

MODE  
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 **HEWLETT-PACKARD**  
**9805A STATISTICS CALCULATOR**  
**OPERATING GUIDE**

## Introduction

The 9805 Statistics Calculator provides the user with basic statistical calculations at the touch of a key. From mean and standard deviations to curve fitting, the Statistics Calculator simplifies statistics by:

- preserving data once it has been entered regardless of the number of calculations.
- providing a printed record of all data entries and all calculations.
- permitting the addition or deletion of data at any time during calculations.
- identifying statistical output with accepted statistical symbols.

In addition, the 9805 will solve math problems involving logs, exponents, percentages, squares, and square roots. After trying it once, you'll wonder how you ever managed without it.

JOHN KEITH

## **9805A Statistics Calculator Operating Guide**



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# Table of Contents

## Introduction

## Chapter 1: Getting Started

Preliminaries . . . . .	1
Keying In Numbers . . . . .	1
Clearing Numbers . . . . .	1
Simple Arithmetic . . . . .	2
Constant Storage . . . . .	3
Using Negative Numbers . . . . .	3
The Busy Light . . . . .	4
Printer . . . . .	4
Display Option . . . . .	4

## Chapter 2: Basic Statistics

DATA ENTRY . . . . .	5
BASIC STAT . . . . .	5

## Chapter 3: Histograms

OFFSET—WIDTH . . . . .	7
DATA ENTRY . . . . .	7
DELETE . . . . .	8
HISTO . . . . .	8
BASIC STAT . . . . .	10
Data Storage Locations . . . . .	11

## Chapter 4: Curve Fitting—Linear & Parabolic

DATA ENTRY . . . . .	13
DELETE . . . . .	13
LINEAR . . . . .	13
PARA . . . . .	13
Ŷ EVAL — Linear Estimate . . . . .	15
PLOT . . . . .	15
Ŷ EVAL — Parabolic Estimate . . . . .	16
PLOT . . . . .	16
BASIC STAT . . . . .	16
Data Storage Locations . . . . .	17

## Chapter 5: Two-Sample t

DATA ENTRY . . . . .	19
DELETE . . . . .	19
t . . . . .	19
Data Storage Locations . . . . .	22

**CAUTION**

THE 9805 STATISTICS CALCULATOR CAN BE  
SEVERELY DAMAGED IF IT HAS NOT BEEN SET  
TO THE CORRECT VOLTAGE; IF IN DOUBT,  
PLEASE REFER TO APPENDIX A.

We make no express or implied warranty of any kind, including, but not limited to, the implied warranties of merchantability and fitness for a particular purpose, with regard to the programs used in the 9805 Statistics Calculator. HP shall not be liable for incidental or consequential damages in connection with or arising out of the furnishing, performance, or use of these programs.

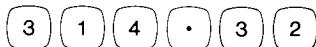
**Getting Started****Preliminaries**

Your 9805 Statistics Calculator is shipped fully assembled and is ready to operate after making a few simple checks. If you have just received your calculator, please be sure to immediately inspect it before switching it on (refer to Appendix A of this manual for both inspection and turn on procedures). But if the calculator has already been running in your area, simply do the following:

- If the calculator is not plugged in, plug one end of the power cord into the rear panel of the calculator; plug the other end into a suitable power outlet.
- If the calculator is switched off, check to see that the two-position switches **PRT OFF** and **AUTO** are in the up position. Then press and lock the switch marked **LINE**. The word '**CLEAR**' should be printed; if it is not, see Calculator Service, Appendix C.

**Keying In Numbers**

Key in numbers from left to right and include the decimal point if it is a part of the number. For example, the number 314.32 would be keyed in as:

**Clearing Numbers**

When you wish to erase the number you're keying in (perhaps you keyed it in wrong) press **CANCEL ENTRY** and key it in correctly. To erase the previous problem, press **CLEAR**. The word '**CLEAR**' is printed.

## Simple Arithmetic

To solve arithmetic problems with your Statistics Calculator:

1. enter the first number;
2. press the operation (+, -, x, ÷) you want to do;
3. enter the second number;
4. press = (the letter 'R' is printed with each result).

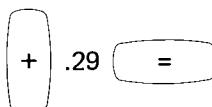
The calculator prints your keyboard operations as you key them in.

**Examples** Before doing these examples, be sure PRT OFF and AUTO- are not pressed down.

To add \$5.98 and \$.29:

Press: 

Then press: 5.98





5.98 +  
.29 =  
6.27 R

Take a moment to notice how the calculator records your keyboard operations. Each number is printed after an operation key is pressed; then the result of the problem (R) is printed after pressing =.

Subtraction:  $31 - 8 = ?$

31.00 -  
8.00 =  
23.00 R

Press: 31  8 

Multiplication and Division:  $\frac{35 \times 4}{4}$

35.00 x  
4.00 ÷  
.40 =  
350.00 R

Press: 35  4  

Whenever you wish to keep a printout for later use, press PAPER↑ and tear the paper off.

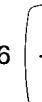
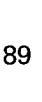
When working problems with more than two numbers, the calculator uses the result of the previous operation to perform each new operation. No subtotals are printed. Thus, when you pressed ÷ in the last example, the product of  $35 \times 4$  was calculated (but not printed) and then that product was divided by .4. The final answer was printed when you pressed =.

For example, to add this list of numbers:

12  
45  
8  
23  
6  
89  

---

?

Press: 12  + 45  + 8  +  
  
23  + 6  89  =

12.00	+
45.00	+
8.00	+
23.00	+
6.00	+
89.00	=
183.00	R

### Constant Storage

To store a number for later use, key in the number and press **STORE**. You can also store the result of a problem by pressing **STORE** after the result is calculated. A stored constant remains unchanged until either another number is stored or the calculator is switched off.

To use the stored constant in a problem, just press **RECALL** instead of keying in the number.

### Using Negative Numbers

Negative numbers are entered by keying in the number and then changing its sign by pressing  (CHS).

For example, to solve this problem:

Press: 35  x 5  ÷ 2

35.00  x

 (CHS)  =

- 5.00  ÷  
- 2.00  =  
- 87.50  R

Remember that the sign must be changed after the number is entered. Also, notice that negative numbers are printed in red.

## **The Busy Light**

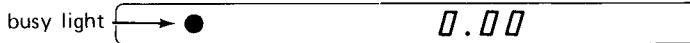
The small red light that flashes in the display window is the Busy Light. When you're running internal programs or doing keyboard calculations, the busy light may stay on for up to a few seconds. The busy light is there to remind you that the calculator will ignore any keys you press while it's working your problem. In most cases, the calculating time includes time for the printer to record your keyboard operations. So, if you wish to do 'chain calculations' as fast as possible, switch the printer OFF by pressing **PRT OFF** down — you can still print the number just keyed in, or the current result, by pressing **PRINT**.

## **Printer**

The printer provides a written record of all calculations, using an easy-to-understand notation for each function. In addition, the calculator lets you know of operating errors by printing a special 'NOTE' after an error is made. When a note is printed, you should compare it with the list in Appendix D. You'll find that most errors can be easily corrected by simply keying in the problem correctly.

## **Display Option**

The display allows the operator to see each number as it's entered or to see the result just calculated. Each number is displayed in the same form that it is printed. If your calculator has the optional display, it should appear like this whenever the calculator is switched on:



Chapter **2**  
**Basic Statistics**

One of the most basic statistical calculations is to find the mean and standard deviation of a single group of numbers.

To set up a one-variable problem press . This erases the machine of previous data and prepares it for the entry of a single array. If, by accident, you press the **VAR#** key in the middle of a problem, follow it with a numerical key greater than 2 in order to retain the current data and problem. An Operating Note is printed, but in this case you can ignore it and continue with the problem.



Key in each number and follow it with **DATA ENTRY**. Each entry is automatically printed. If you find you have made a mistake, or if you want to delete a data value at some later time, it can easily be corrected. Press **DELETE**, key in the unwanted entry, and then press **DATA ENTRY**. Data can be added or deleted at any time. The statistical summations of the data are preserved regardless of the number of calculations.



Pressing **BASIC STAT** calculates the sample size, mean and standard deviation\* of the data and prints it in the following form:

sample size (N)  
mean ( $\bar{x}$ )  
standard deviation ( $\Delta$ )

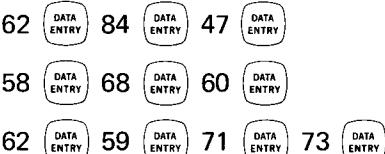
### Example

In a recent survey to determine the average age of the 10 wealthiest people in Monte Carlo, the following data was obtained:

62 84 47 58 68 60 62 59 71 73

\*The formula used for calculating the standard deviation is included in Appendix D.

Of the ages given, what is the mean and standard deviation?

Press:    

	62.00	#
84.00		#
47.00		#
58.00		#
68.00		#
60.00		#
62.00		#
59.00		#
71.00		#
73.00		#

 sample size  $\longrightarrow$    

mean  $\longrightarrow$    

standard deviation  $\longrightarrow$    

Delete the highest and lowest age. What is the new mean and standard deviation?

Press:      

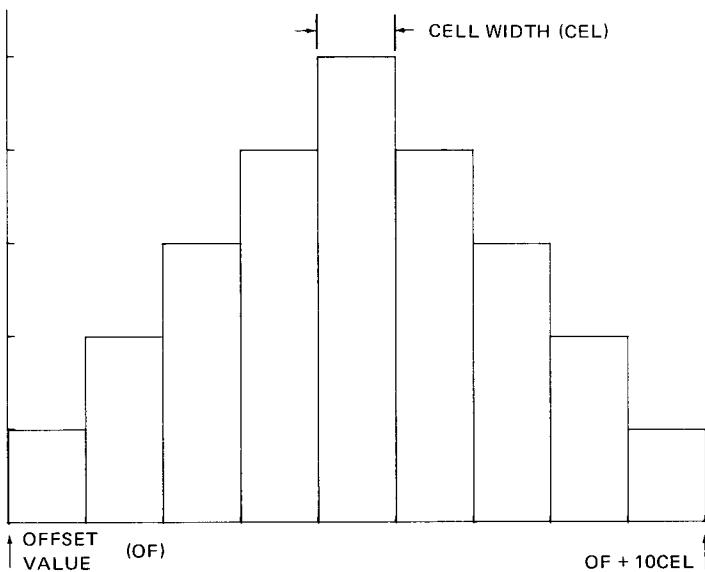
The mean, for all practical purposes, is the same. The standard deviation, on the other hand, has been cut nearly in half.

Chapter **3**  
**Histograms**

To set up a histogram first press **VAR#** **1**. All previous data is erased.

**OFFSET  
WIDTH**

The 9805 Statistical Calculator groups data for each histogram into ten cells. The offset defines the lower boundary of the first cell. The cell width defines the width of each cell. (See drawing.)



To define the offset and cell width, first press **OFFSET  
WIDTH**. Key in the offset value and press **DATA ENTRY**. Then key in the cell width and press **DATA ENTRY** again.

**DATA  
ENTRY**

Key in each data value and press **DATA ENTRY**. Each entry is automatically printed. Data included in the histogram must fall in this range:

$$\text{offset} \leq \text{data} < \text{offset} + 10 \times \text{cell width}$$

If the value does not fall into one of the 10 cells, as described by the above range, the letter L (for too 'low') or H (for too 'high') is printed above the number on the printout.



If you find you have made a mistake, or if you want to delete a data value at some later time, the procedure is simple. Press **DELETE**, key in the unwanted entry, and press **DATA ENTRY**. The number of entries is shown in the optional display after each entry or operation.

Data can be added or deleted at any time. The statistical summations of the data are preserved regardless of the number of calculations.



Pressing the **HISTO** key calculates and prints the following information for each of the 10 cells:

- cell number
- lower boundary of the cell
- frequency of the cell
- relative percent frequency of the cell

### Example

The data set below represents the weights of canned tuna produced at a cannery. The cans coming off the production line were randomly sampled hourly. 27 cans were selected and weighed from one packing machine.

Weights: 113.3 112.1 115.6 114.1 117.2 116.1 117.1 116.4  
114.0 115.0 115.7 113.1 117.7 116.0 115.1 118.1  
119.0 115.9 118.2 118.1 117.7 117.0 114.6 116.3  
116.2 115.0 116.6

Set up a histogram to find the distribution of the weights. By examining the data we can determine that a reasonable offset is 110 and a reasonable cell width is 1.

Set up the histogram by pressing:

VAR # 1  
OFFSET WIDTH  
110 DATA ENTRY  
1 DATA ENTRY

V1 . . . . .  
OF =  
110.00 #  
C E L =  
1.00 #

To enter the data values, press:

113.3	DATA ENTRY	112.1	DATA ENTRY	115.6	DATA ENTRY	113.30	#
						112.10	#
						115.60	#
114.1	DATA ENTRY	117.2	DATA ENTRY	116.1	DATA ENTRY	114.10	#
						117.20	#
						116.10	#
117.1	DATA ENTRY	116.4	DATA ENTRY	114.0	DATA ENTRY	117.10	#
						116.40	#
						114.00	#
115.0	DATA ENTRY	115.7	DATA ENTRY	113.1	DATA ENTRY	115.00	#
						115.70	#
						113.10	#
117.7	DATA ENTRY	116.0	DATA ENTRY	115.1	DATA ENTRY	117.70	#
						116.00	#
						115.10	#
118.1	DATA ENTRY	119.0	DATA ENTRY	115.9	DATA ENTRY	118.10	#
						119.00	#
						115.90	#
118.2	DATA ENTRY	118.1	DATA ENTRY	117.7	DATA ENTRY	118.20	#
						118.10	#
						117.70	#
117.0	DATA ENTRY	114.6	DATA ENTRY	116.3	DATA ENTRY	117.00	#
						114.60	#
						116.30	#
116.2	DATA ENTRY	115.0	DATA ENTRY	116.6	DATA ENTRY	116.20	#
						115.00	#
						116.60	#

Calculate histogram information by pressing:  .

	HG	
Cell Number	1.00	#
Lower Boundary	110.00	#
Frequency	.00	#
Percent Frequency	.00	#
	2.00	#
	111.00	#
	.00	#
	.00	#
	3.00	#
	112.00	#
	1.00	#
	3.70	#
	4.00	#
	113.00	#
	2.00	#
	7.41	#
	5.00	#
	114.00	#
	3.00	#
	11.11	#
	6.00	#
	115.00	#
	6.00	#
	22.22	#
	7.00	#
	116.00	#
	6.00	#
	22.22	#
	8.00	#
	117.00	#
	5.00	#
	18.52	#
	9.00	#
	118.00	#
	3.00	#
	11.11	#
	10.00	#
	119.00	#
	1.00	#
	3.70	#

You can see that the greatest cell frequency is 6 and it occurs in both cells 6 and 7.



You can also calculate the sample size, mean and standard deviation of the histogram data by pressing **BASIC STAT**. The printout is shown:

N	27.00	#
$\bar{x}$	115.97	#
s <sub>1</sub>	1.71	#

If you have a plotter connected you can plot the histogram by first setting up the axes and then pressing **PLOT**. A plot of this histogram can be found on page 33.

### **Data Storage Locations**

During calculations, summations and other information are stored in 17 storage locations numbered 0 through 16. The table below shows what information is stored in which data location.

Location	Contents	Location	Contents
0	No. of entries	9	freq. of cell 7
1	$\Sigma x$	10	freq. of cell 8
2	$\Sigma x^2$	11	freq. of cell 9
3	freq. of cell 1	12	freq. of cell 10
4	freq. of cell 2	13	$\bar{x}$
5	freq. of cell 3	14	$\Delta x$
6	freq. of cell 4	15	cell width
7	freq. of cell 5	16	offset
8	freq. of cell 6		

To recall the contents of these locations:

1. Key in the location number
2. Press 

This information can be used to calculate additional statistical functions using keys on the right of the machine which are described in Chapter 9.

## **Notes**

**Curve Fitting-Linear & Parabolic**

To set up a curve fit first press **VAR** **2**. This sequence erases the machine of previous data and prepares it for the entry of x and y values.



If you have a plotter connected, set up the axes now as described in Chapter 8, Plotting Curve Fits and Data Points. Data points will then be plotted as they are entered.

Data points are entered in pairs, that is,  $x_1, y_1; x_2, y_2$ ; etc. Press **DATA ENTRY** after each x or y value has been keyed in. Entries are automatically printed and the number of entries is shown in the optional display.



To correct mistakes or to delete a data pair at some later time: press **DELETE**, key in the x value of the unwanted point, press **DATA ENTRY**, key in the y value and press **DATA ENTRY** again.

Data can be added or deleted at any time. The statistical summations of the data are preserved regardless of the number of calculations.



By pressing **LINEAR** you can calculate the coefficients of the equation  $y = A + Bx^*$  and the coefficient of determination ( $r^2$ ).



By pressing **PARA** you can calculate the coefficients of the equation  $y = A + Bx + Cx^2$  and the coefficient of determination ( $r^2$ ).

The coefficient of determination is a value between 0 and 1. At  $r^2 = 0$ , you have the worst fit. At  $r^2 = 1$ , you have a perfect fit.

\*The equations used to calculate the coefficients are in Appendix D.

## Example

A quality control engineer notes that there seems to be a relationship between the amount of chemical added to a batch, and the final concentration of the chemical in the final product. The following data represents the weight in grams added (x) and the weight in the final product (y).

x	y
2	3
1	1
6	5
3	5
7	7
6	8
9	8.5

Set up the curve fit by pressing:  



If you have a plotter, set up the axes now, as described in Chapter 8.

Next, enter the data.

Press: 2  3 

2.00   
3.00 

1  1 

1.00   
1.00 

6  5 

6.00   
5.00 

3  5 

3.00   
5.00 

7  7 

7.00   
7.00 

6  8 

6.00   
8.00 

9  8.5 

9.00   
8.50 

Calculate the linear coefficients (you could start with the parabolic model if you wanted) by pressing:

**LINEAR**

1.22	A	=
.85	B	=
.83	$r^2$	=

The linear equation is  $y = 1.22 + .85x$ . Since  $r^2 = .83$ , you can assume you have a relatively good fit.

**Y EVAL**

### **Linear Estimate**

Calculate a predicted y by keying in an x value and pressing **Y EVAL**. A printout of the linear estimate (LE) for x = 5 is shown:

Press: 5 **Y EVAL**

5.00	LE	=
5.48		#

**PLOT**

If you have a plotter connected you can plot the linear curve fit by first setting up the axes and then pressing PLOT. A plot of this curve fit can be found on page 39.

If you are dissatisfied with the linear curve fit, calculate the parabolic curve fit.

Press: 

A	=
.05	#
B	=
1.55	#
C	=
-	#
$r^2$	=
.86	#

The parabolic equation is  $y = .05 + 1.55x - .07x^2$ . As you can see from the printout above, the coefficient of determination ( $r^2$ ) is a little closer to 1; the fit is a little better.

 - **Parabolic Estimate**

By keying in an x value and pressing  $\hat{Y}$  EVAL you can calculate a parabolic estimate (PE) this time:

Press: 5 

PE	
5.00	#
6.00	#

$\hat{Y}$  EVAL calculates a predicted y based on the previous curve fit.



If you have a plotter connected you can plot the parabolic curve fit using the axes already set up for the linear model. Simply press PLOT. A plot of the parabolic model is found on page 39.



You can also calculate the sample size, mean of x, standard deviation of x, mean of y, standard deviation of y, and simple correlation coefficient by pressing BASIC STAT.

Press:



N	7.00	=
$\bar{x}$	4.86	=
$\Delta 1$	2.91	=
$\bar{y}$	5.36	=
$\Delta 2$	2.72	=
R	.91	=

#### NOTE

To use  $\hat{Y}$  EVAL or PLOT after pressing BASIC STAT, you must press PARA or LINEAR again since the coefficients of the curve fits are stored in the same locations as the BASIC STAT calculations.

#### Data Storage Locations

During calculations, summations and other information are stored in 17 storage locations numbered 0 through 16. The following table shows what information is stored in which location.

Location	Contents	Location	Contents
0	No. of entries	9	
1	$\Sigma x$	10	
2	$\Sigma x^2$	11	See
3	$\Sigma xy$	12	Expansion
4	$\Sigma y$	13	Below
5	$\Sigma y^2$	14	
6	$\Sigma x^3$	15	
7	$\Sigma x^4$	16	
8	$\Sigma x^2 y$		

#### Location After These Operations

	Data Entry	Basic Stat	Linear	$\hat{Y}$ Eval	PARA
10	---	$\bar{Y}$	A	---	A
11	---	$\Delta Y$	B	---	B
12	---	R	---	---	C
13	x value	$\bar{X}$	$r^2$	x value	$r^2$
14	y value	$\Delta X$	---	$\hat{Y}$ value	---

To recall the contents of any of these locations:

1. Key in the location number
2. Press 

This information can be used to calculate additional statistical functions using keys on the right side of the machine which are described in Chapter 9.

Chapter **5**  
**Two-Sample t**

Press **VAR #** **0** to set up a two-sample t calculation. This sequence erases the machine of previous data and prepares it for the entry of two sets of data.



Enter the first set of data values by keying in each entry and pressing **DATA ENTRY**. Each entry is automatically printed. The number of entries appears in the optional display.

To enter the second set of data, press **CHANGE SAMPLE**, key in each data value and follow it with **DATA ENTRY**.



If you find that you have made a mistake, or if you want to delete a data value at some later time, first determine whether the value is in data set one or two. If it is in the same data set you are currently in, press **DELETE**, key in the unwanted value and press **DATA ENTRY**. If it is in the other data set, press: **CHANGE/SAMPLE**, **DELETE**, the unwanted value, and finally **DATA ENTRY**.

Data can be added or deleted at any time. The statistical summations of the data are preserved regardless of the number of calculations.



By pressing **t** you calculate the two-sample t value and the number of degrees of freedom. Both values are printed. A **t** table is located in Appendix D of this manual for easy reference.

### Example

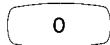
Eagleton Mining Tools of Waynesburg, Pa. has two classes of salesmen: 1) senior salesmen who operate on straight commission and 2) junior salesmen who operate on a base salary. Is there a difference between the average sales of each group? The following data was compiled.

	Senior	Junior
Average	10.1	7.7
Sales	8.7	9.1
Over	6.2	10.8
The	11.8	5.2
Last	9.3	7.9
Six	12.1	6.5
Months	6.9	
	7.5	

We'll set up the problem to test the hypothesis that there is no difference in sales, that is,  $H_0 \bar{x} = \bar{y}$ :

If  $|t_{\text{calc.}}| \leq t_{\text{table}}$ , we accept the hypothesis

If  $|t_{\text{calc.}}| > t_{\text{table}}$ , we reject the hypothesis

First press:  

2 T . . . . .

Next, enter the data from the first sample.

Press: 10.1  8.7   
 6.2  11.8   
 9.3  12.1   
 6.9  7.5 

DATA 1  
 10.10 #  
 8.70 #  
 6.20 #  
 11.80 #  
 9.30 #  
 12.10 #  
 6.90 #  
 7.50 #

Now enter the data from the second sample.

Press: 

7.7  9.1  10.8 

5.2  7.9  6.5 

DATA 2

7.70 

9.10 

10.80 

5.20 

7.90 

6.50 

Calculate  $t$  and the number of degrees of freedom by pressing:



$t$

1.07 



12.00 

If we assume a confidence level of 95% we find that at 12 degrees of freedom  $t_{table} = 2.18$ .

$$|1.07| \leq 2.18$$

$$|t_{calc.}| \leq t_{table}$$

Since the absolute value of  $t_{calc.}$  is less than  $t_{table}$  we accept the hypothesis. The average sales for each group were about the same.

If you need additional information about the two classes of salesmen, pressing **BASIC STAT** will print the following information:

sample size of the first data set	$N_1$	=	
	8.00	#	
mean of the first data set	$\bar{x}$	=	
	9.08	#	
standard deviation of the first data set	$\Delta_1$	=	
	2.18	#	
sample size of the second data set	$N_2$	=	
	6.00	#	
mean of the second data set	$\bar{y}$	=	
	7.87	#	
standard deviation of the second data set	$\Delta_2$	=	
	1.96	#	

### **Data Storage Locations**

During calculations, summations and other information are stored in 17 storage locations numbered 0 through 16. The table below shows what information is stored in which data location.

Location	Contents	Location	Contents
0	No. of entries in 1st sample	9	No. of entries in 2nd sample
1	$\Sigma x$	10	$\bar{y}$
2	$\Sigma x^2$	11	$\Delta y$
3	---	12	---
4	$\Sigma y$	13	$\bar{x}$
5	$\Sigma y^2$	14	$\Delta x$
6	---	15	t value
7	---	16	degrees of freedom
8	---		

To recall the contents of any of these locations:

1. Key in the location number
2. Press 

This information can be used to calculate additional statistical functions using the keys on the right side of the machine which are described in Chapter 9.

## **Notes**

Chapter **6**  
**Paired t**

Press **VAR #** **2** to set up a paired t calculation. This sequence erases the calculator of previous data and prepares it for the entry of x and y values.



Data points are entered in pairs, that is  $x_1, y_1; x_2, y_2$ ; etc. After each x or y value has been keyed in, press **DATA ENTRY**. Each entry is automatically printed and the number of entries is shown in the optional display after each operation.



To correct mistakes or delete a data pair; press **DELETE**, key in the x value of the unwanted point, press **DATA ENTRY**, key in the y value, and finally press **DATA ENTRY** again.

Data can be added or deleted at any time. The statistical summations of the data are retained regardless of the number of calculations.



By pressing **t** you can calculate the paired t value and the number of degrees of freedom. Both values are printed. A t table is located in Appendix D for your convenience.

### Example

In a test to determine the effectiveness of hypnotic treatments in reducing or eliminating sleep walking, the following data was collected from patients before and after treatment.

Incidents Per Month

Patient	Before	After
1	6	2
2	4	3
3	7	5
4	4	4
5	3	3
6	2	2
7	6	1
8	5	2
9	4	2
10	6	3

Set up a null hypothesis:  $H_0: \bar{x} = \bar{y}$  (the treatment had no effect on the patients).

If  $|t_{\text{calc.}}| \leq t_{\text{table}}$  - accept the hypothesis

If  $|t_{\text{calc.}}| > t_{\text{table}}$  - reject the hypothesis

Assume a confidence level of 95%.

Set the problem up by pressing:

VAR # 2

V2

•••••

Next enter the data by pressing:

6  2

4  3

7  5

4  4

3  3

2  2

6  1

5  2

4  2

6  3

6.00	#
2.00	#
4.00	#
3.00	#
7.00	#
5.00	#
4.00	#
4.00	#
3.00	#
3.00	#
2.00	#
2.00	#
6.00	#
1.00	#
5.00	#
2.00	#
4.00	#
2.00	#
6.00	#
3.00	#

Calculate the t paired value and the number of degrees of freedom by pressing:

TP

3.59

0

9.00

At 9 degrees of freedom and a confidence level of 95%  $t_{table} = 2.26$ .

$|3.59| > 2.26$

$|t_{calc.}| > t_{table}$

Therefore we reject the hypothesis. Hypnotism was indeed effective in reducing sleep walking.

BASIC  
STAT

To obtain further information about the data press **BASIC STAT**. The sample size, means, standard deviations, and simple correlation coefficient, are calculated and printed:

N	10.00
$\bar{x}$	4.70
$\Delta_1$	1.57
$\bar{y}$	2.70
$\Delta_2$	1.16
R	.19

### Data Storage Locations

During t paired calculations, summations and other information are stored in 17 storage locations numbered 0 through 16. The table following shows what information is stored in which data location.

Location	Contents	Location	Contents
0	No. of entries	9	No. of entries
1	$\Sigma x$	10	$\bar{y}$
2	$\Sigma x^2$	11	$\Delta y$
3	$\Sigma xy$	12	See Expansion Below
4	$\Sigma y$	13	
5	$\Sigma y^2$	14	
6	$\Sigma x^3$	15	t paired degrees of freedom
7	$\Sigma x^4$	16	
8	$\Sigma x^2 y$		

Location	After These Operations	
	Data Entry	Basic Stat
13	x value	$\bar{x}$
14	y value	$\Delta x$

To recall the contents of any of these locations:

1. Key in the location number
2. Press 

This information can be used to calculate additional statistical functions using the keys on the right side of the calculator which are described in Chapter 9.

## **Notes**

# Plotting the Histogram

Histograms are easily plotted once the range of axes, tic marks, and axes intercepts have been defined. First connect the plotter to the calculator and set the lower left and upper right plotting limits as described in the 9862A Plotter Peripheral Manual.

## X Axis Range

The range of the X axis determines the number of cells plotted. Normally you want to plot all 10 cells. This is done by keying in 0 and pressing **STORE** then keying in 10 and pressing **AXES** **1**.

## Y Axis Range

The range of the Y axis represents the range of cell frequencies. Key in 0 and press **STORE**. Then key in a number that is one or two greater than the greatest cell frequency (remember cell frequencies are printed for each cell in the histogram), and press **AXES** **2**.

## Tic Mark Intervals

To divide the X and Y axes into segments with tic marks, specify the tic mark intervals for both axes. For the X axis you probably want to have a tic mark at each cell boundary. To do this, key in 1 and press **STORE**. For the Y axis key in the tic interval which shows the range of cell frequencies. Finally press **AXES** **3**. To specify no tic marks for an axis, use 0 for the tic interval.

## Axes Intercept Coordinates

The axes intercept coordinates specify at what point the X and Y axes will cross. This is usually 0,0. Key in the x value for the intercept point and press **STORE**.

Remember that x is a cell value, not an actual number on the axis. If, for example, you key in 5 for x, the y axis will be drawn crossing the x axis at the upper boundary of cell 5, whether the cell width is 1 or 10.

Key in the y intercept value and then press **AXES** **4**.

The plotter will plot both the axes and the tic marks at this time. Any value not specified will remain as it was in the previous problem. To specify exactly the same axes as the previous problem press **AXES 0**.

The axes and tic marks are not plotted using this sequence unless you specify again the tic interval and axes intercepts, but you can plot the histogram by itself.

PLOT

With the axes defined, press PLOT and the histogram is plotted.

### Example

To plot the histogram calculated in Chapter 3, first set up the axes. From the histogram information printed, we can determine the following values:

x values --- 0 and 10 (this plots all 10 cells)

y values --- 0 and 7 (one greater than the greatest frequency)

tic intervals ---  $x = 1$

$y = 1$

axes intercepts ---  $x = 0$

$y = 0$

To set up this plot press:

X axis values  
(Range 1)

0      STORE  
10     AXES    1

00  
RG1  
00  
10.00

Y axis values  
(Range 2)

0      STORE  
7      AXES    2

00  
RG2  
00  
7.00

tic intervals

1      STORE  
1      AXES    3

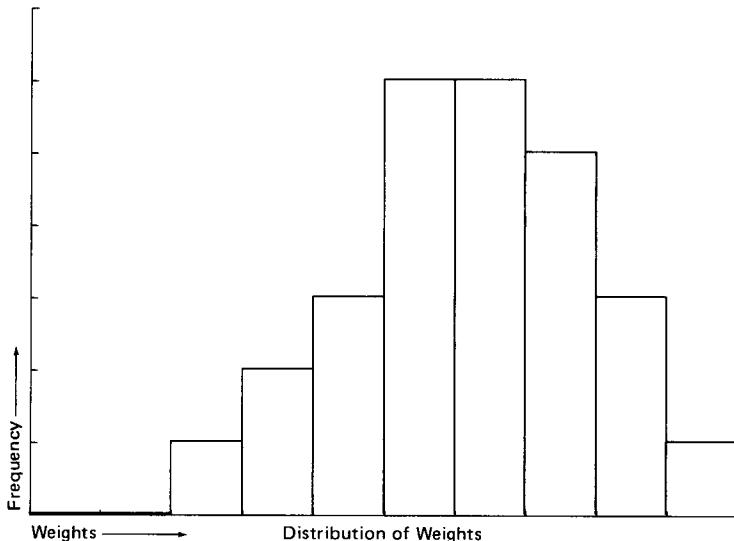
1.00  
TI  
1.00  
1.00

axis intercepts

0	STORE
0	AXES
4	

• 00  
A 1  
• 00  
• 00

Now press PLOT. The graph below was generated with this axes set up.



To plot portions of the histogram the procedure is similar. Define the X axis range in the following manner. Key in the number of cells you want to suppress at the beginning of the histogram and press STORE. Then key in the number of the last cell you want to plot and press 

AXES	1
------	---

. For example, suppose you wanted to plot cells 4 through 9. First key in 3, representing the three cells you didn't want to have plotted. Then press STORE and key in 9, specifying that the ninth cell is the last to be plotted. Finally press 

AXES	1
------	---

. The Y axis range, tic marks, and axes intercepts are defined as before.

When you have specified only a portion of the histogram to be plotted, the plotter will still go through the motions of plotting the suppressed cells at the beginning of the histogram. However, only the cells specified are actually plotted.

## **Notes**

## Plotting Curve Fits and Data Points

Once the range of the axes, tic marks, and axes intercept have been defined, you can easily plot parabolic and linear curve fits as well as individual data points.

### X Axis Range

The range of the X axis is determined from the data. Decide upon minimum and maximum values for x such that all the x values will fall within that range. Then key in the minimum value, press **STORE**, key in the maximum value and press **AXES** **1**. When the calculator is first switched on, the X axis range is from 0 to 1.

### Y Axis Range

The Y axis is set up in the same way as the X axis. Decide upon the minimum and maximum values for y first. Key in the minimum value, press **STORE**, key in the maximum value, and press **AXES** **2**. At turn-on, this range is also from 0 to 1.

### Tic Mark Intervals

To divide the X and Y axes into segments with tic marks, specify the tic mark intervals for both axes. Use a tic interval which will best show the range of the data. For example, if your data falls between 0 and 100, you probably want to have a tic interval of 10 or 20 rather than 1. Key in the x tic interval, press **STORE**, key in the y tic interval, and finally press **AXES** **3**. To specify no tic marks for an axis, use 0 for the tic interval.

### Axes Intercept Coordinates

The axes intercept coordinates specify at what point the X and Y axes will cross. Key in the x value for the intercept point and press **STORE**. Then key in the y value and press **AXES** **4**.

The plotter will now plot both the axes and the tic marks. Any value not specified will remain as it was in the previous problem. To specify exactly the same axes as the previous problem, simply press **AXES 0**.

The axes and tic marks are not plotted using this sequence unless you again specify the tic interval and axes intercept.

### Individual Data Points

With the axes defined, you can plot data points as they are entered. Normally the plotter draws an  $\times$  at each point plotted. However, you have the option of specifying four other characters and whether you want the points connected by straight lines or unconnected (see table below).

DIGIT CODE

Unconnected	Connected	Character
0	5	x
1	6	+
2	7	$\diamond$
3	8	$\square$
4	9	X (delete)

To specify the character, press **CHAR #** and follow it with a number between 0 and 9. If part of a character falls outside the plotting limits, the character will be distorted. To avoid this it is a good idea to set up the graph limits so that they extend beyond the smallest and largest data points by at least 1% of the graph range.

When data points are deleted, a large X is plotted over the previous character. This character can also be specified, if needed, by selecting either character code 4 or 9.

### Curve Fits

After data has been entered and either the linear or parabolic coefficients have been calculated, you can plot the curve fit by pressing **PLOT**.

## Example A: Plotting Curves

To plot the curve fits calculated in Chapter 4, first set up the axes. By examining the data, the following values can be determined:

X range --- 0 thru 10

Y range --- 0 thru 10

tic intervals:

X = 1

Y = 1

axes intercept:

X = 0

Y = 0

The axes should be set up before the data is entered so that the individual points can also be plotted.

Press:  VAR # 2

V2

• • • • •  
.00

0  STORE 10  AXES 1

RG1  
.00  
10.00

0  STORE 10  AXES 2

RG2  
.00  
10.00

1  STORE 1  AXES 3

T 1  
1.00  
1.00

0  STORE 0  AXES 4

A 1  
.00  
.00

As you can see, the axes and tic marks are plotted after pressing AXES  
4. The data points are plotted as they are entered:

Press: 2  3   
↓  
9  8.5 

2.00 #  
3.00 #  
9.00 #  
8.50 #

Calculate the linear coefficients by pressing:



A =  
1.22 #  
B =  
.85 #  
C =  
.83 #

Plot the linear curve fit by pressing:



Calculate the parabolic coefficients by pressing:

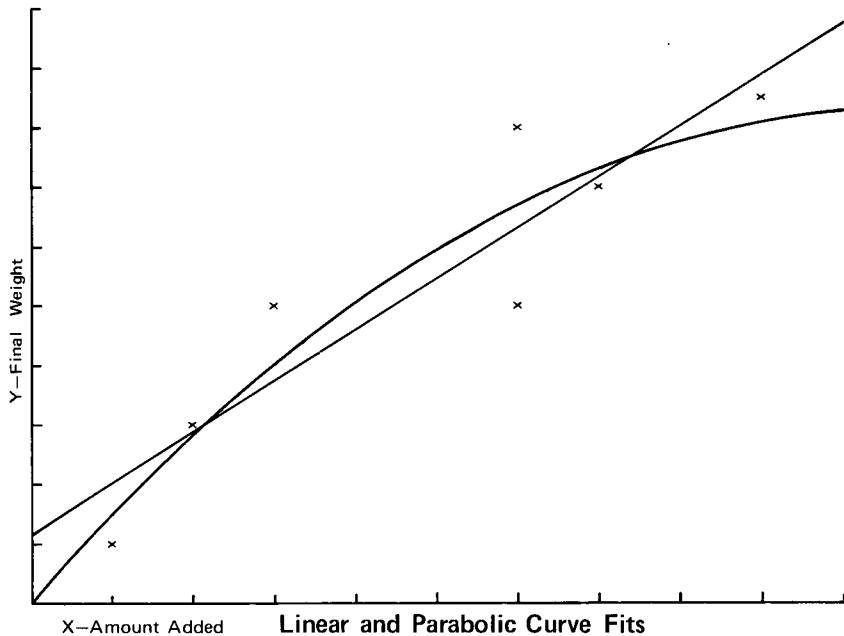


A =  
.05 #  
B =  
1.55 #  
C =  
.07 #  
= #  
.86 #

Plot the parabolic curve fit by pressing:



The final graph should duplicate the one shown on the next page.



### Example B: Plotting Data

A high school counselor would like to determine what effect mathematics studies have on future student success in various university studies. In particular, does the number of years of math relate to university physics, chemistry, and German? Data was collected for 100 students who received his counseling prior to university study. All 100 students were required to enroll in physics, chemistry, and German. The data table below lists the average grades for each group:

Group (yrs. of math)	German	Chemistry	Physics
1	90	65	60
2	85	70	65
3	80	78	85
4	70	85	92

To set up the calculator for data plotting press:



In order to plot the data points first define the range of the axes, the tic intervals, and the axes intercept. From the data we can determine that:

X range --- 0 thru 5

Y range --- 50 thru 100

tic intervals:

X = 1

Y = 10

axes intercept:

X = 50

Y = 4

Set up the axes by pressing:

0  5  1

.00

RG1

.00

5.00

50  100  2

50.00

RG2

50.00

100.00

1  10  3

1.00

0  50  4

.00

AI

.00

50.00

The axes and tic marks are plotted after AXES 4 has been pressed. Individual data points can now be plotted as they are entered.

The first plot is for German grades. For this plot we'll use the connected character , character #5.

Press:  5

CT 5

Next enter the data:

Press: 1  90

1.00  
90.00

2  85

2.00  
85.00

3  80

3.00  
80.00

4  70

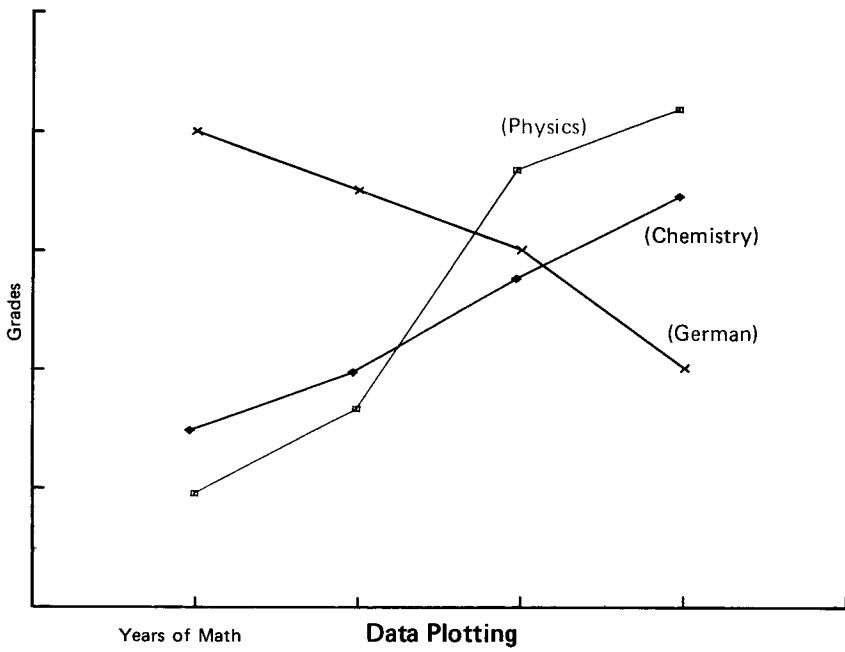
4.00  
70.00

The chemistry plot is done in a similar manner. First press  2. Next specify the same axes set-up as before by pressing  0. Pick a different character for this plot. We used character #7. Now enter the data.

The physics plot is done exactly the same way as the chemistry plot. We used character #8.

The three plots are shown on the following page. They show that:

1. Mathematics is very useful to university physics; the more the better.
2. Mathematics is also very useful to university chemistry; but less than for physics.
3. Mathematics seems to have a negative effect on university German.



## Additional Math Functions

This chapter describes the additional functions and features of the calculator which you can use to derive other statistical equations or simply to do your income tax.

### Rounding

When the calculator is switched on, the printing format (and the display format, if your calculator has a display) is set to 'Round 2'. That means that the calculator rounds each number printed to the nearest hundredth. The printing format can be set to any rounding value between 0 and 6 by pressing RND () followed by the appropriate numerical key. The calculator can also be set to print in 'scientific notation' by pressing RND() .

Whenever a number is too large for the current printing format, the number is automatically printed (and displayed) in scientific form.

#### NOTE

The printing format does not affect calculating accuracy, since the calculator performs all calculations to ten digits.

Here are the possible printing formats for the number 12.3456789:

1.234567890 01 #

Scientific notation

12.345679 #

12.34568 #

12.3457 #

12.346 #

12.35 #

12.3 #

12. #

'Round 6' through 'Round 0'

## What's Scientific Notation ?

Scientific notation is merely a shorthand way of expressing very large or very small numbers. In scientific form a number is expressed with a mantissa and an exponent. For example:

$$93,000,000 \text{ (93 million)} = 9.3 \times 10^7 \quad 9.300000000 \quad 07$$

mantissa      exponent      mantissa      exponent

## Accumulating Results

The Model 5 has an automatic accumulator feature which you can use whenever you wish — here's how it works:

Each time you press **=** the resulting number (R) is also added to the number in the accumulator. Before using the accumulator, press **CLEAR** to erase it. Later, when you wish to recall and print the current accumulated number, press **SHIFT** **=**; the letters 'RT' (result total) are printed with the number.

### Example

Multiply each number in the list below by the constant .25 and then find the sum of the products.

27  
35  
72  
53  
61

To erase the accumulator, press **CLEAR**

To store the constant multiplier, press **.** **2** **5** **STORE**

Now press:

27

CLEAR

•25

→

27.00

×

•25

←

•25

=

6.75

R

35

35.00

×

•25

←

•25

=

8.75

R

72

72.00

×

•25

←

•25

=

18.00

R

53

53.00

×

•25

←

•25

=

13.25

R

61

61.00

×

•25

←

•25

=

15.25

R

To recall and print the sum,

press

62.00

RT

## Using Parentheses

As you saw in some of the previous examples, the Model 5 calculates each new operation by using the result of the previous one. By using the keys, you can group operations together in the same way as when parentheses are used in math notation. For example, solve:

$$9 \div (35 - 8) = ?$$

Here's one way to solve the problem without using the PARENS keys (constant storage is used to store an intermediate result):

$$35 - 8 = C \text{ (constant storage)}$$
$$9 \div C = ?$$

Press these keys:

35  $\boxed{-}$  8  $\boxed{=}$

$\boxed{\text{STORE}}$

9  $\boxed{\div}$   $\boxed{\text{RECALL}}$   $\boxed{=}$

35.00  
8.00  
27.00  
27.00  
9.00  
27.00  
27.00  
• 33 R

Now, by using  $( \quad )$ , you can key in the problem just as it was originally written by pressing:

9  $\boxed{\div}$   $($  35  $\boxed{-}$  8  $)$   $\boxed{=}$

9.00  
35.00  
8.00  
27.00  
• 33 R

Notice that the calculator prints the result of the operation within parentheses when  $)$  is pressed.

Using parentheses not only makes the problem easier to key in, but it can eliminate the need for storing and recalling intermediate results.

By using  $( \quad )$ , expressions like  $(35 - 8)$  can be grouped within other expressions five levels deep (this is called 'nesting' expressions). For example:

$9 \times (6+4) \text{ divided by } 5 \times (7-4) = ?$

We cannot key in the problem just as it appears, since the calculator would first divide the result of  $9 \times (6+4)$  by 5 and *then* multiply that product by  $(7-4)$ . But since parentheses can be nested, the complete denominator can be enclosed within parentheses as the problem is keyed in. Here's the problem to key in:

$$9 \times (6+4) \div (5 \times (7-4)) = ?$$

To solve the problem, press:

9 ( 6 + 4 ) ÷ ( 5 ( 7 - 4 ) ) =

9.00 x  
6.00 +  
4.00 )  
10.00 +  
5.00 x  
7.00 -  
4.00 )  
3.00 )  
15.00 =  
6.00 R

Also, notice that  $\times$  keys were not used since the calculator automatically assumes multiplication when  $($  follows a number entry.

## Numbers To Powers

$\uparrow$  is used to raise the current result, or a number just keyed in, to a power. The power is indicated by the second number keyed in.

## Examples

a. Cube 25 (that's  $25 \times 25 \times 25$ )

Press: 25  $\uparrow$  3 =

25.00 ↑  
3.00 =  
15625.00 R

b. Find  $10^6$  (that's  $10 \times 10 \times 10 \times 10 \times 10 \times 10$ )

Press: 10  $\uparrow$  6 =

10.00 ↑  
6.00 =  
1000000.00 R

c. Now, find  $10^{33}$  (that's a decillion).

Press: 10  $\uparrow$  33 =

10.00 ↑  
33.00 =  
1.000000001 33 T

The last printout shows an example of rounding error. Since the operation includes an internal routine using logarithms, results are not always accurate to the last decimal place — in this case the magnitude of error is only one billionth!

d. Find the area of a circle that has a radius of 8 feet.

Problem: Area =  $\pi r^2$

where: r = 8 feet

$\pi = 3.14 \dots$

Press: 3.14 ( 8  $\uparrow$  2 ) =

3.14 x  
(  
8.00 ↑  
2.00 )  
64.00 =  
area in sq. ft. → 200.96 R

## Percentage Calculations

The **%** key can be used either to find a percentage of the number just keyed in, or to use a percentage of a number within a problem.

### Examples

a. Find 6% of 39.95.

Press:

**CLEAR** 39.95 **x** 6 **%** **=**

**CLEAR**  
39.95 **x**  
6.00 **%**  
.06 **=**  
2.40 **R**

b. Find the cost of an \$8.00 item after it's discounted 15%.

Press:

8 **-** 15 **%** **=**

8.00 **-**  
15.00 **x**  
1.20 **=**  
6.80 **R**

c. Find the simple interest on a loan for \$500.00 that's payable in two years at a 7% interest rate.

Problem:  $I = PRT = 500 \times 7\% \times 2 = ?$

Press:

500 **x** 7 **%** **x** 2 **=**

500.00 **x**  
7.00 **x**  
.07 **x**  
2.00 **=**  
70.00 **R**

d. Now, find the total cost of these items after discounting them:

a. 7 - \$3.00 items (15% discount)

b. 2 - \$6.50 items (15% discount)

c. 5 - \$32.00 items (25% discount)

Since this problem requires that the 'sum of the products' be found, the accumulator feature can be used to 'sum-total' the separate products (discounted costs).

First, press **CLEAR** to erase the accumulator. Then press:

7 **x** 3 **-** 15 **%** **=**

**CLEAR**  
7.00 **x**  
3.00 **-**  
15.00 **x**  
3.15 **=**  
17.85 **R**

2 **x** 6.5 **-** 15 **%** **=**

2.00 **x**  
6.50 **-**  
15.00 **x**  
1.95 **=**  
11.05 **R**

5 **x** 32 **-** 25 **%** **=**

5.00 **x**  
32.00 **-**  
25.00 **x**  
40.00 **=**  
120.00 **R**

Now, to recall the total discounted cost, press:

**SHIFT** **=**

148.90 **RT**

## Special Functions

Your Model 5 has five special functions which are printed in green on the front-side of some keys. You can perform each of the special functions by first pressing **SHIFT** and then the function key. You need not press **=** when using these functions since the result is calculated (but not accumulated) immediately after you press the function key.

## Divide By 12

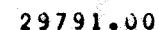
Press   to divide the number just keyed in or the current result by 12. 

## Reciprocal Value

Pressing   calculates the reciprocal value of the number keyed in or the current result. 

## Examples

a. Find the cube root of 29791. Since  $\sqrt[3]{29791}$  can also be expressed as  $29791^{1/3}$ , press:

29791  3   =      = 

b. Find the monthly payment on a 2 year, \$3000 installment loan with an 11.5% annual interest rate.

$$\text{Monthly Payment} = \frac{\text{Principal} \times \text{Monthly Interest Rate}}{1 - \left[ \left( \frac{1}{1 + \text{Monthly Interest Rate}} \right)^{\text{no. of payments}} \right]}$$

$$= \frac{3000 (11.5/12)}{1 - \left( \frac{1}{1 + 11.5\%/12} \right)^{24}}$$

Press:

3000 ( 11.5 % **SHIFT** - ) **STORE**  
 $\times_{12}$

**÷** ( 1 - ( ( ( 1 + **RECALL** ) )

**SHIFT**  $\uparrow$   $\uparrow$  24 ) ) =

monthly payment →

3000.00

11.50

.12

.01

.01

.01

1.00

1.00

.01

.01

1.01

.99

24.00

.80

.20

140.52

**x**

(

x

12

)

→

+

(

-

(

(

+

→

1.00

.01

.01

1.01

.99

↑

24.00

.80

.20

=

R

## Logarithms

The Model 5 has internal routines for calculating common logarithms, natural logarithms, and antilog<sub>e</sub> (e=2.71828 . . .).

To find the common log (log<sub>10</sub>) value, press **SHIFT** **÷**

To find the natural log (ln) value, press **SHIFT** **x** **ln**

To find the antilog<sub>e</sub> (e<sup>x</sup>) press **SHIFT** **+**  
e<sup>x</sup>

To find the antilog<sub>10</sub> (10<sup>x</sup>), press 10 **↑**, enter the 'X' value, then  
press **=**

## Example

Since sound level is measured on a logarithmic scale (in 'decibels' or 'db'), you could find the relative loudness of live rock music you listened to once, since you noticed that the sound level meter which monitored the music measured 123 db.

Since the formula for finding sound level is:

$$db = 10 \log_{10} x$$

where:  $x$  is the increase in relative sound level (number of times louder than the least audible sound)

We can solve for  $x$  by using this formula:

$$\text{relative loudness} = \text{antilog } \frac{db}{10} = \text{antilog } \frac{123}{10} = 10^{(123/10)}$$

Press:

10  $\uparrow$  ( 123  $\div$  10 )  
=

10.00  $\uparrow$   
123.00  $\uparrow$   
10.00 )  
12.30 =  
1.995262307 12R

Your calculation is quite realistic since live rock music is known to be about *two-trillion* times louder than the softest sound that could be heard.

While working with the decibel scale, it's known that ordinary conversation is about one million times louder than the softest sound that can be heard. If that is true, at what decibel level would conversation register on the sound level meter?

$$db = 10 \log_{10} x  
= 10 \log 10^6$$

Press:

10 ( 10  $\uparrow$  6 SHIFT  $\div$  )  
lg =

10.00 x  
10.00 (  $\uparrow$   
6.00 lg  
.78 )  
6.00 =  
60.00 R

## Automatic Decimal Point

When you're solving problems which include many numbers of the same form, such as dollars and cents, press **AUTO** down to automatically enter a decimal point at the same position when you key in each number. For example, add this column of figures:

39.95  
25.50  
1.45  
5.00  
\_\_\_\_\_  
.95

?

When not using the **AUTO** feature, you must enter each number and press **.** at the correct place. But, after switching **AUTO** on, you just enter each number, since the decimal point is correctly entered for you. Here's how to add the numbers when the **AUTO** feature is used ('Round 2' format should be set).

Press: **CLEAR** **AUTO** (down)

now, press: 3995

**+** 2550 **+**

145 **+** 5. **+** 95 **=**

**CLEAR**  
39.95 +  
25.50 +  
1.45 +  
5.00 +  
.95 =  
72.85 R

By the way, notice that you can still enter a decimal point manually (see the \$5.00 entry) when **AUTO** is switched on.

**Turn-On Procedure**

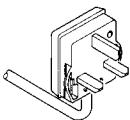
Please read the following pages before using your Model 5 for the first time.

**Accessories**

Each Model 5 is furnished with these basic accessories:

<u>DESCRIPTION</u>	<u>-hp- PART NUMBER</u>
Operating Guide	09805-90002
Instruction Booklet	09805-90003
Printer Paper (2 rolls)	9281-0415
Printer Ribbon	9282-0511
Power Cord	(see below)
Dust Cover	4040-0989
Spare Fuses:	
$\frac{1}{2}$ A, 250 V, normal-blo	2110-0004
$\frac{1}{4}$ A, 250 V, normal-blo	2110-0012
Travel Case	5061-0707

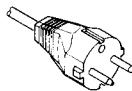
Power cords with different plugs are available for the calculator. Each plug, together with the part number of the power cord which has that plug, is shown below. Each plug has a ground connector. The cord packaged with each calculator depends upon where that calculator is to be delivered. If your calculator has the wrong power cord for your area, please contact your local -hp- Sales and Service Office.



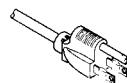
8120-1351



8120-1369



8120-1689

9120-1378  
(Standard)**Initial Inspection**

Please check to see that all the accessories listed above are present when unpacking your Model 5. Also, inspect the Model 5 for damage which may have occurred during shipment. If you find any damage, or if any accessories listed are missing, you should file a claim with the carrier and contact the nearest -hp- Sales and Service Office listed at the back of Appendix C.

## Turn-On Procedure

### Power Requirements

The Model 5 operates on power line voltages of either 101 to 130 volts ac or 202 to 259 volts ac, with a power line frequency from between 48 and 66 Hz. The calculator requires a maximum power of 40 voltamps.

### Grounding Requirements

The Model 5 meets current NEMA (National Electrical Manufacturers' Association) grounding standards provided that a three-conductor power cord is used to supply power to the calculator from a suitably grounded outlet.

Follow these steps to switch your Model 5 on for the first time:

1. Before connecting the power cord to the back of your calculator, check the position of the voltage selector card in the power module (see the following photographs). The number visible indicates which nominal voltage range is set. If the card is set to the correct voltage range, you may skip the next step and go to step 3.

#### CAUTION

YOUR MODEL 5 CAN BE DAMAGED IF IT'S SWITCHED ON WHEN NOT SET FOR THE CORRECT LINE VOLTAGE.

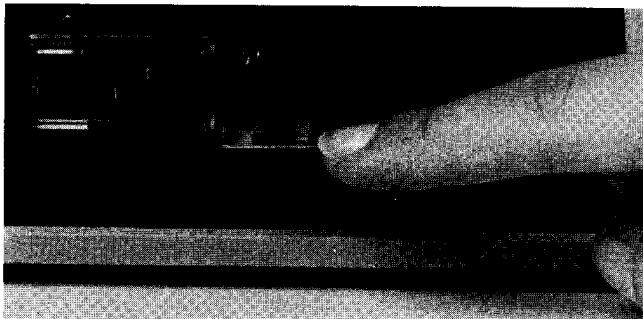
2. To reset the voltage selector card:



- a. Slide the plastic window to the left and move the FUSE PULL lever to the left (removing the fuse).



b. Position the line voltage selector such that the number indicating the required voltage setting is on the left.

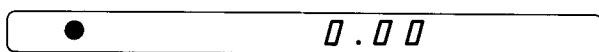


c. Push the line voltage selector into the power module, insert the proper fuse, and slide the plastic window to the right.

#### NOTE

For 120V ac operation, use a  $\frac{1}{2}$ A. fuse. For 240V ac operation, use a  $\frac{1}{4}$ A. fuse.

3. Plug the power cord into the back of the calculator and into a suitable wall outlet.
4. Turn your calculator on by pressing the LINE switch down. Each time the Model 5 is switched on, the word 'CLEAR' is printed, the busy light should flash on for a moment, and the display (if installed) should appear like this:

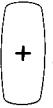


Your Model 5 is now ready to use. To switch the calculator off, merely press the LINE switch again so that 'OFF' is visible.

If your calculator does not operate as described in Step 4, see 'CALCULATOR SERVICE', Appendix C.

Appendix **B**  
**Operating Limits**

### **Accuracy**

Basic arithmetic operations , , , ,  are accurate to

10 places, with a possible error of one count in the tenth (least significant) digit.

Special functions ( $1/x$ ,  $x/12$ ,  $\lg$ ,  $\ln$ ,  $e^x$ ) and exponentiation ( $\uparrow$ ) operations are accurate to not less than 8 places — the accuracy is due to rounding error and depends upon the individual problem.

### **Calculating Range**

Any number entry or calculation resulting in a number equal to or greater than  $10^{100}$  causes 9.999999999 99 to be printed (and displayed). Number entries or calculations having a result less than  $10^{-99}$  are printed (and displayed) as zero.

### **Operating Errors**

Improper number entries, key sequences and calculations are indicated by printed 'NOTES' — a list of notes is in Appendix D. Some improper calculations are:

- dividing by 0
- finding the log or  $\ln$  of 0
- raising 0 to a negative power
- finding the log or  $\ln$  of a negative number
- raising a negative number to a fractional power.

### **Temperature Range**

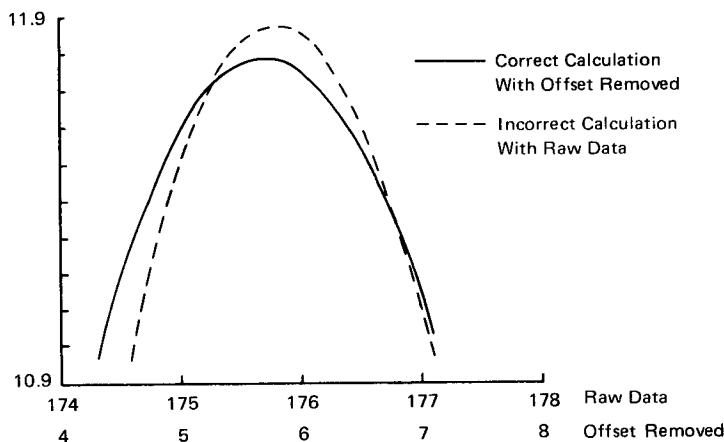
Operating and Storage: 0° to 45°C (32° to 113°F)

## Accuracy of the Parabolic Coefficients

Data which is clustered in x (small x) and far from the y axis can lead to inaccuracies in the parabolic coefficients. To obtain the greatest accuracy in the parabolic coefficients, you should subtract large offsets from the x data. Consider the following data gathered by a high school coach on four members of his track team.

Height (cm)		100 yd. Dash
Raw Data	Offset Removed	Time (sec.)
175	5	11.6
175	5	11.5
176	6	11.8
176	6	11.7
177	7	11.3
177	7	10.9

If he takes no account of the large offset in the x data and simply enters it in raw form, the parabolic coefficients will be in error by 33% (see drawing). By subtracting 170 cm from each x value, however, the accuracy of the coefficients is improved to .0006%. The effect of this improvement can be seen in the following curve plots.



The surest way of appraising coefficient errors is to re-enter the data with the offset removed and examine the change in the coefficient C. This coefficient is (in the absence of errors) independent of data translations. In addition, a graph of the data and the calculated parabolic curve fit will greatly assist in the detection of possible coefficient errors due to large x data offset.

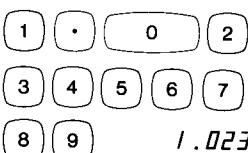
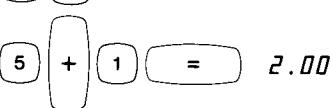
## Calculator Checkout Procedure

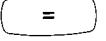
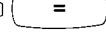
If the calculator fails to turn on properly (see Step 4 of the 'Turn-on Procedure'), check these possible causes:

- Is the calculator set to operate on the correct line voltage?
- Is the fuse burned out? (examine the filament inside the fuse) Follow Steps 2a and 2c of the 'Turn-on Procedure' when checking or replacing the fuse.

If the calculator prints anything but 'CLEAR' when it's switched on, carefully press the keys in each step of the following procedure; then compare the results with those shown.

**NOTE:** Be sure **PRINT OFF** and **AUTO+** are *not* pressed down!

1. Press:  **CLEAR**
2. Press:  **1.023456789 00**
3. Press:  **1.023456789 00** **1.023456789 00 \***
4. Press:  **1.023456789 00** **1.023456789 00 -**
5. Press:  **0.000000000 00** **CLEAR**
6. Press:  **1.023456789 00** **1.023456789 00 -**
7. Press:  **1.02**
8. Press:  **6.00** **6.00** **-**
9. Press:  **5.00** **1.00** **2.00** **R**

10. Press: 	2.00	2.00	x
11. Press:    	5.00	5.00	+
		2.00	=
		5.00	R
12. Press: 	5.00	5.00	+
13. Press:  	10.00	5.00	↑
14. Press:  	100.00	2.00	=
		100.00	R
15. Press:  	2.00	100.00	Ig
16. Press:  	7.39	2.00	€
17. Press:  	2.00	7.39	In
18. Press:   	0.10	2.00	+
		5.00	%
19. Press: 	2.10	.10	=
		2.10	R
20. Press:  	0.48	2.10	%
21. Press:  	0.04	.48	12
22. Press:   	0.04	-	#
23. Press:  	109.10	109.10	RT

If your printout (and display) results do not compare with the samples, or if the calculator has a problem not checked by the above procedure (for example, the LINE switch does not stay down, or some characters are not printed correctly), contact the nearest -hp- Sales and Service Office for assistance; office locations are listed at the end of this section.

## Statistical Functions Checkout

Once you've verified calculator operation by performing the previous checkout, carefully do each step of this procedure to verify your calculator stat functions:

### NOTE

If a plotter is not available, *skip* the steps numbered in green.

#### 1. On the plotter:

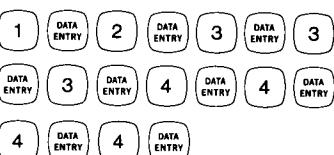
Press the **LINE ON(IN)** switch down. Then place a sheet of 8½" x 11" paper on the platen and press the **CHART HOLD** switch down. Now set the Graph Limits Controls (set the **LOWER LEFT** controls first) about one-inch in from the corners of the paper (see the sample plot on Page 68). Be sure the plotter is properly connected to the calculator.

#### One-Variable Function (return to step 2 if an error is made)

2. Press:  **CLEAR**

3. Press:  **V1** **.....**

4. Press:  **OF** **.00**

5. Press: 

**C E L =**  
**1.00** **#**  
**2.00** **#**  
**3.00** **#**  
**3.00** **#**  
**3.00** **#**  
**4.00** **#**  
**4.00** **#**  
**4.00** **#**  
**4.00** **#**

6. Verify the printout for step 5,

then press

**BASIC STAT**

**N** **=**  
**9.00** **#**  
 **$\bar{x}$**  **=**  
**3.11** **#**  
 **$\Delta 1$**  **=**  
**1.05** **#**

7. Press: 

Printout:

HG			
1.00	#	6.00	#
.00	#	5.00	#
.00	#	.00	#
.00	#	.00	#
2.00	#	7.00	#
1.00	#	6.00	#
1.00	#	.00	#
11.11	#	.00	#
3.00	#	8.00	#
2.00	#	7.00	#
1.00	#	.00	#
11.11	#	.00	#
4.00	#	9.00	#
3.00	#	8.00	#
3.00	#	.00	#
33.33	#	.00	#
5.00	#	10.00	#
4.00	#	9.00	#
4.00	#	.00	#
44.44	#	.00	#

8. Press:      .00 #

RG1 =  
.00 #  
5.00 #

9. Press:    RG2 =  
.00 #  
5.00 #

10. Press:     1.00 #

T I =  
1.00 #  
1.00 #

11. Press: 

.00

AI

.00

.00

♦

=

#

#

The X and Y axes should now be plotted (see the sample plot).

12. Press:  The complete histogram (see the sample plot) should now be plotted.

Two-Variable Functions (return to step 13 if an error is made)

13. Press: 

CLEAR

14. Press: 

V2 ..... .

15. Press: 

.00

RG1

.00

6.00

♦

=

#

16. Press: 

RG2

.00

6.00

♦

=

#

17. Press: 

1.00

T I

1.00

1.00

♦

=

#

18. Press: 

.00

AI

.00

.00

♦

=

#

The X axis should be plotted directly over the previous one; however, the Y axis will include different tic marks (see green tic marks on the sample plot).

19. Press:  

CT 2

20. Press:    

1.00 #  
1.00 #

21. Press:    

5.00 #  
2.00 #

22. Press: 

A =  
.75 #

B =  
.25 #

R =  
1.00 #

23. Press: 

The linear regression is now plotted (see green plot on Page 68).

24. Press:  

CT 3

25. Press: 

D E L

26. Press:      
     
   

5.00 #  
5.00 #

4.00 #  
2.00 #

5.00 #  
1.00 #

27. Press: 

- A =  
3.67 #

B =  
5.75 #

- C =  
1.08 #

- R =  
.57 #

28. Press: 

The parabolic curve is now plotted (see the red plot on Page 68).

Paired Statistics Function (return to Step 29 if an error is made)

29. Press:   

CLEAR

2 T •••••

30. Press:      

DATA 1

1.00 #  
2.00 #  
3.00 #

Press: 

DATA 2

Press:      

5.00 #  
4.00 #  
3.00 #

31. Press: 

N1

3.00 #

$\bar{x}$

2.00 #

$\Delta 1$

1.00 #

N2

3.00 #

$\bar{y}$

4.00 #

$\Delta 2$

1.00 #

T

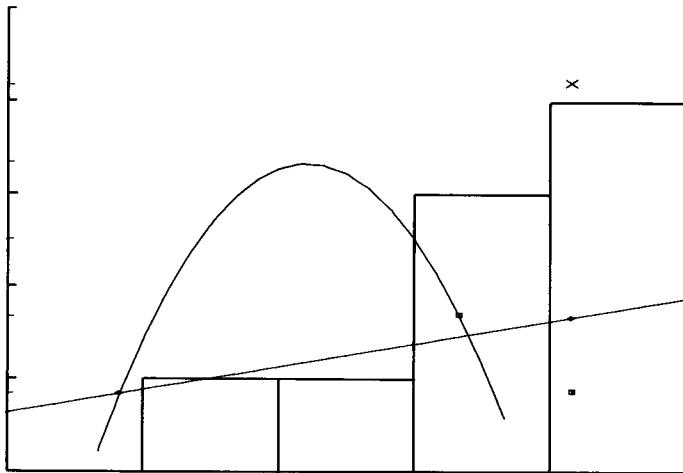
- 2.45 =

D =

4.00 #

32. Press: 

If your printout does not compare with the sample, return to the indicated step in the checkout and try again. If you still cannot verify the operation, contact the nearest -hp- Sales and Service Office for assistance.



Statistical Functions Checkout Plot

## Replacing Printer Paper

The Model 5 is furnished with two rolls of printer paper. If you wish to purchase paper other than that supplied by -hp-, many replacement products are available - just be sure to specify 2 $\frac{1}{4}$ " wide, adding machine paper.

When replacing the printer paper:

1. Be sure to remove any remaining old paper before loading the new roll.
2. After folding the free end of the new paper and inserting it into the printer as shown in the diagram on the printer, press **PAPER↑** and guide the advancing paper under the paper tear-off bracket.

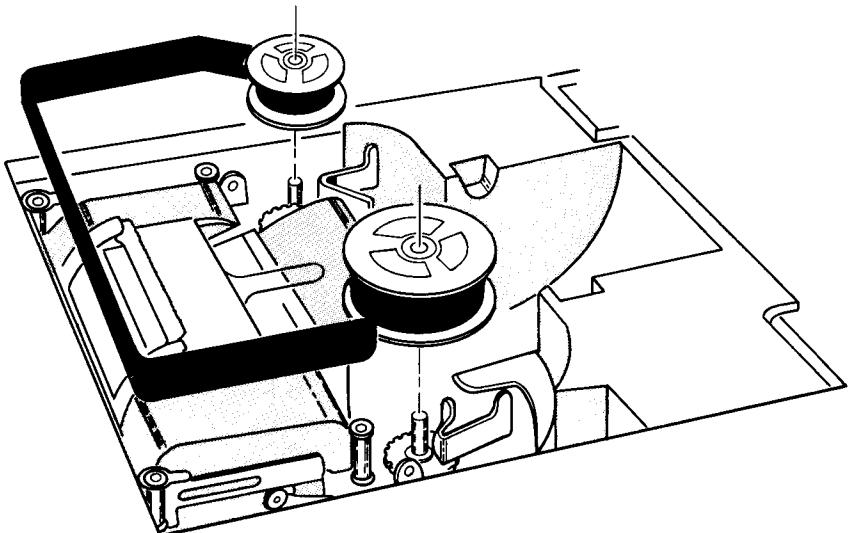
## Replacing Printer Ribbon

The printer ribbon supplied should give many months of reliable service, but when the printout becomes light or intermittent, the ribbon needs replacing. Any adding machine ribbon equivalent to either the one supplied or any of the products listed below can be used.

- General Ribbon Co.; type E200, black and red intense ribbon.
- Columbia Ribbon Co.; type 43, black-red record, double-spool ribbon.

When replacing the printer ribbon:

1. Notice the path of the old ribbon before removing it. (See the following diagram.)
2. Be sure the black portion of the new ribbon is up when installed.
3. Press **PAPER↑** to draw the ribbon taut before closing the calculator top cover.



Ribbon Installation

## Cleaning The Printer

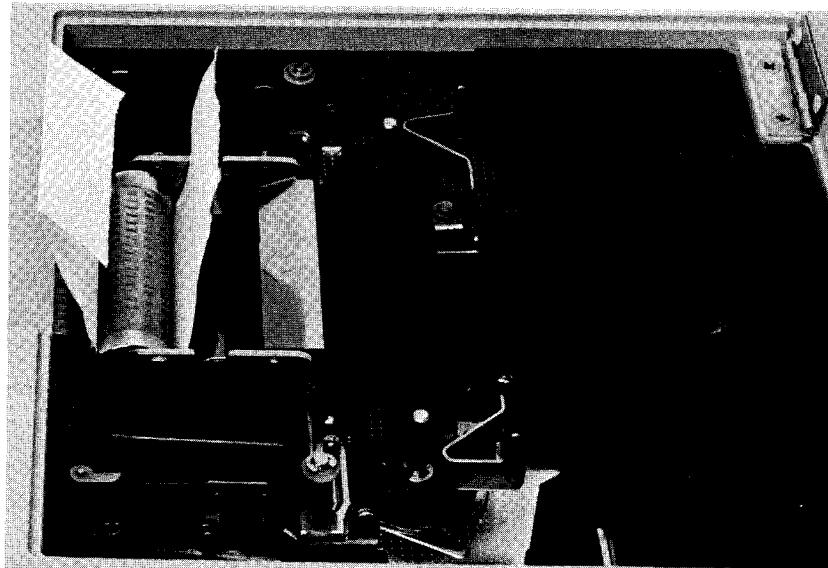
To ensure clear printouts, it's recommended that the printer be cleaned at least every 3 months. The only equipment needed to clean the printer is a typewriter cleaning brush (any small, stiff-bristled brush will do) and a *small* amount of denatured (isopropyl) alcohol.

To clean the printer:

1. Remove the printer paper; then lift up the paper tear-off bracket and lift off the small, metal cover plate (see the next photo).
2. Remove the ribbon and inspect it for wear; if it looks frayed or perforated, install a new one in Step 6.
3. Slide a strip of printer paper about 6" long under and around the metal print drum as shown. This paper will catch the ribbon and paper particles brushed from the print drum.
4. Use the stiff-bristled brush and a *small* amount of alcohol to clean each character on the print drum.

### CAUTION

BE SURE ALCOHOL DOES NOT GET ON ANY COMPONENTS EXCEPT THE PRINT DRUM.



5. After you've cleaned the drum, fold the paper as shown and slowly pull the paper back out from under the drum. Now blow any dust or remaining ribbon particles out of the printer.
6. Replace the small cover plate, snap the paper tear-off bracket back into place, then replace the ribbon and the printer paper.

### **Cleaning The Calculator**

The calculator can be cleaned with a soft cloth dampened either in clean water or in water containing a mild detergent. Do not use an excessively wet cloth nor allow water to penetrate inside the calculator. Also, do not use any abrasive cleaners, especially on the display window.

**ELECTRONIC**  
**SALES & SERVICE OFFICES**

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TWX: 810-726-2024

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Phoenix 85034  
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TWX: 910-951-1330

5737 East Broadway

Tucson 85716  
Tel: (602) 298-2313  
TWX: 910-952-1162

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Tel: (213) 677-2828  
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1101 Embarcadero Road

Palisade 54303  
Tel: (415) 377-6500  
TWX: 910-373-1280

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Tel: (916) 482-1463  
TWX: 910-387-2092

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TWX: 910-335-2000

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Tel: (203) 389-6551  
TWX: 710-465-2029

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Tel: (305) 731-2020  
TWX: 510-555-4099

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Orlando, 32809  
Tel: (305) 859-2900  
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Honolulu 96814  
Tel: (808) 955-4455

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TWX: 910-223-3613

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Indianapolis 46205  
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Tel: (301) 948-6370  
TWX: 710-828-9684

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TWX: 710-326-6904

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Southfield 48075  
Tel: (313) 353-9100  
TWX: 810-224-4882

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Tel: (612) 645-9461  
TWX: 910-563-3734

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Kansas City 64137  
Tel: (816) 753-8000  
TWX: 910-771-2087

**148 Weldon Parkway**

Maryland Heights 63043  
Tel: (314) 567-1455  
TWX: 910-850-0830

**NEW JERSEY**

W. 120 Century Road  
Paramus 07652  
Tel: (201) 265-5000  
TWX: 710-990-4951

1080 N. Kings Highway

Chester Hill 19013  
Tel: (509) 657-4000  
TWX: 710-892-4945

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Station C  
6501 Lomas Boulevard N.E.  
Albuquerque 87108  
Tel: (505) 265-3713  
TWX: 910-989-1665

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Computer Park  
Albany 12205  
Tel: (518) 458-1550  
TWX: 710-441-8270

1219 Campbell Road

Endicott 13760  
Tel: (607) 754-0500  
TWX: 510-252-0890

82 Washington Street

Poughkeepsie 12601  
Tel: (914) 454-7330  
TWX: 510-248-0012

39 Saginaw Drive

Rochester 14623  
Tel: (716) 473-9500  
TWX: 510-253-5981

5858 East Molloy Road

Syracuse 13211  
Tel: (315) 454-2486  
TWX: 710-541-0482

1 Crossways Park West

Westbury 11787  
Tel: (516) 921-0300  
TWX: 510-223-0811

**NORTH CAROLINA**

P.O. Box 5188  
1923 North Main Street  
High Point 27262  
Tel: (919) 885-8101  
TWX: 510-526-1516

**MANITOBA**

Hewlett-Packard (Canada) Ltd.  
513 Century St.  
Winnipeg  
Tel: (204) 786-7581  
TWX: 610-671-3531

**NOVA SCOTIA**

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2745 Dutch Village Rd.  
Suite 206  
Halifax  
Tel: (902) 455-0511  
TWX: 610-271-4482

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Cleveland 44145  
Tel: (216) 835-0300  
TWX: 810-427-9129

**NEW YORK**

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Dayton 45439  
Tel: (513) 298-0351  
TWX: 810-459-1925

1120 Morse Road

Columbus 43229  
Tel: (614) 846-1300

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Oklahoma City 73122  
Tel: (405) 721-0200  
TWX: 910-830-6862

**OREGON**

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4475 S.W. Scholls Ferry Road  
Portland 97225  
Tel: (503) 292-9171  
TWX: 910-464-6103

**PENNSYLVANIA**

2500 Moss Side Boulevard  
Monroeville 15146  
Tel: (412) 271-0724  
TWX: 710-797-3650

1021 8th Avenue

King of Prussia Industrial Park  
King of Prussia 19406  
Tel: (215) 265-7000  
TWX: 510-660-2670

**RHODE ISLAND**

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East Providence 02914  
Tel: (401) 434-5535  
TWX: 710-381-7573

**•TENNESSEE**

Memphis  
Tel: (731) 274-7472

**TEXAS**

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201 E. Arapaho Rd.  
Richardson 75080  
Tel: (214) 231-6101  
TWX: 910-667-4723

**TEXAS**

P.O. Box 27409  
6300 Westpark Drive  
Suite 100  
Houston 77027  
Tel: (713) 781-6000  
TWX: 910-881-2645

**TEXAS**

1000 Main Street  
Dallas 75201  
Tel: (214) 930-1000  
TWX: 810-223-0811

**ONTARIO**

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t Table

D.F.	90%	95%	98%	99%
1	6.31	12.7	31.8	63.7
2	2.92	4.31	6.96	9.92
3	2.35	3.18	4.54	5.84
4	2.13	2.78	3.75	4.60
5	2.02	2.57	3.36	4.03
6	1.94	2.45	3.14	3.71
7	1.90	2.36	3.00	3.50
8	1.86	2.31	2.90	3.36
9	1.83	2.26	2.82	3.25
10	1.81	2.23	2.76	3.17
12	1.78	2.18	2.68	3.06
14	1.76	2.14	2.62	2.98
16	1.75	2.12	2.58	2.92
18	1.73	2.10	2.55	2.88
20	1.72	2.09	2.53	2.84

## Notation & Formulas

### Notation:

$y_i$  = Dependent or response variable

$x_i$  = Independent or predictor variable

$n$  = Number of  $(x_i, y_i)$  pairs,  $i=1, 2, \dots, n$

$\bar{x}$  = Mean of the independent variable

$\bar{y}$  = Mean of the dependent variable

### Mean and Standard Deviation:

$$\bar{x} = \frac{1}{n} \sum_{i=1}^n x_i \quad \Delta x = \sqrt{\frac{1}{n-1} \sum (x_i - \bar{x})^2}$$

$$\bar{y} = \frac{1}{n} \sum_{i=1}^n y_i \quad \Delta y = \sqrt{\frac{1}{n-1} \sum (y_i - \bar{y})^2}$$

### Linear Regression:

$A$  = Intercept  $B$  = Slope

$$= \frac{1}{n} \left[ \sum_{i=1}^n y_i - B \sum_{i=1}^n x_i \right] \quad = \frac{\sum x_i y_i}{\sum x_i^2}$$

$$r^2 = \text{Square of the correlation coefficient} \quad = \frac{(\sum x_i y_i)^2}{\sum x_i^2 \sum y_i^2}$$

### Parabolic Regression:

$A$  = Intercept  $B$  = Linear coefficient

$$= \frac{1}{n} \left[ \sum_{i=1}^n y_i - C x_i^2 - B \sum_{i=1}^n x_i \right] \quad = \frac{\sum x_i y_i - C \sum x_i^2 - B \sum x_i}{\sum x_i^2}$$

(continued)

C = Quadratic coefficient

$$\frac{U_x U_{x^2} y - U_{xx^2} U_{xy}}{U_x U_{x^2} - (U_{xx^2})^2}$$

$r^2$  = Square of the multiple correlation coefficient

$$\frac{BU_{xy} + CU_{x^2} y}{U_y}$$

Two-Sample t:

$$t = \frac{\bar{x} - \bar{y}}{\sqrt{\frac{(n_1 - 1) \Delta_1^2 + (n_2 - 1) \Delta_2^2}{n_1 + n_2 - 2}} \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}$$

Degrees of Freedom =  $n_1 + n_2 - 2$

Paired t:

$$t = \frac{\bar{d}}{\sqrt{\frac{\Delta_d^2}{n}}} \quad d_i = (x_i - y_i)$$

Degrees of Freedom =  $n - 1$

n = # of pairs of observations

$\Delta_d$  = standard deviation of the differences between pairs of observations.

### Intermediate Equations

$$U_x = \sum_{i=1}^n (x - \bar{x})^2$$

$$U_{xx}^2 = \sum_{i=1}^n (x_i - \bar{x})(x_i^2 - \bar{x}^2)$$

$$U_y = \sum_{i=1}^n (y_i - \bar{y})^2$$

$$U_{xy} = \sum_{i=1}^n (x_i - \bar{x})(y_i - \bar{y})$$

$$U_x^2 = \sum_{i=1}^n (x_i^2 - \bar{x}^2)^2$$

$$U_{x^2 y} = \sum_{i=1}^n (x_i^2 - \bar{x}^2)(y_i - \bar{y})$$

## Glossary

### Analysis of Variance\*

Analysis of variance is the method statistician's use to split the total variation in data into its various sources. For example, when using the regression  $y = A + B_1 x + B_2 x + \dots$ , you can split the total variation of  $y$  about  $\bar{y}$  into two parts (the variation explained by regression and the unexplained variation). Then, you can use certain ratios of the variations to test the addition of new variables to the fit or to test the significance of the fit.

### Average

Average is synonymous with *Mean* and is defined as  $1/n (x_1 + x_2 + \dots + x_n)$ . It is symbolized as  $\bar{x}$  (pronounced 'x bar').

### Coefficient of Determination ( $r^2$ )

The coefficient of determination is a measure of the goodness of fit in a regression. It is the square of the *Correlation Coefficient (R)*.

### Coefficients of Regression

In the regression equation  $y = A + B_1 x + B_2 x + \dots$ , the constants  $A$ ,  $B_1$ ,  $B_2$ , ... are called the coefficients of the regression equation.

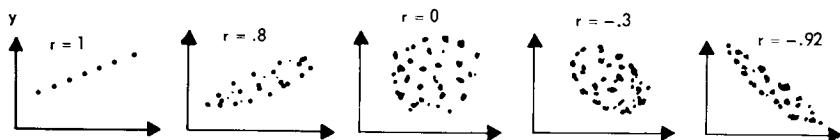
### Confidence Statements

Confidence statements are predictions made on the basis of the regression equation. For example, with a confidence level of 95%, you are saying that the true value of a predicted  $y$  lies somewhere between 90 and 96.

\*These Functions are available with the Expanded Stat Programs Block.

## Correlation

The degree of interdependence between two variables is called the correlation. Correlation tells the amount of association between two variables; regression describes the relationship between the variables.

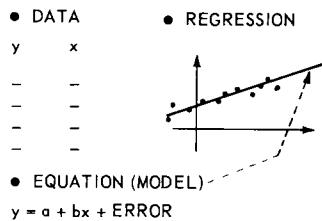


## Correlation Coefficient (R)

This is the measure of association between two variables. (See Correlation.)

## Curve Fitting

Curve fitting, usually synonymous with regression, is the process of finding the best equation to relate variables.



## Degrees of Freedom

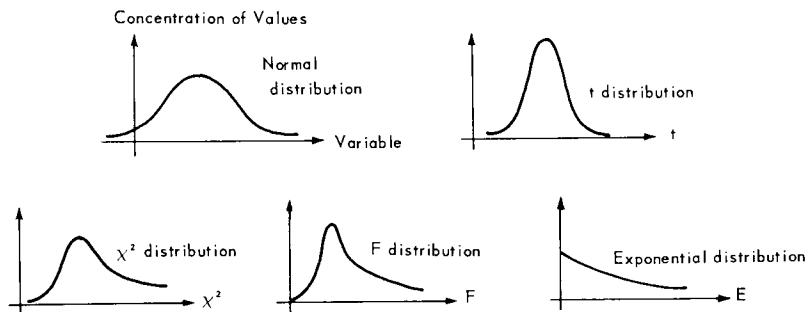
Degrees of freedom measures the number of independent contributions in deriving estimates.

## Dependent Variable

In the equation  $y = A + Bx$ ,  $y$  is usually termed the dependent variable while  $x$  is the independent variable.

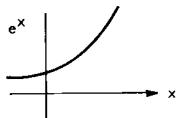
## Distribution

There are several classic patterns or distributions of data. These are shown by the drawings at the right.



## Exponential Curve Fit\*

An equation of the form  $y = Ae^{Bx}$ .



## Goodness of Fit

A regression is measured by how close the equation fits the data. The coefficient of determination is one such measure of the goodness of fit.

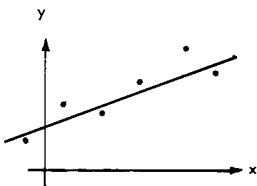


## Histogram

A diagram illustrating the distribution of the frequency of occurrence of observations from some population or sample of data points.

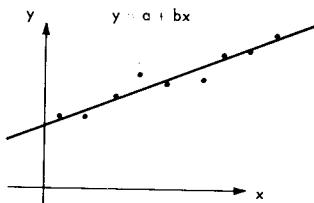
## Least Squares

Least squares is a mathematical method for finding the best possible equation relating x's and y. It is the method used by the Model 9805 to derive all regression coefficients.



## Linear Curve Fit

An equation of the form  $y = A + Bx$ . The graph of this equation is a straight line.



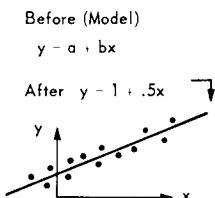
## Logarithmic Curve Fit\*

An equation of the form:  $y = A + B\ln x$ .

Mean — see Average

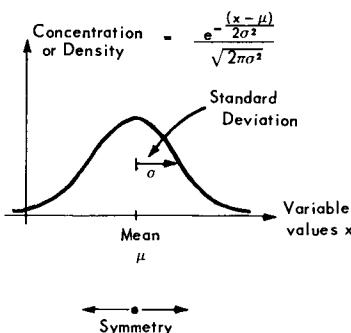
## Model

The general form of the equation is termed the model. For example,  $y = A + Bx$  is a linear model.



## Normal Distribution

One of the classic patterns of data, normal distribution produces a symmetric bell-shaped curve and is prevalent in nature. For example, the heights of men are normally distributed. (See *Distribution*.)



## Normal Curve Overlay\*

A plot based on the sample *Mean* and *Standard Deviation* of histogrammed data.

## Parabolic Curve Fit

An equation of the form  $y = A + Bx + Cx^2$ .

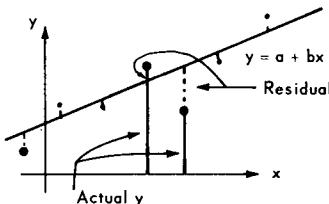
## Power Curve Fit\*

An equation of the form  $y = Ax^B$

## Regression — see Curve Fitting

## Residual

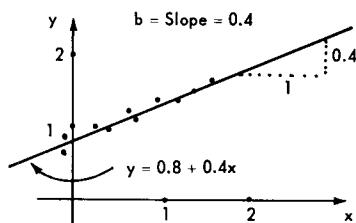
The residual is the difference between the actual value of  $y$  and the estimate found from the curve fit.



$r^2$  – see Coefficient of Determination

## Slope

The slope is the change in  $y$  for a unit increase in  $x$ . In the equation  $y = A + Bx$ , the slope is  $B$ .



## Standard Deviation

Standard deviation measures the scattering of the points about the curve fit. The 9805 calculates the sample standard deviation.

## t-Paired

The 9805 calculates t-paired on the differences between pairs of observations. This is a more sensitive test than the two-sample t test. The statistic calculated follows a t distribution with  $n-1$  degrees of freedom.

## Two-Sample t

This is a hypothesis test to determine the difference, if any, between two populations means. The assumption is that the variances of the two populations are equal. The statistic calculated follows the t distribution with  $n_1 + n_2 - 2$  degrees of freedom if the null hypothesis is true.

## Variance

Another statistical measure of the scattering of data around the average. It is equal to the square of the *Standard Deviation*.

## Operating Notes

NOTE 00	Internal Program encountered an error - see instructions on restarting the program
NOTE 04	Too many ( keys pressed - parentheses can be nested 5 levels deep
NOTE 05	Too many ) keys pressed
NOTE 09	Attempt to find the $\log_{10}$ or Ln value of a negative number
9.999999999 99R	RANGE OF CALCULATION EXCEEDED - Also check the current result of the accumulator
NOTE 11	
NOTE 12	Attempt to find $\log_{10}$ or Ln of '0'
NOTE 15	Attempt to raise '0' to a negative power
NOTE 16	Attempt to divide by '0'
NOTE 20	Internal Program encountered an error - see instructions on restarting the program
NOTE 21	Internal Program encountered an error - check peripheral device and interconnecting cables
NOTE 22	( pressed before a number entry - enter number and continue
NOTE 24	Not enough ) keys pressed.

**NOTE 25**

Peripheral device not ready - check device and interconnecting cables

**NOTE 26**

Incorrect extra register number keyed in - to complete store or recall operation

1. press  and key in correct register number
2. press 

**NOTE 30**

Incorrect key pressed after pressing  ; press  and repeat key sequence correctly.

**NOTE 31**

Range of calculation exceeded during statistics calculation.

**NOTE 32**

Incorrect digit entered after pressing 

**NOTE 33**

Calculation attempted before entering the y value of the last data point.

**NOTE 34**

 pressed before pressing  

**NOTE 35**

Attempt to delete data from an empty histogram cell.

**NOTE 36**

 or  pressed before first setting up the histogram or regression.

**NOTE 37**

 pressed before first setting up axes.

**1 NOTE 50****1 NOTE 51****1 NOTE 53****2 NOTE 50****9 NOTE 50**

Incorrect keys pressed while calculator is controlling the plotter — also see below.

Plotter control is interrupted — to regain plotter control, switch the calculator OFF and then ON.



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