Using the TI-83/84 Plus
Chapter 9: Hypothesis Testing - Two Samples

Here we see how to use the TI 83/84 to conduct hypothesis tests about mean differences, differences in means, and differences in proportions between two samples. The software will calculate the test statistic and the P-value for the test statistic. It does not give you the critical value. For tests about means, you can either input raw data via a list or simply enter the sample statistics. In all cases you will need to input a value from the null hypothesis and whether the test is left, right, or two-tailed.

All of these test functions can be found by pressing the `STAT` button and highlighting `TESTS`.

Each topic has its own page or you can go directly to the videos.

Tests for Mean Differences - Paired Data: `T-Test`

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This is just a T-Test where the mean difference and standard deviation of differences are used.

1. Press the `STAT` button and highlight `TESTS`.
2. Scroll down to `2:T-Test...`
3. Highlight `Data` or `Stats`
   - `Data`: If you choose `Data` you need to create a list of sample differences and reference this list. Then you have to test on this single list by choosing two-tailed ($\mu \neq \mu 0$), left-tailed ($\mu < \mu 0$) or right-tailed ($\mu > \mu$). If your list of differences is in standard form (not a frequency distribution), set `Freq:` to 1.
   - `Stats`: If you choose, `Stats`, you have to enter the mean difference from the null hypothesis ($\mu 0$), the sample mean (difference) ($\bar{x}$), the sample standard deviation for the differences (Sx), the sample size (number of pairs) (`n`), and select two-tailed ($\mu \neq \mu_0$), left-tailed ($\mu < \mu_0$) or right-tailed ($\mu > \mu_0$).
4. Highlight `Calculate` and hit ENTER
5. It gives you the test statistic (`t`) and the P-value for the test statistic (`p`) based on your choice of two-tailed, left-tailed, or right-tailed test (so make sure you entered that correctly).
   Warning: The P-value may be given in scientific notation.
   For example `2.143 E-6` $= 2.143 \times 10^{-6} = 0.000002143$.

Example: Here is the data for the cholesterol levels of 10 men diagnosed with high cholesterol. The first row gives the cholesterol levels before taking a certain medication (x). The second row gives the levels after one year of regular medication (y). I put in a third row for $x - y$, which will be the actual data we analyze and our problem boils down to a one-population test. Here, the single population is that of differences. Test the claim that, on average, the medication lowers cholesterol for all men diagnosed with high cholesterol. Test this claim at the 0.01 significance level.

	Cholesterol Levels in mg/dL										mean	s^2	s
Before (x)	237	289	257	228	303	275	262	304	244	233	263.2	811.1	28.5
After (y)	194	240	230	186	265	222	242	281	240	212	231.2	864.0	29.4
$d = x - y$	43	49	27	42	38	53	20	23	4	21	32.0	238.0	15.4

Here we are claiming the $\mu_d > 0$ where $\mu_d = \mu_y - \mu_x$.

Claim: $\mu_d > 0$	H_o: $\mu_d = 0$	H_1: $\mu_d > 0$

Getting There: `STAT`

```
EDIT CALC TESTS
1:Z-Test…
2:T-Test…
3:2-SampZTest…
4:2-SampTTest…
5:1-PropZTest…
6:2-PropZTest…
7↓ZInterval…
```

Input

```
T-Test
 Inpt:Data Stats
 μ0:0
 x̄:32
 Sx:15.4
 n:10
 μ:≠μ0 <μ0 >μ0
 Calculate Draw
```

Output

```
T-Test
 μ>0
 t=6.570966567
 p=5.1326791E-5
 x̄=32
 Sx=15.4
 n=10
```

Conclusion: The P-value ($5.13 \times 10^{-5} \approx 0.0000513$) is less than α (0.01). We reject the null hypothesis and the data supports the claim.

Tests for Two Means - Independent Data: `2-SampTTest`

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1. Press the STAT button and highlight `TESTS`.
2. Scroll down to `4:2-SampTTest`...
3. Highlight `Data` or `Stats`
   - `Data`: If you choose `Data` the calculator does all the work but you have to select two-tailed ($\mu 1 \neq \mu 2$), left-tailed ($\mu 1 < \mu 2$) or right-tailed ($\mu 1 > \mu 2$) and then select `Yes` or `No` to `Pooled` (this asks if you want to pool the variances - `No` is the safer answer). If your data is a standard list, set `Freq:` to 1. If your data is entered as a frequency distribution, put in the list which contains the frequencies.
   - `Stats`: If you choose, `Stats`, you have to enter the the sample means ($\bar{x}1$ and $\bar{x}2$), the sample standard deviations (Sx1 and Sx2), the sample sizes (n1 and n2), and select two-tailed ($\mu 1 \neq \mu 2$), left-tailed ($\mu 1 < \mu 2$) or right-tailed ($\mu 1 > \mu 2$). Select `No` for `Pooled`.
4. Highlight `Calculate` and hit ENTER
5. It gives you the test statistic (`t`) and the P-value for the test statistic (`p`) based on your choice of two-tailed, left-tailed, or right-tailed test (so make sure you entered that correctly).
   Warning: The P-value may be given in scientific notation.
   For example `2.143 E`$^-$`6` $= 2.143 \times 10^{-6} = 0.000002143$.

Demonstration Example: Here is the data for the cholesterol levels of men diagnosed with high cholesterol. This time we assume the first row comes from 10 men who don't use the drug (x_1) and the second row comes from 10 **different** men who took the drug for one year (x_2). Test the claim that the mean cholesterol level for all men who use the drug is less than the mean for those who do not use the drug. Use a 0.05 significance level.

	Cholesterol Levels in mg/dL										mean	s^2	s
No Drug (x_1)	237	289	257	228	303	275	262	304	244	233	263.2	811.1	28.5
Drug (x_2)	194	240	230	186	265	222	242	281	240	212	231.2	864.0	29.4

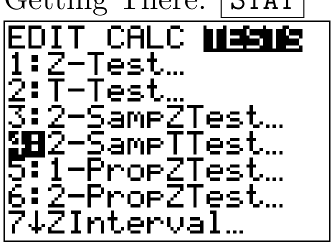
Here we are claiming that $\mu_2 < \mu_1$ which means $\mu_1 > \mu_2$ or $\mu_1 - \mu_2 > 0$.

Claim: $\mu_1 - \mu_2 > 0$

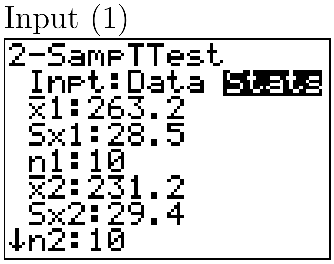
H_o: $\mu_1 - \mu_2 = 0$

H_1: $\mu_1 - \mu_2 > 0$

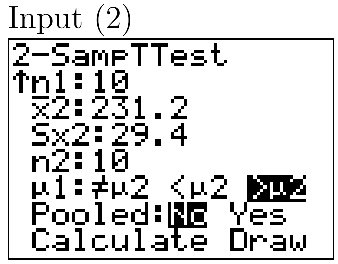
Getting There: STAT



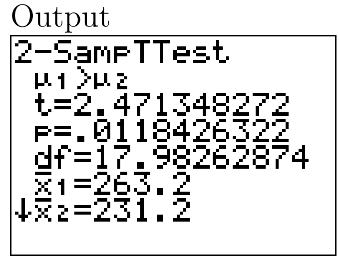
Input (1)



Input (2)



Output



Conclusion: The P-value (0.01184) is less than α (0.05). We reject the null hypothesis and the data supports the claim.

Tests for Two Proportions: `2-PropZTest`

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1. Press the STAT button and highlight `TESTS`.
2. Scroll down to `6:2-PropZTest` ...
3. You have to enter the number of successes in samples 1 and 2 (`x1` and `x2`), the number of trials (or sample sizes) (`n1` and `n2`), then select two-tailed (`p1` $\neq$ `p2`), left-tailed (`p1` $<$ `p2`) or right-tailed (`p1` $>$ `p2`).
4. Highlight `Calculate` and hit ENTER
5. It gives you the test statistic (`z`) and the P-value for the test statistic (`p`) based on your choice of two-tailed, left-tailed, or right-tailed test (so make sure you entered that correctly).

   Warning: The P-value may be given in scientific notation.
   For example `2.143 E⁻6` $= 2.143 \times 10^{-6} = 0.000002143$.

Example: A popular cold-remedy was tested for it's efficacy only this time the control group took a placebo remedy. In a sample of 150 people who took the remedy upon getting a cold, 117 (78%) had no symptoms one week later. In a sample of 120 people who took the placebo upon getting a cold, 90 (75%) had no symptoms one week later. The table summarizes this information.

group	# who are Symptom Free after one week (x)	total # in group (n)	proportion $\hat{p} = x/n$
Remedy	117	150	0.78
Placebo	90	120	0.75

The Test: Test the claim that the proportion of all remedy users who are symptom-free after one week is greater than the proportion for placebo users. Test this claim at the 0.05 significance level.

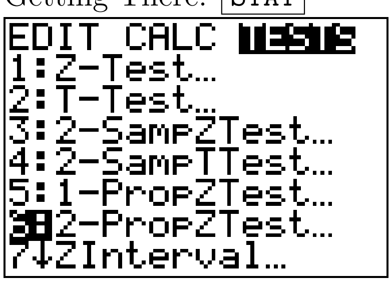
Let p_1 represent the proportion of all remedy-users who are symptom-free after one week and p_2 represent the proportion of all placebo-users who are symptom-free after one week.

Claim: $p_1 - p_2 > 0$

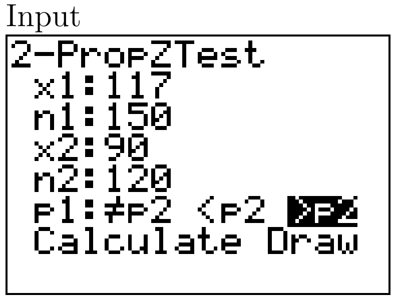
H_o: $p_1 - p_2 = 0$

H_1: $p_1 - p_2 > 0$

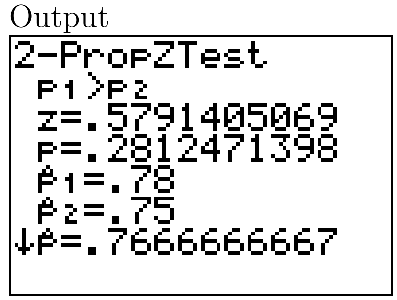
Getting There: STAT



Input



Output



Conclusion: The P-value (0.2812) is greater than α (0.05). We fail to reject the null hypothesis. There is not enough data to support the claim that the proportion of all remedy users who are symptom-free after one week is greater than the proportion for placebo users.

Entering Data into Lists:

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1. Press the $\boxed{\texttt{STAT}}$ button.
2. Highlight the `EDIT` option (using the arrows) and hit $\boxed{\texttt{ENTER}}$.
3. Choose a list (from $\texttt{L}_1$, $\texttt{L}_2, \ldots,$ $\texttt{L}_6$) using the arrows and enter the values by column. Hit $\boxed{\texttt{Enter}}$ or the down-arrow to move down the column.
4. You can **clear** a list by highlighting the list name and hitting the $\boxed{\texttt{Clear}}$ button.