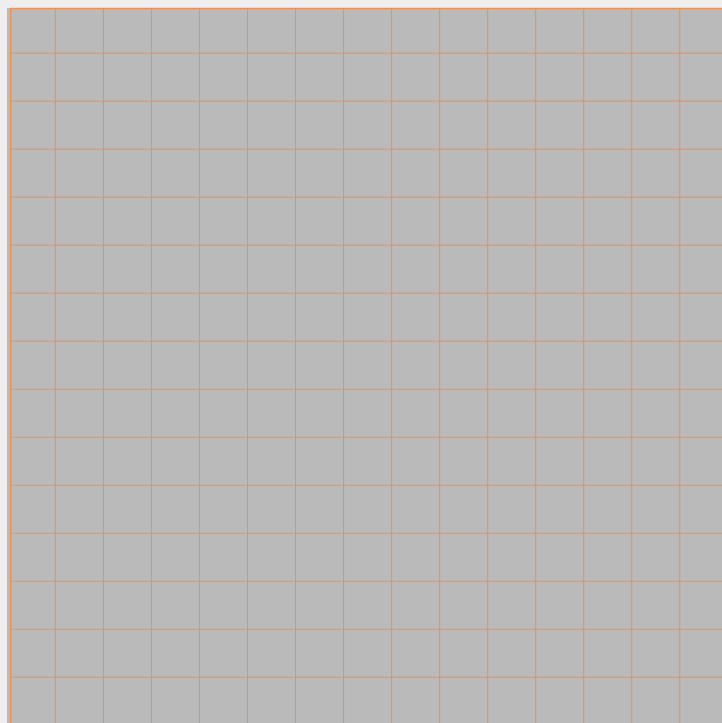


APPLYING
STATISTICS



SHARP
USING THE
EL-9600
Graphing Calculator

DAVID P. LAWRENCE

Applying
STATISTICS
using the
SHARP EL-9600
GRAPHING CALCULATOR

David P. Lawrence
Southwestern Oklahoma State University

This Teaching Resource has been developed specifically for use with the Sharp EL-9600 graphing calculator. The goal for preparing this book was to provide mathematics educators with quality teaching materials that utilize the unique features of the Sharp graphing calculator.

This book, along with the Sharp graphing calculator, offers you and your students 10 classroom-tested, topic-specific lessons that build skills. Each lesson includes *Introducing the Topic*, *Calculator Operations*, *Method of Teaching*, explanations for *Using Blackline Masters*, *For Discussion*, and *Additional Problems* to solve. Conveniently located in the back of the book are 34 reproducible *Blackline Masters*. You'll find them ideal for creating handouts, overhead transparencies, or to use as student activity worksheets for extra practice. *Solutions to the Activities* are also included.

We hope you enjoy using this resource book and the Sharp EL-9600 graphing calculator in your classroom.

Other books are also available:

Applying TRIGONOMETRY using the SHARP EL-9600 Graphing Calculator
Applying PRE-ALGEBRA and ALGEBRA using the SHARP EL-9600 Graphing Calculator
Applying PRE-CALCULUS and CALCULUS using the SHARP EL-9600 Graphing Calculator
Graphing Calculators: Quick & Easy! The SHARP EL-9600

Dedicated to members of First Baptist Church, Okarche, Oklahoma

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Developed and prepared by Pencil Point Studio.

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The blackline masters in this publication are designed to be used with appropriate duplicating equipment to reproduce for classroom use.

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Chapter one

CREATION OF A ONE-VARIABLE DATA SET

Introducing the Topic

In this chapter, you and your students will learn how to delete an old data set, create a one-variable data set, save and retrieve data.

Calculator Operations

Turn the calculator on and press **STAT** to enter the statistics menu.



Touch **A EDIT**, press **ENTER**, to view the statistics data entry screen. If there isn't any statistics data, the following data-entry screen will appear. If there is a data set present within the lists on your calculator, use the arrow keys to move to the list, if necessary, and press **▲** to highlight the list label.

No	1: L1	2: L2	3: L3
1			
2			
3			
4			
5			
6			
7			
8			
9			

Press **DEL** **ENTER** to delete the old data. Repeat for other lists of data.

No	1: L1	2: L2	3: L3
1			
2			
3			
4			
5			
6			
7			
8			
9			

Move the highlighter to the cell directly below the L1 in the table.

Enter the following data set:

5 8 7 6 8 9 3 5

by pressing **5** **ENTER** **8** **ENTER** **7** **ENTER** **6** **ENTER** **8** **ENTER** **9**
ENTER **3** **ENTER** **5** **ENTER** .

No	1: L1	2: L2	3: L3
1	5		
2	8		
3	7		
4	6		
5	8		
6	9		
7	3		
8	5		
9			

To check the data you have entered, press **▲** to move back through the data values.

2 Creation of a One-Variable Data Set/STATISTICS USING THE SHARP EL-9600

Sometimes, you will need to sort the data in an ascending or descending manner. To sort your data set in an ascending manner, press $\left[\begin{smallmatrix} + & \square \\ \times & \square \end{smallmatrix} \right]$ $\left[\begin{smallmatrix} \square \\ + \end{smallmatrix} \right]$ $\left[\text{STAT} \right]$, touch **B OPE**, double touch **1 sortA**, press $\left[\text{2ndF} \right]$ $\left[\text{L1} \right]$ $\left[\right]$ $\left[\text{ENTER} \right]$. Press $\left[\text{STAT} \right]$, touch **A EDIT**, press $\left[\text{ENTER} \right]$. Notice this first cell now contains the smallest value 3.

No	1: L1	2: L2	3: L3
1	3		
2	5		
3	5		
4	6		
5	7		
6	8		
7			

To save this data set, press $\left[\begin{smallmatrix} + & \square \\ \times & \square \end{smallmatrix} \right]$ $\left[\begin{smallmatrix} \square \\ + \end{smallmatrix} \right]$ $\left[\text{2ndF} \right]$ $\left[\text{LIST} \right]$, touch **C L_DATA**, double touch **1 StoLD**, press $\left[\text{1} \right]$ $\left[\text{ENTER} \right]$. You can store up to ten sets of six lists.

```

sortA(L1)           Done
StoLD 1             Done
  
```

To retrieve a data set matrix into a statistical data set, press $\left[\begin{smallmatrix} + & \square \\ \times & \square \end{smallmatrix} \right]$ $\left[\begin{smallmatrix} \square \\ + \end{smallmatrix} \right]$ $\left[\text{2ndF} \right]$ $\left[\text{LIST} \right]$, touch **C L_DATA**, double touch **2 Rc1LD**, press $\left[\text{1} \right]$ $\left[\text{ENTER} \right]$.

```

sortA(L1)           Done
StoLD 1             Done
Rc1LD 1             Done
  
```

Method of Teaching

Use the *Blackline Masters 1.1* and *1.2* to create overheads for entering one variable data sets that are non-weighted and weighted. Go over in detail how to save data sets to and retrieve data sets.

Next, use the *Blackline Masters 1.3* to create worksheets for the students. Have the students enter and save the non-weighted and weighted data sets for one variable. Use the topics *For Discussion* to supplement the worksheets.

Using Blackline Master 1.2

The creation of a non-weighted one-variable data set discussed above under Calculator Operations is presented on *Blackline Master 1.1*. The entering of a weighted one-variable data set appears on *Blackline Master 1.2*.

Turn the calculator on and press **STAT** to enter the statistics menu.





Touch **A EDIT**, press **ENTER**, to view the statistics data entry screen. Remove old data by using the arrow keys to move to the list of data, and press **▲** to highlight the list label. Press **DEL** **ENTER** to delete the old data. Repeat for other lists of data.

Move the highlighter to the cell directly below the L1 in the table. Enter the following data set into L1 with the frequencies entered into L2. If a value appears three times within a data set, its weight or frequency is 3.

Enter the following data set using the weights:

5 5 5 7 7 7 7 8 9 9
by pressing **5** **ENTER** **7** **ENTER** **8** **ENTER** **9** **ENTER** **▶** **3** **ENTER**
4 **ENTER** **1** **ENTER** **2** **ENTER**.

No	1: L1	2: L2	3: L3
1	5	3	-----
2	7	4	
3	8	1	
4	9	2	
5	-----	-----	
6			

To save this data set, press  , touch **C L_DATA**, double touch **1 StoLD**, press  .

For Discussion

You and your students can discuss:

1. Why you would want to sort in an ascending manner?
2. Why you would want to sort in a descending manner?
3. Why you would want to save a data set?

Chapter two

NUMERICAL DESCRIPTION OF A ONE-VARIABLE DATA SET

Introducing the Topic

In this chapter, you and your students will learn how to use the Sharp graphing calculator to find the numerical descriptions of a one-variable data set.

Calculator Operations

Turn the calculator on and press **STAT** to enter the statistics menu.

Touch **A EDIT**, press **ENTER**, to view the statistics data entry screen. If there is a data set present within the lists on your calculator, use the arrow keys to move to the list, if necessary, and press **▲** to highlight the list label. Press **DEL** **ENTER** to delete the old data. Repeat for other lists of data.

Move the highlighter to the cell directly below the L1 in the table.

Enter the following data set:

25 32 28 33 31 27 40 38 29 30

Use the non-weighted format for entering the data since no entry occurs more than once. Refer to Chapter 1 for information on how to enter a non-weighted one-variable data set.

No	1: L1	2: L2	3: L3
5	27		
7	40		
8	38		
9	29		
10	30		
11	-----		

Check the data you have entered and correct any errors you may find.

Press **2ndF** **QUIT** to exit the data entry screen. To calculate the numerical descriptions of the data set, press **STAT**, touch **C CALC**, and double touch **1 1_Stats**.

```
1_Stats
```

Press **ENTER** and the following statistical results will appear:

```
1_Stats
x̄=31.3
sx=4.715223572
sx=4.473253849
Σx=313
Σx²=9997
n=10
↓xmin=25
```

The statistics displayed are:

1. the average or mean value of the data set, \bar{x} ;
2. the standard deviation assuming the data set is a sample from a population, s_x ;

3. the standard deviation assuming the data set represents the entire population, σ_x ;
4. the sum of the data values, $\sum x$;
5. the sum of the squared data values, $\sum x^2$;
6. the number of values in the data set, n ;

Press  four times to see the rest of the statistics.

```

1_Stats
↑Σx²=9997
n=10
xmin=25
Q1=27.5
Med=30.5
Q3=35.5
xmax=40

```

7. the minimum value in the data set, x_{min} ;
8. the first quartile (25th percentile), Q_1 ;
9. the median (50th percentile), Med ;
10. the third quartile (75th percentile), Q_3 ;
11. the maximum value in the data set, x_{max} .

Your students may have trouble with conceptualizing the meaning of standard deviation. Tell them it is a measure of variability (dispersion) that is related to the average deviation or average distance from a data value to the mean.

Method of Teaching

Use the *Blackline Master 2.1* and *2.2* to create an overhead for calculating the numerical descriptions of a one-variable data set. Go over in detail the statistics provided by the calculator. Next, use the *Blackline Masters 2.3* and *2.4* to create worksheets for the students. Have the students enter and save the non-weighted and weighted data sets, and then compute the numerical descriptions. Use the topics *For Discussion* to supplement the worksheets.

Using Blackline Master 2.2

Calculation of one-variable statistics for a non-weighted data set is covered above under *Calculator Operations* and is presented on *Blackline Master 2.1*.

Turn the calculator on and press **STAT** to enter the statistics menu. Touch **A EDIT**, press **ENTER**, to view the statistics data entry screen. If there is a data set present within the lists on your calculator, use the arrow keys to move to the list, if necessary, press **▲** to highlight the list label. Press **DEL** **ENTER** to delete the old data. Repeat for other lists of data.

Move the highlighter to the cell directly below the L1 in the table.

Enter the following data set generated by rolling a die fifty times.

<u>Value</u>	<u>Frequency</u>
1	8
2	10
3	12
4	9
5	6
6	5

Remember to enter the frequencies in L2.

No	1: L1	2: L2	3: L3
1	1	8	
2	2	10	
3	3	12	
4	4	9	
5	5	6	
6	6	5	

Check the data you have entered and correct any errors you may find. Press

2ndF **QUIT** to exit the data entry screen. To calculate the numerical descriptions of the data set, press **STAT**, touch **C CALC**, double touch **1 1_Stats**, and press **2ndF** **L1** , **2ndF** **L2** .

```
1_Stats L1,L2
```

Press **ENTER** and the following statistical results will appear:

```
1_Stats  
x̄=3.2  
sx=1.551825784  
sx=1.53622915  
Σx=160  
Σx2=630  
n=50  
↓xmin=1
```

For Discussion

You and your students can discuss:

1. If the die was fair, how many times should each value appear in fifty tosses?
2. Would you consider this die fair?
3. What should the average value be if the die was fair?
4. If this die is considered loaded, to which end is it loaded?

Additional Problems

Find the numerical descriptions of the following data sets:

1. 66 68 73 55 63 58 71 59 62

2. Value	Frequency
1	20
5	13
10	12

Chapter three

HISTOGRAM REPRESENTATION OF A ONE-VARIABLE DATA SET

Introducing the Topic

In this chapter, you and your students will learn how to use the Sharp graphing calculator to represent a one-variable data set as a histogram. Typically, a histogram is represented on a horizontal (x) axis scaled according to the data, with a vertical (y) axis scaled according to the data's frequency individually (discrete) or within an interval (continuous). In each case, a bar is drawn with its width determined by an interval on the x -axis, and its height determined by the frequency of data within the interval.

Normally, you should seek between 5 and 7 intervals or bars; however, there will be times you will need more or less intervals. Interval widths can be determined logically or mathematically. Remember, the object of viewing a histogram is to obtain or portray characteristics of the data's distribution, therefore the number of intervals may vary.

Calculator Operations

Turn the calculator on and press **STAT** to enter the statistics menu.

Touch **A EDIT**, press **ENTER**, to view the statistics data entry screen.

If there is a data set present within the lists on your calculator, use the

arrow keys to move to the list, if necessary, and press \blacktriangle to highlight the list label. Press $\boxed{\text{DEL}}$ $\boxed{\text{ENTER}}$ to delete the old data. Repeat for other lists of data.

Move the highlighter to the cell directly below the L1 in the table and enter the following data set:

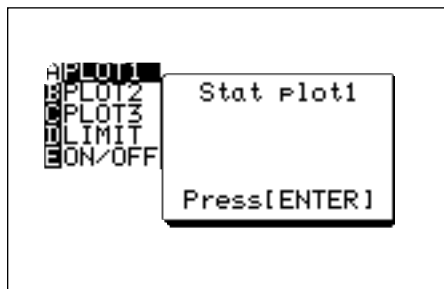
15 28 17 36 38 19 13 25 27 41

by pressing $\boxed{1}$ $\boxed{5}$ $\boxed{\text{ENTER}}$ $\boxed{2}$ $\boxed{8}$ $\boxed{\text{ENTER}}$ $\boxed{1}$ $\boxed{7}$ $\boxed{\text{ENTER}}$ $\boxed{3}$ $\boxed{6}$ $\boxed{\text{ENTER}}$ $\boxed{3}$ $\boxed{8}$ $\boxed{\text{ENTER}}$ $\boxed{1}$ $\boxed{9}$ $\boxed{\text{ENTER}}$ $\boxed{1}$ $\boxed{3}$ $\boxed{\text{ENTER}}$ $\boxed{2}$ $\boxed{5}$ $\boxed{\text{ENTER}}$ $\boxed{2}$ $\boxed{7}$ $\boxed{\text{ENTER}}$ $\boxed{4}$ $\boxed{1}$ $\boxed{\text{ENTER}}$.

Check the data you have entered by pressing \blacktriangle to move back through the data.

Save this data set by pressing $\boxed{\text{+}}$ $\boxed{\text{=}}$ $\boxed{\text{x}}$ $\boxed{\text{+}}$ $\boxed{2\text{ndF}}$ $\boxed{\text{LIST}}$, touch **C L_DATA**, double touch **1 StoLD**, press $\boxed{1}$ $\boxed{\text{ENTER}}$.

To graph a histogram that represents the data set, you must first press $\boxed{2\text{ndF}}$ $\boxed{\text{STAT PLOT}}$. The following menu will appear:

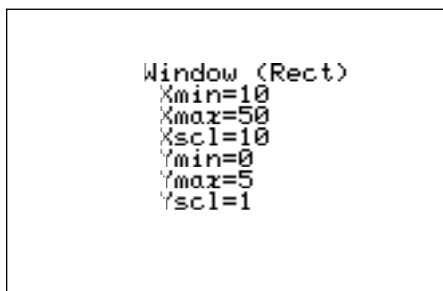


Touch **A PLOT1** and press $\boxed{\text{ENTER}}$ and a PLOT1 setup screen will appear. Turn the plot on by pressing $\boxed{\text{ENTER}}$. Select one-variable data by pressing $\boxed{\blacktriangledown}$ $\boxed{\text{ENTER}}$. Set the list to L1 by pressing $\boxed{\blacktriangledown}$ $\boxed{2\text{ndF}}$ $\boxed{\text{L1}}$ $\boxed{\text{ENTER}}$. A blank Freq: prompt indicates the data is non-weighted and the frequencies are one. Choose the histogram graph by pressing $\boxed{\blacktriangledown}$ $\boxed{2\text{ndF}}$ $\boxed{\text{STAT PLOT}}$, touching **A HIST**, and double touching **1 Hist**.

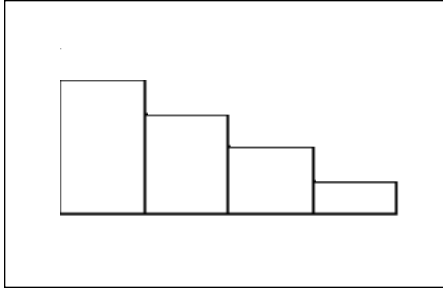


In our example, the smallest value is 13 and the largest value is 41. The logical intervals for the data set would be 10-19 (tens), 20-29 (twenties), 30-39 (thirties), and 40-49 (forties). Notice, each data point is included within an interval (exhaustive intervals) and only within one interval (exclusive intervals).

Set the calculator to rectangular graphing by pressing **2ndF** **SET UP**, touch **E COORD**, double touch **1 Rect**, and press **2ndF** **QUIT**. Set the viewing window by pressing **WINDOW**. Set the horizontal axis to $10 < x < 50$ (beginning and ending values for intervals described previously) with $Xscl = 10$ (width of interval) by pressing **1** **0** **ENTER** **5** **0** **ENTER** **1** **0** **ENTER**. Set the vertical axis to $0 < y < 5$ (from no data points to at most five within the interval) with $Yscl = 1$ (counting) by pressing **0** **ENTER** **5** **ENTER** **1** **ENTER**.



To view the histogram, press **GRAPH**. The following histogram will be constructed for the data.



Method of Teaching

Use the *Blackline Masters 3.1* and *3.2* to create overheads for entering one variable data sets that are non-weighted and weighted and graphing a histogram that represents the data. Go over in detail how to select interval size either logically or mathematically.

Next, use the *Blackline Master 3.3* to create a worksheet for the students. Have the students enter the data sets and construct a histogram. Use the topics *For Discussion* to supplement the worksheets.

Using Blackline Master 3.2

The creation of a non-weighted one-variable data set and its corresponding histogram is discussed previously under Calculator Operations and is presented on *Blackline Master 3.1*. The construction of a weighted one-variable data set and its histogram appears on *Blackline Master 1.2*.

Press **STAT** to enter the statistics menu. Touch **A EDIT**, press **ENTER**, to view the statistics data entry screen. If there is a data set present within the lists on your calculator, use the arrow keys to move to the list, if necessary, and press **▲** to highlight the list label. Press **DEL** **ENTER** to delete the old data. Repeat for other lists of data. Move the highlighter to the cell directly below the L1 in the table and enter the following data set using the weights:

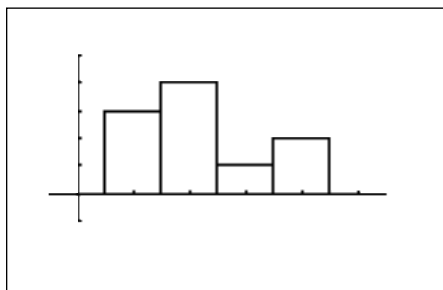
1 1 1 2 2 2 2 3 4 4
 by pressing **1** **ENTER** **2** **ENTER** **3** **ENTER** **4** **ENTER** **▶** **3** **ENTER**
4 **ENTER** **1** **ENTER** **2** **ENTER** .

Save this data set by pressing **⊕ ⊖** **2ndF** **LIST**, touch **C L_DATA**, double touch **1 StoLD**, press **2** **ENTER** .

Press $\boxed{2\text{ndF}} \boxed{\text{STAT PLOT}}$, touch **A PLOT1**, and press $\boxed{\text{ENTER}}$ and a PLOT1 setup screen will appear. Turn the plot on by pressing $\boxed{\text{ENTER}}$. Select one-variable data by pressing $\blacktriangledown \boxed{\text{ENTER}}$. Set the list to L1 by pressing $\blacktriangledown \boxed{2\text{ndF}} \boxed{\text{L1}} \boxed{\text{ENTER}}$. Set the frequencies to L2 by pressing $\boxed{2\text{ndF}} \boxed{\text{L2}} \boxed{\text{ENTER}}$. Choose the histogram graph by pressing $\boxed{2\text{ndF}} \boxed{\text{STAT PLOT}}$, touching **A HIST**, and double touching **1 Hist**.

In our example, the smallest value is 1 and the largest value is 4. The logical intervals for the data set would be 1 (0.5 to 1.5), 2 (1.5 to 2.5), 3 (2.5 to 3.5), and 4 (3.5 to 4.5). Notice, the mutually exclusive and exhaustive intervals.

To set this viewing window, press $\boxed{\text{WINDOW}}$ and set the horizontal axis to $-0.5 < x < 5.5$ (one below the smallest endpoint and one above the largest endpoint) with $\text{Xscl} = 1$ (width of interval) by pressing $\boxed{(-)} \boxed{\cdot} \boxed{5} \boxed{\text{ENTER}} \boxed{5} \boxed{\cdot} \boxed{5} \boxed{\text{ENTER}} \boxed{1} \boxed{\text{ENTER}}$. Next, set the vertical axis to $-1 < y < 5$ (from one less than no data points to at most five within the interval, which is one more than the largest weight) with $\text{Yscl} = 1$ (counting) by pressing $\boxed{(-)} \boxed{1} \boxed{\text{ENTER}} \boxed{5} \boxed{\text{ENTER}} \boxed{1} \boxed{\text{ENTER}}$. Press $\boxed{\text{GRAPH}}$ view the histogram. The following histogram will be constructed for the data.



For Discussion

You and your students can discuss:

1. Why would you not want three or less intervals?
2. Why you might not want more than seven intervals?
3. What are some other logical interval sizes?

Additional Problems

Create the histograms for the following data sets:

1. 66 68 73 55 63 58 71 59 62

2.

Value	Frequency
1	20
5	13
10	12

Chapter four

OTHER GRAPHICAL PORTRAYALS OF A ONE-VARIABLE DATA SET

Introducing the Topic

In this chapter, you and your students will learn how to use the Sharp graphing calculator to represent a one-variable data set with a broken-line graph (frequency polygon) and a box-and-whisker chart.

Typically, a broken-line graph is represented on a horizontal (x) axis scaled according to the data, with a vertical (y) axis scaled according to the data's frequency individually (discrete) or within an interval (continuous). In each case, a point is plotted at the coordinates (x , frequency) for a discrete distribution or the coordinates (interval right-point, interval frequency). Lines are then drawn from one of these points to the next one. Remember, when using intervals, you should seek between 5 and 7 intervals. Once again, there will be times you will need more or less intervals. Interval widths can be determined logically or mathematically. Remember, the object of viewing a broken-line graph is to obtain or portray characteristics of the data's distribution. Therefore, the number of intervals may vary.

A box-and-whisker chart is a graph that consists of five points of interest. The 25th percentile, 50th percentile, and 75th percentiles are each indicated with a vertical line. The three vertical lines are then connected together in order to form a box. Next, vertical lines are extended away from the box to the minimum and maximum. These are called the whiskers of the chart.

Calculator Operations

Turn the calculator on and press **STAT** to enter the statistics menu.

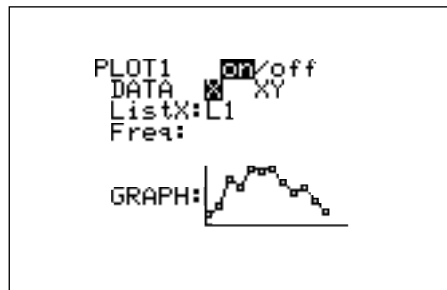
Delete old data and enter the following data set for L1:

15 28 17 36 38 19 13 25 27 41

by pressing **1** **5** **ENTER** **2** **8** **ENTER** **1** **7** **ENTER** **3** **6** **ENTER**
3 **8** **ENTER** **1** **9** **ENTER** **1** **3** **ENTER** **2** **5** **ENTER** **2** **7** **ENTER**
4 **1** **ENTER**.

Check the data you have entered by pressing **▲** to move back through the data.

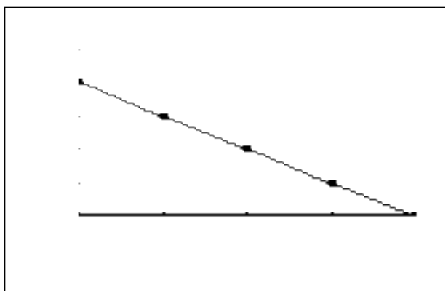
To graph a broken-line graph for the data set, first press **2ndF** **STAT PLOT**, touch **A PLOT1**, and press **ENTER**. Turn PLOT1 on by pressing **ENTER**. Press **▼** **ENTER** to choose one-variable data. Press **▼** **2ndF** **L1** **ENTER** to enter L1 as the data list. Clear the frequency prompt by pressing **►** **DEL** **ENTER**. Set the graph to a broken-line graph by pressing **2ndF** **STAT PLOT**, touch **B B.L.**, and double touch **3 Broken**.



In our example, the smallest value is 13 and the largest value is 41. The logical intervals for the data set would be 10-19 (tens), 20-29 (twenties), 30-39 (thirties), and 40-49 (forties). Notice, each data point is included within an interval (exhaustive intervals) and only within one interval (exclusive intervals).

To set this viewing window, press **WINDOW** and set the horizontal axis to $10 < x < 50$ (beginning and ending values for intervals described previously) with $Xscl = 10$ (width of interval) by pressing **1** **0** **ENTER** **5** **0** **ENTER** **1** **0** **ENTER**. Set the vertical axis to $0 < y < 5$ (from no data points to at most five within the interval) with $Yscl = 1$ (counting) by pressing **0** **ENTER** **5** **ENTER** **1** **ENTER**.

To view the graph, press **GRAPH** . The following graph will be constructed for the data.



Press **TRACE** and then press **▶** repeatedly to trace the points making up the broken-line graph. Turn PLOT1 off by pressing **2ndF** **STAT PLOT** **ENTER** **▶** **ENTER** **2ndF** **QUIT** .

Method of Teaching

Use the *Blackline Masters 4.1* and *4.2* to create overheads for entering one-variable data sets, that are non-weighted and weighted, and graphing broken-line and box-and-whisker charts that represent the data. Go over in detail how to select interval sizes for the broken-line graphs, either logically or mathematically, and talk about how the calculator plots the graphs.

Next, use the *Blackline Master 4.3* to create a worksheet for the students. Have the students enter the data sets and construct a broken-line graph and a box-and-whisker chart. Use the topics *For Discussion* to supplement the worksheets.

Using Blackline Master 4.2

The creation of a non-weighted one-variable data set and its corresponding broken-line graph is discussed previously under *Calculator Operations* and is presented on *Blackline Master 4.1*. The construction of a weighted data set and its box-and-whisker chart appears on *Blackline Master 4.2*.

Press **STAT** to enter the statistics menu. Delete old data and enter the following data set in L1 using weights in L2:

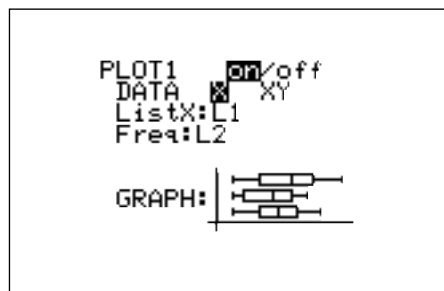
1 1 1 2 2 2 2 3 4 4

Move the highlighter to the cell directly below L1. Enter the data by pressing

1 **ENTER** **2** **ENTER** **3** **ENTER** **4** **ENTER** **▶** **3** **ENTER** **4** **ENTER**
1 **ENTER** **2** **ENTER** .

No	1: L1	2: L2	3: L3
1	1	3	-----
2	2	4	
3	3	1	
4	4	2	
5	-----		
6			

To construct a box-and-whisker chart, first press **2ndF** **STAT PLOT** **ENTER** . Press **ENTER** to turn PLOT1 on. Press **▼** **ENTER** to choose one-variable data. Press **▼** **2ndF** **L1** **ENTER** to enter L1 as the data list. Set the frequency prompt to L2 by pressing **2ndF** **L2** **ENTER** . Set the graph to a broken-line graph by pressing **2ndF** **STAT PLOT** , touch **E BOX**, and double touch **1 Box**.



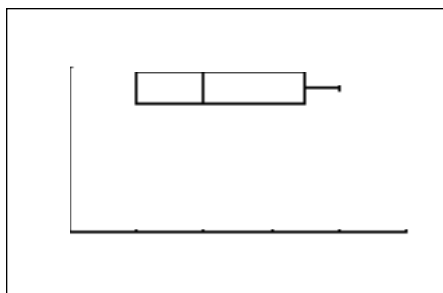
In the example, the data is discrete with a smallest value of 1 and a largest value of 4. Set the viewing window to $0 < x < 5$ (one below the smallest and one above the largest) with $Xscl = 1$ (width of interval) by pressing **WINDOW** **0** **ENTER** **5** **ENTER** **1** **ENTER** . Next, set the vertical axis to $0 < y < 1$ (no specific setting because the calculator places the box chart in whatever y range you set) with $Yscl = 1$ by pressing **0** **ENTER** **1** **ENTER** **1** **ENTER** .

```

Window (Rect)
Xmin=0
Xmax=5
Xscl=1
Ymin=0
Ymax=1
Yscl=1

```

To view the box-and-whisker chart for the example data, press **GRAPH** .
The following graph will be constructed for the data.



Press **TRACE** followed by **◀** and **▶** to view the five values making up the box-and whisker chart. Turn PLOT1 off by pressing **2ndF** **STAT PLOT** **ENTER** **▶** **ENTER** **2ndF** **QUIT** .

For Discussion

You and your students can discuss:

1. Why can't we use the midpoint as the lower bound for the intervals to construct the broken-line graphs? (The intervals would not match our chosen ones.)
2. How might you use the box-and-whisker chart graph for decisions?

Additional Problems

Create the broken-line and cumulative frequency graphs for the following data:

1. 66 68 73 55 63 58 71 59 62

2.

Value	Frequency
1	20
5	13
10	12

Chapter five

CREATION OF A TWO-VARIABLE DATA SET

Introducing the Topic

In this chapter, you and your students will learn how to create a two-variable data set.

Calculator Operations

Turn the calculator on and press **STAT** to enter the statistics menu.

Touch **A EDIT** and press **ENTER** to view the data-entry screen. If old data is present, delete it by moving the highlighter over L1 and pressing **DEL** **ENTER**. Repeat for other lists.

No	1: L1	2: L2	3: L3
1			
2			
3			
4			
5			
6			

Enter the following data set with X in L1 and Y in L2:

X	Y
5	8
7	6
8	9
3	5

by moving the highlighter to the cell below the L1 header and then pressing

5 **ENTER** **7** **ENTER** **8** **ENTER** **3** **ENTER** **▶** **8** **ENTER** **6**
ENTER **9** **ENTER** **5** **ENTER** .


No	1: L1	2: L2	3: L3
1	5	8	-----
2	7	6	
3	8	9	
4	3	5	
5	-----	-----	
6			

Sometimes, you will need to sort the data in an ascending or descending manner for either the X or Y variables. To sort your data set with the X values ascending, press **2ndF** **QUIT** **STAT** , touch **B OPE**, double touch **1 sortA**(press **2ndF** **L1** , **2ndF** **L2**) **ENTER** . Press **STAT** , touch **A EDIT**, press **ENTER** to view the list. Notice the ordered pairs were rearranged with the X values ascending and their appropriate Y values.

No	1: L1	2: L2	3: L3
1	3	5	-----
2	5	8	
3	7	6	
4	8	9	
5	-----	-----	
6			

Save this data set by pressing **⊕ ⊖** **2ndF** **LIST** , touch **C L_DATA**, double touch **1 StoLD**, and press **1** **ENTER** .

sortA(L1,L2)	Done
StoLD 1	Done

To recall the statistical data from memory, press  **2ndF** **LIST**, touch **C L_DATA**, double touch **2 RclLD**, and press **1** **ENTER**.

sortA(L1,L2)	Done
StoLD 1	Done
RclLD 1	Done

Method of Teaching

Use the *Blackline Masters 5.1* and *5.2* to create overheads for entering two-variable data sets that are non-weighted and weighted. Go over in detail how to save data sets to and retrieve data sets.

Next, use *Blackline Master 5.3* to create worksheets for the students. Have the students enter and save the non-weighted and weighted data sets for two variables. Use the topics *For Discussion* to supplement the worksheets.

Using Blackline Master 5.2

The creation of a non-weighted two-variable data set discussed above under *Calculator Operations* is presented on *Blackline Master 5.1*. The entering of a weighted one-variable data set appears on *Blackline Master 5.2*.

Turn the calculator on and press **STAT** to enter the statistics menu.
 Touch **A EDIT** and press **ENTER** to view the data-entry screen. If old data is present, delete it by moving the highlighter over L1 and pressing **DEL** **ENTER**. Repeat for other lists.

No	1: L1	2: L2	3: L3
1			
2			
3			
4			
5			
6			

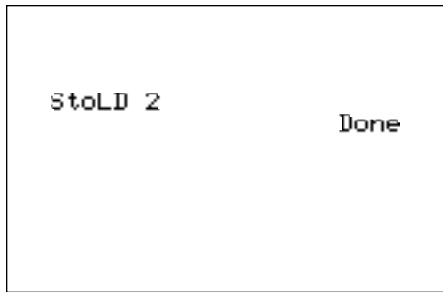
Each card will contain a data point (X, Y) and weight or frequency of occurrence. If a point (X,Y) appears four times within a data set, its weight or frequency is 4. Enter the following data set in L1 and L2 using L3 for the weights:

X	Y	W
5	3	7
4	8	9
2	10	3

by pressing **5** **ENTER** **4** **ENTER** **2** **ENTER** **▶** **3** **ENTER** **8** **ENTER** **1** **0** **ENTER** **▶** **7** **ENTER** **9** **ENTER** **3** **ENTER**.

No	1: L1	2: L2	3: L3
1	5	3	7
2	4	8	9
3	2	10	3
4			
5			
6			

Save this data set by pressing **⊕** **⊖** **2ndF** **LIST**, touch **C L_DATA**, double touch **1 StoLD**, and press **2** **ENTER**.



For Discussion

You and your students can discuss:

1. What kind of data would come in pairs?
2. What kind of data would possibly come in weighted pairs? (Pairs occur more than once.)

Chapter six

NUMERICAL DESCRIPTION OF A TWO-VARIABLE DATA SET

Introducing the Topic

In this chapter, you and your students will learn how to use the Sharp graphing calculator to find the numerical descriptions of a two-variable data set.

Calculator Operations

Turn the calculator on and press **STAT** to enter the statistics menu. Touch **A EDIT** and press **ENTER** to access the data entry screen. Delete old data by highlighting L1 and pressing **DEL** **ENTER** . Repeat for other lists.

Enter the following data set:

<u>X</u>	<u>Y</u>
25	32
28	33
31	27
40	38
29	30

Please refer to Chapter 5 for discussion on entering a non-weighted two-variable data set.

No	1: L1	2: L2	3: L3
1	25	32	
2	28	33	
3	31	27	
4	40	38	
5	29	30	
6			

Check the data you have entered and correct any errors you may find.

To calculate the numerical descriptions of the two variables, press **2ndF**

QUIT **STAT**, touch **C CALC**, and double touch **2_Stats**. Press **ENTER** and the following statistical results will appear:

```

2_Stats
x̄=30.6
sx=5.683308895
σx=5.083306011
Σx=153
Σx²=4811
n=5
↓xmin=25

```

Press **▼** to view more of the numerical descriptions.

```

2_Stats
↑n=5
xmin=25
xmax=40
ȳ=32
sy=4.062019202
σy=3.633180425
↓Σy=160

```

Press **▼** to view the remaining statistics.

```
2_Stats
rsy=4.062019202
sy=3.633180425
Σy=160
Σy2=5186
Σxy=4951
ymin=27
ymax=38
```

The statistics displayed are:

1. the average or mean value of the variable, \bar{x} or \bar{y} ;
2. the standard deviation assuming the data points are a sample from a population, s_x or s_y ;
3. the standard deviation assuming the data points represents the entire population, σ_x or σ_y ;
4. the sum of the values, Σx or Σy ;
5. the sum of the squared values, Σx^2 or Σy^2 ;
6. the number of data points, n ;
7. the minimum variable value, x_{\min} or y_{\min} ;
8. the maximum variable value, x_{\max} or y_{\max} ; and
9. the sum of the x and y products, Σxy .

Your students may have trouble with conceptualizing the meaning of standard deviation. Tell them it is a measure of variability (dispersion) that is related to the average deviation or average distance from a data value to the mean.

Method of Teaching

Use *Blackline Master 6.1* to create an overhead for calculating the numerical descriptions of a two-variable data set. Go over in detail the statistics provided by the calculator.

Next, use *Blackline Masters 6.2* and *6.3* to create work sheets for the students. Have the students enter and save the non-weighted and weighted two-variable data sets, and then compute the numerical descriptions. Use the topics *For Discussion* to supplement the worksheets.

Using Blackline Master 6.2

Turn the calculator on and press **STAT** to enter the statistics menu. Delete old data set by highlighting L1 and pressing **DEL** **ENTER**. Repeat for other lists.


Enter the following data set which represents the frequency of observing doubles with a particular pair of dice. The dice were rolled until fifty doubles were observed.

<u>X</u>	<u>Y</u>	<u>W</u>
1	1	8
2	2	10
3	3	12
4	4	9
5	5	6
6	6	5


Each row will contain a data pair and the frequency of occurrence.

Check the data you have entered. To calculate the numerical descriptions of the two variables, press **2ndF** **QUIT** **STAT**, touch **C CALC**, and double touch **2_Stats**. Press **2ndF** **L1** **,** **2ndF** **L2** **,** **2ndF** **L3** **ENTER** and the following statistical results will appear:

```
2_Stats
x̄=3.2
sx=1.551825784
σx=1.53622915
Σx=160
Σx²=630
n=50
↓xmin=1
```

Press  to view more of the numerical descriptions.

```
2_Stats
↑n=50
xmin=1
xmax=6
ȳ=3.2
sy=1.551825784
σy=1.53622915
↓Σy=160
```

Press  to view the remaining statistics.

```
2_Stats
↑sy=1.551825784
σy=1.53622915
Σy=160
Σy²=630
Σxy=630
ymin=1
ymax=6
```

For Discussion

You and your students can discuss:

1. If the dice are fair, how many times should each double appear in fifty appearances of doubles?
2. Would you consider these dice fair?
3. What should the average value for each variable be if the dice were fair?
4. If these dice are considered loaded, to which end are they loaded?

Additional Problems

Find the numerical descriptions of the following data sets:

1.

<u>X</u>	<u>Y</u>
66	68
73	55
63	58
71	59
62	65

2.

<u>X</u>	<u>Y</u>	<u>W</u>
15	1	20
16	2	13
17	3	12
18	4	17

Chapter seven

GRAPHICAL PORTRAYAL OF A TWO-VARIABLE DATA SET

Introducing the Topic

In this chapter, you and your students will learn how to use the Sharp graphing calculator to graphically portray a two-variable data set with a statistical graph called a scatter diagram or scatter plot.

Calculator Operations

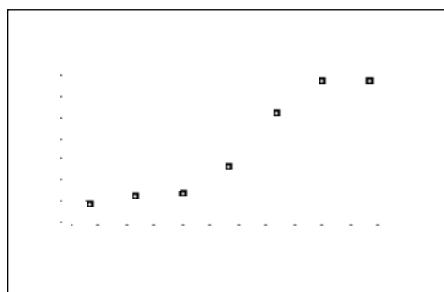
Before drawing a scatter diagram, data must be entered on the statistics data entry screen. You can either enter new data or recall a data set that has been stored within a matrix. (Refer to Chapter 5 for discussion on entering, storing and/or recalling a two-variable data set.) Consider the following table listing the revenue for a large corporation:

<u>Year</u>	<u>Revenue (in millions of dollars)</u>
1990	48.63
1991	48.86
1992	48.91
1993	49.69
1994	51.10
1995	52.00
1996	52.03

Enter the data by first pressing **STAT** to access the statistics menu. Touch **A EDIT** and press **ENTER** to access the statistics data entry screen. To delete old data, highlight L1 and press **DEL** **ENTER** to delete List 1. Repeat for additional lists. Enter the data using L1 for the year and L2 for the revenue (in millions of dollars). Check the data and correct any errors you may find.

No	1: L1	2: L2	3: L3
1	1990	48.63	-----
2	1991	48.86	
3	1992	48.91	
4	1993	49.69	
5	1994	51.1	
6	1995	52	

Press **2ndF** **STAT PLOT**, touch **A PLOT1**, and press **ENTER** to access the PLOT1 set up screen. To turn PLOT 1 on, press **ENTER**. Press **▼** **▶** **ENTER** to set the data to two-variable. Set L1 for the x -variable by pressing **▼** **2ndF** **L1** **ENTER**. Press **2ndF** **L2** **ENTER** to set L2 for the y -variable. To set the graph to scatter diagram, press **2ndF** **STAT PLOT**, touch **G S.D.**, and double touch **3 Scattr**. Construct an autoscaled scatter diagram of this data set by pressing **ZOOM**, touching **A ZOOM**, touching **▼** on the screen, and double touching **9 Stat**. You will see the following graph:



Autoscaling the scatter diagram sets the graphics screen so that the lower left corner of the screen is the data point at which the minimum value of x occurs and the upper right corner of the screen is the point at which the maximum value of x occurs. Press **TRACE** and press **▶** repeatedly to verify that $X_{min}= 1990$, $X_{max}= 1996$, $Y_{min}= 48.63$, and $Y_{max}= 52.03$.

You can discuss with your students possible answers to questions such as the following based on information presented by the scatter diagram:

1. Does the corporation's revenue seem to be increasing by the same amount each year?
2. What appears to be happening to the corporation's revenue after 1995?
3. Between what years was the corporation's greatest growing in revenue?

Method of Teaching

Use *Blackline Masters 7.1* and *7.2* to create an overhead for drawing a scatter diagram of a two-variable data set. Go over drawing the graph with the autoscale feature of the calculator and manually setting the viewing window.

Next, use *Blackline Masters 7.3* and *7.4* to create worksheets for the students. Have the students draw the scatter diagrams and then set the viewing window so that a pattern in the data, if one exists, can be recognized.

Use the topics *For Discussion* to have students use the calculator's random number generator to select certain students in the class from whom to collect data for drawing scatter diagrams and investigating patterns.

Using Blackline Master 7.2

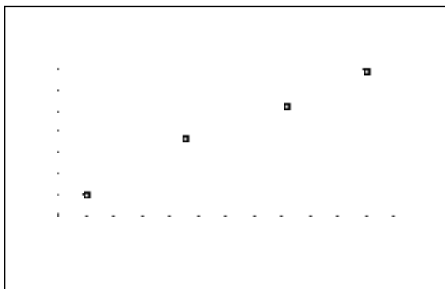
The creation of a scatter diagram is discussed under *Calculator Operations* and is presented on *Blackline Master 7.1*. Press **STAT**, touch **A EDIT**, and press **ENTER** to access the data entry screen. Delete old data and enter the following data set giving the per capita waste generated in the United States between 1960 and 1988. Enter the year in L1 and enter the pounds in L2.

<u>Year</u>	<u>Total Waste generated by the Average U.S. Resident (pounds per day)</u>
1960	2.66
1970	3.27
1980	3.61
1988	4.00

Source: U.S. Environmental Protection Agency

Check the data you have entered, and save the data set by pressing **2ndF** **QUIT** **2ndF** **LIST**, touch **C L_DATA**, double touch **1 StoLD**, and press **1** **ENTER**.

Construct an autoscaled scatter diagram of this data set by pressing **ZOOM**, touching **A ZOOM**, touching **▼** on the screen, and double touching **9 Stat**. You will see the following graph:



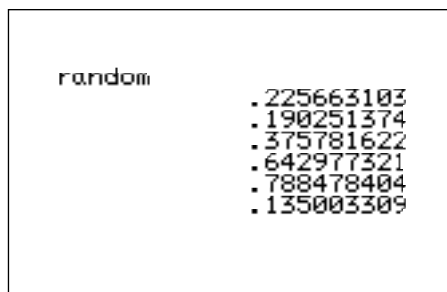
You can use questions such as the following to discuss the information presented by the scatter diagram.

1. As the year increases, is the per capita waste generated by the average U.S. resident increasing or decreasing?
2. Does there appear to be a pattern in the way the per capita waste is changing as the year increases? If so, can you identify the pattern?
3. What was the mean amount of waste generated by the average U.S. resident between 1960 and 1988? Give units with your answer.

For Discussion

Your students will find it interesting to generate their own data to be graphed in the form of a scatter diagram. You can use the calculator's random number generator to select a random sample of students for collection of data.

The random number generator is accessed by pressing **MATH**, touching **C PROB**, and double touching **1 random**. Press **ENTER** several times to observe some of the random values.



A true random number generator on the interval $[0, 1]$ would select each real number in that interval with equal probability. These calculator-generated random values will behave, for most of your experiments, like theoretical random numbers. Adjust the random number generator to give you counting numbers up to your class size (let's say it is 30). Enter the expression:

$$\text{int}(\text{random} * 30) + 1$$

by pressing **MATH**, touching **B NUM**, double touching **5 int**, pressing **(** **MATH**, touching **C PROB**, double touching **1 random**, pressing **×** **3** **0** **)** **+** **1**. Pressing **ENTER** repeatedly will give you counting numbers between and including 1 and 30.

Suppose you decide to collect data on the wrist (x -value) versus ankle (y -value) measurements of students in your class. Assign each student in the class a number, either from the class roll or simply counting in class. Sample some students, take the measurements, and create a scatter diagram.

Additional Problems

Construct scatter diagrams of each of the following data sets. Devise three questions you could ask about information obtained from each of the scatter diagrams.

1.

<u>Year</u>	<u>Glass Waste Materials Generated by the Average U.S. Resident (pounds per day)</u>
1960	0.20
1970	0.34
1980	0.36
1988	0.28

2. During a recent walk-a-thon to raise funds for cancer research, eight of the male participants were chosen at random and each person's age and time to walk one mile (rounded to the nearest minute) recorded:

Age (years)	50	82	23	70	35	18	60	68
Time (minutes)	15	32	10	28	13	12	25	26

3. Use the random number generator to select a sample of 10 students from the class and collect their height in inches and shoe size. Draw a scatter diagram and investigate any pattern you observe.

Chapter eight

LINEAR REGRESSIONS

Introducing the Topic

In this chapter, you and your students will learn how to use the Sharp graphing calculator to find the linear regression (best-fitting line) for a set of data points. A regression line is a linear model of the relationship between the dependent variable Y and the independent variable X . The model is denoted as $Y = a + bX$, where a is the Y -intercept and b is the slope of the regression line.

A third value, r , is calculated for each regression. The r value is the correlation coefficient, which is a measure of how well the line fits the data points, and it will range from -1 to 1 . If $r = -1$ or 1 , then the line intersects all the data points, and the data points are said to be in perfect-linear correlation. A positive sign indicates a direct relationship (as X increases, the Y increases), whereas a negative sign indicates an indirect relationship (as X increases, the Y decreases). Values of r close to -1 or 1 are said to reflect a strong linear correlation, and values close to 0 are said to reflect the absence of linear correlation.

Calculator Operations

Turn the calculator on and press **STAT** to enter the statistics menu. Access the data entry screen by touching **A EDIT** and pressing **ENTER**. Delete old data and enter the following data set:

<u>X</u>	<u>Y</u>
25	32
28	33
31	27
40	38
29	30

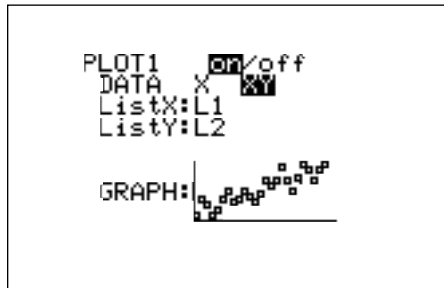
Please refer to Chapter 5 for discussion on entering a non-weighted two-variable data set. Check the data you have entered and correct any errors you may find.

No	1: L1	2: L2	3: L3
1	25	32	
2	28	33	
3	31	27	
4	40	38	
5	29	30	
6			

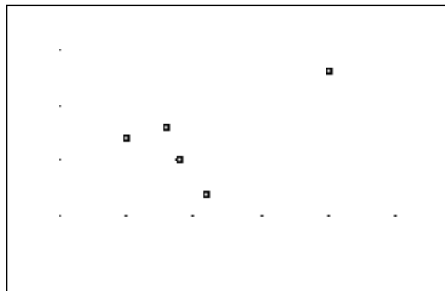
To find the best-fitting line (regression line) for the data, press **2nd** **STAT**, touch **D REG**, double touch **02 Rg ax+b**, and press **ENTER**. The following values for the regression line $y = ax + b$ will appear:

```
Rg_ax+b
y=ax+b
a=.425696594
b=18.97368421
r=.595606549
r^2=.354747162
```

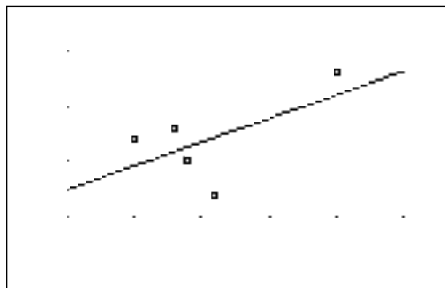
To overlay the regression line and the scatter diagram for the data, you must first set up the scatter diagram by pressing **2ndF** **STAT PLOT**, touching **A PLOT1**, pressing **ENTER** **ENTER** **▼** **▶** **ENTER** **▼** **2ndF** **L1** **ENTER** **2ndF** **L2** **ENTER** **2ndF** **STAT PLOT**, touching **G S.D.**, and touching **3 Scattr**.



Display the scatter diagram for the data (Please refer to Chapter 7 for discussion of how to display a scatter diagram) by pressing **WINDOW** and setting $X_{min} = 20$, $X_{max} = 45$, $X_{scl} = 5$, $Y_{min} = 25$, $Y_{max} = 40$, and $Y_{scl} = 5$. Press **GRAPH** to view the scatter diagram shown below:



To view the overlay of the regression line and the scatter diagram, press **Y=** **CL** **VARS**, touch **H STAT**, press **ENTER**, touch **B REGEQN**, double touch **1 RegEqn**, and press **GRAPH**. The following overlay will be displayed.



Method of Teaching

Use *Blackline Masters 8.1* and *8.2* to create overheads for demonstrating the calculation of a regression line for a set of data points, and the display of an overlay of the scatter diagram for the data points and the regression line. Go over in detail the significance of the a , b , and r values generated by the calculator.

Next, use *Blackline Master 8.3* to create a worksheet for the students. Have the students enter the data points, compute the regression line, and display the overlay of the scatter diagram and regression line. Use the topics *For Discussion* to supplement the worksheets.

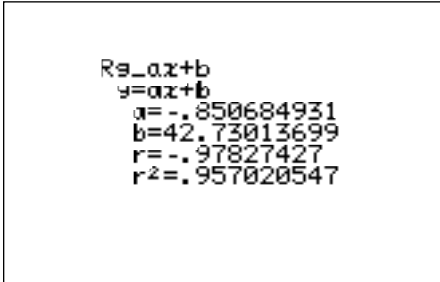
Using Blackline Master 8.2

Press **STAT** to enter the statistics menu. Access the data entry screen by touching **A EDIT** and pressing **ENTER**. Delete old data and enter the following data set:

<u>X</u>	<u>Y</u>
11	35
14	30
17	28
21	23
26	21
29	19

Check the data you have entered and correct any errors you may find.

To find the best-fitting line (regression line) for the data, press **2ND** **STAT**, touch **D REG**, double touch **02 Rg_ $ax+b$** , and press **ENTER**. The following values for the regression line $y = ax + b$ will appear:

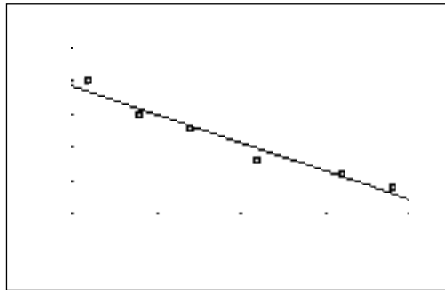


```
Rg_ax+b
y=ax+b
a=-.850684931
b=42.73013699
r=-.97827427
r^2=.957020547
```

To overlay the regression line and the scatter diagram for the data, you must first set up the scatter diagram by pressing **2ndF** **STAT PLOT**, touching **A PLOT1**, pressing **ENTER** **ENTER** **▼** **▶** **ENTER** **▼** **2ndF** **L1** **ENTER** **2ndF** **L2** **ENTER** **2ndF** **STAT PLOT**, touching **G S.D.**, and double touching **3 Scattr.**

Display the scatter diagram for the data by pressing **WINDOW** and setting $X_{min} = 10$, $X_{max} = 30$, $X_{scl} = 5$, $Y_{min} = 15$, $Y_{max} = 40$, and $Y_{scl} = 5$. Press **Y=** **CL** to clear any previously entered expressions. Press **GRAPH** to view the scatter diagram.

To view the overlay of the regression line and the scatter diagram, press **Y=** **VAR5**, touch **H STAT**, press **ENTER**, touch **B REGEQN**, double touch **1 RegEqn**, and press **GRAPH**. The following overlay will be displayed.



For Discussion

You and your students can discuss:

1. In what pattern would the data points lie to form a coefficient of correlation of zero?
2. Engage the trace and pressing **◀** or **▶** and using the regression line to make a prediction.

Additional Problems

Find the equation for the regression lines, and construct the overlays of the scatter diagram and regression lines for the following data sets:

	<u>X</u>	<u>Y</u>	
1.	66	68	$60 < X < 75$, scale of 1
	73	55	$50 < Y < 70$, scale of 5
	63	58	
	71	59	
	62	65	

2.	<u>X</u>	<u>Y</u>	
	1500	99	$1400 < X < 1900$, scale of 100
	1600	201	$0 < Y < 500$, scale of 100
	1700	295	
	1800	403	

Chapter nine

OTHER REGRESSIONS AND MODEL OF "BEST FIT"

Introducing the Topic

In this chapter, you and your students will learn how to use the Sharp graphing calculator to find several regression equations for a set of data points and then determine the model of "best fit." A regression equation is a model of the relationship between the dependent variable Y and the independent variable X . Other regression models include $y = ax^2 + bx + c$ (quadratic), $y = ax^3 + bx^2 + cx + d$ (cubic), $y = ax^4 + bx^3 + cx^2 + dx + e$ (quartic), $y = a + b \ln x$ (natural logarithm), $y = a + b \log x$ (common logarithm), $y = a \cdot bx$ (exponential), $y = a \cdot ebX$ (natural exponential), $y = a + bx^{-1}$ (inverse), and $Y = a \cdot Xb$ (power). The a , b , c , d and e are calculated for each model in order to find the best-fitting curve (minimized error).

A third value, r^2 , is calculated for each regression and is a measure of how well the equation fits the data points, and it will range from 0 to 1. If $r^2 = 1$, then the equation intersects all the data points, and the model is said to have perfect fit. Values of r^2 close to 1 are said to reflect a good fit, and values close to 0 are said to reflect a poor fit.

Calculator Operations

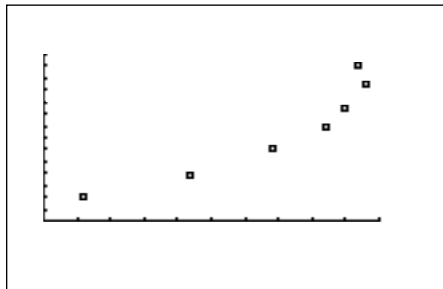
Turn the calculator on and press **STAT** to enter the statistics menu. Touch **A EDIT** and press **ENTER** to access the data entry screen. Delete old data and enter the following data set:

<u>X</u>	<u>Y</u>
6	10
22	19
34	31
42	39
45	47
48	58
47	66

Please refer to Chapter 5 for discussion on entering a non-weighted two-variable data set. Check the data you have entered and correct any errors you may find.

Set up the scatter diagram by pressing **2ndF** **STAT PLOT**, touching **A PLOT1**, pressing **ENTER** **ENTER** **▼** **▶** **ENTER** **▼** **2ndF** **L1** **ENTER** **2ndF** **L2** **ENTER** **2ndF** **STAT PLOT**, touching **G S.D.**, and double touching **3 Scatt**.

Display the scatter diagram for the data (Please refer to Chapter 7 for discussion of how to display a scatter diagram) by pressing **WINDOW** and setting Xmin = 0, Xmax = 50, Xscl = 5, Ymin = 0, Ymax = 70, and Yscl = 5. Clear any expressions entered in the Y prompts by pressing **Y=** **CL**. Press **GRAPH** to view the scatter diagram shown below:



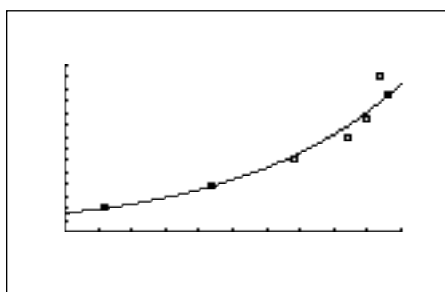
To find the best-fitting exponential curve ($Y = a \cdot eb^X$) for the data, press **2ndF** **STAT** touch **D REG**, touch **▼** on the screen, double touch **10 Rg_aebx**, and press **ENTER**. The following values for the regression will appear:

```

R9_aeb*
y=a·e^(bx)
a=7.536450724
b=.042239995
r=.989226453
r²=.978568975

```

To view the overlay of the regression curve and the scatter diagram, press **Y=** **VARΣ**, touch **H STAT**, press **ENTER**, touch **B REGEQN**, double touch **1 RegEqn**, and press **GRAPH**. The following overlay will be displayed:



Repeat this process to find and view other regression models.

Method of Teaching

Use *Blackline Masters 9.1* and *9.2* to create overheads for demonstrating the calculation of a regression models for a set of data points. Go over in detail the significance of the a , b , and r^2 values generated by the calculator. Emphasize the use of r^2 to find the best fitting model from the models generated.

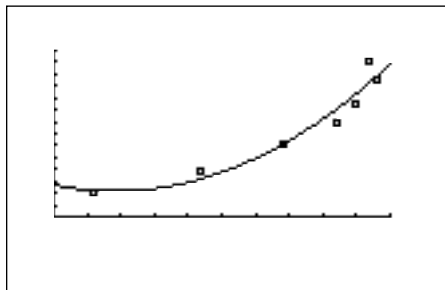
Next, use *Blackline Masters 9.3* and *9.4* to create a worksheet for the students. Have the students enter the data points, compute the regression models, and overlay the models and scatter diagram. Use the topics *For Discussion* to supplement the worksheets.

Using Blackline Master 9.2

To find the best-fitting quadratic curve ($y = ax^2 + bx + c$) for the data, press $\boxed{\oplus} \boxed{-} \boxed{\otimes} \boxed{+}$ $\boxed{\text{STAT}}$, touch **D REG**, double touch **04 Rg x^2** , and press $\boxed{\text{ENTER}}$. The following values for the regression will appear:

```
Reg $_x^2$ 
y=ax2+bx+c
a=.032265432
b=-.601495881
c=13.54578656
R2=.933694711
```





To view the overlay of the regression curve and the scatter diagram, press $\boxed{\text{Y=}}$ $\boxed{\text{CL}}$ $\boxed{\text{VARS}}$, touch **H STAT**, press $\boxed{\text{ENTER}}$, touch **B REGEQN**, double touch **1 RegEqn**, and press $\boxed{\text{GRAPH}}$. The following overlay will be displayed:



Notice, the r^2 value for the quadratic regression model is about .9337, whereas the r^2 value for the exponential regression model was .9786. The exponential regression model (with the r^2 value closer to 1) is considered the better-fitting model. The exponential regression model even fits better than the linear model with an r^2 value of .8553. The students should continue this analysis with the remaining regression models.

For Discussion

You and your students can discuss:

1. Can you tell from the graphs which model fits the best?
2. Engage the trace and press  or  to move the tracer along the curve, or from data point to data point. Press  or  to move from the curve to the data points, or vice versa. Use this mechanism to find the error between a predicted Y value (on the regression curve) and a known Y value for a given X (one of the known points).

Additional Problem

Find the best-fitting regression model for the following data set:

<u>X</u>	<u>Y</u>
66	68
73	55
63	58
71	59
62	65
69	61
74	60
65	60
63	60
79	49

$60 < X < 75$, scale of 1

$50 < Y < 70$, scale of 5

Chapter ten

STATISTICAL TESTS

Introducing the Topic

In this chapter, you and your students will learn how to use the Sharp graphing calculator to perform several statistical tests. A statistical test assists in making a decision between two hypotheses. A statistical test contains five components: a null hypothesis, an alternate hypothesis, an observed statistic from the sample, a rejection statistic for making a decision, and the decision itself. The null hypothesis is generally a statement of equality, whereas the alternate hypothesis is a statement of inequality (\neq , $<$, or $>$). Each of the five components of the statistical test will be identified in each problem addressed.

Calculator Operations

Turn the calculator on and press **STAT** to enter the statistics menu.

Touch **A EDIT** and press **ENTER** to access the data entry screen.

Delete old data and enter the following data set for L1:

7	10	7	6	8	10	15	14	11
12	6	11	11	5	7	9	9	7

Check the data you have entered and correct any errors you may find.

The data shown above reflects the number of wins for the Chicago Bears in each season since 1978 when the NFL went to a 16 game season. The only season left out was the 1982 strike shortened season. Test the alternate hypothesis that "da Bears" are a winning football team against the null hypothesis that "da Bears" are merely a .500 ball club.

Set up the statistical test by pressing **2ndF** **QUIT** **STAT** , touching **E TEST**, and double touching **03 Ttest1samp**. The one-sample T test was chosen because we have one small sample and we do not know the standard deviation. If we had a sample larger than 30 or knew the standard deviation, then we could use the Ztest1samp command. If we had two small samples or did not know the standard deviations, then we would use Ttest2samp. If we had two large samples or knew the standard deviations, then we could use the Ztest2samp. All of these tests are for testing equality of a mean to a number (one sample test) or equality of two means (two sample).

Set the alternate hypothesis to $\mu > \mu_0$ by pressing **▶** **▶** **ENTER** . Set the null hypothesis equal to 8 wins by pressing **▼** **8** **ENTER** . The null hypothesis was set equal to 8, since eight wins would represent a .500 season. Set the List to L1 by pressing **2ndF** **L1** **ENTER** .

```
Ttest1samp
μ≠μ0 μ<μ0 μ>μ0
μ0=8
List:L1 Freq:
```

Press **2ndF** **EXE** to compute the statistical test. The following results will be displayed.

```
Ttest1samp
μ>8
t=1.759731308
P=.048217342
x̄=9.166666667
sx=2.812785933
n=18
```

The first item on the screen, $\mu > 8$, is the alternate hypothesis of the statistical test. Supporting the alternate hypothesis in this case would mean "da Bears," on the average, win more than 8 games in a season and thus are a winning ball team. The null hypothesis is not shown on the screen because it is always the same as the alternate except it is an equality ($\mu = 8$). The second item on the screen is the observed statistic from the sample (observed t). From it, the third item on the screen is calculated and it represents the decision statistic (p value).

Typically in science, the .05 level of significance is used in making decisions. Deviation from this level of significance would need to be defended in a report. A .05 level of significance means that if our observed statistic from the sample falls in the rare 5%, we will reject the null hypothesis and support the alternate hypothesis.

Therefore, if your p value is less than .05 you will reject the null hypothesis and support the alternate hypothesis. In our problem, the p value is .0482 which is less than .05. Our decision is to reject the null hypothesis that $\mu = 8$ and support the alternate hypothesis that $\mu > 8$. This test clearly shows that "da Bears" average more than 8 wins a season and thus are a winning football team.

If the p value is greater than .05 you would support the null hypothesis that $\mu = 8$.

The fourth, fifth and sixth items on the screen show the sample average, sample standard deviation and sample size. On the average, "da Bears" win approximately 9 games a season.

Method of Teaching

Use *Blackline Masters 10.1* and *10.2* to create overheads for performing statistical tests. Go over in detail the five parts of a statistical test and the items generated by the calculator.

Next, use *Blackline Master 10.3* to create a worksheet for the students. Have the students enter the data points, compute the regression models, and overlay the models and scatter diagram. Use the topics *For Discussion* to supplement the worksheets.

Using Blackline Master 10.2

Press **STAT** to enter the statistics menu. Touch **A EDIT** and press **ENTER** to access the data entry screen. Enter the additional data for L2:

L1 Bears	7	10	7	6	8	10	15	14	11
	12	6	11	11	5	7	9	9	7
L2 Packers	8	5	5	8	8	8	8	4	5
	4	10	6	4	9	9	9	11	13

Check the data you have entered and correct any errors you may find.

The data shown above reflects the number of wins for the Chicago Bears and Green Bay Packers in each season since 1978 when the NFL went to a 16 game season. The only season left out was the 1982 strike shortened season. Test the alternate hypothesis that "da Bears" are a better (on the average won more games) football team than the Packers during these recent years. Each won one Super Bowl during this time. The null hypothesis would be that "da Bears" are merely equal to the Packers.

Set up the statistical test by pressing **2ndF** **QUIT** **STAT**, touching **E TEST**, and double touching **04 Ttest2samp**. The two-sample T test was chosen because we have two small samples.

Set the alternate hypothesis to $\mu_1 > \mu_2$ by pressing **▶** **▶** **ENTER**. Pool the standard deviations in the calculation by pressing **▼** **▶** **ENTER**. We pool the standard deviations for the statistical test when the standard deviations are approximately equal. Statistical analysis of each data set showed they were nearly the same. Do not pool the standard deviations when they are subjectively unequal. Set the List1 to L1 by pressing **▼** **2ndF** **L1** **ENTER**. Set List2 to L2 by pressing **2ndF** **L2** **ENTER**.


```
Ttest2samp
μ1=μ2 μ1<μ2 μ1>μ2
Pooled:No Yes
List1:L1 Freq1:
List2:L2 Freq2:
```

Press **2ndF** **EXE** to compute the statistical test. The following results will be displayed. Press **▼** to see the rest of the results.

```
Ttest2samp
μ1>μ2
t=1.909407757
P=.032338752
df=34
x̄1=9.166666667
x̄2=7.444444444
↓sx1=2.812785933
```

```
Ttest2samp
μ1>μ2
↑x̄1=9.166666667
x̄2=7.444444444
sx1=2.812785933
sx2=2.594614835
n1=18
n2=18
```

The first item on the screen, $\mu_1 > \mu_2$, is the alternate hypothesis of the statistical test. Supporting the alternate hypothesis in this case would mean "da Bears," on the average, win more games than the Packers in a season and thus are a better ball team. The null hypothesis is not shown on the screen because it is always the same as the alternate except it is an equality ($\mu_1 = \mu_2$). The second item on the screen is the observed statistic from the sample (observed t). From it, the third item on the screen is calculated and it represents the decision statistic (p value).

In our problem, the p value is .0323 which is less than .05. Our decision is to reject the null hypothesis that $\mu_1 = \mu_2$ and support the alternate hypothesis that $\mu_1 > \mu_2$. This test clearly shows that "da Bears" average more wins a season than the Packers and thus are a better football team.

The fifth and sixth values show the sample averages. On the average, "da Bears" win approximately 9 games a season, whereas the Packers win 7. The seventh and eighth values show the sample standard deviations are nearly the same.

For Discussion

You and your students can discuss:

1. using the Ztest1samp and Ztest2samp for large samples ($n > 30$) or when the standard deviation(s) is/are known.
2. using the Ftest2samp for testing the standard deviations for two samples.

Additional Problem

1. The length of stay in days for 20 randomly selected hospital patients are provided below. Enter the data in L1 and test the alternate hypothesis that the average length of stay is less than 5 days.

2	3	8	6	4	4	6	4	2	5
3	5	2	3	3	2	10	2	4	2

2. The reading scores for two separate classes are provided below. Enter Class 1's scores into L1 and Class 2's scores into L2. Test the alternative hypothesis that Class 1 reads better than Class 2. Pool the standard deviations for the test.

<u>Class 1</u>	87	84	92	83	97	79	76	90
<u>Class 2</u>	82	78	86	78	94	78	71	86

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1.1

CREATION OF A ONE-VARIABLE DATA SET

Steps for creating a non-weighted one-variable data set

1. Turn the calculator on and press **STAT** to enter the statistics menu.
2. Touch **A EDIT**, press **ENTER**, to view the statistics data entry screen.
If there is a data set present within the lists on your calculator, use the arrow keys to move to the list, if necessary, and press **▲** to highlight the list label.
3. Press **DEL** **ENTER** to delete the old data. Repeat for other lists of data.
4. Move the highlighter to the cell directly below the L1 in the table. Enter the following data set:

5	8	7	6	8	9	3	5
---	---	---	---	---	---	---	---

by pressing **5** **ENTER** **8** **ENTER** **7** **ENTER** **6** **ENTER** **8** **ENTER** **9** **ENTER** **3** **ENTER** **5** **ENTER**.

5. To check the data you have entered, press **▲** to move back through the data values.
6. To sort your data set in an ascending manner, press **MODE** **STAT**, touch **B OPE**, double touch **1 sortA**, press **2ndF** **L1** **)** **ENTER**. Press **STAT**, touch **A EDIT**, press **ENTER**. Notice this first cell now contains the smallest value 3.
7. To save this data set, press **MODE** **2ndF** **LIST**, touch **C L_DATA**, double touch **1 StoLD**, press **1** **ENTER**. You can store up to ten sets of six lists.
8. To retrieve a data set matrix into a statistical data set, press **MODE** **2ndF** **LIST**, touch **C L_DATA**, double touch **2 RclLD**, press **1** **ENTER**.

1.2

CREATION OF A ONE-VARIABLE DATA SET

Steps for creating a weighted one-variable data set

1. Turn the calculator on and press **STAT** to enter the statistics menu.
2. Touch **A EDIT**, press **ENTER**, to view the statistics data entry screen. Remove old data by using the arrow keys to move to the list of data, and press **▲** to highlight the list label. Press **DEL** **ENTER** to delete the old data. Repeat for other lists of data.
3. Move the highlighter to the cell directly below the L1 in the table. Enter the following data set into L1 with the frequencies entered into L2. If a value appears three times within a data set, its weight or frequency is 3. Enter the following data set using the weights:

5 5 5 7 7 7 8 9 9
 by pressing **5** **ENTER** **7** **ENTER** **8** **ENTER** **9** **ENTER** **▶** **3**
ENTER **4** **ENTER** **1** **ENTER** **2** **ENTER**.

No	1: L1	2: L2	3: L3
1	5	3	
2	7	4	
3	8	1	
4	9	2	
5			
6			

4. To save this data set, press **⊕ ⊖** **2ndF** **LIST**, touch **C L_DATA**, double touch **1 StoLD**, press **2** **ENTER**.

1.3

CREATION OF A ONE-VARIABLE DATA SET

Activity 1 Creating a non-weighted one-variable data set

1. Turn the calculator on and press **STAT** to enter the statistics menu.
2. Touch **A EDIT**, press **ENTER**, to view the statistics data entry screen.
If there is a data set present within the lists on your calculator, use the arrow keys to move to the list, if necessary, and press **▲** to highlight the list label.
3. Enter the following data set:
6 9 8 7 5 10 4 6
4. Check the data you have entered.
5. Sort the data in an ascending manner by pressing **▢ ▢ ▢ ▢** **STAT**, touch **B OPE**, double touch **1 sortA**, press **2ndF** **L1** **)** **ENTER**. Press **STAT**, touch **A EDIT**, press **ENTER**.
6. Save this data set within L_DATA 3.

Activity 2 Creating a weighted one-variable data set

1. Enter the STAT menu and delete the old data set.
2. Enter the data values and frequency of occurrence.
Enter the following data set using the frequencies.
6 6 8 8 8 9 9 9 9
3. Check the data you have entered.
4. Save this data set within L_DATA 4.

2.1

NUMERICAL DESCRIPTION OF A ONE-VARIABLE DATA SET

Steps for calculating numerical descriptions of a one-variable non-weighted data set

- Turn the calculator on and press **STAT** to enter the statistics menu. Touch **A EDIT**, press **ENTER**, to view the statistics data entry screen. If there is a data set present within the lists on your calculator, use the arrow keys to move to the list, if necessary, and press **▲** to highlight the list label. Press **DEL** **ENTER** to delete the old data. Repeat for other lists of data.
- Move the highlighter to the cell directly below the L1 in the table. Enter the following data set:

25	32	28	33	31	27	40	38	29	30
----	----	----	----	----	----	----	----	----	----
- Check the data you have entered and correct any errors you may find. Press **2ndF** **QUIT** to exit the data entry screen. To calculate the numerical descriptions of the data set, press **STAT**, touch **C CALC**, and double touch **1 1 Stats**. Press **ENTER** and the statistical results will appear.
- The statistics displayed are:
 - the average or mean value of the data set, \bar{x} ;
 - the standard deviation assuming the data set is a sample from a population, s_x ;
 - the standard deviation assuming the data set represents the entire population, σ_x ;
 - the sum of the data values, $\sum x$;
 - the sum of the squared data values, $\sum x^2$;
 - the number of values in the data set, n ;
 Press **▼** four times to see the rest of the statistics.
 - the minimum value in the data set, x_{\min} ;
 - the first quartile (25th percentile), Q_1 ;
 - the median (50th percentile), Med ;
 - the third quartile (75th percentile), Q_3 ; and
 - the maximum value in the data set, x_{\max} .

2.2

NUMERICAL DESCRIPTION OF A ONE-VARIABLE DATA SET

Steps for calculating numerical descriptions of a one-variable weighted data set

1. Turn the calculator on and press **STAT** to enter the statistics menu. Touch **A EDIT**, press **ENTER**, to view the statistics data entry screen. If there is a data set present within the lists on your calculator, use the arrow keys to move to the list, if necessary, and press **▲** to highlight the list label. Press **DEL** **ENTER** to delete the old data. Repeat for other lists of data.

2. Move the highlighter to the cell directly below the L1 in the table. Enter the following data set generated by rolling a die fifty times.

Value	Frequency
1	8
2	10
3	12
4	9
5	6
6	5

Remember to enter the frequencies in L2.

3. Check the data you have entered and correct any errors you may find. Press **2ndF** **QUIT** to exit the data entry screen. To calculate the numerical descriptions of the data set, press **STAT**, touch **C CALC**, double touch **1 1_Stats**, and press **2ndF** **L1** **,** **2ndF** **L2**. Press **ENTER** and the statistical results will appear.

2.3

NUMERICAL DESCRIPTION OF A ONE-VARIABLE DATA SET

Activity 1 Calculating the numerical descriptions for a non-weighted one-variable data set

1. Turn the calculator on and enter the statistics menu. Access the data entry screen and delete old data.

2. Enter the following data set:
 16 19 18 17 15 11 14 20

3. Check the data you have entered and correct any errors. Calculate the numerical descriptions of the data set.

4. Complete the following:
 - The average or mean value of the data set, \bar{x} = _____
 - The sample standard deviation, s_x = _____
 - The population standard deviation, σ_x = _____
 - The sum of the data values, $\sum x$ = _____
 - The sum of the squared data values, $\sum x^2$ = _____
 - The number of values in the data set, n = _____
 - The minimum value in the data set, x_{\min} = _____
 - The first quartile (25th percentile), Q_1 = _____
 - The median (50th percentile), Med = _____
 - The third quartile (75th percentile), Q_3 = _____
 - The maximum value in the data set, x_{\max} = _____

2.4

NUMERICAL DESCRIPTION OF A ONE-VARIABLE DATA SET

Activity 2 Calculating the numerical descriptions for a weighted one-variable data set

1. Delete the old data set.
2. Enter the following data set (a die rolled a hundred times) using the frequencies.

Value	Frequency
1	15
2	18
3	17
4	19
5	16
6	15

Remember to enter the frequencies in L2.

3. Check the data you have entered.
4. Calculate the numerical descriptions of the data set.
5. Complete the following:

The average or mean value of the data set, \bar{x} = _____

The sample standard deviation, s_x = _____

The number of values in the data set, n = _____

Does the die appear to be fair? _____

3.1

HISTOGRAM REPRESENTATION OF A ONE-VARIABLE DATA SET

Steps for creating a non-weighted data set's histogram

1. Turn the calculator on, press **STAT**, touch **A EDIT**, and press **ENTER** to view the statistics data entry screen. Delete old data sets.
2. Move the highlighter to the cell directly below the L1 in the table and enter the following data set:
15 28 17 36 38 19 13 25 27 41
3. Check the data you have entered by pressing **▲** to move back through the data.
4. To graph a histogram that represents the data set, you must first press **2ndF** **STAT PLOT**. Touch **A PLOT1** and press **ENTER** and a PLOT1 setup screen will appear. Turn the plot on by pressing **ENTER**. Select one-variable data by pressing **▼** **ENTER**. Set the list to L1 by pressing **▼** **2ndF** **L1** **ENTER**. A blank Freq: prompt indicates the data is non-weighted and the frequencies are one. Choose the histogram graph by pressing **▼** **2ndF** **STAT PLOT**, touching **A HIST**, and double touching **1 Hist**.
5. Set the calculator to rectangular graphing by pressing **2ndF** **SET UP**, touch **E COORD**, double touch **1 Rect**, and press **2ndF** **QUIT**.
6. Set the viewing window by pressing **WINDOW**. Set the horizontal axis to $10 < x < 50$ with $Xscl = 10$ by pressing **1** **0** **ENTER** **5** **0** **ENTER** **1** **0** **ENTER**. Set the vertical axis to $0 < y < 5$ with $Yscl = 1$ by pressing **0** **ENTER** **5** **ENTER** **1** **ENTER**.
7. To view the histogram, press **GRAPH**.

3.2

HISTOGRAM REPRESENTATION OF A ONE-VARIABLE DATA SET

Steps for creating a weighted data set's histogram

1. Press **STAT**, touch **A EDIT**, and press **ENTER** to view the statistics data entry screen. Delete old data sets.
2. Move the highlighter to the cell directly below the L1 in the table and enter the following data set using weights:

1	1	1	2	2	2	2	3	4	4
---	---	---	---	---	---	---	---	---	---

 by pressing **1** **ENTER** **2** **ENTER** **3** **ENTER** **4** **ENTER** **▶** **3** **ENTER** **4** **ENTER** **1** **ENTER** **2** **ENTER**.
3. Press **2nd F** **STAT PLOT**. Touch **A PLOT1** and press **ENTER** and a PLOT1 setup screen will appear. Turn the plot on by pressing **ENTER**. Select one-variable data by pressing **▼** **ENTER**. Set the list to L1 by pressing **▼** **2ndF** **L1** **ENTER**. Set the frequencies to L2 by pressing **2ndF** **L2** **ENTER**. Choose the histogram graph by pressing **2ndF** **STAT PLOT**, touching **A HIST**, and double touching **1 Hist**.
4. To set this viewing window, press **WINDOW** and set the horizontal axis to $-.5 < x < 5.5$ with Xscl = 1 by pressing **(-)** **•** **5** **ENTER** **5** **•** **5** **ENTER** **1** **ENTER**. Next, set the vertical axis to $-1 < y < 5$ with Yscl = 1 by pressing **(-)** **1** **ENTER** **5** **ENTER** **1** **ENTER**.
5. Press **GRAPH** view the histogram.

3.3

HISTOGRAM REPRESENTATION OF A ONE-VARIABLE DATA SET

Activity 1 Creating a non-weighted data set's histogram

1. Turn the calculator on and enter the statistics menu.
2. Delete old data.
3. Enter the following data set:
113 126 115 134 136 117 111 123 125 139
4. Set the STAT PLOT for a histogram.
5. Set the viewing window to $110 < x < 140$ with $Xscl = 10$, and setting the vertical axis to $0 < y < 5$ with $Yscl = 1$.
6. Press **GRAPH** to view the histogram.

Activity 2 Creating a weighted data set's histogram

1. Enter the statistics menu.
2. Delete old data.
3. Enter the following data set using the weights:
11 11 12 12 12 13 13 13 13 14
4. Set the STAT PLOT for a histogram with frequencies in L2.
5. Set the viewing window to $9.5 < x < 15.5$ with $Xscl = 1$, and set the Y range to $-1 < y < 5$ with $Yscl = 1$.
6. Press **GRAPH** to view the histogram.

4.1

OTHER GRAPHICAL PORTRAYALS OF A ONE-VARIABLE DATA SET

Steps for creating a non-weighted data set's broken-line graph

- Turn the calculator on and press **STAT** to enter the statistics menu.
Delete old data and enter the following data set for L1:
15 28 17 36 38 19 13 25 27 41
- Check the data you have entered by pressing **▲** to move back through the data.
- To graph a broken-line graph for the data set, first press **2ndF** **STAT PLOT**, touch **A PLOT1**, and press **ENTER**. Turn PLOT1 on by pressing **ENTER**. Press **▼** **ENTER** to choose one-variable data. Press **▼** **2ndF** **L1** **ENTER** to enter L1 as the data list. Clear the frequency prompt by pressing **▶** **DEL** **ENTER**. Set the graph to a broken line graph by pressing **2ndF** **STAT PLOT**, touch **B B.L.**, and double touch **3 Broken**.
- In our example, the smallest value is 13 and the largest value is 41. The logical intervals for the data set would be 10-19 (tens), 20-29 (twenties), 30-39 (thirties), and 40-49 (forties). To set this viewing window, press **WINDOW** and set the horizontal axis to $10 < x < 50$ with Xscl = 10. Set the vertical axis to $0 < y < 5$ with Yscl = 1.
- To view the graph, press **GRAPH**.
- Press **TRACE** and then press **▶** repeatedly to trace the points making up the broken-line graph.
- Turn PLOT1 off by pressing **2ndF** **STAT PLOT** **ENTER** **▶** **ENTER** **2ndF** **QUIT**.

4.2

OTHER GRAPHICAL PORTRAYALS OF A ONE-VARIABLE DATA SET

Steps for creating a weighted data set's box-and-whisker chart

1. Press **STAT** to enter the statistics menu. Delete old data and enter the following data set in L1 using weights in L2:
1 1 1 2 2 2 2 3 4 4
2. To construct a box-and-whisker chart, first press **2ndF** **STAT PLOT** **ENTER**. Press **ENTER** to turn PLOT1 on. Press **▼** **ENTER** to choose one-variable data. Press **▼** **2ndF** **L1** **ENTER** to enter L1 as the data list. Set the frequency prompt to L2 by pressing **2ndF** **L2** **ENTER**. Set the graph to a broken-line graph by pressing **2ndF** **STAT PLOT**, touch **E BOX**, and double touch **1 Box**.
3. In the example, the data is discrete with a smallest value of 1 and a largest value of 4. Set the viewing window to $0 < x < 5$ with $Xscl = 1$. Next, set the vertical axis to $0 < y < 1$ with $Yscl = 1$.
4. To view the box-and-whisker chart for the data, press **GRAPH**.
5. Press **TRACE** followed by **◀** and **▶** to view the five values making up the box-and whisker chart.
6. Turn PLOT1 off by pressing **2ndF** **STAT PLOT** **ENTER** **▶** **ENTER** **2ndF** **QUIT**.

4.3

OTHER GRAPHICAL PORTRAYALS OF A ONE-VARIABLE DATA SET

Activity 1 Creating a non-weighted data set's broken-line graph

1. Turn the calculator on and enter the statistics menu.
2. Delete the old data set.
3. Enter the following data set in L1:
113 126 115 134 136 117 111 123 125 139
4. Set PLOT1 to a broken-line graph.
5. Set the viewing window with a horizontal axis of $110 < x < 140$ and $Xscl = 10$.
Set the vertical axis to $0 < y < 5$ with $Yscl = 1$.
6. Press **GRAPH** to display the broken line graph.

Activity 2 Creating a weighted data set's box-and-whisker chart

1. Enter the statistics menu.
2. Delete the old data set.
3. Enter the following data set in L1 with the weights in L2:
11 11 12 12 12 13 13 13 13 14
4. Set PLOT1 to a box-and-whisker chart.
5. Set the viewing window to $10 < x < 15$ with $Xscl = 1$, and $0 < y < 1$ with $Yscl = 1$.
6. Press **GRAPH** to display the box-and-whisker chart.

5.1

CREATION OF A TWO-VARIABLE DATA SET

Steps for creating a non-weighted two-variable data set

1. Turn the calculator on and press **STAT** to enter the statistics menu. Touch **A EDIT** and press **ENTER** to view the data-entry screen. If old data is present, delete it by moving the highlighter over L1 and pressing **DEL** **ENTER**. Repeat for other lists.

2. Enter the following data set with X in L1 and Y in L2:

X	Y
5	8
7	6
8	9
3	5

by moving the highlighter to the cell below the L1 header and then pressing

5 **ENTER** **7** **ENTER** **8** **ENTER** **3** **ENTER** **▶** **8** **ENTER** **6** **ENTER** **9** **ENTER** **5** **ENTER**.

3. Sometimes, you will need to sort the data in an ascending or descending manner for either the X or Y variables. To sort your data set with the X values ascending, press **2ndF** **QUIT** **STAT**, touch **B OPE**, double touch **1 sortA**(, press **2ndF** **L1**, **2ndF** **L2** **)** **ENTER**. Press **STAT**, touch **A EDIT**, and press **ENTER** to view the list. Notice the ordered pairs were rearranged with the X values ascending and their appropriate Y values.
4. Save this data set by pressing **⊕** **⊖** **2ndF** **LIST**, touch **C L_DATA**, double touch **1 StoLD**, and press **1** **ENTER**.
5. To recall the statistical data from memory, press **⊕** **⊖** **2ndF** **LIST**, touch **C L_DATA**, double touch **2 RclLD**, and press **1** **ENTER**.

5.2

CREATION OF A TWO-VARIABLE DATA SET

Steps for creating a weighted two-variable data set

1. Turn the calculator on and press **STAT** to enter the statistics menu. Touch **A EDIT** and press **ENTER** to view the data-entry screen. If old data is present, delete it by moving the highlighter over L1 and pressing **DEL** **ENTER** . Repeat for other lists.
2. Each row will contain a data point (X, Y) and weight or frequency of occurrence. If a point (X,Y) appears four times within a data set, its weight or frequency is 4. Enter the following data set in L1 and L2 using L3 for the weights:

X	Y	W
5	3	7
4	8	9
2	10	3

by pressing **5** **ENTER** **4** **ENTER** **2** **ENTER** **▶** **3** **ENTER** **8**
ENTER **1** **0** **ENTER** **▶** **7** **ENTER** **9** **ENTER** **3** **ENTER** .

No	1: L1	2: L2	3: L3
1	5	3	7
2	4	8	9
3	2	10	3
4	-----		
5			

3. Save this data set by pressing **2ndF** **LIST** , touch **C L_DATA**, double touch **1 StoLD**, and press **2** **ENTER** .

5.3

CREATION OF A TWO-VARIABLE DATA SET

Activity 1 Creating a non-weighted two-variable data set

1. Turn the calculator on and enter the statistics menu.
2. Delete old data.

3. Enter the following data set:

<u>X</u>	<u>Y</u>
6	9
8	7
5	10
4	6

4. Check the data you have entered.
5. Sort the data in an ascending manner.
6. Save this data set within list data 1.

Activity 2 Creating a weighted two-variable data set

1. Delete the old data set.
2. Enter the following data set using the frequencies.

<u>X</u>	<u>Y</u>	<u>W</u>
6	6	8
8	8	9
9	9	10

3. Check the data you have entered.
4. Save this data set within list data 2.

6.1

NUMERICAL DESCRIPTION OF A TWO-VARIABLE DATA SET

Steps for calculating numerical descriptions of a two-variable data set

1. Turn the calculator on and press **STAT** to enter the statistics menu. Touch **A EDIT** and press **ENTER** to access the data entry screen. Delete old data by highlighting L1 and pressing **DEL** **ENTER**. Repeat for other lists.

Enter the following data set:

<u>X</u>	<u>Y</u>
25	32
28	33
31	27
40	38
29	30

2. Check the data you have entered and correct any errors you may find. To calculate the numerical descriptions of the two variables, press **2ndF** **QUIT** **STAT**, touch **C CALC**, and double touch **2_Stats**. Press **ENTER** and the statistical results will appear.
3. Press **▼** to view the remaining statistics.
4. The statistics displayed are:
 1. the average or mean value of the variable, \bar{x} or \bar{y} ;
 2. the standard deviation assuming the data points are a sample from a population, s_x or s_y ;
 3. the standard deviation assuming the data points represents the entire population, σ_x or σ_y ;
 4. the sum of the values, Σx or Σy ;
 5. the sum of the squared values, Σx^2 or Σy^2 ;
 6. the number of data points, n ;
 7. the minimum variable value, x_{\min} or y_{\min} ;
 8. the maximum variable value, x_{\max} or y_{\max} ; and
 9. the sum of the x and y products, Σxy .

6.2

NUMERICAL DESCRIPTION OF A TWO-VARIABLE DATA SET

Steps for calculating numerical descriptions of a two-variable data set

1. Turn the calculator on and press **STAT** to enter the statistics menu. Delete old data set by highlighting L1 and pressing **DEL** **ENTER** . Repeat for other lists.
2. Enter the following data set which represents the frequency of observing doubles with a particular pair of dice. The dice were rolled until fifty doubles were observed.

<u>X</u>	<u>Y</u>	<u>W</u>
1	1	8
2	2	10
3	3	12
4	4	9
5	5	6
6	6	5

Each row will contain a data pair and the frequency of occurrence.

3. Check the data you have entered. To calculate the numerical descriptions of the two variables, press **2ndF** **QUIT** **STAT** , touch **C CALC**, and double touch **2_Stats**. Press **2ndF** **L1** , **2ndF** **L2** , **2ndF** **L3** **ENTER** and the statistical results will appear.
4. Press **▼** to view more of the numerical descriptions.

6.3

NUMERICAL DESCRIPTION OF A TWO-VARIABLE DATA SET

Activity 1 Calculating the numerical descriptions for non-weighted two-variable data set

1. Turn the calculator on and enter the statistics menu. Access the data-entry screen and delete old data.

2. Enter the following data set:

X	Y
16	19
18	17
15	11
14	20

3. Calculate the numerical descriptions and enter the values below.
The average, \bar{x} = _____ and \bar{y} = _____

Activity 2 Calculating the numerical descriptions for a weighted two-variable data set

1. Delete old data and enter the following data set for L1 and L2 (dice rolled until a hundred doubles appeared) using L3 for the frequencies.

X	Y	W
1	1	15
2	2	18
3	3	17
4	4	19
5	5	16
6	6	15

2. Calculate the numerical descriptions and enter values below.
The average, \bar{x} = _____ and \bar{y} = _____
Does the die appear to be fair? _____

7.1

GRAPHICAL PORTRAYAL OF A TWO-VARIABLE DATA SET

Steps for drawing a scatter diagram of a two-variable data set

1. Consider the following table listing the revenue for a large corporation:

<u>Year</u>	<u>Revenue (in millions of dollars)</u>
1990	48.63
1991	48.86
1992	48.91
1993	49.69
1994	51.10
1995	52.00
1996	52.03

2. Access the statistics data entry screen and delete old data.
3. Enter the data using L1 for the year and L2 for the revenue (in millions of dollars). Check the data and correct any errors you may find.
4. Press $\boxed{2\text{ndF}} \boxed{\text{STAT PLOT}}$, touch **A PLOT1**, and press $\boxed{\text{ENTER}}$ to access the PLOT1 set up screen. To turn PLOT 1 on, press $\boxed{\text{ENTER}}$. Press $\boxed{\blacktriangledown} \boxed{\blacktriangleright} \boxed{\text{ENTER}}$ to set the data to two-variable. Set L1 for the x variable by pressing $\boxed{\blacktriangledown} \boxed{2\text{ndF}} \boxed{\text{L1}} \boxed{\text{ENTER}}$. Press $\boxed{2\text{ndF}} \boxed{\text{L2}} \boxed{\text{ENTER}}$ to set L2 for the y variable. To set the graph to scatter diagram, press $\boxed{2\text{ndF}} \boxed{\text{STAT PLOT}}$, touch **G S.D.**, and double touch **3 Scatt**.
5. Construct an autoscaled scatter diagram of this data set by pressing $\boxed{\text{ZOOM}}$, touching **A ZOOM**, touching \blacktriangledown on the screen, and double touching **9 Stat**.
6. Press $\boxed{\text{TRACE}}$ and press $\boxed{\blacktriangleright}$ repeatedly to verify that $X_{\min}= 1990$, $X_{\max}= 1996$, $Y_{\min}= 48.63$, and $Y_{\max}= 52.03$.

7.2

GRAPHIC PORTRYAL OF A TWO-VARIABLE DATA SET

Drawing a scatter diagram of a two-variable data set

1. Access the data entry screen and delete old data.
2. Enter the following data set giving the per capita waste generated in the United States between 1960 and 1988. Enter the year in L1 and pounds in L2.

<u>Year</u>	<u>Total Waste generated by the Average U.S. Resident (pounds per day)</u>
1960	2.66
1970	3.27
1980	3.61
1988	4.00

Source: U.S. Environmental Protection Agency

3. Check the data you have entered, and save the data set by pressing **2ndF** **QUIT** **2ndF** **LIST**, touch **C L DATA**, double touch **1 StoLD**, and press **1** **ENTER**.
4. Construct an autoscaled scatter diagram of this data set by pressing **ZOOM**, touching **A ZOOM**, touching **▼** on the screen, and double touching **9 Stat**.
5. As the year increases, is the per capita waste generated by the average U.S. resident increasing or decreasing?
6. Does there appear to be a pattern in the way the per capita waste is changing as the year increases? If so, can you identify the pattern?
7. What was the mean amount of waste generated by the average U.S. resident between 1960 and 1988? Give units with your answer.

7.3

GRAPHICAL PORTRAYAL OF A TWO-VARIABLE DATA SET

Activity 1 Drawing a scatter diagram of a non-weighted two-variable data set

1. Delete the old data set.
2. Enter the following data set that gives suggested weights for female adults 18 to 35 years of age by using L1 for height and using L2 for the weight of each two-variable data point:

<u>Height (inches)</u>	<u>Weight(pounds)</u>
60	97
62	104
64	111
66	118
68	125
70	132
72	140
74	148

3. Check the data you have entered and correct any errors.
4. Construct an autoscaled scatter diagram.
5. As a woman's height increased, her suggested weight _____.
6. What pattern is indicated by the scatter diagram as the relation between height and weight?

7. Estimate the suggested weight for a 5'11" tall woman between 18 and 35 years old. _____

7.4

GRAPHIC PORTRAYAL OF A TWO-VARIABLE DATA SET

Activity 2 Drawing a scatter diagram of a weighted two-variable data set

1. Access the data entry screen and delete the old data set.
2. Students applying to a certain college are given a personal interview rating from 1 (low potential) to 4 (high potential) and an entrance exam on which the maximum score is 25. Use L1 for the rating, and use L2 for the score.

<u>Rating</u>	<u>Exam Scored</u>
1	14
1	15
1	18
2	16
2	18
3	15
3	17
3	22
4	16
4	20
4	23
4	25

3. Check the data you have entered and correct any errors.
4. Construct an autoscaled scatter diagram.
5. For another view of the data, press **WINDOW**, and set Xmin=0, Xmax= 5, Xscl= 1, Ymin= 0, Ymax= 30, and Yscl= 10. Press **GRAPH** to view the scatter diagram.

8.1

LINEAR REGRESSIONS

Steps for calculating the best-fitting line

1. Turn the calculator on and press **STAT** to enter the statistics menu.
Access the data entry screen by touching **A EDIT** and pressing **ENTER**.
Delete old data and enter the following data set:

X	Y
25	32
28	33
31	27
40	38
29	30

Check the data you have entered and correct any errors you may find.

2. To find the best-fitting line (regression line) for the data, press **2nd** **STAT**, touch **D REG**, double touch **02 Rg ax+b**, and press **ENTER**.
3. To overlay the regression line and the scatter diagram for the data, you must first set up the scatter diagram by pressing **2ndF** **STAT PLOT**, touching **A PLOT1**, pressing **ENTER** **ENTER** **▼** **▶** **ENTER** **▼** **2ndF** **L1** **ENTER** **2ndF** **L2** **ENTER** **2ndF** **STAT PLOT**, touching **G S.D.**, and touching **3 Scattr**.
4. Display the scatter diagram for the data by pressing **WINDOW** and setting $X_{min} = 20$, $X_{max} = 45$, $X_{scl} = 5$, $Y_{min} = 25$, $Y_{max} = 40$, and $Y_{scl} = 5$. Press **GRAPH** to view the scatter diagram.
5. To view the overlay of the regression line and the scatter diagram, press **Y=** **CL** **VARS**, touch **H STAT**, press **ENTER**, touch **B REGEQN**, double touch **1 RegEqn**, and press **GRAPH**.

8.2

LINEAR REGRESSIONS

Calculating the best-fitting line

1. Access the data entry screen and delete old data.
2. Enter the following data set:

<u>X</u>	<u>Y</u>
11	35
14	30
17	28
21	23
26	21
29	19

3. Check the data you have entered and correct any errors you may find.
4. Find the best-fitting line (regression line) for the data.
5. Set up the scatter diagram.
6. Set the viewing window to $X_{\min} = 10$, $X_{\max} = 30$, $X_{\text{scl}} = 5$, $Y_{\min} = 15$, $Y_{\max} = 40$, and $Y_{\text{scl}} = 5$.
7. Press $\boxed{Y=}$ \boxed{CL} to clear any previously entered expressions. Press \boxed{GRAPH} to view the scatter diagram.
8. Overlay of the regression line and the scatter diagram, by pressing $\boxed{Y=}$ \boxed{VARS} , touch **H STAT**, press \boxed{ENTER} , touch **B REGEQN**, double touch **1 RegEqn**, and press \boxed{GRAPH} .

8.3

LINEAR REGRESSIONS

Activity 1 Calculate and plot the regression line.

<u>X</u>	<u>Y</u>
43	55
49	63
38	50
52	64
36	49

1. $y = ax + b =$ _____

2. $r =$ _____

3. Sketch the scatter diagram and regression line overlay.



Activity 2 Calculate and plot the regression line.

<u>X</u>	<u>Y</u>
100	51
98	39
109	45
119	50
121	41

1. $y = ax + b =$ _____

2. $r =$ _____

3. Sketch the scatter diagram and regression line overlay.



9.1

OTHER REGRESSIONS

Steps for calculating other regression models

1. Access the data entry screen and delete old data. Enter the following data set:

<u>X</u>	<u>Y</u>
6	10
22	19
34	31
42	39
45	47
48	58
47	66

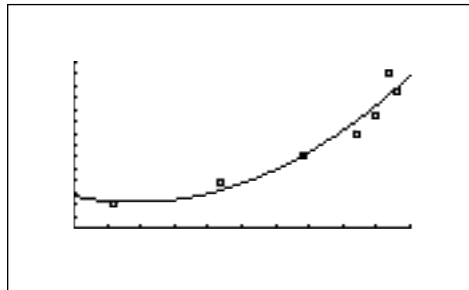
2. Check the data you have entered and correct any errors you may find.
3. Set up the scatter diagram.
4. Display the scatter diagram for the data by pressing **WINDOW** and setting $X_{min} = 0$, $X_{max} = 50$, $X_{scl} = 5$, $Y_{min} = 0$, $Y_{max} = 70$, and $Y_{scl} = 5$. Press **GRAPH** to view the scatter diagram.
5. To find the best-fitting exponential curve ($Y = a \cdot e^{bx}$) for the data, press **2ND** **STAT**, touch **D REG**, touch \blacktriangledown on the screen, double touch **10 Rg ae^{bx}**, and press **ENTER**.
6. To view the overlay of the regression curve and the scatter diagram, press **Y=** **CL** **VARS**, touch **H STAT**, press **ENTER**, touch **B REGEQN**, double touch **1 RegEqn**, and press **GRAPH**.
7. Repeat this process to find and view other regression models.

9.2

OTHER REGRESSIONS AND MODEL OF "BEST FIT"

Steps for calculating other regression models

- To find the best-fitting quadratic curve ($y = ax^2 + bx + c$) for the data, press $\boxed{\begin{matrix} \oplus \\ \ominus \end{matrix}} \boxed{\begin{matrix} \oplus \\ \times \end{matrix}} \boxed{\begin{matrix} \ominus \\ \oplus \end{matrix}}$ **STAT**, touch **D REG**, double touch **04 Rg x²**, and press **ENTER**.
- To view the overlay of the regression curve and the scatter diagram, press **Y=** **CL** **VAR**, touch **H STAT**, press **ENTER**, touch **B REGEQN**, double touch **1 RegEqn**, and press **GRAPH**. The following overlay will be displayed.



Model of best fit

- Notice, the r^2 value for the quadratic regression model is about .9337.
- Whereas the r^2 value for the exponential regression model was .9786.
- The exponential regression model (with the r^2 value closer to 1) is considered the better-fitting model. The exponential regression model even fits better than the linear model with an r^2 value of .8553.
- Continue this analysis with other regression models.

9.3

OTHER REGRESSIONS

Use the data from Blackline Master 9.1.

Activity 1 Calculate the common logarithm regression model.

1. $Y = a + b \log X =$ _____
2. $r^2 =$ _____
3. Sketch the scatter diagram and regression line overlay.



Activity 2 Calculate the power regression model.

1. $Y = a \cdot X^b =$ _____
2. $r^2 =$ _____
3. Sketch the scatter diagram and regression line overlay.



9.4

OTHER REGRESSIONS AND MODEL OF "BEST FIT"

Use the data from Blackline Master 9.1.

Activity 3 Calculate the inverse regression model.

1. $Y = a + bX^{-1} =$ _____
2. $r^2 =$ _____
3. Sketch the scatter diagram and regression line overlay.



Activity 4 Which regression model fits the best?

1. r^2 for linear regression = _____
2. r^2 for quadratic regression = _____
3. r^2 for exponential regression = _____
4. r^2 for common logarithm regression = _____
5. r^2 for power regression = _____
6. r^2 for inverse regression = _____
7. Which model fits the best according to r^2 ? _____
8. Which model fits the best graphically? _____

10.1

STATISTICAL TESTS

Steps for performing a one-small-sample hypothesis test for the population mean

- Turn the calculator on and access the data entry screen. Delete old data and enter the following data set for L1:

7	10	7	6	8	10	15	14	11
12	6	11	11	5	7	9	9	7
- Check the data you have entered and correct any errors you may find. The data shown above reflects the number of wins for the Chicago Bears in each season since 1978.
- Test the alternate hypothesis that "da Bears" are a winning football team against the null hypothesis that "da Bears" are merely a .500 ball club (8 wins).
- Set up the statistical test by pressing **2ndF** **QUIT** **STAT** , touching **E TEST**, and double touching **03 Ttest1samp**.
- Set the alternate hypothesis to $\mu > \mu_0$ by pressing **▶** **▶** **ENTER** .
Set the null hypothesis equal to 8 wins by pressing **▼** **8** **ENTER** .
Set the List to L1 by pressing **2ndF** **L1** **ENTER** .
- Press **2ndF** **EXE** to compute the statistical test.
- The first item on the screen, $\mu_0 > 8$, is the alternate hypothesis of the statistical test. The second item on the screen is the observed statistic from the sample. The third item on the screen is the decision statistic or p value.
- The p value is .0482, which is less than .05. Our decision is to reject the null hypothesis that $\mu_0 = 8$ and support the alternate hypothesis that $\mu_0 > 8$. This test clearly shows that "da Bears" average more than 8 wins a season and thus are a winning football team. The fourth item shows that on the average, "da Bears" win approximately 9 games a season.

10.2

STATISTICAL TESTS

Steps for performing a two-small-sample hypothesis test for the population means

1. Access the data entry screen and enter the additional data for L2.

(Use the Bears data from 10.1):

L2 Packers	8	5	5	8	8	8	8	4	5
	4	10	6	4	9	9	9	11	13

2. Check the data you have entered and correct any errors you may find.

The data shown above reflects the number of wins for the Chicago Bears and Green Bay Packers in each season since 1978. Test the alternate hypothesis that "da Bears" are a better (on the average win more games) football team than the Packers during these recent years.

3. Set up the statistical test by pressing $\boxed{2\text{ndF}}$ $\boxed{\text{QUIT}}$ $\boxed{\text{STAT}}$, touching **E TEST**, and double touching **04 Ttest2samp**.

4. Set the alternate hypothesis to $\mu_1 > \mu_2$ by pressing $\boxed{\blacktriangleright}$ $\boxed{\blacktriangleright}$ $\boxed{\text{ENTER}}$. Pool the standard deviations in the calculation by pressing $\boxed{\blacktriangledown}$ $\boxed{\blacktriangleright}$ $\boxed{\text{ENTER}}$. Set the List1 to L1 by pressing $\boxed{\blacktriangledown}$ $\boxed{2\text{ndF}}$ $\boxed{\text{L1}}$ $\boxed{\text{ENTER}}$. Set List2 to L2 by pressing $\boxed{2\text{ndF}}$ $\boxed{\text{L2}}$ $\boxed{\text{ENTER}}$. Press $\boxed{2\text{ndF}}$ $\boxed{\text{EXE}}$ to compute the statistical test.

5. The first item on the screen, $\mu_1 > \mu_2$, is the alternate hypothesis of the statistical test. The second item is the observed statistic from the sample. The third item is decision statistic or p value. In our problem, the p value is .0323 which is less than .05. Our decision is to reject the null hypothesis that $\mu_1 = \mu_2$ and support the alternate hypothesis that $\mu_1 > \mu_2$. This test clearly shows that "da Bears" average more wins a season than the Packers and thus are a better football team. The fifth and sixth values show on the average, "da Bears" win approximately 9 games a season, whereas the Packers win 7.

10.3

STATISTICAL TESTS

Activity 1 Perform a one-small-sample hypothesis test for the population mean.

The amount of money spent by 12 randomly selected customers at a supermarket is provided below. Enter the data in L1 and test the alternate hypothesis that the average spent is more than \$75.

98	79	151	38	116	55
42	61	88	64	120	93

Alternate hypothesis is _____

$p =$ _____

Decision is to _____ the null hypothesis that $\mu_0=75$.

Activity 2 Perform a two-small-sample hypothesis test for the population means.

The time in minutes to assemble a product using two different procedures is provided below. Enter Procedure 1's times into L1 and Procedure 2's times into L2. Test the alternative hypothesis that Procedure 1 provides higher times than Procedure 2. Pool the standard deviations for the test.

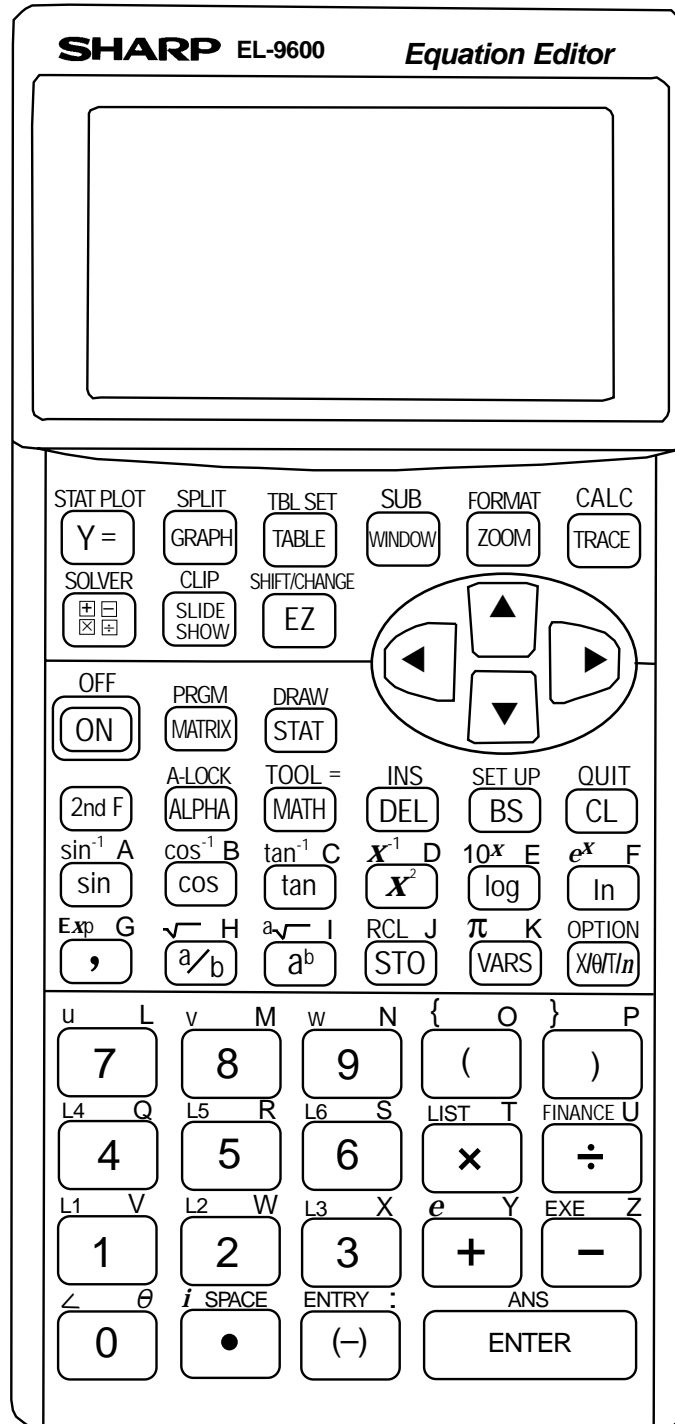
<u>Procedure 1</u>	54	61	58	56	63	52	60
<u>Procedure 2</u>	50	56	56	59	53	47	52

Alternate hypothesis is _____

$p =$ _____

Decision is to _____ the null hypothesis that $\mu_1=\mu_2$.

KEYPAD FOR THE SHARP EL-9600 GRAPHING CALCULATOR



SOLUTIONS TO SELECTED ACTIVITIES

2. NUMERICAL DESCRIPTION OF A ONE-VARIABLE DATA SET

ADDITIONAL PROBLEMS

- 63.9, 6.1, 5.7, 575, 37033, 9, 55, ...
- 4.6, 3.7, 3.7, 205, 1545, 45, 1, ...

BLACKLINE MASTERS 2.3-4

ACTIVITY 1

- 16.3, 2.9, 2.7, 130, 2172, 8, 11, ...

ACTIVITY 2

- 3.48, 1.7, 100, yes

6. NUMERICAL DESCRIPTION OF A TWO-VARIABLE DATA SET

ADDITIONAL PROBLEMS

- 67, 4.8, 4.3, 335, 22539, 5, 62, ...
- 16.4, 1.2, 1.2, 1018, 16804, 62, 15, ...

BLACKLINE MASTER 6.3

ACTIVITY 1

- 15.75, 16.75

ACTIVITY 2

- 3.48, 3.48, yes

7. GRAPHICAL PORTRAYAL OF A TWO-VARIABLE DATA SET

ADDITIONAL PROBLEMS

- Possible questions:
 - When does the per capita glass waste materials begin to decline?
 - What pattern does the per capita glass waste materials seem to follow?
 - Roughly estimate the per capita glass waste materials in the year 1990.
- Possible questions:
 - At which participant's age does the largest increase in time to walk the mile occur?

- As the participant's age increases, what happens to the time it takes the participant to walk one mile?
- Roughly estimate the time a 72 year-old male participant would take to walk the mile?

BLACKLINE MASTER 7.3

ACTIVITY 1

- increases
- a line
- 136 pounds

8. LINEAR REGRESSIONS

ADDITIONAL PROBLEMS

- $y = -.6x + 103.1$
- $y = 1.006x - 1410.4$

BLACKLINE MASTER 8.3

ACTIVITY 1

- $y = 1.02x + 11.86$
- .992

ACTIVITY 2

- $y = .03x + 41.858$
- .0607

9. OTHER REGRESSIONS AND MODEL OF BEST FIT

ADDITIONAL PROBLEM

The best fitting regression model (excluding the cubic and quartic models because the addition of additional predictors will always increase r^2) is the quadratic model of $Y = -.07x^2 + 9.26x - 240.52$ with a r^2 value of .6254. The remaining models and corresponding r values were:

exponential	.4997
natural exponential.	.4997
power	.4793
linear	.4788
natural log	.4601
base ten log	.4601
inverse	.4411

BLACKLINE MASTER 9.3

ACTIVITY 1

1. $y = -37.15 + 51.55 \log x$
2. .693

ACTIVITY 2

1. $y = 1.91X.8413$
2. .896

BLACKLINE MASTER 9.4

ACTIVITY 3

1. $y = 51.46 - 273.69 X^{-1}$
2. .522

ACTIVITY 4

1. .8553
2. .9337
3. .9786
4. .6933
5. .8961
6. .5221

7. exponential

10. STATISTICAL TESTS

ADDITIONAL PROBLEMS

1. $\mu = 5, \mu < 5, t = -2.05, p = .027, \text{support } \mu < 5$
2. $\mu_1 = \mu_2, \mu_1 > \mu_2, t = 1.26, p = .115, \text{support } \mu_1 = \mu_2$

BLACKLINE MASTER 10.3

ACTIVITY 1

$\mu = 75, \mu > 75, t = .889, p = .196, \text{support } \mu = 75$

ACTIVITY 2

$\mu_1 = \mu_2, \mu_1 > \mu_2, t = 2.07, p = .031, \text{support } \mu_1 > \mu_2$

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