Chapter 8 / **Example 5**
χ^2 goodness of fit to the normal distribution

The GDC can work out the values of the chi squared statistic and the *p*-value.

The scores for IQ tests are normally distributed with a mean of 100 and standard deviation of 10. Cinzia gives an IQ test to all 200 IB Diploma Programme students in the school. Her results are shown in the table. Cinzia wants to test if these results are also normally distributed and performs a χ^2 goodness of fit test at the 10% significance level.

Score, x	Frequency
x< 90	5
90 ≤ x < 100	14
100 ≤x< 110	74
110 ≤x< 120	58
120 ≤x< 130	34
130 ≤x	15

a Write down her null and alternative hypotheses

b Find the expected values.

c If any expected values are less than 5 then rewrite both tables.

d Write down the number of degrees of freedom.

The critical value is 6.251.

e Find the χ^2 test statistic and thepvalue, and state the conclusion for the test.

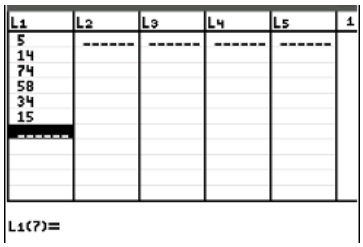
First you will enter the observed frequencies in a list.

Press [stat] 1:Edit and press [enter]

Enter the frequencies in the first column.

Press [enter] or [▼] after each number to move to the next cell.

Note: *If the list contains other numbers, you can clear it by pressing* [stat] 4:ClrList *and press* [enter]. *The home screen displays* ClrList. *Press* [2nd] [1] [L1] *and press* [enter]. *Press* [stat] 1:Edit *and press* [enter] *to return to the table*.



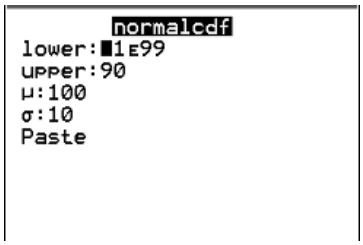
To calculate the expected values, you will use the normal cdf function.

Press [2nd] [vars] ([distr]) 2:normalcdf(.

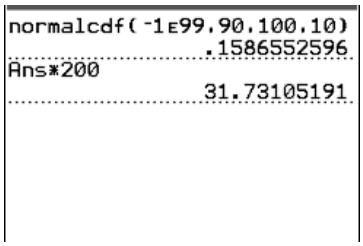
The lower limit is −1E99 which means -1×10^{99} - a very small number. The upper limit is 90, μ is 100 and σ is 10.

To enter E press [2nd] [,] ([EE]).

Navigate to Paste and press [enter].



Multiply the answer by 200 (type [×] 200).



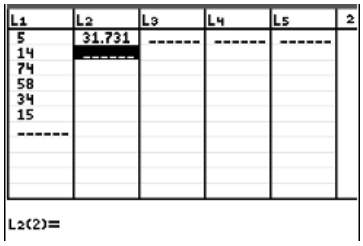
Chapter 8 / **Example 5**
χ^2 goodness of fit to the normal distribution

Press stat 1:Edit and press enter

Press ▶ to move to the first cell in the second column.

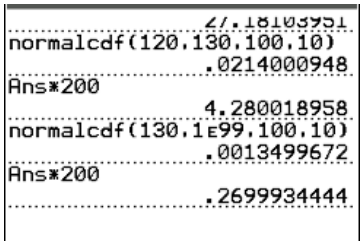
Press 2nd (-) ([ans]) and press enter

This will enter the expected score.

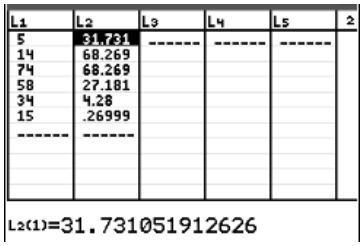


Repeat the process to calculate the other expected frequencies and enter them all in the second column.

The final interval $130 \leq x$ has lower limit 130 and upper limit 1E99.



There are now 6 entries in each of the lists.

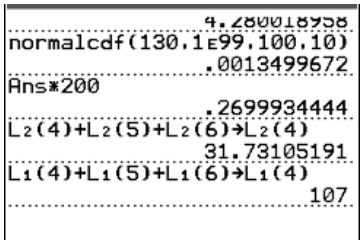


The last two scores are both less than 5, even when added together, and so you will have to combine them with the one above. You will also have to combine the observed frequencies.

Press 2nd [quit] to enter the home screen.

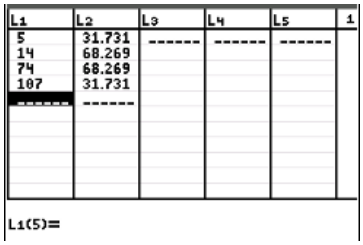
Type $L_2(4)+L_2(5)+L_2(6)$ sto→ $L_2(4)$

and $L_1(4)+L_1(5)+L_1(6)$ sto→ $L_1(4)$



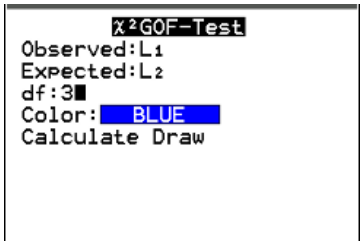
Press stat 1:Edit and delete the last two entries in each list.

There are now 4 entries so the degrees of freedom is 3.



Chapter 8 / **Example 5**

χ^2 goodness of fit to the normal distribution

Press 2nd [quit] to enter the home screen. Press stat. Press ▶ ▶ to access the TESTS menu. Select D: χ^2GOF-Test… Select L_1 as the observed list, L_2 as the expected list and enter 3 for df. Use ▼ to navigate down to Calculate. Press enter.	
The χ^2 statistic is 245 and the p-value is 9.23×10^{-53}. Since $9.23\times10^{-53} < 0.1$ or 245 > 6.251, the null hypothesis is rejected: the scores are not normally distributed with mean of 100 and standard deviation of 10.