

2009 AP® STATISTICS FREE-RESPONSE QUESTIONS

4. One of the two fire stations in a certain town responds to calls in the northern half of the town, and the other fire station responds to calls in the southern half of the town. One of the town council members believes that the two fire stations have different mean response times. Response time is measured by the difference between the time an emergency call comes into the fire station and the time the first fire truck arrives at the scene of the fire.

Data were collected to investigate whether the council member's belief is correct. A random sample of 50 calls selected from the northern fire station had a mean response time of 4.3 minutes with a standard deviation of 3.7 minutes. A random sample of 50 calls selected from the southern fire station had a mean response time of 5.3 minutes with a standard deviation of 3.2 minutes.

- (a) Construct and interpret a 95 percent confidence interval for the difference in mean response times between the two fire stations.
 - (b) Does the confidence interval in part (a) support the council member's belief that the two fire stations have different mean response times? Explain.
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5. For many years, the medically accepted practice of giving aid to a person experiencing a heart attack was to have the person who placed the emergency call administer chest compression (CC) plus standard mouth-to-mouth resuscitation (MMR) to the heart attack patient until the emergency response team arrived. However, some researchers believed that CC alone would be a more effective approach.

In the 1990s a study was conducted in Seattle in which 518 cases were randomly assigned to treatments: 278 to CC plus standard MMR and 240 to CC alone. A total of 64 patients survived the heart attack: 29 in the group receiving CC plus standard MMR, and 35 in the group receiving CC alone. A test of significance was conducted on the following hypotheses.

H_0 : The survival rates for the two treatments are equal.

H_a : The treatment that uses CC alone produces a higher survival rate.

This test resulted in a p -value of 0.0761.

- (a) Interpret what this p -value measures in the context of this study.
- (b) Based on this p -value and study design, what conclusion should be drawn in the context of this study? Use a significance level of $\alpha = 0.05$.
- (c) Based on your conclusion in part (b), which type of error, Type I or Type II, could have been made? What is one potential consequence of this error?

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STATISTICS SECTION II Part B Question 6

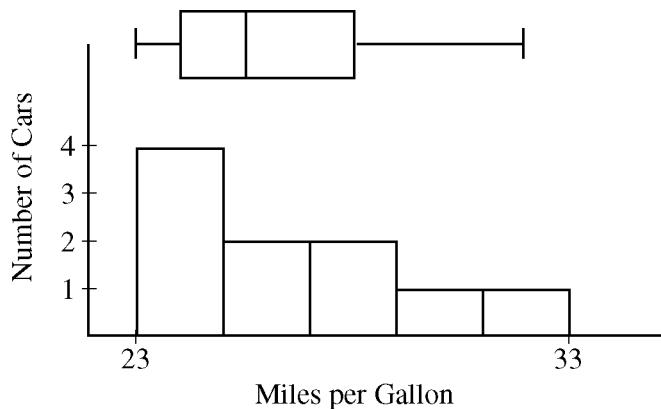
Spend about 25 minutes on this part of the exam.

Percent of Section II score—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 and completeness of your results and explanations.

6. A consumer organization was concerned that an automobile manufacturer was misleading customers by overstating the average fuel efficiency (measured in miles per gallon, or mpg) of a particular car model. The model was advertised to get 27 mpg. To investigate, researchers selected a random sample of 10 cars of that model. Each car was then randomly assigned a different driver. Each car was driven for 5,000 miles, and the total fuel consumption was used to compute mpg for that car.
- (a) Define the parameter of interest and state the null and alternative hypotheses the consumer organization is interested in testing.

One condition for conducting a one-sample t -test in this situation is that the mpg measurements for the population of cars of this model should be normally distributed. However, the boxplot and histogram shown below indicate that the distribution of the 10 sample values is skewed to the right.



- (b) One possible statistic that measures skewness is the ratio $\frac{\text{sample mean}}{\text{sample median}}$. What values of that statistic (small, large, close to one) might indicate that the population distribution of mpg values is skewed to the right? Explain.

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Question 5

Intent of Question

The primary goals of this statistical inference question were to assess a student's ability to (1) interpret a *p*-value in context; (2) make an appropriate conclusion about the study based on the *p*-value; and (3) based on the conclusion, identify the type of error that could have occurred and a possible consequence of this error in context.

Solution

Part (a):

The *p*-value of 0.0761 measures the chance of observing a difference between the two sample proportions $(\hat{p}_{CC} - \hat{p}_{CC+MMR})$ as large as or larger than the one observed, if the survival rates for the two treatments (CC alone and CC + MMR) are in fact the same.

Part (b):

Because the *p*-value of 0.0761 is greater than 0.05, the null hypothesis should not be rejected. That is, there is not sufficient evidence to conclude that the treatment "CC alone" produces a higher survival rate than the standard treatment "CC + MMR."

Part (c):

Because the null hypothesis was not rejected, a Type II error could have occurred. A possible consequence is that CC + MMR would continue as the accepted practice when, in fact, CC alone would result in a higher survival rate.

Scoring

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

Part (a) is scored as follows:

A correct interpretation must include the following three components:

- Correct probability phrase (e.g., "The *p*-value of 0.0761 measures the chance of . . .") that includes the words "as large as" (or something similar).
- Correct conditional phrase (e.g., "if the survival rates for the two treatments are in fact the same").
- Correct context.

Essentially correct (E) if the response includes all three components.

Partially correct (P) if the response includes the first component and one of the other two components

OR

if the probability phrase is complete except for the omission of the words "as large as" (or something similar) and the other two components are included.

Incorrect (I) if the response includes no more than one component.

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Question 5 (continued)

Part (b) is scored as follows:

Essentially correct (E) if a correct conclusion (failure to reject H_0) is provided in context with appropriate linkage to the p -value.

Partially correct (P) if a correct conclusion is provided but either the context or linkage is missing
OR

the student “accepts H_0 ” (or something similar) and provides both context and linkage.

Incorrect (I) if the student rejects H_0

OR

the student provides neither context nor linkage.

Part (c) is scored as follows:

A correct response must include the following two components:

- The type of error named is consistent with the conclusion in part (b).
- A consequence is provided (in context) that is consistent with the conclusion in part (b) and is specific with regard to the treatments. The consequence must address how heart attack patients will be treated as a result of the error.

Essentially correct (E) if the response includes both components.

Partially correct (P) if the response includes only the consequence component

OR

the type of error named is consistent with the conclusion in part (b) *AND* a correct definition (either generic or in context) of that error is given, but the consequence component is either missing or incorrect.

Incorrect (I) if the response does not include the consequence component, apart from the exception given above as the second type of a partially correct response.

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 no part partially correct

OR

One part essentially correct and one or two parts partially correct

OR

Three parts partially correct

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Question 5 (continued)

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Minimal Response

- One part essentially correct and no parts partially correct
OR
No parts essentially correct and two parts partially correct