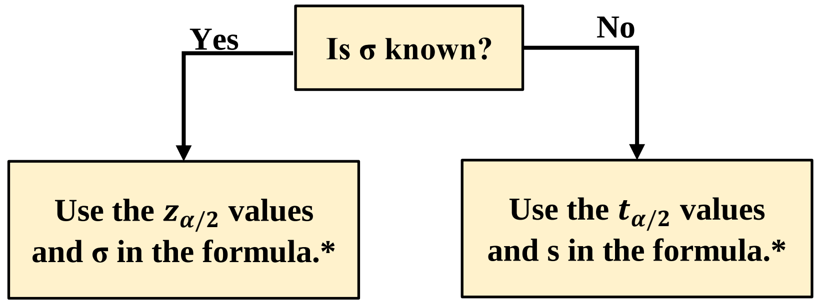
Common Symbols

n = Sample Size	N = Population Size
$\bar{x}$ = Sample Mean	μ = Population Mean
s = Sample Standard Deviation	σ = Population Standard Deviation
s^2 = Sample Variance	σ^2 = Population Variance
$\hat{p}$ = Sample Proportion	p = Population Proportion
r = Sample Correlation Coefficient	ρ = Population Correlation Coefficient
α = P(Type I error)	

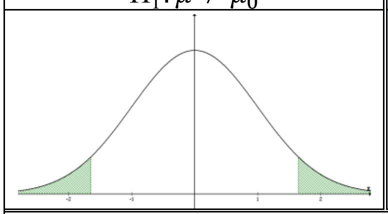
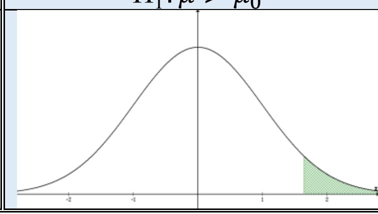
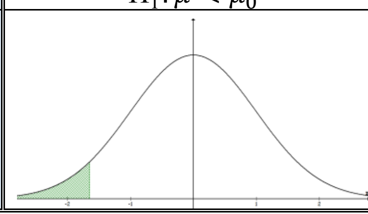
The rejection rule:

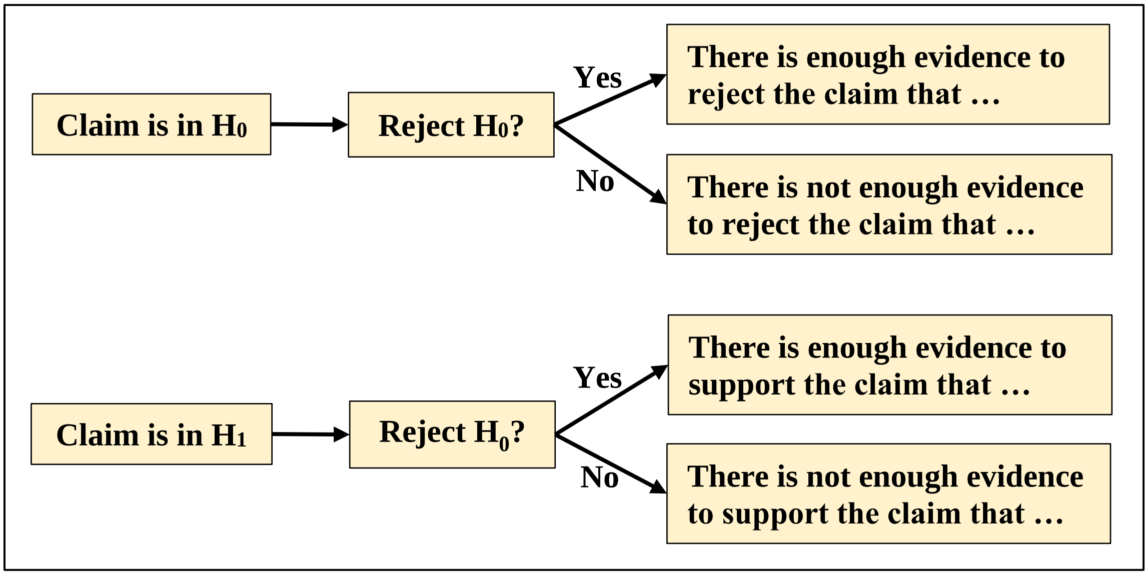
- p-value method: reject H_0 when the p-value $\leq \alpha$.
- Critical value method: reject H_0 when the test statistic is in the critical tail(s).
- Confidence Interval method, reject H_0 when the hypothesized value found in H_0 is outside the bounds of the confidence interval.



***If n < 30, the variable must be normally distributed.**

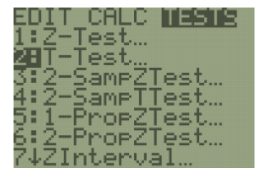
Look for these key words to help set up your Hypotheses:

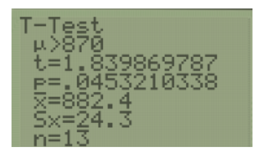
Two-tailed Test	**Right-tailed Test**	**Left-tailed Test**
$H_0: \mu = \mu_0$ $H_1: \mu \neq \mu_0$	$H_0: \mu = \mu_0$ $H_1: \mu > \mu_0$	$H_0: \mu = \mu_0$ $H_1: \mu < \mu_0$
		
	Claim is in the Null Hypothesis	
=	≤	≥
Is equal to	Is less than or equal to	Is greater than or equal to
Is exactly the same as	Is at most	Is at least
Has not changed from	Is not more than	Is not less than
Is the same as	Within	Is more than or equal to
	Claim is in the Alternative Hypothesis	
≠	>	<
Is not	More than	Less than
Is not equal to	Greater than	Below
Is different from	Above	Lower than
Has changed from	Higher than	Shorter than
Is not the same as	Longer than	Smaller than
	Bigger than	Decreased
	Increased	Reduced



One Sample Tests:
Mean

t-test $H_0: \mu = \mu_0$ $H_1: \mu \neq \mu_0$ Test statistic when σ is unknown: $t = \frac{\bar{x}-\mu_0}{\left(\frac{s}{\sqrt{n}}\right)}$ with df = n – 1

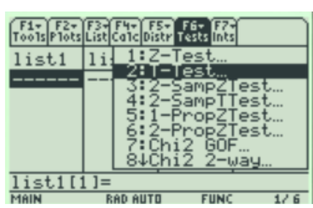


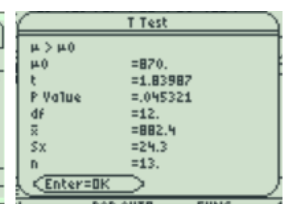


TI-83 or 84
If you have raw data, enter the data into a list before you go to the test menu. Press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the [2:T-Test] option and press the [ENTER] key. Arrow over to the [Stats] menu and press the [ENTER] key. Then type in the hypothesized mean (μ_0), sample or population standard deviation, sample mean, sample size, arrow over to the ≠, <, > sign that is the same as the problems alternative hypothesis statement then press the [ENTER] key, arrow down to [Calculate] and press the [ENTER] key. The calculator returns the t-test statistic and p-value.

Or (If you have raw data in list one) Arrow over to the [Data] menu and press the [ENTER] key. Then type in the hypothesized mean (μ_0), L_1, leave Freq:1 alone, arrow over to the ≠, <, > sign that is the same in the problems alternative hypothesis statement then press the [ENTER]key, arrow down to [Calculate] and press the [ENTER] key. The calculator returns the t-test statistic and the p-value.

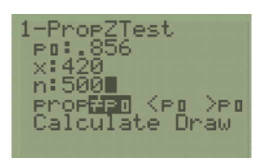
TI-89
Go to the [Apps] **Stat/List Editor**, then select 2nd then F6 [Tests], then select **2: T-Test**. Choose the input method, data is when you have entered data into a list previously or stats when you are given the mean and standard deviation already. Then type in the hypothesized mean (μ_0), sample standard deviation, sample mean, sample size, (or list name (list1), and Freq: 1), arrow over to the ≠, <, > and select the sign that is the same as the problems alternative hypothesis statement then press the [ENTER] key to calculate. The calculator returns the t-test statistic and p-value.

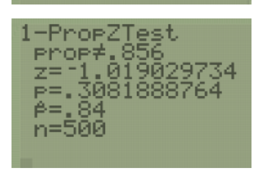




Proportion

1-PropZTest $H_0: p = p_0$ $H_1: p \neq p_0$ Test statistic is $z = \frac{\hat{p}-p_0}{\sqrt{\left(\frac{p_0 q_0}{n}\right)}}$ where $\hat{p} = \frac{x}{n}$





TI-83 or 84
Press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the option [5:1-PropZTest] and press the [ENTER] key. Type in the hypothesized proportion (p_0), X, sample size, arrow over to the ≠, <, > sign that is the same in the problems alternative hypothesis statement then press the [ENTER] key, arrow down to [Calculate] and press the [ENTER] key. The calculator returns the z-test statistic and the p-value. Note: sometimes you are not given the x value but a percentage instead. To find the x to use in the calculator, multiply $\hat{p}$ by the sample size and round off to the nearest integer. The calculator will give you an error message if you put in a decimal for x or n. For example, if $\hat{p}$= .22 and n = 124 then .22*124 = 27.28, so use x = 27.

TI-89

Go to the [Apps] **Stat/List Editor**, then select 2nd then F6 [Tests], then select **5: 1-PropZ-Test**. Type in the hypothesized proportion (p_0), x, sample size, arrow over to the ≠, <, > sign that is the same in the problems alternative hypothesis statement then press the [ENTER] key to calculate. The calculator returns the z-test statistic and the p-value. Note: sometimes you are not given the x value but a percentage instead. To find the x value to use in the calculator, multiply $\hat{p}$ by the sample size and round off to the nearest integer. The calculator will give you an error message if you put in a decimal for x or n. For example, if $\hat{p}$= .22 and n = 124 then .22*124 = 27.28, so use x = 27.

Two Sample Tests

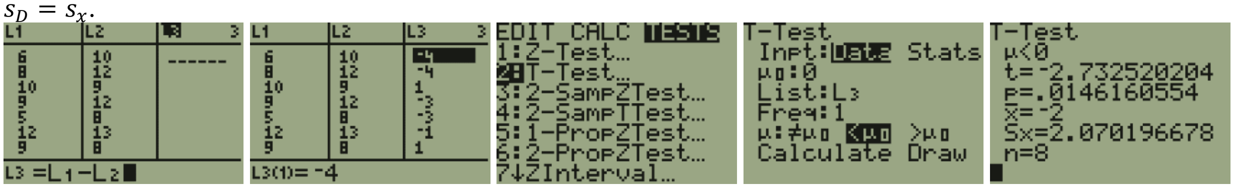
2 Means – Dependent Populations

Find the difference (d) between each matched pairs.

Paired t-test $H_0: \mu_D = 0 \quad H_1: \mu_D \neq 0$ Test statistic: $t = \frac{\bar{D} - \mu_D}{\left(\frac{s_D}{\sqrt{n}}\right)}$ with df= n – 1

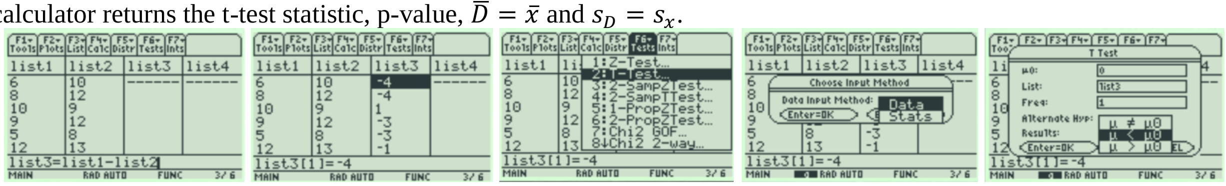
TI-83 or 84

Find the differences between the sample pairs (you can subtract two lists to do this). Press the [STAT] key and then the [EDIT] function, enter the difference column into list one. Press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the option [2:T -Test] and press the [ENTER] key. Arrow over to the [Data] menu and press the [ENTER] key. Then type in the hypothesized mean as 0, List: L_1, leave Freq:1 alone, arrow over to the ≠, <, > sign that is the same in the problems alternative hypothesis statement then press the [ENTER] key, arrow down to [Calculate] and press the [ENTER] key. The calculator returns the t-test statistic, the p-value, $\bar{D} = \bar{x}$ and $s_D = s_x$.



TI-89

Find the differences between the sample pairs (you can subtract two lists to do this). Go to the [Apps] **Stat/List Editor**, enter the two data sets in lists 1 and 2. Move the curser so that it is highlighted on the header of list3. Select [2nd] Var-Link and move down to list1 and select [Enter]. This brings the name list1 back to the list3 at the bottom, select the minus [-] key, then select [2nd] Var-link and this time highlight list2 and select [Enter]. You should now see list1-list2 at the bottom of the window. Select [Enter] then the differences will be stored in list3. Select [2nd] then F6 [Tests], select **2: T-Test**. Select the [Data] menu. Then type in the hypothesized mean as 0, List: list1, Freq:1, arrow over to the ≠, <, > and select the sign that is the same in the problems alternative hypothesis, press the [ENTER] key to calculate. The calculator returns the t-test statistic, p-value, $\bar{D} = \bar{x}$ and $s_D = s_x$.



Paired t-test Confidence Interval: $\bar{D} \pm t_{\alpha/2}\left(\frac{s_D}{\sqrt{n}}\right)$ with df= n – 1.

TI-83 or 84

First, find the differences between the samples. Then on the TI-83 press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the [8:TInterval] option and press the [ENTER] key. Arrow over to the [Data] menu and press the [ENTER] key. The defaults are List: L_1, Freq:1. If this is set with a different list, arrow down and use [2nd] [1] to get L_1. Then type in the confidence level. Arrow down to [Calculate] and press the [ENTER] key. The calculator returns the confidence interval, $\bar{D} = \bar{x}$ and $s_D = s_x$.

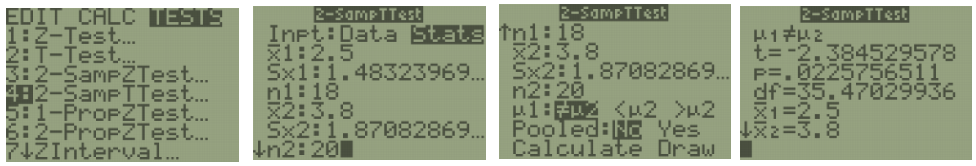
TI-89

First, find the differences between the samples. Go to the [Apps] **Stat/List Editor**, then enter the differences into list 1. Select 2nd then F7 [Ints], then select **2: T-Interval**. Select the [Data] menu. Enter in List: list1, Freq:1. Then type in the confidence level. Press the [ENTER] key to calculate. The calculator returns the confidence interval, $\bar{D} = \bar{x}$ and $s_D = s_x$.

---

2 Means – Independent Populations-Population Standard Deviations Unknown

Test statistic when s_1 and s_2 are given in the problem: $t=\frac{(\bar{x}_1-\bar{x}_2)-(\mu_1-\mu_2)_0}{\sqrt{\left(\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}\right)}}$, use $df=\frac{\left(\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}\right)^2}{\left(\left(\frac{s_1^2}{n_1}\right)^2\left(\frac{1}{n_1-1}\right)+\left(\frac{s_2^2}{n_2}\right)^2\left(\frac{1}{n_2-1}\right)\right)}$.

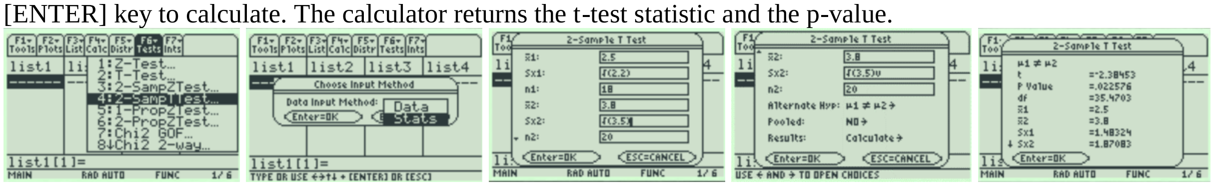


TI-83 or 84

Press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the option [4:2-SampTTest] and press the [ENTER] key. Arrow over to the [Stats] menu and press the [Enter] key. Enter the means, standard deviations, sample sizes, confidence level. Then arrow over to the not equal, <, > sign that is the same in the problems alternative hypothesis statement then press the [ENTER] key. Highlight the No option under Pooled for unequal variances. Arrow down to [Calculate] and press the [ENTER] key. The calculator returns the test statistic and the p-value. If you have raw data, press the [STAT] key and then the [EDIT] function, enter the data into list one for males and list two for females. Press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the option [4:2-SampTTest] and press the [ENTER] key. Arrow over to the [Data] menu and press the [ENTER] key. The defaults are List1: L_1, List2: L_2, Freq1:1, Freq2:1. If these are set different arrow down and use [2nd] [1] to get L_1 and [2nd] [2] to get L_2.

TI-89

Go to the [Apps] **Stat/List Editor**, then select 2nd then F6 [Tests], then select **4: 2-SampT-Test**. Enter the sample means, sample standard deviations, and sample sizes, (or list names (list3 & list4), and Freq1:1 & Freq2:1). Then arrow over to the not equal, <, > and select the sign that is the same in the problems alternative hypothesis statement. Highlight the No option under Pooled. Press the [ENTER] key to calculate. The calculator returns the t-test statistic and the p-value.



Confidence interval when s_1 and s_2 are given in the problem: $(\bar{x}_1-\bar{x}_2)\pm t_{\alpha/2}\sqrt{\left(\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}\right)}$,

$$df=\frac{\left(\frac{s_1^2}{n_1}+\frac{s_2^2}{n_2}\right)^2}{\left(\left(\frac{s_1^2}{n_1}\right)^2\left(\frac{1}{n_1-1}\right)+\left(\frac{s_2^2}{n_2}\right)^2\left(\frac{1}{n_2-1}\right)\right)}$$

TI-83 or 84

Press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the option [**0:2-SampTInt**] and press the [ENTER] key. Arrow over to the [Stats] menu and press the [Enter] key. Enter the means, standard deviations, sample sizes, confidence level. Highlight the No option under Pooled for unequal variances. Arrow down to [Calculate] and press the [ENTER] key. The calculator returns the confidence interval.

Or (If you have raw data in list one and list two) press the [STAT] key and then the [EDIT] function, type the data into list one for sample one and list two for sample two. Press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the option [0:2-SampTInt] and press the [ENTER] key. Arrow over to the [Data] menu and press the [ENTER] key. The defaults are List1: L_1, List2: L_2, Freq1:1, Freq2:1. If these are set different, arrow down and use [2nd] [1] to get L_1 and [2nd] [2] to get L_2. Then type in the confidence level. Highlight the No option under Pooled for unequal variances. Arrow down to [Calculate] and press the [ENTER] key. The calculator returns the confidence interval.

TI-89

Go to the [Apps] **Stat/List Editor**, then select 2nd then F5 [Ints], then select **4: 2-SampTInt**. Enter the sample means, sample standard deviations, sample sizes, (or list names (list3 & list4), and Freq1:1 & Freq2:1), confidence level. Highlight the No option under Pooled. Press the [ENTER] key to calculate. The calculator returns the confidence interval. If you have the raw data, select Data and enter the list names as in the following example to the right.

2 Proportions

$H_0: p_1 = p_2$
$H_1: p_1 \neq p_2$

Test statistic $z = \frac{(\hat{p}_1-\hat{p}_2)-(p_1-p_2)}{\sqrt{\left(\hat{p}\cdot\hat{q}\left(\frac{1}{n_1}+\frac{1}{n_2}\right)\right)}}$, (usually $p_1 - p_2 = 0$) where $\hat{p} = \frac{(x_1+x_2)}{(n_1+n_2)} = \frac{(\hat{p}_1\cdot n_1+\hat{p}_2\cdot n_2)}{(n_1+n_2)}$, $\hat{q} = 1-\hat{p}$.

Press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the option [2-PropZTest] and press the [ENTER] key. Type in the x_1, n_1, x_2, n_2, arrow over to the ≠, <, > sign that is in the alternative hypothesis statement then press the [ENTER] key, arrow down to [Calculate] and press the [ENTER] key. The calculator returns the z-test statistic and the p-value. Note x_1 and x_2 need to be a whole number, not a decimal.

Confidence Interval: $(\hat{p}_1 - \hat{p}_2) \pm z_{\alpha/2}\sqrt{\left(\frac{\hat{p}_1\hat{q}_1}{n_1}+\frac{\hat{p}_2\hat{q}_2}{n_2}\right)}$ where $\hat{p}_1 = \frac{x_1}{n_1}$, $\hat{p}_2 = \frac{x_2}{n_2}$.

Press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the option [7:2-PropZInterval] and press the [ENTER] key. Type in the x_1, n_1, x_2, n_2, the confidence level, then press the [ENTER] key, arrow down to [Calculate] and press the [ENTER] key. The calculator returns the confidence interval.

Other Types of Tests

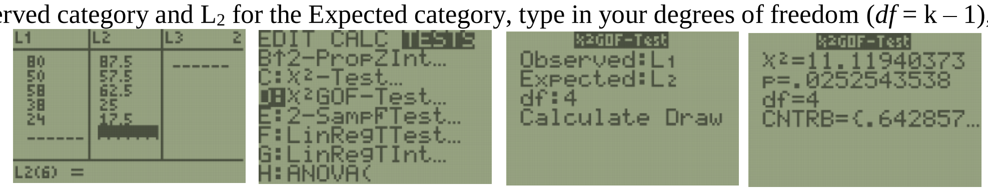
Goodness of Fit Test

"There is no preference" w/ 4 groups H_0: p_1=.25, p_2=.25, p_3=.25, p_4=.25 "There is not a preference"
H_1: At least one proportion is different. "There is a preference"

Proportions are 1/k or different percentages for each group given in the problem. If %'s are given use those decimals for each p_i. Expected values are found by taking each group's proportion times the sample size ($p_i \times n$), df=k–1. Test statistic: $\chi^2 = \sum\frac{(O-E)^2}{E}$

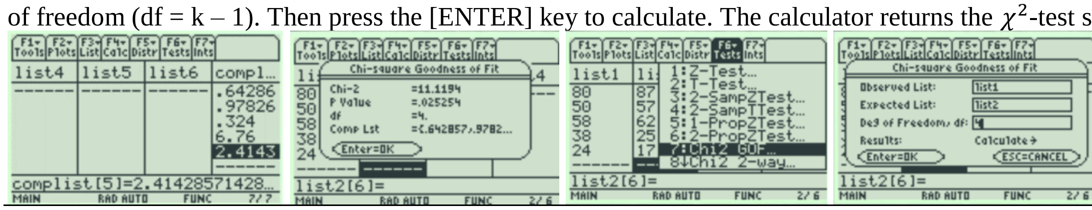
TI-83 or 84

Hypothesis test for three or more proportions (goodness of fit test). Before you start write down your observed and expected values. Select Stat, then Calc. Type in the observed values into list 1, and the expected values into list 2. Select Stat, then Tests. Go down to option D: χ^2GOF. Choose L_1 for the Observed category and L_2 for the Expected category, type in your degrees of freedom (df = k – 1), and then select Calculate. The calculator returns the χ^2-test statistic and the p-value. Right arrow to see more.



TI-89

Hypothesis test for three or more proportions (goodness of fit test). Go to the [Apps] Stat/List Editor, then type in the observed values into list 1, and the expected values into list 2. Select 2nd then F6 [Tests], then select 7: Chi-2GOF. Type in the list names and the degrees of freedom (df = k – 1). Then press the [ENTER] key to calculate. The calculator returns the χ^2-test statistic and the p-value.



Test for Independence

H_0: <u>Variable 1</u> is independent of <u>Variable 2</u>.

H_1: <u>Variable 1</u> is dependent of <u>Variable 2</u>.

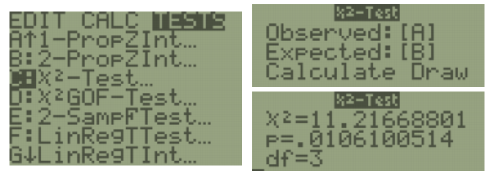
Expected Value= $\frac{\text{Row Sum}\cdot\text{Column Sum}}{\text{Grand Total}}$ for each cell. Test statistic: $\chi^2 = \sum\frac{(O-E)^2}{E}$, df = (R-1)(C-1).

TI-83 or TI-84

Hypothesis test for the independence of two variables (contingency tables). Press the [2nd] then [MATRX] key. Arrow over to the EDIT menu and 1:[A] should be highlighted, press the [ENTER] key. For a m X n contingency table, type in the number of rows(m) and the number of columns(n) at the top of the screen so that it looks like this MATRIX[A] m X n. For example a 2 X 3 contingency table, the top of the screen would look like this MATRIX[A] 2 X 3, as you hit [ENTER] the table will automatically widen to the size you put in. Now enter all of the observed values in their proper positions. Then press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the option

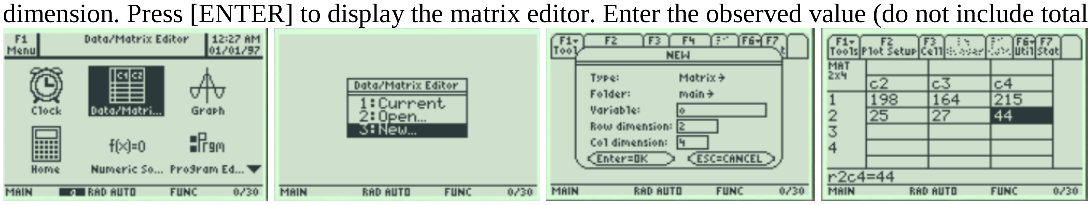
5

[C: χ^2-Test] and press the [ENTER] key. Leave the default as Observed:[A] and Expected:[B], arrow down to [Calculate] and press the [ENTER] key. The calculator returns the χ^2-test statistic and the p-value. If you go back to the matrix menu [2nd] then [MATRX] key, arrow over to EDIT and choose 2:[B], you will see all of the expected values.



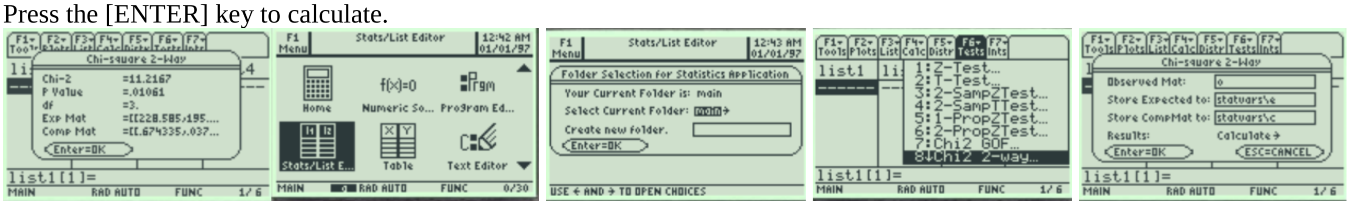
TI-89

First you need to create the matrix for the observed values: Press: [Home] to return to the Home screen, press [Apps] and select Data/Matrix Editor. A menu is displayed, select 3:New. The New dialog box is displayed. Press the right arrow key to highlight 2:Matrix, and press [ENTER] to choose Matrix type. Press the down arrow key to highlight 1:main, and press [ENTER], to choose main folder. Press the down arrow key, and then enter the letter o for the name in the Variable field. Enter 2 for Row dimension and 4 for Column dimension. Press [ENTER] to display the matrix editor. Enter the observed value (do not include total row or column).



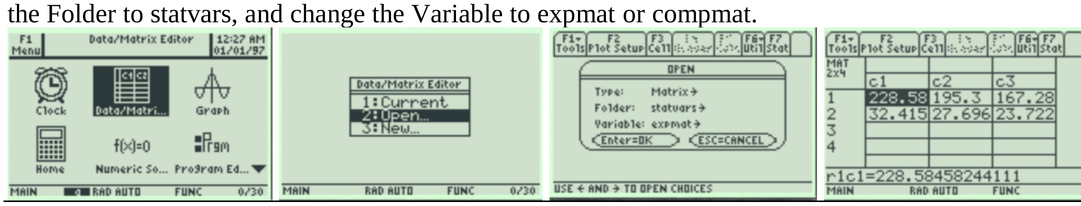
<u>Note: Next time you use this test instead of option 3:New, choose 2: Open. The Open dialog box is displayed. Press the right arrow key to highlight 2:Matrix, and press [ENTER] to choose Matrix type. Press the down arrow key to make sure you are in the Main folder and that your variable says o.</u>

Press [Apps], and then select Stats/List Editor. To display the Chi-square 2-Way dialog box, press 2nd then F6 [Tests], then select 8: Chi-2 2-way. Enter in in the Observed Mat: o; leave the other rows alone: Store Expected to: statvars\e; Store CompMat to: statvars\c. This will store the expected values in the matrix folder statvars with the name expmat, and the (o-e)^2/e values in the matrix compmat. Press the [ENTER] key to calculate.



The calculator returns the χ^2-test statistic and the p-value. If you go back to the matrix menu, you will see all of the expected and (o-e)^2/e values.

To see the expected and (o-e)^2/e values, select [APPS] and select Data/Matrix Editor. Select 2:Open, change the Type to Matrix, change the Folder to statvars, and change the Variable to expmat or compmat.



One-Factor ANOVA table k=#of groups, N=total of all n's

$H_0: \mu_1 = \mu_2 = \mu_3 = \cdots = \mu_k$

H_1: At least one mean differs

Source	SS = Sum of Squares	*df*	MS = Mean Square	F
Between (Factor)	SSB = $\sum n_i(\bar{x}_i - \bar{x}_{GM})^2$	$k - 1$	$MSB = \frac{SSB}{k-1}$	$F = \frac{MSB}{MSW}$
Within (Error)	SSW = $\sum(n_i - 1)s_i^2$	$N - k$	$MSW = \frac{SSW}{N-k}$	
Total	SST	$N - 1$		

Bonferroni test statistic: $t = \frac{\bar{x}_i - \bar{x}_j}{\sqrt{\left(msw\left(\frac{1}{n_i}+\frac{1}{n_j}\right)\right)}}$

$H_0: \mu_i = \mu_j$
$H_1: \mu_i \neq \mu_j$

Multiply p-value by m = $_kC_2$, divide area for critical value by m = $_kC_2$.

Correlation and Regression

$SS_{xx} = (n-1)s_x^2$ $SS_{yy} = (n-1)s_y^2$ $SS_{xy} = \sum(xy) - n \cdot \bar{x} \cdot \bar{y}$	Correlation Coefficient $r = \frac{SS_{xy}}{\sqrt{(SS_{xx} \cdot SS_{yy})}}$
Correlation t-test $H_0: \rho = 0$ $H_1: \rho \neq 0$ $\quad t = r\sqrt{\left(\frac{n-2}{1-r^2}\right)}$ $\quad$ df = n – 2	Regression Equation (Line of Best Fit) $\hat{y} = b_0 + b_1 x$
Slope $b_1 = \frac{SS_{xy}}{SS_{xx}}$	y-Intercept $b_0 = \bar{y} - b_1 \bar{x}$
Slope t-test $H_0: \beta_1 = 0$ $H_1: \beta_1 \neq 0$ $\quad t = \frac{b_1}{\sqrt{\left(\frac{MSE}{SS_{xx}}\right)}}$ df = n – p – 1 = n – 2	Slope/Model F-test $H_0: \beta_1 = 0$ $H_1: \beta_1 \neq 0$
Standard Error of Estimate $s = \sqrt{\frac{\sum(y_i - \hat{y}_i)^2}{n-2}} = \sqrt{MSE}$	Residual $e_i = y_i - \hat{y}_i$
Prediction Interval $\hat{y} \pm t_{\alpha/2} \cdot s\sqrt{\left(1 + \frac{1}{n} + \frac{(x-\bar{x})^2}{SS_{xx}}\right)}$	Coefficient of Determination $R^2 = (r)^2 = \frac{SSR}{SST}$
Multiple Linear Regression Equation $\hat{y} = b_0 + b_1 x_1 + \cdots + b_p x_p$	Model F-Test for Multiple Regression $H_0: \beta_1 = \beta_2 = \cdots = \beta_p = 0$ H_1: At least one slope is not zero.
Adjusted Coefficient of Determination $R^2_{adj} = 1 - \left(\frac{(1-R^2)(n-1)}{(n-p-1)}\right)$	