STATISTICS 7 FINAL EXAM

NAME: **KEY** Seat Number: ____________

Student ID#: ________________________________ Circle your discussion: 9am 10am noon 1pm

Make sure you have 8 pages. Part of Table A.1 will be provided separately.
You may use four pages of notes (both sides) and a calculator.
Multiple choice questions: There are 30 questions for credit, worth 2 points each (30 x 2 pts each = 60 pts).
Free response questions: Show all work. Total of 40 points; points for each part of each question are shown.

1. (**10 pts; a to e are 1 point each**) Students in the Stat 7 classes in 2011 were categorized as male or female and were asked how many Facebook friends they have. Assume that these students are representative of all college students with respect to how many Facebook friends they have. (Only students on Facebook were included.) The question of interest is whether the mean number of Facebook friends differs for males and females in the population. Define Population 1 to be Men and Population 2 to be Women. R Commander output is shown here. Answer the questions that follow.

```
     Welch Two Sample t-test
data:  Facebook by Sex
t = 0.9318, df = 99.83, p-value = 0.3537
alternative hypothesis: true difference in means is not equal to 0
95 percent confidence interval:
 -116.0494     321.6049
sample estimates:
mean in group  Men   mean in group Women
            564.6989            461.9212
```

a. These results are based on (circle your choice): Paired data ***Independent samples***

b. The *notation* for the sample statistic is: $\bar{x}_1 - \bar{x}_2$

c. The *numerical value* for the sample statistic is (round to whole numbers): 565 – 462 = 103

d. The null value is: 0

e. The numerical value of the test statistic is: 0.9318

f. (**2 pts**) Write the *alternative* hypothesis, using appropriate notation: Ha: $\mu_1 - \mu_2 \neq 0$

g. (**3 pts**) *Using only the confidence interval results* shown in the output, would you conclude that the null hypothesis can be rejected (using $\alpha = 0.05$)? Why or why not?

No. The interval covers 0 (so 0 is a plausible value for the difference.)

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Page	1	2	3	Multiple Choice	TOTAL
Points					
Points Possible	10	16	14	60	100

Scenario for Questions 2 to 5: An online clothing retailer knows that historically 40% of potential customers that visit its website actually buy something. To see if they can increase the proportion of visitors who buy something, they randomly select 1000 visitors to the website and offer to give them free shipping if they make a purchase. Of the 1000 visitors who receive this offer, 430 actually buy something. The company wants to test to see if offering free shipping to all customers would increase the proportion who would buy something.

2. (**3 pts**) Define the parameter of interest. Use appropriate notation and write a sentence saying what it is. Make sure you are clear about the population is.

   p = the proportion of the population of visitors to the website who would buy something if they were offered free shipping.

3. (**13 pts total**) Carry out the 5 steps of the applicable hypothesis test in the spaces provided.

   Step 1 (3 pts) *Specify the null and alternative hypotheses*: Use notation, not words.

   $$H_0\colon p = .40,\ H_a\colon p > .40$$

   Step 2 (4 pts) *Compute the test statistic.* (***Show your work***):

   The sample proportion is $\hat{p} = \dfrac{430}{1000} = .43$ *and the null value is* $p_0 = .4$.

   The null standard error is $\sqrt{\dfrac{p_0(1-p_0)}{n}} = \sqrt{\dfrac{.4(.6)}{1000}} = .0155$

   The test statistic is $z = \dfrac{.43-.40}{.0155} = 1.94$ *(Answers could differ slightly depending on rounding.)*

   Step 3 (2 pts) *Find the p-value*:

   It's the area above 1.94, which is the same as the area below -1.94, read from the table as .0262. (Your answer could differ slightly based on rounding in Step 3.

   Step 4 (2 pts) *Make a conclusion (use α = 0.05):*

   Reject the null hypothesis because the p-value of .0262 < .05.

   Step 5 (2 pts) *Report the conclusion in context by informing the company about whether the free shipping would work to increase the proportion who buy something.*

   We can conclude that the proportion who would buy something if offered free shipping is greater than the historical proportion of .30, so it appears that offering free shipping does work to increase the proportion who buy something.

4. (**5 pts**) **(Scenario above, continued)** Explain what a Type 1 error would be in this situation and the consequences for the company.

   A type 1 error is that offering free shipping does not increase the proportion who buy something, but the company thinks it does. They would lose money because they would pay for shipping when it doesn't help sales.

5. Now the company is interested in the mean of the amount spent by customers who do buy something. Historically, the mean has been \$90 with a standard deviation of \$80.

   a. (**3 pts**) Do you think that the amounts spent follow a normal distribution? Why or why not?

      Clearly not. If it did, there would be lots of negative values, which are not possible values for the amount spent. For instance, two standard deviations below the mean is –\$70.

   b. (**4 pts**) The company plans to see if the mean amount spent by the 330 customers who bought something after being offered free shipping is consistent with what customers have historically spent. Describe the sampling distribution of the sample mean for the amount spent by 330 customers of this company if the historical behavior still holds. Include the shape, mean, and standard deviation.

      Shape is approximately normal.
      Mean = population mean = \$90.
      Standard deviation $= s.d.(\bar{x}) = \frac{\sigma}{\sqrt{n}} = \frac{80}{\sqrt{330}} = 4.40$

   c. (**2 pts**) Suppose that the mean amount spent by these 330 customers is \$100. Is that consistent with the historical data? Support your answer numerically.

      The z-score for \$100 is $\frac{100-90}{4.40} = 2.27$*, which is far into the tail (area above 2.27 is .0116), so it is not really consistent with the historical data. It's a bit higher than would be expected.*

MULTIPLE CHOICE (2 points each)
Clearly circle your answer. You will receive no credit if it isn't obvious which answer you have chosen.

1. Which of the following is a legitimate reason for deleting an outlier?
   A. The outlier is more than 3 standard deviations from the mean.
   B. The outlier is clearly a mistake and there is no way to figure out what the value should have been.
   C. Neither A nor B describes a legitimate reason for deleting an outlier.
   D. Both A and B describe a legitimate reason for deleting an outlier.

2. Suppose the mean of the sampling distribution for the difference in means for independent samples is 0. This tells us that:
   A. The two population means are both 0.
   B. The two population means are equal to each other.
   C. The two sample means are both 0.
   D. The two sample means are equal to each other.

3. A poll taken the week before Election Day asked 1000 registered voters whether they planned to vote for Proposition 12, a statewide proposition on the ballot. Exactly 50% of those in the poll said yes. Using the usual notation from class and the textbook, which of these is correct based on this poll?
   A. μ = 50% but $\bar{x}$ is unknown.
   B. μ_d = 50% but $\bar{d}$ is unknown.
   C. p = .50 but $\hat{p}$ is unknown.
   D. $\hat{p}$ = .50 but p is unknown.

4. Which of the following is definitely true for independent events A and B?
   A. P(A and B) = 0
   B. P(A) + P(B) = 1
   C. P(A and B) = P(A)P(B)
   D. P(A or B) = P(A) + P(B)

5. Which of the following is definitely true for mutually exclusive events A and B?
   A. P(A and B) = 0
   B. P(A) + P(B) = 1
   C. P(A and B) = P(A)P(B)
   D. P(A or B) = P(A) + P(B) – P(A)P(B)

6. In the linear relationship between an explanatory (x) variable and response (y) variable, suppose R^2 = .81 (or 81%) and the slope is –4.0. What is the correlation between x and y?
   A. 0.9
   B. –0.9
   C. –2.0
   D. It can't be determined from the information given.

7. Suppose the *p*-value for a hypothesis test is 0.08 and a level of significance of 0.05 is to be used. Which of the following is a valid conclusion for this test?
   A. Accept the null hypothesis
   B. Reject the null hypothesis
   C. Do not reject the null hypothesis
   D. Accept the alternative hypothesis.

8. In an observational study, which of these is true about a confounding variable?
   A. Its affect on the response variable can't be separated from the explanatory variable's affect on the response variable.
   B. It is related to the explanatory variable.
   C. It may affect the response variable.
   D. All of the above are true about confounding variables.

9. When can the results of a study done on a sample be extended to a population?
   A. When the participants were randomly assigned to the treatment conditions.
   B. When the participants are a representative sample from the population for the question of interest.
   C. Only when the study is a randomized experiment.
   D. Only when the study is an observational study.

10. Which of the following is *not* a random variable:
   A. np = the expected value for the number of successes in a binomial experiment.
   B. X = the number of successes in a binomial experiment.
   C. $\hat{p}$ = the proportion of successes in a binomial experiment.
   D. All of the above are random variables.

11. Scores on an IQ test for a population of college students are bell-shaped with a mean of 120 points and a standard deviation of 10 points. If the *z*-score for the IQ of an individual is 2, what is that individual's IQ score?
   A. 122
   B. 140
   C. It could be either 118 or 122, but which one it is cannot be determined from the information given.
   D. It could be either 100 or 140, but which one it is cannot be determined from the information given.

12. Suppose that the regression equation relating x = midterm score and y = final exam score for students who take calculus is $y = 20 + 0.8x$. Which of the following is a valid conclusion based on this equation?
   A. If one student scores 10 points higher than another student on the midterm, then that student will score 8 points higher than the other student on the final.
   B. If a student scores 0 on the midterm, then that student will score 20 on the final.
   C. On average, students' scores on the final will only be 80% of what they were on the midterm.
   D. Students who score 90 on the midterm are predicted to score 92 on the final.

13. Which type of error can be made when the alternative hypothesis is true?
   A. Type 1 error only
   B. Type 2 error only
   C. Type 1 error if the alternative hypothesis is one-sided, and Type 2 error if the alternative hypothesis is two-sided.
   D. Type 1 error if the null hypothesis is not rejected and Type 2 error if the null hypothesis is rejected.

14. Suppose the *p*-value for a one-sided test for a proportion was 0.06. The *p*-value for the corresponding two-sided test would be:
   A. 0.03
   B. 0.06
   C. 0.12
   D. It depends on whether the one-sided test has a "greater than" or a "less than" sign in the alternative hypothesis.

15. Suppose that a 95% confidence interval for the proportion of adult Americans who exercise regularly (at least 4 days a week) is .37 to .43. Which of the following statements is *false*?
    A. It is reasonable to say that more than 35% of adult Americans exercise regularly.
    B. It is reasonable to say that fewer than 45% of adult Americans exercise regularly.
    C. The null hypothesis that 40% of adult Americans exercise regularly can be accepted.
    D. The null hypothesis that 40% of adult Americans exercise regularly cannot be rejected.

16. A test of H_0: $\mu_d = 0$ versus H_a: $\mu_d > 0$ will be conducted using $\alpha = .05$ and a random sample of $n = 45$. The power of the test is only 0.39. Which of the following is the best interpretation of the power of 0.39?
    A. It is the probability that the null hypothesis is true.
    B. It is the probability that the alternative hypothesis is true.
    C. It is the probability that the null hypothesis will be rejected, given that the null hypothesis is true.
    D. It is the probability that the null hypothesis will be rejected, given that the alternative hypothesis is true.

17. A test of H_0: $\mu_d = 0$ versus H_a: $\mu_d > 0$ will be conducted using $\alpha = .05$ and a random sample of $n = 45$. The power of the test is only 0.39. Which of the following will increase the power of the test?
    A. Increase the sample size to be $n = 100$.
    B. Increase the level of significance to be $\alpha = .10$
    C. Both A and B will increase the power.
    D. Neither A nor B will increase the power.

18. Which of the following describes a binomial random variable?
    A. X = number of siblings a randomly selected student in the class has.
    B. X = number of games won by the most talented player in a chess tournament, where the player plays against opponents with differing levels of skill.
    C. X = number of points earned for the quizzes in this class if you are just guessing on each question. (Quizzes have 5 questions worth 2 points each.)
    D. X = number of questions correct for the quizzes in this class if you are just guessing on each question.

19. A test for ESP involves having someone repeatedly try to guess which one of four photographs is the chosen "target," with a different set of photographs used for each trial. Define p to be the probability of a correct guess. Suppose someone guesses 100 times, and gets 30 correct, so $\hat{p} = 0.30$. What is the appropriate null hypothesis in this situation?
    A. $\boldsymbol{H_0: p = .25}$
    B. H_0: $p = .30$
    C. H_0: $\hat{p} = .25$
    D. H_0: $\hat{p} = .30$

20. If the probability of a success in each trial of a binomial experiment is 0.4 and $n = 3$ trials are done, which of the following is the best way to find the probability of at least one success?
    A. Compute a z-score corresponding to $k = 1$, then find the area above z.
    B. Find the probability of no successes, and subtract it from 1.
    C. Find the probability of 1 success, and multiply that by 3.
    D. Find the probability of 3 successes, and subtract it from 1.

21. Which of the following is not a correct way to state an alternative hypothesis?
    A. H_a: $\mu = 0$
    B. H_a: $\mu > 10$
    C. H_a: $\mu < 0$
    D. H_a: $\mu \neq \mu_0$

22. Which of the following is closest to the confidence level if a confidence interval for a mean based on a large sample is found as $\bar{x} \pm \frac{s}{\sqrt{n}}$?
    A. 95%
    B. 90%
    C. 70%
    D. 50%

23. In an example shown in one of the lectures, 10 male volunteers (with an average age of 28 years) drank a fruit-flavored slushie (icee) and measured how long they could exercise in a hot room. In a different week, they drank fruit-flavored cold water, and measured how long they could exercise. The order was randomized. The results showed that drinking the slushie increased the amount of time they could exercise by an average of about 9.5 minutes. This result was statistically significant. Which of the following conclusions can be made based on these results, and why?
    A. A random sample was used so we can conclude that drinking slushies actually causes the endurance time to increase.
    B. Because this was a randomized experiment, we can conclude that drinking slushies actually causes the endurance time to increase.
    C. A random sample was used so we can extend the results from these 10 men to the population of all people who exercise.
    D. Because this was a randomized experiment, we can extend the results from these 10 men to the population of all people who exercise.

24. In hypothesis testing, a statistically significant difference may not have much practical importance. This is most likely to happen when:
    A. the true population difference is small and the sample size is small.
    B. the true population difference is small and the sample size is large.
    C. the true population difference is large and the sample size is small.
    D. the true population difference is large and the sample size is large.

25. Suppose that the highway patrol collects data for a random sample of cars passing a certain spot on a freeway and computes a 95% confidence interval for the mean speed as 65 to 69 miles per hour. An interpretation of this interval is:
    A. 95% of the population of cars passing that spot are going between 65 and 69 miles per hour.
    B. 95% of the sample of cars measured passing that spot were going between 65 and 69 miles per hour.
    C. The highway patrol can be 95% confident that the mean speed for the population of cars passing that spot is between 65 and 69 miles per hour.
    D. The highway patrol can be 95% confident that the mean speed for the sample of cars they measured passing that spot is between 65 and 69 miles per hour.

26. A professor wants to know what proportion of the 50 students in his class are available for an evening review session. He polls everyone in the class and finds that 70% of them are available. What margin of error should be used when presenting the results for this poll?
   A. 14%
   B. 12%
   C. 0% [Note that he measured the whole population, so there is no uncertainty.]
   D. It depends on the sample size.

27. The standard deviation of the sampling distribution of $\bar{x}$ depends on the value(s) of:
   A. The sample size and the population standard deviation.
   B. The sample size but not the population standard deviation
   C. The population standard deviation but not the sample size
   D. Neither the sample size nor the population standard deviation.

Scenario for Questions 28 to 30:
The results of a large observational study were reported as follows: "People who meditate regularly require significantly less sleep than people who do not meditate ($p < .0001$)."

28. Which one of the following headlines is justified based on this result?
   A. Meditation Lowers the Amount of Sleep Needed.
   B. People who Need Less Sleep Have More Time to Meditate.
   C. Link Found Between Meditation and Amount of Sleep Needed.
   D. Meditation Causes People to Sleep Less.

29. Which of the following parameters would the reported result have been based on?
   A. $\boldsymbol{\mu_1 - \mu_1}$
   B. μ_d
   C. $p_1 - p_2$
   D. $\hat{p}_1 - \hat{p}_2$

30. The use of the word "significantly" in this report most likely refers to which of the following:
   A. The fact that people who meditate need much, much less sleep than people who don't.
   B. The fact that the difference between average sleep hours for those who meditate and those who don't was found to be statistically significantly different from 0, with a p-value less than .0001.
   C. The fact that the difference in amount of sleep for those who meditate and those who don't has practical significance.
   D. The fact that it is important to know that meditation can reduce how much sleep people need.