Practice Multiple Choice

1. One effect of the pesticide DDT upon birds is to inhibit the production of the enzyme carbonic anhydrase, which controls calcium metabolism. It is believed that this causes eggshells to be thinner and weaker than normal and makes the eggs more prone to breakage. An experiment was conducted where 16 sparrow hawks were fed a mixture of 3 ppm dieldrin and 15 ppm DDT (a combination often found in contaminated prey). The first egg laid by each bird was measured, and the mean shell thickness was found to be 0.19 mm. A "normal" eggshell has a mean thickness of 0.2 mm. The null and alternative hypotheses are

A. $H_0: \mu = 0.2; H_a: \mu < 0.2$ B. $H_0: \mu < 0.2; H_a: \mu = 0.2$ C. $H_0: \bar{x} = 0.2; H_a: \bar{x} < 0.2$

D. $H_0: \bar{x} = 0.19; H_a: \bar{x} = 0.2$ E. $H_0: \mu = 0.2; H_a: \mu \neq 0.2$

2. To determine if having children within the first two years of marriage *increases* the divorce rate, where p = proportion of marriages that end in divorce, we should test the hypotheses

A. $H_0: \hat{p} = 0.5; H_a: \hat{p} \neq 0.5$ B. $H_0: \hat{p} = 0.5; H_a: \hat{p} > 0.5$ C. $H_0: p > 0.5; H_a: p = 0.5$

D. $H_0: p = 0.5; H_a: p < 0.5$ E. $H_0: p = 0.5; H_a: p > 0.5$

3. In tests of significance about an unknown parameter of some population, which of the following is considered strong evidence against the null hypothesis?

A. The value of an estimate of the unknown parameter based on a simple random sample from the population is not equal to zero.
B. The value of an estimate of the unknown parameter lies within 2 units of the sample value.
C. We observe a value of an estimate of the unknown parameter based on a simple random sample from the population that is very consistent with the null hypothesis.
D. We observe a value of an estimate of the unknown parameter based on a simple random sample from the population that is very unlikely to occur if the null hypothesis is true.
E. The value of an estimate of the unknown parameter based on a simple random sample from the population is equal to zero.

4. A university administrator obtains a sample of the academic records of past and present scholarship athletes at the university. The administrator reports that no significant difference was found in the mean GPA (grade point average) for male and female scholarship athletes ($P = 0.287$). This means that

A. the GPAs for male and female scholarship athletes are identical, except for 28.7% of the athletes.
B. the maximum difference in GPAs between male and female scholarship athletes is 0.287.
C. the chance of obtaining a difference in GPAs between male and female scholarship athletes as large as that observed in the sample, if there is no difference in mean GPAs, is 0.287.
D. the chance that a pair of randomly chosen male and female scholarship athletes would have a significant difference in GPAs is 0.287.
E. the probability that female athletes have higher GPAs than males do is 0.287.

5. A researcher plans to conduct a test of hypotheses at the $\alpha = 0.01$ significance level. She designs her study to have a power of 0.90 at a particular alternative value of the parameter of interest. The probability that the researcher will commit a Type I error is

A. 0.01. B. 0.10. C. 0.89. D. 0.90.
E. equal to the *P*-value and cannot be determined until the data have been collected.

6. In testing hypotheses, if the consequences of incorrectly rejecting the null hypothesis are very serious, we should

A. use a very large level of significance.
B. use a very small level of significance.
C. insist that the *P*-value be smaller than the level of significance.
D. insist that the level of significance be smaller than the *P*-value.
E. consult with an expert in the field you're studying for an interpretation of the *P*-value index.

7. The power of a statistical test of hypotheses is

A. the smallest significance level at which the data will allow you to reject the null hypothesis.
B. equal to 1 - (*P*-value).
C. the probability that the test will reject both one-sided and two-sided hypotheses.
D. the probability that a significance test will reject the null hypothesis when a particular alternative value of the parameter is true.
E. equal to 1 - *P* (Type I error).

8. An advertiser wishes to see if a new advertisement is effective in promoting an existing product. The previous advertisement has a recognition score of 3.7. An SRS of 12 potential buyers resulted in a mean recognition score of 3.4 with a standard deviation of 1.7. Which of the following required conditions for conducting a *t*-test for a mean has not been met?

A. The population is at least 10 times the sample size.
B. The data are taken from a simple random sample.
C. The population is Normally distributed or *n* is large.
D. The decision of each buyer is independent.
E. All of the required conditions are met.

A December 2007 Gallup Poll reported that 43% of Americans use the internet for an hour or more each day. You suspect that a higher proportion of students at your school use the internet that much. To find out, you take a simple random sample of 60 students and find that 35 of them use the internet for an hour or more each day. (Assume your school has enough students so that this is a small sample relative to the size of the population). You will test the hypotheses $H_0 : p = 0.43;\ H_a : p > 0.43$, where p = the proportion of students at your school who use the internet for an hour or more each day, at the $\alpha = 0.01$ level.

9. Which of the following best describes the sampling distribution of proportions for this test?

A. Mean = 0.583; Standard deviation = 0.064; shape approximately Normal
B. Mean = 0.583; Standard deviation = 0.064; shape unknown
C. Mean = 0.5; Standard deviation = 0.064; shape approximately Normal
D. Mean = 0.43; Standard deviation = 0.064; shape approximately Normal
E. Mean = 0.43; Standard deviation = 0.064; shape unknown

10. The test statistic, P-value, and appropriate decision for this test are:

A. $z = 2.40$; P-value = 0.008; reject H_o
B. $z = 2.40$; P-value = 0.008; fail to reject H_o
C. $t = 2.40$; P-value = 0.0103; reject H_o
D. $t = 2.40$; P-value = 0.0103; fail to reject H_o
E. no conclusion can be drawn, because the shape of the sampling distribution is unknown.

11. You are thinking of using a *t* procedure to test hypotheses about the mean of a population using a significance level of 0.05. You suspect that the distribution of the population is not normal and may be moderately skewed. Which of the following statements is correct?

A. You should not use the *t* procedure because the population does not have a normal distribution.
B. You may use the *t* procedure provided your sample size is at least thirty.
C. You may use the *t* procedure, but you should probably claim only that the significance level is 0.10.
D. You may not use the *t* procedure. *t* procedures are robust to nonnormality for confidence intervals but not for tests of hypotheses.
E. You may use the *t* procedure provided that there are no outliers.

12. The most important condition for sound conclusions from statistical inference is usually

A. that the population standard deviation is known.
B. that at least 30 people are included in the study.
C. that the data can be thought of as a random sample from the population of interest.
D. that the population distribution is exactly Normal.
E. that no calculation errors are made in the confidence interval or test statistic.

13. You construct a 95% confidence interval for a mean and find it to be 1.1 ± 0.8. Which of the following is true?

A. A test of the hypotheses H_0: $\mu = 1.2$, H_a: $\mu \neq 1.2$ would reject H_0 at the 0.05 level.
B. A test of the hypotheses H_0: $\mu = 1.1$, H_a: $\mu \neq 1.1$ would reject H_0 at the 0.05 level.
C. A test of the hypotheses H_0: $\mu = 0$, H_a: $\mu \neq 0$ would reject H_0 at the 0.05 level.
D. All three tests above would reject H_0 at the 0.05 level.
E. A test of hypothesis cannot be performed from only a confidence interval.

14. A student's AP statistics project involves comparing the time it takes a student to complete a set of 25 basic trinomial factoring problems while listening to either rap music or country music. Twelve students are timed on two different sets of problems and the order of both which set of problems he does first and which music he listens to first are randomized. The resulting data is thus paired, with each student acting as his own "pair." Which of the following conditions is required to perform a *t*-test on these paired data?

A. The distribution of times for all students on each set of problems must be approximately Normal.
B. The distribution of times for all students while listening to each type of music must be approximately Normal.
C. The distribution of times for all 24 sets of problems (12 students are taking 2 tests each) must be approximately Normal.
D. The distribution of differences between each individual student's times on each of the two tests (time with rap – time with country) must be approximately Normal.
E. More than one of the four conditions above must be satisfied.

15. An engineer designs an improved light bulb. The previous design had an average lifetime of 1200 hours. The new bulb had a lifetime of 1201 hours, using a sample of 2000 bulbs. Although the difference is quite small, the effect was statistically significant. The explanation is that

A. new designs typically have more variability than standard designs.
B. the sample size is very large.
C. the mean of 1200 is large.
D. the new bulbs last longer than the old bulb.
E. all of the above.

16. Here's a quote from a medical journal: "An uncontrolled experiment in 17 women found a significantly improved mean clinical symptom score after treatment. Methodologic flaws make it difficult to interpret the results of this study." The authors of this paper are skeptical about the significant improvement because

A. there is no control group, so the improvement might be due to the placebo effect or to the fact that many medical conditions improve over time.
B. the P-value given was $P = 0.03$, which is too large to be convincing.
C. the response variable might not have an exactly Normal distribution in the population.
D. the study didn't use enough subjects to achieve any statistically significant findings.
E. the mean is not resistant.

17. A medical researcher wishes to investigate the effectiveness of exercise versus diet in losing weight. Two groups of 25 overweight adult subjects are used, with a subject in each group matched to a similar subject in the other group on the basis of a number of physiological variables. One of the groups is placed on a regular program of vigorous exercise but with no restriction on diet, and the other is placed on a strict diet but with no requirement to exercise. The weight losses after 20 weeks are determined for each subject, and the difference between matched pairs of subjects (weight loss of subject in exercise group − weight loss of matched subject in diet group) is computed. The mean of these differences in weight loss is found to be − 2 lb with standard deviation $s = 4$ lb. Is this evidence of a difference in mean weight loss for the two methods? To answer this question, you should use

A. one-proportion z test.
B. one-sample t test.
C. one-proportion z interval.
D. one-sample t interval.
E. none of the above.

18. You have two large bins of marbles. In bin A, 40% of the marbles are red. In bin B, 52% of the marbles are red. You select a simple random sample of 30 marbles from bin A and 40 marbles from bin B. What is the probability that the proportion of red marbles in the sample from bin A is greater than the proportion of red marbles from bin B?

A. nearly zero
B. 0.0010
C. 0.1190
D. 0.1357
E. 0.1562

19. According to recent polls, 24% of people in the United States answered Yes to the question, "Did you smoke any form of tobacco yesterday?" In the European Union, 28% of people answered yes to a similar question. Let's assume these are population parameters for the two populations. If you select a simple random sample of 40 people in the U.S. and 50 people in the E.U., which of the following expressions represents the standard deviation of the sampling distribution for the difference in the proportion of smokers in the two groups?

A. $\sqrt{\frac{(0.26)(0.74)}{90}}$
B. $\sqrt{\frac{(0.24)(0.76)}{40}} + \sqrt{\frac{(0.28)(0.72)}{50}}$
C. $\sqrt{\frac{(0.24)(0.76)}{40} + \frac{(0.28)(0.72)}{50}}$
D. $\sqrt{\frac{(0.24)(0.76)+(0.28)(0.72)}{90}}$
E. $\sqrt{\left(\frac{(0.24)(0.76)}{40}\right)^2 + \left(\frac{(0.28)(0.72)}{50}\right)^2}$

20. At a large state university, the heights of male students who are interscholastic athletes is approximately Normally distributed with a mean of 74.3 inches and a standard deviation of 3.5 inches. The heights of male students who don't play interscholastic sports (we'll call them "non-interscholastics") is approximately Normally distributed with a mean of 70.3 inches and a standard deviation of 3.2 inches. You select an SRS of 10 interscholastic athletes and 12 non-interscholastics. What is the probability that the sample mean of non-interscholastics is greater than the sample mean of interscholastic athletes?

A. nearly 0
B. 0.0027
C. 0.0035
D. 0.9965
E. 0.9973

In a large Midwestern university (with the class of entering freshmen being on the order of 6000 or more students), an SRS of 100 entering freshmen in 1993 found that 20 finished in the bottom third of their high school class. Admission standards at the university were tightened in 1995. In 1997, an SRS of 100 entering freshmen found that 10 finished in the bottom third of their high school class. Let p_1 be the proportion of all entering freshmen in 1993 who graduated in the bottom third of their high school class, and let p_2 be the proportion of all entering freshmen in 1997 who graduated in the bottom third of their high school class.

21. Which of the following represents 99% confidence interval for $p_1 - p_2$?

A. $(0.2-0.1) \pm 1.96\sqrt{\frac{(0.2)(0.8)}{100} + \frac{(0.1)(0.9)}{100}}$
B. $(0.2-0.1) \pm 1.96\sqrt{\frac{(0.2)(0.8)}{100} - \frac{(0.1)(0.9)}{100}}$

C. $(0.2-0.1)\pm 1.96\sqrt{\frac{(0.15)(0.85)}{100}+\frac{(0.15)(0.85)}{100}}$ D. $(0.2-0.1)\pm 2.576\sqrt{\frac{(0.2)(0.8)}{100}+\frac{(0.1)(0.9)}{100}}$

E. $(0.2-0.1)\pm 2.576\sqrt{\frac{(0.15)(0.85)}{100}+\frac{(0.15)(0.85)}{100}}$

22. Is there evidence that the proportion of freshmen who graduated in the bottom third of their high school class in 1997 has been reduced as a result of the tougher admission standards adopted in 1995, compared to the proportion in 1993? To determine this, you test the hypotheses H_0: $p_1 = p_2$, H_a: $p_1 > p_2$ at the $\alpha = 0.05$ level. You calculate a test statistic of 1.980. Which of the following is the appropriate P-value and conclusion for your test?

A. *P*-value = 0.047; fail to reject H_0; we do not have evidence that the proportion who graduated in the bottom third of their class has been reduced.

B. *P*-value = 0.047; accept H_a; there is evidence that the proportion who graduated in the bottom third of their class has been reduced.

C. *P*-value = 0.024; fail to reject H_0; we do not have evidence that the proportion who graduated in the bottom third of their class has been reduced.

D. *P*-value = 0.024; reject H_0; we have evidence that the proportion who graduated in the bottom third of their class has been reduced.

E. *P*-value = 0.024; fail to reject H_0; we have evidence that the proportion who graduated in the bottom third of their class has not changed.

An SRS of 45 male employees at a large company found that 36 felt that the company was supportive of female and minority employees. An independent SRS of 40 female employees found that 24 felt that the company was supportive of female and minority employees. Let p_1 represent the proportion of all male employees members at the company and p_2 represent the proportion of all female employees members at the company who hold this opinion. We wish to test the hypotheses $H_0: p_1 - p_2 = 0$ *vs.* $H_0: p_1 - p_2 > 0$

23. Which of the following is the correct expression for the test statistic?

A. $\frac{0.8-0.6}{\sqrt{\frac{(0.8)(0.2)}{45}+\frac{(0.6)(0.4)}{40}}}$ B. $\frac{0.8-0.6}{\sqrt{\frac{(0.706)(0.294)}{45}+\frac{(0.706)(0.294)}{40}}}$ C. $\frac{0.8-0.6}{\sqrt{\frac{(0.706)(0.294)}{45}-\frac{(0.706)(0.294)}{40}}}$

D. $\frac{0.8-0.6}{\frac{(0.8)(0.2)}{\sqrt{45}}+\frac{(0.6)(0.4)}{\sqrt{40}}}$ E. $\frac{0.8}{\frac{(0.8)(0.2)}{\sqrt{45}}}+\frac{0.6}{\frac{(0.6)(0.4)}{\sqrt{40}}}$

24. The *P*-value for this test is 0.0217. Which of the following is a correct conclusion?

A. Reject H_0 at $\alpha = 0.01$: we have evidence that the proportion of male employees who feel that the company is supportive of women and minority employees is higher than the proportion of women who feel this way.

B. Reject H_0 at $\alpha = 0.01$: we do not have evidence that the proportion of male employees who feel that the company is supportive of women and minority employees is higher than the proportion of women who feel this way.

C. Accept H_0 at $\alpha = 0.01$: we do not have evidence that the proportion of male employees who feel that the company is supportive of women and minority employees is higher than the proportion of women who feel this way.

D. Accept H_a at $\alpha = 0.01$: we do not have evidence that the proportion of male employees who feel that the company is supportive of women and minority employees is higher than the proportion of women who feel this way.

E. Fail to reject H_0 at $\alpha = 0.01$: we do not have evidence that the proportion of male employees who feel that the company is supportive of women and minority employees is higher than the proportion of women who feel this way.

25. Some researchers have conjectured that stem-pitting disease in peach tree seedlings might be controlled with weed and soil treatment. An experiment was conducted to compare peach tree seedling growth with soil and weeds treated with one of two herbicides. In a field containing 20 seedlings, 10 were randomly selected from throughout the field and assigned to receive Herbicide A. The remaining 10 seedlings were to receive Herbicide B. Soil and weeds for each seedling were treated with the appropriate herbicide, and at the end of the study period, the height (in centimeters) was recorded for each seedling. A box plot of each data set showed no indication of non-Normality. The following results were obtained:

	$\bar{x}$ (cm)	*S* (cm)
Herbicide A	94.5	10
Herbicide B	109.1	9

A 95% confidence interval for $\mu_B - \mu_A$ is given by which of the following expressions? (Use the conservative value for degrees of freedom.)

A. $(109.1-94.5)\pm\sqrt{\frac{10^2}{10}+\frac{9^2}{10}}$ B. $(109.1-94.5)\pm 1.96\sqrt{\frac{10^2}{10}+\frac{9^2}{10}}$ C. $(109.1-94.5)\pm 2.262\sqrt{\frac{10^2}{10}+\frac{9^2}{10}}$

D. $(109.1-94.5)\pm 1.96\sqrt{\frac{10^2}{9}+\frac{9^2}{9}}$ E. $(109.1-94.5)\pm 2.262\sqrt{\frac{10^2}{9}+\frac{9^2}{9}}$

A researcher wishes to compare the effect of two stepping heights (low and high) on heart rate in a step-aerobics workout. He randomly assigns 50 adult volunteers to two groups of 25 subjects each. Group 1 does a standard step-aerobics workout at the low height. The mean heart rate at the end of the workout for the subjects in group 1 was $\bar{x}_1 = 90.0$ beats per minute with a standard deviation of $s_1 = 9.0$ beats per minute. Group 2 did the same workout but at the high step height. The mean heart rate at the end of the workout for the subjects in group 2 was $\bar{x}_2 = 95.2$ beats per minute with a standard deviation of $s_2 = 12.3$ beats per minute. Assume the two groups are independent and both data sets are approximately Normal. Let μ_1 and μ_2 represent the mean heart rates we would observe for the entire population represented by the volunteers if all members of this population did the workout using the low or high step height, respectively.

26. Which of the following is a 98% confidence interval for $\mu_2 - \mu_1$ (using the conservative value for the degrees of freedom)?

A. $(2.15, 8.25)$ B. $(-0.77, 11.17)$ C. $(-1.90, 12.30)$ D. $(-2.40, 12.80)$ E. $(-4.09, 14.49)$

27. Which of the following is a correct interpretation of this interval?

A. 98% of the time, the true difference in the mean heart rate of subjects in the high-step *vs*. low-step groups will be in this interval.

B. We are 98% confident that this interval captures the true difference in mean heart rate of subjects in the high-step *vs*. low-step groups.

C. There is a 0.98 probability that the true difference in mean heart rate of subjects in the high-step *vs*. low-step groups in this interval.

D. 98% of the intervals construction this way will contain the value 0.

E. There is a 98% probability that we have <u>not</u> made a Type I error.

28. The researcher decides to test the hypotheses $H_0: \mu_2 - \mu_1 = 0$ *vs.* $H_a: \mu_2 - \mu_1 > 0$ at the $\alpha = 0.05$ level and produces a *P*-value of 0.0475. Which of the following is a correct interpretation of this result?

A. The probability that the difference $\mu_2 - \mu_1 = 0$ is 0.0475.

B. The probability that this test resulted in a Type II error is 0.0475.

C. If this test were repeated many times, we would make a Type I error 4.75% of the time.

D. If the null hypothesis is true, the probability of getting a difference in sample means as far or farther from 0 as the difference in our samples is 0.0475.

E. If the null hypothesis is false, the probability of getting a difference in sample means as far or farther from 0 as the difference in our samples is 0.0475.

29. An experiment to test the effectiveness of regular treatments with fluoride varnish to reduce tooth decay involved 36 volunteers who had half of their teeth—the right side or left side, determined by a coin flip—painted with a fluoride varnish every six month for 5 years. At the end of the treatments, the number of new cavities during the treatment period was compared on treatment (fluoride varnish) side *versus* the control (no fluoride varnish) side. The appropriate statistical test for analyzing the results of this experiment is

A. One-sample *z*-test of proportions. B. Two-sample *z*-test for difference of proportions.

C. One-sample *t*-test on paired data. D. Two-sample *t*-test for difference of means.

E. Two-sample *z*-test for difference of means.

30. Does listening to music increase the speed at which people complete routine tasks? Fifteen volunteers are asked to sort 100 red and white beads into two piles according to color, once while listening to Handel's *Water Music* and once in silence (the order—music or silence first—is determined for each subject by the flip of a coin). Here are the data (times are in seconds), along with summary statistics in the last two columns:

	Subject																
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	$\bar{x}$	***s***
Handel	14	15	17	21	13	18	21	24	15	25	22	30	13	15	16	18.6	5.04
Silence	16	18	17	20	15	17	22	27	14	22	20	32	15	13	17	19.0	5.13
Difference	2	3	0	–1	2	–1	1	3	–1	–3	–2	2	2	–2	1	0.4	1.96

We wish to test the hypothesis that the mean difference in time to sort the beads with and without music is 0. Which of the following is the appropriate test statistic?

A. $\frac{19.0-18.6}{\sqrt{\frac{5.04^2}{15}+\frac{5.13^2}{15}}}$ B. $\frac{19.0-18.6}{\sqrt{\frac{5.04^2}{14}+\frac{5.13^2}{14}}}$ C. $\frac{19.0-18.6}{\frac{5.04}{\sqrt{15}}+\frac{5.13}{\sqrt{15}}}$ D. $\frac{0.4}{\frac{1.96}{\sqrt{30}}}$ E. $\frac{0.4}{\frac{1.96}{\sqrt{15}}}$

31. With a sample size 18 and t = -3.56, should the null hypothesis be rejected in a two-sided test for a mean?

a) yes if alpha is 0.05 and yes if alpha is 0.01.
b) yes if alpha is 0.05, but no if alpha is 0.01
c) no of alpha is 0.05, but yes if alpha is 0.01
d) no if alpha is 0.05 and 0.01
e) never, because t is negative.

32. A radio talk show host with a large audience is interested in the proportion *p* of adults in his listening area who think the drinking age should be lowered to eighteen. To find this out he poses the following question to his listeners. "Do you think that the drinking age should be reduced to eighteen in light of the fact that eighteen-year-olds are eligible for military service?" He asks listeners to phone in and vote "yes" if they agree the drinking age should be lowered and "no" if not. Of the 100 people who phoned in 70 answered "yes." Which of the following conditions for inference about a proportion using a confidence interval are violated?

(a) The data are an SRS from the population of interest.
(b) The population is at least ten times as large as the sample.
(c) *n* is so large that both the count of successes n p and the count of failures $n(1-p)$ are ten or more.
(d) There appear to be no violations.
(e) More than one condition is violated.

33. Some scientists believe that a new drug would benefit about half of all people with a certain blood disorder. To estimate the proportion of patients who would benefit from taking the drug, the scientists will administer it to a random sample of patients who have the blood disorder. What sample size is needed so that the 95% confidence interval will have a *width* of 0.06?

(a) 748 (b) 1,068 (c) 1,503 (d) 2,056 (e) 2,401

34. Scotland recently imposed a ban on smoking in bars. Before the ban, a researcher thought that the respiratory health of bar employees should improve after working in smoke-free air. Before the ban went into effect, he scored the respiratory health of a random sample of Scottish employees. Two months after the ban, he obtained an independent random sample of bar employees and scored their respiratory health. The increase in the mean scores was statistically significant. (*p*-value = 0.049). Which of the following is the best interpretation of this result?

(a) Only 4.9% of bar employees had their scores drop while the other 95.1% had their scores increase.
(b) The probability is only 0.049 that the mean score for all bar employees increased from before the ban to after the ban.
(c) The mean score for all employees increased by more than 4.9%.
(d) There is a 4.9% chance that the mean score of all bar employees after the ban is actually lower than before the ban, despite the increase observed in the samples.
(e) An observed difference in sample means as large as or larger than that in this sample is unlikely to occur if the mean score for all bar employees before the ban is equal to the mean after the ban.