Section 11.2 Exercises

27. Why men and women play sports Do men and
pg 697 women participate in sports for the same reasons?
One goal for sports participants is social comparison—
the desire to win or to do better than other people.
Another is mastery—the desire to improve one's
skills or to try one's best. A study on why students
participate in sports collected data from independent
random samples of 67 male and 67 female under-
graduates at a large university.[13] Each student was
classified into one of four categories based on his or
her responses to a questionnaire about sports goals.
The four categories were high social comparison–high
mastery (HSC-HM), high social comparison–low mas-
tery (HSC-LM), low social comparison–high mastery
(LSC-HM), and low social comparison–low mastery
(LSC-LM). One purpose of the study was to compare
the goals of male and female students. Here are the
data displayed in a two-way table:

Goal	Gender	
	Female	Male
HSC-HM	14	31
HSC-LM	7	18
LSC-HM	21	5
LSC-LM	25	13

(a) Calculate the conditional distribution (in propor-
tions) of the reported sports goals for each gender.

(b) Make an appropriate graph for comparing the condi-
tional distributions in part (a).

(c) Write a few sentences comparing the distributions of
sports goals for male and female undergraduates.

28. How are schools doing? The nonprofit group
Public Agenda conducted telephone interviews with
three randomly selected groups of parents of high
school children. There were 202 black parents, 202
Hispanic parents, and 201 white parents. One ques-
tion asked was "Are the high schools in your state do-
ing an excellent, good, fair, or poor job, or don't you
know enough to say?" Here are the survey results:[14]

	Black parents	Hispanic parents	White parents
Excellent	12	34	22
Good	69	55	81
Fair	75	61	60
Poor	24	24	24
Don't know	22	28	14
Total	202	202	201

(a) Calculate the conditional distribution (in propor-
tions) of responses for each group of parents.

(b) Make an appropriate graph for comparing the condi-
tional distributions in part (a).

(c) Write a few sentences comparing the distributions of
responses for the three groups of parents.

29. Why women and men play sports Refer to Exercise
pg 704 27. Do the data provide convincing evidence of a
difference in the distributions of sports goals for male
and female undergraduates at the university?

(a) State appropriate null and alternative hypotheses for
a significance test to help answer this question.

(b) Calculate the expected counts. Show your work.

(c) Calculate the chi-square statistic. Show your work.

30. How are schools doing? Refer to Exercise 28. Do
the data provide convincing evidence of a differ-
ence in the distributions of opinions about how
high schools are doing among black, Hispanic, and
white parents?

(a) State appropriate null and alternative hypotheses for
a significance test to help answer this question.

(b) Calculate the expected counts. Show your work.

(c) Calculate the chi-square statistic. Show your work.

31. Why women and men play sports Refer to Exer-
pg 704 cises 27 and 29.

(a) Check that the conditions for performing the
chi-square test are met.

(b) Use Table C to find the P-value. Then use your
calculator's χ^2cdf command.

(c) Interpret the P-value from the calculator in context.

(d) What conclusion would you draw? Justify your
answer.

32. How are schools doing? Refer to Exercises 28 and 30.

(a) Check that the conditions for performing the
chi-square test are met.

(b) Use Table C to find the P-value. Then use your
calculator's χ^2cdf command.

(c) Interpret the P-value from the calculator in context.

(d) What conclusion would you draw? Justify your
answer.

33. **Python eggs** How is the hatching of water python eggs influenced by the temperature of the snake's nest? Researchers randomly assigned newly laid eggs to one of three water temperatures: hot, neutral, or cold. Hot duplicates the extra warmth provided by the mother python, and cold duplicates the absence of the mother. Here are the data on the number of eggs that hatched and didn't hatch:[15]

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	Water Temperature		
Hatched?	Cold	Neutral	Hot
Yes	16	38	75
No	11	18	29

(a) Compare the distributions of hatching status for the three treatments.

(b) Are the differences between the three groups statistically significant? Give appropriate evidence to support your answer.

34. **Don't do drugs!** Cocaine addicts need cocaine to feel any pleasure, so perhaps giving them an antidepressant drug will help. A three-year study with 72 chronic cocaine users compared an antidepressant drug called desipramine with lithium (a standard drug to treat cocaine addiction) and a placebo. One-third of the subjects were randomly assigned to receive each treatment. Here are the results:[16]

	Drug administered		
Relapsed?	Desipramine	Lithium	Placebo
Yes	10	18	20
No	14	6	4

(a) Compare the distributions of relapse status for the three treatments.

(b) Are the differences among the three groups statistically significant? Give appropriate evidence to support your answer.

35. **Sorry, no chi-square** How do U.S. residents who travel overseas for leisure differ from those who travel for business? The following is the breakdown by occupation:[17]

Occupation	Leisure travelers (%)	Business travelers (%)
Professional/technical	36	39
Manager/executive	23	48
Retired	14	3
Student	7	3
Other	20	7
Total	100	100

Explain why we can't use a chi-square test to learn whether these two distributions differ significantly.

36. **Going Nuts** The UR Nuts Company sells Deluxe and Premium nut mixes, both of which contain only cashews, brazil nuts, almonds, and peanuts. The Premium nuts are much more expensive than the Deluxe nuts. A consumer group suspects that the two nut mixes are really the same. To find out, the group took separate random samples of 20 pounds of each nut mix and recorded the weights of each type of nut in the sample. Here are the data:[18]

	Type of mix	
Type of nut	Premium	Deluxe
Cashew	6 lb	5 lb
Brazil nut	3 lb	4 lb
Almond	5 lb	6 lb
Peanut	6 lb	5 lb

Explain why we can't use a chi-square test to determine whether these two distributions differ significantly.

37. **How to quit smoking** It's hard for smokers to quit. Perhaps prescribing a drug to fight depression will work as well as the usual nicotine patch. Perhaps combining the patch and the drug will work better than either treatment alone. Here are data from a randomized, double-blind trial that compared four treatments.[19] A "success" means that the subject did not smoke for a year following the beginning of the study.

Group	Treatment	Subjects	Successes
1	Nicotine patch	244	40
2	Drug	244	74
3	Patch plus drug	245	87
4	Placebo	160	25

(a) Summarize these data in a two-way table. Then compare the success rates for the four treatments.

(b) Explain in words what the null hypothesis $H_0: p_1 = p_2 = p_3 = p_4$ says about subjects' smoking habits.

(c) Do the data provide convincing evidence of a difference in the effectiveness of the four treatments at the $\alpha = 0.05$ significance level?

38. **Preventing strokes** Aspirin prevents blood from clotting and so helps prevent strokes. The Second European Stroke Prevention Study asked whether adding another anticlotting drug named dipyridamole would be more effective for patients who had already had a stroke. Here are the data on strokes during the two years of the study:[20]

Group	Treatment	Number of patients	Number of strokes
1	Placebo	1649	250
2	Aspirin	1649	206
3	Dipyridamole	1654	211
4	Both	1650	157

(a) Summarize these data in a two-way table. Then compare the stroke rates for the four treatments.

(b) Explain in words what the null hypothesis $H_0: p_1 = p_2 = p_3 = p_4$ says about the incidence of strokes.

(c) Do the data provide convincing evidence of a difference in the effectiveness of the four treatments at the $\alpha = 0.05$ significance level?

39. **How to quit smoking** Perform a follow-up analysis of the test in Exercise 37 by finding the individual components of the chi-square statistic. Which cell(s) contributed most to the final result and in what direction?

40. **Preventing strokes** Perform a follow-up analysis of the test in Exercise 38 by finding the individual components of the chi-square statistic. Which cell(s) contributed most to the final result and in what direction?

41. **Attitudes toward recycled products** Some people believe recycled products are lower in quality than other products, a fact that makes recycling less practical. Here are data on attitudes toward coffee filters made of recycled paper from a random sample of adults:[21]

	Recycled coffee filter status	
Quality rating	Buyers	Nonbuyers
Higher	20	29
Same	7	25
Lower	9	43

Make a well-labeled bar graph that compares buyers' and nonbuyers' opinions about recycled filters. Describe what you see.

42. **Is astrology scientific?** The General Social Survey asked a random sample of adults their opinion about whether astrology is very scientific, sort of scientific, or not at all scientific. Here is a two-way table of counts for people in the sample who had three levels of higher education:[22]

	Degree Held		
	Associate's	Bachelor's	Master's
Not at all scientific	169	256	114
Very or sort of scientific	65	65	18

Make a well-labeled bar graph that compares opinions about astrology for the three education categories. Describe what you see.

43. **Attitudes toward recycled products** Refer to Exercise 41.

(a) State appropriate hypotheses for performing a chi-square test of independence in this setting.

(b) Compute the expected counts assuming that H_0 is true. Show your work.

(c) Calculate the chi-square statistic, df, and P-value.

(d) What conclusion would you draw?

44. **Is astrology scientific?** Refer to Exercise 42.

(a) State appropriate hypotheses for performing a chi-square test of independence in this setting.

(b) Compute the expected counts assuming that H_0 is true. Show your work.

(c) Calculate the chi-square statistic, df, and P-value.

(d) What conclusion would you draw?

45. **Regulating guns** The National Gun Policy Survey asked a random sample of adults, "Do you think there should be a law that would ban possession of handguns except for the police and other authorized persons?" Here are the responses, broken down by the respondent's level of education:[23]

	Education				
	Less than high school	High school grad	Some college	College grad	Postgrad degree
Yes	58	84	169	98	77
No	58	129	294	135	99

Does the sample provide convincing evidence of an association between education level and opinion about a handgun ban in the adult population?

46. **Market research** Before bringing a new product to market, firms carry out extensive studies to learn how consumers react to the product and how best to advertise its advantages. Here are data from a study of a new laundry detergent.[24] The participants are a random sample of people who don't currently use the established brand that the new product will compete with. Give subjects free samples of both detergents. After they have tried both for a while, ask which they prefer. The answers may depend on other facts about how people do laundry.

	Laundry Practices			
	Soft water, warm wash	Soft water, hot wash	Hard water, warm wash	Hard water, hot wash
Prefer standard product	53	27	42	30
Prefer new product	63	29	68	42

Does the sample provide convincing evidence of an association between laundry practices and product preference in the population of interest?

47. **Where do young adults live?** A survey by the National Institutes of Health asked a random sample of young adults (aged 19 to 25 years), "Where do you live now? That is, where do you stay most often?" Here is the full two-way table (omitting a few who refused to answer and one who claimed to be homeless):[25]

	Female	Male
Parents' home	923	986
Another person's home	144	132
Own place	1294	1129
Group quarters	127	119

(a) Should we use a chi-square test for homogeneity or a chi-square test for independence in this setting? Justify your answer.

(b) State appropriate hypotheses for performing the type of test you chose in part (a).

Minitab output from a chi-square test is shown below.

```
Chi-Square Test: Female, Male
Expected counts are printed below observed
counts
Chi-Square contributions are printed below
expected counts
            Female      Male     Total
    1         923       986      1909
            978.49    930.51
             3.147     3.309

    2         144       132       276
            141.47    134.53
             0.045     0.048

    3        1294      1129      2423
           1241.95   1181.05
             2.181     2.294

    4         127       119       246
            126.09    119.91
             0.007     0.007

  Total      2488      2366      4854
Chi-Sq = 11.038, DF = 3, P-Value = 0.012
```

(c) Check that the conditions for carrying out the test are met.

(d) Interpret the P-value in context. What conclusion would you draw?

48. **Students and catalog shopping** What is the most important reason that students buy from catalogs?

The answer may differ for different groups of students. Here are results for separate random samples of American and Asian students at a large midwestern university:[26]

	American	Asian
Save time	29	10
Easy	28	11
Low price	17	34
Live far from stores	11	4
No pressure to buy	10	3

(a) Should we use a chi-square test for homogeneity or a chi-square test for independence in this setting? Justify your answer.

(b) State appropriate hypotheses for performing the type of test you chose in part (a).

Minitab output from a chi-square test is shown below.

```
Chi-Square Test: American, Asian
Expected counts are printed below observed
counts
Chi-Square contributions are printed below
expected counts
            American    Asian     Total
    1          29        10        39
             23.60     15.40
              1.236     1.894

    2          28        11        39
             23.60     15.40
              0.821     1.258

    3          17        34        51
             30.86     20.14
              6.225     9.538

    4          11         4        15
              9.08      5.92
              0.408     0.625

    5          10         3        13
              7.87      5.13
              0.579     0.887

  Total        95        62       157
Chi-Sq = 23.470, DF = 4, P-Value = 0.0001
```

(c) Check that the conditions for carrying out the test are met.

(d) Interpret the P-value in context. What conclusion would you draw?

49. **Treating ulcers** Gastric freezing was once a recommended treatment for ulcers in the upper intestine. Use of gastric freezing stopped after experiments showed it had no effect. One randomized comparative experiment found that 28 of the 82 gastric-freezing patients improved, while 30 of

the 78 patients in the placebo group improved.[27] We can test the hypothesis of "no difference" in the effectiveness of the treatments in two ways: with a two-sample z test or with a chi-square test.

(a) Minitab output for a chi-square test is shown below. State appropriate hypotheses and interpret the P-value in context. What conclusion would you draw?

```
Chi-Square Test: Gastric freezing, Placebo
Expected counts are printed below observed
counts
Chi-Square contributions are printed below
expected counts
        Gastric freezing   Placebo   Total
1                   28         30       58
                 29.73      28.27
                 0.100      0.105
2                   54         48      102
                 52.27      49.73
                 0.057      0.060
Total               82         78      160
Chi-Sq = 0.322, DF = 1, P-Value = 0.570
```

(b) Minitab output for a two-sample z test is shown below. Explain how these results are consistent with the test in part (a).

```
Test for Two Proportions
Sample     X      N      Sample p
1          28     82     0.341463
2          30     78     0.384615
Difference = p (1) - p (2)
Estimate for difference: -0.0431520
Test for difference = 0 (vs not = 0):
Z = -0.57 P-Value = 0.570
```

50. **Opinions about the death penalty** The General Social Survey asked separate random samples of people with only a high school degree and people with a bachelor's degree, "Do you favor or oppose the death penalty for persons convicted of murder?" The following table gives the responses of people whose highest education was a high school degree and of people with a bachelor's degree:

	Highest education level	
	High school	Bachelor's degree
Favor	1010	319
Oppose	369	185

We can test the hypothesis of "no difference" in support for the death penalty among people in these educational categories in two ways: with a two-sample z test or with a chi-square test.

(a) Minitab output for a chi-square test is shown below. State appropriate hypotheses and interpret the P-value in context. What conclusion would you draw?

```
Chi-Square Test: C1, C2
Expected counts are printed below
observed counts
Chi-Square contributions are printed be-
low expected counts
          C1        C2      Total
1        1010       319      1329
        973.28    355.72
         1.385     3.790
2         369       185       554
        405.72    148.28
         3.323     9.092
Total    1379       504      1883
Chi-Sq = 17.590, DF = 1, P-Value = 0.000
```

(b) Minitab output for a two-sample z test is shown below. Explain how these results are consistent with the test in part (a).

```
Test for Two Proportions
Sample     X      N      Sample p
1         1010   1379    0.732415
2          319    504    0.632937
Difference = p (1) - p (2)
Estimate for difference: 0.0994783
Test for difference = 0 (vs not = 0):
Z = 4.19 P-Value = 0.000
```

Multiple choice: Select the best answer for Exercises 51 to 56.

Exercises 51 to 55 refer to the following setting. The National Longitudinal Study of Adolescent Health interviewed a random sample of 4877 teens (grades 7 to 12). One question asked was "What do you think are the chances you will be married in the next ten years?" Here is a two-way table of the responses by gender:[28]

	Female	Male
Almost no chance	119	103
Some chance, but probably not	150	171
A 50–50 chance	447	512
A good chance	735	710
Almost certain	1174	756

51. Which of the following would be the most appropriate type of graph for these data?

(a) A bar chart showing the marginal distribution of opinion about marriage

(b) A bar chart showing the marginal distribution of gender

(c) A bar chart showing the conditional distribution of gender for each opinion about marriage

(d) A bar chart showing the conditional distribution of opinion about marriage for each gender

(e) Dotplots that display the number in each opinion category for each gender

The appropriate null hypothesis for performing a chi-square test is that

equal proportions of female and male teenagers are almost certain they will be married in 10 years.

there is no difference between the distributions of female and male teenagers' opinions about marriage in this sample.

there is no difference between the distributions of female and male teenagers' opinions about marriage in the population.

there is no association between gender and opinion about marriage in the sample.

there is no association between gender and opinion about marriage in the population.

The expected count of females who respond "almost certain" is

487.7.   (c) 965.   (e) 1174.

525.   (d) 1038.8.

The degrees of freedom for the chi-square test for this two-way table are

4.   (c) 10.   (e) 4876.

8.   (d) 20.

For these data, $\chi^2 = 69.8$ with a P-value of approximately 0. Assuming that the researchers used a significance level of 0.05, which of the following is true?

A Type I error is possible.

A Type II error is possible.

Both a Type I and a Type II error are possible.

There is no chance of making a Type I or Type II error because the P-value is approximately 0.

There is no chance of making a Type I or Type II error because the calculations are correct.

When analyzing survey results from a two-way table, the main distinction between a test for independence and a test for homogeneity is

how the degrees of freedom are calculated.

how the expected counts are calculated.

the number of samples obtained.

the number of rows in the two-way table.

the number of columns in the two-way table.

For Exercises 57 and 58, you may find the inference summary chart inside the back cover helpful.

57. **Inference recap** In each of the following settings, state which inference procedure from Chapter 8, 9, 10, or 11 you would use. Be specific. For example, you might say "two-sample z test for the difference between two proportions." You do not need to carry out any procedures.[29]

(a) What is the average voter turnout during an election? A random sample of 38 cities was asked to report the percent of registered voters who actually voted in the most recent election.

(b) Are blondes more likely to have a boyfriend than the rest of the single world? Independent random samples of 300 blondes and 300 nonblondes were asked whether they have a boyfriend.

58. **Inference recap** (8.1 to 11.2) In each of the following settings, state which inference procedure from Chapter 8, 9, 10, or 11 you would use. Be specific. For example, you might say "two-sample z test for the difference between two proportions." You do not need to carry out any procedures.[30]

(a) Is there a relationship between attendance at religious services and alcohol consumption? A random sample of 1000 adults was asked whether they regularly attend religious services and whether they drink alcohol daily.

(b) Separate random samples of 75 college students and 75 high school students were asked how much time, on average, they spend watching television each week. We want to estimate the difference in the average amount of TV watched by high school and college students.

Exercises 59 to 60 refer to the following setting. For their final project, a group of AP® Statistics students investigated the following question: "Will changing the rating scale on a survey affect how people answer the question?" To find out, the group took an SRS of 50 students from an alphabetical roster of the school's just over 1000 students. The first 22 students chosen were asked to rate the cafeteria food on a scale of 1 (terrible) to 5 (excellent). The remaining 28 students were asked to rate the cafeteria food on a scale of 0 (terrible) to 4 (excellent). Here are the data:

1 to 5 scale					
Rating	1	2	3	4	5
Frequency	2	3	1	13	3

0 to 4 scale					
Rating	0	1	2	3	4
Frequency	0	0	2	18	8

59. Design and analysis (4.2)

(a) Was this an observational study or an experiment? Justify your answer.

(b) Explain why it would not be appropriate to perform a chi-square test in this setting.

60. Average ratings (1.3, 10.2) The students decided to compare the average ratings of the cafeteria food on the two scales.

(a) Find the mean and standard deviation of the ratings for the students who were given the 1-to-5 scale.

(b) For the students who were given the 0-to-4 scale, the ratings have a mean of 3.21 and a standard deviation of 0.568. Since the scales differ by one point, the group decided to add 1 to each of these ratings. What are the mean and standard deviation of the adjusted ratings?

(c) Would it be appropriate to compare the means from parts (a) and (b) using a two-sample t test? Justify your answer.

FRAPPY! Free Response AP® Problem, Yay!

The following problem is modeled after actual AP® Statistics exam free response questions. Your task is to generate a complete, concise response in 15 minutes.

Directions: Show all your work. Indicate clearly the methods you use, because you will be scored on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.

Two statistics students wanted to know if including additional information in a survey question would change the distribution of responses. To find out, they randomly selected 30 teenagers and asked them one of the following two questions. Fifteen of the teenagers were randomly assigned to answer Question A, and the other 15 students were assigned to answer Question B.

A: When choosing a college, how important is a good athletic program: very important, important, somewhat important, not that important, or not important at all?

B: It's sad that some people choose a college based on its athletic program. When choosing a college, how important is a good athletic program: very important, important, somewhat important, not that important, or not important at all?

The table below summarizes the responses to both questions. For these data, the chi-square test statistic is $\chi^2 = 6.12$.

	Question A	Question B	Total
Very important	7	2	9
Important	4	3	7
Somewhat important	2	3	5
Not that important	1	2	3
Not important at all	1	5	6
Total	15	15	30

(a) State the hypotheses that the students are interested in testing.

(b) Describe a Type I error and a Type II error in the context of the hypotheses stated in part (a).

(c) For these data, explain why it would *not* be appropriate to use a chi-square distribution to calculate the P-value.

(d) To estimate the P-value, 100 trials of a simulation were conducted, assuming that the additional information didn't have an effect on the response to the question. In each trial of the simulation, the value of the chi-square statistic was calculated. These simulated chi-square statistics are displayed in the dotplot below.

Simulated chi-square statistic
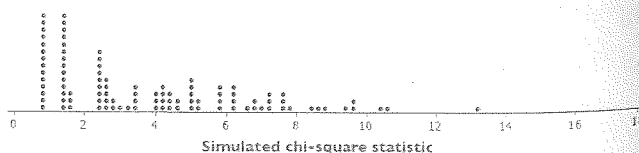
Based on the results of the simulation, what conclusion would you make about the hypotheses stated in part (a)?

After you finish, you can view two example solutions on the book's Web site (www.whfreeman.com/tps5e). Determine whether you think each solution is "complete," "substantial," "developing," or "minimal." If the solution is not complete, what improvements would you suggest to the student who wrote it? Finally, your teacher will provide you with a scoring rubric. Score your response and note what, if anything, you would do differently to improve your own score.