AP® STATISTICS
2014 SCORING GUIDELINES

Question 1

Intent of Question

The primary goals of this question were to assess a student's ability to (1) calculate conditional proportions from a two-way table; (2) comment on association between two categorical variables as displayed in a graph; and (3) draw an appropriate conclusion from the *p*-value of a chi-square test.

Solution

Part (a):

The proportion of on campus residents who participate in at least one extracurricular activity is $\frac{17 + 7}{33} = \frac{24}{33} \approx 0.727$. The proportion of off campus residents who participate in at least one extracurricular activity is $\frac{25 + 12}{67} = \frac{37}{67} \approx 0.552$.

Part (b):

The graph reveals that on campus residents in this sample are more likely to participate in extra-curricular activities than off campus residents. The proportions who participate in two or more extra-curricular activities are similar between the two groups but slightly greater for on campus residents (on campus: 0.212, off campus: 0.179). On campus residents have a greater proportion who participate in one activity (on campus: 0.515, off campus: 0.373) and a smaller proportion who participate in no extracurricular activities (on campus: 0.273, off campus: 0.448) than off campus residents.

Part (c):

The *p*-value of 0.23 is greater than conventional significance levels such as $\alpha = 0.10$ or $\alpha = 0.05$ or $\alpha = 0.01$. Therefore, the *p*-value indicates that the sample data do not provide strong enough evidence to conclude that participation in extracurricular activities differs between on and off campus residents in the population of all students at the university.

Scoring

Parts (a), (b), and (c) were scored as essentially correct (E), partially correct (P), or incorrect (I).

Part (a) is scored as follows:

Essentially correct (E) if the response correctly performs <u>both</u> calculations with work shown.

Partially correct (P) if the response correctly performs one of the two calculations with work shown;
> *OR*

if the response provides both correct answers with no work shown;
> *OR*

if the response calculates the proportion of students involved in exactly one extracurricular activity rather than the proportion of students involved in at least one extracurricular activity for both groups, with work shown.

Incorrect (I) if the response does not meet the criteria for E or P.

Note: Answers reported as fractions rather than decimals are acceptable.

Part (b) is scored as follows:

Essentially correct (E) if the response correctly compares proportions between the two groups of students for at least two of the three categories.

Partially correct (P) if the response correctly lists proportions for at least two categories for the two groups but does not make an explicit comparison between the two groups;
> *OR*

if the response correctly compares the relative values of the proportions between the two groups of students for only one of the three categories.

Incorrect (I) if the response does not meet the criteria for E or P.

Notes:
- A response without any reference to percentages or proportions is scored as at most P, (for example, a response that attempts to compare counts).
- A response that treats bar graphs as distributions of a quantitative variable lowers the score one level (that is, from E to P, or from P to I) in part (b).

Part (c) is scored as follows:

Essentially correct (E) if the response states a correct conclusion in the context of the study *AND* provides correct justification/decision of that conclusion based on linkage to the *p*-value.

Partially correct (P) if the response provides no conclusion in context but does provide correct justification/decision based on linkage to the *p*-value;
  OR
if the response provides a correct conclusion in context but with incorrect or missing justification/decision based on linkage to the *p*-value;
  OR
if the response provides the conclusion in context and correct justification/decision based on linkage to the *p*-value but states a conclusion equivalent to accepting the null hypothesis.

Incorrect (I) if the response does not meet the criteria for E or P.

  Notes:
  - Justification based on the *p*-value can be given by stating a significance level and noting that the *p*-value is larger than the significance level *OR* by simply stating that the *p*-value is large.
  - A conclusion that is equivalent to "accept the null hypothesis", either as a stated decision or as a conclusion in context, cannot be scored as E. Such a response is scored as P if it includes both content and correct justification based on linkage to *p*-value. If such a response lacks either context or linkage, it is scored as I.

4　Complete Response

   All three parts essentially correct

3　Substantial Response

   Two parts essentially correct and one part partially correct

2　Developing Response

   Two parts essentially correct and one part incorrect
OR
   One part essentially correct and one or two parts partially correct
OR
   Three parts partially correct

1　Minimal Response

   One part essentially correct and two parts incorrect
OR
   Two parts partially correct and one part incorrect

STATISTICS
SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II score—75

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.

1. An administrator at a large university is interested in determining whether the residential status of a student is associated with level of participation in extracurricular activities. Residential status is categorized as on campus for students living in university housing and off campus otherwise. A simple random sample of 100 students in the university was taken, and each student was asked the following two questions.

   - Are you an on campus student or an off campus student?

   - In how many extracurricular activities do you participate?

   The responses of the 100 students are summarized in the frequency table shown.

Level of Participation in Extracurricular Activities	Residential Status		Total
	On campus	Off campus	
No activities	9	30	39
One activity	17	25	42
Two or more activities	7	12	19
Total	33	67	100

   (a) Calculate the proportion of on campus students in the sample who participate in <u>at least one</u> extracurricular activity and the proportion of off campus students in the sample who participate in <u>at least one</u> extracurricular activity.

   On campus proportion:

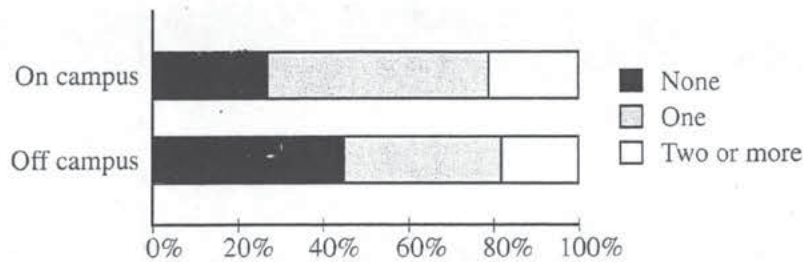 $$= \frac{17 + 7}{33} = 0.73$$

   About 73% of on campus students participate in at least 1 extracurricular.

   Off campus proportion:

   $$= \frac{25 + 12}{67} = 0.55$$

   About 55% of all off campus students participate in at least 1 extracurricular activity.

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The responses of the 100 students are summarized in the segmented bar graph shown.

(b) Write a few sentences summarizing what the graph reveals about the association between residential status and level of participation in extracurricular activities among the 100 students in the sample.

For on campus students, there is a larger proportion who participate in one activity than the off campus students. The off campus students have a larger proportion who do not participate in extracurricular activities than the on campus students. The graph also reveals that the proportion of those who participate in 2 or more activities are about equal for on campus and off campus students.

(c) After verifying that the conditions for inference were satisfied, the administrator performed a chi-square test of the following hypotheses.

H_0 : There is no association between residential status and level of participation in extracurricular activities among the students at the university.

H_a : There is an association between residential status and level of participation in extracurricular activities among the students at the university.

The test resulted in a *p*-value of 0.23. Based on the *p*-value, what conclusion should the administrator make?

At a 5% significance level, the high P-value of 0.23 leads the administrator to fail to reject the null hypothesis that there is no association. We do not have enough evidence from this sample to conclude that there is an association between residential status and level of participation in extracurriculars for the students at this university.

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STATISTICS
SECTION II
Part A
Questions 1-5
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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.

1. An administrator at a large university is interested in determining whether the residential status of a student is associated with level of participation in extracurricular activities. Residential status is categorized as on campus for students living in university housing and off campus otherwise. A simple random sample of 100 students in the university was taken, and each student was asked the following two questions.

   - Are you an on campus student or an off campus student?

   - In how many extracurricular activities do you participate?

   The responses of the 100 students are summarized in the frequency table shown.

Level of Participation in Extracurricular Activities	Residential Status		Total
	On campus	Off campus	
No activities	9	30	39
One activity	17	25	42
Two or more activities	7	12	19
Total	33	67	100

   (a) Calculate the proportion of on campus students in the sample who participate in <u>at least one</u> extracurricular activity and the proportion of off campus students in the sample who participate in <u>at least one</u> extracurricular activity.

   On campus proportion:

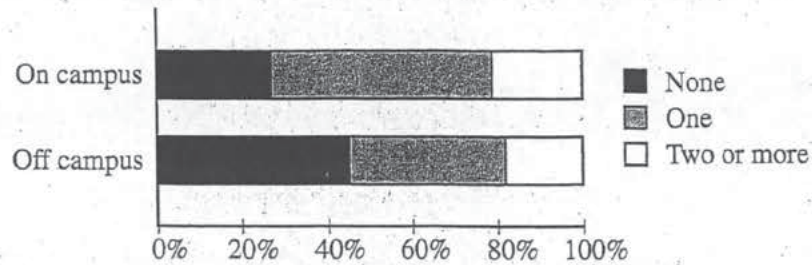 $$\frac{17+7}{33} = \boxed{.72}$$

   Off campus proportion:

   $$\frac{30+25}{67} = \boxed{.82}$$

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The responses of the 100 students are summarized in the segmented bar graph shown.

(b) Write a few sentences summarizing what the graph reveals about the association between residential status and level of participation in extracurricular activities among the 100 students in the sample.

Students living off campus appear to be more likely to do one activity than none when compared to on campus students, but both groups have nearly the same proportion of students doing two or more activities

(c) After verifying that the conditions for inference were satisfied, the administrator performed a chi-square test of the following hypotheses.

H_0 : There is no association between residential status and level of participation in extracurricular activities among the students at the university.

H_a : There is an association between residential status and level of participation in extracurricular activities among the students at the university.

The test resulted in a p-value of 0.23. Based on the p-value, what conclusion should the administrator make?

The typical alpha value of a significance test is $\alpha = .05$. .23 is substantially larger than .05, so the administrator should fail to reject the null hypothesis and conclude that there is no association between residential status and level of participation in extracurricular activities among the students at the university.

STATISTICS
SECTION II
Part A
Questions 1-5
Spend about 65 minutes on this part of the exam.
Percent of Section II score—75

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.

1. An administrator at a large university is interested in determining whether the residential status of a student is associated with level of participation in extracurricular activities. Residential status is categorized as on campus for students living in university housing and off campus otherwise. A simple random sample of 100 students in the university was taken, and each student was asked the following two questions.

   • Are you an on campus student or an off campus student?

   • In how many extracurricular activities do you participate?

The responses of the 100 students are summarized in the frequency table shown.

Level of Participation in Extracurricular Activities	Residential Status		Total
	On campus	Off campus	
No activities	9	30	39
One activity	17	25	42
Two or more activities	7	12	19
Total	33	67	100

(a) Calculate the proportion of on campus students in the sample who participate in at least one extracurricular activity and the proportion of off campus students in the sample who participate in at least one extracurricular activity.

On campus proportion:

Total on campus = 33

$\frac{24}{33} = .72727$

The proportion of on campus students in the sample who participate in at least one extracurricular activity is .7272 ≈ 73%.
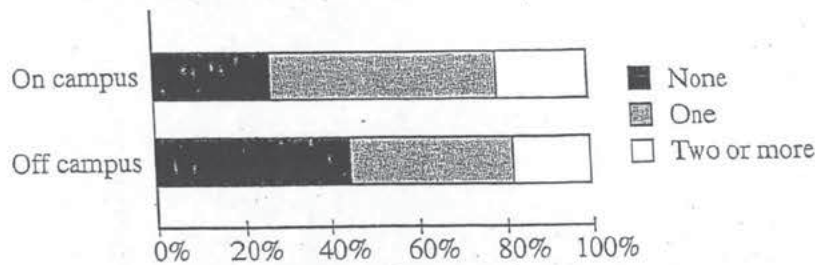
Off campus proportion:

total off campus = 67

$\frac{37}{67} = .5522$

The proportion of off campus students in the sample who participate in atleast one extracurricular activity is .5522 ≈ 55%.

The responses of the 100 students are summarized in the segmented bar graph shown.

(b) Write a few sentences summarizing what the graph reveals about the association between residential status and level of participation in extracurricular activities among the 100 students in the sample.

There are more students that live off campus that do not participate in extracurricular activities, than those who live on-campus. However, the students there are more off-campus students that participate in at least one activity, than the students who live on--campus.

(c) After verifying that the conditions for inference were satisfied, the administrator performed a chi-square test of the following hypotheses.

H_0 : There is no association between residential status and level of participation in extracurricular activities among the students at the university.

H_a : There is an association between residential status and level of participation in extracurricular activities among the students at the university.

The test resulted in a p-value of 0.23. Based on the p-value, what conclusion should the administrator make?

Based on the p-value of 0.23, the administrator should make the conclusion that there is a correlation between residential status and the level of participation in extracurricular activities among the students at the university. -

Question 1

Overview

The primary goals of this question were to assess a student's ability to (1) calculate conditional proportions from a two-way table; (2) comment on association between two categorical variables as displayed in a graph; and (3) draw an appropriate conclusion from the p-value of a chi-square test.

Sample: 1A
Score: 4

In part (a) the proportion (and percentage) of students in the sample who participate in at least one (that is, one or more) extracurricular activity is calculated correctly for each residential status (on and off campus), with work shown. Therefore, part (a) was scored as essentially correct. In part (b) the two different residential statuses are compared correctly using the proportion of participation at each of the three different activity levels. Therefore, part (b) was scored as essentially correct. In part (c) the correct conclusion is presented in context. The conclusion is justified by indicating that the p-value is high at the significance level of $\alpha = 0.05$ and arriving at the correct decision of fail to reject the null hypothesis. Therefore, part (c) was scored as essentially correct. Because all three parts were scored as essentially correct, the response earned a score of 4.

Sample: 1B
Score: 2

In part (a) the proportion of students in the sample who participate in at least one (that is, one or more) extracurricular activity is calculated correctly for the on campus students, with work shown. The corresponding proportion for the off campus students is incorrect, calculated for at most one (that is, one or less). Therefore, part (a) was scored as partially correct. In part (b) only one correct comparison of the two residential statuses is given using the proportion of students participating in two or more activities. One statement involving both residential statuses is given, but it presents a comparison within a residential status (compares student involvement in one activity to that in none for the same residential status). Therefore, part (b) was scored as partially correct. In part (c) the conclusion is given in context and the p-value is linked correctly with the selected significance level of $\alpha = 0.05$ arriving at a correct decision. However, the conclusion presented is equivalent to accepting the null hypothesis. Therefore, part (c) was scored as partially correct. Because three parts were scored as partially correct, the response earned a score of 2.

Sample: 1C
Score: 1

In part (a) the proportion of students in the sample who participate in at least one (that is, one or more) extracurricular activity is calculated correctly for each residential status (on and off campus), with work shown. Therefore, part (a) was scored as essentially correct. In part (b) the two different residential statuses are compared using the number of students participating in at least one extracurricular activity and in no activity resulting in two complementary comparisons, none of which is in terms of the proportions or the percentages. Therefore, part (b) was scored as incorrect. In part (c) the incorrect conclusion is given that there is an association between the residential statuses and level of participation. No linkage between the p-value and the conclusion is provided. Therefore, part (c) was scored as incorrect. Because one part was scored as essentially correct and two parts were scored as incorrect, the response earned a score of 1.