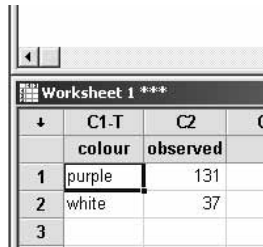


5.4.1 Chi-squared goodness of fit test when there is one degree of freedom

EXAMPLE 5.4. The genetics of tepal colour in *Allium schoenoprasum*

BOX 5.5. How to calculate a goodness of fit chi-squared test when there is one degree of freedom

Step 1. Enter the observed data into the worksheet window of Minitab.



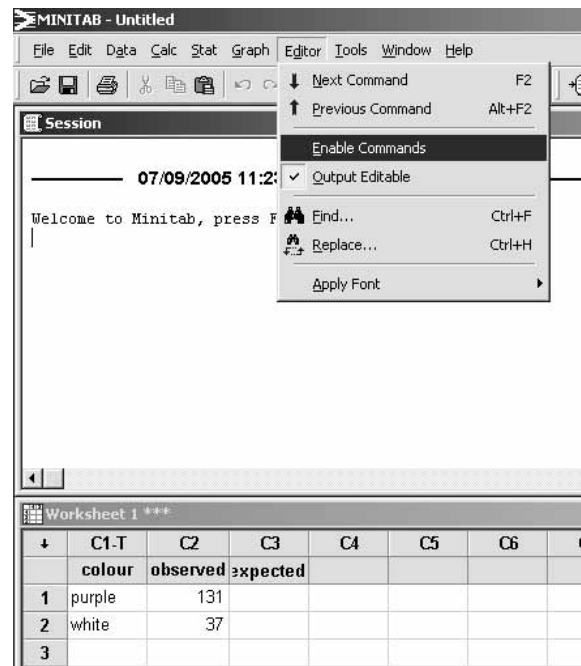
The screenshot shows a Minitab worksheet window titled 'Worksheet 1 ***'. The window contains a table with the following data:

	C1-T	C2	C3
	colour	observed	
1	purple	131	
2	white	37	
3			

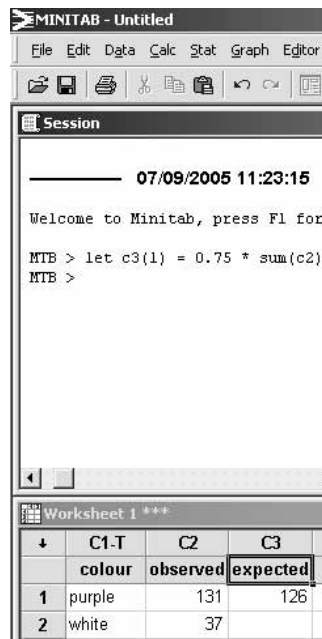
Step 2. Calculate the **expected** values. In this case, we expect three-quarters (0.75) of the flowers to be purple, and one-quarter (0.25) to be white.

Label column 3 'expected'.

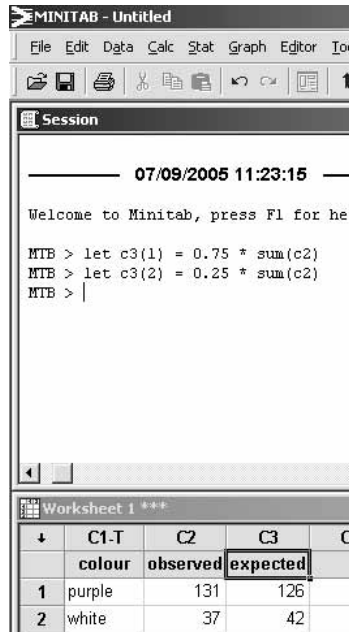
Click in the session window, go to 'Editor' and select 'Enable Commands'.



At the 'MTB >' prompt, type 'let c3(1) = 0.75 * sum(c2)' and press the 'enter' key.



Repeat for the white flowers, remembering that we need this number in the second cell of column 3, and that we only expect 0.25 of the flowers to be white.

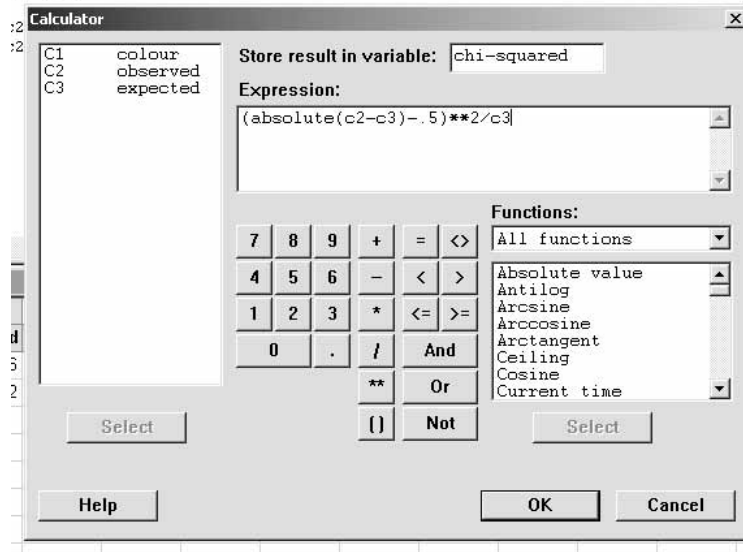


Step 2. Calculate the values of chi-squared using the Yates' correction. This involves calculating the **absolute** value of the difference between the observed and expected values using the 'Absolute' operator in Minitab.

Go to 'Calc', 'Calculator', and insert 'chi-squared' in the 'Store results in variable' window. Type '(absolute(c2 - c3) - .5)**2/c3' in the 'Expression' window.

4 Chi-squared goodness of fit test when there is one degree of freedom

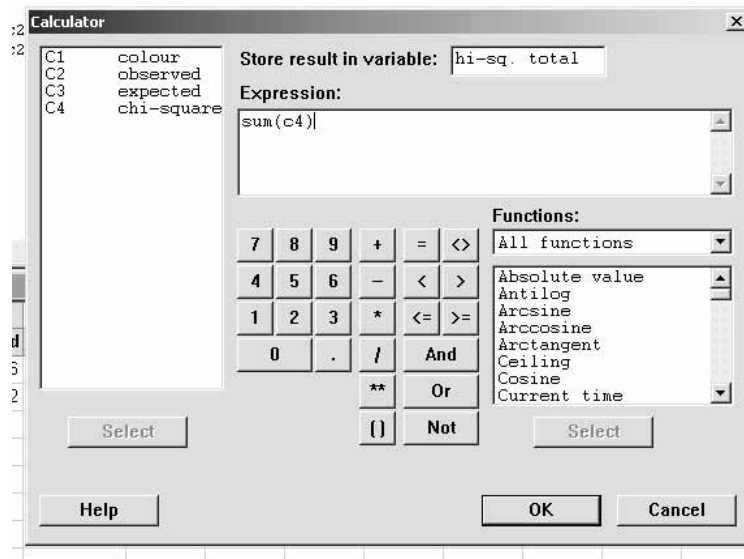
for help.



Click on 'OK'.

	C1-T	C2	C3	C4
	colour	observed	expected	chi-squared
1	purple	131	126	0.160714285
2	white	37	42	0.482143
3				

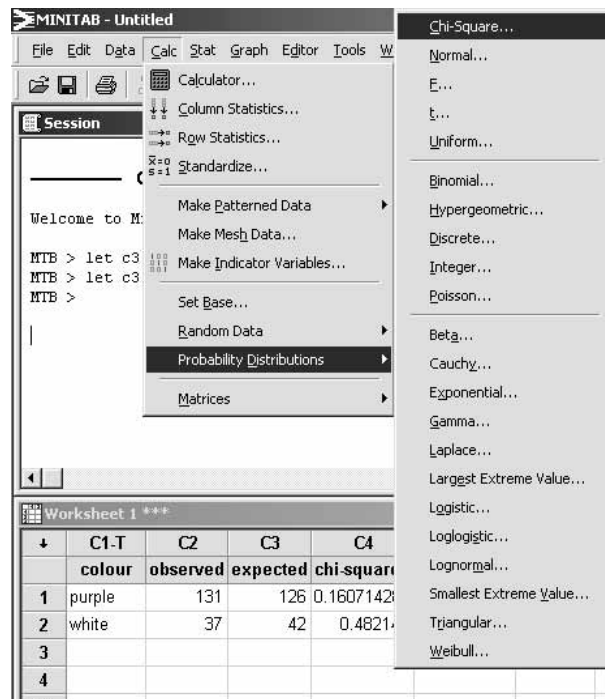
Add the individual values of chi-squared together. Go to 'Calc', Calculator'. In the 'Store result as variable' window, type 'chi-sq. total', and in the 'Expression' window type 'sum(c4)'.



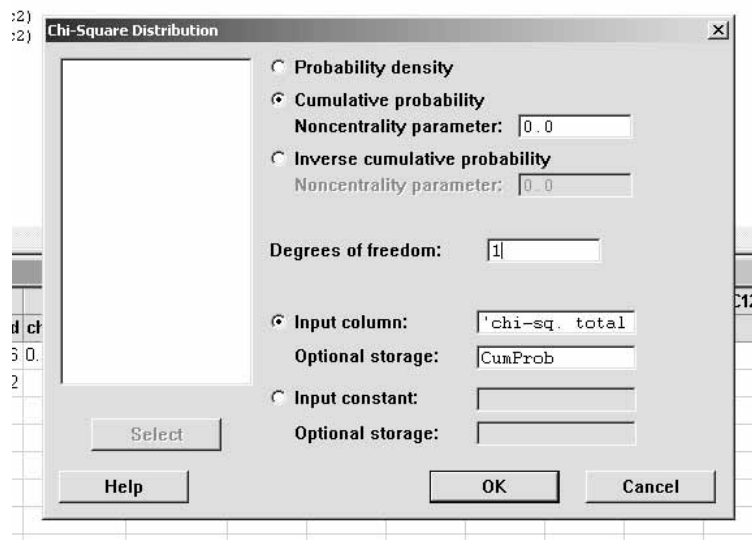
Click on 'OK'.

	C1-T	C2	C3	C4	C5	C6
	colour	observed	expected	chi-squared	chi-sq. total	
1	purple	131	126	0.1607142857	0.642857	
2	white	37	42	0.482143		

Step 3. The final step is to find the probability that the null hypothesis (there is no difference between the observed numbers of plants with purple or white flowers in the F2 of *Allium schoenoprasum* plants and that expected from the *a priori* prediction of three purple flowering plants: one white flowering plant) can be rejected. Go to 'Calc', 'Probability Distributions' and select 'Chi-square'.



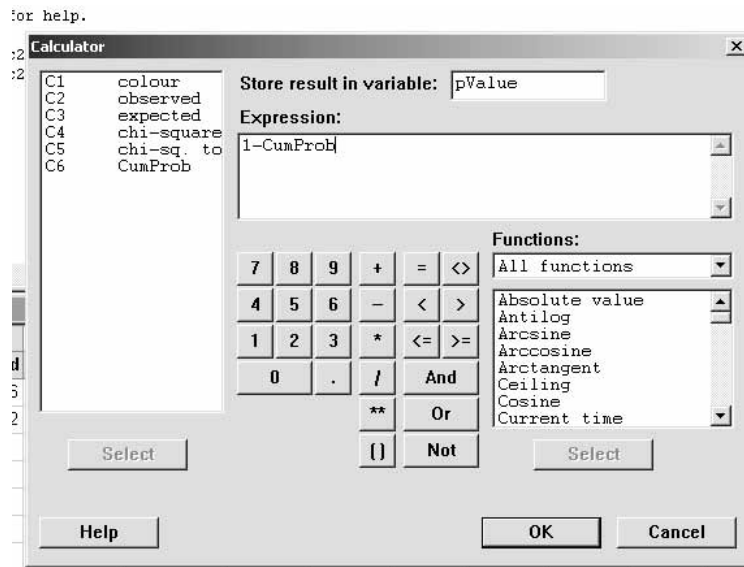
Select 'Cumulative Probability', enter '1' in the **degrees of freedom** box, put 'c5' (or 'chi-sq. total') in the 'Input column' box, and put 'CumProb' in the 'Optional storage' box.



Click on 'OK'.

	C1-T	C2	C3	C4	C5	C6
	colour	observed	expected	chi-squared	chi-sq. total	CumProb
1	purple	131	126	0.160714285	0.642857	0.577322
2	white	37	42	0.482143		

Next, Calculate the p value. Go to 'Calc', 'Calculator' and enter 'pValue' in the 'Store result as variable' window. Type '1-CumProb' in the 'Expression' window.



Click on 'OK'.

	C1-T	C2	C3	C4	C5	C6	C7
	colour	observed	expected	chi-squared	chi-sq. total	CumProb	pValue
1	purple	131	126	0.160714285	0.642857	0.577322	0.422678
2	white	37	42	0.482143			
3							

This p value ($p=0.423$) is very large and exceeds the threshold of $p=0.05$. We therefore do not reject the null hypothesis. The flower colours in the F2 generation of *Allium schoenoprasum* plants do not differ significantly ($\chi^2_{\text{calculated}} 0.64$, $p=0.05$) from the predicted ratio of three purple: one white.