





A major car manufacturer wants to test a new engine to determine if it meets new air pollution standards. The mean emission  $\mu$  of all engines of this type must be approximately 20 parts per million of carbon. If it is higher than that, they will have to redesign parts of the engine. Ten engines are manufactured for testing purposes and the emission level of each is determined. Based on data collected over the years from a variety of engines, it seems reasonable to assume that emission levels are roughly Normally distributed with  $\sigma = 3$ .

54. What are the appropriate null and alternative hypotheses?

- A)  $H_0: \mu = 20$  vs.  $H_a: \mu < 20$
- B)  $H_0: \mu = 20$  vs.  $H_a: \mu \neq 20$
- C)  $H_0: \mu = 20$  vs.  $H_a: \mu > 20$

Answer: C

Topic: 6.2 Tests of Significance

55. The data result in an average of 22 parts per million. What is the value of the test statistic?

- A)  $z = -2.11$
- B)  $z = 0.667$
- C)  $z = 2.11$
- D)  $z = 6.67$

Answer: C

Topic: 6.2 Tests of Significance

56. What is the value of the  $P$ -value?

- A) Less than 0.0001
- B) 0.0175
- C) 0.2525
- D) 0.9825

Answer: B

Topic: 6.2 Tests of Significance

6. The heights (in inches) of males in the U.S. are believed to be Normally distributed. The average height of a random sample of 25 American adult males is found to be  $\bar{x} = 69.72$  inches with a standard deviation of  $s = 4.15$ . What is the standard error of  $\bar{x}$  ?

- A) 0.17
- B) 0.69
- C) 0.83
- D) 2.04

Answer: C

Topic: 7.1 Inference for the Mean of a Population

Sixteen people volunteered to be part of an experiment. All sixteen people were Caucasian, between the ages of 25 and 35, and were supplied with nice clothes. Eight of the people were male and eight were female. The question of interest in this experiment was whether females receive faster service at restaurants than males. Each of the eight male participants was randomly assigned a restaurant, and each of the eight females was randomly assigned to one of these same eight restaurants. One Friday night, all sixteen people went out to eat, each one alone. The male and female assigned to the same restaurant would arrive within 5 minutes of each other, with the order determined by flipping a coin

(male first or female first). Each person then ordered a similar drink and a similar meal. The time (in minutes) until the food arrived at the table was recorded. They are shown below:

Restaurant	1	2	3	4	5	6	7	8
Male	22	14	16	26	18	13	9	27
Female	25	12	13	21	21	14	9	16

The hypotheses being tested are  $H_0: \mu = 0$ ,  $H_a: \mu > 0$ , where  $\mu$  represents the mean of the differences in service time (male – female). Assume that the differences are Normally distributed.

23. What is the value of the  $t$  test statistic?

- A)  $t = 1.05$
- B)  $t = 1.75$
- C)  $t = 2.99$
- D)  $t = 8.00$

Answer: A

Topic: 7.1 Inference for the Mean of a Population

24. What can you say about the value of the  $P$ -value?

- A)  $P\text{-value} < 0.025$
- B)  $0.025 < P\text{-value} < 0.05$
- C)  $0.05 < P\text{-value} < 0.10$
- D)  $P\text{-value} > 0.10$

Answer: D

Topic: 7.1 Inference for the Mean of a Population

You wish to compare the prices of apartments in two neighboring towns. You take a simple random sample of 12 apartments in town A and calculate the average price of these apartments. You repeat this for 15 apartments in town B. Let  $\mu_1$  represent the true average price of apartments in town A and  $\mu_2$  the average price in town B.

48. What would be the hypotheses for this problem?

- A)  $H_0: \mu_1 = \mu_2$  versus  $H_a: \mu_1 < \mu_2$
- B)  $H_0: \mu_1 = \mu_2$  versus  $H_a: \mu_1 > \mu_2$
- C)  $H_0: \mu_1 = \mu_2$  versus  $H_a: \mu_1 \neq \mu_2$

Answer: C

Topic: 7.2 Comparing Two Means

49. If we were to use the pooled  $t$  test, what would be the degrees of freedom?

- A) 11
- B) 12
- C) 14
- D) 25

Answer: D

Topic: 7.2 Comparing Two Means





A manufacturer receives parts from two suppliers. A simple random sample of 400 parts from supplier 1 finds 20 defective. A simple random sample of 200 parts from supplier 2 finds 20 defective. Let  $p_1$  and  $p_2$  be the proportion of all parts from suppliers 1 and 2, respectively, that are defective.

57. What is the estimate for the difference in proportions,  $p_1 - p_2$ ?

- A) -0.05
- B) 0.05
- C) 0.067
- D) 0.10

Answer: A

Topic: 8.2 Comparing Two Proportions

58. Is this difference statistically significant at the 5% significance level? To determine this, test the hypotheses  $H_0: p_1 = p_2$  versus  $H_a: p_1 \neq p_2$ .

- A) Yes
- B) No
- C) This cannot be determined from the information given.

Answer: A

Topic: 8.2 Comparing Two Proportions

59. Would a 95% confidence interval for  $p_1 - p_2$  contain the value zero?

- A) Yes
- B) No
- C) This cannot be determined from the information given.

Answer: B

Topic: 8.2 Comparing Two Proportions

15. What do we know about the  $P$ -value for testing the null hypothesis that the probability of complaining is the same for the United States and Puerto Rico?

- A)  $P\text{-value} < 0.010$
- B)  $0.010 < P\text{-value} < 0.025$
- C)  $0.025 < P\text{-value} < 0.05$
- D) This cannot be determined, because these are not the hypotheses being tested by the chi-square test.

Answer: B

Topic: 9.1 Inference for Two-Way Tables

16. Which of the following statements about the analysis of two-way tables is (are) TRUE?

- A) Under the null hypothesis the expected cell count is  $= \frac{(\text{row total}) \times (\text{column total})}{n}$ .
- B) In a table with  $r$  rows and  $c$  columns the number of degrees of freedom is  $(r - 1)(c - 1)$ .
- C) A possible null hypothesis is that there is no association between the row and column variables.
- D) All of the above are true.
- E) Only A and B are true.

Answer: D  
Topic: 9.1 Inference for Two-Way Tables

17. The following table provides the results of a study in a major hospital concerning patients and their supplemental health coverage. A random sample of 95 surgical patients showed that 36 had supplemental health coverage; in a second random sample of 125 medical patients 56 had coverage:

	Medical Patients	Surgical Patients
Supplemental Health	56	36
No Supplemental Health	69	59

If we wanted to test for the equality of the proportion of patients of the two types that have supplemental health coverage, i.e.,  $H_0: p_M = p_S$  against  $H_a: p_M \neq p_S$ , which of the following statements about the appropriate analysis (at the  $\alpha = 0.05$  level) would be FALSE?

- A) We could use a  $\chi^2$  test with 1 degree of freedom.
- B) We would reject the null hypothesis here if the observed  $|Z| > 1.96$  or if  $\chi^2 > 3.84$ .
- C) Both the  $z$  test and the  $\chi^2$  test can be extended to test the equality of more than two proportions.
- D) We could use a two-tailed  $z$  test for the equality of two proportions.
- E) The  $\chi^2$  test and the  $z$  test are equivalent because the square of the  $z$  statistic is equal to  $\chi^2$  with 1 degree of freedom.

Answer: C  
Topic: 9.1 Inference for Two-Way Tables

18. Which of the following statements about  $r \times c$  tables is (are) FALSE?

- A) The null hypothesis is tested using the chi-square statistic with  $(r-1)(c-1)$  degrees of freedom.
- B) The statistic used to test the null hypothesis is denoted by  $\chi^2 = \sum \frac{(\text{observed} - \text{expected})^2}{\text{observed}}$ .
- C) The  $P$ -value for the test is  $P(\chi^2 \geq X^2)$  where  $\chi^2$  is a random variable having the  $\chi^2$  (df) distribution with  $df = (r-1)(c-1)$ .
- D) Under the null hypothesis the  $\chi^2$  statistic has approximately a chi-square distribution with  $(r-1)(c-1)$  degrees of freedom.
- E) The chi-square approximation is adequate when the average expected cell count is 5 or greater and all individual expected counts are 1 or greater, except in the case of  $2 \times 2$  tables.

Answer: B  
Topic: 9.1 Inference for Two-Way Tables

Use the following to answer questions 19–22:

A specific type of electronic sensor has been experiencing failures. The manufacturer has studied 200 of these devices and has determined the type of failure (A, B, C) that occurred and the location on the sensor where the failure happened (External, Internal). The following table summarizes the findings:

Location of Failure	Type of Failure			Total
	A	B	C	
Internal	50	16	31	97
External	61	26	16	103
Total	111	42	47	200

19. Which of the following statements is (are) TRUE?
- A) The null hypothesis is that all the population proportions for Type of Failure are equal.
  - B) The null hypothesis is that there is no association between Type of Failure and Location of Failure.
  - C) The alternative hypothesis is that there is an association between the row and column variables.
  - D) The test statistic will have 6 degrees of freedom.
  - E) Only B and C are true.

Answer: E

Topic: 9.1 Inference for Two-Way Tables

20. Under the appropriate null hypothesis what is the expected cell count for External Failures that are of Type B?
- A) 63.7
  - B) 11.1
  - C) 21.6
  - D) 4.5
  - E) 31.3

Answer: C

Topic: 9.1 Inference for Two-Way Tables

21. It was calculated that the test statistic was  $\chi^2 = 8.083$ . The approximate  $P$ -value for this test is then
- A) between 0.02 and 0.04.
  - B) between 0.01 and 0.02.
  - C) less than 0.01.
  - D) greater than 0.04.
  - E) between 0.15 and 0.25.

Answer: B

Topic: 9.1 Inference for Two-Way Tables