AP® Statistics (Operational)
2004 Sample Student Responses

A1

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. A pharmaceutical company has developed a new drug to reduce cholesterol. A regulatory agency will recommend the new drug for use if there is convincing evidence that the mean reduction in cholesterol level after one month of use is more than 20 milligrams/deciliter (mg/dl), because a mean reduction of this magnitude would be greater than the mean reduction for the current most widely used drug.

   The pharmaceutical company collected data by giving the new drug to a random sample of 50 people from the population of people with high cholesterol. The reduction in cholesterol level after one month of use was recorded for each individual in the sample, resulting in a sample mean reduction and standard deviation of 24 mg/dl and 15 mg/dl, respectively. $\bar{x} = 24$ $s = 15$

   (a) The regulatory agency decides to use an interval estimate for the population mean reduction in cholesterol level for the new drug. Provide this 95 percent confidence interval. Be sure to interpret this interval.

1 sample t interval

Assumptions
- μ, σ unknown ✓
- random sample ✓
- normal population or $n \geq 40$ ($n = 50$) ✓

$\bar{x} \pm t^* \frac{s}{\sqrt{n}}$ $\quad n = 50$ $\quad df = 49$ $\quad t^*$ (using df = 50 from table) $= 2.009$

$24 \pm 2.009\left(\frac{15}{\sqrt{50}}\right)$

24 ± 4.262

$(19.738, 28.262)$ mg/dl

We are 95% confident that the true mean reduction in cholesterol level after one month of use (of the new drug) is between 19.7 mg/dl and 28.3 mg/dl

A_2

If you need more room for your work to part (a), use the space below.

(b) Because the 95 percent confidence interval includes 20, the regulatory agency is not convinced that the new drug is better than the current best-seller. The pharmaceutical company tested the following hypotheses.

H_0: $\mu = 20$ versus H_a: $\mu > 20$,

where μ represents the population mean reduction in cholesterol level for the new drug.

The test procedure resulted in a t-value of 1.89 and a p-value of 0.033. Because the p-value was less than 0.05, the company believes that there is convincing evidence that the mean reduction in cholesterol level for the new drug is more than 20. Explain why the confidence interval and the hypothesis test led to different conclusions.

A confidence interval is comparable to a two-sided test of the same significance level. So the p-value for a two-sided test is two times the p-value for a one-sided test. So the p-value for the two-sided test would be 2(.033) = .066 ≠ .05, so the two-sided test is not significant at the α=.05 level (consistent with the 95% confidence interval results).

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A3

(c) The company would like to determine a value L that would allow them to make the following statement.

We are 95 percent confident that the true mean reduction in cholesterol level is greater than L.

A statement of this form is called a one-sided confidence interval. The value of L can be found using the following formula.

$$L = \bar{x} - t^* \frac{s}{\sqrt{n}}$$

This has the same form as the lower endpoint of the confidence interval in part (a), but requires a different critical value, t^*. What value should be used for t^*?

df still = 49 (use 50 in table)
Use a tail probability of .05 instead of .025 because there's only one tail and we still need a .05 significance level.
So $t^* = 1.676$

Recall that the sample mean reduction in cholesterol level and standard deviation are 24 mg/dl and 15 mg/dl, respectively. Compute the value of L. $\bar{x} = 24$ $s = 15$ $n = 50$

same assumptions still before (still satisfied)

$L = 24 - 1.676\left(\frac{15}{\sqrt{50}}\right)$
$= 24 - 3.555$
$L = 20.445$ mg/dl

We are 95% confident that the true mean reduction in cholesterol level is greater than 20.4 mg/dl

(d) If the regulatory agency had used the one-sided confidence interval in part (c) rather than the interval constructed in part (a), would it have reached a different conclusion? Explain.

Yes, it would have reached a different conclusion.
The regulatory agency said it would recommend the new drug for use if there was convincing evidence that the mean reduction in cholesterol level after one month of use was 20 mg/dl. They were not convinced that the new drug was better than the current best-seller because the confidence interval in(a) contained 20 mg/dl. However, the new interval in(c) provides convincing evidence at the 5% level that the reduction is greater than 20 mg/dl, so the regulatory agency would probably have reached the different conclusion that they would recommend the new drug for use.

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B1

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6. A pharmaceutical company has developed a new drug to reduce cholesterol. A regulatory agency will recommend the new drug for use if there is convincing evidence that the mean reduction in cholesterol level after one month of use is more than 20 milligrams/deciliter (mg/dl), because a mean reduction of this magnitude would be greater than the mean reduction for the current most widely used drug.

   The pharmaceutical company collected data by giving the new drug to a random sample of 50 people from the population of people with high cholesterol. The reduction in cholesterol level after one month of use was recorded for each individual in the sample, resulting in a sample mean reduction and standard deviation of 24 mg/dl and 15 mg/dl, respectively.

   (a) The regulatory agency decides to use an interval estimate for the population mean reduction in cholesterol level for the new drug. Provide this 95 percent confidence interval. Be sure to interpret this interval.

$\bar{x} = 24 \quad s = 15 \quad t^* =$

$\bar{x} \pm t^* \frac{s}{\sqrt{n}} \qquad 24 \pm 2.009\left(\frac{15}{\sqrt{50}}\right)$

(19.7383, 28.2617)

The company cannot claim that the mean reduction is greater than 20 because 20 is included in the interval. They can be 95% confident that the actual mean is between 19.7383 and 28.2617.

B_2

If you need more room for your work to part (a), use the space below.

(b) Because the 95 percent confidence interval includes 20, the regulatory agency is not convinced that the new drug is better than the current best-seller. The pharmaceutical company tested the following hypotheses.

$$H_0: \mu = 20 \text{ versus } H_a: \mu > 20,$$

where μ represents the population mean reduction in cholesterol level for the new drug.

The test procedure resulted in a t-value of 1.89 and a p-value of 0.033. Because the p-value was less than 0.05, the company believes that there is convincing evidence that the mean reduction in cholesterol level for the new drug is more than 20. Explain why the confidence interval and the hypothesis test led to different conclusions.

The conclusions were different because the confidence interval uses a set (chosen) probability while the t-test calculates an exact probability.

B3

(c) The company would like to determine a value L that would allow them to make the following statement.

We are 95 percent confident that the true mean reduction in cholesterol level is greater than L.

A statement of this form is called a one-sided confidence interval. The value of L can be found using the following formula.

$$L = \bar{x} - t^* \frac{s}{\sqrt{n}}$$

This has the same form as the lower endpoint of the confidence interval in part (a), but requires a different critical value, t^*. What value should be used for t^*?

$t^* = 1.676$

Recall that the sample mean reduction in cholesterol level and standard deviation are 24 mg/dl and 15 mg/dl, respectively. Compute the value of L.

$$L = 24 - 1.676 \cdot \frac{15}{\sqrt{50}} = 20.4447$$

(d) If the regulatory agency had used the one-sided confidence interval in part (c) rather than the interval constructed in part (a), would it have reached a different conclusion? Explain.

Yes, because the one-sided confidence interval gives a minimum mean of 20.4, which is higher than the required 20.