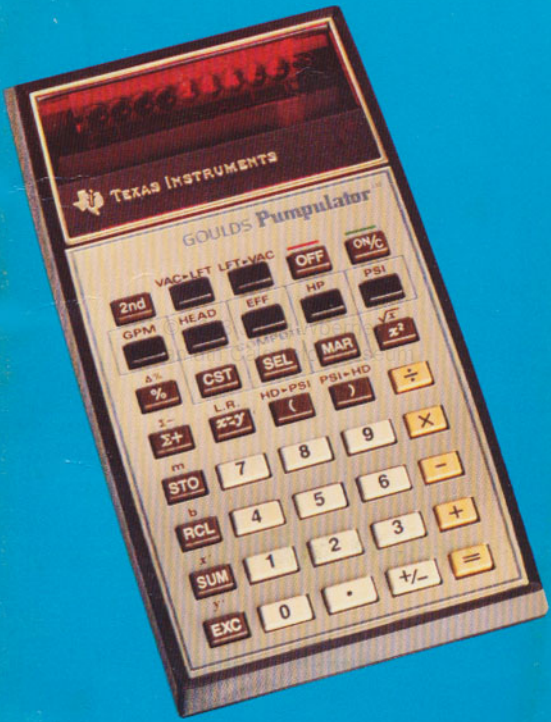
GOULDS
Pumpulator™



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I. INTRODUCTION

The GOULDS **Pumpulator**™ *was custom-designed for Goulds Pumps, Inc. by Texas Instruments.*

Your GOULDS **Pumpulator**™ is the first and only calculator specially programmed for the pump industry. Pump calculation has never been faster or easier.

Your GOULDS **Pumpulator**™ can provide answers to pump equations you use every day in just seconds. You can calculate Head, PSI, Horsepower, Gallons per Minute, Efficiency, Vacuum, and Suction Lift. All the mathematics are done inside the **Pumpulator**™ so you never have to add, subtract, multiply, or divide to find your answer. It's as simple as entering the number and pressing the right key for your answer.

In addition to calculating pump functions, your GOULDS **Pumpulator**™ gives you the benefit of being able to calculate other business and statistical problems. As a Goulds pump professional, you only need to learn a few simple key sequences as described in this instruction manual, and you can solve all the above problems faster than you ever thought possible.

The following *Features and Functions* gives a preview of what the GOULDS **Pumpulator**™ will do for you. The detailed descriptions in this manual are easy to understand. The *Key Definitions* in Section II are a quick-reference guide to summarize specific keys and key sequences. Section III is *Basic Instructions* and explains how all functions in the GOULDS **Pumpulator**™ — pump, business and statistical — can be calculated.

Many examples are provided to help you master your GOULDS **Pumpulator**™ in just a short time.

FEATURES AND FUNCTIONS

- **Pump functions** convert:
  - Head → PSI
  - PSI → Head
  - Vacuum → Suction Lift
  - Suction Lift → Vacuum

Also calculate Horsepower, Gallons per Minute, Head, and Efficiency.

- **Financial functions** can solve problems involving:
  Simple Interest
  Depreciation
- **Mathematical functions** include:
  Arithmetic (+, −, x, ÷)
  Square (X^2) and Square Root ($\sqrt{X}$)
- **Profit margin functions** – involve cost, selling price and profit margin calculations.
- **Parentheses** – 15 sets at each of 4 processing levels, allow you to dictate the order of interpretation of any mathematical sequence.
- **Memory** – totally accessible memory with store, sum, recall and exchange capabilities.
- **Statistical analyses** – Linear regression and trend-line analysis of statistical information.
- **Electronic on and off** provides for special power savings features. Only traveling decimal is left in the display after typically 25 to 50 seconds of nonuse. The previously displayed value can be easily retrieved without interfering with pending operations. The GOULDS **Pumpulator**™ turns itself off completely after approximately 7 to 14 minutes of nonuse.
- **Display advantages** – automatic display control provides a standard 8-digit display with scientific notation format available for displaying numbers up to $\pm 9.999 \times 10^{99}$ and down to $\pm 1.0 \times 10^{-99}$.
- **Floating minus sign** occurs immediately to the left of every negative number.

OPTIONAL ACCESSORY

Rechargeable Kit RK-2 – A kit is available from your calculator dealer or from the nearest Texas Instruments service facility or exchange center to operate your calculator from a rechargeable power source. The kit consists of an electronic battery and an AC adapter. Under normal use, the charged battery will provide typically 2 hours of continuous operation without recharging. The battery can be recharged while in or out of the calculator. About 4 hours of recharging will restore full charge when the calculator is off (12 hours if the calculator is in use).

II. KEY DEFINITIONS

A brief definition of each key's function is listed here as well as a page number to serve as a quick-reference guide to the keys.

[ON/C] **On/Clear Key** – Initially this key applies power to the calculator. Once turned on, pressing this key clears an entry if no function or operation key has been pressed. When pressed after an operation or a functions, this key clears the display and all pending operations. Pressing this key twice at any time clears the display and all pending operations. [ON/C] must be pressed after use of the financial functions or linear regression to clear calculator registers. See page 10.

[OFF] **Off Key** – Removes power from the calculator.

[0] through [9] **Digit Keys** – Enter numbers 0 through 9. See page 10.

[•] **Decimal Point Key** – Enters a decimal point. See page 10.

[+/–] **Change Sign Key** – When pressed after number entry or a calculation, changes the sign of that number. See page 10.

[+] **Add Key** – Instructs the calculator to add the next entered quantity to the displayed number. See page 14.

[–] **Subtract Key** – Instructs the calculator to subtract the next entered quantity from the displayed number. See page 14.

[×] **Multiply Key** – Instructs the calculator to multiply the displayed number by the next entered quantity. This displayed value must be less than 1×10^{99} or an error condition may result. See page 14.

[÷] **Divide Key** – Instructs the calculator to divide the displayed number by the next entered quantity. See page 14.

[=] **Equals Key** – Completes all previously entered numbers and operations. This key is used to obtain both intermediate and final results. See page 14.

[2nd] **Second Function Key** — Calculates the unknown for financial and pump functions on the second function level. Used the same as the equals key, but is pressed before you press the desired unknown key.

[2nd] [HD→PSI] **Head to PSI Key** — This two-key sequence converts displayed number Head (in feet) to PSI (in pounds). See page 23.

[2nd] [PSI→HD] **PSI to Head Key** — This two-key sequence converts displayed number PSI (in pounds) to Head (in feet). See page 23.

[GPM] **Gallons Per Minute Key** — Enters a number in gallons per minute.

[2nd] [GPM] — This two-key sequence computes gallons per minute, if [HEAD] (or [PSI]), [HP], and [EFF] were entered previously. See page 25.

[HEAD] **Head Key** — Enters total dynamic head number (in feet).

[2nd] [HEAD] — This two-key sequence computes total dynamic head, if [HP], [GPM], and [EFF] were entered previously. See page 26.

[EFF] **Efficiency Key** — Enters the pump efficiency in a decimal number (as a percent).

[2nd] [EFF] — This two-key sequence computes efficiency in a decimal number (as a percent), if [GPM], [HEAD] (or [PSI]) and [HP] were entered previously. See page 26.

[HP] **Horsepower Key** — Enters the pump horsepower.

[2nd] [HP] — This two-key sequence computes horsepower, if [GPM], [HEAD] (or [PSI]), and [EFF] were entered previously. See page 24.

[PSI] **Pounds per Square Inch Key** — Enters the [PSI] (in pounds) and at the same time *internally converts pounds to Head* (in feet). The display will still show the number in pounds to avoid confusion when doing other calculations.

[2nd] [PSI] — This sequence function will not work. If entered, no computation will occur. See page 27.

[VAC→LFT] **Vacuum to Suction Lift Key** — Directly converts displayed number Vacuum (in inches) to Suction Lift (in feet). See page 28.

[LFT→VAC] **Suction Lift to Vacuum Key** — Directly converts displayed number Suction Lift (in feet) to Vacuum (in inches). See page 28.

[(] [)] **Parentheses Keys** – Used to isolate particular numerical expressions for correct mathematical interpretation. See page 17.

[x^2] **Square Key** – Calculates the square of the number in the display. See page 15.

[2nd] [$\sqrt{x}$] **Square Root Key** – Calculates the square root of the number in the display ($x \geqslant 0$). See page 15.

[%] **Percent Key** – Converts displayed number from a percentage to a decimal. Used with +, −, ×, ÷, this key can perform add-on, discount and other percentage calculations. See page 15.

[2nd] [Δ%] **Percent Change Key** – Calculates the percentage change between two values. Press x_1 [2nd] [Δ%] x_2 and $\frac{x_2 - x_1}{x_1} \times 100$ is calculated. See page 17.

[STO] **Store Key** – Stores the displayed quantity in the memory without removing it from the display. Any previously stored value is cleared. See page 20.

[RCL] **Recall Key** – Retrieves stored data from the memory to the display. Use of this key does not clear the memory. See page 20.

[SUM] **Sum to Memory Key** – Algebraically adds the display value to the memory content. This key does not affect the displayed number or calculations in progress. See page 21.

[EXC] **Exchange Key** – Exchanges the content of the memory with the display value. The display value is stored and the previously stored value is displayed. See page 22.

[CST] **Cost Key** – Enters the cost of an item in profit margin calculations. [2nd] [CST] computes item cost when the selling price and profit margin have been entered. See page 29.

[SEL] **Sell Key** – Enters the selling price of an item in profit margin calculations. [2nd] [SEL] computes the selling price when the cost and profit margin have been entered. See page 29.

[MAR] **Profit Margin Key** – Enters the profit margin in percent for profit margin calculations. [2nd] [MAR] computes the profit margin when the item cost and selling price have been entered. See page 29.

[x:y] **x Exchange y Key** – Exchanges the last two numbers (not digits) entered. Used primarily to exchange divisor and dividend in division problems, x and y for y^x or $\sqrt[x]{y}$ calculations and for data entry and result display in linear regression. Must not be used when financial calculations are in progress. See page 38.

[Σ+] **Sum Plus Key** – Enters data points for linear regression calculations. See page 38.

[2nd] [Σ-] **Sum Minus Key** – Removes unwanted data entries from linear regression calculations. See page 38.

[2nd] [m] **Slope Key** – Computes the slope of the calculated linear regression curve. If the line is vertical, an error condition results. See page 38.

[2nd] [b] **Intercept Key** – Computes the y-intercept of the calculated linear regression curve. See page 38.

[2nd] [x'] **Compute x Key** – Calculates a new x value for a new y entry from the keyboard. See page 38.

[2nd] [y'] **Compute y Key** – Calculates a new y value for a new x entry from the keyboard. See page 38.

[2nd] [L R] **Linear Regression Mode Select Key** – Prepares calculator to work linear regression problems or trend-line analyses. See page 38.

III. BASIC INSTRUCTIONS

BATTERY CONSIDERATIONS

The calculator operates on a 9-volt non-rechargeable battery.

An alkaline battery is recommended for your calculator. It has an operating life of approximately 20 hours. A nonalkaline battery may be used but it should be removed prior to a prolonged period of non-use or immediately after discharge to prevent possible damage to the calculator from leakage.

When the battery becomes discharged, the display becomes dim or may flash or show erroneous symbols and numbers just before fading away. Refer to the Service Information section in the back of this manual for battery replacement instructions.

INITIAL OPERATION

Pressing [ON/C], the upper right most key on the keyboard, applies power and totally clears the calculator. Power-on condition is indicated by the presence of a lighted digit in the display. The [OFF] key, of course, removes power from the calculator. When a battery is first inserted and the display is not blank, press [OFF] then [ON/C] to clear the calculator.

DATA ENTRY

For maximum versatility, your calculator operates with a floating decimal point. When entering numbers, the decimal remains to the right of the mantissa until [•] is pressed and the fractional part of the number is entered.

The [0] through [9] digit keys, [•] decimal point key and [+/−] change sign key enter data into the calculator. Numbers up to 8 digits in length can be entered directly from the keyboard.

CLEARING OPERATIONS

To remove an incorrect entry from the display before any function or operation key is used, press [ON/C]. When pressed after an operation or function key (including

[=]), this key clears the display, the financial mode and all pending operations. Pressing [ON/C] twice always clears the display, any financial values and all pending operations. This key does not affect memory contents or change the mode status.

DUAL FUNCTION KEYS

Most of your calculator's keys have dual functions. The first function is printed on the key and its second function is written above that key. To execute a function shown on a key, simply press the desired key. To use the second function of a key, press the [2nd] key, then press the key immediately below the desired second function. For example, to find the square of a number, press [x^2]. To find the square root of a number, press [2nd] [$\sqrt{x}$]. Throughout this manual, a black key symbol with white letters denotes the second function of a particular key and must be prefixed by [2nd]. When [2nd] is pressed twice in succession or pressed before a key that does not have a second function, the calculator performs the first function operation.

The [2nd] key is used with the financial and pump operations to calculate unknowns. Entry of all known values for profit margin calculations is accomplished through use of the appropriate first function keys. To calculate any of the variables, press [2nd], then the desired unknown key.

DISPLAY TIME OUT

Only a traveling decimal is left in the display after typically 25-50 seconds of nonuse. *Press [EXC] twice to retrieve the display without affecting calculations.*

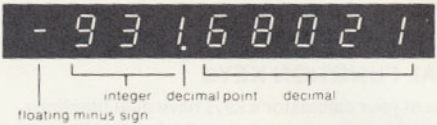
DISPLAY FORMATS

The various display capabilities greatly increase the operating range and flexibility of your calculator.

Standard Display

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

Numbers as large as 8 digits can be entered directly. All digit keys pressed after the 8th are ignored.

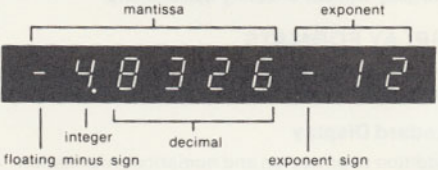


Any negative number displays a minus sign immediately to the left of the number. This is the way you normally write negative numbers, for instance:

Only the first 8 digits of calculated results are displayed. Internally, results are carried to 11 digits. This format displays all numbers from 99999999 to −99999999.

Scientific Notation

Calculated results that exceed eight digits (display limit) to the left of the decimal point are automatically displayed in scientific notation. This format consists of a number (mantissa) multiplied by ten raised to some power (exponent). The integer portion of the mantissa is always a single digit other than 0. For example: −.0000000000048326 can be expressed as -4.8326×10^{-12} and would be displayed as shown.



In scientific notation, a positive exponent indicates how many places the decimal point of the mantissa should be shifted to the right to produce the actual number. Conversely, if the exponent is negative, the decimal point should be moved to the left. In the last example, you need to move the decimal point 12 places to the left to obtain the result in the normal form:

$$-.0000000000048326$$

Because of the display space, only 5 digits of the mantissa can be displayed. Internally, the mantissa is carried to 11 digits so that there is no accuracy loss due to this format.

The scientific notation allows you to calculate numbers as small as $\pm 1 \times 10^{-99}$ and as large as $\pm 9.9999 \times 10^{99}$.

"ERROR" CONDITIONS

The display shows "Error" when an overflow or underflow occurs, or when an improper operation or invalid key sequence is attempted. When "Error" appears, the calculator must be cleared with [ON/C] or turned off with [OFF]. It is usually easier to start over after clearing an "Error" condition. However, if the "Error" condition repeats, the *Error Conditions and Parameters* in Appendix A may help you locate the problem.

ACCURACY

Your calculator uses up to 11 digits internally to perform calculations even though only 8 digits can be displayed. The extra three digits that you cannot see are generally referred to as guard digits and their purpose is to increase the accuracy of the calculator. These guard digits allow you to obtain a result that is normally more accurate than ±1 in the eighth digit. Accuracy may decrease when several functions are used successively.

IV. CALCULATOR OPERATIONS

The keys have been selectively positioned on the keyboard for efficient calculator operation. Although many of the operations may be obvious, the following instructions and examples can help you develop skill and confidence in your problem solving routine.

ARITHMETIC OPERATIONS

To perform simple addition, subtraction, multiplication and division, just key in the problem as it is written. When each operation is keyed, it completes the previously entered operation. This includes +, −, ×, ÷, and Δ%.

It is a safe procedure to press [ON/C] at the start of each new problem to make sure the calculator is cleared. This is not required after an [=]. Following [=] with a number entry automatically clears the previous result.

Example: 37 + 16.9 − 11 = 42.9

Enter	Press	Display
	[ON/C]	0.
37	[+]	37.
16.9	[−]	53.9
11	[=]	42.9

Example: 4 × (−6.6) − (−17.1) = −9.3

Enter	Press	Display
4	[×]	4.
6.6	[+/−] [−]	−26.4
17.1	[+/−] [=]	−9.3

SINGLE-VARIABLE FUNCTIONS

The simplest operations to describe and understand are the single-variable functions. These functions operate on the displayed value immediately, replacing the displayed value with its function. These functions do not interfere with any calculations in progress and can therefore be used at any point in a calculation.

Because of the complexity of some of these functions, be sure that each calculation has been completed before the next key is pressed.

Roots and Powers

The square key [x^2] calculates the square of the number x in the display.

Example: $(4.235)^2 = 17.935225$

Enter	Press	Display
4.235	[x^2]	17.935225

The square root sequence [2nd] [$\sqrt{x}$] calculates the square root of the number x in the display for $x \geqslant 0$.

Example: $\sqrt{6.25} = 2.5$

Enter	Press	Display
6.25	[2nd] [$\sqrt{x}$]	2.5

Example: $[\sqrt{3.1452} - 7 + (3.2)^2]^{1/2} = 2.2390782$

Enter	Press	Display
3.1452	[2nd] [$\sqrt{x}$] [−]	1.7734712
7	[+]	−5.2265288
3.2	[x^2]	10.24
	[=]	5.0134712
	[2nd] [$\sqrt{x}$]	2.2390782

PERCENT AND PERCENT CHANGE

The percent key [%] converts the displayed percent value to its decimal equivalent (percent ÷ 100 = decimal percent). For example, if you enter 43.9 and press [%], 0.439 is displayed.

The [%] key can be used with +, −, ×, and ÷ functions. Add-on, discount, straight and inverted percentages, and other problems can be solved by these functions.

The rules for [%] key are tabulated below.

- [+] n [%] [=] add n% to the original number displayed.
- [−] n [%] [=] subtract n% of the original number displayed.

- [×] n [%] [=] multiplies the original number in the display by the number (n% ÷ 100).
- [÷] n [%] [=] divides the original number in the display by the number (n% ÷ 100).

Add-on Example: How much is a $15 book with 5% tax added to it?

Enter	Press	Display
15	[+]	15
5	[%] [=]	15.75

Discount Example: Discount $5 hat by 10%.

Enter	Press	Display
5	[−]	5.
10	[%] [=]	4.5

IN ADD-ON AND DISCOUNT SEQUENCES, PARENTHESES MAY NOT IMMEDIATELY PRECEDE [%].

Example: A watch company has shipped 40% of your 12000-unit order. How many watches are on the way? (In other words, what is 40% of 12000?)

Enter	Press	Display
12000	[×]	12000.
40	[%] [=]	4800.

Example: 30 deliveries have satisfied 15% of your customers. How many deliveries are needed to satisfy all of your customers? (30 is 15% of what number?)

Enter	Press	Display
30	[÷]	30.
15	[%] [=]	200.

Percent Change Sequence – X_1 [2nd] [Δ%] X_2 [=], calculates the percentage of change between two values X_1 and X_2 where:

$$\Delta\% = \frac{X_2 - X_1}{X_1} \times 100$$

Example: A shirt that cost $16 last year now costs $18, what is the percentage increase in the price?

Enter	Press	Display
16	[2nd] [Δ%]	16.
18	[=]	12.5

The price increased 12.5 percent.

PARENTHESES

Parentheses are available to designate the interpretative order of a problem, allowing you to enter the sequence just as it is stated. This is done by isolating an expression(s) with parentheses. These isolated expressions are evaluated before being combined with the rest of the problem.

With parentheses, as many as 4 numbers and their operations can be stored away, then blended into the problem when the parentheses indicate to do so.

Example: 5 + {8/[9 – (2/3)]} = 5.96

Enter	Press	Display	Comments
5	[+] [(]	5.	(5 +) stored
8	[÷] [(]	8.	(8 ÷) stored
9	[–] [(]	9.	(9 –) stored
2	[÷]	2.	(2 ÷) stored
3	[)]	.66666667	2/3 evaluated
	[)]	8.3333333	9 – (2/3)
	[)]	0.96	8/[9 – (2/3)]
	[=]	5.96	Answer

The [=] key has the additional capability of automatically supplying closed parentheses to match any open parentheses that have not been closed. In the previous example, [=] could have been pressed instead of the first [)] and the problem would still have been correctly completed. Try it and see.

Actually, you can have 15 open parentheses for each of the 4 levels of processing. This flexibility should allow you to enter the most complex problems in a straightforward manner. If you do attempt to progress to a fifth level of processing, an error message will result.

Parentheses cannot be used while in a financial mode.

COMBINING OPERATIONS

In review:

- Operations are normally completed in a sequential manner. Each time [+], [−], [×], [÷], or [2nd] [Δ%] is pressed, the previous operation is completed.
- Parentheses alter the interpretive order by completing the contents each set contains before being combined with the rest of the problem.
- Single-variable functions operate only on the displayed value, immediately replacing the displayed value with its function.

Example: $\frac{(7 \times 6 + 7 - 1)}{12} = 4$

Enter	Press	Display	
7	[×]	7.	
6	[+]	42.	
7	[−]	49.	
1	[÷]	48.	
12	[=]	4.	Answer

INPUT ERROR CORRECTION

At any point in a calculation, [ON/C] can be pressed twice to clear all calculations, including any errors and start over. This is seldom necessary.

If an incorrect *number* entry is made, pressing the [ON/C] key before any non-number key clears the incorrect number without affecting any calculation in progress.

Special circuitry has been provided to facilitate the correction of a wrong operation entered while keying in your problem. When an *unwanted operation* key is entered ([+], [−], [÷], [×]) and before any other key is pressed, simply press the correct operation key and continue.

When two operations in a row are entered, the calculator performs only the last operation.

Example: 7 − × 6 × + 6 5 = 47

Enter	Press	Display	Comments
7	[−] [×]	7.	Replace − with ×
6	[×] [+]	42.	7 × 6
6	[ON/C]	0.	6 erased
5	[=]	47.	7 × 6 + 5

V. MEMORY USAGE

The memory keys allow data to be stored and retrieved at will for additional flexibility in calculations. Use of the memory does not affect any calculations in progress, so memory operations can be used wherever needed.

STORE AND RECALL

The Store key [STO] stores the displayed quantity in the memory without removing it from the display. Any previously stored value is cleared.

The Recall key [RCL] retrieves stored data from the memory to the display. Use of this key does not clear the memory.

Example: Store and recall 3.012

Enter	Press	Display
3.012	[STO]	3.012
	[ON/C]	0.
	[RCL]	3.012

Use of these keys allows you to store a long number that is to be used several times.

Example: If the monetary conversion rate between dollars and pesos is 8.6120894, convert the following dollars to pesos: 7, 15, 1266, 88 and 121.

Enter	Press	Display
7	[X]	7.
8.6120894	[STO] [=]	60.284626
15	[X] [RCL] [=]	129.18134
1266	[X] [RCL] [=]	10902.905
88	[X] [RCL] [=]	757.86387
121	[X] [RCL] [=]	1042.0628

You can sée that by storing the conversion factor the first time it is entered saved you from having to key it in the other times it is needed. A single press of the [RCL] key brings the eight digit factor to the display each time. Notice also that the use of [STO] and [RCL] did not interfere with calculator operations.

SUM TO MEMORY

The Sum to Memory key [SUM] algebraically adds the display value to the memory content. This key does not affect the displayed number or calculations in progress.

Important: The clear key [ON/C] does not clear memory except when the calculator is first turned on. Therefore the first quantity should be stored using [STO], or a zero should be stored to ensure the memory is empty before using [SUM].

This key is used to accumulate the results from a series of independent calculations. [SUM] replaces the arithmetic sequence [+] [RCL] [=] [STO].

Example:

$$28.3 \times 7 = 198.1$$
$$173 + 16 = 189$$
$$312 - 42 + 7.8 = \underline{277.8}$$
$$\text{Total} \quad 664.9$$

Enter	Press	Display	Memory
28.3	[×]	28.3	0.
7	[=] [STO]	198.1	198.1
173	[+]	173.	198.1
16	[=] [SUM]	189.	387.1
312	[−]	312.	387.1
42	[+]	270.	387.1
7.8	[=] [SUM]	277.8	664.9
	[RCL]	664.9	664.9

This example could have been performed continuously by linking each expression together and not using the memory. But if each of the three expressions

had been far more complicated, then solving the entire problem sequentially could be risky. An uncorrectable mistake during calculations would mean starting over from the first. Summing to memory saves each completed expression making the calculation of each new series of terms independent from the previous ones.

MEMORY EXCHANGE

The Exchange key [EXC] exchanges the content of the memory with the display value. The display value is stored and the previously stored value is displayed.

This key combines the store and recall operations into a single key. Use of this key, like the other memory keys, does not disturb a sequence of calculations and can consequently be used anywhere in the solution of a problem.

The [EXC] key permits you to solve problem 1 and store the result. Then solve problem 2 and compare the results of the two problems while retaining both answers. Also, numbers can be temporarily stored and used as needed.

Example: Evaluate $A^2 + 2AB + B^2 =$ for $A = .258963$ and $B = 1.25632$

Enter	Press	Display	Comments
.258963	[STO] [x^2] [+] [(]	.06706184	Store A
1.25632	[×]	1.25632	Enter B
	[EXC]	0.258963	Store B, recall A
	[×]	0.3253404	A × B displayed
2	[)] [+] [(]	.71774263	$A^2 + 2AB$ displayed
	[RCL]	1.25632	Recall B
	[x^2]	1.5783399	B^2
	[=]	2.2960826	Answer

When A is recalled from memory for the last time it is needed, B is instantly stored in its place by the single keystroke [EXC].

VI. PUMP CALCULATIONS

HEAD → PSI

The [2nd] [HD→PSI] key sequence converts the number HEAD (in feet) in the display to PSI (in pounds).

Example: 125′ Head is equal to how many pounds per square inch (PSI)?

Enter	Press	Display
125	[2nd] [HD→PSI]	54.25

The answer is 54.25 pounds (PSI).

PSI → HEAD

The [2nd] [PSI→HD] key sequence converts the number PSI (in pounds) in the display to HEAD (in feet).

Example: 50 PSI is equal to how many feet of HEAD?

Enter	Press	Display
50	[2nd] [PSI→HD]	115.20737

The answer is 115.2 feet of HEAD.

CALCULATE HP

When you want to calculate the horsepower of a pump (HP), you must know gallons per minute (GPM); total dynamic head (HEAD) or PSI; and efficiency (EFF).

Example 1: For the Goulds Model 3656 centrifugal pump, GPM is 140; HEAD is 175'; and EFF is 70% (or .70). *Calculate horsepower.*

Enter	Press	Display
140	GPM	140
175	HEAD	175
.70	EFF	0.7
(To find the answer) →	2nd HP	8.8383838

The answer is 8.8 horsepower (rounded-off).

Example 2: For the same pump, GPM is 140; PSI is 75.9; and EFF is .70. *Calculate horsepower.*

Enter	Press	Display
140	GPM	140
75.9	PSI	75.9 — The **Pumpulator**™ internally converts 75.9 PSI to 175' HEAD.
.70	EFF	0.7
(To find the answer) →	2nd HP	8.83225653

The answer is 8.8 HP (rounded-off).

CALCULATE GPM

To calculate gallons per minute (GPM), you must already know total dynamic head (HEAD) or PSI; efficiency (EFF); and horsepower (HP).

Example 1: Calculate *gallons per minute (GPM)* when HEAD is 175'; EFF is 70% (or .70); and HP is 8.83.

Enter	Press	Display
175	HEAD	175
.70	EFF	0.7
8.83	HP	8.83
(To find the answer) →	2nd GPM	139.8672

The answer is 140 GPM (rounded-off).

Example 2: Calculate *gallons per minute (GPM)*, when PSI is 75.9; EFF is .70; and HP is 8.83.

Enter	Press	Display
75.9	PSI	75.9 — The **Pumpulator** ™ internally converts 75.9 PSI to 175' HEAD.
.70	EFF	0.7
8.83	HP	8.83
(To find the answer) →	2nd GPM	139.95934

The answer is 140 GPM (rounded-off).

CALCULATE HEAD

Example: Calculate *total dynamic head (HEAD)* when GPM is 140; EFF is 70%; and HP is 8.83.

Enter	Press	Display
140	GPM	140
.70	EFF	0.7
8.83	HP	8.83
(To find the answer) →	2nd HEAD	174.834

The answer is 175 feet of head (rounded-off).

CALCULATE EFF

To calculate efficiency (EFF), you must already know gallons per minute (GPM), total dynamic head (HEAD) or PSI; and horsepower (HP).

Example 1: *Calculate efficiency (EFF)*, when GPM is 140; HEAD is 175'; and HP is 8.83.

Enter	Press	Display
140	GPM	140
175	HEAD	175
8.83	HP	8.83
(To find the answer) →	2nd EFF	.70066463

The answer is 70% EFF (rounded-off).

[GPM] [HEAD] [EFF] [HP] [PSI]

Example 2: *Calculate efficiency (EFF)*, when GPM is 140; PSI is 75.9; and HP is 8.83.

Enter	Press	Display
140	[GPM]	140
75.9	[PSI]	75.9 — The **Pumpulator**™ internally convert 75.9 PSI to 175' HEAD.
8.83	[HP]	8.83
(To find the answer) ——→	[2nd] [EFF]	.70020336

The answer is 70% EFF (rounded-off).

CALCULATE PSI

PSI cannot be calculated in conjunction with GPM, Efficiency, and Horsepower. You *CAN* calculate Head from these knowns as described in the *CALCULATE HEAD* section on page 26. When you get your answer in feet of Head, use the [2nd] [HD→PSI] key sequence as described on page 23 to find your answer in PSI.

VACUUM → SUCTION LIFT

The [VAC→LFT] key *directly* converts the number VACUUM (in inches) to SUCTION LIFT (in feet).

Example: 16 inches of vacuum equals how much suction lift?

Enter	Press	Display
16	[VAC→LFT]	18.08

The answer is 18.08 feet suction lift.

SUCTION LIFT → VACUUM

The [LFT→VAC] key *directly* converts the number SUCTION LIFT (in feet) to VACUUM (in inches).

Example: 19 feet of suction lift equals how *many inches of* vacuum?

Enter	Press	Display
19	[LFT→VAC]	16.814159

The answer is 16.8 inches vacuum (rounded-off).

VII. PROFIT MARGIN

Cost, selling price and profit margin problems can be readily solved with your calculator. Knowing any two of the following three variables—item cost, item selling price, profit margin—the remaining variable can be calculated.

The [CST], [SEL] or [MAR] keys are used to enter 2 of the variables (cost, sell or margin). Preceding the third key with [2nd], signals the calculator to compute that variable.

Calculations are based on

$$\textbf{Profit Margin (\%)} = \frac{\textbf{Sell-Cost}}{\textbf{Sell}} \times 100$$

which is percentage profit margin based on the selling price.

Example 1: You need to *determine the selling price* for a pump. You require a 40% profit margin (MAR) and the pump cost you $300 (CST). What should the selling price be (SEL)?

Enter	Press	Display
40	[MAR]	40
300	[CST]	300
(To find the answer) →	[2nd] [SEL]	500

The answer is: $500.00 should be the selling price (SEL).

Example 2: You want to *determine your profit margin* when the pump cost you $1250 (CST) and you sold it to a customer for $1736.12 (SEL).

Enter	Press	Display
1250	[CST]	1250
1736.12	[SEL]	1736.12
(To find the answer) →	[2nd] [MAR]	28.000369

The answer is 28% profit margin.

Example 3a: You need to *determine the selling prices* for a pump and accessories. You require a 45% profit margin (MAR). What should be the selling prices for the items that cost you $300, $675, $1500 (CST)?

Enter	Press	Display
45	MAR	45
300	CST	300
(To find the answer) →	2nd SEL	545.45455
(To find the 2nd answer) → **675**	CST 2nd SEL	1227.2727
(To find the 3rd answer) → **1500**	CST 2nd SEL	2727.2727

The selling prices (SEL) are $545.45, $1227.27 and $2727.27.

Example 3b: If you want to find the *TOTAL of the selling prices* of these items, do the above calculations this way:

Enter	Press	Display
45	MAR	45
300	CST	300
	2nd SEL	545.45455
	STO	545.45455
675	CST 2nd SEL	1227.2727
	SUM	1227.2727
1500	CST 2nd SEL	2727.2727
	SUM	2727.2727
(To find the answer) →	RCL	4500

The total of the Selling Prices is $4500.

VIII. FINANCIAL OPERATIONS

INTEREST

The occurrence of interest is found throughout the financial world. Interest is the rent paid for the use of someone else's money. Interest can be the money your savings account earns, paid by the bank that is using your money, or money that you pay for a car loan.

Interest is also a factor when looking at investments. Money is worth more in the future because of the accrued interest it can accumulate along the way. Today's money will have a different value at some future date because of its interest drawing potential. Conversely, some future sum of money must be discounted when considering its value today.

The charge for using money is based on an interest rate which is a certain percent per time period (day, week, month, year, etc.). Usually this percentage is set at a yearly rate, called an annual percentage rate (APR). The other two factors controlling the amount of interest paid are the amount of money being used and the length of time it is used.

The two basic ways of charging interest are termed simple and compound.

SIMPLE INTEREST

Interest earned is based on the use of a certain amount of money for some time at an agreed interest rate. When simple interest is applied, only the initial amount of money earns the interest. No additional capital is added to the account by deposit or by retaining any interest earned previously. Simple interest is the product of three variables.

Interest earned (I) = Principal (P) × interest rate(r) × number of periods (t)

$$I = Prt$$

Example: If you deposited $2000 in a fund that guarantees 12% simple interest per year, how much interest would you draw in 3 years?

Enter	Press	Display
2000	[×]	2000.
12	[%] [×]	240.
3	[=]	720.

Your $2000 investment will return $720 in interest—$240 per year.

	Principal	Interest Earned
1st year	$2000	$240
2nd year	2000	240
3rd year	2000	240
		$720 Total

The total amount (S) is now the principal (P) plus the interest (I).

$$S = P + I$$

The total amount for the above problem is P + I or 2000 + 720 = $2720.

Discount (Present Value vs Future Value)

The principal amount is actually a present value and the total amount is a future value because time has passed and interest has been generated. Anticipating some future value, the present value can be determined for a simple interest situation by

$$S = P + I \text{ where } I = Prt$$

$$\text{substituting, } S = P + Prt \text{ or } S = P(1 + rt)$$

$$\text{and } P = \frac{S}{1 + rt}$$

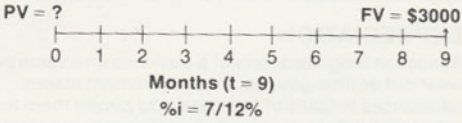
which represents some future value(s) discounted at r interest rate for some time t.

Example: What is the present value of a $3000 bond at 7% simple interest that matures in 9 months? The face value of the bond ($3000) must be discounted to the present.

$$P = \frac{3000}{1 + \frac{7\%}{12}(9)}$$

Enter	Press	Display
3000	[÷] [(]	3000.
1	[+] [(]	1.
7	[%] [÷]	0.07
12	[×]	.00583333
9	[=]	2850.3563

Graphically, the problem can be represented as shown below.



This problem could have been rephrased to read "How much should you invest now at 7% simple interest to accumulate $3000 in 9 months?"

Exact and Ordinary Simple Interest

When computing simple interest, you should be aware of several different methods of measuring time and how they affect your calculations. Exact simple interest is based on the exact number of days in a year, whereas ordinary simple interest uses a fixed 360 day year. The interest earned for part of a period in any simple interest situation is based directly on the part of the period that is used.

Example: Calculate the exact and ordinary simple interest on $3000 for 60 days at an APR of 7%.

For exact: **Interest** = **Prt** = $3000(7\%)\left(\frac{60}{365}\right)$

Enter	Press	Display
3000	[×]	3000.
7	[%] [×]	210.
60	[÷]	12600.
365	[=]	34.520548

For ordinary interest = $3000(7\%)\left(\frac{60}{360}\right)$

Enter	Press	Display
3000	[×]	3000.
7	[%] [×]	210.
60	[÷]	12600.
360	[=]	35.

In the same manner, the number of days per month used in calculations can be exact or fixed at 30.

DEPRECIATION

Almost all tangible assets of a business lose value or wear out as time goes by. The government makes allowances in taxes of businesses to permit them to set aside funds to eventually replace worn out assets. First, the decreasing value or depreciation of an asset must be determined.

There are three different methods for calculating depreciation. These three methods will be applied to show the depreciation differences when discounting an $18,000 computer over a 5-year time span. The computer can be sold in five years for $3500. The depreciable value thus becomes $18000 − 3500 = $14500.

Straight-Line Method

This method depreciates items a fixed amount each year. The computer is depreciated $14500 ÷ 5 = $2900 per year for 5 years. A depreciation schedule can be established as follows:

Enter	Press	Display	Comments
18000	[−]	18000.	Purchase price
3500	[÷]	14500.	Depreciable value
5	[=] [STO]	2900.	Annual depreciation
18000	[−] [RCL] [=]	15100.	Value after 1 year
	[−] [RCL] [=]	12200.	Value after 2 years
	[−] [RCL] [=]	9300.	↓
	[−] [RCL] [=]	6400.	↓
	[−] [RCL] [=]	3500.	Value after 5 years

The straight-line method is simple and straightforward, but most assets really lose most of their value in the first few years.

Sum-of-the-Year's-Digits Method

The annual depreciation for this method is based on the sum of digits representing each year of the life of the asset. For the computer, sum the digits 1 through 5 (for years 1 through 5) to get 15. Now to compute the first year's depreciation take 5/15 of the depreciable value, then 4/15 of the depreciable value for the next year, etc.

Enter	Press	Display	Comments
14500	STO ×	14500.	Store depreciable value
5	÷	72500.	
15	=	4833.3333	First year's depreciation
	RCL ×	14500.	
4	÷	58000.	
15	=	3866.6667	Second year's depreciation
	RCL ×	14500.	
3	÷	43500.	
15	=	2900.	Third year's depreciation
	RCL ×	14500.	
2	÷	29000.	
15	=	1933.3333	Fourth year's depreciation
	RCL ×	14500.	
1	÷	14500.	
15	=	966.66667	Fifth year's depreciation

This method decreases the depreciation a fixed percentage (1/15 or 6 2/3%) each year.

Declining Balance Method

Here, a fixed percentage (declining balance factor) is applied to the remaining value of the asset, not to the depreciable value as in the previous method. The salvage value cannot be taken into account, so the initial value is your starting point. The remaining value of the asset cannot, by law, go below the salvage value. The factor for straight declining balance is 100%. For double declining balance, the factor is 200%. Other depreciation rates are generally referred to in terms of the declining balance factor such as 150% declining balance.

For our computer problem, choose 125% as the declining balance factor.

Enter	Press	Display	Comments
125	[÷]	125.	Declining balance factor
5	[=] [STO]	25.	Store % annual depreciation
18000	[−] [RCL] [%]	4500.	First year depreciation
	[=]	13500.	Depreciated value
	[−] [RCL] [%]	3375.	Second year depreciation
	[=]	10125.	Depreciated value
	[−] [RCL] [%]	2531.25	Third year depreciation
	[=]	7593.75	Depreciated value
	[−] [RCL] [%]	1898.4375	Fourth year depreciation
	[=]	5695.3125	Depreciated value
	[−] [RCL] [%]	1423.8281	Fifth year depreciation
	[=]	4271.4844	Depreciated value

The computer can now be sold after being fully depreciated by the next year.

IX. STATISTICAL APPLICATIONS

In addition to offering a wide range of financial capabilities, your calculator also provides keys for linear regression and trend-line analyses.

LINEAR REGRESSION

Linear regression allows you to express one variable in terms of another even though they may not be analytical functions of each other. These can be represented as a scatter of points on a two-dimensional graph. A straight line can then be drawn to best approximate the pattern formed by this array of points. Placement of the line is determined by a least-squares linear regression that minimizes the sum of the squares of the deviations of the actual data points from the straight line of best fit. The linear equation of the form $y = mx + b$ is determined for the line.

$$m = \text{slope} = \frac{\sum_{i=1}^{n} x_i y_i}{N} - \bar{x}\,\bar{y} \Big/ \sigma_x^2$$

$$b = \text{y-intercept} = \bar{y} - m\bar{x}$$

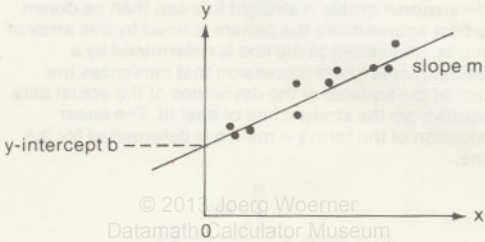
$$\bar{x} = \text{average of x values} = \frac{\sum_{i=1}^{N} x_i}{N}$$

$$\bar{y} = \text{average of y values} = \frac{\sum_{x=i}^{N} y_i}{N}$$

Linear regression is extremely useful for analyzing historical data and using the results to project future information. The data points are entered by their x–y coordinates using the following keys.

The [2nd] [LR] sequence initializes the calculator to perform linear regression types of problems and must be pressed first to enter this mode. The [x:y] and [Σ+] keys enter the x and y values respectively for linear regression type of problem. The data entry key sequence is **x** [x:y] **y** [Σ+]. The [2nd] [Σ−] sequence is used to remove invalid entries.

The remainder of the keys are used to compute results. Press [2nd] [m] to compute the slope of the line fitted to the input points and [2nd] [b] calculates the point of intersection of the line with the y-axis.



If the line is vertical, no y-intercept exists and the slope is undefinable. Calculating the slope will yield an error condition and additional x points cannot be predicted. If the line is horizontal, the slope is 0 and new y values cannot be predicted.

The [2nd] [x'] and [2nd] [y'] sequences are used to predict new points on the line that has been derived from preceding data.

Example: NoDie Life Insurance Company has found that the volume of sales varies according to the number of sales people employed.

Number of sales people	7	12	3	5	11	8
Sales in thousands/mo.	99	152	81	98	151	112

How many sales people does this company need for $200,000 monthly sales? What monthly sales should 15 sales people generate?

Enter	Press	Display	Comments
	2nd L.R.	0.	Initialize
7	x:y	0.	First x value
99	Σ+	1.	Data point 1
12	x:y	8.	Second x
152	Σ+	2.	Data point 2
3	x:y	13.	etc.
81	Σ+	3.	
5	x:y	4.	
98	Σ+	4.	
22	x:y	6.	Incorrect entry
151	Σ+	5.	
22	x:y	23.	Remove incorrect entry
151	2nd Σ−	4.	
11	x:y	22.	
151	Σ+	5.	
8	x:y	12.	
112	Σ+	6.	
200	2nd x̄	17.815789	People for $200,000
15	2nd ȳ	176.55618	Sales for 15 people
	2nd m	8.3258427	Slope of line
	2nd b	51.668539	Y-intercept of line

The slope and y-intercept have been calculated so that the line can be plotted, if desired. The slope is incremental sales per person. The y-intercept is independent sales.

Due to the complexity of the linear regression calculations, the memory cannot be used. Consequently, any stored value is lost when 2nd L.R. is pressed. Simple arithmetic can be performed where each operation completes the previous operation. The math functions can still be used, but parentheses are ignored.

TREND-LINE ANALYSIS

For this type of linear regression, the calculator automatically increments the x values by 1 for each data point. The calculator initially assigns a 0 for the x value of the first data point, 1 for the second, etc. All data points are entered by pressing [Σ+] only. The starting x value can be set to any number other than 0 by entering the first x value, then letting the calculator increment from there: x_1 [x:y], y_1 [Σ+], y_2 [Σ+], y_3 [Σ+], etc

Example: Dates Unlimited, a computer dating service, has the following annual profits:

Year	1962	1963	1964	1965-1971
Profit in millions	−2.1	−0.3	0.8	inactive
Year	1971	1972	1973	1974
Profit in millions	2.9	2.8	3.6	4.0

What profit can be expected in 1980 and when will the company break the $10 million mark?

Enter	Press	Display	Comments
	[2nd] [LR]	0.	Enter linear regression mode
1962	[x:y]	0.	Initialize x
2.1	[+/−] [Σ+]	1.	1962 loss
.3	[+/−] [Σ+]	2.	1963 loss
.8	[Σ+]	3.	1964 gain
1971	[x:y]	1965.	Reinitialize x
2.9	[Σ+]	4.	1971 gain
2.8	[Σ+]	5.	1972 gain
3.6	[Σ+]	6.	1973 gain
4	[Σ+]	7.	1974 gain
1980	[2nd] [y']	6.521649	
10	[2nd] [x']	1988.2985	

In 1980 the company can expect over $6.52 million profit and to reach the $10 million mark in early second quarter of 1988.

APPENDIX A

ERROR CONDITIONS AND PARAMETERS

The display shows "Error" whenever the limits of the calculator are exceeded or when an improper operation is requested. Press [ON/C] to remove the "Error" message from the display. This also eliminates the number and operation that caused the error condition. Calculations or data entries up to that point are preserved when not in a financial mode. Pressing [ON/C] twice not only removes the error condition, but also clears the calculator entirely, except for the memory.

"Error" is produced in the display for the following reasons:

1. The calculation results (in display or memory) are outside the range of the calculator, $\pm 1 \times 10^{-99}$ to $\pm 9.9999 \times 10^{99}$.
2. Calculation of root or logarithm of a negative number.
3. Dividing a number by 0.
4. Attempting to calculate financial unknowns before enough known variables have been entered or when no valid solution exists.
5. Attempting to open more than 4 levels of processing or to have more than 15 open parentheses at any one level.
6. Linear regression calculations that deal with a vertical line.
7. Attempting to calculate x' for a horizontal line in linear regression.
8. Trying to use linear regression with less than two data points.
9. Key sequences 0 [2nd] [Δ%] 0 or 0 [2nd] [Δ%] number.

10. Multiplying a number greater than 1×10^{99} by another number (decimal or integer) may cause an error condition.
11. Calculating profit margin with the selling price equal to zero.
12. Calculating any statistical function with no data points.
13. Entering statistical data points (X_i) such that $\Sigma (X_i)^2$ exceeds the upper or lower limit of the calculator.

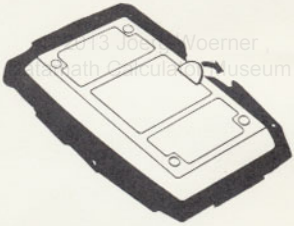
APPENDIX B

SERVICE INFORMATION

BATTERY REPLACEMENT

An alkaline battery is recommended for your calculator. It has an operating life of approximately 20 hours. A nonalkaline battery may be used but it should be removed prior to a prolonged period of non-use or immediately after discharge to prevent possible damage to the calculator from leakage.

To install a battery, insert a coin into the slot in the back of the calculator and pry off the battery cover. (see sketch) Attach the battery terminals to the connecting wires in the calculator. Position the connected battery in the compartment according to the diagram on the battery cover and snap the cover back into place.



If you have the optional rechargeable battery kit, refer to the instructions furnished with the kit.

IN CASE OF DIFFICULTY

1. If using the optional rechargeable kit RK-2, check for power at AC outlet and proper insertion of plug into calculator.

   CAUTION: Use of other than a 9 volt battery or RK-2 kit with electronic battery may apply improper voltage to your calculator and will cause damage.

2. If display is dim, erratic or fails to light on battery operation, check for an improperly inserted or discharged battery. See *Battery Considerations* in Section III.
3. Review operating instructions to be certain calculations are performed correctly.
4. When a battery is inserted into the calculator and the display is not blank, pressing [OFF] then [ON/C] should blank the display and prepare the calculator for your use.

APPENDIX C
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**
grams	ounces	28.349523
kilograms	pounds	**0.45359237**
liters	gallons (U.S.)	3.7854118
liters	gallons (Imp.)	4.546090
milliliters (cc)	fl. ounces	29.573530
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	0.02831685
cu. meters	cu. yards	0.76455486

Temperature Conversions

$$°F = \frac{9}{5}(°C) + 32$$

$$°C = \frac{5}{9}(°F) - 32$$

Boldface numbers are exact; others are rounded.

PUMP FUNCTIONS

1. Convert Head → PSI
   Head (feet) x .434 = PSI (pounds)
2. Convert PSI → Head
   PSI (pounds) x 2.31 = Head (feet)
3. Calculate Horsepower
   $$HP = \frac{\text{Gallons per Minute x Head}}{\text{Efficiency x 3960}}$$
4. Convert Vacuum → Suction Lift
   VAC (inches) x 1.13 = S.LFT. (feet)
5. Convert Suction Lift → Vacuum
   $$\frac{\text{S.LFT (feet)}}{1.13} = \text{VAC (inches)}$$

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