

## 2003 AP<sup>®</sup> STATISTICS FREE-RESPONSE QUESTIONS

5. A random sample of 200 students was selected from a large college in the United States. Each selected student was asked to give his or her opinion about the following statement.

“The most important quality of a person who aspires to be the President of the United States is a knowledge of foreign affairs.”

Each response was recorded in one of five categories. The gender of each selected student was noted. The data are summarized in the table below.

	Response Category				
	Strongly Disagree	Somewhat Disagree	Neither Agree nor Disagree	Somewhat Agree	Strongly Agree
Male	10	15	15	25	25
Female	20	25	25	25	15

Is there sufficient evidence to indicate that the response is dependent on gender? Provide statistical evidence to support your conclusion.

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## STATISTICS

### SECTION II

#### Part B

#### Question 6

Spend about 25 minutes on this part of the exam.

Percent of Section II grade—25

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

6. The Blue Shell Shuttle Bus Company has recently acquired the rights to run a shuttle between Lonestar's hotels and its airport, which is several miles away. For the new route, the company has a choice of running coaches that can carry up to 60 people or smaller vans that can carry up to 12 people. The company has a policy that each of its routes is served only by one type of shuttle vehicle. In addition, due to the allocation of their vehicles to other routes, no change in their decision can be considered for at least a year. The annual return (profit or loss) depends on whether the demand for the service is strong or weak. Research suggests that the following returns can be expected.

Annual Return (\$10,000)		
Vehicle Decision	Demand	
	Strong	Weak
Coach	84	-27
Van	61	45

For instance, if a coach is used and demand is strong, the expected annual return is \$840,000. The expected return to the company can be calculated based on the probability of a strong demand. Let  $p$  represent the probability of strong demand; then  $(1 - p)$  represents the probability of weak demand.

An equation that can be used to compute the expected return from the use of coaches based on the value of  $p$  is

$$84p + (-27)(1 - p) = 111p - 27.$$

An equation that can be used to compute the expected return from the use of vans based on the value of  $p$  is

$$61p + 45(1 - p) = 16p + 45.$$

These two functions are shown on the graph on the next page.

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**Question 5**

**Solution**

**Part 1:** States a correct pair of hypotheses

$H_o$ : Response and gender are independent

$H_a$ : Response and gender are not independent

OR

$H_o$ : There is no association between response and gender

$H_a$ : There is an association between response and gender

**Part 2:** Identifies a correct test (by name or by formula) and checks appropriate conditions.

Chi-Square test (for independence)

$$\chi^2 = \sum \frac{(Obs - Exp)^2}{Exp}$$

Conditions: Random sample and large sample size

Expected counts are

	Strongly Disagree	Somewhat Disagree	Neither Agree or Disagree	Somewhat Agree	Strongly Agree
Male	13.5	18.0	18.0	22.5	18.0
Female	16.5	22.0	22.0	27.5	22.0

All expected counts are greater than 5 (or 10), so the sample size is large enough for the Chi-Square test to be appropriate.

(Or, all expected counts are  $\geq 1$ , and no more than 20% of expected counts  $< 5$ .)

**Part 3:** Correct mechanics, including the value of the test statistic, df, and P-value (or rejection region)

$$\chi^2 = 0.907 + 0.500 + 0.500 + 0.278 + 2.722 + 0.742 + 0.409 + 0.409 + 0.227 + 2.227 = 8.921$$

$$df = 4 \quad P\text{-value} = 0.063$$

(Or, using tables,  $0.05 < P\text{-value} < 0.10$ , or rejection regions:  $\alpha = 0.05$  is 9.48,  $\alpha = 0.01$  is 13.27)

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**Question 5 (cont'd)**

**Part 4:** Stating a correct conclusion in the context of the problem, using the result of the statistical test.

Because P-value  $>$  selected  $\alpha$  (or because  $\chi^2$  is not in the rejection region, or because the P-value is large), fail to reject the null hypothesis. There is not sufficient evidence to conclude that response is dependent on gender (or that response and gender are not independent, or that response and gender are associated)

OR

Because results this extreme would occur about 6 times in 100 by chance alone, there is marginal evidence to reject the null hypothesis and conclude that there is an association between response and gender.

**Scoring**

Note that the solution has 4 parts and each part is either correct or incorrect. No partial credit is given for individual parts.

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|----------|---|
| <b>4</b> | <b>Complete Response</b><br>Four parts are correct.     |
| <b>3</b> | <b>Substantial Response</b><br>Three parts are correct. |
| <b>2</b> | <b>Developing Response</b><br>Two parts are correct.    |
| <b>1</b> | <b>Minimal Response</b><br>Only one part is correct.    |