STATISTICS 8, FINAL EXAM

NAME:_____KEY_____ Seat Number: _____

Last six digits of Student ID#: _____ Circle your Discussion Section: 1 2 3 4

Make sure you have 8 pages. You will be provided with a table as well, as a separate page.
You may use four pages of notes (both sides) and a calculator.
Multiple choice questions: There are 32 questions worth 2 points each (32 x 2 pts each = 64 pts). Instructions will be given when those begin on page 4.
Free response questions: Show all work. If you need extra space use the back of the page, but make sure to tell us it's there. Total of 36 points; points for each part of each question are shown.

1. (**1 pt each**) Read the following quote (adapted from one of the medical journal articles for the last discussion), then provide the requested information. "Researchers studied students at high risk of academic failure, and compared students who had participated in a government preschool program with a control group of students who had not. They found that of those who participated in the program, 49.7% finished high school, while for those in the control group only 38.5% completed high school, for a difference of 11.2%. The chance of a difference that extreme or more so in the sample if there is no population difference is .01. Because .01 is less than .05, the researchers concluded that participation in the program would be associated with higher high school completion rates for the population of students similar to the ones in the study."

   a. The notation for the parameter of interest is: $p_1 - p_2$

   b. The notation for the sample statistic is: $\hat{p}_1 - \hat{p}_2$

   c. The *p*-value = ___.01__

   d. The null value = ___0___

   e. The level of significance = ___.05_____

   f. The value of the sample statistic = ____.112____

2. (**6 pts total**) Write the null and alternative hypotheses for each of the following scenarios. Use symbols where possible instead of writing things out in words. You do not need to define the meaning of the symbols in your hypotheses as long as you use standard notation.
   a. (**4 pts**) According to Mendel's basic law of inheritance, under certain conditions the ratio of phenotypes for two traits inherited independently should be 9:3:3:1 (for dominant-dominant, dominant-recessive, recessive-dominant and recessive-recessive). To test whether two specific traits really are inherited independently, a researcher plans to investigate the phenotypes for these two traits for a random sample of 900 people.

      Null hypothesis: $p_1 = \frac{9}{16}, p_2 = \frac{3}{16}, p_3 = \frac{3}{16}, p_4 = \frac{1}{16}$ [*Note: In order to have the desired ratio and sum to 1, this is what the probabilities would need to be.*]

      Alternative hypothesis: *Not all of the probabilities specified in the null hypothesis are correct.*

b. (**2 pts**) Researchers speculate that the average amount of time it takes for young adults to react to drinking caffeine is shorter than the average amount of time it takes for older adults to react to drinking caffeine. To study this question, they plan to recruit volunteers from two age groups and have them drink a highly caffeinated beverage. Group 1 is 18 to 25 years old and Group 2 is 60 to 65 years old. After drinking the beverage the participants will be tested to see how long it takes (in minutes) for them to react to the caffeine. (We will assume the researchers have a test for doing this!)

Null hypothesis: $\mu_1 - \mu_2 = 0$

Alternative hypothesis: $\mu_1 < \mu_2$ or $\mu_1 - \mu_2 < 0$ [*Mean reaction time is lower for the young group*]

3. (**14 pts total**) A new drug is being proposed for the treatment of migraine headaches. Unfortunately some users in early tests of the drug have reported mild nausea as a side effect. The FDA will reject the drug if it thinks that more than 15% (i.e. 0.15) of the population would suffer from this side effect. In an experiment to test this side effect, 400 people who suffer from migraine headaches receive the new drug and 80 of them report nausea as a side effect.

a. (**2 pts**)Define the parameter of interest, giving appropriate notation and writing a sentence saying what it is.

p = proportion of the population of migraine headache sufferers that would have nausea as a side effect if they were to take this drug.

b. Carry out the 5 steps of a hypothesis test to determine if the FDA should reject the drug.

Step 1 (2 pts) *Specify the null and alternative hypotheses*: Use notation, not words.

H_0: $p = .15$ H_a: $p > .15$

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

First, compute $\hat{p} = \frac{80}{400} = .20$. Then $z = \frac{\hat{p} - p_0}{\sqrt{\frac{p_0(1-p_0)}{n}}} = \frac{.20 - .15}{\sqrt{\frac{.15(.85)}{400}}} = \frac{.05}{.01785} = 2.80$.

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

From Table A.1, the area below 2.80 = .9974, so p-value = 1 – .9974 = .0026.

Step 4 (2 pts) *Decide whether the result is statistically significant (i.e. make a conclusion about the hypotheses); use $\alpha = 0.05$*:

You can either say "Reject the null hypothesis" or "The result is statistically significant."

Step 5 (2 pts) *Report the conclusion in context*:

Because the null hypothesis is rejected, we can conclude that more than 15% of the population would experience nausea, and the FDA should reject the drug.

4. (**6 pts total**) A survey of n = 686 college students asked (among other things) how important religion is in the student's life (very important, fairly important, not important), and how many hours they typically study in a week during the regular term. The sample sizes and sample mean study hours were as follows:

Importance of religion	Sample mean (hours)	Sample size
Very	16.01	148
Fairly	12.87	316
Not	11.67	222

a. (**1 pt each**) An analysis of variance table for this situation is as follows. Fill in the missing numbers.

Source	DF	SS	MS	F	P
ReligImp	**2**	1721.4	860.7	**9.77**	0.000
Error	683	60183.6	**88.12**		
Total	685	61905.1			

NOTE: MSError is found as $\frac{60183.6}{683} = 88.12$ *and F is* $\frac{860.7}{88.12} = 9.77$

b. (**3 pts**) Write a sentence stating the conclusion that would be made about importance of religion and mean study hours for the population represented by these students.

The p-value is 0.000 so the null hypothesis is rejected. We can conclude that for the population, the mean study hours for at least one of the 3 religious importance groups differs from the others.

5. (**4 pts**) Suppose the distribution of red blood cell counts for a healthy population is known to have a mean of 5.0 million cells per microliter (cells/mcL) with a standard deviation of 0.4 million cells/mcL. An epidemiologist is concerned that a certain environmental hazard is lowering the count for people in the region. A random sample of 100 people in the region will be taken and the sample mean computed. If there really is no harmful effect, describe what the sampling distribution of the sample mean will be by giving the approximate shape, the mean and the standard deviation (in units of million cells per microliter).

The sampling distribution is approximately normal with mean = 5.0 and standard deviation $= \frac{0.4}{\sqrt{100}} = 0.04$

MULTIPLE CHOICE

- **You have Exam Version A. Write this on your Scantron *on the "SUBJECT" line.***
- **Fill in and bubble your ID at the top of the Scantron.**
- ***Circle* the best answer on this exam paper *and* bubble in the Scantron sheet.**

1. Which of the following is *not* a correct way to state a null hypothesis?
   A. ***H_0:*** $\hat{p}_1 - \hat{p}_2 = 0$ **[The symbols are for sample proportions; hypotheses are about populations.]**
   B. H_0: $\mu_d = 10$
   C. H_0: $\mu_1 - \mu_2 = 0$
   D. H_0: $p = .5$

2. A test to screen for a serious but curable disease is similar to hypothesis testing, with a null hypothesis of no disease, and an alternative hypothesis of disease. If the null hypothesis is rejected treatment will be given. Otherwise, it will not. Assuming the treatment does not have serious side effects, in this scenario it is better to increase the probability of:
   A. ***making a Type 1 error, providing treatment when it is not needed***.
   B. making a Type 1 error, not providing treatment when it is needed.
   C. making a Type 2 error, providing treatment when it is not needed.
   D. making a Type 2 error, not providing treatment when it is needed.

3. Which of the following would be a legitimate reason for removing an outlier from a dataset?
   A. The outlier is the result of natural variability in the measurement of interest.
   B. The outlier clearly belongs to a different population.
   C. The outlier is more than two standard deviations from the mean.
   D. The outlier is the only negative number in the dataset.

4. Which of the following null hypotheses would be tested using a chi-square goodness-of-fit test?
   A. There is no relationship between frequent cell phone use (yes, no) and brain cancer (yes, no).
   B. There is no relationship between age and opinion on gun control.
   C. The probabilities that a family with two children will have 2 boys, 1 boy and 1 girl, and 2 girls are ¼, ½ and ¼, respectively.
   D. The probability that a randomly selected person age 50 of older has arthritis is .3.

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

6. When a random sample is to be taken from a population and a statistic is to be computed, the statistic can also be thought of as
   A. A point estimate
   B. A random variable
   C. Both of the above
   D. None of the above

7. Past data has shown that the regression line relating the final exam score and the midterm exam score for students who take statistics from a certain professor is: final exam = 50 + (0.5)(midterm). An interpretation of the slope is:
   A. A student who scored 0 on the midterm would be predicted to score 50 on the final exam.
   B. A student who scored 2 points higher than another student on the midterm would be predicted to score 1 point higher than the other student on the final exam.
   C. A student who scored 100 on the midterm would be predicted to score 100 on the final exam.
   D. None of the above are an interpretation of the slope.

8. If the role of the explanatory (x) variable and the response (y) variable are switched in a regression and correlation situation, which of the following would stay the same?
   A. The slope of the regression line.
   B. The intercept of the regression line.
   C. The correlation between the two variables.
   D. None of the above would stay the same.

9. If two events are mutually exclusive and both have probability > 0, then
   A. They must also be independent.
   B. They cannot also be independent.
   C. They must also be complements.
   D. They cannot also be complements.

10. For a sample of 400 blood pressure values, the mean is 120 and the standard deviation is 10. Assuming a bell-shaped curve, which interval is likely to contain almost all (over 99%) of the blood pressure values in the sample?
   A. 119 to 121
   B. 110 to 130
   C. 100 to 140
   D. 90 to 150

11. Based on the National Household Survey on Drug Abuse, the percentage of 17-year olds who ever tried cigarette smoking is 56.2%. The relative risk of ever having tried smoking for a 17-year old versus a 12-year old is 3.6. What is the risk of smoking for a 12-year-old (i.e. what was the percentage of 12-year olds who ever tried smoking)?
   A. 14.1%
   B. 15.6%
   C. 52.6%
   D. 56.2%

12. In a newspaper article about whether the regular use of Vitamin C reduces the risk of getting a cold, a researcher is quoted as saying that Vitamin C performed better than placebo in an experiment, but the difference was not larger than what could be explained by chance. In statistical terms, the researcher is saying the results are ____.
   A. due to non-sampling errors.
   B. definitely due to chance.
   C. statistically significant.
   D. not statistically significant.

13. A medical treatment has a success rate of .8. Two patients will be treated with this treatment. Assuming the results are independent for the two patients, what is the probability that neither one of them will be successfully cured?
    A. ***.04***
    B. .20
    C. .36
    D. .64

14. Suppose that for X = net amount won or lost in a lottery game, the expected value is E(X) = –$0.50. What is the correct interpretation of this value?
    A. The most likely outcome of a single play is a net loss of 50 cents.
    B. A player will have a net loss of 50 cents every single time he or she plays this lottery game.
    C. Over a large number of plays the average outcome for plays is a net loss of 50 cents.
    D. A mistake must have been made because it's impossible for an expected value to be negative

15. Pulse rates of adult men are approximately normal with a mean of 70 and a standard deviation of 8. Which choice correctly describes how to find the proportion of men that have a pulse rate greater than 78?
    A. Find the area to the left of z = 1 under a standard normal curve.
    B. Find the area between z = –1 and z = 1 under a standard normal curve.
    C. Find the area to the right of z = 1 under a standard normal curve.
    D. Find the area to the right of z = –1 under a standard normal curve.

16. Which one of the following probabilities is a "cumulative" probability?
    A. The probability that there are exactly 4 people with Type O+ blood in a sample of 10 people.
    B. The probability of exactly 3 heads in 6 flips of a coin.
    C. The probability that the annual rainfall in a certain city next year will be 18 inches.
    D. The probability that a randomly selected woman's height is 67 inches or less.

17. Suppose a 95% confidence interval for the proportion of Americans who exercise regularly is 0.29 to 0.37. Which one of the following statements is FALSE?
    A. It is reasonable to say that more than 40% of Americans exercise regularly.
    B. It is reasonable to say that more than 25% of Americans exercise regularly.
    C. The hypothesis that 33% of Americans exercise regularly cannot be rejected.
    D. It is reasonable to say that fewer than 40% of Americans exercise regularly.

18. Null and alternative hypotheses can be statements about which of the following?
    A. population parameters.
    B. sample estimates.
    C. sample statistics.
    D. it depends - sometimes population parameters and sometimes sample statistics.

19. A test of H_0: $\mu = 0$ versus Ha: $\mu > 0$ is conducted on the same population independently by two different researchers. They both use the same sample size and the same value of $\alpha = 0.05$. Which of the following will be the same for both researchers?
    A. The *p*-value of the test.
    B. The power of the test if the true $\mu = 6$.
    C. The value of the test statistic.
    D. The decision about whether or not to reject the null hypothesis.

20. Consider a random sample of 100 females and 100 males. Suppose 15 of the females are left-handed and 12 of the males are left-handed. What is the estimated difference between population proportions of females and males who are left-handed (females – males)? Select the choice with the correct notation and numerical value.
    A. $p_1 - p_2 = 3$
    B. $p_1 - p_2 = 0.03$
    C. $\hat{p}_1 - \hat{p}_2 = 3$
    D. $\hat{p}_1 - \hat{p}_2$ ***= 0.03***

21. The *confidence leve*l for a confidence interval for a mean is
    A. the probability of making a Type 1 error if the interval is used to test a null hypothesis about the population mean.
    B. the probability that individuals in the population have values that fall into the interval.
    C. the probability that the procedure provides an interval that covers the sample mean.
    D. the probability that the procedure provides an interval that covers the population mean.

22. A result is called "statistically significant" whenever
    A. The null hypothesis is true.
    B. The alternative hypothesis is true.
    C. The p-value is less than or equal to the significance level.
    D. The p-value is larger than the significance level.

23. A test for a disease has sensitivity of 0.9. If 50 people who have the disease are independently tested, the number who have a positive test result will be:
    A. a binomial random variable.
    B. 90% of those tested.
    C. 45 people
    D. 5 people

24. A random variable cannot be both normal and
    A. continuous
    B. uniform
    C. symmetric
    D. have mean of 100

25. Which of the following would NOT be a problem in a sample survey?
    A. Placebo effect.
    B. Asking the uninformed.
    C. Ordering of the questions.
    D. Unnecessary complexity of the questions.

26. Which of the following is true about the standard deviation of $\bar{x}$?
    A. it increases as *n* increases
    B. it decreases as n increases
    C. it stays the same as *n* increases
    D. it is an estimate of the standard error of $\bar{x}$

27. Which of the following does *not* have a sampling distribution?
    A. Sample proportion $\hat{p}$
    B. Sample mean $\bar{x}$
    C. The point estimate for the population proportion
    D. Population proportion p

28. The mean of the sampling distribution of $\bar{x}_1 - \bar{x}_2$ is:
    A. always 0
    B. always positive
    C. always negative
    D. always $\mu_1 - \mu_2$

29. The *p*-value for a one-sided test for a proportion was 0.04. If the test had been two-sided instead, the *p*-value would be:
    A. .02
    B. .04
    C. .08
    D. it depends on whether the one-sided test had a "greater than" or a "less than" alternative.

30. The level of significance (usually .05) associated with a significance test is the probability
    A. that the alternative hypothesis is true.
    B. that the null hypothesis is true.
    C. of not rejecting a true null hypothesis.
    D. of rejecting a true null hypothesis.

31. Analysis of variance is used to test:
    A. Whether *k* population variances are all equal.
    B. Whether *k* population standard deviations are all equal.
    C. Whether k population means are all equal.
    D. Whether *k* sample means are all equal.

32. A study compared people who routinely drink at least one sugary (i.e. not diet sugar-free) soda a day with people who do not drink soda and found that the relative risk of obesity for the two groups was 2.0, with higher risk for those who drink the soda. From this we can conclude that:
    A. Drinking sugary soda causes people to be twice as likely to be obese.
    B. Drinking sugary soda causes people to weigh more than they would otherwise.
    C. Avoiding drinking sugary soda causes people to lose weight.
    D. We cannot say anything about how drinking sugary soda affects weight.

For use by graders: Page 1: _____ out of 10

Page 2: _____ out of 16

Page 3: _____ out of 10

Free response score:_____

Multiple choice score:_____

Total score: _____