STATISTICS 243 FORMULAS

Signs Are Important!		
=	≤	≥
Is	Is less than or equal to	Is greater than or equal to
Is equal to	Is at most	Is at least
Is exactly the same as	Is not greater than	Is not less than
Has not changed from	Within	
Is the same as		
≠	>	<
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

Common Symbols

n = Sample Size
$\bar{x}$ = Sample Mean
s = Sample Standard Deviation
s^2 = Sample Variance
$\hat{p}$ = Sample Proportion

N = Population Size
μ = Population Mean
σ = Population Standard Deviation
σ^2 = Population Variance
p = Population Proportion

Descriptive Statistics

$$\bar{x} = \frac{\Sigma x}{n} \quad s^2 = \frac{\Sigma(x-\bar{x})^2}{n-1} \quad s = \sqrt{\frac{\Sigma(x-\bar{x})^2}{n-1}} \quad z = \frac{x-\bar{x}}{s} \quad \text{Range} = \text{Max} - \text{Min} \quad \text{Midrange} = \frac{\text{Min} + \text{Max}}{2}$$

IQR=interquartile range = $Q_3 - Q_1$ Outlier Limits: Lower limit = $Q_1 - 1.5*IQR$ Upper limit = $Q_3 + 1.5*IQR$

Calculator Shortcuts

TI-84 Entering Data

- Press [STAT] the first option is already highlighted (1:Edit) so you can either press [ENTER] or 1.
- Make sure the cursor is in the list, not on the list name and type the desired values pressing [ENTER] after each one. For x-y data pairs, enter all x-values in one list. Enter all corresponding y-values in a second list.
- Press [2nd] [QUIT] to return to the home screen.
- To clear a previously stored list of data values, arrow up to the list name you want to clear, press [CLEAR], then press enter. An alternative way is press [STAT], press 4 for 4:ClrList, press [2nd], then press the number key corresponding to the data list you wish to clear, for example 2nd 1 will clear L1. Press [ENTER].
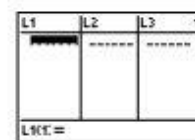
TI-89 Entering Data

- Press [APPS], select **FlashApps** then press [ENTER]. Highlight **Stats/List Editor** then press [ENTER]. Press [ENTER] again to select the main folder.
- Make sure the cursor is in the list, not on the list name and type the desired values pressing [ENTER] after each one. For x-y data pairs, enter all x-values in one list. Enter all corresponding y-values in a second list.
- Press [Home] to return to the home screen.
- To clear a previously stored list of data values, arrow up to the list name you want to clear, press [CLEAR], then press enter.
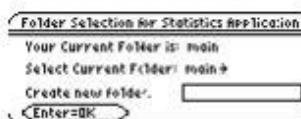
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TI-84 One Variable Statistics
- Press [STAT]. Use cursor keys to highlight CALC. Press 1 or [ENTER] to select **1:1-Var Stats**. Press [2nd], then press the number key corresponding to your data list. Press Enter to calculate the statistics. Note: the calculator always defaults to L1 if you do not specify a data list.
- Note: Sx is the sample standard deviation. The quartiles calculated by the TI calculators differ somewhat from those found using the procedure in the text for this class. Make sure that you do the quartiles by hand.

TI-89 One Variable Statistics
- Enter the data in list1. Select F4 for the **Calc** menu. Use cursor keys to highlight **1:1-Var Stats**. Type in the name of your list without space, for example list1. Press enter twice and the statistics will appear in a new window. Use the cursor keys to arrow up and down to see all of the values.
- Note: Sx is the sample standard deviation. The quartiles calculated by the TI calculators differ somewhat from those found using the procedure in the text for this class. Make sure that you do the quartiles by hand.

TI-84 Sorting Data
- Press [STAT]. Press 2 or [ENTER] to select **SortA(**. Press [2nd], then press the number key corresponding to your data list that you want to sort. Press Enter, the calculator says Done. To see the sorted data go back into the Edit mode.

TI-89 Sorting Data
- After the data is entered in a list, make sure your cursor is on the list you want to sort. Select F3 List, then select 2:Ops, then select 1:Sort List. Make sure the list number is correct and that Ascending is selected then hit Enter.

Probability

Union Rule: $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

Complement Rule: $P(A^C) = 1 - P(A)$

Conditional Probability: $P(A \mid B) = \dfrac{P(A \cap B)}{P(B)}$
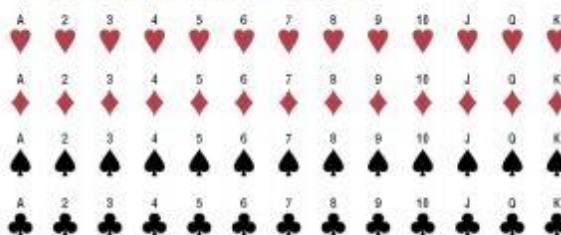
Mutually Exclusive Events: $P(A \cap B) = 0$

Dependent Events: $P(A \cap B) = P(B) \cdot P(A \mid B)$

Independent Events: $P(A \cap B) = P(B) \cdot P(A)$

Sum of Two Dice

		Second Die				
+	1	2	3	4	5	6
1	2	3	4	5	6	7
2	3	4	5	6	7	8
3	4	5	6	7	8	9
4	5	6	7	8	9	10
5	6	7	8	9	10	11
6	7	8	9	10	11	12

(First Die labels rows 1–6)

Standard Deck of Cards

Face Cards are Jack (J), Queen (Q) and King (K)

Counting Rules

TI-84 Factorials
- On the home screen, enter the number of which you would like to find the factorial. Press [MATH]. Use cursor keys to move to the PRB menu. Press 4 (4: !) Press [ENTER] to calculate.

TI-89 Factorials
- On the home screen, enter the number of which you would like to find the factorial. Press [2nd] [Math] > 7:**Probability** > 1:!. Press [ENTER] to calculate.
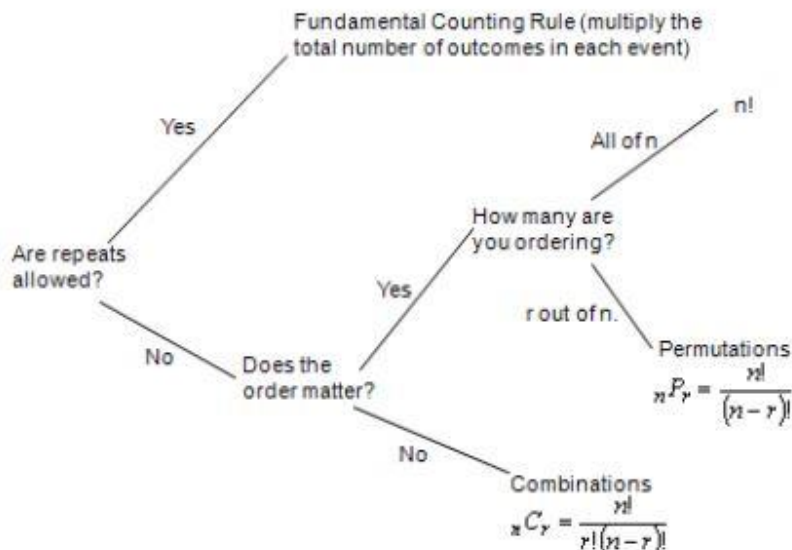
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TI-84 Combinations/Permutations
- Enter the number "trials" (n) on the home screen. Press [MATH]. Use cursor keys to move to the PRB menu. Press 2 for permutation (2: $_nP_r$), 3 for combination (3: $_nC_r$). Enter the number of "successes" (r). Press [ENTER] to calculate.

TI-89 Combinations/Permutations
- Press [2nd] **Math** > **7:Probability** > Press 2 for permutation (2: $_nP_r$), 3 for combination (3: $_nC_r$). Enter the sample size on the home screen, then a comma, then enter the number of "successes" then end the parenthesis. Press [ENTER] to calculate.

Fundamental Counting Rule (multiply the total number of outcomes in each event)

$$_nP_r = \frac{n!}{(n-r)!}$$

$$_nC_r = \frac{n!}{r!(n-r)!}$$

Discrete Probability Distributions

$$\text{Mean} = E(x) = \mu = \Sigma x \cdot P(x) \quad \text{Variance} = \sigma^2 = \left(\Sigma x^2 \cdot P(x)\right) - \mu^2 \quad \text{Standard Deviation} = \sigma = \sqrt{\left(\Sigma x^2 \cdot P(x)\right) - \mu^2}$$

TI-84 Mean, Variance and Standard Deviation of a Discrete Probability Distribution Table
- Press [STAT] the first option is already highlighted (1:Edit) so you can either press [ENTER] or 1.
- Make sure the cursor is in the list, not on the list name and type the desired values pressing [ENTER] after each one. For X and P(X) data pairs, enter all X-values in one list. Enter all corresponding P(X)-values in a second list.
- Press [STAT]. Use cursor keys to highlight CALC. Press 1 or [ENTER] to select **1:1-Var Stats**. Press [2nd], then press the number key corresponding to your X list, then a comma, then [2nd] and the number key corresponding to your P(X) values. (Should look like this 1-Var Stats L₁,L₂) Press Enter to calculate the statistics. Where the calculator says $\bar{X}$ this is μ the population mean and σx is the population standard deviation (square this number to get the population variance).

TI-89 Mean, Variance and Standard Deviation of a Discrete Probability Distribution Table
- Go to the [Apps] **Stat/List Editor**, and type the X values into List 1 and P(X) values into List2.
- Select F4 for the **Calc** menu. Use cursor keys to highlight **1:1-Var Stats**. Type in the name of your X list without space, for example list1 where it says List. Type in the name of your P(X) list without space, for example list2 where it says Freq. Press enter twice and the statistics will appear in a new window. Use the cursor keys to arrow up and down to see all of the values.
- Note: $\bar{X}$ this is μ the population mean and σx is the population standard deviation; square this value to get the variance.

Binomial Distribution: $P(x) = {}_nC_x \cdot p^x \cdot q^{(n-x)}$ $\qquad \mu = n \cdot p \quad \sigma^2 = n \cdot p \cdot q \quad \sigma = \sqrt{n \cdot p \cdot q}$

TI-84 Binomial Distribution
- Press [2nd] [DISTR]. This will get you a menu of probability distributions.
- Press 0 or arrow down to **0:binompdf(** and press [ENTER]. This puts binompdf(on the home screen. Enter the values for n, p and x with a comma between each. Press [ENTER]. This is the probability density function and will return you the probability of <u>exactly</u> x successes. If you leave off the x value and just enter n and p, you will get all the probabilities for each x from 0 to n.
- Press [ALPHA] A or arrow down to **A:binomcdf(** and press [ENTER]. This puts binomcdf(on the home screen. Enter the values for n, p and x with a comma between each. Press [ENTER]. This is the cumulative distribution function and will return you the probability of <u>at most</u> x successes.

TI-89 Binomial Distribution
- Go to the [Apps] **Stat/List Editor**, then select F5 [DISTR]. This will get you a menu of probability distributions.

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- Arrow down to **binomial Pdf** and press [ENTER]. Enter the values for n, p and x into each cell. Press [ENTER]. This is the probability density function and will return you the probability of <u>exactly</u> x successes. If you leave off the x value and just enter n and p, you will get all the probabilities for each x from 0 to n.
- Arrow down to **binomial Cdf** and press [ENTER]. Enter the values for n, p and lower and upper value of x into each cell. Press [ENTER]. This is the cumulative distribution function and will return you the probability between the lower and upper x-values, inclusive.

Signs Are Important For Discrete Distributions!		
P(X=x)	**P(X≤x)**	**P(X≥x)**
Is	Is less than or equal to	Is greater than or equal to
Is equal to	Is at most	Is at least
Is exactly the same as	Is not greater than	Is not less than
Has not changed from	Within	
Is the same as		
=BINOM.DIST(x,n,p,false)	=BINOM.DIST(x,n,p,true)	=1-BINOM.DIST(x−1,n,p,true)
TI: binompdf(n,p,x)	TI: binomcdf(n,p,x)	TI: 1−binomcdf(n,p,x−1)

Where:	**P(X>x)**	**P(X<x)**
x is the value in the	More than	Less than
question that you are	Greater than	Below
finding the probability for.	Above	Lower than
p is the proportion of a	Higher than	Shorter than
success expressed as a	Longer than	Smaller than
decimal between 0 and 1	Bigger than	Decreased
n is the sample size	Increased	Reduced
	Smaller	Larger
Excel:	=1−BINOM.DIST(x,n,p,true)	=BINOM.DIST(x−1,n,p,true)
TI-Calculator:	1−binomcdf(n,p,x)	binomcdf(n,p,x−1)

Poisson Distribution: $P(x) = \dfrac{e^{-\mu}\mu^x}{x!}$ Change mean to fit the units in the question: $\text{new } \mu = \text{old } \mu \times \left(\dfrac{\text{new units}}{\text{old units}}\right)$

P(X=x)	**P(X≤x)**	**P(X≥x)**
Is	Is less than or equal to	Is greater than or equal to
Is equal to	Is at most	Is at least
Is exactly the same as	Is not greater than	Is not less than
Has not changed from	Within	
Is the same as		
=POISSON.DIST(x,mean,false)	=POISSON.DIST(x,mean,true)	=1−POISSON.DIST(x−1,mean,true)
TI: poissonpdf(mean,x)	TI: poissoncdf(mean,x)	TI: 1−poissoncdf(mean,x−1)

Where:	**P(X>x)**	**P(X<x)**
x is the value in the	More than	Less than
question that you are	Greater than	Below
finding the probability for.	Above	Lower than
	Higher than	Shorter than
The mean has been rescaled to	Longer than	Smaller than
the units of the question.	Bigger than	Decreased
	Increased	Reduced
	Smaller	Larger
Excel:	=1−POISSON.DIST(x,mean,true)	=POISSON.DIST(x−1,mean,true)
TI-Calculator:	1−poissoncdf(mean,x)	poissoncdf(mean,x−1)

Hypergeometric Distribution $P(x) = \dfrac{{}_aC_x \cdot {}_bC_{n-x}}{{}_NC_n}$

P(X=x)	P(X≤x)	P(X≥x)
Is	Is less than or equal to	Is greater than or equal to
Is equal to	Is at most	Is at least
Is exactly the same as	Is not greater than	Is not less than
Has not changed from	Within	
Is the same as		
=HYPGEOM.DIST(x,n,a,N,false)	= HYPGEOM.DIST(x, n,a,N,true)	=1- HYPGEOM.DIST(x-1, n,a,N,true)

Where:	P(X>x)	P(X<x)
x is the value in the	More than	Less than
question that you are	Greater than	Below
finding the probability for.	Above	Lower than
N = Population Size	Higher than	Shorter than
n = Sample Size	Longer than	Smaller than
a = Number of Successes out of N	Bigger than	Decreased
b = Number of Failures out of N	Increased	Reduced
No shortcut for the TI	Smaller	Larger
Excel:	=1- HYPGEOM.DIST(x, n,a,N,true)	= HYPGEOM.DIST(x-1, n,a,N,true)

Normal Distribution $z = \dfrac{x - \mu}{\sigma}$ $\qquad x = z \cdot \sigma + \mu$

TI-84 Normal Distribution
- Press [2nd] [DISTR]. This will get you a menu of probability distributions.
- Press 2 or arrow down to **2:normalcdf(** and press [ENTER]. This puts normalcdf(on the home screen. Enter the values for the lower x value (x_1), upper x value (x_2), μ, and σ with a comma between each. Press [ENTER]. This is the cumulative distribution function and will return $P(x_1 < x < x_2)$. For example to find $P(80 < X < 110)$ when the mean is 100 and the standard deviation is 20, you should have normalcdf(80,110,100,20)
- If you leave out the μ and σ, then the default is the **standard normal distribution**.
- For a left tail area use a lower bound of –E99 (negative infinity), (press [2nd] [EE] to get E) and for a right tail are use an upper bound of E99 (infinity). For example to find $P(Z < -1.37)$ you should have normalcdf(-E99,-1.37)

TI-89 Normal Distribution
- Go to the [Apps] **Stat/List Editor**, then select F5 [DISTR]. This will get you a menu of probability distributions.
- Arrow down to **Normal Cdf** and press [ENTER]. Enter the values for the lower x value (x_1), upper x value (x_2), μ, and σ into each cell. Press [ENTER]. This is the cumulative distribution function and will return $P(x_1 < x < x_2)$. For example to find $P(80 < X < 110)$ when the mean is 100 and the standard deviation is 20, you should have in the following order 80, 110, 100, 20.
- If you have a z-score, use $\mu = 0$ and $\sigma = 1$, then you will get **standard normal distribution**.
- For a left tail area use a lower bound of negative infinity (-∞), and for a right tail are use an upper bound infinity (∞).

Note that in Excel the NORM.S.DIST function is for a standard normal when $\mu = 0$ and $\sigma = 1$.

Inverse Normal Distribution
TI-84 Inverse Normal Distribution
- Press [2nd] [DISTR]. This will get you a menu of probability distributions.
- Press 3 or arrow down to **3:invNorm(** and press [ENTER]. This puts invNorm(on the home screen. Enter the area to the left of the x value, μ, and σ with a comma between each. Press [ENTER]. This will return the percentile for the x value. For example to find the 95th percentile when the mean is 100 and the standard deviation is 20, you should have invNorm(.95,100,20).
- If you leave out the μ and σ, then the default is the **z-score** for the standard normal distribution.

TI-89 Inverse Normal Distribution
- Go to the [Apps] **Stat/List Editor**, then select F5 [DISTR]. This will get you a menu of probability distributions.
- Arrow down to **Inverse Normal** and press [ENTER]. Enter the area to the left of the x value, μ, and σ into each cell. Press [ENTER]. This will return the percentile for the x value. For example to find the 95th percentile when the mean is 100 and the standard deviation is 20, you should enter .95, 100, 20.
- If you use $\mu = 0$ and $\sigma = 1$, then the default is the **z-score** for the standard normal distribution.

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Note that for a continuous distribution there is no area at a line under the curve, so $\geq$ and $>$ will have the same probability and use the same Excel commands.

Normal Distribution Finding a Probability		
$P(X\leq x)$ or $P(X<x)$	$P(x_1<X<x_2)$ or $P(x_1\leq X\leq x_2)$	$P(X\geq x)$ or $P(X>x)$
Is less than or equal to	Between	Is greater than or equal to
Is at most		Is at least
Is not greater than		Is not less than
Within		More than
Less than		Greater than
Below		Above
Lower than		Higher than
Shorter than		Longer than
Smaller than		Bigger than
Decreased		Increased
Reduced		Larger
=NORM.DIST $(x,\mu,\sigma,\text{true})$	=NORM.DIST $(x_2,\mu,\sigma,\text{true})$- NORM.DIST $(x_1,\mu,\sigma,\text{true})$	=1- NORM.DIST $(x,\mu,\sigma,\text{true})$
normalcdf(-1E99,x_1,μ,σ)	normalcdf(x_1,x_2,μ,σ)	normalcdf($x_1,1$E99,μ,σ)

Normal Distribution Finding an X-value Given an Area or Probability		
$P(X\leq x)$ or $P(X<x)$	$P(x_1<X<x_2)$ or $P(x_1\leq X\leq x_2)$	$P(X\geq x)$ or $P(X>x)$
Lower	Between	Upper
Bottom		Top
Below		Above
Reduced		More than
Less than		Greater than
Lower than		Larger
Shorter than		Higher than
Smaller than		Longer than
Decreased		Bigger than
		Increased
=NORM.INV(area,μ,σ)	x_1 =NORM.INV$(1-\text{area}/2,\mu,\sigma)$ $x_2 = |x_1|$	=NORM.INV$(1-\text{area},\mu,\sigma)$
invNorm(area,μ,σ)	x_1 =invNorm$(1-\text{area}/2,\mu,\sigma)$	invNorm$(1-\text{area},\mu,\sigma)$

Central Limit Theorem
When finding the probability of a sample mean use the following z-score: $z = \dfrac{\bar{x} - \mu}{\left(\dfrac{\sigma}{\sqrt{n}}\right)}$ Use the same normalcdf as before, but enter $\sigma/\sqrt{(n)}$ for the standard deviation.

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Confidence Intervals

When n < 30 the variable must be approximately normally distributed.

Is σ given in the problem?
- Yes → Use $z_{a/2}$ and σ in the formula.
- No → Use $t_{a/2}$ and s in the formula.
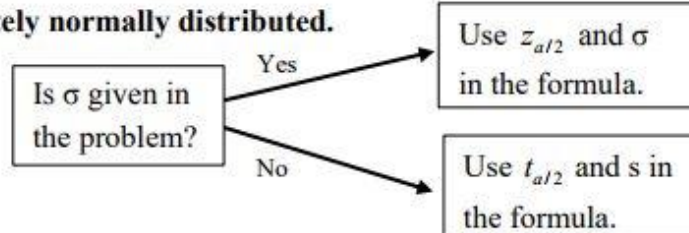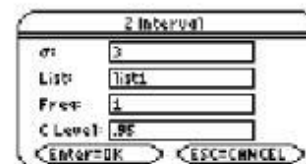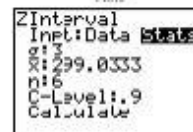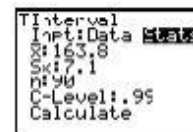
Z-Interval: The $100(1 - \alpha)\%$ confidence interval for μ, when σ is known, is $\bar{x} \pm z_{a/2} \dfrac{\sigma}{\sqrt{n}}$

- On the TI-83 you can find a confidence interval using the statistics menu. Press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the [7:ZInterval] option and press the [ENTER] key. Arrow over to the [Stats] menu and press the [ENTER] key. Then type in the population or sample standard deviation, sample mean, sample size and confidence level, arrow down to [Calculate] and press the [ENTER] key. The calculator returns the answer in interval notation.
- On the TI-89 go to the [Apps] **Stat/List Editor**, then select 2nd then F7 [Ints], then select **1: ZInterval**. 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. Type in the population standard deviation, sample mean, sample size (or list name (list1), and Freq: 1) and confidence level, and press the [ENTER] key to calculate. The calculator returns the answer in interval notation.

T-Interval: The $100(1 - \alpha)\%$ confidence interval for μ, σ is unknown, is $\bar{x} \pm t_{n-1,a/2} \dfrac{s}{\sqrt{n}}$.

- On the TI-83 you can find a confidence interval using the statistics menu. 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 [Stats] menu and press the [ENTER] key. Then type in the mean, sample standard deviation, sample size and confidence level, arrow down to [Calculate] and press the [ENTER] key. The calculator returns the answer in interval notation. Be careful, if you accidentally use the [7:ZInterval] option you would get the wrong answer.
- *Or* (If you have raw data in list one) Arrow over to the [Data] menu and press the [ENTER] key. Then type in the list name, L_1, leave Freq:1 alone, enter the confidence level, arrow down to [Calculate] and press the [ENTER] key.
- On the TI-89 go to the [Apps] **Stat/List Editor**, then select 2nd then F7 [Ints], then select **1:TInterval**. 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. Type in the mean, standard deviation, sample size (or list name (list1), and Freq: 1) and confidence level, and press the [ENTER] key. The calculator returns the answer in interval notation. Be careful, if you accidentally use the [1:ZInterval] option you would get the wrong answer.

Proportion Interval: A $100(1 - \alpha)\%$ confidence interval for the population proportion p is $\hat{p} \pm z_{a/2} \sqrt{\left(\dfrac{\hat{p}(1 - \hat{p})}{n} \right)}$

- On the TI-84 press the [STAT] key, arrow over to the [TESTS] menu, arrow down to the [A:1-PropZInterval] option and press the [ENTER] key. Then type in the values for X, sample size and confidence level, arrow down to [Calculate] and press the [ENTER] key. The calculator returns the answer in interval notation. 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.
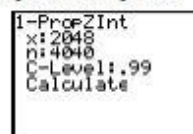
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- On the TI-89 go to the [Apps] **Stat/List Editor**, then select 2nd then F7 [Ints], then select **5: 1-PropZInt**. Type in the values for X, sample size and confidence level, and press the [ENTER] key. The calculator returns the answer in interval notation. 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.

Sample Size

Always round **up** to the next whole number.

$$n = \left(\frac{z_{\alpha/2}\sigma}{E}\right)^2 \qquad n = \hat{p}(1-\hat{p})\left(\frac{z_{\alpha/2}}{E}\right)^2$$