Method 2: *p*-Values

The calculator reported a *p*-value of approximately 0.5831, so we can compare that to the level of significance, $\alpha = 0.10$. Since *p*-value > α, we fail to reject the null hypothesis.

Interpretation: Thus, there is not enough evidence at this level of significance to conclude that there is an association between hair color and the combination of gender and marital status for this hairdresser's clients.

10.7 Section Exercises

Contingency Tables of Expected Values

Use each contingency table of observed values to find the contingency table of expected values.

1. The following data represent preferred cereal brands for a random sample of adults.

Observed Sample of 146 Adults					
	Brand A	**Brand B**	**Brand C**	**Brand D**	**Total**
18-22 year olds	28	14	11	27	80
23-27 year olds	9	16	8	33	66
Total	37	30	19	60	146

2. The following data represent preferred writing hands for a random sample of adults.

Observed Sample of 237 Adults				
	Ages 20–29	**Ages 30–39**	**Ages 40–49**	**Total**
Left Hand	15	42	31	88
Right Hand	35	41	50	126
Ambidextrous	10	5	8	23
Total	60	88	89	237

3. The following data represent preferences for user interfaces of proposed tablet models, as chosen by participants of four different consumer focus groups.

Observed Sample of 119 Consumers					
	Group A	**Group B**	**Group C**	**Group D**	**Total**
Model 1	8	12	4	9	33
Model 2	11	15	6	3	35
Model 3	4	10	3	11	28
Model 4	6	11	4	2	23
Total	29	48	17	25	119

4. The following data represent the favorite sports of adults living in various regions of the United States for a random sample of adults.

Observed Sample of 336 Adults					
	Football	**Basketball**	**Baseball**	**Soccer**	**Total**
Northeast	27	25	23	20	95
Southeast	26	21	19	17	83
Midwest	24	25	18	11	78
West	20	22	17	21	80
Total	97	93	77	69	336

Test Statistics for Chi-Square Tests for Association

Calculate the test statistic, χ^2, for a chi-square test for association using the given contingency tables.

5. The following data represent the observed values and expected values of the eating habits of runners and swimmers for a random sample of adult athletes.

Observed Sample of 390 Adult Athletes			
	Prefer to Eat Before a Workout	**Prefer to Eat After a Workout**	**Total**
Runner	68	121	189
Swimmer	73	128	201
Total	141	249	390

Expected Values			
	Prefer to Eat Before a Workout	**Prefer to Eat After a Workout**	**Total**
Runner	68.330769	120.669231	189
Swimmer	72.669231	128.330769	201
Total	141	249	390

6. The following data represent the observed values and expected values of the song preferences for a random sample of adults.

Observed Sample of 343 Adults					
	Song 1	**Song 2**	**Song 3**	**Song 4**	**Total**
18–22 year-olds	34	3	46	20	103
23–27 year-olds	33	25	48	17	123
28–32 year-olds	28	18	17	9	72
33–37 year-olds	3	15	20	7	45
Total	98	61	131	53	343

Expected Values					
	Song 1	**Song 2**	**Song 3**	**Song 4**	**Total**
18–22 year-olds	29.428571	18.317784	39.338192	15.915452	103
23–27 year-olds	35.142857	21.874636	46.976676	19.005831	123
28–32 year-olds	20.571429	12.804665	27.498542	11.125364	72
33–37 year-olds	12.857143	8.002915	17.186589	6.953353	45
Total	98	61	131	53	343

7. The following data represent the observed values and expected values of the fat contents and brands of microwaveable meals sold at a local grocery store for a random sample of meals sold.

Observed Sample of 3283 Microwaveable Meals Sold

	Less Than 5 g Fat	5–10 g Fat	More Than 10 g Fat	Total
Brand A	160	27	1380	1567
Brand B	86	9	789	884
Brand C	55	7	770	832
Total	301	43	2939	3283

Expected Values

	Less Than 5 g Fat	5–10 g Fat	More Than 10 g Fat	Total
Brand A	143.669510	20.524216	1402.806275	1567
Brand B	81.049041	11.578434	791.372525	884
Brand C	76.281450	10.897350	744.821200	832
Total	301	43	2939	3283

8. The following data represent the observed values and expected values of the movie preferences for a random sample of college students.

Observed Sample of 409 College Students

	Suspense	Drama	Comedy	Horror	Total
Freshman	24	28	37	18	107
Sophomore	19	25	35	15	94
Junior	31	33	30	12	106
Senior	26	29	34	13	102
Total	100	115	136	58	409

Expected Values

	Suspense	Drama	Comedy	Horror	Total
Freshman	26.161369	30.085575	35.579462	15.173594	107
Sophomore	22.982885	26.430318	31.256724	13.330073	94
Junior	25.916870	29.804401	35.246944	15.031785	106
Senior	24.938875	28.679707	33.916870	14.464548	102
Total	100	115	136	58	409

Conclusions of Chi-Square Tests for Association

State the critical value of χ^2 and determine the appropriate conclusion for a chi-square test for association using the given information.

9. $\alpha = 0.10$, Number of rows $= 2$, Number of columns $= 3$, $\chi^2 = 5.13$

10. $\alpha = 0.025$, Number of rows $= 5$, Number of columns $= 5$, $\chi^2 = 31.1$

11. $\alpha = 0.005$, Number of rows $= 5$, Number of columns $= 7$, $\chi^2 = 40.8$

12. $\alpha = 0.10$, Number of rows $= 7$, Number of columns $= 6$, $\chi^2 = 40.3$

Hypothesis Tests for Association

Perform each test for association using the method of your choice or the one assigned by your instructor. For each exercise, complete the following steps.

a. State the null and alternative hypotheses.
b. Determine which distribution to use for the test statistic, and state the level of significance.
c. Find the expected value for each possible outcome, and calculate the test statistic.
d. Draw a conclusion and interpret the decision.

13. One state's Department of Education wants to know if there is a relationship between grades and the particular sport student athletes play in the state. A random sample of student athletes in the state produces the following results. Is there sufficient evidence at the 0.005 level of significance to show that there is a relationship between grades and the sport student athletes play?

Observed Sample of 440 Students

	A	B	C	D	F	Total
Swimming	12	30	44	15	9	110
Tennis	5	24	37	36	8	110
Cross Country	16	41	39	10	4	110
Basketball	10	40	35	19	6	110
Total	43	135	155	80	27	440

14. An insurance company wants to know if the color of an automobile has a relationship with the number of moving violations. The following contingency table gives the results of data collected from police reports across the nation. The columns list the numbers of reported moving violations in a year. Use a level of significance of $\alpha = 0.01$ to conduct this test.

Observed Sample of 443 Cars

	0–1	2–3	More Than 3	Total
White	76	33	13	122
Black	44	21	8	73
Red	50	46	12	108
Silver	33	27	7	67
Other	28	34	11	73
Total	231	161	51	443

15. A soft drink company is interested in knowing whether there is a relationship between cola preference and age. A random sample of 800 people is chosen for a taste test. The results of the study are found in the following table. Is there sufficient evidence at the 0.005 level of significance to lead you to believe that there is an association between cola preference and age?

Observed Sample of 800 People

	Cola A	Cola B	Cola C	Total
15–29	94	102	105	301
30–44	99	97	86	282
45–59	68	73	76	217
Total	261	272	267	800

16. A marketing firm wants to know if there is a difference in the best marketing strategy for new customers compared to returning customers. To determine the relationship between marketing strategy and customer type, the following information on number of sales generated is obtained for each group. Does the evidence gathered support the claim at $\alpha = 0.01$?

Observed Sample of 926 Customers

	Paid search	Social Media	Web retargeting	Total
New customer	158	165	153	476
Returning customer	149	147	154	450
Total	307	312	307	926

17. Suppose that a bookseller wants to study the relationship between book preference and residential area. A random sample of readers is chosen for the study, and each participant is asked to choose their favorite genre out of the following choices: mystery, fiction, nonfiction, and self-help. The results are detailed below. Does the evidence gathered show a relationship between book preference and residential area at $\alpha = 0.005$?

Observed Sample of 266 Readers

	Mystery	Fiction	Nonfiction	Self-Help	Total
Rural	28	30	41	22	121
Urban	32	59	28	26	145
Total	60	89	69	48	266

18. A travel agency is interested in finding out if different age groups frequent different Spring Break destinations, to better target the appropriate audiences. A random sample of college Spring Break vacationers produces the results given in the table below. Is there enough evidence at the 0.05 level of significance to show that there is a relationship between age (by college classification) and destination?

Observed Sample of 192 College Students

	Beach	Mountains	City	Home	Total
Freshman	19	2	7	24	52
Sophomore	15	4	3	20	42
Junior	18	1	9	19	47
Senior	21	6	4	20	51
Total	73	13	23	83	192

19. A marketing firm wants to know if there is an association between a person's age and level of educational attainment and his or her favorite Super Bowl commercial. A random sample of people is asked to choose between two commercials, and the results are in the following table. Given these results, is there enough evidence at the 0.10 level of significance to conclude that an association exists?

Observed Sample of 80 Adults

	Commercial 1	Commercial 2	Total
College Degree, 18–30	14	6	20
No College Degree, 18–30	9	11	20
College Degree, 31–45	12	8	20
No College Degree, 31–45	6	14	20
Total	41	39	80

20. Pollsters want to test if an association exists between a person's profession and their political party. A random sample of 236 voters is polled, resulting in the data in the following table. Based on these results, is there enough evidence at the 0.025 level of significance to say that an association exists?

Observed Sample of 236 Voters

	Democrat	Republican	Total
Doctor	13	35	48
Lawyer	33	19	52
Teacher	23	25	48
Farmer	39	11	50
Laborer	28	10	38
Total	136	100	236