Set B # 5
(2009B #5a)

AP® STATISTICS
2009 SCORING GUIDELINES (Form B)

Question 5

Intent of Question

The primary goals of this question were to assess students' ability to (1) state the appropriate hypotheses, (2) identify and compute the appropriate test statistic, (3) make a conclusion in the context of the problem for a one-sample t test, and (4) use simulation results to find a simulated p-value to make an inference about the standard deviation.

Solution

Part (a):

Step 1: State a correct pair of hypotheses.

H_0: $\mu = 12.1$

H_a: $\mu \neq 12.1$, where μ is the mean number of fluid ounces dispensed into all juice bottles filled in the past hour

Step 2: Identify a correct test (by name or by formula) and check appropriate conditions. (Stem of the question said to assume that conditions for inference are met.)

One-sample t test for a mean *OR* $t = \dfrac{\bar{x} - \mu_0}{\frac{s}{\sqrt{n}}}$

Step 3: Correct mechanics, including the value of the test statistic, df, and p-value (or rejection region).

test statistic: $t = \dfrac{12.05 - 12.1}{\frac{0.085}{\sqrt{4}}} = \dfrac{-0.05}{0.0425} = -1.176$

p-value: $2 \cdot P(T_{3df} < -1.176) = 0.324$

Step 4: State a correct conclusion in the context of the problem, using the result of the computations.

Because the p-value of 0.324 is larger than any reasonable significance level, such as $\alpha = .05$, do not reject the null hypothesis that the mean number of fluid ounces being dispensed is 12.1 fluid ounces. There is not sufficient evidence to conclude that the machine is filling the juice bottles with an average amount different from 12.1 fluid ounces.

Part (b):

In 300 simulated sample standard deviations, the value of the computed standard deviation (0.085) from our sample in part (a) or a value larger than 0.085 occurred only 12 times. This is a simulated p–value of $\frac{12}{300}$ or 0.04. If the actual population standard deviation is 0.05, then we estimate that the chance of observing a sample standard deviation of 0.085 or larger is 4 percent.

Because this simulated p-value is less than a significance level of 5 percent, the sample from part (a) provides strong evidence that the standard deviation of the juice being dispensed exceeds 0.05 ounces.

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Question 5 (continued)

Scoring

This problem is scored in four sections. Section 1 consists of part (a), step 1. Section 2 consists of part (a), steps 2 and 3. Section 3 consists of part (a), step 4. Section 4 consists of part (b). Sections 1, 2, and 3 are each scored as essentially correct (E) or incorrect (I). Both step 2 and step 3 in section 2 must be completely correct to earn an E for section 2. Section 4 is scored as essentially correct (E), partially correct (P), or incorrect (I).

Section 1 [part (a), step 1] is scored as follows:

Essentially correct (E) if the student states a correct pair of hypotheses.

Incorrect (I) otherwise.

Section 2 [part (a), steps 2 and 3] is scored as follows:

Essentially correct (E) if the student identifies a correct test (by name or formula) and includes correct mechanics.

Incorrect (I) otherwise.

Section 3 [part (a), step 4] is scored as follows:

Essentially correct (E) if the student states a correct conclusion in the context of the problem.

Incorrect (I) otherwise.

Section 4 [part (b)] is scored as follows:

Essentially correct (E) if the student finds the correct simulated p-value from the dotplot or states that the actual standard deviation of 0.085 would be unusual if $\sigma = 0.05$ because 0.085 lies in the tail of the distribution *AND* an appropriate conclusion is made.

Partially correct (P) if only the simulated p-value or statement that 0.085 lies in the tail is correct, but the conclusion is weak, wrong, or missing.

Incorrect if the value 0.085 is not linked to the distribution.

Notes:

- If the p-value in section 2 is incorrect but the conclusion is consistent with the computed p-value, section 4 can be considered correct.
- In section 4, if both an α and a p-value are given together, the linkage between the p-value and the conclusion is implied. If no α is given, the solution must be explicit about the linkage by giving a correct interpretation of the p-value or explaining how the conclusion follows from the p-value.

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Question 5 (continued)

Each essentially correct (E) response counts as 1 point, and a partially correct (P) response in section 4 counts as ½ point.

4 **Complete Response**

3 **Substantial Response**

2 **Developing Response**

1 **Minimal Response**

If a response is between two scores (for example, 1½ points), use a holistic approach to determine whether to score up or down, depending on the strength of the response and communication.

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