Connecting Algebra and Biology Using Graphing Calculators

Activities Using the TI-83 and Casio 9850 G Plus

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COMMONWEALTH OF VIRGINIA
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Correlation of Activities to SOL

Introduction

The *Connecting Algebra and Biology Using Graphing Calculators* resource document is intended to assist classroom teachers of algebra and biology in implementing the Virginia Standards of Learning for mathematics and science. This resource document includes a sampling of activities that have been correlated to the Standards of Learning for Algebra I, Algebra II, and Biology. Where appropriate, activities have also been correlated to Standards of Learning for other grade levels or courses.

The purpose of this resource document is to enhance the implementation of the Mathematics and Science Standards of Learning, especially in algebra, biology, data analysis, applications, and technology. The content of the activities focuses on algebra, statistics, and data analysis with applications from biology. The activities require students to use graphing calculators, data collecting devices, and/or scientific probes to investigate and solve problems. The scientific investigations require the use of algebra and data analysis. Thus, students will learn connections between algebra and biology content while solving application problems and using the technology required in the Standards of Learning.

The activities in this resource document were field tested and edited by classroom teachers. Each activity has been written for use with both the Texas Instruments-(TI) 83 and the Casio 9850 G Plus graphing calculators. The document also includes activities for use with the following scientific probe kits that interface with the graphing calculators: Texas Instruments Calculator-Based Laboratory (CBL) and the Casio EA-100 Data Analyzer. A special section includes activities written by classroom teachers of algebra and biology during a Connecting Algebra and Biology summer institute, which was sponsored by the Virginia Department of Education in 1997. Contributing teachers' names are listed on the activities.

To assist teachers who have had limited training or experience in using graphing calculators, operating procedures for the TI-83 and Casio 9850 G Plus graphing calculators are included in the appendix. These instructions are not intended to be comprehensive. They are intended as a starting point for teachers who want to begin immediately using the activities. The instructions focus on the data analysis procedures that the activities require.

The materials in this document may be duplicated and distributed as desired for use in Virginia. The Virginia Department of Education will provide school divisions with additional information to be included in this document as other resources are identified. School divisions are also encouraged to add appropriate activities and resource materials to this document.

The *Connecting Algebra and Biology Using Graphing Calculators* resource document is being provided to school divisions through an appropriation from the General Assembly and in accordance with the Virginia Department of Education's responsibility to develop and pilot model teacher, principal, and superintendent training activities geared to the Standards of Learning content and assessments, and to technology applications.

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Foxes and Rabbits

Related SOL: BIO.1, BIO.5, BIO.8, BIO.9, and A.5

Overview

Predators are organisms that feed upon other living things called **prey.** The effect of this interaction on the health and welfare of both the predator and prey populations can be seen in this representative simulation. The simulation will use a fox to represent the **predator** and rabbits to represent the **prey.**

Problem Statement

How does the predator / prey relationship affect the growth of each population?

Material

masking tape	fox (1 large weighted square)
meter stick	data chart
rabbits (300 small squares)	graphing calculator

Procedure and Data

What is your prediction (hypothesis) about the predator-prey relationship?

1. Construct a square that is 70 centimeters on each side on a tabletop using masking tape to mark the boundaries. This is your woodland.

2. Use the chart provided to record your data. A suggestion to simplify recording procedures is to keep tally marks on a separate piece of paper until all foxes of a generation are tossed, and then enter the numbers on the data chart.

3. Generation 1 consists of three rabbits and one fox.

4. Toss three rabbits into the square (your woodland).

5. Stand one meter from the table. Toss the fox into the large square. Each toss will represent one fox. Try to land on as many rabbits as possible. After the fox lands, any rabbit it touches will be considered captured. Count the captured rabbits and remove them.

6. Tally the following information based on the number of rabbits captured:

   - ✓ Tally the number of captured rabbits.

   - ✓ If the fox catches fewer than three rabbits, it starves to death. Place a tally mark in the fox starvation column.

   - ✓ If the fox catches three or more rabbits, place a tally mark in the fox survival column.

   - ✓ Determine the number of offspring produced by your fox by dividing the number of rabbits captured by 3. Record only the whole number of offspring with a tally mark in the fox birth column; DO NOT ROUND. For example, six, seven, or eight rabbits captured by one fox will support fox offspring.

   - ✓ Determine the number of rabbits and foxes for the next generation.

   - ✓ To calculate the number of foxes that will make up your next generation, add the fox survival and fox birth columns. Enter this data in the start column of the next generation.

   - ✓ If zero foxes are left to begin the next generation, a new fox moves in from a new woodland, so enter “1” in the start column of the next generation.

   - ✓ Calculate the number of rabbits remaining by subtracting the rabbits captured column from the rabbit start column. Enter this number in the rabbits remaining column.

- ✓ Each rabbit remaining will produce an average of two offspring. To calculate the number of rabbits that will make up the next generation, multiply the number of remaining rabbits by “3”. This will account for the current generation’s rabbits that survive, as well as their offspring. For example, if 4 rabbits remained after all of the foxes were tossed, your next generation will begin with 12 rabbits, since 4 x 3 = 12. Enter your result in the start column of the next generation.

- ✓ The woodland vegetation can support no more that 300 rabbits. If your rabbit population reaches or exceeds 300, enter “300” in the rabbit start column of the next generation.

- ✓ If zero rabbits are left to begin the next generation, a new rabbit family moves into the woodland, so enter “1” in the start column of the next generation.

7. Determine the start values for generations 1 through 7. Stop here for data interpretation.

   Refer to the CASIO or TI information now.

8. Now repeat the activity for generations 8 through 14.

   Refer to the CASIO or TI information now.

Analysis:

1. Compare the actual model to the predictions for generations 8, 11 and 14. How are they similar or different?

   Similarities *Differences*

   ________________________ ________________________

   ________________________ ________________________

2. What do you think would be the population of rabbits and foxes after 20 generations? _____________ 30 generations? _____________

3. Name two reasons for the differences.

   a. ______________________ b. __________________________

4. What do you think would happen to the rabbit population if all the foxes were trapped for their fur? Name at least two things.

   a. ____

   b. ____

5. What do you think would happen to the fox population if the rabbits caught a lethal disease such as pneumonia? Name at least two things.

   a. ____

   b. ____

6. Why do you think the population graph fluctuates?

7. What other factors may affect the balance of each population? Name at least three.

   a. __________________ b. __________________ c. ___________________

8. If you were a chicken and vegetable farmer, write a short essay to explain why you would or would not support a bounty on foxes in your area. Be sure to state both pros and cons to your argument.

CASIO 9850 G+ Graphing Information

1. On your graphing calculator, plot the starting populations of rabbits and foxes using one symbol for rabbits and another for foxes.

Go to STAT Mode (#2). Make sure to clear all previous lists.

Enter into List 1 the generation numbers, 1 through 14. Enter into List 2 the starting number of rabbits for each of the 7 generations you have calculated thus far. Enter into List 3 the starting number of foxes for each of the 7 generations you have calculated thus far.

Press F1 (GRPH). Press F6 (SET). Set StatGraph1 as a scatter plot for the rabbits. Highlight Graph Type, and press F1 (Scat). Highlight XList, and press F1 (List 1). Highlight YList, and press F2 (List 2). Highlight Frequency, and press F1 (1). For the last two settings, make your own choices. Just remember what your choices were so that you make different choices when making a scatter plot for the foxes. Press the EXE key.

Press F6 (SET). Press F2 (GPH2). Set StatGraph2 as a scatter plot for the foxes. Highlight Graph Type, and press F1 (Scat). Highlight XList, and press F1 (List 1). Highlight YList, and press F3 (List 3). Highlight Frequency, and press F1 (1). For the last two settings, make your own choices keeping in mind that you want a different mark type and graph color than what you chose for the rabbit scatter plot. Press the EXE key.

Press F4 (SEL). To compare the scatter plot for the rabbits and the scatter plot for the foxes, StatGraph1 and StatGraph2 must both say, “DrawOn” and StatGraph3 must say, “DrawOff”. Press F6 (DRAW). Utilize the Trace function to help you analyze the data. To do this, press the yellow SHIFT key and then F1 (Trace). Use the up and down arrow keys to go back and forth between the data of the different scatter plots. Use the left and right arrow keys to trace the data along each scatter plot.

2. From the graphs, make some predictions for the populations of generations 8, 11, and 14.

   Go to STAT Mode (#2). Finish inputting your rabbit data into List 2 and your fox data into List 3. Press F1 (GRPH). Press F4 (SEL). Make sure StatGraph1 and StatGraph2 are on, and StatGraph3 is off. Press F6 (DRAW).

TI-83 Graphing Information

Note: Refer to the **Getting Started Setup Procedures** to ensure the calculators have functions and STAT PLOTS cleared or turned off, STAT Editor Setup and Defaults set for Mode and Window Format.

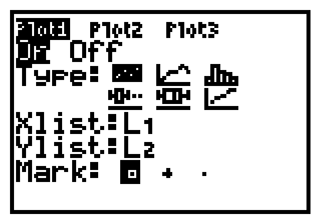
Data Entry

1. **Enter the information from your data table into the lists.**
   L_1 will hold the Generation number.
   L_2 will hold the Starting Rabbit Population for each generation.
   L_3 will hold the Starting Fox Population for each generation.

- Go to the STAT Editor
  1. Press STAT
  2. Select 1:Edit
- Key the values for the first seven generations from the activity sheet into the lists as described in #1 above.

2. Set up a STAT PLOT for RABBITS

- This will be a scatter plot of (generation, population)
  The generation number is the independent variable. It is in L_1.
  The starting population of rabbits is the dependent variable. It is in L_2.
- Press 2nd STAT PLOT
- Press ENTER to select 1:Plot1
- Press ENTER to select ON
- Press cursor down arrow
- Press ENTER to select the scatter plot picture

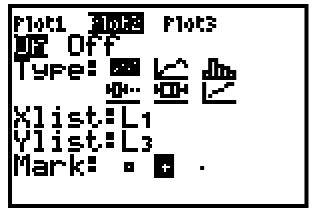


- Press the down arrow
- Set the Xlist and Ylist if they are not correct
- Press 2nd L_1
  (this is the number 1 key)
- Select whichever Mark you prefer
  Generally the box or + are best if there are not a lot of data points. The dot is best if there are a large number of data points.

Repeat the process described for the rabbits but this time make the mark different. Use the + for the foxes.

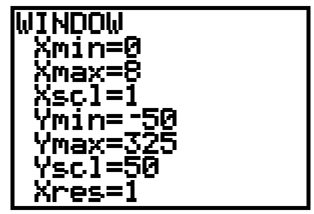
3. Set up a STAT PLOT for foxes

- This will be a scatter plot of (generation, population)
  The generation number is the independent variable. It is still L_1.
  The starting population of foxes is the dependent variable. It is in L_3.
  Make Xlist: L_1
  Ylist: L_3



- Press 2^{nd} STAT PLOT
- Press 2 to select 2:Plot2
- Press ENTER to select ON
- Down arrow to select Type
- Press ENTER to select the scatter plot picture.
- Press the down arrow
- Set the Xlist: L_1 ; Ylist: L_3
- Select a different Mark so you will be able to distinguish the graphs.

There should be two STAT PLOTS turned on. The STAT PLOTS screen shows this status.



4. Establish a viewing window for the graph.
   - Press WINDOW
     There are 7 generations with between 1 and 300 rabbits
     Set the min and max values accordingly.
   - Press GRAPH

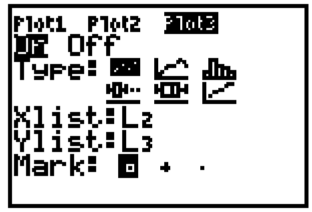
5. Return to the activity sheet for data interpretation and to gather more data.

6. Extend the graph to include generations 1 – 14.
   - Add the additional data for generations 8 – 14 into the Lists L_1, L_2 and L_3.
   - Increase Xmax to include 14 generations.

7. Activity Sheet Conclusion:

In considering the predator-prey relationship it is interesting to view the graph of the rabbit population vs the fox population.

Turn off the previous Plots



- Press 2nd STAT PLOT
- Press 4: PlotsOff

This will paste the command to the home screen

- Press ENTER to execute the command.
- Press 2nd STAT PLOT to return to the STAT PLOT menu.

- Select 3:Plot3
- Set it up as shown.
- Set the Xlist: L_2 ;Ylist: L_3.
- Fix the WINDOW for a different Xlist, values between 0 and 300.
- Press GRAPH.

Punnett Squares using Matrices

Related SOL: BIO.1, BIO.6, and A.4

Overview

Punnett squares are powerful tools that help biologists determine possible phenotypes and genotypes of offspring given the genotypes of the parents. A matrix can be used to simulate a Punnett square.

In genetics, letters are used to represent alleles; a capital letter represents the dominant allele and the corresponding lower case letter represents the recessive allele. In mathematics, data in a matrix must ultimately be in the form of a number. To bridge this gap, we must assign a value to each allele. For this activity, use the following definitions:

Dominant	Recessive
Q = 2	q = 1

This activity will use three column matrices to represent the possible genotypes of one of the parents in a test cross and three row matrices to represent the possible genotypes of the other parent. The 2 x 2 square matrix will be generated by multiplying (crossing) a column matrix by a row matrix. The resulting matrix simulates the result of a Punnett square and will be used to determine the possible genotypes and phenotypes of the offspring.

Procedure

1. Matrices [A], [B], and [C] will represent one parent. This will be the parent associated with the left side of the Punnett square; therefore, these matrices need to be column matrices. Dimension these matrices to be 2 x 1.

2. Matrices [D], [E], and [F] will represent the other parent. This will be the parent associated with the top of the Punnett square; therefore, these matrices need to be row matrices. Dimension these matrices to be 1 x 2.

3. To determine what data should be entered into each matrix consider the following:

   [A] and [D] will represent a parent that is homozygous, dominant for the trait;
   [B] and [E] will represent a parent that is heterozygous for the trait; and
   [C] and [F] will represent a parent that is homozygous, recessive for the trait.

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Enter the appropriate data into each matrix.

- Remember: Dominant alleles should receive a number value of 2, and recessive alleles should receive a number value of 1.

Refer to the CASIO and TI Information now.

4. Perform the indicated test crosses by multiplying the column matrix by the row matrix. Record your results below:

Trial 1: [A] x [D]   Trial 2: [A] x [E]   Trial 3: [A] x [F]

Trial 4: [B] x [D]   Trial 5: [B] x [E]   Trial 6: [B] x [F]

Trial 7: [C] x [D]   Trial 8: [C] x [E]   Trial 9: [C] x [F]

Analysis

1. It is important to remember that the numbers returned by the product of the matrices represent one pair of alleles. Each different number represents a different genotype. Considering all the trials performed in this lab, how many different genotypes are possible for the offspring? List them.

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2. Even though the genotypes given by the matrix multiplication is a single number, you should think of it as the product of two numbers. For each of the listed genotypes from question 1, express the results in terms of the alleles Q and q.

3. If we considered the allele Q to express **complete dominance** over q, how many different phenotypes could be expressed? (Again, consider all trials!)

4. Develop a simple rule that you could use to quickly decide the phenotype of a certain offspring given by the matrix multiplication.

5. How would the answer to question 3 change if the alleles express **incomplete dominance**? Explain.

6. Which crosses would produce offspring that had only one possible genotype? What must be true about the genotypes of the parents for this to occur?

7. Which crosses would produce offspring that had two possible genotypes? What must be true about the genotypes of the parents for this to occur

8. Which crosses would produce offspring that had more than two possible genotypes? What must be true about the genotypes of the parents for theis to occur?

9. Which crosses would produce offspring that had only one possible phenotype? What must be true about the genotypes of the parents for this to occur?

10. Which crosses would produce offspring that had two possible phenotypes? What must be true about the genotypes of the parents for this to occur?

Extension

Experiment with other number definitions for Q and q. Can you find a number combination that could be used to show only the phenotypes? That is, find a combination of numbers in which the results of the matrix multiplication would give the same value for homozygous, dominant and heterozygous offspring and a different value for homozygous, recessive offspring.

CASIO 9850 G+ Information

- Go to Mat Mode (#3). Make sure all six of the matrices are cleared. To do this press F2 (DEL-A), then press F1 (YES).

- Mat A should be highlighted. Press the number 2, then EXE. Press the number 1, then EXE. The screen should now depict matrix A as having dimensions of 2 x 1. No data should be inputted into the matrix yet. Press EXIT. Repeat these steps to make matrices B and C have dimensions of 2 x 1.

- Mat D should be highlighted. Press the number 1, then EXE. Press the number 2 then EXE. The screen should now depict matrix D as having dimensions of 1 x 2. No data should be inputted into the matrix yet. Press EXIT. Repeat these steps to make matrices E and F have dimensions of 1 x 2.

- Highlight Mat A. Press EXE. This matrix represents a parent that is homozygous, dominant; therefore, we must input two dominant alleles. Press the number 2, then EXE. Press the number 2, then EXE. Press EXIT. Repeat these steps to input the correct alleles for each matrix.

- Go to Run Mode (#1). Press OPTN key. Press F2 (MAT). Press F1 (Mat). The word "Mat" should now be visible at the top of the screen.

- Press the red ALPHA key, then press the X,Θ,T key located below the red ALPHA key. "Mat A" should now be seen at the top of the screen.

- Press the multiplication symbol located under the DEL key. Press F1 (Mat). Press the red ALPHA key, then press the "sin" key located under the EXIT key. The screen should now read: "Mat A x Mat D". This means we are multiplying the contents of matrix A with the contents of matrix D. Press EXE to get your answer. Notice the answer is in the form of a square matrix. Press the EXIT key to return to the previous screen. Complete the rest of the test crosses.

TI-83 Information

Procedure for entering data into a matrix:

MATRIX A

- Press the MATRX key
- Press the right arrow key twice to highlight EDIT
- Matrix A is highlighted. Press ENTER
  The cursor is blinking on the row dimension, press 2 and then the Enter key.
  The cursor is blinking on the column dimension, press 1 and then the ENTER key.
  Enter the data into the matrix, 2 ENTER; 2 ENTER
- Press 2nd MODE to Quit.
  This must be done after each matrix entry.

MATRIX B

- Press the MATRX key
- Press the right arrow key twice to highlight EDIT
- Press the down arrow key to highlight Matrix B. Press ENTER
  The cursor is blinking on the row dimension, press 2 and then the Enter key.
  The cursor is blinking on the column dimension, press 1 and then the ENTER key.
  Enter the data into the matrix, 2 ENTER; 1 ENTER
- Press 2nd MODE to Quit.
  This must be done after each matrix entry.

MATRIX C

- Press the MATRX key
- Press the right arrow key twice to highlight EDIT
- Press the down arrow key to highlight Matrix C. Press ENTER
  The cursor is blinking on the row dimension, press 2 and then the Enter key.
  The cursor is blinking on the column dimension, press 1 and then the ENTER key.
  Enter the data into the matrix, 1 ENTER; 1 ENTER
- Press 2nd MODE to Quit.
  This must be done after each matrix entry.

MATRIX D

- Press the MATRX key
- Press the right arrow key twice to highlight EDIT
- Press the down arrow key to highlight Matrix D. Press ENTER
  The cursor is blinking on the row dimension, press 1 and then the Enter key.
  The cursor is blinking on the column dimension, press 2 and then the ENTER key.
  Enter the data into the matrix, 2 ENTER; 2 ENTER
- Press 2nd MODE to Quit.
  This must be done after each matrix entry.

MATRIX E

- Press the MATRX key
- Press the right arrow key twice to highlight EDIT
- Press the down arrow key to highlight Matrix E. Press ENTER
  The cursor is blinking on the row dimension, press 1 and then the Enter key.
  The cursor is blinking on the column dimension, press 2 and then the ENTER key.
  Enter the data into the matrix, 2 ENTER; 1 ENTER
- Press 2^{nd} MODE to Quit.
  This must be done after each matrix entry.

MATRIX F

- Press the MATRX key
- Press the right arrow key twice to highlight EDIT
- Press the down arrow key to highlight Matrix F. Press ENTER
  The cursor is blinking on the row dimension, press 1 and then the Enter key.
  The cursor is blinking on the column dimension, press 2 and then the ENTER key.
  Enter the data into the matrix, 1 ENTER; 1 ENTER
- Press 2^{nd} MODE to Quit.
  This must be done after each matrix entry.

To perform an operation

- Press the MATRX key
- Press the down arrow key to highlight the Matrix desired.
- Press ENTER
  This places the matrix on the main screen.
- Press the multiplication key.
- Press the MATRX key
- Press the down arrow key to highlight the second matrix
- Press ENTER
  This places the second matrix on the screen.
- Press ENTER
  The answer matrix shows on the screen.

How Big Is That Cell?

Related SOL: BIO.4, BIO.6, and A.5

Overview

The simplest organisms are unicellular. When conditions are appropriate (adequate food, water, O_2) these organisms are abundant, and a strong **SELECTIVE PRESSURE** for size exists. A large organism can eat more of its neighbors and be eaten by fewer. A single cell is limited as to its maximum size because as it gets bigger the distance from the center to the outside increases and raw material/waste products cannot move between the external environment and the cell's interior fast enough.

As the size increases, the ratio of volume:surface area decreases meaning that each unit volume of cytoplasm gets a smaller amount of supplies per unit time. Hence, your somatic cell (a typical body cell) generally enters mitosis and cytokinesis (nuclear and cytoplasmic division) to retain the optimal size: volume ratio.

Procedure

This activity will examine the ratio of surface Area: Volume as the size of the cell increases. A cube-shaped cell will be assumed for simplicity.

The formula for the volume of a cube is $V = s^3$, where V is the volume and s is the length/width/depth of a side. The formula for a surface area of a cube is $A = 6s^2$, where A is the area and s the length of a side.

Refer to the CASIO or TI-83 information now.

TI-83 Graphing Information

To compare how the volume would compare to the surface area on a graph:

Note: Refer to the **Getting Started Setup Procedures** to ensure the calculators have functions and STAT PLOTS cleared and turned off, STAT Editor Setup and Defaults set for Mode and Window Format.

1. Press **Y=** and enter the equations Y_1 = X^ 3 and Y_2 = 6X^2

2. Press **WINDOW.** Xmin=0, Xmax=5, Xscl=1, Ymin=0, Ymax=100, Yscl=10. Ignore the Xres.

3. Press **GRAPH.** Draw the shape of the two lines - be sure to label them as surface area or volume.

4. Press **TRACE** to look at the curves individually (moving the <--- or --> arrow keys will move from one graph to another). Which increases first?

   ____

   Which has the fastest RATE of increase overall?

   ____

5. Clear all the **Y=** formulas.

6. Press **2nd,** then **QUIT**. The calculator is now back to its regular math mode. Use the calculator to complete the following data table for surface area (x) and volume (y). Use s = side.

Side	0	0.5	1	1.5	2	2.5	3	3.5	4
Surface Area (x)									
Volume (y)									

7. Set up a STAT PLOT of (surface area, volume):
   - Press second STAT PLOT
   - Press ENTER to select 1:Plot1
   - Press ENTER to select ON
   - Press cursor down arrow
   - Press ENTER to select the scatter plot picture
   - Press the down arrow
   - Set the Xlist and Ylist if they are not correct
   - Select any Mark

8. Press **WINDOW** to reset the range - Xmin=0, Xmax=150, Xscl=10, Ymin=0, Ymax=100,Yscl=10. Explain why it was necessary to reset the range? ____

9. Press **GRAPH.** This will show the relationship between the surface area and volume for the data. Remember that x = S.A. and y = V. Make the graph below and label the coordinates - SA or Vol

10. To determine the line of best fit:
    - Press VARS, STAT, move over to EQ and press 7 (this determines the r value)
    - Press 2^{nd}, Quit, STAT, move to CALC, press 3 Med-Med
    - Press ENTER twice to obtain the information for the following questions:

      a. Write out the equation for y= ________________________

      b. What does r equal? _________________ (to 2 decimal places)

      c. What does r represent?
      ____

      d. What is the slope for this equation? _____________________
      (to 2 decimal places)

11. To draw the line on the scatter plot:
    - Press Y=, VARS, scroll to #5, ENTER
    - Press the right arrow key twice, ENTER
    - Press Graph

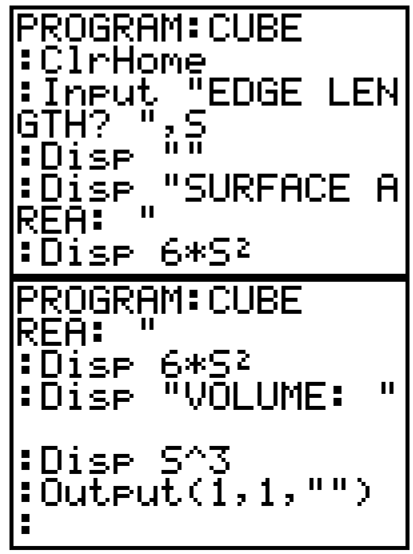
12. Look carefully at the graph and the data in #10. What increases faster: surface area or volume? __________

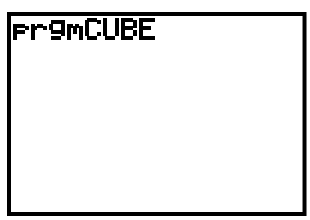
TI-83 Program Information

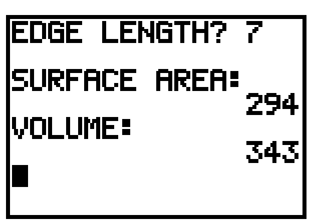
Two programs can be entered into the TI-83 calculator which will be useful with this lab.

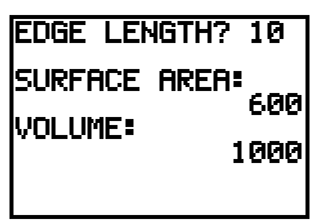
The first will prompt the user for the side length of a cube. It will then calculate and print the Surface Area and Volume of the Cube.

```
PROGRAM:CUBE
:ClrHome
:Input “EDGE LENGTH? “, S
:Disp “”
:Disp “SURFACE AREA: “
:Disp 6*S²
:Disp “VOLUME: “
:Disp S^3
:Output (1,1,””)
```



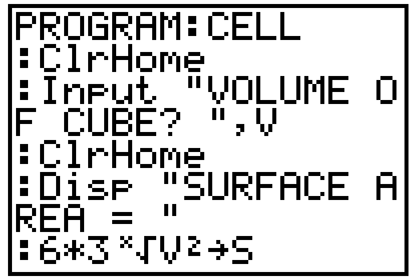


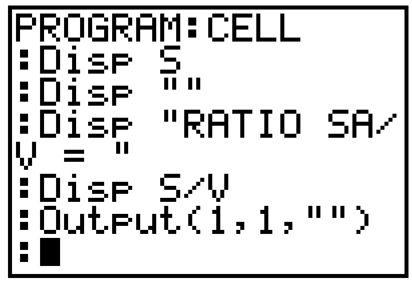


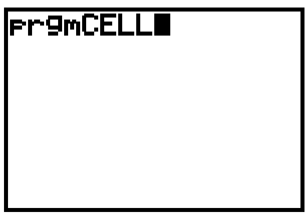


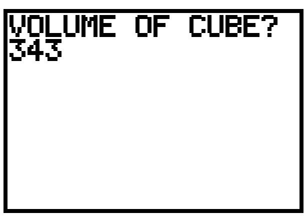
The second will prompt the user for the Volume of the Cube. It will then compute and display the Surface Area and the ratio of the Surface Area to the Volume.

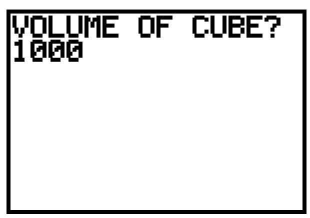
PROGRAM:CELL
```
:ClrHome
:Input "VOLUME OF CUBE? ",V
:ClrHome
:Disp "SURFACE AREA = "
:6*3ˣ√V²→S
:Disp S
:Disp ""
:Disp "RATIO SA/V = "
:Disp S/V
:Output (1,1,"")
```

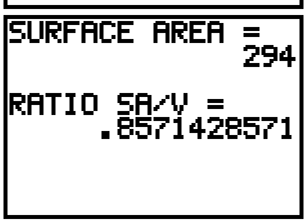


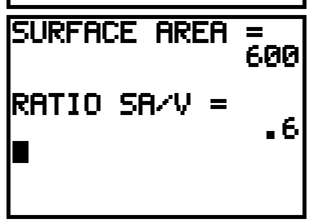












CASIO 9850 G+ Graphing Information

To enter the equations y = x^3 and y = 6x^2 into the graphing calculator:

Go to GRAPH Mode (#5)

- Press the X,Θ,T key located below the red ALPHA key. Press the ^ key located beneath the VARS key.
- Press the number 3. Press the EXE key. The formula for volume of a cube has now been entered.
- Press the number 6. Press the X,Θ,T key located below the red ALPHA key. Press the ^ key located beneath the VARS key.
- Press the number 2. Press the EXE key. The formula for surface area of a cube has now been entered.
- Press the SHIFT key. Press F3 (V-Window). Set the viewing window as follows: Xmin = 0, Xmax = 5, Xscale = 1, Ymin = 0, Ymax = 100, and Yscale = 10. Press the EXIT key.
- Press F6 (DRAW).

1. Describe the shape of the two curves.

2. Which increases faster, the area or the volume?

Complete the following data table for the surface area (x) and volume (y) of a cube over the range 0 to 4.5.

Side	0	0.5	1	1.5	2	2.5	3	3.5	4	4.5
Surface Area (x)										
Volume (y)										

The data table can easily be filled in by putting a program into the RUN Mode (#1) of the graphing calculator.

Extension

1. Enter the ordered pairs (x,y) = (surface area, volume) into a two-variable statistical data set within your graphing calculator.

2. Use the graphing calculator to draw a scatter plot in a range of Xmin = 0, Xmax = 150, Xscale = 10, Ymin = 0, Ymax = 100, and Yscale = 10.

3. Find the best fitting line for the data points (linear regression). Write the equation below.

   Y = ___________________________ r = ___________________________

4. What is the slope of the line?

5. What is the significance of this value?

6. Looking at the data, which increases most rapidly, the volume or the area?

CASIO 9850 G+ Program Information

Go to RUN Mode (#1).

Press the yellow SHIFT key. Press the VARS key. This is the PRGM screen.

- Press F4 (?). Press the send to arrow key (→) located above the AC/ON key.
- Press the red ALPHA key. Press the multiplication symbol (x).
- Press F6 (ω).
- Press F5 (**:**).
- Press the red ALPHA key. Press the multiplication symbol (x).
- Press the ^ key located below the VARS key.
- Press the number 3.
- Press F6 (ω).
- Press F5 (ψ).
- Press the number 6. Press the multiplication symbol (x).
- Press the red ALPHA key. Press the multiplication symbol (x).
- Press the ^ key located below the VARS key. Press the number 2.
- Press the EXE key. At this point there should be a question mark below the program you have just inputted.

Input each of the side values from the data chart and the program will calculate the volume first and then the surface area.

- Press the number 0. Press the EXE key.
  This is the volume for a side of 0.
- Press the EXE key. This is the surface area for a side of 0. Continue putting in each side value in order to complete the data chart.

Genetics: What is the Chance?

Related SOL: BIO.1, BIO.6, and A.18

Overview

Genetic problems express the probability that a certain event will occur at any one time. The more things that are introduced into the mix, the less likely it becomes that things will happen as expected.

Back in the 1870's Gregor Mendel, an Austrian monk, noticed patterns between parents and offspring in the sweetpea, *Pisum savium*. These patterns occurred with a degree of regularity. Mendel wondered if these patterns had a mathematical order or predictability to them. All of the sweetpea traits that Mendel studied were ***independent*** or discrete events gene residing on a separate chromosome.

This activity also examines what would happen if Mendel had chosen genes that are ***linked*** together (genes that are located on the same chromosome).

Materials

four coins
clear plastic tape
graphing calculator

Procedure

1. If a coin is tossed fifty times, **predict** how many times it would land on heads and how many times it would land on tails. Enter the data into Table #1.

2. Take one of the four coins. Flip it in the air exactly fifty times. Count the number of times it lands on heads and the number on tails. Complete data table #1.

Data Table #1

Heads		Tails	
Predicted	Actual	Predicted	Actual

3. Take two coins. Flip them at the same time for fifty times. Count the number of times they land head-head, tail-tail, or head-tail. Fill in data table #2.

Data Table #2

head-head	
head-tail	
tail-tail	

4. Take all four coins. Flip the coins at the same time and once again record the results of fifty tosses - 4 heads, 3 heads-1 tail, 2 heads-2 tails, 1 head- 3 tails, and 4 tails. Fill in the data table #3.

Data Table #3

4 heads	
3 heads-1 tail	
2 heads-2 tails	
1 head-3 tails	
4 tails	

Refer to the CASIO or TI-83 Instructions now.

Analysis

1. What was the ratio found in the first experiment? Remember to reduce to lowest possible numbers. **PREDICTED RATIO _______TO________**
ACTUAL RATIO _______TO________

2. What was the ratio found in the second experiment?
_________TO___________TO

3. Express the ratio of the third experiment in terms of whole numbers but in smallest possible numbers.
________TO_________TO_________TO_________TO

4. Were any parts of experiment three's ratio similar or very close? Explain the answer.

5. Compare/contrast the 3 graphs.

Data chart #1 Data chart #2

Data chart #3

5. Would very different ratios be expected if this experiment were done 200 times? Why or why not? Which set of tosses would be more accurate?

CASIO 9850 G+ Graphing Information

Steps for Data Chart 1:

- Press MENU. Go to STAT (#2) icon and press EXE
  To avoid confusion, enter the tails information with the 1 and the heads information with the 2.

- In List1, enter 1 and 2. In List2 enter the number of tails and then the number of heads from Data Chart 1.

- Press F1(GRPH) to graph the information

- Press F6(SET) to set up the graph

Graph Type:	F6, F1(Hist)
Xlist:	F1(List1)
Frequency:	F3(List2)
Mark Type:	Any of the choices
Graph Color:	Any of the choices

- Press EXIT, F4(SEL). Make sure that StaGraph1 is On and the rest are Off.

- Press F6. Highlight pitch and change it to .25. Press EXE.

- Press F6 for DRAW.

Steps for Data Chart 2:

- Repeat the steps for Data Chart 1 **except**

  In List1 enter 1 for 2 tails; 2 for 2 heads; 3 for 1 head-1 tail.

Steps for Data Chart 3:

- Repeat the steps for Data Chart 1 **except**

  In List1 enter 1 for 4 tails; 2 for 4 heads; 3 for 3 heads-1 tail; 4 for 2 heads-2 tails; 5 for 1 head-3 tails.

TI-83 Graphing Information

Note: Refer to the **Getting Started Setup Procedures** to set up your Calculator with the unwanted functions and STAT PLOTS turned off, Lists cleared, proper MODE settings, etc.

Steps for Data Chart 1

Use List1 as the list for heads or tails.

Use List2 as the list for number of occurrences as entered in the data chart.

- Press STAT
- Select 1: EDIT
- Clear List1 and List2
- Enter 1 for heads and 2 for tails into List1
- Enter the number of heads opposite the 1 and the number of tails opposite the 2 into List2

WINDOW Settings:

- Press WINDOW
- Enter Xmin = 0, Xmax = 3, xscl = 1, Ymin = -1, Ymax = 50, Yscl = 5

To Graph

- Press 2nd STAT PLOT
- Press ENTER to select Plot1
- Press ENTER to turn on Plot1
- Press the down arrow key to move the cursor to TYPE
- Press the right arrow key to the 3rd icon for Histogram
- Press ENTER to highlight Histogram.
- Press the down arrow key to move the cursor to Xlist
  The Xlist should be L_1.
  NOTE: L_1 is a 2nd function over the 1 key.
- Press the down arrow key to Freq
  The Freq should be L_2.
  NOTE: L_2 is the 2nd function over the 2 key.
- Press GRAPH to view the histogram
- Press TRACE to trace on the histogram
  The min and max values for each bar as well as the number of entries in that range are given.

Steps for Data Chart 2

Repeat the process for Data Chart 1 with these changes:

- Enter into List1, 1 to represent 2 heads;
  2 to represent 1 head-1 tail; 3 to represent 2 tails

WINDOW Setting:

- Change Xmax to 4

Steps for Data Chart 3

Repeat the process for Data Chart 1 with these changes:

- Enter into List 1, 1 to represent 4 heads;
  2 to represent 3 heads-1 tail; 3 to represent 2 heads- 2 tails;
  4 to represent 1 head- 3 tails; 5 to represent 4 tails

WINDOW Setting

- Change Xmax to 6

WEIGHTS AND DRUG DOSES

Related SOL: BIO. 1, BIO.2, BIO.4, BIO.5, and A.17

Overview

Every day in the newspaper, one can read about bacteria – how they cause disease, how they are used in research, and how they are becoming resistant to our medicines. These tiny ***prokaryotic*** cells are important to all life in many different ways.

Normally, when ***pathogenic*** (disease causing) bacteria enter your body, the various cells of your immune system begin to defend you against this invasion. Some white blood cells (***WBC***) would recognize them as foreign and attempt to surround them and then send out a distress signal to other WBCs, such as macrophages. These cells engulf the bacteria and send out even more specific messages to ***B-cells*** (who produce antibodies) ***and T-cells.*** However, sometimes the immune system is not successful. This is when the doctor tries bringing the patient back to health using available drugs. It is very important that the doctor prescribe not only the correct medicine, but the medicine must be in the correct dose (amount). The dose is usually based upon the size of the individual, but may also include factors such as age and sex.

The drug chart below was prepared by a drug company to help doctors who prescribe ***Tobramycin***, a drug that combats serious bacterial infections such as those of the central nervous system (***CNS***), in life-threatening situations.

Weight (in pounds)	Usual Dosage	Maximum Dosage
88	40	66
99	45	75
110	50	83
121	55	91
132	60	100
143	65	108
154	70	116
165	75	125
176	80	133
187	85	141
198	90	150
209	95	158

Procedure

Refer to the CASIO or TI information now.

1. Plot (weight, usual dosage) and draw a best-fit line.

2. Plot (weight, maximum dosage) on the same axes. Draw a best-fit line.

3. Find the slope for each line. What do they mean and how do they compare?

4. Write the equations of the two lines.

5. Are the lines parallel? Why or why not?

6. Use a graphing calculator to plot {usual dosage, maximum dosage}. Use the calculator to construct a regression line for this data set. How does this line compare to the two lines found in questions 1 and 2?

Applications

1. Find two current newspaper articles that discuss bacteria and drug resistance. You may use on-line services. Summarize each article and provide an accurate bibliography for each article.

2. Explain why it is very important to take medication as it is prescribed. Provide at least three different reasons and be sure to provide a thorough discussion for each reason.

CASIO 9850 G+ Graphing Information

- Go to STAT Mode (#2). Enter the weight into List 1, the usual dosage into List 2, and the maximum dosage into List 3.

- Select F1 (GRPH). Select F6 (SET). Use the down arrow key to highlight Graph Type, and press F1 (Scat). Arrow down to highlight XList, and press F1 (List 1). Arrow down to highlight YList, and press F2 (List 2). Arrow down to highlight Frequency, and press F1 (1). For the settings Mark Type and Graph Color, make your own choices. Press the EXIT key.

- Select F6 (SET). This time select F2 (GPH2). Use the down arrow key to highlight Graph Type, and press F1 (Scat). Arrow down to highlight XList, and press F1 (List 1). Arrow down to YList, and press F3 (List 3). Arrow down to highlight Frequency, and press F1 (1). For the settings Mark Type and Graph Color, make your own choices. Press the EXIT key.

- Select F4 (SEL). StatGraph1 should be highlighted. Make sure it says, "DrawOn" next to it. If not, press F1 (On). Make sure that StatGraph2 and StatGraph3 say, "DrawOff" next to them. If not, press F2 (Off). Press F6 (DRAW).

- Press the EXIT key. Select F4 (SEL). To graph only StatGraph2, when StatGraph1 is highlighted, press F2 (Off). Arrow down to highlight StatGraph2, press F1 (On). Press F6 (DRAW).

- To answer question 6, press the EXIT key. Press F6 (SET), and then F3 (GPH3). Set the Graph Type to Scatter, the XList to List 2, the YList to List 3, and the Frequency to 1. Press the EXIT key. Select F4 (SEL). Make sure that only StatGraph3 is turned on. Press F6 (DRAW). When the graph appears, select F2 for the Median-Median line information. Press F6 (DRAW) to draw the line on the scatter plot.

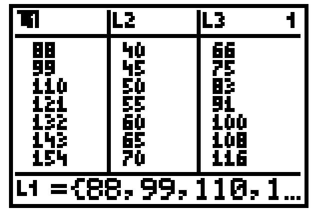
TI-83 Graphing Information

Note: Refer to the **Getting Started Setup Procedures** to ensure the calculators have functions and STAT PLOTS cleared or turned off, STAT Editor Setup and Defaults set for Mode and Window Format.

Data Entry

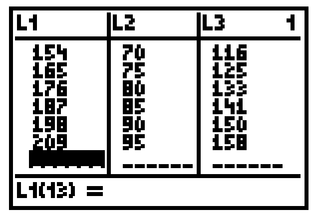
Enter the information from your data table into the lists.

Use L_1 for the Weight (pounds)
Use L_2 for the Usual dosage (mg)
Use L_3 for the Maximum dosage (mg)



1. Press STAT
   Select 1:Edit

2. Key the values from the activity sheet into the lists.

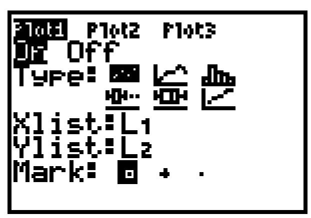


Scatter Plots

Activity Sheet Question #1 Plot (weight, usual dosage)

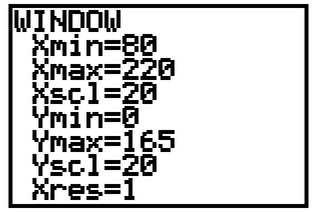
Weight is the independent variable so L_1 (weight) will be the Xlist.
Usual dosage is the dependent variable so L_2 (usual dosage) will be the Ylist.

Set up a STAT PLOT

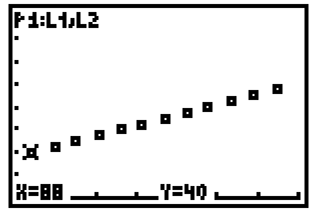


- Press 2nd STAT PLOT
- Press ENTER to select 1:Plot1
- Press ENTER to select ON
- Press cursor down arrow
- Press ENTER to select the scatter plot picture.
- Press the down arrow
- Set the Xlist and Ylist if they are not correct.
  Press 2nd L_1 (this is the number 1 key)
- Select a Mark. Generally the box or + are best if there are not a lot of data points. The dot is best if there are a large number of data points.

Establish Viewing Window



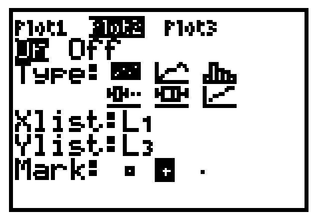
- Press WINDOW
  Xmin must be less than 88
  Xmax must be more than 209
  Xscl is the unit size
  Ymin is less than 40
  Ymax is greater than 158
  Yscl for unit marks on Y-axis
- Press GRAPH
- Press TRACE to see the values of each of the data points



If you would like to see the Y-axis as an aid in choosing the line of best fit, set the Xmin = 0 and Ymin = -20

Activity Sheet Question #2 Plot (weight, maximum dosage)

Weight is the independent variable so L_1 (weight) will be the Xlist.
Maximum dosage is the dependent variable so L_3 (maximum dosage) will be the Ylist.



Set up a STAT PLOT

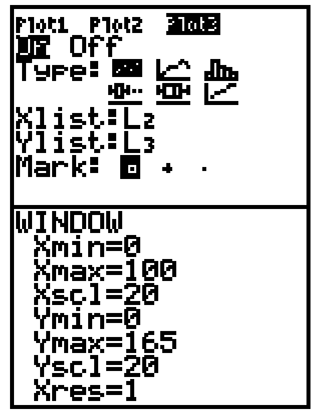
- Press 2nd STAT PLOT
- Press 2 to select 2:Plot2
- Press ENTER to select ON
- Down arrow to select Type
- Press ENTER to select the scatter plot picture.
- Press the down arrow
- Set the Xlist: L_1
  Ylist: L_3
- Select a different Mark so you will be able to distinguish the graphs.
- Press GRAPH

Activity Sheet Question # 6 Plot (usual dosage, maximum dosage)

Turn off the previous Plots

- Press 2^{nd} STAT PLOT
- Press 4: PlotsOff
  This will paste the command to the home screen
- Press ENTER to execute the command

- Press 2^{nd} STAT PLOT to return to the STAT PLOT menu
- Select 3:Plot3
  In this way the other Plots remain available
- Set it up as shown.
- Set the Xlist: L_2 ;Ylist: L_3
- Fix the WINDOW for a different Xlist
- Press GRAPH



Find the Regression line with the calculator

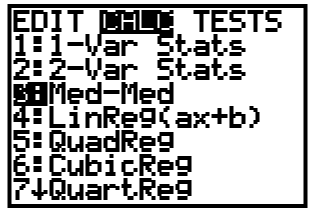
There are three linear regression models available in the TI-83. Med-Med and LinReg (ax+b) are the ones which are normally used. We will use the median-median method.

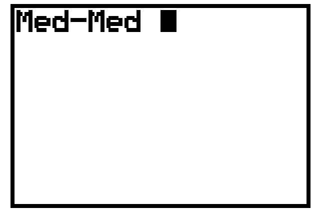
- Press STAT
- Right Arrow to CALC
- Select #3Med-Med

  This pastes the command on the home screen.

  Supply the lists to be used L_2,L_3

  (The comma is the key above the 7 key)

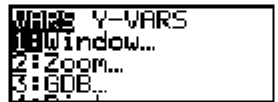


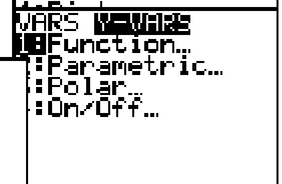


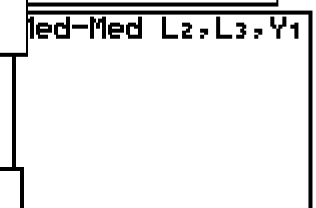
To get the equation stored as a function which will graph

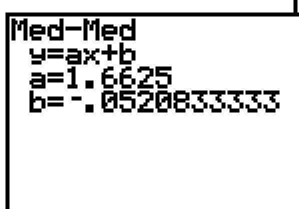
- Press VARS

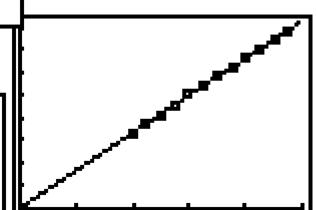
  Right arrow to Y-VARS
- Press ENTER to select Function
- Press ENTER to Select Y_1
- Press ENTER to execute the command
- Press Y= to see that the equation is stored in Y_1
- Press GRAPH to see the Regression line superimposed over the Statistical Plot of the data.

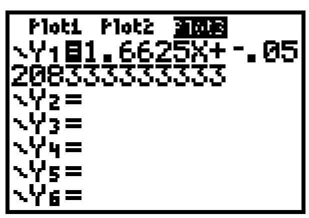




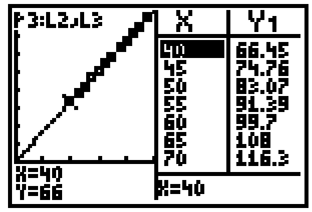


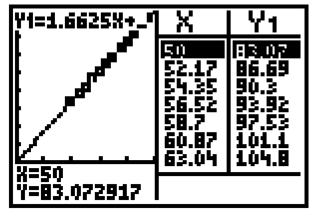






- MODE G-T allows you to view the graph and Table
- Press TRACE to trace on the STAT PLOT
- Press down arrow for the TRACE to move to the equation.





You Gotta Have Heart

Related SOL: BIO.1, BIO.5, and A.18

Overview

What do you know about your heartbeat? All organisms with a closed circulatory system have a pump to move the blood and therefore have a heartbeat. Various drugs affect the heart - some speed up the heart rate (**stimulants**) and others slow the heart rate (**depressants**). In this laboratory exercise, you will test the effect of a common drug – caffeine. The class will test a variety of common everyday beverages and food that contain caffeine.

Materials

one can 12 oz of soda, diet caffeine free
one can 12 oz of soda, diet with caffeine (Mountain Dew has a lot of caffeine)
12 oz of coffee - caffeinated
12 oz of tea - not herbal
one chocolate candy bar, no nuts
clock with second hand

Procedure

1. At the beginning of the class, each student should take their heart rate three times.

2. Find the pulse in the wrist or the neck below the chin, remember not to use your thumb.

3. Using a clock with a second hand, count the number of beats in 10 seconds.
   Multiply that number by 6 to get a resting heart rate for one minute.
   Record each in the table below.

RESTING HEART RATE

Trial #1	Trial #2	Trial #3	Average

4. Divide the class into groups of 5 students.

5. Have each person select and drink a different beverage or eat the candy bar at the same time. Why is it important to drink/eat at the same time? ___________________.
   What did you drink/eat ? _________________ When ?____________

6. Wait 5 minutes, then repeat taking your heart rate and complete the table below.

HEART RATE AFTER EATING

Trial #1	Trial #2	Trial #3	Average

7. Compare your Resting and After Heart rates by completing the table below.

Average Resting Heart Rate	Average after test Heart Rate	Difference of the Heart Rates

8. Continue the experiment by recording your heart rate every 5 minutes and fill in the table below.

Time in minutes	Trial #1 (x 6)	Trial #2 (x 6)	Trial #3 (x 6)	Average Rate	Resting Heart Rate	Percent of change (+/-)
5						
10						
15						
20						
25						
30						
35						

9. To examine class data, take the highest percent of change you had and put it on the board under your group's name.

10. Fill in the table below from the board and find the average rate of increase for the substance tested.

CLASS DATA TABLE

Substance Tested (X)	Group 1	Group 2	Group 3	Group 4	Group 5	Group 6
Decaf Soda (X=1)						
Regular Soda (X=2)						
Coffee (X=3)						
Tea (X=4)						
Chocolate (X-5)						

Graphing: Refer to the CASIO or TI instructions.

Analysis and Conclusions

1. Was caffeine a stimulant or a depressant? ____________________

2. What was your proof for this answer?

3. What were the ***constants*** in this experiment?

4. What was the ***dependent variable*** in this experiment? ____________________

5. What was the reason for using diet beverages?

6. Which substance had the greatest effect on the heart rate? _________________

7. Which group had the greatest increase in heart rate? ______________________

8. What might be other contributing factors that could have altered the results of this experiment?

9. How might you change this experiment to remove these factors or keep them constant?

CASIO 9850 G+ Graphing Instructions

1. Using the data make a histogram showing the heart rate increase (using averages) for each substance. (For example, if the average heart rate increase for decaf. soda was 8, then enter a 1 for x and 8 for y. If the average heart rate increase for soda was 5, then you enter 2 for x and 5 for y. Continue entering the data for coffee (x=3, y=average), tea (x=4, y=average), and chocolate (x=5, y=average). Set the viewing window to the following specifications: Xmin = .5, Xmax = number of groups in class + .5, Xscale = 1, Ymin = 0, Ymax = 15, and Yscale = 5.

Go to STAT Mode (#2). Make sure to clear out any existing lists.

- Enter in the new data by putting the x-axis values into List 1, and y-axis values into List 2.
- Press F1 (GRPH), and then F6 (SET).
- Arrow down to highlight Graph Type. Press F6 (ω). Press F1 (Hist).
- Arrow down to highlight XList. Press F1 (List 1).
- Arrow down to highlight Frequency. Press F3 (List 2).
- Choose any graph color you want. Press the EXIT key.

At this point, set the viewing window to the correct specifications.

- Press the yellow SHIFT key, followed by the F3 (V-Window) key.
- The Xmin should already be highlighted. Change it to .5, then press the EXE key.
- Xmax should now be highlighted. Change it to the number of five-person groups in the class + .5, then press the EXE key.
- Xscale should now be highlighted. Change it to 1, and then press the EXE key.
- Ymin should now be highlighted. Change it to 0, and then press the EXE key.
- Ymax should now be highlighted. Change it to 15, and then press the EXE key.
- Yscale should now be highlighted. Change it to 5, and then press the EXE key.
- Press the EXE key again.
- Press F1 (GRPH).
- Press F4 (SEL). Make sure the only graph that is on is StatGraph1.
- Press F6 (DRAW). This is the Set Interval window.
- Set the Start at 1. Press the EXE key. Set the pitch at 1. Press the EXE key. Press F6 (DRAW).

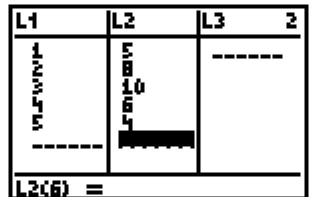
2. Make a histogram choosing one of the 5 substances and using all groups in the class for that substance. (Let x=1 for group 1, and y=average heart rate for group 1. Let x=2 for group 2, and y=average heart rate for group 2. Continue inputting data until each group's data has been included.) Set the viewing window as follows: Xmin = .5, Xmax = number of groups + .5, Xscale = 1, Ymin = 0, Ymax = 30, and Yscale = 5.

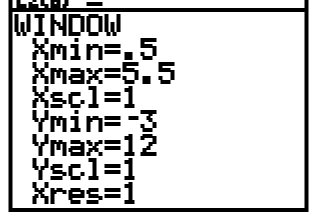
TI-83 Graphing Information

Note: Refer to the **Getting Started Setup Procedures** to ensure the calculators have functions and STAT PLOTS cleared or turned off, STAT Editor Setup and Defaults set for Mode and Window Format.

Data Entry:

Enter the information from your data table into the lists in the TI-83.
Use L_1 for the Substance # 1 - 5
Use L_2 for the Average Heart Rate Increase

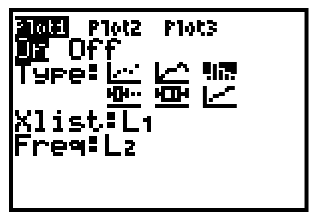




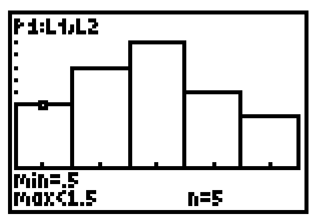
1. Press STAT
   Select 1:Edit

2. Key the values from the activity sheet into the lists.
   For example:
   If the average heart rate increase for decaf was 5, enter 1 in L_1 and 5 in L_2.
   If soda's increase was 8, enter 2 in L_1 and 8 in L_2.
   Sample data and WINDOW are shown

3. Set up STAT PLOT for a Histogram



   - Press 2nd STAT PLOT
   - Press ENTER to select 1:Plot1
   - Press ENTER to select ON
   - Press cursor down arrow
   - Arrow over to the Histogram
   - Press ENTER to select it.
   - Press the down arrow
   - Set the Xlist Press 2nd L_1 (this is the number 1 key)
   - Press the down arrow
   - Set the Freq: L_2



- **Press TRACE**

4. Make a histogram choosing one of the five substances and using all groups for that substance. Use x=1 for group 1, with group 1's average for the corresponding y value. Continue with the other groups and their averages.

   Set the WINDOW with Xmin = .5, Xmax = number of groups+.5, and Xscl=1. The Y WINDOW values are dependent upon the averages stored.

The Hermit's Epidemic

Related SOL: BIO.1, BIO.5, and A.18

Overview

Six (unusually sociable) hermits live on an otherwise deserted island. An infectious disease strikes the island. The disease has a one-day infectious period and after that the person is immune (cannot get the disease again). Assume one of the hermits gets the disease (maybe from a piece of Skylab). He randomly visits one of the other hermits during his infectious period. If the visited hermit has not had the disease, he gets it and is infectious the following day. The visited hermit then visits another hermit. The disease is transmitted until an infectious hermit visits another hermit. The disease is transmitted until an infectious hermit visits an immune hermit, and the disease dies out. There is one hermit visit per day. Assuming this pattern of behavior, how many hermits can be expected, on the average, to get the disease?

Pre- Activity Questions

1. What is the least number of hermits that could get infected?
2. What is the greatest number of hermits that could get infected?
3. What sort of <u>model</u> could you use for this problem?
4. How would you solve this problem <u>analytically</u>?
5. How would changing the number of hermits on the island affect the expected number of infected hermits?

Procedure

1. Use a six-sided die where each side represents a hermit**.**
2. Roll the die to see which hermit gets the disease.
3. Roll the die again to see which hermit is visited and gets the disease.
4. Continue rolling until an immune hermit (one of the numbers that has already been rolled) is visited. **NOTE:** If the same number is rolled one after the other, ignore the second roll, since these hermits do not visit themselves.
5. Count how many different numbers were rolled (how many hermits got the disease).

6. Repeat steps 2 through 5 ten times.

Refer to the CASIO or TI-83 Information for an alternate method.

CASIO CFX-9850 G+ Information

Method I:

- Go to the RUN Mode (#1).
- Press the yellow SHIFT key, and then the MENU key This will get into the SET UP.
- Arrow down to “Display” Press F1 (Fix). Press F1 (0) Press the EXIT key
- Press the OPTN key. Press F6 (ω). Press F3 (PROB)
- Type in the maximum random number minus one. For example, in this simulation of rolling a die to utilize the numbers 1 through 6 (random number, 6, minus 1).
- Press F4 (Ran#).
- Press the addition symbol (+). Press the number 1. Hit the EXE key repeatedly to produce as many random numbers as needed.

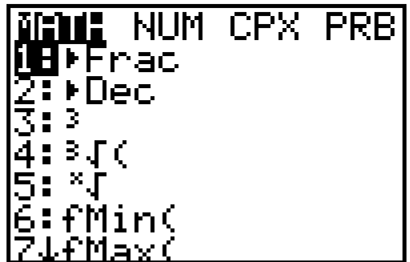
Method II:

- Go to the RUN Mode (#1).
- Press the OPTN key. Press F6 (ω). Press F4 (NUM). Press F2 (Int).
  Type in the maximum random number (6 in this case).
- Press the EXIT key.
- Press F3 (PROB). Press F4 (Ran#).
- Press the addition symbol (+), followed by the number 1.
- Press the yellow SHIFT key. Press the MENU key. To go into SET UP.
- Arrow down to “Display”. Press F1 (Fix). Press F1 (0). Press the EXIT key. Hit the EXE key repeatedly to produce as many random numbers as needed.

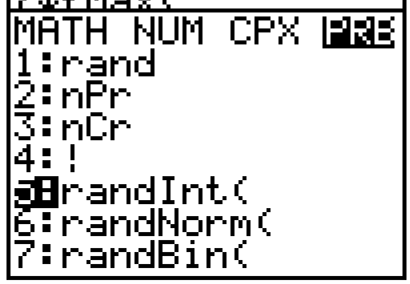
TI-83 Information

Method for Generating Random Integers

1. Press the MATH key

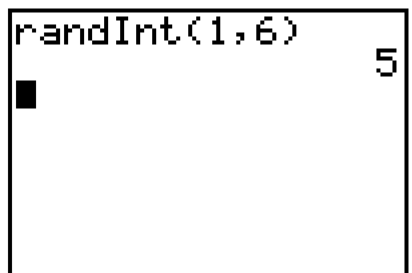


2. Arrow over to PRB
   This stands for
   probability

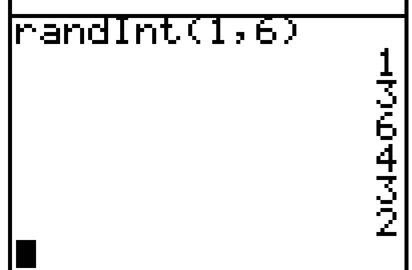


3. Select 5:randInt(
   This pastes the command
   to the home screen

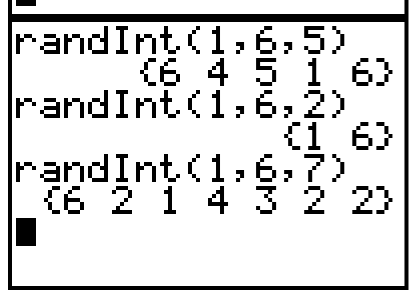
4. To simulate the roll of a 6-sided die
   random integers between 1 and 6 are
   needed.
   Enter 1,6.
   The comma is the key above the 7 key.



5. Continually pressing ENTER will
   re-execute the same command. It
   is not necessary to key it in again.
   Or pressing 2nd ENTER will recall the
   last executed command if you would
   like to see it again.



6. If you want more than one of the
   random integers generated at a time
   add a third argument to the list following
   randInt(



Analytical Solution

# of Infected Hermits	Explanation	Probability
0	This cannot happen, because at least one hermit must get sick in order to begin the outbreak (trial).	**0**
1	This cannot happen, because at least one hermit must get sick and then he visits someone else who, in turn, also gets sick.	**0**
2	Once the second hermit is visited, there are five hermits that he can visit (one of which is immune). If he visits the immune hermit, only two will be infected.	1/5 = **0.2**
3	For three hermits to be infected, the second hermit must have visited one of the four non-immune hermits. Then, the third hermit must visit another hermit (two of which are immune). If he visits one of the two immune hermits, only three will be infected.	(4/5)(2/5) = **8/25** = **0.32**
4	For four hermits to be infected, the second hermit must have visited one of the four non-immune hermits. Then, the third hermit must have visited one of the three remaining non-immune hermits. Then that hermit must visit one of the three immune hermits.	(4/5)(3/5)(3/5) = **36/125** = **0.288**
5	For five hermits to be infected, the second hermit visited one of four non-immune hermits, the third hermit visited one of the three non-immune hermits, the fourth hermit visited one of two non-immune hermits, and fifth hermit visited one of four immune hermits.	(4/5)(3/5)(2/5)(4/5) = **96/625 = 0.1536**
6	For all the hermits to be infected, the second hermit visited one of four non-immune hermits, the third hermit visited one of three non-immune hermits, the fourth hermit visited one of two non-immune hermits, and the fifth hermit visited the last non-immune hermit.	(4/5)(3/5)(2/5)(1/5) = **24/625 = 0.0384**

In order to solve this problem analytically, you must find the probability that each possible number of hermits will be infected. There will be at least two infected (one gets the disease and visits another) and at most six infected (all get visited without anyone getting visited twice). Look at each case separately.

Now we can find the expected value, E(x), by multiplying each value by its respective probability and adding them all together.

E(x) = 0(0) + 1(0) + 2(1/5) + 3(8/25) + 4(36/125) + 5(96/625) + 6(24/625) =

0 + 0 + (2/5) + (24/25) + (144/125) + (480/625) + (144/625) =

(250/625) + (600/625) + (720/625) + (480/625) + (144/625) =

(2194/625) = 3.5104

Thus, by averaging all the trials from the model, you should get something near 3.5104 as your answer.

Questions

1. Should the average of the trials from the model be exactly 3.5104?
2. Does an expected value of 3.5104 mean that we expect 3 whole hermits and only part of a fourth hermit to get sick each time?
3. How accurate are the answers from the models?

Extension

1. How could you model an island with 4 hermits? 10 hermits? 52 hermits?
2. What would the expected value of this problem be if there were 4 hermits? 10 hermits?

What's The Change?

Related SOL: BIO.1, BIO.3, and A.17

Overview

Many textbooks teach that the rate of chemical change doubles for each 10° C change in temperature. Although this is a good generalization, temperature does not affect all chemical changes the same, and the rate of increase of a chemical change with respect to temperature is an individual thing for each different change.

In the following reaction between Effervescent Aspirin Tablets and water, the rate of reaction is generally affected by the temperature of the water. The increase is exponential and can be graphed, but it will give less than a doubling per each 10° C rise in temperature.

Materials

5 Effervescent Aspirin Tablets
Data Collector and Temperature Probe
Ice or very cold water
Room temperature water
Boiling or very hot water
5 clear plastic cups or 5 250 mL beakers
Clock or watch (with a second hand)

Procedure

1. Place 150 mL of ice cold water (no ice) in one beaker, 150 mL of room temperature water in another beaker, and 150 mL of very hot water in another beaker.

2. Measure and record the temperature of the water in each container.
   - Connect the graphing calculator to the Data Analyzer with a data link.
   - Attach temperature probe to Data Analyzer in CH1.
   - To operate the Data Analyzer manually, use the following keystrokes:
     - Press the ON/OFF key. Press the SHIFT key, followed by the MODE key to access the SETUP.
     - Press the DataLOG key until 5.00 sec. appears on the screen. This is the number of seconds between each sample taken.
     - Press the TRIGGER key.
     - Press the DataLOG key until 20 appears on the screen. This is the total number of samples to be taken. Press the TRIGGER key.
     - Press the DataLOG key until 1 appears on the screen. This sets the analyzer to record actual time. Press the TRIGGER key.

    - "Ready" should appear on the left side of the screen. To begin sampling data, press the TRIGGER key.
    - When all samples have been taken, "Done" will appear on the screen.
- To transfer the data from the Data Analyzer to the graphing calculator.

    - Turn the graphing calculator ON. Go to the RUN Mode (#1).
    - Press the yellow SHIFT key, then the VARS key. This takes us into the PRGM screen. Press F6 (ω). Press F4 (I/O). Press F4 (Recv). The word "Receive" should now be on the screen.
    - Press the OPTN key. Press F1 (LIST). Press F1 (List). Press the number 1. Press the end parenthesis key ")".
    - Press the EXE key. The calculator screen should now say, "DONE". The time data has now been recorded into List 1.
    - We now must input the temperature data into List 2. Press the yellow SHIFT key, then the VARS key. Press F6 (ω). Press F4 (I/O). Press F4 (Recv). Press OPTN. Press F1 (LIST). Press F1 (List). Press the number 2. Press the end parenthesis key ")". Press the EXE key.
    - Repeat the above keystrokes on the Data Analyzer to record the temperature of each of the other beakers of water. Make sure you transfer the data into Lists 3, 4, 5, and 6.

3. Have a timekeeper give a signal and drop an Effervescent Aspirin Tablet into each beaker all at the same time.

4. Record the time in seconds when the Effervescent Aspirin Tablet is completely dissolved (has stopped fizzing).

5. Fill in the table below with the data you have collected:

Temperature (x)	Time (y)	Reaction Rate (time/sec.)

- To find the average temperature of each beaker that we sampled with the Data Analyzer, we must study Lists 2, 4, and 6 in the graphing calculator.

  - Go to RUN Mode (#1). Press OPTN key. Press F1 (LIST). Press F6 (ω). Press F6 (ω). Press F1 (Sum). Press the EXIT key. Press F1 (LIST). Press F1 (List). Press the number 2. Press the division symbol key (¤). Press F3 (Dim). Press F1 (List). Press the number 2. Press the EXE key. The average temperature put into List 2 is now on the screen.

  - Repeat the above steps to get the average temperature in Lists 4 and 6. Record the data in the table provided.

Extension

1. Enter the data into a two-variable statistical data set within your graphing calculator where temperature is the x and time is the y.

2. Draw a scatter plot for the data points in the range: Xmin = 0, Xmax = 100, Xscale = 10, Ymin = 0, Ymax = set this number a bit higher than the data you have collected, and Yscale = 5.

3. Find the best fitting curve for the data.

4. Graph this curve and use the graphing calculator's trace feature to predict the amount of time necessary for the reaction to be completed in water that is at a temperature about half-way between the hot and room temperature and half-way between the cold and room temperature.

5. In another beaker, mix 75 mL of the room temperature water with 75 mL of the cold water and in another beaker, mix 75 mL of the room temperature water with 75 mL of the hot water.

6. Time and run the reaction, then add this information to the data table provided.

7. How close was this value to your predicted value?
   % error = ((predicted – measured) ¤ predicted) x 100

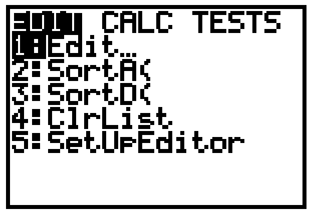
TI-83 Information

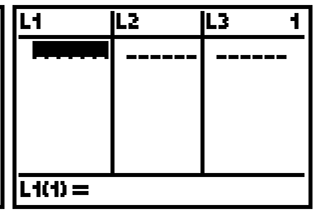
Note: Refer to the Getting Started Setup Procedures to ensure the calculators have functions and STAT Plots cleared or turned off, STAT Editor Setup and Defaults set for Mode and Window Format.

Data Entry

1. Enter the information from your data table into the lists in the TI-83.
L_1 will hold the temperature values (x).
L_2 will hold the time values (y).

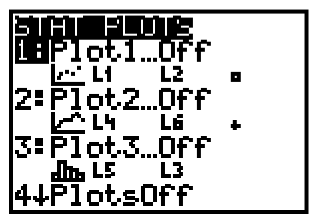
- Go to the STAT Editor
  1. Press STAT
  2. Select 1:Edit





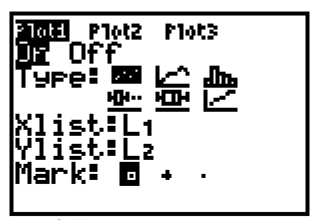
- Key in the values from your data table on the lab sheet

2. Set up a STAT PLOT for reaction rate.
- This will be a scatter plot of (temperature, time)
  Make Xlist: L_1
  Ylist: L_2
- Press 2nd STAT PLOT
- Press ENTER to select 1:Plot1
- Press ENTER to select ON
- Press cursor down arrow



Press ENTER to select the scatter plot picture.

- Press the down arrow
- Set the Xlist and Ylist if they are not correct.
  Press 2nd L_1 (this is the number 1 key)
- Select whichever Mark you prefer. Generally the box or + are best if there are not a lot of data points. The dot is best if there are a large number of data points.

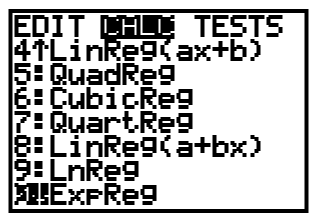


3. Establish a viewing window for the graph.
   - Press WINDOW key

     The x values represent temperature in C°.
     Set the min and max values accordingly.
     Use: Xmin = 0
     Xmax= 100
     Xscl = 10

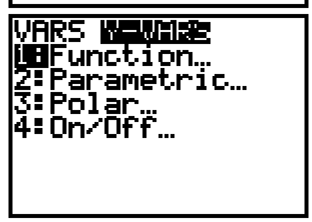
     The y values represent time in seconds for the fizzing to stop.
     Choose Ymax larger than the greatest time.
     Use: Ymin = 0
     Yscl = 5
   - Press GRAPH
4. Return to the activity sheet for data interpretation.

5. Have the calculator find the Regression Equation which best models the time required for the reaction at a given temperature.
   Since the reaction rate is exponential and predicted to be about double for each 10°C rise in temperature, the time required for the tablet to finish fizzing should be about halved for each 10°C change in temperature.
   This will still be an exponential regression model.



The calculator can find an exponential regression model for you.
- Press STAT
- Right arrow to CALC
- Arrow down to ExpReg
- Press ENTER (or press 0)

The calculator screen shown is ready to store the equation in Y1.



- Press 2nd L_1 (over 1)
  Press the comma key
- Press 2nd L_2
- Press the comma key
- Press VARS
  - **Press right arrow to Y-VARS**
- Select Function Y1
  Press ENTER

The calculator screen is set.

FLAPPING GILLS

Related SOL: BIO .1, BIO.5, AND A.17

Objective

The student will investigate how temperature affects the breathing rate of a goldfish.

Overview

What happens to the breathing rate as the body temperature increases? The body is able to adjust to the environment in order to maintain **HOMEOSTASIS** (tendency to maintain internal stability by responding and compensating for environmental changes). What about a fish, would it be able to maintain **HOMEOSTASIS?** In order to survive all living things must be able to respond to their environment. This laboratory deals with observing how a goldfish=s respiration rate responds to temperature variation in its habitat.
What is the independent variable? What is the dependent variable?

Materials

100 ml beaker
500 ml tap water at room temperature (leave out over night to remove chlorine)
Dishpan with ice
Goldfish
Stopwatch
Electronic data collector with temperature probe
Graphing calculator

Procedure

1. Pour 500 ml of tap water into a 1000 ml beaker.
2. Place the temperature probe into the water and record water temperature.
3. Place the goldfish in the beaker of tap water. Allow 5 minutes for the goldfish to stabilize.
   Insert temperature probe into the water.
4. Set the electronic data collector to record temperature for manual intervals.
5. Using the stopwatch, count the number of gill flaps of the goldfish for twelve 15-second intervals. At the end of each time interval, record the number of gill flaps and activate the temperature recorder.
6. Place the beaker containing the goldfish and temperature probe in the dish pan with ice.
   Be sure the ice covers the sides of the beaker.
7. Count the gill flaps in 15-second intervals for 10 minutes. Record gill flap counts and temperature at the end of each 15-second interval.
8. Enter data from the data collector and data tables into the graphing calculator.
9. Using the data, construct graphs comparing temperature and breathing rates.

10. Collect class data from the board.
11. Using the data, construct a class data graph comparing temperature and breathing rates.

Data Table

Time	Temperature	Respiration Rate

Graphing

1. Set range on the graphing calculator to Xmin: 0, Xmax: 30, Xscl: 5, Ymin: 0, Ymax: 120, Yscl: 10.
2. Create a statistical data set on the graphing calculator with the ordered pairs of (x,y) = (temperature, respiration).
3. Use the graphing calculator to produce a scatter plot for the data set formed in step 2.
4. Use the graphing calculator to find the best-fitting line for the data (linear regression).

Analysis

1. How does the change in temperature affect the respiration rate in the goldfish?

2. Is the slope of the best-fit line going to be (+) or (-)?

3. If the temperature readings started at the warm end of the scale and progressed toward the cold end of the scale, what would the slope of the best-fit line be (+) or (-)?

4. Compare your individual graph with the class graph. Which graph is a better indication of what is occurring? Explain why.

5. Name the two types of relationships that can exist in graphing variables.

6. What ultimately happens to goldfish in a pond as the water freezes?

Credits
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Wilburn Wilson, Suffolk County Public Schools

TI-83 Graphing Information

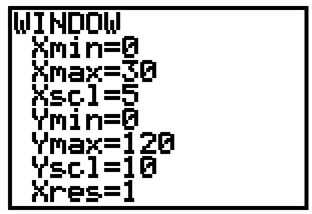
Note: Refer to the **GETTING STARTED SETUP PROCEDURES** to set up the calculator with unwanted functions and STAT PLOTS turned off, lists cleared, proper MODE settings, etc.

Data Entry

1. Press STAT
2. Select 1:EDIT
   Puts you in the STAT Editor
3. Clear L_1 and L_2
   (Described in Setting up a STAT Plot)
4. Key Temperature values into L_1 column.
5. Key Respiration Rate values into L_2 column.

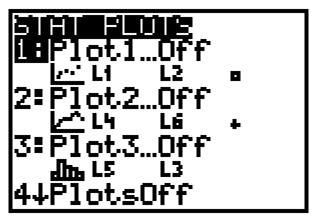
Establish Viewing Window

1. Press WINDOW and key in the values.



Set Up Statistical Plot

1. Go to the STAT PLOT menu
   a. Press 2nd STAT PLOT
      (over the Y= key)
   b. If all STAT PLOTs are not OFF
      - Select 4:PlotsOff
      - After the command is pasted to the home screen
      - Press ENTER



   c. Press 2nd STAT PLOT to return to

      the STAT PLOT menu

2. Set up Plot1
   a. Press ENTER to select Plot1
   b. Press Enter to activate Plot1
   c. Press the down arrow key to select Type
   d. Press Enter to select scatterplot
      The cursor is blinking on the icon for scatterplot
   e. Press the cursor control down arrow key to enter the Xlist:
      If L_1 is not already there, Press 2nd L_1.
      Note: L_1 is a 2nd function over the 1 key.
      (Either overstrike the list name which is there, or press CLEAR first.)
   f. Ylist: L_2 Repeat the process from e. to make Ylist: L_2
   g. Mark
      Position the cursor on any selection and press ENTER

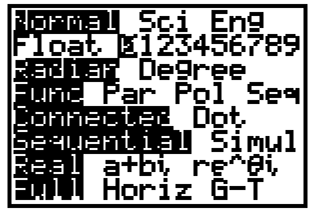
Press GRAPH to view the graph.

3. Press TRACE to trace on the Data Points

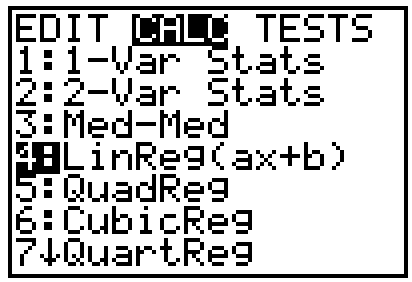
Notice that the x and y values for each point are printed at the bottom of the graphics screen.

4. Limiting Decimal Places Displayed.

To trace values rounded to a number change the MODE setting from Float to 0.



Regression Equation



1. Press STAT and right arrow to CALC
2. Choose 4:LinReg (ax+b)

   Note: This selection can be made either by arrowing down and pressing ENTER or pressing the number 4 on the calculator.

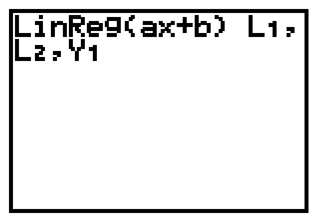
   This will "paste" LinReg (ax+b) on the home screen.
3. Key in L_1, L_2, Y_1 as shown at the right

   Note 1: the comma key is the key above the 7 key.

   Note 2: The Y_n for the functions in the Y= menu are found by pressing VARS, right arrow to Y-VARS then select 1:Function.

   Note 3: The regression equation can be stored in any Y_n.

   It can also be omitted from the command.
4. Press ENTER.
5. As shown this will calculate the Regression equation using List 1 and List 2 and store this equation in the Y_1 function register.



Repeating the experiment

In order to compare the values obtained with different fish, store several functions and view all graphs simultaneously.

In order to do this each time calculate a new regression equation and store it in a different Y_n.

BRAIN STORM

Related SOL: BIO.1, BIO.2, BIO.3, BIO.9, A.7, A.15, A.17

Objective:

The student will investigate and understand how populations evolve over time.

Overview

Scientists have been able to study **natural selection** in peppered moths, *Biston betularia,* in England since the Industrial revolution. The peppered moth population was observed in the 1800's to be primarily made up of light-colored lichens covering the trees and rocks and found hiding places on the bark of the lichen-covered trees. With the rise of industry and the burning of fossil fuels, air pollution killed off the lichens and left the dark-colored bark exposed. What do you think happened in the population of light- and dark-colored moths over time? This laboratory will explore how to make predictions with the graphing calculator in order to test your hypothesis.

Materials

Graphing Calculator
Digital Camera...Optional
Flex Camera... Optional

Procedure

Use the table below to complete the list of activities.

TABLE #1:

Year	Number of light moths captured	Number of dark moths captured
2	537	112
3	484	198
4	392	210
5	246	281
6	225	357
7	193	412
8	147	503
9	84	594
10	56	638

ACTIVITIES:

1. Create a two variable statistical data set within the calculator with the ordered pair (x,y).
   a) (x,y) = (year, number of light moths captured)
   b) (x,y) = (year, number of dark moths captured)

2. Use the graphing calculator to draw a scatter plot for each set of statistical data. Use the range Xmin = -1, Xmax = 12, Xscl = 1, Ymin = -1, Ymax = 640, Yscl = 1.

3. Use the graphing calculator to find the best fitting curve for the data. Try all regression equations available on the calculator, comparing the correlation coefficient (r) to determine which curve fits the data better.

   y=_________________ r=__________________

4. Sketch the graph of the best fit curve of each.

5. Determine the slope of the line using the calculator. Then use the trace button to choose two points on the line. Use the slope formula to compute the slope manually. Compare the two answers.

6. Using the graph that represents the light moths captured, approximate in years and months when the light moths will become extinct. Explain your answer.

Credits:

Janece Bibby, Richmond City Schools
Martha Cook, Richmond City Schools
Catherine Robinson, Richmond City Schools
Diane Williams, Richmond City Schools

TI-83 Graphing Information

Note: Refer to the **GETTING STARTED SETUP PROCEDURES** to set up the Calculator with the unwanted functions and STAT PLOTS turned off, Lists cleared, proper MODE settings, etc.

Data Entry

1. Press STAT
2. Select 1:EDIT
   Goes into STAT Editor
3. Clear L_1, L_2, L_3
4. Enter Years into L_1
5. Enter light moths into L_2
6. Enter dark moths into L_3

Set up STAT Plot

1. Press 2^{nd} STAT PLOT
2. Press ENTER to select Plot1
3. Select scatter plot
4. Enter L_1 into Xlist
5. Enter L_2 into Ylist
6. Press 2^{nd} STAT PLOT
7. Select Plot2
8. Enter L_3 into Ylist

WINDOW Setting

1. Press WINDOW
2. Enter Xmin=0; Xmax=11; Xscl=1; Ymin=-50; Ymax=650; Yscl=50; Xres=1

Regression Equation

1. Press STAT and right arrow to CALC
2. Select #3 Med-Med.
3. Key in L_1, L_2, Y_1 to model the number of light moths.
4. Press ENTER
5. Press GRAPH to view the Eq superimposed on the STAT plot
6. Repeat the process for List 1 and List 3 to get a model for the dark moths.
7. Try other regression models to find a good fit.

Survivalists

Related SOL: BIO.8 and A.17

Objective

The student will investigate and understand how populations change through time, including how environmental pressures impact on the survival of a population.

Materials

Beverage of choice
Graphing calculator
EA-100 with temperature probe

Procedure

1. Enter program FIRE into the graphing calculator.
2. Link the graphing calculator and EA-100.
3. Place beverage in front of a fan, air conditioner, or heater.
4. Insert the temperature probe into the beverage.
5. When the experiment is completed, set the graphing calculator to do a scatter plot for the data.
6. Draw the Median-Median line to predict when the will be between 5 C and 10 C (if using a fan or air conditioner).

Questions

1. Will the type of beverage affect the outcome? (Diet versus regular; Carbonated versus Non-Carbonated; Different Fruit juices; etc.)

2. What would be the cost of cooling a drink in this manner? Is this cost effective?

3. Could this be applied to other situations?

Extension Problems

1. How would this work in a moving stream of water? In a still pool?

2. How could this be adapted to test materials used in the making of cold weather gear such as flannel shirts and polar plus jackets?

Problems and Solutions

1. Problem: The EA-100 would turn off prematurely
   Solution: Use the AC adaptor which will override the automatic turnoff.

2. Problem: The CFX-9850G Plus turns off prematurely.
   Solution: Press one of the directional keys every 20 - 30 minutes to keep it on.

3. Problem: The program starts but gives a command error.
   Solution: a) Check the program to make sure there are no errors in typing in lines of the program.
   b) Check to make sure the set up of the equipment is right.

Credits

Nancy Bell, I.C. Norcom HS
J.Dianne Johnson, I.C. Norcom HS
Nancy Parker, John S. Battle HS
William Wynn III, Brunswick Sr. HS

PROGRAM FIRE adapted for SURVIVALIST

```
{0}\->\List 6
\Send(\List 6)
\Cls
{1,0}\->\List 6
\Send(\List 6)
{1,1,7}\->\List 6
\Send(\List 6)
"PRESS TRIGGER ON DA"
"PUT PROBE IN CAN OF@
ASODA UNTIL DONE@
"PRESS EXE"
{3,900,12,1}\->\List 6
\Send(\List 6)\Disp\Receive(\List 1)
\Receive(\List 2)
\S-WindAuto
\S-Gph1 \DrawOn,\Scatter,\List 1,\List 2,1,\Cross,\Blue
\S-Gph2 \DrawOff
\S-Gph3 \DrawOff
\DrawStat
0\->\Ymin
0\->\Xmin
30\->\Xscl
5\->\Yscl
\S-WindMan
\DrawStat
%End


%Header Record
Format:TXT
Communication SW:0
Data Type:PG
Capacity:17
File Name:RECEIVE
Group Name:
Password:
Option1:NL
Option2:
Option3:
Option4:
%Data Record
\Receive(\List 1)
\Receive(\List 2)

%End
```

Hanging Around the Lake

Objective

The student will investigate and understand how populations change with their environment.

Overview

Even though we think of a lake as a single environment, it is actually made up of many smaller habitats. Each living thing in the lake has its own special needs for survival- light, temperature, food, pH, oxygen levels, and water movement are some examples. In this exercise, you will explore some of the physical characteristics of a lake or pond and try to identify the type(s) of organisms that live in each of theses special habitats. You will learn how to identify and classify some of the more common species found in the lake/pond.

Materials

Two small watercraft
Two graphing calculators
A data collector interface
A temperature probe
A light probe
A pH probe
A ball of string
weights (100 g)
Plastic bottles
Plankton nets
Seine net (optional)
White specimen trays
Microscope along with slides and cover slips
Classification books for reference

Procedure

1. Survey the lake and place the plastic bottles as float markers at points to be monitored.
   Try to make measuring points at least fifty feet apart in all directions.
2. Measure the water temperature, water pH and water clarity at each survey point.
   Enter in data table.
3. Measure depth of water at the survey point. Enter this information in the data table.

4. At each location identified,
   a. Collect some water with the plankton net to look at under the microscope.
   b. Use the identification books to try to identify any living organisms found.
   b. Use the seine net to trap larger organisms to identify. Set these in the White specimen trays to study in the field or bring back to the laboratory.
   d. Remember to also collect and identify plant specimens.

5. As the lake is studied over several weeks, be sure to note any changes in the population(s) of any of the organisms.

Data Table

Survey	Temp of water ©	PH in water	Clarity of water	Depth of water (m)	No. of fish	No. of different kinds of species

Analysis

Use the graphing calculator:

1. Set the program of the graphing calculator on Receive to load data. In the program Receive, set-up List 1 - List 6.

2. Create a statistical data set on the graphing calculator using all six files when reading data from the lake.

3. Use the graphing calculator to produce a scatter plot for the data set for each file.

4. If the class needs to see the graph from each reading, store each picture, Then recall each on File 6 to show the change in the data.

5. Use the graphing calculator to find the best-fit line for the points (med-med).

Questions

1. How would extreme temperature changes effect the aquatic population?

2. How will the slope of the temperature graph change as the temperature increases?

3. What effect would you expect with increasing water pH?

4. What is the relationship of the temperature and the pH?

.

Credits

Alvin Coleman, Chesapeake City Public Schools
Mary Copeland, Chesapeake City Public Schools
Donald Rima, Hampton City Public Schools
Eleanor Teed, Greene County Public Schools

Let There Be Light

Objective

The student will be able to define and recognize the slope of a line
The student will be able to analyze data to form a conclusion about the effects of erosion.

Overview

When development occurs near waterways and ponds careful consideration should be taken to prevent excess soil from entering the water. Sediment mixes with the water, making the water **turbid** (cloudy/muddy).This turbidity reduces the amount of sunlight entering the water by acting as a filter. The small **submerged aquatic vegetation** (SAV) cannot obtain enough light for sufficient photosynthesis activity. The result is the death of the SAVs. As they die and decay, carbonic acid is produced. If many plants die, it may cause the water to become more acidic (lowering the pH). Another problem that may result from the death of SAVs is the increase of nitrogen compounds in the water. This acts as a fertilizer and causes **algal blooms**. The decaying SAVs cause a reduction in the amount of **dissolved oxygen** (the amount of oxygen in the water available to animals such as fish and zooplankton). Hence, a simple thing such as erosion may have a major impact on the environment. In this activity, you will simulate the effect of **turbidity.**

Materials

1 link cord	Water
one plastic tub	Soil
flashlight	1 EA-100 and 1 light probe
measuring cup	Spoon or stirring rod
5 containers for water and soil	Tape
block or piece of styrofoam to stabilize the light probe	
stopwatch or watch with a second hand	1 CFX-9850+ calculator

Procedure

1. On a level surface, place the plastic tub.
2. Plug light probe into *Channel* 1 of the EA-100.
3. Position and secure the flashlight on the level surface of one side of the plastic tub.
4. Position and secure the light probe on the other side of the plastic tub. The l light probe should be the same level as the most intense beam of the flashlight. (Use the block of wood to raise the light probe to appropriate level if needed.)
5. Fill 4 containers with 1/4 cup of dirt.

6. Fill the 5th container with 3 quarts of water.
7. Push the red **ON** button to activate the EA-100.
8. Press **SHIFT MODE** to enter the setup.
9. The first setting is the number of seconds wanted between samples. Use the **dataLOG** key to scroll forward through the choices until you reach **20 seconds**. Press **TRIGGER** to make your choice.

10. The next setting is the total number of samples that desired. Use the **dataLOG** key to scroll through the choices until you reach **20**. Press **TRIGGER** to make your choice.
11. The final setting on the EA-100 is the time recording mode. Use the **dataLOG** key to choose A1" so the actual times will be recorded. Press **TRIGGER** to make your choice.
12. **NOTE:** This lab is designed to take 3 samples every minute for approximately 7 minutes. For the first minute your tub should be empty. After the first minute add water to the tub. During the next 4 minutes add one container of dirt each minute. DO NOT add dirt directly in front of the flash light because this could give a false reading.
13. We are now ready to start the experiment.
14. Turn on the flashlight.
15. Press the **TRIGGER** to start sampling. The word Asampling@ should be flashing on the screen at this time. ADone@ will appear on the screen of the EA-100 when the sampling is complete.
16. Connect the CFX-9850+ to the EA-100 with the link cord. Be sure the cables are pushed in securely. Turn the calculator **ON.**
17. Select **PRGM** from the main menu and push **EXE.**
18. Use the arrow key to locate your *Receive* program. **F1(EXE).** The little box in the right hand corner means that the calculator is thinking.
19. When the screen says DONE, you are ready to view your graph. Choose **STAT** from the main menu and push **EXE. F1(Grph); F6(SET);** highlight **Graph Type; F2(xy);** scroll down to **Mark Type;** select **F3( ); EXIT; SHIFT MENU(setup);**highlight **Stat Wind; F1(Auto);EXIT;F1(Grph).** The graph should appear on the screen. Sketch the graph from the view window.

Analysis/Questions

1. Explain what happened in the data in the following portions of the lab and why
   a. when the water was added?
   b. when the first 1/4 cup of soil was added?
   c. When the last 1/4 cup of soil was added?

2. Sketch the graph in the space below. Now highlight the following with the appropriate color:
   a. Use blue to show the location of a slope of 0.
   b. Use red to show the location of a negative slope.
   c. Use green to show the location of the positive slope.

Compare your actual graph to that of your prediction in the *Getting Ready* section.

3. How many changes occurred in the graph and explain what happened to cause the change?

4. Based on the data from the graph, will the graph ever reach zero? What would be the difference between a graph of a pond and that of a river?

Extensions

1. If the graph were to start at the point of erosion, what type of function does the data resemble?

2. Based on your understanding of the effects of erosion on the clarity of water in rivers and streams, what do you anticipate will happen to the nekton and zooplankton in those areas? Write an informational letter to your local representative describing the ramifications of residential and commercial development on waterways.

Getting Ready

1. What are the two variables in this experiment? What is the independent variable? The dependent variable?

2. What type of graph do you anticipate with the following trials:
   *an empty tub?
   *a tub with water?
   *a tub with water and 1/4 cup of soil?
   *a tub with water and 1 cup of soil?

Sketch each graph below in a different color and label.

Credits
Robin Carey, west Point Public Schools
Anne Fary, Gloucester County Public Schools
Teresa Haskiell, Gloucester County Public Schools
Helen Luster, Portsmouth City Public Schools

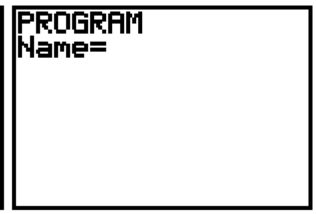
TI-83 Information

CBL program

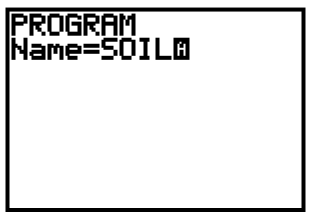
The following program for the CBL can be keyed into the TI-83 and then run. It will give instructions to the CBL and then get the data from the CBL. It is very basic, so the student will need to know what the lab is about, and that the CBL is simply gathering the light intensity and time data. The calculator will get the actual time data into list L_1 and the corresponding light intensity data into list L_2. As soon as the experiment is complete the calculator will display a scatterplot of the data (time, light intensity)

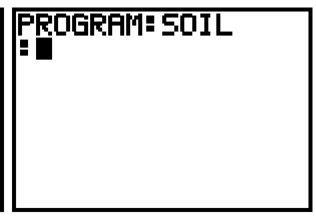
In order to enter a program

- •Press PRGM key
- •Right arrow to NEW

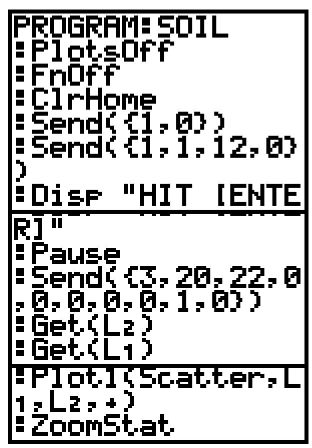


- •Key in a name such as SOIL
- •Press ENTER
- •Key in the Program
- •Other students can link.






```
:PlotsOff
:FnOff
:ClrHome
:Send ({1,0})
:Send ({1,1,12,0})
:Disp "HIT [ENTER]"
:Pause
:Send({3,20,22,0,0,0,0,1,0})
:Get (L2)
:Get (L1)
:Plot1(Scatter,L1,L2,+)
:ZoomStat
```



Bear With Us

Objective

The student will investigate the relationship between the number of bears in Virginia's annual bear hunting harvest and the state's bear population.

Overview

An important aspect of wildlife management is to keep the number of animals within their **carrying capacity** (the maximum size that a population can be supported by the available resources- food, shelter). In Virginia, black bears, *Ursus americanus*, have been living successfully in many diverse habitats such as coastal plains, central piedmont, and mountains. However, as the human population grows, many of these environments are becoming less available for wildlife. One way that Virginia's Department of Natural Resources evaluates the health of a population is to examine the harvesting rate.

Materials

Graphing Calculator

Procedure

Use the table below to complete the activities:

Bear Harvest

YEAR	NUMBER OF BEARS
1975	190
1976	212
1977	208
1978	195
1979	203
1980	216
1981	418
1982	320
1983	340
1984	475
1985	480
1986	525
1987	540
1988	579
1989	625
1990	323
1991	657
1992	483
1993	781
1994	500

Enter the data into the Graphing Calculator using the following steps:

1. Go to **STAT** on the MENU screen
2. Enter the years into List 1.
3. Enter the number of bears into List 2.
4. Make sure your pairs of years and bear harvest match.

Graphing

To make a Scatter Plot:

1. Remain in **STAT.**
2. Press F1 (Graph), F6 (SET)
3. Enter choices:
   Graph 1 (F1)
   Arrow down to Graph Type, press F1
   At x-List, press F1
   At y-List, press F2
   Arrow down to Frequency, press F1 and press **EXE**
   Press F1 (Graph1) and the scatter plot appears.
4. Press F2 for linear interpretation and F6 for best fit graph.
5. Transfer the linear equation to the **GRAPH** menu for interpretation and predictions.

To make a Histogram from the data:

1. Make sure you are in **STAT**.
2. Press F1 (Graph), F6 (Set) and change Graph Type to Histogram (F6), press F1
3. At x-List, press F1.
4. At Frequency, press F3 (List 2), press **EXE, EXIT,** then F6.
5. Press F4 (SEL), make sure Graph 1 is ON (F1), press Draw (F6)
6. Screen set interval appears. Change Pitch to 1, press **EXE** , press Draw (F6).

BEARO!----Your Histogram

Analysis/Questions

1. Based on the data what appears to be happening to the bear population in the last 20 years?

2. As a result of the harvests predict what the harvest could be in the next 5 to 10 years.

3. What are some possible habitat changes that would affect the bear population in VA?

4. What is the most likely region in VA where bears may still successfully reside in 10 years?

4. What wildlife management methods and policies could Virginia institute that would increase and/or stabilize Virginia's bear population?

5. Considering the bear **carrying capacity** in Virginia, state one possible reason why the bear harvest decreased from 1989 to 1990.

Additional Bear Facts

1. Native Americans and the early Virginia settlers used bears for many valuable commodities. Bear skins were made into heavy winter robes, moccasins, and blankets. Twisted bear gut was made into bowstrings. Teeth and claws were used as ornaments. Bear fat was used as butter, body and hair oil, and in the making of body paints.

2. The normal range an animal will frequent is called a home range. Home range must provide food, water, den sites, and adequate concealment for the bear population. An adult male's home range is approximately 15 sq. miles, an adult female's is approximately 10 sq. miles.

3. Bears are omnivorous, and opportunistic feeders. They will readily feed on the food that is available to them. In the spring, they will consume grasses, forbs, and other plants until soft mast, such as berries, pin cherries, etc. are present. Fall foods are generally hard mast, consisting of acorns, hickory nuts, and beechnuts.

Credits

Mildred Calhoun, B.T. Washington H.S., Norfolk
Susan Currier, Petersburg H.S., Petersburg
Jacqueline Gooden-Seay, Petersburg H.S., Petersburg
Larry Turner, Spotswood H.S. Rockingham County

TI-83 Graphing Information

Note: Refer to the **GETTING STARTED SETUP PROCEDURES** to set up the Calculator with the unwanted functions and STAT PLOTS turned off, Lists cleared, proper MODE settings, etc.

Data Entry

7. Press STAT
8. Select 1:EDIT
   Goes into STAT Editor
9. Clear L_1, L_2, L_3
10. Enter Years into L_1
11. Arrow over and up onto the L_2 heading
12. Key in L_1-1975. Press ENTER to fill in the column
13. Enter Bear Harvest values into L_3

Set up STAT Plot

9. Press 2^{nd} STAT PLOT
10. Press ENTER to select Plot1
11. Select scatter plot
12. Enter L_2 into Xlist
13. Enter L_3 into Ylist

WINDOW Setting

3. Press WINDOW
4. Enter Xmin=0; Xmax=20; Xscl=1; Ymin=0; Ymax=800; Yscl=100; Xres=1
5. Press GRAPH to view the graph

Regression Equation

8. Press STAT and right arrow to CALC
9. Select #3 Med-Med.
10. Key in L_2, L_3, Y_1
11. Press ENTER
12. Press GRAPH to view the Eq superimposed on the STAT plot

Set up a Histogram

1. Go to STAT Plot1 and turn it off
2. Set up STAT Plot2 :
   - Choose histogram as the TYPE (icon 3)
   - Xlist: L_2
   - Freq: L_3
3. Press GRAPH
4. Press TRACE. This will tell the number of bears in each year.

An Interdisciplinary Deer and Human Population Study

Objective

The student will investigate what environmental problems arise due to overpopulation and competition for resources.

Overview

Ecology is the study of how organisms interact with their environment- both the **biotic** (living) and the **abiotic** (non-living such as temperature and light). Climate, which is made up of temperature, light, wind, and water, affects where a population may settle. Virginia falls mostly within the temperate forest climate. Deer do well in this type of environment, but so do many other animals. This may lead to competition between the deer themselves or competition between a different species for food, shelter, and other resources. A basic rule in ecology is called the **competitive exclusion principle** which is defined in Campbell's Fourth Edition Biology as: when the populations of two or more species compete for the same limited resources, one population will use the resources more efficiently and have a reproductive advantage that will eventually lead to the elimination of the other population.

In this laboratory, you will explore what happens to a deer population when resource such as food becomes scarce. Is this due to a loss of habitat? To a change in climate? Or are we that other species?

Materials

Graphing Calculators
Checkerboard Grid

Procedure

The following programs will be needed:

Random Numbers:
Menu (1), optn, F6, F4, F2, **EXIT**, (enter #), F3, F4 + 1, **EXE**

Note: To begin game use 2 and the first 32 numbers.

Graphing

Histogram:

Menu (2), Highlight the List you want to use, F1 (graph), F6 (Set), F6, F1 ([Graph Type]-hist) F1([xList]-List1), **EXIT**, F1 (Set interval-choose appropriate #s), F6 (Draw), F1 (view statistics)

Teacher Notes:

This entire lesson plan may be down loaded at: http://www.gene.com.
The original activity has been modified to make use of the graphing calculator technology. Tokens will be used instead of checkers. We recommend the use of scripts to present the six events. The use of the random number generator on the calculator will replace the random drawing of tokens and also will be used to determine the sex of fawns. Instead of a hunting screen (as described in the original plan) we will again use the random number generator to determine which of the 64 possible territories will be hunted. The number of hunters should be determined by each group.

Migration is when a deer on the perimeter of the park occupying a light colored square moves to an adjacent dark square or leaves the park. At that time any deer occupying light squares should be considered to have starved to death and the pieces should be removed. New deer occupy any dark perimeter squares. Then the final count for population is done and the data entered for the migration.

Credits

Rodney Berry, Richmond City Public Schools
James Gardner, Mecklenburg County Public Schools
Glenn Gould, Liberty H.S., Fauquier County
Robert A. Spain, Hampton City Public Schools
Joseph D. Sweat, Hampton City Public Schools

Examination of the Hardy-Weinberg Theorem

Objectives

At the completion of this laboratory, students should be able to:

1. Calculate allele and genotype frequencies using the Hardy-Weinberg theorem.

2. Discuss the effect of natural selection on allelic frequencies.

3. Discuss the relationship between evolution and changes in allele frequencies, as measured by the Hardy-Weinberg Law of Genetic Equilibrium.

Overview

In 1908 the Englishman G.H. Hardy and the German W. Weinberg independently suggested that evolution could be viewed as changes in the frequency of alleles (one member of a pair of genes) in a population of organisms. The Hardy-Weinberg Law of Genetic Equilibrium for a population states that the frequency of the alleles or the genotypes in the gene **pool** (the total alleles in the population at that time) *remain constant unless* factors other than the sheer randomness of meiosis or fertilization occur.
A population that is in equilibrium must meet these five criteria:

1. The population is very large.
2. Mating is random.
3. No mutation occurs.
4. The population remains isolated-no migration or emigration.
5. No natural selection occurs.

Materials

Graphing Calculator
2 3"X5" index cards labeled *a*
2 3"X5" index cards labeled *A*
extra cards labeled *A*
extra cards labeled *a*
handout
Writing utensil

Procedure

1. Record the number of people in the class who are tongue rollers and who are not tongue rollers.

    # of tongue rollers

# of non-tongue rollers

2. Each member of the class will receive four cards. Two cards will have the letter *A* printed on them and the other two the letter *a*. *A* represents the dominant allele and *a* is a recessive allele. Each student will work with a partner. Each mate contributes one allele towards the next generations trait.

3. Turn the cards over, shuffle, and take the card on top to contribute to the production of the first offspring. Your partner should do the same. Put the two cards together. You are now the proud parents of the first offspring. One of you should record the genotype of this offspring in the Generation 1 row of the table. Each student pair must produce two offspring, so all four cards must be reshuffled and the process repeated to produce a second offspring.

4. Your partner should then record the genotype of the second offspring in his/her table. The very short reproductive career of this generation is over. You and your partner now become the next generation of the two offspring. That is, student 1 assumes the genotype of the first offspring and student 2 assumes the genotype of the second offspring.

5. Each student should obtain, if necessary, new cards representing the alleles in his/her respective gametes after the process of mating. Each participant should ***randomly*** seek out another person with whom to mate in order to produce the offspring for he next generation. **The sex of your partner does not matter, nor does the genotype.** You should follow the same mating procedures as for the first generation, being sure to record your new genotype after each generation in the table. Class data should be collected after each generation for five generations. At the end of each generation, remember to record the genotype that you have assumed. Class data will be collected and recorded after each generation by asking you to raise your hand to report your genotype.

Data Table

	Offsprings Genotype			Class Totals for Each		
Generation	*AA*	*Aa*	*aa*	List1 (*AA*)	List2(*Aa*)	List3 (*aa*)
1						
2						
3						
4						
5						

Analysis/Questions

The resulting data will compare gene frequency from one generation to another. The starting generation for the ***tongue-rolling gene*** is ***p*** (**tongue-rolling gene frequency**) = 0.5 and ***q*** (**non-tongue-rolling gene**) =0.5. After 5 generations (or for any number) calculate ***p*** and ***q*** again. Compare these values to our beginning values.
Are the frequencies still the same or have they changed? If changed, how?

Recall that the allele frequency ***p*** and ***q***, have been calculated for the population after five generations of random mating.

p = File2 List3

q = File2 List2

- How do the ***p*** and ***q*** values in the last generation compare to those in the original population in which ***p*** = 0.5 and ***q*** = 0.5?

- What would you expect to happen to the values of ***p*** and ***q*** after another 5, 10,... generations? Explain your answer-think back to the overview on page 1.
- Does our sample population meet these criterion? Justify your answer.
- Would you expect the class data for tongue-rolling to fit the national values? Explain your answer.

KEYSTROKES FOR ENTERING THE LISTS FOR HARDY-WEINBERG LAB

Use the **LIST** menu (4).

In File 1

For List1: enter the data from your table List1 (*AA);* press **EXE** after each entry.

For List2: enter the data from your table List2 (*Aa);* press **EXE.**

For List 3: enter the data from your table List3 (*aa*); press **EXE.**

For List 4 (frequency of *AA*):

Arrow to the top of List 4 so that List 4 is highlighted. To insert the equation, press **OPTN** F1, then F1 again to write List so that on your screen you enter List1 /(List1 + List2 +List3). **EXE.**

For List 5 (frequency of *Aa*):

Arrow to the top of List 5 so that List 5 is highlighted. To insert the equation use F1 to write List so that on your screen you enter List2 /(List1 + List2 + List3). **EXE**

For List 6 (frequency of *aa*):

Arrow to the top of List 6 so that List 6 is highlighted. To insert the equation use F1 to write List so that on your screen you enter List 3 /(List1 + List2 + List3). **EXE**

Now we need to go to File 2 to create the rest of the needed Lists because we have used all the lists in File 1. Since we cannot reference a list from File 1 to use in creating lists in another file, write List 6 from File 1 on a piece of paper. Change your calculator to File 2 by pressing **SHIFT** Menu F2 **EXE.**

In File 2

For List 1 (frequency of *aa*):

Enter the handwritten data (File 1 List 6)

For List 2 (*a* or ***q***):

Arrow to the top of List 2 so that List 2 is highlighted.

To insert the equation press **SHIFT** x^2 for the .Then **OPTN** F1 then F1 again to write List then 1 **EXE**.

For List 3 (***p***):

Arrow to the top of list 3 so that List 3 is highlighted. To insert the equation, press 1 - F1 2 **EXE.**

For List 4 (***p^2****):*

Arrow to the top of List 4 so that List 4 is highlighted. To insert the equation, press F1 then 3 then x^2. **EXE**

For List 5 (2***pq****):*

Arrow to the top of List 5 so that List 5 is highlighted. Insert the equation 2List3List2 **EXE**

For List 6 (***p^2 + 2pq + q^2***):

Arrow to the top of List 6 so that List 6 is highlighted. Insert the equation List4 + List5 + List1 **EXE**

Credits

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Lynne Uebelhoer, Virginia Beach City Public Schools

TI-83 Information

Note: Refer to the **GETTING STARTED SETUP PROCEDURES** to set up your calculator with unwanted functions and STAT PLOTS turned off, lists cleared, proper MODE settings, etc.

STAT Editor set up:

1. Press STAT
2. Select 1:EDIT
3. Clear L_1 through L_6
4. Arrow over to L_6 and up onto the heading
5. Press the right arrow one more time to open a new list position
6. Press ENTER

   The cursor will be blinking in the Name position at the bottom of the screen.
7. Press the) key to record the L
8. Press the ALPHA key to exit ALPHA mode
9. Press the number 7. L_7 is now set.
10. Repeat the process in steps #5- #9 for setting up L_8 through L_{10}

Data Entry

List 1: Enter the data from table List 1 (AA)

List 2: Enter the data from table List 2 (Aa)

List 3: Enter the data from table List 3 (aa)

List 4: Frequency of AA
- Arrow to the heading for List 4
- Key in $L_1 / (L_1 + L_2 + L_3)$
- Press ENTER

List 5: Frequency of Aa
- Arrow to the heading for List 5
- Key in $L_2 / (L_1 + L_2 + L_3)$
- Press ENTER

List 6: Frequency of aa
- Arrow to the heading for List 6
- Key in $L_3 / (L_1 + L_2 + L_3)$
- Press ENTER

List 7: for p^2
- Arrow to the top of L_7
- Press 2nd 1 for L_1
- Press the x^2 key
- Press ENTER

List 8: for 2pq
- Arrow to the top of L_8
- Press 2* L_1 L_3
- Press ENTER

List 9: for q^2

- Arrow to the top of L_9
- Press L_3
- Press the x^2 key
- Press ENTER

List 10: for $p^2 + 2pq + q^2$

- Arrow to the top of L_{10}
- Press $L_7 + L_8 + L_9$
- Press ENTER

Texas Instruments TI-83
Data Analysis

I. Getting Started Setup Procedures

A. Calculator Display Contrast

1. Darken Display

- Press and release the yellow 2nd key in the upper left corner of the calculator.
- Press and *hold down* the "cursor move" up arrow key on the upper right side of the calculator key pad. The display should darken.

2. Lighten Display

- Press and release the yellow 2nd key.
- Press and *hold down* the "cursor move" down arrow key.

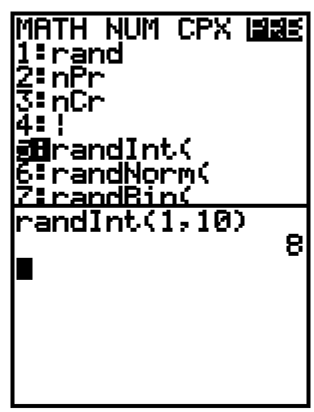
3. Numerical Indicator

- A number between 0 and 9 will appear in the upper right corner of the calculator screen.
- The number will be increasing as the display darkens/decreasing as the display lightens.

4. Repeat as necessary

- This process can be repeated until the contrast is to your liking.
- If the number is 8 or 9 you should change batteries soon.

B. Menu Selections

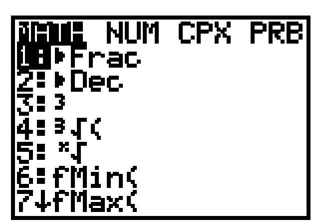


1. Pressing the number or pressing ENTER

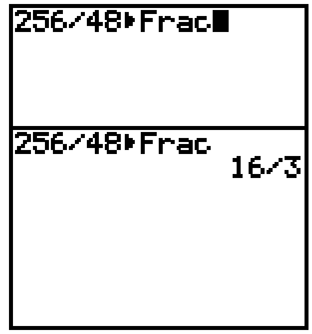
- When making a selection from a menu you can either Press the # of the desired selection or Down arrow to highlight the selection # and then press ENTER

  Example: Print a random integer between 1 and 10.
  Press the MATH key
  Right arrow to PRB
  Down arrow *or* press 5

NOTE: Often this process will "paste" the command on the home screen of the calculator.
The command is not executed until you press ENTER.
If you press CLEAR it will be removed from the screen without being executed.



Example: Write 256/48 as a reduced fraction.
Press 256/48 MATH ENTER
The command is on the home screen.
Press ENTER to execute the command.



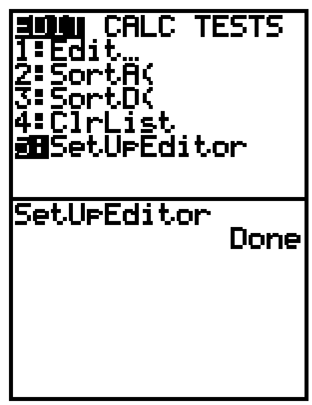
C. Default settings

The calculators may be in any one of many different modes with a variety of settings. This will make a lesson extremely difficult. Everyone's calculators should be set the same. Usually you do not want to reset all memory, because there may be programs or other data which needs to be preserved. It is probably better to just set up the STAT Editor and then reset defaults.
Follow the process described in part **1** below and then any of the three options described in **2.**

1. STAT Editor

Set up so that all 6 lists are present and in order.

- Press STAT
- Select # 5:SetUpEditor
  The command is now pasted on the home screen.
- Press ENTER



2. Setting DEFAULTS

a. Reset Defaults only with a Memory command. **This will:**

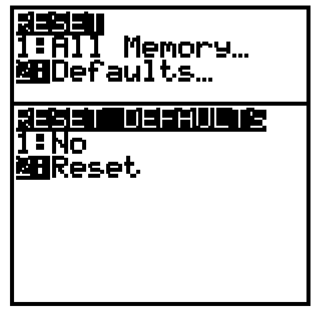
1. Set all MODE and graphics window FORMAT settings to the factory default values.
2. Turn off all functions and STAT Plots

This will not:

1. Clear any Y= functions.
2. Delete programs
3. Change the set up of the STAT Editor
4. Change any of the STAT Plots. They will just be turned off.

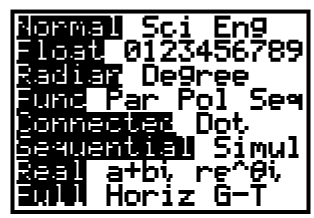
Reset Defaults:

- Press 2nd MEM (the + key)
- Select #5: Reset
- Select #2: Defaults
- Select #2: Reset

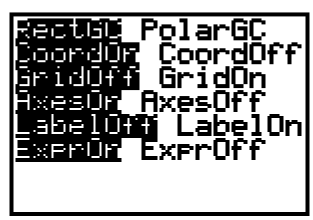


b. Verify/Change all MODE and FORMAT settings individually.

- Press MODE
  Arrow down and press ENTER on each line so that all selections on the left are highlighted.

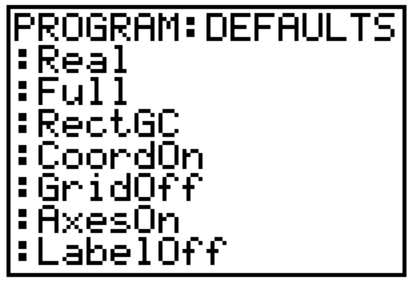


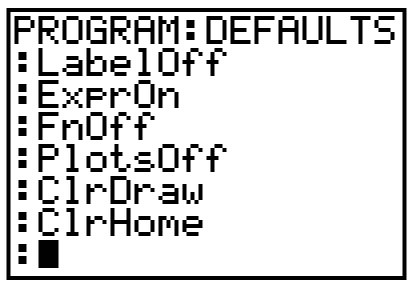
- Press 2nd FORMAT
  (over the ZOOM key in the top row)
  Arrow down and press ENTER on each line so that all selections on the left are highlighted.



c. Run a Defaults program.
One version is listed below

PROGRAM:DEFAULTS
:Normal
:Float
:Radian
:Func
:Connected
:Sequential
:Real
:Full
:RectGC
:CoordOn
:GridOff
:AxesOn
:LabelOff
:ExprOn
:FnOff
:PlotsOff
:ClrDraw
:ClrHome

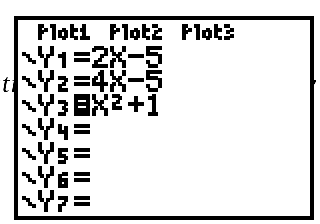




II. Setting Up A STAT PLOT

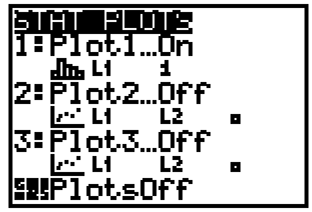
A. Preliminaries

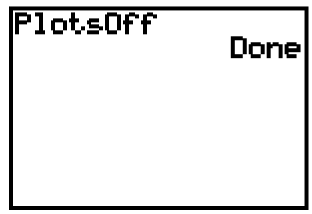
1. Set up STAT Editor and set Defaults as described in the previous section
2. Turn off or clear out unwanted functions.
   - Press Y= key
   - To clear out functions:
     Press CLEAR
     Down arrow and repeat
3. Deactivate functions
   - Position cursor over the =



- Press ENTER
  If the = is highlighted, the function is active.
  If the = is not highlighted, the function is turned off or deactivated.

4. Turn off all STAT PLOTS.
   - Press 2nd STAT PLOT
   - Select 4:PlotsOff
     This pastes command to the home screen.
   - Press ENTER to execute the command

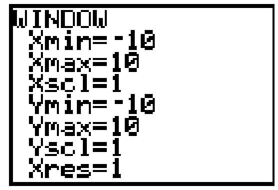




B. Establish a WINDOW

1. Review your experiment.
2. Determine which is the independent variable.
   This will be the Xlist
3. Determine which is the dependent variable.
   This will be the Ylist
4. Review the data values
5. Set up the range of values for the horizontal (X) and vertical (Y) axes.

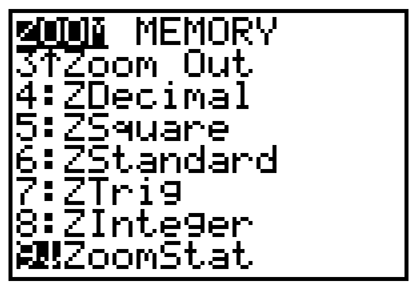
6. Press WINDOW to enter the values.
Xmin and Xmax are the least and greatest values for the horizontal axis (independent variable)
Ymin and Ymax are the least and greatest values for the vertical axis (dependent variable)
Xscl and Yscl are representative of the size of the unit markings on the axes
Xres is only significant with Y= function graphs. It tells the calculator whether to calculate and plot every pixel, or just every 2nd or 3rd pixel etc.



- **WINDOW setting notes for Histogram (vertical bar graph):**
  1. Xscl sets the bar width.
  2. Make Xmax one bar width beyond the last meaningful data value.
     (if there are test scores 0 – 100 displayed with bar widths10 set Xmax = 110)
  3. Xmax – Xmin divided by Xscl must be at least 2 since the calculator must be able to draw up and back down to form a bar.

  No more than 47 bars will fit on the screen.

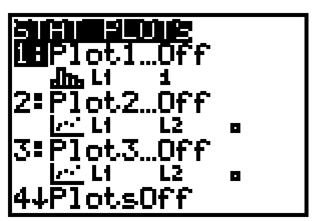
- **Note:** ZOOM Key
  9:ZOOMSTAT
  This choice will automatically fit a window to the data for all active STAT Plots.



It **is *not*** advisable to have students use this.
They will not understand the data as fully if they do not go through the process of interpreting the data in order to determine the graphic WINDOW settings.

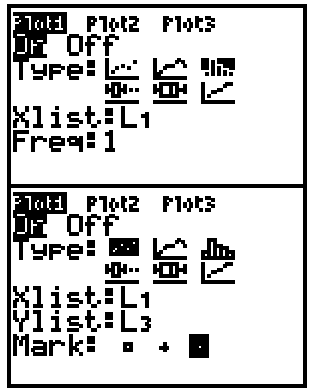
C. Set up a Statistical Plot

1. STAT PLOT menu
   - Press 2nd STAT PLOT to view the STAT PLOT menu.
   - Select one of the plots from the STAT PLOT menu
     Either press the number or arrow down and press ENTER.

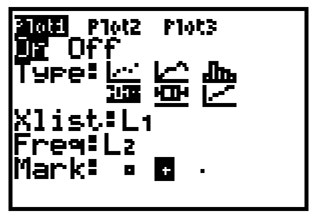


2. Set up selections

- On/Off
  All are selected by locating the cursor over the selection and pressing ENTER
- PLOT Types
  Scatter Plot and xy-line are used for 2 variable statistics. When these are chosen there will be a prompt for Xlist: Ylist: and Mark

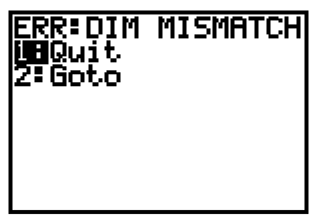


Histogram; Modified Box Plot; Box and Whisker Plot are used for 1 variable statistics.
When these are chosen, there will be a prompt for Xlist: and Frequency. The frequency is either 1 or it may be another list if there is a count of occurrences in a list.
The Modified Box Plot also asks for a mark. The mark is for the outliers.



3. Additional points

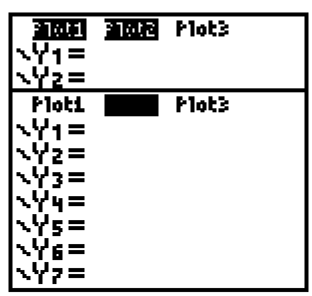
- Advance set up
  It is possible to set up the STAT plot before entering the data into the lists as long as the GRAPH key is not pressed before the data is entered.



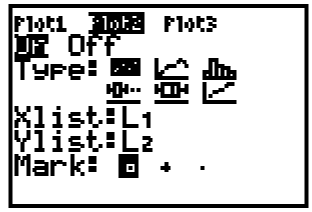
- DIM MISMATCH
  An error will occur if the two lists identified as the Xlist and Ylist don't have the same number of data points or if they are empty.

- In the Y= menu screen if a Plot is highlighted the Plot is active and will attempt to graph.

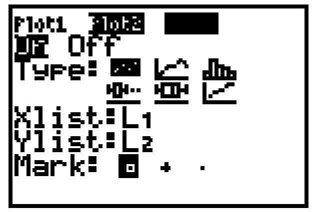
- To turn the Plot off
  Arrow up to place the cursor on the active Plot icon.
  Press ENTER. It will turn off.



- In the STAT PLOT screen after one of the Plots is selected, the plot which is highlighted at the top indicates the plot being used.



- If you want to switch to a different plot arrow up onto one of the other Plot icons and press ENTER. This will go to the set up window for that plot.



- It is not possible to determine which plots are active while working in one of the Plot setup windows.

- The PLOTS which are active can only be determined from the Y= menu or the main STAT PLOT menu.

D. TRACE on a STAT PLOT

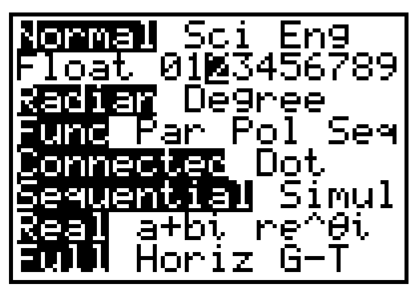
Each of the Stat Plot graphs can be traced by pressing the TRACE key. The information differs slightly for each type of graph.

Scatter or xy-line

Trace begins at the first value in the data lists. This may or may not be the leftmost point on the graph. If the Xlist values are not in ascending order the trace will not move from left to right. TRACE follows the data values in the Xlist in the order in which they occur in the list.

E. Using the calculator to find the Regression Equation

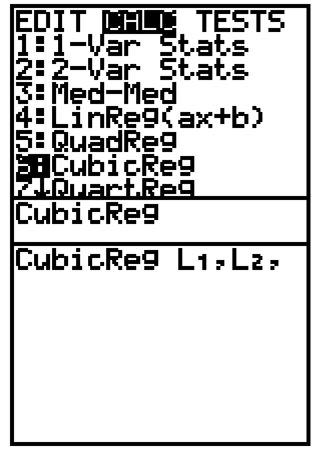
After the students have formulated their own function to model the experiment they can compare it to the Regression model produced by the calculator.



- Set MODE to two decimal places
  In order to avoid lengthy decimal values when calculating the regression equation it is a good idea to put the calculator into a decimal place mode other than FLOAT.
- Press MODE
- Arrow down and over
- Press ENTER on the desired number of decimal places.
- 2nd QUIT back to home screen

1. STAT CALC

The students have determined that the model is cubic based upon the experiment. So they will ask for a cubic regression model



Press STAT

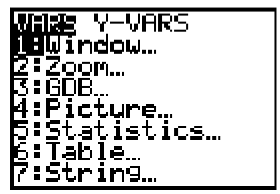
- Right arrow over to CALC
- Arrow down to 6:
- Press ENTER

This pastes the command on the home screen

Do *not* press enter again

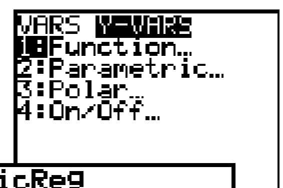
Indicate which lists to use in finding the equation and where the equation should be stored after it is calculated.

By storing it into one of the Y= registers it can be graphed as as a function on the screen



- Press 2^{nd} L_1 (on the 1 key)
- Press the comma key (black key above the 7 key)

- Press 2^{nd} L_2 (on the 2 key)
- Press the comma key



Next find the name of an empty Y= function location, use Y_1

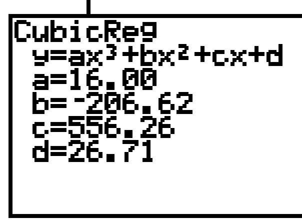
- Press VARS

next to the CLEAR key

- Right arrow to Y-VARS
- Select Function

Select Y_1

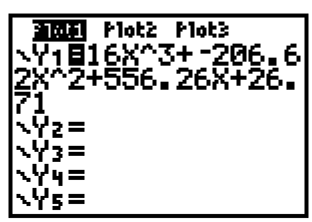
- Press ENTER



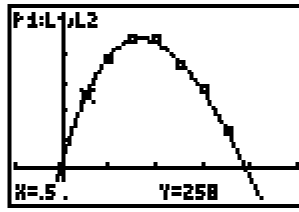
At this point the general form of a cubic polynomial is displayed along with the calculated values for the coefficients.

- Press Y= to see the

regression equation stored in as requested.

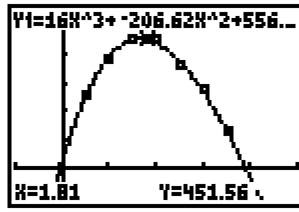


View the graphs of the STAT PLOT and the Regression Equation superimposed.



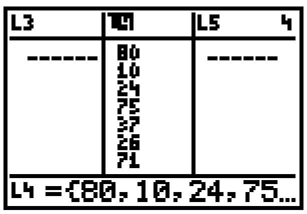
- APH
- ACE

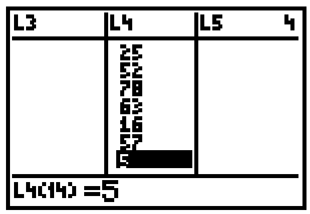
The TRACE cursor will always go to the first active STAT PLOT first.



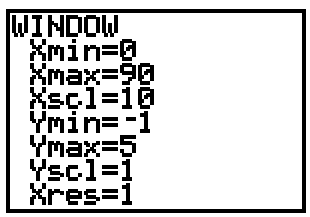
- wn arrow to n the function.

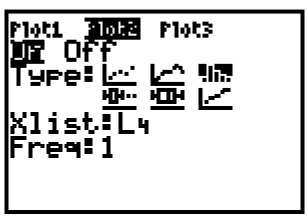
The following histogram and box and whisker plots are created with the small sample data set shown in List 4. Two screens are used to show all 14 members of the data set.





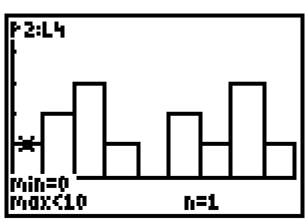
Notice the Xmax value of the window is one full Xscl amount more than the last value so that all bars will be included. Otherwise the data point 80 which is included in the bar from 80 to <90 would not appear.





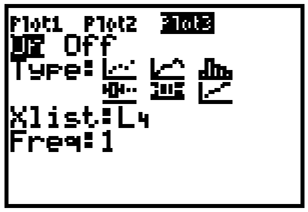
Histogram

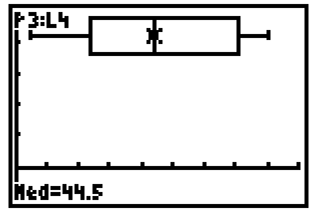
The trace begins at the top center of the first bar. The trace cursor moves from the center of one bar to the next from left to right. At the bottom of the screen the min and max values of the interval are reported along with n, the number of values which fall in that interval.

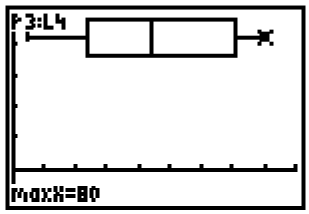


Box and Whisker Plots

The trace begins at the median value. The left cursor arrow moves to Q_1, the 1st quartile and then minX. Moving right Q_3 and maxX values are given.

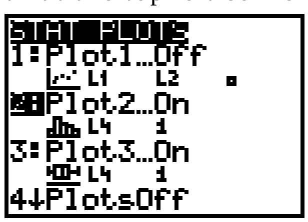


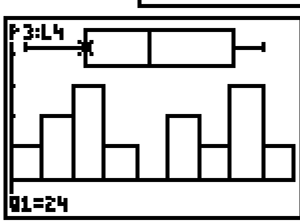


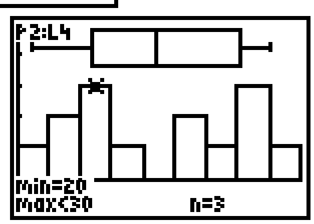


2. **Viewing and tracing more than one Stat Plot or graph simultaneously.**

The right and left cursor move arrows advance the cursor along the graph or STAT PLOT during TRACE. The TRACE cursor can be moved from one graph or STAT PLOT to another using the up and down cursor move arrows. All Y= functions which are turned on and all STAT PLOTs which are ON will be graphed when the GRAPH key is pressed (even if the graph doesn't show in the current viewing window). When TRACE is pressed the trace will begin on the lowest numbered plot which is active. The cursor move down arrow will advance through the Plots and the Y= functions in numerical order. If the default FORMAT is set to ExprOn the Plot# and the plotted data lists, or the Y_n = function appear at the top left corner of the graphic screen during trace.







III. List Operations

Prior to beginning this section it may be necessary to refer to the information regarding setting up the editor in the **I. Getting Started Setup Procedures** section. Also if there is currently data in a list which you want to eliminate skip ahead to the information on Clearing out a list.

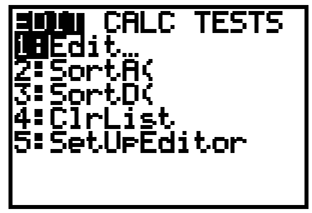
A. Storing Data in a List

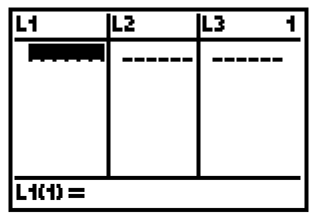
There are three main methods for storing data in a list.

Method 1

With the STAT Editor

- Press STAT key
- Select 1: Edit (Press 1 *or* press ENTER)
- Key in values Press ENTER or down arrow after each value
- Cursor move arrows can be used to move from list to list or through the values in a list.





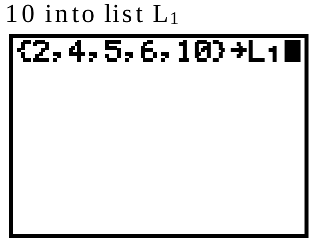
Method 2

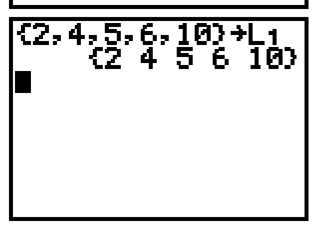
From the home screen

A list of elements can be stored to a list using the STO→ key.

For example store the values 2,4,5,6 and 10 into list L_1

- Press { 2,4,5,6,10} →L_1
  Note: The { } are grouping symbols.
  They are found as the 2nd function over the parentheses ( ) keys.
  The STO→ key is the key above the ON key.
  L_1 is 2nd and the number 1 key
- Press ENTER to execute the command





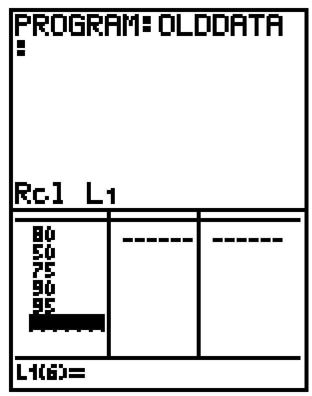
Method 3

Store data to a list from a program

- Press PRGM key
- Arrow over to NEW
- Press ENTER
- Give the program a name not more than 8 letters
  The calculator is in ALPHA LOCK so you just have to find the green letters.
- Press ENTER to enter the Program Editor
- Key in the statement shown in Method 2 above and press ENTER

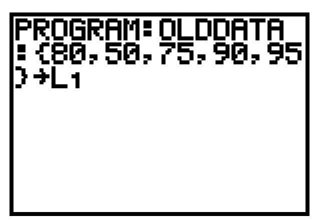
B. Recalling data from a list into a program

This is especially convenient if a data gathering device such as the CBL or CBR has been used. Prior to running another experiment or repeating the same experiment it is a good idea to pull the lists into a program using 2ndRCL. Then the lists can be restored later by running the program. To save data that is in a List:



- Create a program as was done in Method 3 above. Use a Different name
- Press 2nd RCL for recall
  This is the 2nd function on the STO→ key
- Key in L_1 after the Rcl
- Press ENTER
- Press STO→
- Press 2nd L_1
- Press 2nd QUIT to exit the Program Editor

To restore this data into L_1, execute the program. The program will store the data into List 1.

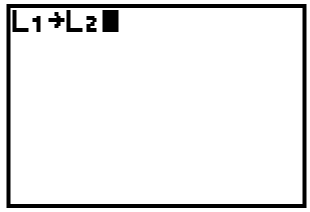


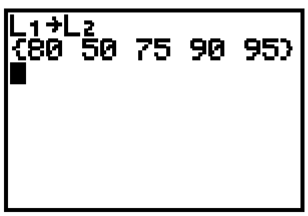
C. Copying Data from one List to Another List

If there is data in a list already and you would like to copy this data into another list:

1. On the home screen with a simple assignment using STO→.

- Press 2nd L_1
- Press STO→
- Press 2nd L_2
- Press ENTER 1

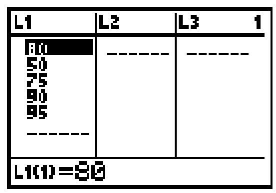




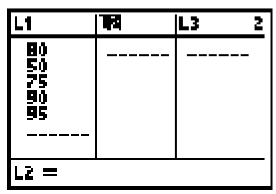
From the STAT Editor

- Press STAT
- Press ENTER to select 1:Edit

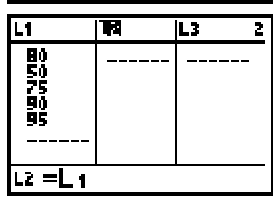
- Right arrow to list 2

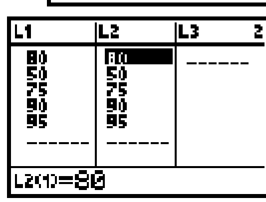


- Press the up arrow to move the cursor so that it is on the heading L_2.



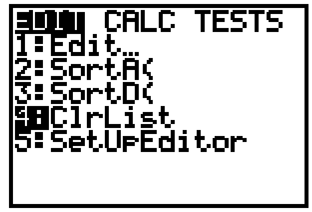
- Press 2nd L_1
  A copy is put in L_2





D. Clearing out a List

It is best to clear a list before entering new data. Although the data can be overwritten, the remaining data does not go away without being deleted somehow.

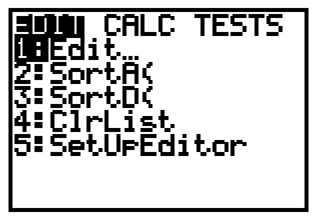


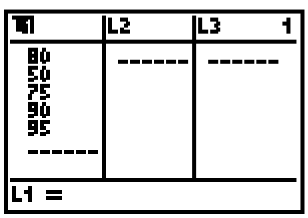
From the home screen:

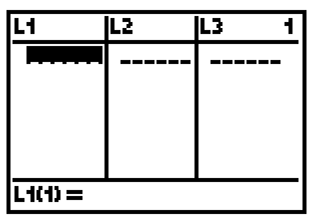
- Press STAT
- Select 4: ClrList (either press 4 *or* arrow down and press ENTER)
- After ClrList type the names of the list(s) to be cleared.

From the STAT Editor

- Press STAT
- Select 1:Edit
- Arrow up to place the cursor on the list heading.
- Press CLEAR
- Press ENTER.







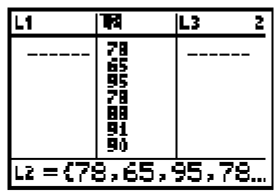
E. Sorting a List

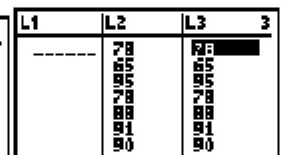
Data in a list can be sorted into either ascending or descending order. This comes in handy when viewing data to find maximum, minimum and mode values among other things. Also if a scatter plot is being done it is convenient. The Xlist should be sorted into ascending order so that the TRACE will move from left to right. For an xy-line the data must be plotted in order.

SortA(sort into ascending order, i.e., from smallest to largest; and

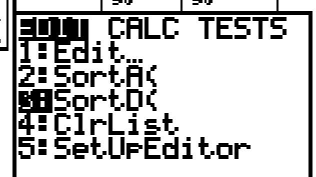
SortD(sort into descending order, i.e., from largest to smallest can be found in two places. They are in the STAT EDIT menu as selections #2 and #3 and they are also in the 2nd LIST OPS (operations) menu as selections #1 and #2. Use whichever you prefer. The operation should be done on the home screen.

It is a good idea to make a copy of the unsorted list before sorting. Sometimes you will want to refer to the data in its original order.

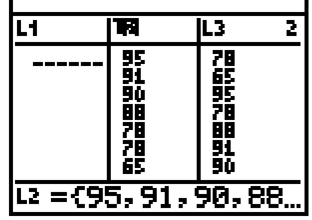




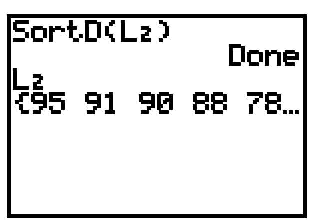
Suppose that L_2 is a sample list of seven test scores. Make a copy of L_2 in L_3. In order to have the highest score listed at the top and to search for the mode, we will Sort L_2 into decreasing order.

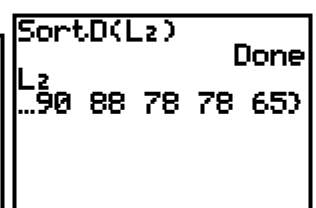


- Press STAT
- Select #3:SortD(
  Key in 2nd L_2
- Press ENTER
  To check go to the STAT Editor or simply print L_2 on the home screen



- Press 2nd L_2
- Press ENTER
- The ellipsis at the right indicates that there is more.
- Hold the right arrow to scroll the list.

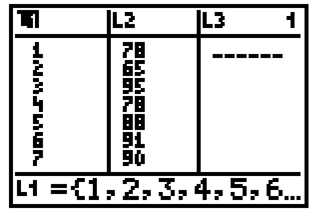




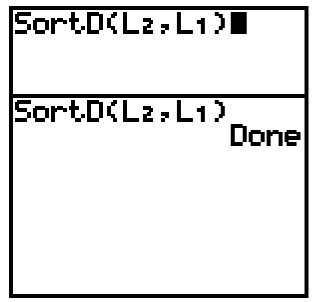
Frequently it is necessary to carry another list of values along with the sort. For example, you might have student numbers from your grade book in L_1 and the corresponding student test scores in L_2. You want to sort the test scores into descending order, but you need to keep the correct student number with each score. So you want to sort L_2 and carry L_1 along as a parallel list.

The command would be SortD(L_2, L_1)

The first list, L_2 is the one being sorted and the corresponding values in all other lists are carried along to the same relative position.



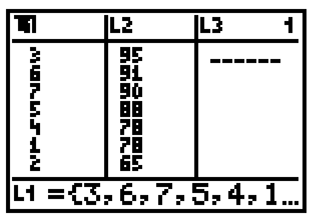
- Set up SortD(L_2, L_1)
- Press ENTER to execute the command.
- View sorted lists in STAT Editor.



Notice that student number 3 had the highest score on the test.

The mode of 78 can be identified.

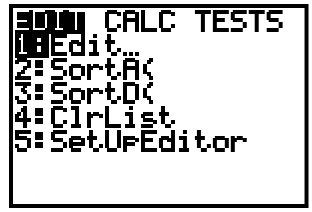
To restore the original order of the gradebook, use SortA(L_2, L_1)

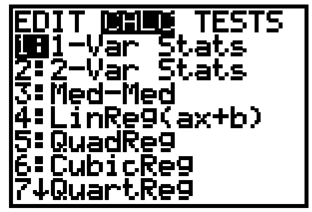


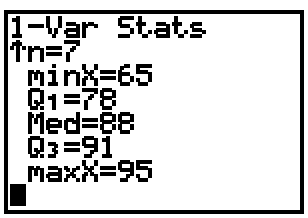
F. Statistical Analysis of a List

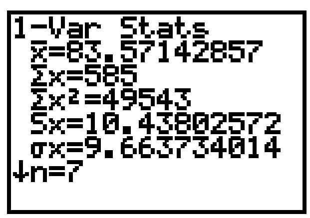
The calculator can perform statistical analysis on one or two variable data sets. Using the set of 7 test scores we will do a one variable analysis.

- Press STAT
- Right arrow to CALC
- Press ENTER
- Press 2nd L_2 since the test scores are in L_2
- Press ENTER
- The x-bar is the mean
- Information about standard deviation n is the number of items
- The downward arrow means there is more.
- Press the down arrow on the calculator to see the rest of the information.
  It is the maximum, minimum, median and 1st and 3rd quartiles for the data set.



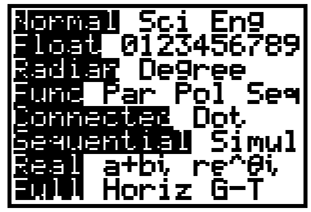




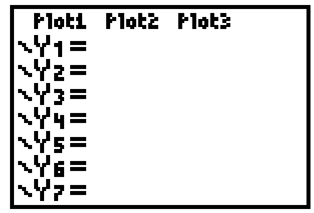


IV. Function Graphing Y= MENU

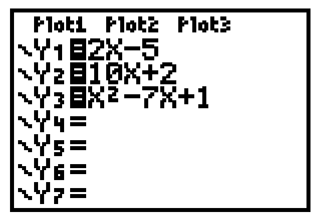
The TI-83 provides 10 registers for storing functions when in the default Function mode.



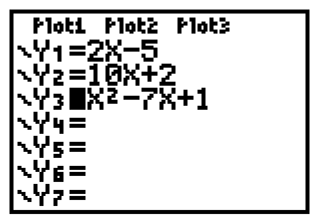
- Press MODE and set the calculator to the default settings with all shaded selections on the left.



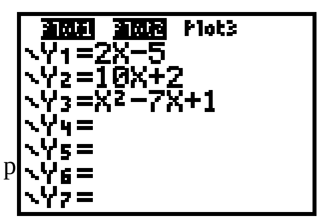
- Press the Y=key in the upper left location on the calculator key pad.
  1. If there are equations present which are not needed .
     - Press CLEAR
     - Down arrow to delete them



  2. If there are equations present which you will need, but not want them to be graphing now:
     - Locate the cursor on the = sign
     - Press ENTER

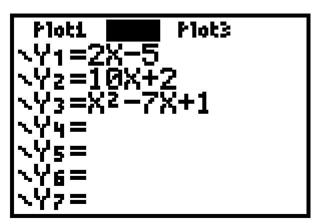


     This will remove the shading from the = sign and indicates that the function has been turned off and will not show in either the graphing screen or tables.



  3. If any of the Plots are active the indicator will be highlighted
     - Press up arrow
     - Press ENTER to turn off the p

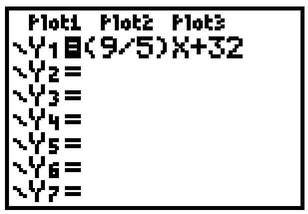
     It will no longer be highlighted. This method can also be used in reverse to activate one or more of the statistical plots from the Y= menu.



To enter a function simply press Y=, CLEAR if necessary to remove an unwanted function and key in your equation. Regardless of the variable in your formula, you must use X as the independent variable when graphing in Function mode. The independent variable key is next to the green ALPHA key. It has X,T,Θ,*n* on it. These are the four different independent variables corresponding to the four different calculator modes. They are Function (Func), Parametric (Par), Polar (Pol), and Sequence (Seq). You will probably only use Function mode.

So if you want to graph a function representative of $F = (9/5)C + 32$ you would need to enter into Y_1 the expression $(9/5)x + 32$

The slash mark to the left of the Y_1 indicates graphing style. Default is a normal thin line.



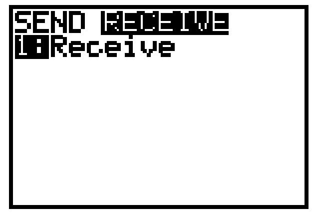
V. Linking

A. Calculator to Calculator

The black link cable supplied with the calculator allows you to transfer data from one calculator to another. It is possible to transfer programs, lists, equations, etc., or even make one calculator an exact copy of the other by doing a back up.

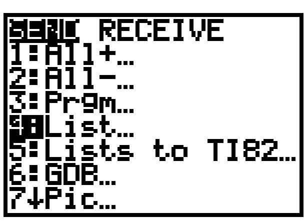
The process is described in the TI-83 users manual. Briefly it is as follows.

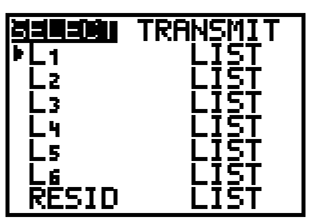
1. Press the link cable *firmly* into the link port in the bottom of each calculator. Push hard. Sometimes it does not go in all the way at first.
2. Turn on both calculators.
3. On the calculator which will be receiving the data:
   - Press 2nd LINK (it is over the independent variable key (X,T,Θ,n)
   - Right arrow to RECEIVE
   - Press ENTER
   - Waiting...

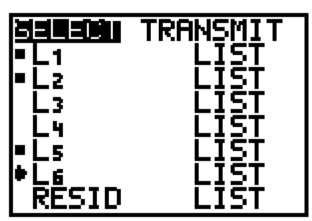


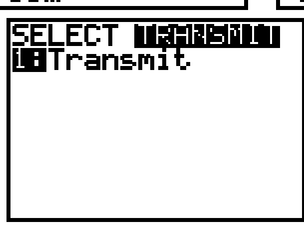
4. On the sending calculator
   - Press 2nd LINK
   - Press the number of your choice
   - Press ENTER next to any item which you want to send. This will put a box next to that item indicating that it is selected.
   - Arrow over to TRANSMIT
   - Press ENTER

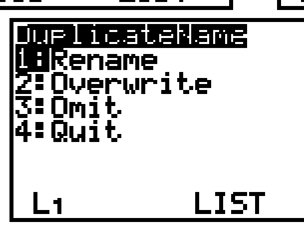
5. If the receiving calculator already has data in the named item which is being sent the calculator will offer the options of Rename, Overwrite, Omit, or Quit.











B. Calculator to CBL Linking

The calculator is linked to the CBL with the same cord as is used for the calculator to calculator linking. The link port for the CBL to calculator link is located at the bottom of the CBL in a place similar to where it is on the calculator. Both devices must be turned on. A program is necessary to either send commands to the CBL or to receive data from the CBL into the calculator.

C. Calculator to Computer Linking

The TI-GRAPH LINK™ made by Texas Instruments is sold through all educational dealers who carry TI products as well as at some local stores. If purchased from an educational dealer you will receive one link cable with adapters which allow you to connect to either a MacIntosh or PC through the serial port. A manual and software are provided for both operating systems and for all of the Texas Instruments link-able calculators. The software is self-installing.

Advantages include:

1. Programs and data can be saved on the computer or floppy so that there will be enough memory in the calculator for other activities.
2. Special programs distributed by vendors along with activity workbooks can be loaded into the calculator.
3. Graphs, data lists and other calculator screens can be printed by the teacher for activities.
4. Graphs, data lists and other calculator screens can be printed by students for inclusion in lab reports.
5. Data can be loaded into the computer for analysis with other software.
6. Programs can be sent to the calculator after being downloaded from Web sites.

Menu Descriptions

#1	**RUN**	Use this mode for arithmetic calculations and function calculations, and for calculations involving binary octal, decimal and hexadecimal values.
#2	**STAT**istics	Use this mode to perform single-variable (standard deviation) and paired-variable (regression) statistical calculations, to perform tests, to analyze data and to draw statistical graphs.
#3	**MAT**rix	Use this mode for storing and editing matrices.
#4	**LIST**	Use this mode for storing and editing numeric data.
#5	**GRAPH**	Use this mode to store graph functions and to draw graphs using the functions.
#6	**DYNA**mic	Use this mode to store graph functions and to draw multiple versions of a graph by changing the values assigned to the variables in a function.
#7	**TABLE**	Use this mode to store functions, to generate a numeric table of different solutions as the values assigned to variables in a function change, and to draw graphs.
#8	**RECUR**sion	Use this mode to store recursion formulas, to generate a numeric table of different solutions as the values assigned to variables in a function change, and to draw graphs.

#9	**CONICS**	Use this mode to draw graphs of implicit functions.
A	**EQUA**tion	Use this mode to solve linear equations with two through six unknowns, quadratic equations, and cubic equations.
B	**PR**o**G**ra**M**	Use this mode to store programs in the program area and to run programs.
C	**T**ime **V**alue	Use this mode to perform financial calculations of **M**oney and to draw cash flow and other types of graphs.
D	**LINK**	Use this mode to transfer memory contents or back-up data to another unit.
E	**CONT**rast	Use this mode to adjust the color contrast of the display.
F	**MEM**ory	Use this mode to check how much memory is used and remaining, to delete data from memory, and to initialize (reset) the calculator.

Measurement and Conversion

This activity is an introduction to the Casio 9850G-Plus. It serves as an overview of some of the capabilities of this graphing calculator.

Materials

- ✓ Casio 9850G-Plus graphing calculator
- ✓ Measuring tape (English)
- ✓ Measuring tape (Metric)
- ✓ Class data worksheet

Procedure

Get a partner.

You and your partner should use the appropriate measuring tapes to measure each other's heights in both inches and centimeters.

Each person should record his/her height data on a group chart in the front of the room.

Each person should copy the class data onto the attached class data worksheet.

Follow the calculator procedure.

Calculator Procedure

NOTE**: For the purpose of showing directions in this section, a set of data will be provided; your data will vary slightly from the sample data but should show similar trends.**

List 1: 65, 61, 57, 69, 63, 71, 68 inches

List 2: 165, 154, 145, 175, 160, 180, 173 centimeters

1. To Clear Lists and Functions
In order to manipulate the class data, any existing data within the calculator will have to be cleared.

A. To clear existing equations:

Go to the GRAPH mode (#5) on the calculator.

Select F2 (DEL), select F1 (YES). The second command here allows you a second chance to say whether you really want to delete the highlighted equation or not.

Press the down arrow key in order to highlight any other existing equations. Once each existing equation has been highlighted, select F2 (DEL), then select F1 (YES).

B. To clear data in existing lists:

Go to the STAT mode (#2) on the calculator.

Press the F6 (ω) key until you see the DEL-A option above the F4 Function key.

Press the up arrow key in order to highlight the words "List 1". Press F4 (DEL-A). All data in List 1 should now be highlighted. Press F1 (YES) to finish the job of deleting List 1.

Use the right arrow key in order to highlight any other Lists that contain data. Select F4 (DEL-A), then select F1 (YES). It is important to make sure that you initially highlight the name of the list at the top of each column and not the first piece of data in order to delete all data that is contained in that list.

2. Now that the graphing calculator is cleared of equations and lists, it's time to enter the New Data.

Go to the STAT Mode (#2) on the calculator. The cursor should be in the first position of List 1.

Enter the inch data into List 1 by keying in the digits of your first measurement. Check your entry at the bottom of your screen on the left-hand side above the option labels before hitting the EXE key. Pressing the EXE key will automatically move you to the next line ready for more data input.

Any data that has been input incorrectly can be easily fixed.

If the mistake is discovered **before** the EXE key is pressed, then use the left arrow key to place the cursor under the incorrect digit(s) and then press the DEL key. Now input the correct data and press the EXE key.

If the mistake is discovered **after** the EXE key is pressed, then use the up arrow key to highlight the incorrect piece of data and simply type in the corrected data and press the EXE key. The new data will now appear.

A piece of data that has been inputted and is no longer needed in that space will require a different set of key strokes. First of all, use the up or down arrow key in order to highlight the extraneous piece of data. Secondly, select F6 (ω). Lastly, select F3(DEL). The data should now be gone. The rest of the data in the list will move up the column accordingly.

Any data that has been accidentally omitted can be inserted in using these steps. Use the up or down arrow key to highlight the place where the missing data belongs. Select F6 (ω), the select F5 (INS). Input the missing piece of data now. Press the EXE key. The rest of the data in the list will move down the column accordingly.

Once all of the inch data has been entered, use the right arrow key to move over to List 2, position one. Enter the centimeter data into List 2.

3. To organize the data within the lists according to ascending value

Go to the STAT Mode (#2) on your calculator.

Press F6 (ω).

Select F1 (SRT-A). Sort the data in List 1.

At this point, the calculator is asking, “How Many Lists? (H)”. Press 1, and then EXE to sort one list.

The calculator is now asking, “Select List (L)”. Press 1, and then EXE. The data in List 1 should now be in ascending order.

4. Analyze the data.

Go to the STAT Mode (#2) on the calculator.

Press F2 (CALC). This will bring up another row of options above the function keys.

Press F6 (SET). On the screen now is a listing of where the statistical data for the calculation is located. For the purposes of this exercise, we only need to be concerned with the first item that is already highlighted, "1Var XList : List1". This is specifying List1 to be the list where single-variable statistic x-values (XList) are located. To change the specificity of the list to List2, List3, List4, List5, or List6, use the function keys that correlate with the option labels at the bottom of the screen. Now, make sure that for this exercise List1 has been specified.

Select the EXIT key. This moves back to the previous screen.

Select F1 (1VAR). This will give an analysis of the data in List1. Use the down arrow key to scroll down the screen and view the items that run off the bottom of the screen. The following describes the meaning of each of the parameters:

² .... Mean of data
åx .... Sum of data
åxâ .... Sum of squares
xsÌ .... Population standard deviation
xsÌý .... Sample standard deviation
Ì .... Number of data items
minx .... Minimum
Q1 .... First Quartile
Med .... Median
²-xsÌ .... Data mean – Population standard deviation
²+xsÌ .... Data mean + Population standard deviation
Q3 .... Third Quartile
maxX .... Maximum
Mod .... Mode

5. **Data can be analyzed in the RUN Mode (#1) as well.**

Go to the RUN Mode (#1). This is a section of the calculator where basic functions (i.e. - addition, subtraction, multiplication, and division) can be accomplished, as well as so much more.

Select the OPTN key. A row of icons appears at the bottom of the screen and above the six function keys.

Select F1 (LIST). Another row of icons now appears. Select F6 (ω) to reveal more icons.

At this point we could find out the Median of the data in List 1. Select F4 (Med). Select the EXIT key to go back to the previous screen of option icons. Select F1 (LIST). Select F1 (List) again. Press the number 1 to denote finding the median of List 1. Press the EXE key to execute the command. The answer should appear on the right-hand side of the screen.

The mean of List 1 could be found very similarly. Select F6 (ω). Select F3 (Mean). Press the EXIT key. Select F1 (LIST). Select F1 (List). Press the number 1 and then the EXE key.

At this point, clear the screen by pressing the AC/ON key. Repeatedly press the EXIT key to clear the option icons at the bottom of the screen.

To find out how many pieces of data are in a list, press the OPTN key. Select F1 (LIST). Select F3 (Dim). Select F1 (List). Press the number 1 and then the EXE key.

To find the differences between successive terms in a list, in other words creating a delta list, do the following: Press F6 (ω), Press F6 (ω) again, Press F5 (Δ), Press the number 1 to denote List 1 and then the EXE key. Use the up and down arrow keys to scroll up and down the delta list.

This delta list can even be stored in a different list as part of the STAT Mode (#2). Select F5 (Δ). Press the number 1. Now **before** pressing the EXE key, press the ➜ (send) key located above the AC/ON key. This is telling the calculator to send the answer somewhere else. At this point, we need to type in where the answer should be sent. Press the EXIT key. Select F1 (LIST). Select F1 (List). Press the number 3 to send the answer into List 3. Press the EXE key. A message on the right-hand side of the screen says, “Done”. To see the answer in List 3, press the MENU key. Go to STAT Mode (#2). Use the arrow keys to scroll up and down List 3.

To square the inches from List 1, go back to the Main Menu. Press the MENU key. Select the RUN Mode (#1). Press the OPTN key. Select F1 (LIST). Select F1 (List). Press the number 1. Press the x^2 key located to the right of the red ALPHA key. Now select the ➜ (send) key above the AC/ON key. Press F1 (List). Press the number 4 to send the answers to List 4. Press the EXE key. To see the answers, press the MENU key. Select the STAT Mode (#2) key.

6. To look at the domain of the values in a list using a Box Plot:

Select STAT Mode (#2).

Press F1 (GRPH). This takes us into the Graph options.

Press F6 (SET). This will allow us to set up our Box Plot graph.

Use the down arrow key to highlight the Graph Type. Press F6 (ω). Select F2 (Box). This will set the graph as a Box Plot.

Use the down arrow key to highlight the XList. Select F1 (List1). The Box Plot is to be drawn from the data in List 1

Use the down arrow key to highlight the Frequency. Select F1 (1).

Use the down arrow key to highlight the Graph Color. Choose any of the three colors. Press F1 (Blue), F2 (Orng), or F3 (Grn).

Use the down arrow key to highlight the Outliers. Press F1 (On) to turn the outliers on.

Press the EXE key to complete the set-up of our Box Plot.

Press F4 (SEL). This goes into another screen that gives the option of viewing up to three graphs at once. At this point, we only want to view StatGraph1. Use the arrow keys to highlight StatGraph1. Press F1 (On). Highlight StatGraph2. Press F2 (Off). Highlight StatGraph 3. Press F2 (Off). Press F6 (DRAW) to draw our box plot.

Trace along the box plot to read the quartile data. Select the SHIFT key, then press the F1 (TRCE) key. Press the left and right arrow keys to read the quartile data.

7. To establish a histogram of the List 1 data, height of the class in inches:

From the Main Menu, choose STAT Mode (#2).

Press F6 (SET). Highlight the Graph Type. Press the F6 (ω) key. Select F1 (Hist). Highlight the XList. Select F1 (List 1) to pull the data from List 1 to create the histogram. Highlight the Frequency. Select F1 (1). Highlight Graph Color. Choose any of the three colors. Press the EXE key.

Press F4 (SEL). Make sure only StatGraph1 is ON.

Select F6 (DRAW).

This is the Set Interval screen. "Start" refers to the histogram start point. "Pitch" refers to the bar spacing or the scale unit. The calculator can automatically choose these settings or you can customize them. For the purposes of this exercise, leave the Start setting alone, but change the pitch to 3. Do this by highlighting the pitch setting. Press the number 3. Press the EXE key. The EXE key must be pressed at this point, or the calculator will automatically revert the pitch setting back to what it had wanted to set it at. Press F6 (DRAW).

Press the SHIFT key followed by F1 (TRCE). Use the left and right arrow keys to obtain values represented. Notice the height intervals defined by each portion of the bar graph; notice the number of people whose height fell within that interval is defined under "f".

To practice the skills outlined in this lesson, examine the data in List 2, height in centimeters. It was not sorted with List 1 because it was not included in the sort command. Sort the data and answer the following questions using the techniques presented in this exercise.

1. From the sorted list, what is the shortest height in centimeters?

2. From the sorted list, what is the tallest height in centimeters?

3. What is the sum of all the heights in List 2?

4. What is the sum of all the heights squared in List 2? What is the unit?

5. What is the standard deviation of List 2?

6. What is the mean height of List 2?

7. What is the median height of List 2?

8. Set up a box and whiskers plot of List 2. What is the lower quartile? What is the upper quartile?

9. What is the inner quartile difference in heights (Q3 – Q1)?

10. Construct a histogram of the data in List 2. Allow the calculator to set a pitch, as well as set a pitch of your choice. What is the most common height interval in the class?

8. To establish a direct or inverse relationship between the measurements in inches and in centimeters,

A. Gather the data together in a scatter plot.

Go to the STAT Mode (#2) on the calculator.

Press F1 (GRPH). Press F6 (SET).

Use the down arrow key to highlight Graph Type. Select F1 (Scat). Enter the appropriate list values as follows:

XList	: List 1
YList	: List 2
Frequency	: 1
Mark Type	: Choose one
Graph Color	: Choose one

Press EXE when all of the previous information has been entered in.

Select F4 (SEL). Make sure only StatGraph1 is on. Select F6 (DRAW).

B. Establish a regression equation which best fits experimental data.

The data appears to be linear by its scatter plot; therefore select F1 (x). The screen now shows the coefficients of a and b in linear regression analysis, y = ax + b; a is the slope of the line, b is the y intercept. The lower case r is the regression coefficient, which indicates how close the scattered points fit the regression line. Values closer to one are considered a good fit! This data reflects the direct relationship between measurements made in metric and English. The slope of the resulting line will show the equivalency between centimeters and inches and should be close to 2.54; 2.54 centimeters is approximately equal to 1.00 inch.

Press F5 (COPY). This will transfer the equation directly to the Graph Function Y = screen. Press EXE. Press F6 (DRAW). The line created from the equation is now drawn on the scatter plot.

Understand the Casio Data Analyzer (EA-100) Keyboard

The keyboard has eight function keys and five additional shifted functions.

Description of Eight EA-100 Keys:

ON/OFF Turns Data Analyzer on and off.

SHIFT Used to access the functions printed above the keys in gold. The word SHIFT appears in the upper right-hand corner of the screen.

MODE Shifts the Data Analyzer between the multimeter mode (the word MULTIMETER appears in the lower left-hand corner of the screen when in this mode) and the communications mode; most often you want to be in the communications mode.

TRIGGER Each press of this key while the Data Analyzer is in the READY state takes a data sample. (The word READY appears on the left-hand side of the screen.)

CH-View Depends on the mode (e.g., changes which channel's data are displayed). See pages 6 and 7 of the Data Analyzer manual.

- Communication
- Multimeter
- Internal
- Data-Log Mode

INTERNAL Tells you the current voltage remaining in the Data Analyzer's batteries.

DataLOG Allows you to scroll through data stored in the Data Analyzer. In the multimeter mode, this key changes the unit of measurement for the displayed channel.

HALT Serves several functions (e.g., halts a sampling operation). See page 7 of the Data Analyzer manual.

Description of Five Shift Functions (printed in gold above the keys):

SETUP Press **SHIFT + MODE** to enter the **SETUP** mode to use the Data Analyzer as a stand-alone device to sample data (no program is needed for a calculator).

XMIT-9800 Sends data to a CFX-9800G calculator.

RESTART Pressing **SHIFT + HALT** clears any existing sampled data and returns the Data Analyzer to the READY state to begin again.

NEXT In the Setup Mode and the DataLOG Mode, this key gives the next choice in a sequence or the next data value.

ENTER The Trigger key serves as an "enter" key when selecting values for the Setup mode.

Casio Program-Link (FA-122)

Transferring files from the graphing calculator to the computer:

1. Install the Casio Program-Link into the computer's hard drive. To retrieve it, go to **Programs** on the hard drive.

2. Connect the communication cable to the computer's COM1 or COM2 port.

3. Turn the calculator **ON**. Make sure to connect the communication cable from the computer to the calculator!

4. On the computer select **LINK** on the menu control bar. Scroll down to highlight **Receive**.

5. On the graphing calculator, go to **LINK** Mode (letter D). Press F1 (**TRAN**). Press F1 (**SEL**). Highlight the data item you want to send. Press F6 (**TRAN**). Press F1 (**YES**). The data transfer should start at this time, with its progress indicated by a dialog box on the computer screen. The message, "Transmit ERROR!" appears on the calculator screen if the computer is not set up to receive data.

6. When data transfer is complete, a new catalog window appears on the computer screen. Save the data as a file. On the computer, select **FILE** on the menu control bar. Scroll down to highlight **Save** or **Save As**. Specify a file name and click **OK** to save it as a catalog file.

7. Double check the following items whenever data transfer is not performed correctly:

   - Check for proper connection of the communication cable.

   - Check that the port was correctly selected on the computer. Do this by selecting **LINK** on the menu control bar, and then scrolling down to highlight **Communications**.

Transferring files from the computer to the calculator:

1. Install the Casio Program-Link into your computer's hard drive. To retrieve it, go to **Programs** on the hard drive.

2. Connect the communication cable to the computer's COM1 or COM2 port.

3. Turn the calculator **ON**. Make sure to connect the communication cable from the computer to the calculator!

4. On the computer select **FILE** on the menu control bar. Scroll down to highlight **OPEN**. A dialog box should appear. This dialog box can be used to specify a file name and also to specify a drive and directory.

5. Click on a group and item to select it for transfer.

6. Go to **LINK** mode (letter D) on the graphing calculator. Press F2 (**RECV**).

7. On the computer select **LINK** on the menu control bar. Scroll down to highlight **TRANSMIT**. Double check to make sure that both units are set up correctly for data transfer and then click **OK**. Data transfer starts at this time, with its progress indicated by a dialog box on the computer screen. If a received file has a name of a file already stored in calculator memory, a dialog box appears asking if you want to overwrite the existing file. Select **YES** or **NO** in response to the dialog message. The message "Transmit ERROR" appears if the calculator is not set up to receive data.

8. When data transfer is complete, the dialog box closes.

9. Double check the following items whenever data transfer is not performed correctly:

    - Check for proper connection of the communication cable.

    - Check that the port was correctly selected on the computer. Do this by selecting **LINK** on the menu control bar, and then scrolling down to highlight **Communications**.

Capturing a screen to your computer:

1. Install the Casio Program-Link into your computer's hard drive. To retrieve it, go to **Programs** on the hard drive.

2. Connect the communication cable to the computer's COM1 or COM2 port.

3. Turn the calculator **ON**. Make sure to connect the communication cable from the computer to the calculator!

4. Go to **LINK** Mode (letter D) on your calculator. Press F6 (**IMGE**). Press F2 (**MONO**). Perform the necessary operations on the calculator to produce the desired screen.

5. On the computer, select **LINK** on the menu control bar. Scroll down to highlight **Screen Capture**.

6. On the graphing calculator, press the **F « D** key located above the number 8. The data transfer should begin now, with its progress indicated by a dialog box on the computer screen.

7. After the transfer is complete, the screen data appears on the computer screen.

8. Save the data in a file. Select **FILE** on the control menu bar. Scroll down to highlight **SAVE** or **SAVE AS**. Specify a file name and click **OK** to save it.

9. While the image is on the display, select **FILE** on the control menu bar. Scroll down to highlight **PRINT**. Specify the printer, print options, number of copies, and enlargement factors, and then start the printing. The preview function can be used to display an image of the printout on the screen.