psi}$$

Enter	Press	Display
.875	×	.875
.333	×	.291375
2.5	×	.7284375
8.5	x^2	72.25
	=	52.62960938
	$1/x$ ×	0.019000711
2	×	0.038001422
28500	=	1083.040529

Care of Your SR-20

Your SR-20 is supplied with a protective vinyl dust cover. When your SR-20 is not in use it should be enclosed in this dust cover to protect it from dust and other foreign material. If properly protected with the dust cover, your SR-20 should retain its attractive styling and finish for years with a minimum amount of care.

When the calculator case needs to be cleaned, a damp, not wet, soft, lint-free cloth should be used. Care should be exercised to keep excessive moisture out of the keyboard. Excessive dust and abrasive foreign material should be removed carefully to prevent scratching the case.

After cleaning the case, a very light application of a good quality, nonabrasive furniture polish on a soft lint-free cloth may be used to restore the original luster of the case.

Caution: Never use solvents, abrasive, or strong cleaners on your SR-20 Engineering Desk Calculator.

In Case of Difficulty

1. Check to be sure calculator is correctly plugged into a proper outlet that has power.

2. Check to be sure ON-OFF switch is in the ON position. A number should appear in the mantissa.

3. Review operating instructions to be certain calculations are performed correctly.

If none of these corrects the difficulty, return the unit 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.

Specifications

Type – SR-20.

Display – 10-digit gas discharge display.

Decimal Point – Complete floating decimal on input and output.

Types of Calculations – Addition, subtraction, multiplication and division. Factorials. Chain and mixed calculations. Reciprocals. Squares. Square roots. Scientific notation.

Negative Sign – True value indication with minus sign on display.

Calculation Components – Two MOS/LSI integrated circuits.

Power Source – Operates directly from AC line current – 108 to 130 V, 60 Hz.

Warranty

The SR-20 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, 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 Purchase Registration Card has been properly completed and mailed to Texas Instruments Incorporated within 10 days of purchase.

Texas Instruments Consumer Services Facilities

For warranty or out of warranty service send your SR-20 calculator to the nearest service facility.

Texas Instruments Service Facility
P. O. Box 477
Springfield, New Jersey 07081

Texas Instruments Service Facility
P. O. Box 970
Arlington Heights, Illinois 60006

Texas Instruments Service Facility
P. O. Box 1967
Orange, California 92668

Texas Instruments Service Facility
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