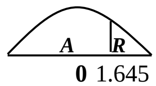
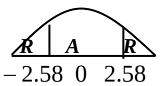
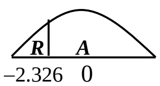
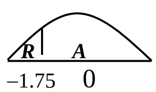
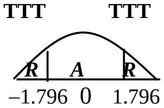
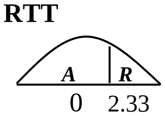
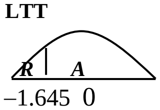
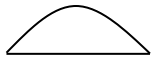
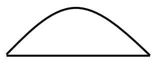
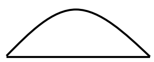
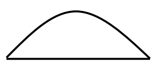
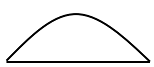
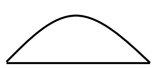
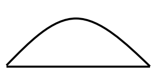
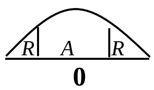
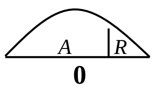
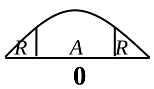
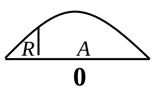
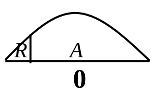
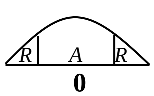
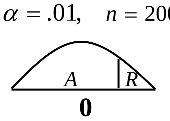
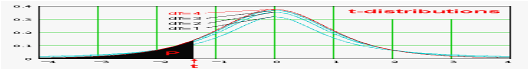
	Step 1	Step 2	Step 3	Test Statistics (*ts*)	Conclusion About H_0	Comment About SC	P- value
1	**SC** $\mu > 40$ **OC** $\mu \le 40$	H_0: $\mu \le 40$ H_1: $\mu > 40$ RTT	$\alpha = .05,\ n = 49$ RTT  **CV =** 1.645	$n = 49,\quad \bar{x} = 41.8,\quad s = 3.8$ $z = \frac{\sqrt{49}\,(41.8 - 40)}{3.8} = 3.316$	***ts*** falls inside ***CR*** $\Rightarrow$ Reject that H_0: $\mu \le 40$	Accept **That SC**: $\mu > 40$	0.00004 Lower than $\alpha = .05$
2	**SC** $\mu \ne 40$ **OC** $\mu = 40$	H_0: $\mu = 40$ H_1: $\mu \ne 40$ TTT	$\alpha = .01\ \ n = 49$ **TTT TTT**  **CV =** ± 2.576	$n = 49,\quad \bar{x} = 42.8,\quad s = 4.8$ $z = \frac{\sqrt{49}\,(42.8 - 40)}{4.8} = 4.08$	***ts*** falls inside ***CR*** $\Rightarrow$ Reject that H_0: $\mu = 40$	Accept **That SC**: $\mu \ne 40$	0.00004 Lower than $\alpha = .01$
3	**SC** $\mu < 40$ **OC** $\mu \ge 40$	H_0: $\mu \ge 40$ H_1: $\mu < 40$ LTT	$\alpha = .01\ \ n = 56$ **LTT**  **CV =** -2.326	$n = 56,\quad \bar{x} = 39.5,\quad s = 1.9$ $z = \frac{\sqrt{56}\,(39.5 - 40)}{1.9} = -1.969$	***ts*** falls not inside ***CR*** $\Rightarrow$ Accept that H_0: $\mu \ge 40$	Reject **That SC**: $\mu < 40$	0.00245 Not lower than $\alpha = .01$
4	**SC** $\mu < 40$ **OC** $\mu \ge 40$	H_0: $\mu \ge 40$ H_1: $\mu < 40$ LTT	$\alpha = .05,\ n = 16$ **LTT**  **CV =** -1.753	$n = 16,\quad \bar{x} = 38.5,\quad s = 2.2$ $t = \frac{\sqrt{16}\,(38.5 - 40)}{2.2} = -2.727$	***ts*** falls inside ***CR*** $\Rightarrow$ Reject that H_0: $\mu \ge 40$	Accept **SC**: $\mu < 40$	0.00779 Not lower than $\alpha = .05$
5	**SC**: $\mu = 15$ **OC** $\mu \ne 15$	H_0: $\mu = 15$ H_1: $\mu \ne 15$ TTT	$\alpha = .10,\ n = 12$ **TTT TTT**  **CV =** ± 1.796	$n = 12,\quad \bar{x} = 13.8,\quad s = 2.7$ $t = \frac{\sqrt{12}\,(13.8 - 15)}{2.7} = -1.52$	***ts*** falls not inside ***CR*** $\Rightarrow$ Accept that H_0: $\mu = 15$	Accept **That SC**: $\mu = 15$	0.1519 Not lower than $\alpha = .01$
6	**SC** $p > 0.40$ **OC** $p \le 0.40$	H_0: $p \le 0.40$ H_1: $p > 0.40$ RTT	$\alpha = .01,\ n = 250$ **RTT**  **CV =** 2.326	$n = 250,\quad x = 120,$ $\hat{p} = 120/250 = .48$ $z = \frac{.48 - .40}{\sqrt{\frac{.4(1-.4)}{250}}} = 2.57$	***ts*** falls inside ***CR*** $\Rightarrow$ Reject that H_0: $p \le 0.40$	Accept **That SC**: $p > .40$	0.0049 Lower than $\alpha = .01$
7	**SC**: $p \ge 0.40$ **OC**: $p < 0.40$	H_0: $p \ge 0.40$ H_1 $p < 0.40$ LTT	$\alpha = .05,\ n = 360$ **LTT**  **CV =** -1.645	$n = 360,\quad x = 135,$ $\hat{p} = 135/360 = .375$ $z = \frac{.375 - .40}{\sqrt{\frac{.4(1-.4)}{360}}} = -.968$	***ts*** falls not inside ***CR*** $\Rightarrow$ Accept that H_0: $p \ge 0.40$	Accept **That SC**: $p \ge .40$	0.16646 Not lower than $\alpha = .05$

Please complete the table

	Step 1	Step 2	Step 3	Test Statistics = ts	Conclusion	Comment	P- value
1	**SC**: $\mu = 41$ **OC**:	$\mathbf{H_0}$: $\mathbf{H_1}$:	$\alpha = .01, \quad n = 36$  **0** CV = ? =	$n = 36, \quad \bar{x} = 42.2, \quad s = 3.2$ ts = ________________	***ts*** falls inside of ***CR or not ?*** ⇒ **R**eject $\mathbf{H_0}$ **or** **A**ccept $\mathbf{H_0}$?	Accept **or** Reject **SC**:	
2	**SC**: $\mu \le 55$ **OC**:	$\mathbf{H_0}$: $\mathbf{H_1}$:	$\alpha = 0.01 \quad n = 64$  **0** CV = ? =	$n = 64, \quad \bar{x} = 56.2, \quad s = 8.4$ ts = ________________	***ts*** falls inside of ***CR or not ?*** ⇒ **R**eject $\mathbf{H_0}$ **or** **A**ccept $\mathbf{H_0}$?	Accept **or** Reject **SC**:	
3	**SC**: $\mu \ne 14$ **OC**:	$\mathbf{H_0}$: $\mathbf{H_1}$:	$\alpha = .05 \quad n = 20$  **0** CV = ? =	$n = 20, \quad \bar{x} = 13.12, \quad s = 3.2$ ts = ________________	***ts*** falls inside of ***CR or not ?*** ⇒ **R**eject $\mathbf{H_0}$ **or** **A**ccept $\mathbf{H_0}$?	Accept **or** Reject **SC**:	
4	**SC**: $\mu \ge 400$ **OC**:	$\mathbf{H_0}$: $\mathbf{H_1}$:	$\alpha = .025, \quad n = 25$  **0** CV = ? =	$n = 25, \quad \bar{x} = 380, \quad s = 32$ ts = ________________	***ts*** falls inside of ***CR or not ?*** ⇒ **R**eject $\mathbf{H_0}$ **or** **A**ccept $\mathbf{H_0}$?	Accept **or** Reject that **SC**:	
5	**SC**: $\mu < 102$ **OC**:	$\mathbf{H_0}$: $\mathbf{H_1}$:	$\alpha = .01, \quad n = 82$  **0** CV = ? =	$n = 82, \quad \bar{x} = 97.5, \quad s = 17.521$ ts = ________________	***ts*** falls inside of ***CR or not ?*** ⇒ **R**eject $\mathbf{H_0}$ **or** **A**ccept $\mathbf{H_0}$?	Accept **or** Reject **SC**:	
6	**SC**: $p \ne 0.13$ **OC**:	$\mathbf{H_0}$: $\mathbf{H_1}$:	$\alpha = .05, \quad n = 400$  **0** CV = ? =	$n = 400, \quad x = 64 \quad \hat{p} =$ ts = ________________	***ts*** falls inside of ***CR or not ?*** ⇒ **R**eject $\mathbf{H_0}$ **or** **A**ccept $\mathbf{H_0}$?	Accept **or** Reject **SC**	
7	**SC**: $p > 0.44$ **OC**:	$\mathbf{H_0}$: $\mathbf{H_1}$:	$\alpha = .01, \quad n = 200$  **0** CV = ? =	$n = 200, \quad x = 92, \quad \hat{p} =$ ts = ________________	***ts*** falls inside of ***CR or not ?*** ⇒ **R**eject $\mathbf{H_0}$ **or** **A**ccept $\mathbf{H_0}$?	Accept **or** Reject **SC**:	

Answers on Page 3

	Step 1	Step 2	Step 3	Test Statistics = ts	Conclusion	Comment	P -value
1	**SC**: $\mu = 41$ **OC**: $\mu \neq 41$	**H$_0$**: $\mu = 41$ **H$_1$**: $\mu \neq 41$	$\alpha = .01, \quad n = 36$  **CV =** $\pm\ 2.576$	$n = 36, \quad \overline{x} = 42.2, \quad s = 3.2$ $z = \frac{\sqrt{36}\left(42.2 - 41\right)}{3.2} = 2.25$	***ts*** falls not inside of ***CR*** $\Rightarrow$ **A**ccept **H$_0$** $\mu = 41$	**A**ccept that **SC**: $\mu = 41$	0.024 Not lower than $\alpha = .05$
2	**SC**: $\mu \leq 55$ **OC**: $\mu > 55$	**H$_0$**: $\mu \leq 55$ **H$_1$**: $\mu > 55$	$\alpha = 0.01 \quad n = 64$  **CV =** 2.326	$n = 64, \quad \overline{x} = 56.2, \quad s = 8.4$ $z = \frac{\sqrt{64}\left(56.2 - 55\right)}{8.4} = 1.1429$	***ts*** falls not inside of ***CR*** $\Rightarrow$ **A**ccept **H$_0$** $\mu \leq 55$	Accept that **SC**: $\mu \leq 55$	0.127 Not lower than $\alpha = .01$
3	**SC**: $\mu \neq 14$ **OC**: $\mu = 14$	**H$_0$**: $\mu = 14$ **H$_1$**: $\mu \neq 14$	$\alpha = .05 \quad n = 20$  **CV =** ± 2.093	$n = 20, \quad \overline{x} = 13.12, \quad s = 3.2$ $t = \frac{\sqrt{20}\left(13.12 - 14\right)}{3.2} = -1.229$	***ts*** falls not inside of ***CR*** $\Rightarrow$ **A**ccept **H$_0$** $\mu = 14$	Reject that **SC**: $\mu \neq 14$	0.2338 Not lower than $\alpha = .05$
4	**SC**: $\mu \geq 400$ **OC**: $\mu < 400$	**H$_0$**: $\mu \geq 400$ **H$_1$**: $\mu < 400$	$\alpha = .025, \quad n = 25$  **CV =** -2.064	$n = 25, \quad \overline{x} = 380, \quad s = 32$ $t = \frac{\sqrt{25}\left(380 - 400\right)}{32} = -3.125$	***ts*** falls inside of ***CR*** $\Rightarrow$ **R**eject **H$_0$** $\mu \geq 400$	Reject that **SC**: $\mu \geq 400$	0.0023 Lower than $\alpha = .025$
5	**SC**: $\mu < 102$ **OC**: $\mu \geq 102$	**H$_0$**: $\mu \geq 102$ **H$_1$**: $\mu < 102$	$\alpha = .01, \quad n = 82$  **CV =** -2.326	$n = 82, \quad \overline{x} = 97.5, \quad s = 17.521$ $z = \frac{\sqrt{82}\left(97.5 - 102\right)}{17.521} = -2.326$	***ts*** falls on the border line of ***CR*** $\Rightarrow$ **I**nconclusive	**SC**: **I**nconclusive	0.0100 Same as $\alpha = .01$
6	**SC**: $p \neq 0.13$ **OC**: $p = 0.13$	**H$_0$**: $p = 0.13$ **H$_1$**: $p \neq 0.13$	$\alpha = .05, \quad n = 400$  **CV =** ± 1.96	$n = 400, \quad x = 64$ $\hat{p} = 64 / 400 = .16$ $z = \frac{.16 - .13}{\sqrt{\frac{.13(1 - .13)}{400}}} = 1.784$	***ts*** falls ***not*** inside of ***CR*** $\Rightarrow$ **A**ccept **H$_0$**	Reject that **SC**: $p \neq 0.13$	0.0744 Not lower than $\alpha = .05$
7	**SC**: $p > 0.44$ **OC**: $p \leq 0.44$	**H$_0$**: $p \leq 0.44$ **H$_1$**: $p > 0.44$	$\alpha = .01, \quad n = 200$  **CV =** 2.326	$n = 200, \quad x = 92,$ $\hat{p} = 92 / 200 = .46$ $z = \frac{.46 - .44}{\sqrt{\frac{.44(1 - .44)}{200}}} = 0.5698$	***ts*** falls ***not*** inside of ***CR*** $\Rightarrow$ **A**ccept **H$_0$**	Reject that **SC**: $p > 0.44$	0.2844 Not lower than $\alpha = .01$



t -Distribution for small sample $n < 30$ and σ Unknown

df = n-1	<-------------------- alpha α -------------------->							
2-Tailed	**0.40**	**0.30**	**0.20**	**0.10**	**0.05**	**0.02**	**0.01**	**0.005**
1-Tailed	**0.20**	**0.15**	**0.10**	**0.05**	**0.025**	**0.01**	**0.005**	**0.0025**
Conf. Levl.	**60%**	**70%**	**80%**	**90%**	**95%**	**98%**	**99%**	**99.5%**
1	1.376	1.963	3.078	6.314	12.706	31.821	63.656	127.321
2	1.061	1.386	1.886	2.920	4.303	6.965	9.925	14.089
3	0.978	1.250	1.638	2.353	3.182	4.541	5.841	7.453
4	0.941	1.190	1.533	2.132	2.776	3.747	4.604	5.598
5	*0.920*	*1.156*	*1.476*	*2.015*	*2.571*	*3.365*	*4.032*	*4.773*
6	0.906	1.134	1.440	1.943	2.447	3.143	3.707	4.317
7	0.896	1.119	1.415	1.895	2.365	2.998	3.499	4.029
8	0.889	1.108	1.397	1.860	2.306	2.896	3.355	3.833
9	0.883	1.100	1.383	1.833	2.262	2.821	3.250	3.690
10	*0.879*	*1.093*	*1.372*	*1.812*	*2.228*	*2.764*	*3.169*	*3.581*
11	0.876	1.088	1.363	1.796	2.201	2.718	3.106	3.497
12	0.873	1.083	1.356	1.782	2.179	2.681	3.055	3.428
13	0.870	1.079	1.350	1.771	2.160	2.650	3.012	3.372
14	0.868	1.076	1.345	1.761	2.145	2.624	2.977	3.326
15	*0.866*	*1.074*	*1.341*	*1.753*	*2.131*	*2.602*	*2.947*	*3.286*
16	0.865	1.071	1.337	1.746	2.120	2.583	2.921	3.252
17	0.863	1.069	1.333	1.740	2.110	2.567	2.898	3.222
18	0.862	1.067	1.330	1.734	2.101	2.552	2.878	3.197
19	0.861	1.066	1.328	1.729	2.093	2.539	2.861	3.174
20	*0.860*	*1.064*	*1.325*	*1.725*	*2.086*	*2.528*	*2.845*	*3.153*
21	0.859	1.063	1.323	1.721	2.080	2.518	2.831	3.135
22	0.858	1.061	1.321	1.717	2.074	2.508	2.819	3.119
23	0.858	1.060	1.319	1.714	2.069	2.500	2.807	3.104
24	0.857	1.059	1.318	1.711	2.064	2.492	2.797	3.091
25	*0.856*	*1.058*	*1.316*	*1.708*	*2.060*	*2.485*	*2.787*	*3.078*
26	0.856	1.058	1.315	1.706	2.056	2.479	2.779	3.067
27	0.855	1.057	1.314	1.703	2.052	2.473	2.771	3.057
28	0.855	1.056	1.313	1.701	2.048	2.467	2.763	3.047
29	0.854	1.055	1.311	1.699	2.045	2.462	2.756	3.038
30	*0.854*	*1.055*	*1.310*	*1.697*	*2.042*	*2.457*	*2.750*	*3.030*
$n > 30$ *n>30* $\Rightarrow Z$	*0.842*	*1.036*	*1.282*	*1.645*	*1.96*	*2.326*	*2.576*	*2.807*

2-T	0.40	0.30	0.20	0.10	0.05	0.02	0.01	0.005
1-T	0.20	0.15	0.10	0.05	0.025	0.01	0.005	0.0025
Conf. Levl.	60%	70%	80%	90%	95%	98%	99%	99.5%

Hypothesis Testing on the TI-83/84

Written by Jeff O'Connell – joconnell@ohlone.edu
Ohlone College
http://www2.ohlone.edu/people2/joconnell/ti/ - A video tutorial can be found at this site

Stat vs. Data – Throughout this section the calculator will ask you if you have [Data] or [Stats]. *Stats* is when you just have the statistics about the data such as the mean and standard deviation. *Data* is when you have the actual data. In the case where you have Data, you will enter the data into a list and tell the calculator which list the data is in. Both types of examples are shown in this section.

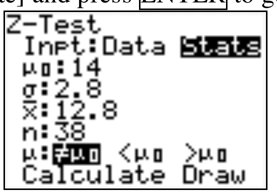
p-values – The Calculator does hypothesis testing by finding the p-value. Recall that the p-value is the area of the tail(s) that the test statistic cuts off. If the p-value is less than the level of significance then we reject the null hypothesis, if the p-value is more that the level of significance then we fail to reject the null hypothesis.

All Confidence intervals and Hypothesis testing can be found by pressing STAT and scrolling to [TESTS]

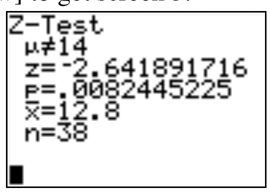
The Population Mean

Example 1: A sample of 38 items is chosen from a normally distributed population with a sample mean of 12.5 and a population standard deviation of 2.8. At the 0.05 level of significance test the null hypothesis that the population mean is 14, that is H_0: $\mu = 14$, H_1: $\mu \neq 14$, with $\alpha = 0.05$.

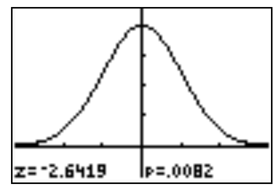
Solution: We choose [1:Z-TEST...] since we are using a z-distribution. Enter the information as shown in screen 1 below, highlight [Calculate] and press ENTER to get screen 2 or [Draw] to get screen 3.



Screen1



Screen 2

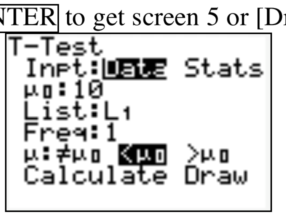


Screen 3

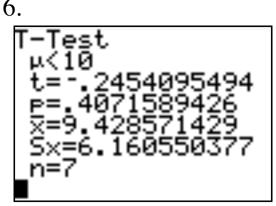
The p-value is 0.0082 < α so we Reject H_0.

Example 2: A sample of 7 items is chosen from a normal distribution with the following results: {1, 5, 6, 8, 12, 16, 18}. Test the claim that $\mu < 10$, that is H_0: $\mu = 10$, H_1: $\mu < 10$, with $\alpha = 0.01$.

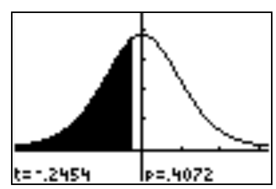
Solution: Here we are given the actual data from the sample. We can have the calculator do all of the work on the sample by entering the data into a list, say L1. We choose [2:T-TEST...]. Enter the information as shown in screen 4 below, highlight [Calculate] and press ENTER to get screen 5 or [Draw] to get screen 6.



Screen 4



Screen 5



Screen 6

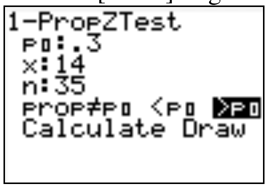
The p-value is 0.4072 > α so we Fail to Reject H_0.

NOTE: Freq stands for Frequency which may be used if you have data where a lot of the data points are repeated. For example, if your data consists of 1, 1, 1, 2, 2, 3, 4 you can enter all of the distinct the data points in L1 and the frequencies in L2. So L1 = {1, 2, 3, 4} and L2 = {3, 2, 1, 1}. We can enter L1 as the *List* and L2 as the *Freq*. It will most often be the case that we will use 1 as the Freq but this option is available.

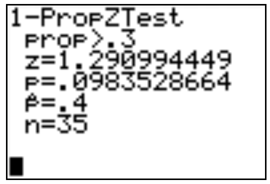
The population proportion

Example 3: For x = 14, n = 35 test the claim that p > 0.3, that is H_0: p = 0.3, H_1: p > 0.3, with α = 0.05.

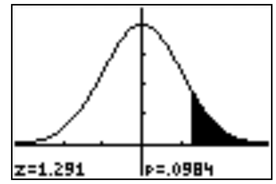
Solution: We choose [5:1–PropZTest...]. Enter the information as shown in screen 7 below, highlight [Calculate] and press ENTER to get screen 8 or [Draw] to get screen 9.



Screen 7



Screen 8



Screen 9

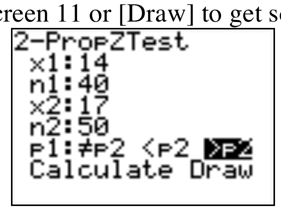
The p-value is 0.0984 > α so we Fail to Reject H_0.

NOTE: *x* and *n* must be an integers.

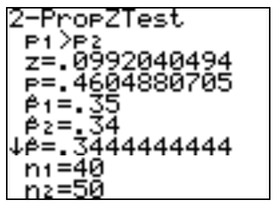
Comparing two population proportions

Example 4: For x_1 = 14, n_1 = 40, x_2 = 17, and n_2 = 50 test the claim that $p_1 > p_2$, that is H_0: $p_1 = p_2$, H_1: $p_1 > p_2$, with α = 0.1.

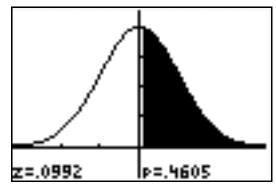
Solution: We choose [6:2–PropZTest...]. Enter the information as shown in screen 10 below, highlight [Calculate] and press ENTER to get screen 11 or [Draw] to get screen 12.



Screen 10



Screen 11



Screen 12

The p-value is 0.4605 > α so we Fail to Reject H_0.

Hypothesis testing for two population means.

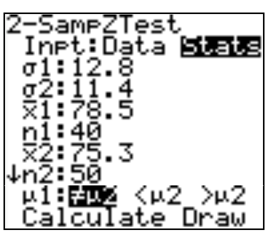
Example 5: The following samples were taken from normal distributions. Test the claim that $\mu_1 \neq \mu_2$, that is H_0: $\mu_1 = \mu_2$, H_1: $\mu_1 \neq \mu_2$, with α = 0.05.

$\bar{x}_1 = 78.5$ $\quad \bar{x}_2 = 75.3$

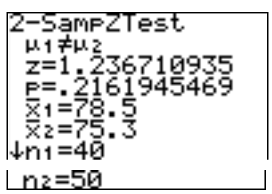
$\sigma_1 = 12.8$ $\quad \sigma_2 = 11.4$

$n_1 = 40$ $\quad n_2 = 50$

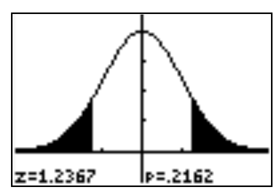
Solution: Select [3:2–SampZtest...] and enter the information shown in screen 13, highlight [Calculate] press ENTER to get the results shown in screen 14 or [Draw] to get the results in screen 15.



Screen 13



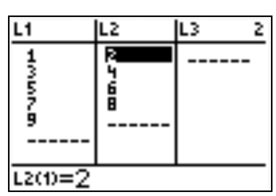
Screen 14



Screen 15

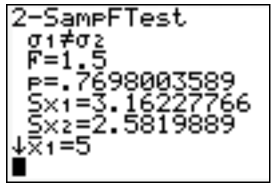
The p-value is 0.2162 > α so we Fail to Reject H_0.

Example 6: For the sample information taken from normal distributions shown in the screen to the right with L1 being sample from population 1 and L2 from population 2 test the claim that $\mu_1 > \mu_2$, that is H_0: $\mu_1 = \mu_2$, H_1: $\mu_1 > \mu_2$, with α = 0.05.

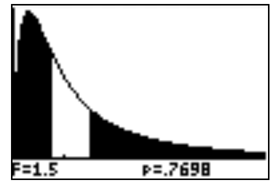


Solution: After entering the sample data into L1 and L2 as shown, we must determine if the variances are significantly different, that is, test the claim H_0: $\sigma_1^2 = \sigma_2^2$ against H_1: $\sigma_1^2 \neq \sigma_2^2$. Select [D:2–SampFTest...] and enter the information shown in screen 16, highlight [Calculate] press ENTER to get the results shown in screen 17 or [Draw] to get the results in screen 18.

Screen 16



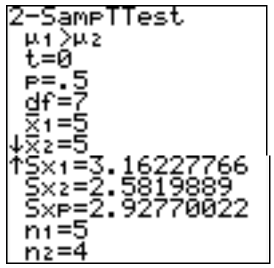
Screen 17



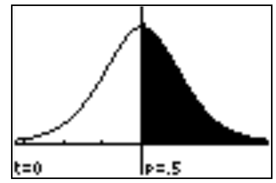
Screen 18

The large p-value (bigger than $\alpha = 0.05$) indicated that we must "pool" the variances. If the p-value were smaller than α we would not pool the variances. Select [4:2–SampTTest...] and enter the information shown in screen 19, highlight [Calculate] press ENTER to get the results shown in screen 20 or [Draw] to get the results in screen 21.

Screen 19



Screen 20



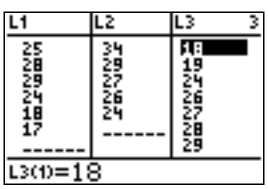
Screen 21

The p-value is $0.5 > \alpha$ so we Fail to Reject H_0.

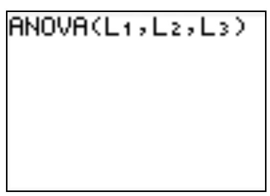
ANOVA

Example 7: Consider the samples taken from three normally distributed populations shown in screen 22. Test the claim that the populations all have the same mean, that is H_0: $\mu_1 = \mu_2 = \mu_3$, H_1: *Not all populations have the same mean*, with $\alpha = 0.05$.

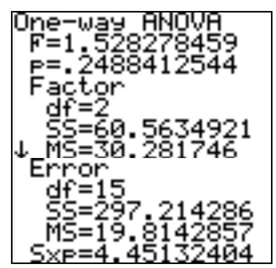
Solution: After entering the data as shown, select [F:ANOVA(], enter the information shown in screen 23, press ENTER to get the results shown in screen 24.



Screen 22



Screen 23



Screen 24

The p-value is $0.2488 > \alpha$ so we Fail to Reject H_0.

NOTE: To do the ANOVA test on the TI-83/84 you must have the data, not the statistics for the data.