Name: _____ **Class:** _____ **Date:** _____ **ID: A**

Two Sample and Chi-Square Inference Test

Multiple Choice
Identify the choice that best completes the statement or answers the question.

____ 1. A randomized experiment was performed to determine whether two fertilizers, A and B, give different yields of tomatoes. A total of 33 tomato plants were grown; 16 using fertilizer A, and 17 using fertilizer B. The distributions of the data did not show marked skewness and there were no outliers in either data set. The results of the experiment are shown below.

	Fertilizer A	**Fertilizer B**
Average # of tomatoes per plant	19.54	23.39
Standard deviation	3.68	4.93
Number of plants	16	17

Which of the following statements best describes the conclusion that can be drawn from this experiment?

A. There is no statistical evidence of difference in the yields between fertilizer A and fertilizer B $(p > 0.15)$.
B. There is a borderline statistically significant difference in the yields between fertilizer A and fertilizer B $(0.10 < p < 0.15)$.
C. There is evidence of a statistically significant difference in the yields between fertilizer A and fertilizer B $(0.05 < p < 0.10)$.
D. There is evidence of a statistically significant difference in the yields between fertilizer A and fertilizer B $(0.01 < p < 0.05)$.
E. There is evidence of a statistically significant difference in the yields between fertilizer A and fertilizer B $(p < 0.01)$.

____ 2. A manufacturer claims its Brand *A* battery lasts longer than its competitor Brand *B's* battery. Nine batteries of each brand are tested independently, and the hours of battery life are shown in the table below.

Brand A	88	85	80	81	72	90	85	85	84
Brand B	80	79	77	82	75	81	77	73	78

Provided that the assumptions for inference are met, which of the following tests should be conducted to determine if Brand *A* batteries do, in fact, last longer than Brand *B* batteries?

A. A one-sided, paired *t*-test
B. A one-sided, two-sample *t*-test
C. A two-sided, two-sample *t*-test
D. A one-sided, two-sample *z*-test
E. A two-sided, two-sample *z*-test

____ 3. A large number of randomized experiments were conducted to determine whether taking a particular drug regularly would decrease the chance of getting a certain disease. For each of the experiments, the drug effect is the difference between the proportion of people taking the drug who got the disease and the proportion of people taking a placebo who got the disease. If the drug had no effect whatsoever, which of the following experimental results would be anticipated?

I. *p*-values will be greater than 0.05 for about 95 percent of the experiments.
II. There will be about an equal number of experiments showing positive and negative values of drug effect.
III. When 95 percent confidence intervals for the population drug effect are constructed, those confidence intervals include 0 about 95 percent of the time.

A. I only
B. II only
C. III only
D. I and II only
E. I, II and III

____ 4. A study was conducted using data collected on the birth weights of a random sample of 10 pairs of identical twins to determine whether the twin born first tends to weigh more than the twin born second. Let μ_F represent the average birth weight of all twins born first, μ_S represent the average birth weight of all twins born second, and μ_D represent the average difference in birth weight (weight of the first minus weight of second) for all pairs of twins. Which of the following would be the null and alternative hypotheses for this study?

A. $H_0: \mu_F = \mu_S$ and $H_a: \mu_F < \mu_S$
B. $H_0: \mu_F = \mu_S$ and $H_a: \mu_F \neq \mu_S$
C. $H_0: \mu_D = 0$ and $H_a: \mu_D > 0$
D. $H_0: \mu_F - \mu_S = \mu_D$ and $H_a: \mu_F - \mu_S > \mu_D$
E. $H_0: \mu_F - \mu_S = \mu_D$ and $H_a: \mu_F - \mu_S \neq \mu_D$

____ 5. In a large school district, 16 of 85 randomly selected high school seniors play a varsity sport. In the same district, 19 of 67 randomly selected high school juniors play a varsity sport. A 95 percent confidence interval for the difference between proportion of high school seniors who play a varsity sport in the school district and high school juniors who play a varsity sport in the school district is to be calculated. What is the standard error of the difference?

A. 0.0347
B. 0.0695
C. 0.1362
D. 0.9800
E. 1.6900

____ 6. Each person in a random sample of adults indicated his or her favorite color. The results, shown in the table below, are reported by age of respondents.

	Red	Green	Blue	Other	Total
Under 30	20	42	16	36	114
30-50	24	35	24	25	108
Over 50	25	22	35	10	92
Total	69	99	75	71	314

If choice of color is independent of age group, which of the following expressions is equal to the expected number of respondents who are aged 30 to 50, inclusive, and prefer green?

A. $\frac{(99)(108)}{314}$

B. $\frac{(68)(108)}{314}$

C. $\frac{(35)(99)}{108}$

D. $\frac{(35)(108)}{314}$

E. $\frac{(35)(99)}{314}$

____ 7. Sophomore, junior and senior students at a high school will be surveyed regarding a potential increase in the extracurricular student activities fee. There are three possible responses to the survey question-- agree with the increase, do not agree with the increase, or no opinion. A chi-square test will be conducted to determine whether the response to this question is independent of the class in which the student is a member. How many degrees of freedom should the chi-square test have?

A. 9
B. 6
C. 4
D. 2
E. 1

____ 8. To determine whether employees at Site X have higher salaries, on average, than employees at Site Y of the same company do, independent random samples of salaries were obtained for the two groups. The data are summarized below.

	Site X	Site Y
Mean	\$61,234	\$60,529
Standard Deviation	\$4,352	\$3,456
n	235	183

Based on the data, which of the following statements is true?

A. At the 5% significance level, employees at Site Y have a significantly higher mean salary than employees at Site X do.

B. At the 1% significance level, employees at Site Y have a significantly higher mean salary than employees at Site X do.

C. At the 5% significance level, employees at Site X have a significantly higher mean salary than employees at Site Y do.

D. At the 1% significance level, employees at Site X have a significantly higher mean salary than employees at Site Y do.

E. At the 10% significance level, there is no significant difference in salaries between the employees at the two sites.

____ 9. In order to plan its next advertising campaign, the Trendy Motor Vehicle Company is investigating whether the type of vehicle and the color of vehicle are related. Each person in a random sample of size 275 selected from the company's mailing list was classified according to the type (car or truck) and the color of vehicle he or she drove. The data are shown in the table below.

		Vehicle Color				
		Red	Black	White	Tan	Green
Vehicle Type	Car	35	23	41	21	12
	Truck	27	55	39	12	10

Which of the following procedures would be most appropriate to use for investigating whether there is a relationship between vehicle type and color?

A. A two-sample t-test
B. A two-sample z-test
C. A matched pairs t-test
D. A chi-square goodness-of-fit test
E. A chi-square test of independence

____ 10. Which of the following is a criterion for choosing a t-test rather than a z-test when making an inference about the mean of a population?

A. The standard deviation of the population is unknown.
B. The mean of the population is unknown.
C. The sample may not have been a simple random sample.
D. The population is not normally distributed.
E. The sample size is less than 100.

____ 11. A marketing research consultant for a hotel chain hypothesizes that men and women differ in their color preference for guest rooms. The consultant shows pictures of rooms decorated with three different color scheme to each person in a random sample of 110 men and to each person in a random sample of 90 women. The consultant asks each person to choose his or her favorite color scheme. A chi-square test for homogeneity of proportions will be used to test the consultant's hypothesis. Assuming that the conditions for inference are met, which of the following statements is true for the test?

A. The null hypothesis for the test is that the proportion of each gender who prefer each color scheme is $\frac{1}{3}$.
B. The sample size is too small to detect a significant difference in a chi-square test for homogeneity of proportions.
C. The test is not valid because the sample sizes are not equal.
D. The more that men and women differ in their color preferences, the larger the chi-square statistic will be.
E. The test would also be appropriate if 90 married couples had been used for the two samples.

____ 12.

Brown Eyes	Green Eyes	Blue Eyes
34	15	11

A geneticist hypothesizes that half of a given population will have brown eyes and the remaining half will be split evenly between blue-and green-eyed people. In a random sample of 60 people from this population, the individuals are distributed as shown in the table above. What is the value of the χ^2 statistic for the goodness of fit on these data?

A. Less than 1
B. At least 1, but less than 10
C. At least 10, but less than 20
D. At least 20, but less than 50
E. At least 50

____ 13. An ecologist studying the differences in populations of a certain species of lizards on two different islands collects lizards in live traps, weighs them, and then releases them again. (He marks them so he won't weigh the same lizard twice). During one study period, he collects the following data. All weights are in grams.

	n	Mean (gm)	Std. Dev. (gm)
Sheep Island	24	46.5	5.97
Pig Island	30	44.2	4.24

Which of the following is the correct expression for the test statistic to test the hypothesis that the mean weights on the two islands are equal?

A. $t = \dfrac{46.5 - 44.2}{\left(\dfrac{5.97}{\sqrt{24}} + \dfrac{4.24}{\sqrt{30}}\right)^2}$

B. $t = \dfrac{46.5 - 44.2}{\sqrt{\dfrac{5.97}{24} + \dfrac{4.24}{30}}}$

C. $t = \dfrac{46.5 - 44.2}{\sqrt{\dfrac{5.97^2}{24} + \dfrac{4.24^2}{30}}}$

D. $t = \dfrac{46.5 - 44.2}{\sqrt{\dfrac{5.97^2}{24}} + \sqrt{\dfrac{4.24^2}{30}}}$

E. $t = \dfrac{46.5 - 44.2}{\sqrt{\dfrac{5.97^2 + 4.24^2}{54}}}$

____ 14. Independent random samples of 100 luxury cars and 250 non-luxury cars in a certain city are examined to see if they have bumper stickers. Of the 250 non-luxury cars, 125 have bumper stickers and of the 100 luxury cars, 30 have bumper stickers. Which of the following is a 90 percent confidence interval for the difference in the proportion of non-luxury cars with bumper stickers and the proportion of luxury cars with bumper stickers from the populations of cars represented by these samples?

A. $(0.5-0.3)\pm 1.96\sqrt{\frac{(0.5)(0.5)}{250}+\frac{(0.3)(0.7)}{100}}$

B. $(0.5-0.3)\pm 1.645\sqrt{\frac{(0.5)(0.5)}{250}+\frac{(0.3)(0.7)}{100}}$

C. $(0.5-0.3)\pm 1.645\sqrt{\left(\frac{155}{390}\right)\left(\frac{195}{350}\right)\left(\frac{1}{250}+\frac{1}{100}\right)}$

D. $(0.5-0.3)\pm 1.96\sqrt{\left(\frac{155}{390}\right)\left(\frac{195}{350}\right)\left(\frac{1}{250}+\frac{1}{100}\right)}$

E. $(0.5-0.3)\pm 1.645\sqrt{(0.4)(0.6)\left(\frac{1}{250}+\frac{1}{100}\right)}$

____ 15. Dan selected a random sample of 100 students from the 1,200 at his school to investigate preferences for making up school days lost due to emergency closings. The results are shown in the table below.

Preference	Number of Students
Extend the school year into the summer	58
Go to school on Saturdays in the spring	42

Dan incorrectly performed a large sample test of the difference in the two proportions using $\frac{58}{100}$ and $\frac{42}{100}$ and caculated a p-value of 0.02. Consequently, he concluded that there was a significant difference in preference for the two options. Which of the following best describes his error in the analysis of these data?

A. No statistical test was necessary because 0.58 is clearly larger than 0.42.
B. The results of the test were invalid because less than 10% of the population was sampled.
C. Dan performed a two-tailed test and should have performed a one-tail test.
D. A one-sample test for a proportion should have been performed because one sample was used.
E. More options should have been included, and a chi-square test should have been performed.

Scenario 10-1

Different varieties of fruits and vegetables have different amounts of nutrients. These differences are important when these products are used to make baby food. We wish to compare the carbohydrate content of two varieties of peaches. The data were analyzed with MINITAB, and the following output was obtained:

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            N   Mean  StDev  SE Mean
Variety 1   5   33.6  3.781    1.691
Variety 2   7   25.0 10.392    3.927

Difference = mu (Variety 1) - mu (Variety 2)
Estimate for difference:  8.6
T-Test of difference = 0 (vs not =): T-Value = 2.011  P-Value = 0.0791
DF = 8
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____ 16. Use Scenario 10-1. We wish to test if the two varieties are significantly different in their mean carbohydrate content. Which of the following are the appropriate null and alternative hypotheses for this situation?

A. $H_0 : \mu_1 = \mu_2; H_a : \mu_1 < \mu_2$

B. $H_0 : \mu_1 = \mu_2; H_a : \mu_1 > \mu_2$

C. $H_0 : \mu_1 = \mu_2; H_a : \mu_1 \neq \mu_2$

D. $H_0 : \bar{x}_1 = \bar{x}_2; H_a : \bar{x}_1 < \bar{x}_2$

E. $H_0 : \bar{x}_1 = \bar{x}_2; H_a : \bar{x}_1 \neq \bar{x}_2$

____ 17. A researcher wants to see if birds that build larger nests lay larger eggs. She selects two random samples of nests: one of small nests and the other of large nests. She weighs one egg from each nest. The data are summarized below.

	n	Mean (gm)	Std. Dev. (gm)
Small nests	60	37.2	4.97
Large nests	159	35.6	6.24

Which of the following represents a 95% confidence interval for the difference between the average mass of eggs in small and large nests?

A. $(37.2-35.6)\pm 2.009\sqrt{\frac{4.97^2}{60}+\frac{6.24^2}{159}}$

B. $(37.2-35.6)\pm 2.009\sqrt{\frac{4.97^2}{59}+\frac{6.24^2}{158}}$

C. $(37.2-35.6)\pm\sqrt{\frac{4.97}{59}+\frac{6.24}{158}}$

D. $(37.2-35.6)\pm\sqrt{\frac{4.97^2+6.24^2}{59+158}}$

E. $(37.2-35.6)\pm\frac{4.97}{\sqrt{59}}+\frac{6.24}{\sqrt{158}}$

Scenario 11-4
A market research firm wants to know if there is an obvious leader among the five most popular manufacturers of laptop computers, or whether they are all about equally popular. They ask a random sample of 250 people which brand of computer they trust most. Here are the results:

Most-trusted brand	Apple	Dell	HP/Compaq	Sony	Toshiba
Frequency	42	66	45	43	54

____ 18. Use Scenario 11-4. Which of the following is an appropriate null hypothesis for the company to test?
A. $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5$
B. The observed counts are all equal to 50.
C. People are equally likely to identify each the five brands as most trustworthy.
D. The proportion of people who trust at least one of the five brands most is different from the other four proportions.
E. The observed counts are equal to the expected counts.

____ 19. Use Scenario 11-4. Which of the following are conditions that must be met in order to test this hypothesis using a chi-square test?
I. Each respondent is randomly selected from the population.
II. All expected cell counts are greater than 5.
III. The population is normally distributed, or *n* is large enough for the central limit theorem to apply.
A. I and II only
B. II and III only
C. I and III only
D. II only
E. I, II, and III

____ 20. Use Scenario 11-4. Which of the following represents the component of the chi-square statistic for Toshiba?
A. $\dfrac{54-50}{54}$
B. $\sqrt{\dfrac{(54-50)^2}{50}}$
C. $\sqrt{\dfrac{(54-50)^2}{54}}$
D. $\dfrac{(54-50)^2}{50}$
E. $\dfrac{(54-50)^2}{54}$

Two Sample and Chi-Square Inference Test
Answer Section

MULTIPLE CHOICE

1. ANS: D PTS: 1
2. ANS: B PTS: 1
3. ANS: E PTS: 1
4. ANS: C PTS: 1
5. ANS: B PTS: 1
6. ANS: A PTS: 1
7. ANS: C PTS: 1
8. ANS: C PTS: 1
9. ANS: E PTS: 1
10. ANS: A PTS: 1
11. ANS: D PTS: 1
12. ANS: B PTS: 1
13. ANS: C PTS: 1
14. ANS: B PTS: 1
15. ANS: D PTS: 1
16. ANS: C
    /C/Correct! The null ("no effect") hypothesis is that the means are the same, and "We wish to test if the two varieties are significantly different…" calls for a two-tailed test.

    PTS: 1 REF: Test 10A
17. ANS: A
    /A/Correct! Since Table B has no entry for 59 degrees of freedom, the conservative approach requires that we use 50 degrees of freedom. The critical *t* for 50 degrees of freedom is 2.009. The formula for the confidence interval is $\left(\overline{x}_1 - \overline{x}_2\right) \pm t^* \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$.

    PTS: 1 REF: Test 10B
18. ANS: C
    /C/Correct! Null hypothesis should refer to the distribution of the population, not observed values. In this setting, the null is that all computer brands have equal popularity, so the proportion preferred is the same for each brand.

    PTS: 1 REF: Test 11B
19. ANS: A
    /A/Correct! Statement III is a condition for a one-sample test of means—categorical distributions can't be "Normal." Statements I and II are both conditions for a chi-square test.

    PTS: 1 REF: Test 11B

20. ANS: D

/D/Correct! Each component of a chi-square statistic is $\frac{(\text{Observed}-\text{Expected})^2}{\text{Expected}}$ for the given cell.

PTS: 1 REF: Test 11B