Example 1 (Testing Goodness of Fit of a Discrete Distribution):

The results of 180 rolls of a die are given below:

X	Ox
1	28
2	36
3	36
4	30
5	27
6	23
TOTAL	180

Test if the die is fair.

Null hypothesis to be tested is

H_0: P(X=x) = 1/6 for x = 1, 2, ..., 6

Under the null hypothesis, the Expected Frequencies are:

E_x = 180 x (1/6) = 30, for x = 1, 2, ..., 6

The test statistic is

$$\chi^2_{OBS} = \sum_{x=1}^{6} \frac{(O_x - E_x)^2}{E_x} = 4.47$$

which is easily calculated in Excel (see worksheet Goodness of Fit of the file chi-square tests in excel.xlsx). The P-value can be obtained from the chi-square distribution with degrees of freedom = #of cells - # of parameters estimated - 1 = 6 - 0 - 1 = 5 (see Figure 1a) or using the CHITEST function of Excel (see Figure 1b).

B13 =CHIDIST(D11,5)

	A	B	C	D
	Example 1:			
	Use the data to test if the die is fair.			
	X	Ox	Ex	Chi-square
	1	28	30	0.13
	2	36	30	1.20
	3	36	30	1.20
	4	30	30	0.00
	5	27	30	0.30
	6	23	30	1.63
	TOTAL	180	180	4.47
	P(Chi-sqr > 4.47)	0.484356		P-value
	P - Value	0.484356		
	=chitest(b5:b10,c5:c10)	0.484356		

Figure 1a: Looking up P-value in Excel

B15 =CHITEST(B5:B10,C5:C1

	A	B	C	D
1	Example 1:			
2	Use the data to test if the die is fair.			
3				
4	X	Ox	Ex	Chi-square
5	1	28	30	0.13
6	2	36	30	1.20
7	3	36	30	1.20
8	4	30	30	0.00
9	5	27	30	0.30
10	6	23	30	1.63
11	TOTAL	180	180	4.47
12				
13	P(Chi-sqr > 4.47)	0.484356		P-value
14				
15	P - Value	0.484356		
16				
17	=chitest(b5:b10,c5:c10)	0.484356		

Figure 1b: Calculating P-value using CHITEST function of Excel

Example 2 (Testing Independence):

Given the following data, test if Voting Preference is independent of Gender (see worksheet Independence of the file chi-square tests in excel.xlsx).

GENDER	Voting Preferences			Row total
	Republican	Democrat	Independent	
Male	300	150	50	500
Female	250	300	50	600
Column total	550	450	100	1100

Under the null hypothesis H_0: Voting Preference is independent of Gender, the expected frequency of cell (i,j) is given by:

$E_{i,j}$ = Total of Row i x Total of Column j/N

For example,

$E_{1,1}$ = 500 x 550/1100 = 250.

To calculate all of the expected frequencies, go to cell D13, type formula =D$8*$G6/$G$8, then copy formula in cells D13:F14 (see Figure 2a).

Extra Example : Test if Voting Preference is independent of Gender.

OBSERVED TABLE

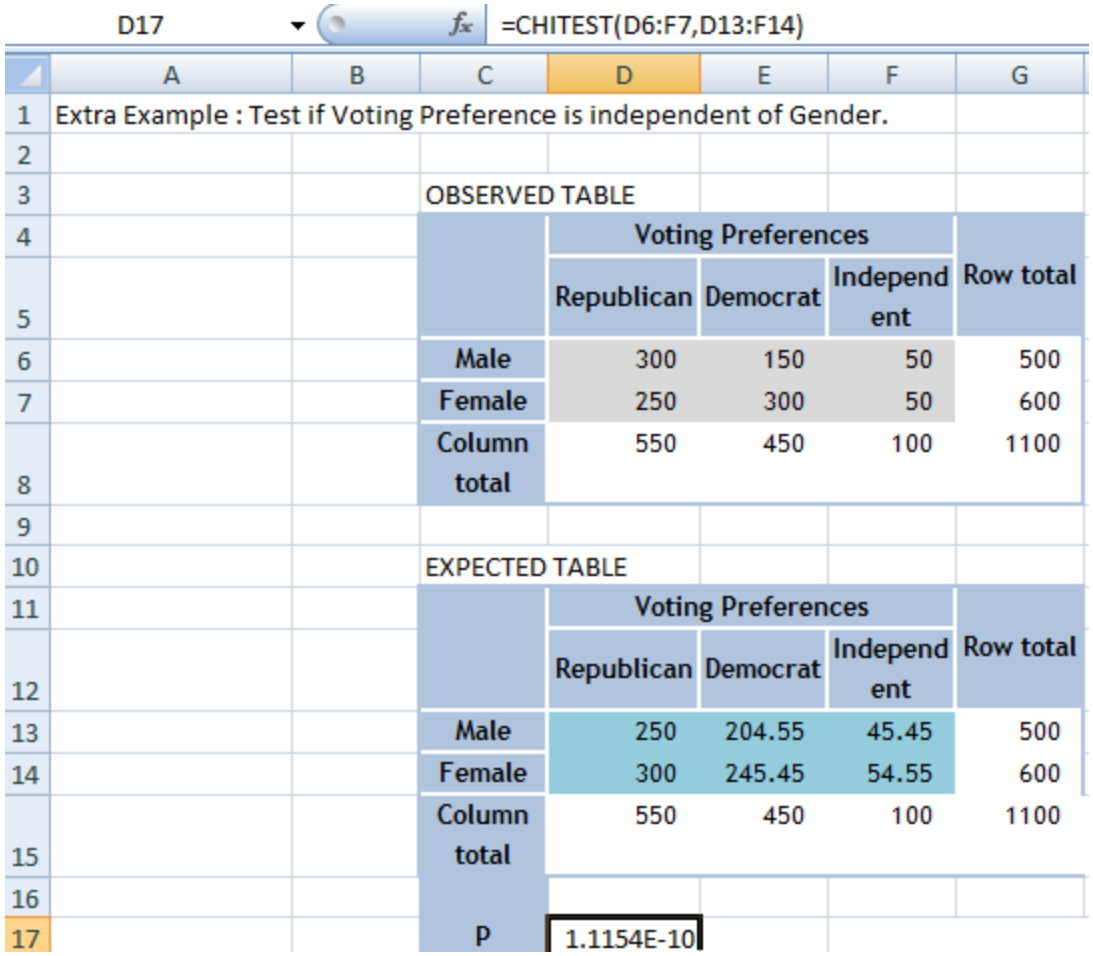
	Voting Preferences			Row total
	Republican	Democrat	Independent	
Male	300	150	50	500
Female	250	300	50	600
Column total	550	450	100	1100

EXPECTED TABLE

	Voting Preferences			Row total
	Republican	Democrat	Independent	
Male	250	204.55	45.45	500
Female	300	245.45	54.55	600
Column total	550	450	100	1100

Figure 2a: Calculating Expected Frequencies in a Contingency Table

Once the Expected Frequencies have been computed, you can calculate the P-value of the Chi-square test of independence as follows: in cell D17, type formula
=CHITEST(D6:F7,D13:F14), which returns the P-value of 1.1154E-10;
since this P-value is < .05, the null hypothesis of independence is rejected (see Figure 2b).



	A	B	C	D	E	F	G
1	Extra Example : Test if Voting Preference is independent of Gender.						
2							
3			OBSERVED TABLE				
4				Voting Preferences			
5				Republican	Democrat	Independent	Row total
6			Male	300	150	50	500
7			Female	250	300	50	600
8			Column total	550	450	100	1100
9							
10			EXPECTED TABLE				
11				Voting Preferences			
12				Republican	Democrat	Independent	Row total
13			Male	250	204.55	45.45	500
14			Female	300	245.45	54.55	600
15			Column total	550	450	100	1100
16							
17			P	1.1154E-10			

Figure 2b: Calculating the P-value for Chi-Square Test of Independence

Example 3 (Testing Homogeneity of Proportions):

In a telephone survey, respondents were asked to indicate their level of agreement with the statement "Cigarette smoking should be banned in public places". The results are shown in the table below: SA = strongly agree, A = agree, N = neutral, D = disagree, SD = strongly disagree. Test if there is no difference in Males and Females with respect to their level of agreement on the banning of smoking in public places.

Gender	SA	A	N	D	SD	TOTAL
F	40	38	16	37	5	136
M	16	25	11	25	11	88
TOTAL	56	63	27	62	16	224

(see worksheet Homogeneity of the file chi-square tests in excel.xlsx).

Under the null hypothesis H_0: Voting Preference if there is no difference in Males and Females with respect to their level of agreement on the banning of smoking in public places, the expected frequency of cell (i,j) is given by:

$E_{i,j}$ = Total of Row i x Total of Column j/N

For example,

$E_{1,1}$ = 56 x 136/224 = 34.

Type the formula =B$13*$G11/$G$13 in cell B17, and copy formula in cells B17:F18 to obtain all expected frequencies, then use the excel function CHITEST (exactly as in Example 2 above) to get the P-value of 0.072652; since the P-value > .05, the null hypothesis is not rejected.