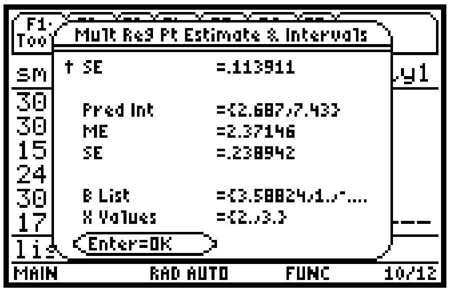

Figure 45

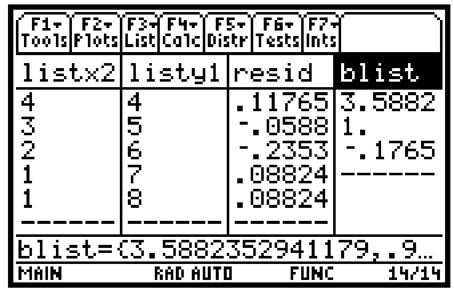

Figure 46

Hypothesis Testing for a Single Population Mean. Use as a null hypothesis H_0: $\mu = 14$ for the data set ns and use a t-test. Hit 2nd[F6](Tests)–>2:T-Test. In the first window that comes up, choose Data. Put 14 for μ0, ns for List, 1 for Freq, and choose $\mu \neq \mu$0 for Alternate Hyp. For Results, choose Calculate. See Figure 47. Then hit ENTER. The results window gives t=.494324 and p=.627404 along with other results. See Figure 48.

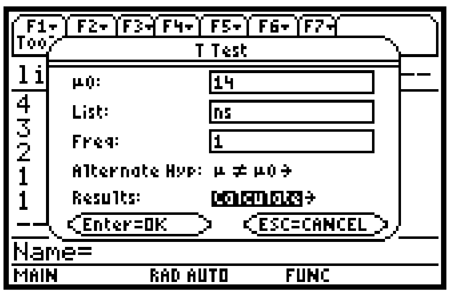

Figure 47

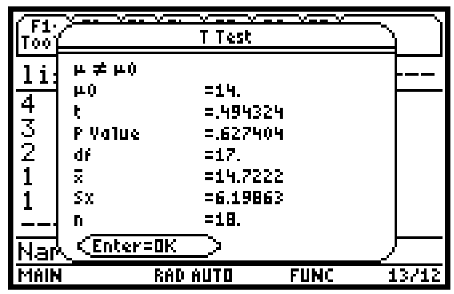

Figure 48

To get a graphical representation instead, choose Draw instead of Calculate for Results. The t and p values are given below the graph with the p equaling the shaded area. See Figure 49. Notice that you are now in the graph page.

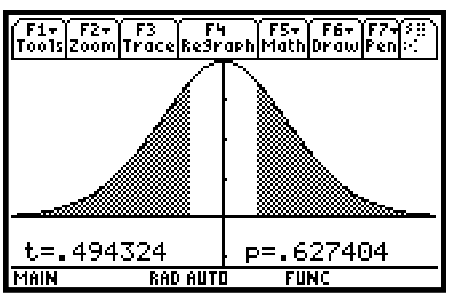

Figure 49

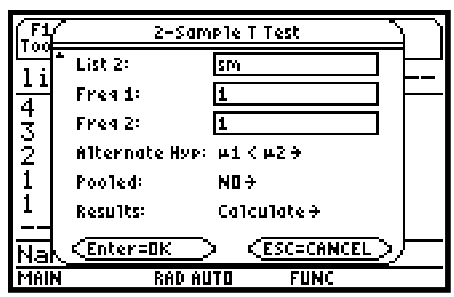

Figure 50

If the population standard deviation σ is known, you can make use of the normal distribution by choosing 2nd[F6](Tests)–>1:Z-Test instead of 2nd[F6](Tests)–>2:T-Test.

Hypothesis Testing for the Difference between Two Population Means. Use as a null hypothesis H_0: $\mu 1 = \mu 2$ for the data sets ns and sm and use a t-test. Hit 2nd[F6](Tests)–>4:2-SampTTest. Again, choose Data in the first window that opens and then press ENTER. Put ns for List1, sm for List2, 1 for Freq1 and Freq2, $\mu 1 < \mu 2$ for Alternate Hyp., No for Pooled, and Calculate for Results. See Figure 50. Notice that you have to scroll to get to all of the options. Then hit ENTER. The results window gives t=–2.43759 and p=.010862, along with other results. See Figure 51.

To get a graphical representation instead, choose Draw instead of Calculate for Results. The t and p values are given below the graph with the p equaling the shaded area. Again, notice that you are now in the graph page.

If the population standard deviations $\sigma 1$ and $\sigma 2$ are known, you can make use of the normal distribution by choosing 2nd[F6](Tests)–>3: 2-SampZTest instead of 2nd[F6](Tests)–> 4:2-SampTTest.

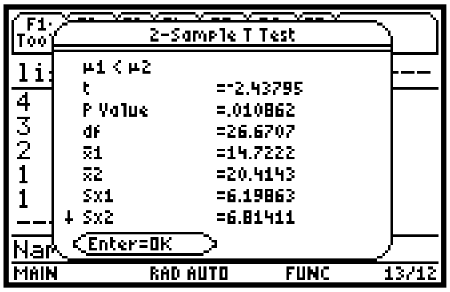

Figure 51

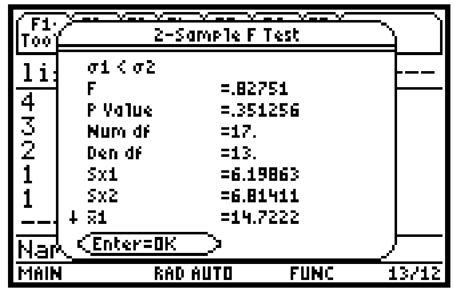

Figure 52

Hypothesis Testing for comparing Two Standard Deviations. Use as a null hypothesis H_0: $\sigma 1 = \sigma 2$ for the data sets ns and sm and use an F-test. We will also use as an alternate hypothesis H_A: $\sigma 1 < \sigma 2$. Hit 2nd[F6](Tests)–>9: 2-SampFTest. See Figure 42. Choose Data in the first window that opens and then press ENTER, filling in the rest of the boxes as in previous example (Figure 50). Then hit ENTER. The results window gives F=.82751 and p=.351256, along with other results. See Figure 52.

To get a graphical representation instead, choose Draw instead of Calculate for Results. The F and p values are given below the graph with the p equaling the shaded area. Recall that you are now in the graph page.

Hypothesis Testing for a Single Population Proportion. In a survey of injection drug users in a large city, 18 out of 423, i.e. p-hat = .0426, were HIV positive. Can one conclude that fewer than 5% of the population of injection drug users in the city are HIV positive. Use H_0: p = .05, so H_A: p < .05. Hit 2nd[F6](Tests)–>5: 1-PropZTest. Put in .05 for p0, 18 for Successes, x, 423 for n, Prop<p0 for Alternate Hyp., and Calculate for Results. Then hit ENTER. The results window gives z=–.702738 and p=.241109, along with other results. See Figure 53.

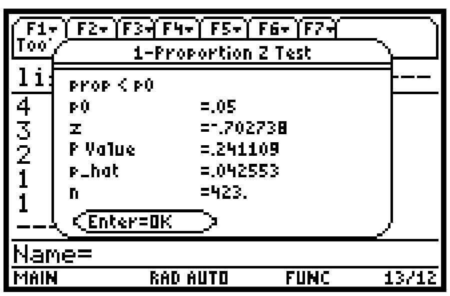

Figure 53

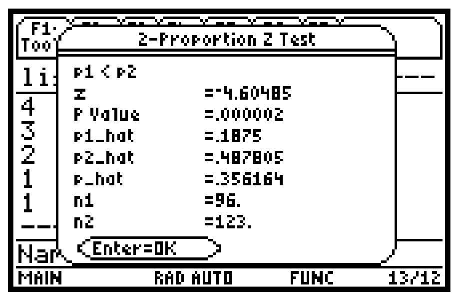

Figure 54

To get a graphical representation instead, choose Draw instead of Calculate for Results. The z and p values are given below the graph with the p equaling the shaded area. Recall that you are now in the graph page.

Hypothesis Testing for the Difference between Two Population Proportions. Return to the situation where 18 of 96 boys and 60 of 123 girls attempted suicide. Use as a null hypothesis H_0: p1 = p2 with H_A: p1 < p2. Hit 2nd[F6](Tests)–>5: 2-PropZTest. For Successes,x1, enter 18; for n1, enter 96; for Successes,x2, enter 60; for n2, enter 123; and for Alternate Hyp., p1<p2. Then hit ENTER. The results window gives z=–4.60485 and p=.000002, along with other results. See Figure 54.

One-Way Anova. Enter three lists in the calculator, a1={7, 4, 6, 6, 5}, a2={6,5,5,8,7}, and a3={4,7,6,7,6}. The null hypothesis here is H_0: $\mu 1=\mu 2=\mu 3$ with H_A: not all of $\mu 1$, $\mu 2$, $\mu 3$ are equal. To run the test, hit 2nd[F6](Tests)–>C: ANOVA. In the first window that opens, choose Data and 3 for Number of Groups, and then hit ENTER. Complete the second window as in Figure 55. Then hit

[ENTER]. The results window gives F=.311111 and p=.738367, along with other results, some of which you have to scroll to see. See Figure 56.

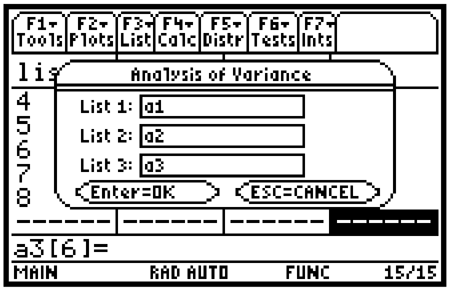

Figure 55

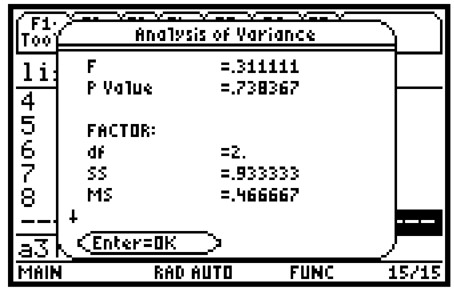

Figure 56

Three new lists appear in the List Editor, as seen in Figure 57. The three lists are xbarlist (the means of the three lists) and lowlist and uplist, the left and right endpoints of the 95% confidence interval for each mean. For instance, the mean of list a1 is 5.6 and the 95% confidence interval for that mean is (4.4066,6.7934).

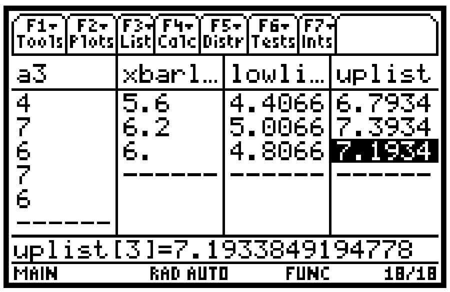

Figure 57

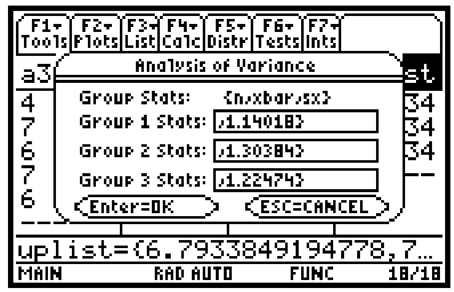

Figure 58

We see the means x-bar of the three lists are 5.6, 6.2, and 6. We can find that the standard deviations Sx are 1.14018, 1.30384, and 1.22474, and each list has a sample size of 5. If you had chosen the Stats option instead of Data, for each group you enter a list {n,xbar,sx} as prompted on the screen. See Figure 58. Then press [ENTER] to get the same results as before.

Two-Way Anova. Enter four lists in the calculator, a21={7, 4, 6, 6, 5,6}, a22={6,5,5,8,7,7}, a23={4,7,6,7,6,6}, and a24={4,7,8,9,5,7}. ANOVA2-Way computes a two-way analysis of variance for comparing the means of two to twenty populations (levels of factor A called Lvls of Col Factor). In the 2 Factor, Equal Repetitions design, each of the considered populations has an equal number of levels of factor B (Lvls of Row Factor). In the Block design, the levels of factor B are equal to the block. The ANOVA2-Way procedure compares the means of the experimental factors, factor A, factor B, and factor AB (the interaction effect). For each of the experimental factors, the null hypothesis H_0: $\mu 1=\mu 2=\ldots=\mu k$ is tested against the alternative hypothesis H_A: not all of $\mu 1$, $\mu 2$,…, μk are equal. In the case of the Block design, there is no interaction effect.

Consider the Block design first. To run the test, hit [2nd][F6](Tests)–>D: ANOVA2-WAY. In the first window that opens, choose Block for Design and 4 for Lvls of Col Factor, and then hit [ENTER]. Complete the second window as in Figure 59. Then hit [ENTER]. The results window gives first, under Factor, an F=.704225 and p=.56416 for the treatment (column) factor. See Figure 60. Scrolling down, in Figure 61 you see the F=1.56338 and p=.229969 for the Block factor. You can also see that further scrolling will provide the Error results.

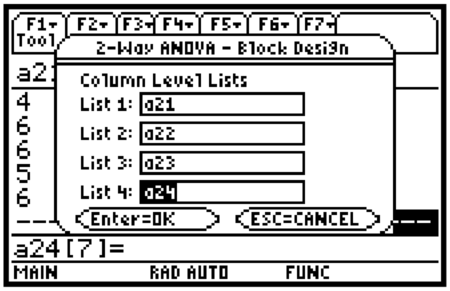

Figure 59

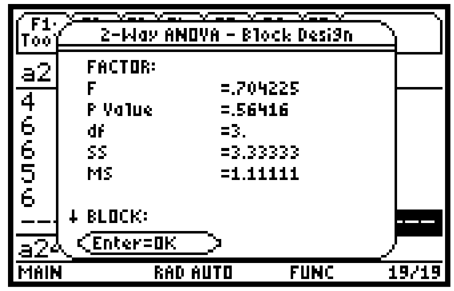

Figure 60

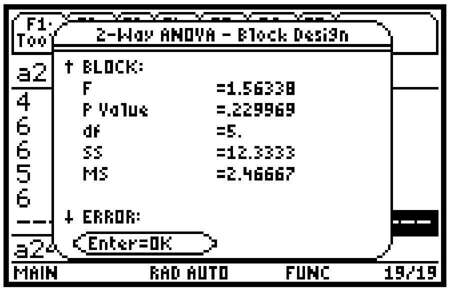

Figure 61

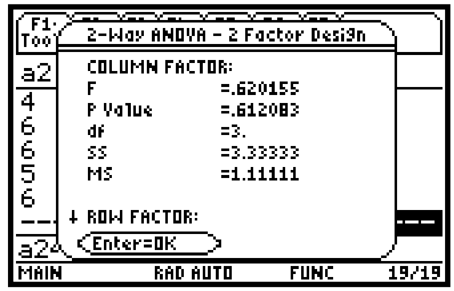

Figure 62

Now to the 2 Factor, Equal Repetitions design. Hit [2nd][F6](Tests)–>D: ANOVA2-WAY. In the first window that opens, choose 2 Factor, Eq Reps for Design, 4 for Lvls of Col Factor, 2 for Lvls of Row Factor, and then hit [ENTER]. Complete the second window as in Figure 59 above. Then hit [ENTER]. The results window gives first, under Column Factor, an F=.620155 and p=.612083. See Figure 62. Scrolling down, under Row Factor, you get F=2.32558 and p=.146785, and under Interaction, you get F=.589147 and p=.630932. You can also see that further scrolling will provide the Error results.

Chi-Square Goodness of Fit. Chi2 GOF performs the chi square goodness of fit test to confirm that sample data is from a population that conforms to a specified distribution. For example, **Chi2 GOF** can confirm that the sample data came from a normal distribution. Enter two lists in the calculator, ch1={16,25,22,8,10} (the observed values) and ch2={9,12,9,8,7} (the expected values if the data were from a particular distribution. To run the test, hit [2nd][F6](Tests)–>7: Chi2 GOF. In the window that opens, choose ch1 for Observed List, ch2 for Expected List, Calculate for Results, and then hit

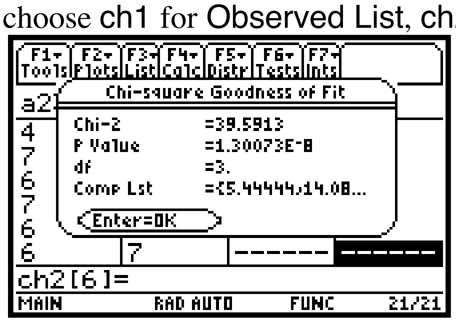

Figure 63

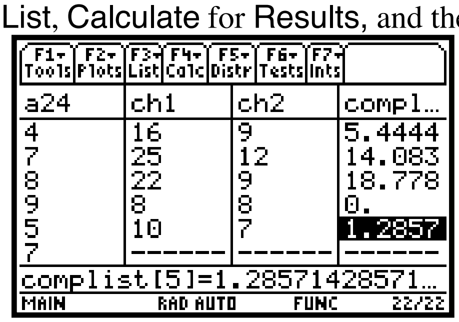

Figure 64

[ENTER]. The results window gives χ^2 =39.5913 and p=1.30073E–8=.000000013. See Figure 63. You will also find a new list in the List Editor, complist, which gives the element by element contributions to χ^2, the sum of the items in the list. See Figure 64.

To get a graphical representation instead, choose Draw instead of Calculate for Results. The χ^2 and p values are given below the graph with the p equaling the shaded area.

Chi-Square Test of Independence. First enter a matrix of observed values. Call this matrix ob. Here use $ob = \begin{bmatrix} 23 & 4 & 10 \\ 10 & 14 & 35 \end{bmatrix}$. To enter the matrix, return to the home page ([HOME])and hit [APPS]–>6:Data/Matrix Editor–>3:New. Choose Matrix for Type, main for folder, type in ob for Variable, 2 for Rows, 3 for Columns, and then hit [ENTER]. See Figure 65. Then continue by hitting each number in succession followed by [ENTER]. See Figure 66. When you are finished, hit [HOME]. Then return to the List Editor.

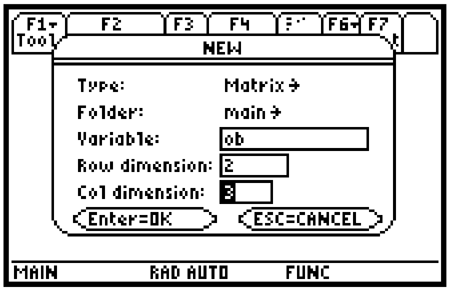

Figure 65

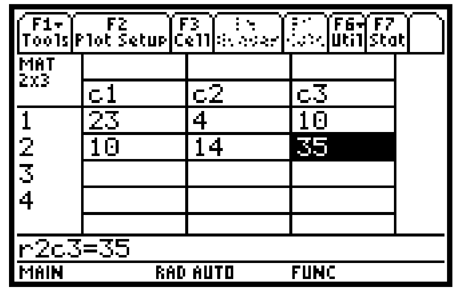

Figure 66

To run the test, hit [2nd][F6](Tests)–>8: Chi2 2-way. In the window that opens, enter ob for Observed Mat, statvars\expmat (the default) for Store Expected to, statvars\compmat (the default) for Store CompMat to, Calculate for Results (see Figure 67), and then hit [ENTER].

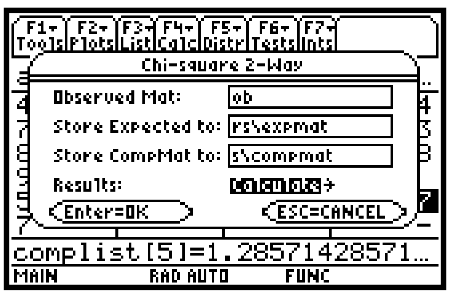

Figure 67

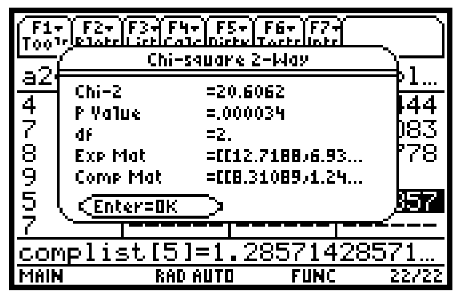

Figure 68

The null hypothesis is that there is no association between the row and column variable, with the alternative hypothesis being that the variables are related. From Figure 68, you get a χ^2 of 20.6062 and a p-value of .000034.

To see the expected matrix, from the home page hit [APPS]–>6:Data/Matrix Editor–>2:Open. In the window that opens, choose Matrix for Type, statvars for folder, expmat for Variable, and hit [ENTER]. The matrix is in Figure 69. You can do the same to get compmat, the matrix of component contributions whose sum is χ^2. See Figure 70.

To get a graphical representation instead, choose Draw instead of Calculate for Results. The χ^2 and p values are given below the graph with the p equaling the shaded area

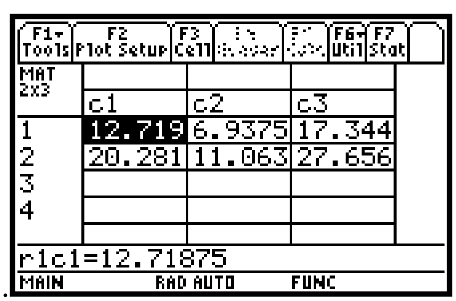

Figure 69

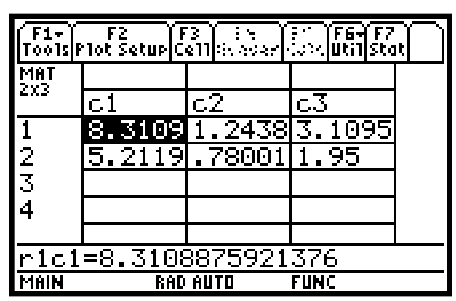

Figure 70

Hypothesis Testing for the slope and correlation coefficient in Linear Regression using *t*. Return to the earlier linear regression example using listx and listy. LinRegTTest (linear regression *t* test) computes a linear regression on the given data and a *t* test on the value of slope b and the correlation coefficient r for the equation y=a+bx. It tests the null hypothesis H_0: b=0 (equivalently, r=0) against one of the following alternatives: H_A: b≠0 and r≠0, H_A: b<0 and r<0, or H_A: b>0 and r>0. The first option will be used here. To run the test, from within the List Editor hit [2nd][F6](Tests)–>A: LinRegTTest. Fill in the window that opens as in Figure 71. Then hit [ENTER] to get the results window. See Figure 72. You see that you get t=4.23937 and p=.002176. Thus you can conclude that there is a linear relationship between the variables. You can see that the regression equation is y=3.00245+.499727x with a standard error of the estimate s=1.23631, and by scrolling down, that the coefficient of determination r^2=.666324 and the correlation coefficient is r=.816287. Resid, the list of residuals of the regression, is also added to the List Editor.

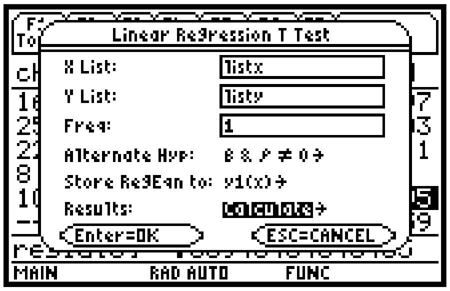

Figure 71

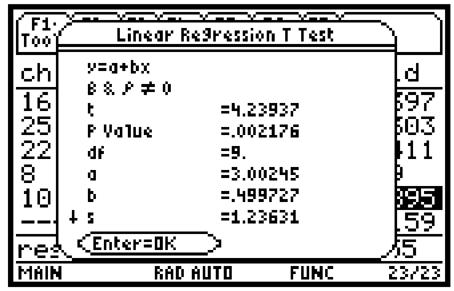

Figure 72

Hypothesis Testing for Multiple Regression. Return to the earlier multiple regression example using listx1, listx2, and listy1. MultRegTests computes a multiple regression on the given data yielding an equation Y=B0+B1*X1+B2*X2, an F test on the hypotheses H_0: B1=B2=0 with H_A: not both B1, B2 equal to 0, *t* tests on the coefficients B1, B2, B3, and the coefficient of determination. To run the test, from within the List Editor hit [2nd][F6](Tests)–>B: MultRegTests. Fill in the window that opens as in Figure 73. Then hit [ENTER] to get the results window. See Figure 74. You see that you get F=112.333 and p=.008824. Thus you can conclude that there is a linear relationship between the variables. You can see that the coefficient of multiple determination R^2=.991176 and the standard error of the estimate is s=.210042. Several columns have been added to the List Editor. From the column blist we get the coefficients for the regression, yielding the equation Y=3.5882+1.000*X1-.1765*X2. Two columns to the right of blist is tlist, giving the t values for the corresponding B's, and one column to the right of that is plist, giving the corresponding p-values.

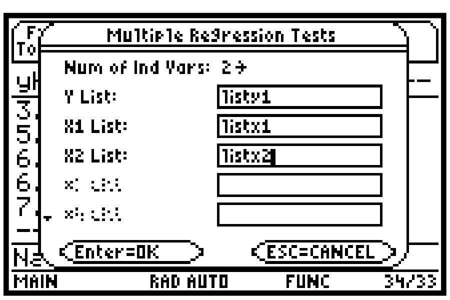

Figure 73

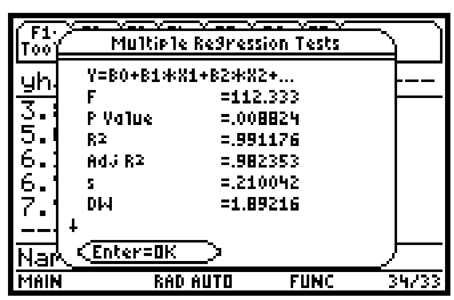

Figure 74