Name: _____

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AP Statistics — Practice Exam

Instructions: A graphing calculator and the AP Statistics formula sheet and tables may be used. 20 multiple-choice questions (four answer choices each, 1 point each) followed by one free-response question (10 points), 40 minutes in total. Wrong multiple-choice answers are not penalized. On the free-response question, show your work: define the parameters, name the procedure, check its conditions with numbers from the question, and give conclusions in the context of the question. Give p-values to three decimal places.

Time Limit: 40 minutes

Multiple Choice (20 questions)

[1 point] 1. Using software, a statistics class drew 1,000 random samples of 60 households each from a large town in which the proportion of households that own a cat is $p = 0.30$. From each sample the class calculated three different statistics, I, II and III, each intended as an estimator of p. The table shows the mean and the standard deviation of the 1,000 values of each statistic. Which statement is best supported by the simulation?

Statistic	Mean of the 1,000 values	Standard deviation of the 1,000 values
I	0.300	0.059
II	0.242	0.041
III	0.301	0.083

A. Statistic II appears to be the best estimator of p, because its values vary the least from sample to sample, so its estimates tend to be closest to p

B. All three statistics appear to be unbiased estimators of p, because each one was calculated from a random sample of the town's households

C. Statistic III appears to be the best estimator of p, because its larger spread makes its values more likely to reach the true value of p

D. Statistics I and III both appear to be unbiased, and Statistic I is the better estimator of p because its values vary less from sample to sample

[1 point] 2. In a large region, 20 percent of all households have rooftop solar panels. A random sample of 100 households from the region is selected, and $\hat{p}$ is the proportion of the sampled households that have rooftop solar panels. Using a Normal approximation to the sampling distribution of $\hat{p}$, which of the following is closest to the probability that $\hat{p}$ is greater than 0.26?

A. 0.067
B. 0.086
C. 0.440
D. 0.933

[1 point] 3. At a large orchard, 6 percent of the apples have a blemish that makes them unsuitable for sale. An inspector selects a random sample of 50 apples from a harvest of many thousands of apples, and $\hat{p}$ is the proportion of blemished apples in the sample. Which of the following best describes the sampling distribution of $\hat{p}$?

A. Skewed to the right with mean 0.06 and standard deviation 0.034, because the expected number of blemished apples is less than 10
B. Approximately Normal with mean 0.06 and standard deviation 0.0011, because the 50 apples are less than 10 percent of the whole harvest
C. Approximately Normal with mean 0.06 and standard deviation 0.0011, because the sample size of 50 apples is at least 30
D. Skewed to the right with mean 3 and standard deviation 1.679, because the expected number of blemished apples is less than 10

[1 point] 4. An internet provider surveyed a random sample of 400 of its many thousands of customers, and 248 of them reported at least one service outage in the past month. Which of the following is a 95 percent confidence interval for the proportion of all the provider's customers who had at least one outage in the past month?

A. $(0.557,\ 0.683)$
B. $(0.572,\ 0.668)$
C. $(0.580,\ 0.660)$
D. $(0.596,\ 0.644)$

[1 point] 5. A state wildlife agency plans to survey a random sample of licensed anglers to estimate the proportion of all licensed anglers in the state who released at least one fish last season. The agency wants a 95 percent confidence interval with a margin of error of no more than 0.04, and it has no earlier estimate of the proportion. What is the smallest sample size that guarantees this margin of error?

A. 423
B. 600
C. 601
D. 1,201

[1 point] 6. A fitness-club chain asked a random sample of 500 of its members whether they would attend a new 6 a.m. class, and 224 said yes. From these data, a 90 percent confidence interval for the proportion of all the chain's members who would attend the class is $(0.411, 0.485)$. Which of the following is a correct interpretation of the 90 percent confidence level?

A. In many random samples of 500 members, about 90 percent of the intervals built this way would capture the proportion of all members who would attend

B. There is a 0.90 probability that the proportion of all the chain's members who would attend the new 6 a.m. class lies between 0.411 and 0.485

C. In many random samples of 500 members, about 90 percent of the sample proportions would lie between 0.411 and 0.485, the limits of this one interval

D. We are 90 percent confident that the proportion of the 500 sampled members who would attend the new 6 a.m. class lies between 0.411 and 0.485

[1 point] 7. A city parks department surveyed a random sample of 250 residents, and 80 of them had visited a city park in the past week. The 95 percent confidence interval for the proportion of all residents who had visited a park in the past week had a margin of error of about 0.058. The department will take a new random sample and wants a 95 percent confidence interval with a margin of error of about 0.029. If the sample proportion turns out about the same, approximately how many residents should be in the new sample?

A. 125

B. 354

C. 500

D. 1,000

[1 point] 8. A national report states that 35 percent of adults in a country did volunteer work in the past year. A city official believes that the proportion is lower among adults in her city. She selects a random sample of 220 adults in the city and finds that 66 of them, a proportion of 0.30, did volunteer work in the past year. Which of the following are appropriate hypotheses for testing the official's belief?

A. $H_0 : p = 0.35$ and $H_a : p < 0.35$, where p is the proportion of the 220 sampled adults who did volunteer work in the past year

B. $H_0 : \hat{p} = 0.35$ and $H_a : \hat{p} < 0.35$, where $\hat{p}$ is the proportion of all adults in the city who did volunteer work in the past year

C. $H_0 : p = 0.35$ and $H_a : p < 0.35$, where p is the proportion of all adults in the city who did volunteer work in the past year

D. $H_0 : p = 0.30$ and $H_a : p < 0.30$, where p is the proportion of all adults in the city who did volunteer work in the past year

[1 point] 9. A meal-kit company believes that more than 25 percent of its subscribers skip at least one weekly delivery each month. In a random sample of 300 subscribers, 89 had skipped at least one delivery in the past month. A test of $H_0 : p = 0.25$ against $H_a : p > 0.25$, where p is the proportion of all the company's subscribers who skipped at least one delivery in the past month, gives a p-value of 0.031. Which of the following is a correct interpretation of this p-value?

A. The probability that the proportion of all subscribers who skipped at least one delivery in the past month is equal to 0.25 is 0.031

B. If exactly 25 percent of all subscribers skipped a delivery, the probability of a sample proportion of $\frac{89}{300}$ or more in a random sample of 300 is 0.031

C. If more than 25 percent of all subscribers skipped a delivery, the probability of a sample proportion of $\frac{89}{300}$ or more in a random sample of 300 is 0.031

D. If the company rejects H_0 on the basis of this sample, the probability that the company is making a Type I error by doing so is 0.031

[1 point] 10. A ferry company states that 90 percent of its crossings depart on time. A consumer group suspects that the true proportion is lower. In a random sample of 200 of the company's several thousand crossings last year, 172 departed on time. The group tests $H_0 : p = 0.90$ against $H_a : p < 0.90$ at the $\alpha = 0.05$ level, where p is the proportion of all the company's crossings last year that departed on time. Which of the following gives the test statistic, the p-value and the correct decision?

A. $z \approx -1.89$ and p-value ≈ 0.030; reject H_0

B. $z \approx -1.89$ and p-value ≈ 0.059; fail to reject H_0

C. $z \approx -1.89$ and p-value ≈ 0.970; fail to reject H_0

D. $z \approx -1.63$ and p-value ≈ 0.052; fail to reject H_0

[1 point] 11. A water utility monitors a reservoir. Let p be the proportion of all water samples from the reservoir in which a contaminant exceeds the safety limit. Each month the utility tests $H_0 : p = 0.02$ against $H_a : p > 0.02$, and if it rejects H_0 it closes the reservoir for treatment. Which of the following describes a Type II error and its consequence?

A. Finding convincing evidence that $p > 0.02$ when in fact $p = 0.02$, so the reservoir is closed for a treatment that it does not really need

B. Not finding convincing evidence that $p > 0.02$ when in fact $p = 0.02$, so the reservoir stays open and its water is not given treatment

C. Finding convincing evidence that $p > 0.02$ when in fact $p > 0.02$, so the reservoir is closed and its water is given the treatment

D. Not finding convincing evidence that $p > 0.02$ when in fact $p > 0.02$, so the reservoir stays open while its water needs treatment

[1 point] 12. A town council member will test whether more than half of the town's adults favor a ban on gas-powered leaf blowers. She plans to survey a random sample of 120 adults and test $H_0 : p = 0.50$ against $H_a : p > 0.50$ at the $\alpha = 0.05$ level. Suppose that, in fact, 56 percent of the town's adults favor the ban. Which of the following changes to her plan would increase the power of the test, with everything else unchanged?

A. Surveying a random sample of 300 of the town's adults instead of a random sample of 120 adults

B. Carrying out the test at the $\alpha = 0.01$ significance level instead of at the $\alpha = 0.05$ level

C. Using the two-sided alternative $H_a : p \neq 0.50$ instead of the one-sided alternative $H_a : p > 0.50$

D. Testing $H_0 : p = 0.53$ against $H_a : p > 0.53$ instead of testing against the null value 0.50

[1 point] 13. At a large university with thousands of students in each of its schools, 40 percent of engineering students and 25 percent of business students own a tablet computer. Independent random samples of 100 engineering students and 150 business students are selected, and $\hat{p}_E - \hat{p}_B$ is the difference between the proportions of tablet owners in the two samples. What are the mean and the standard deviation of the sampling distribution of $\hat{p}_E - \hat{p}_B$? (Standard deviations are rounded to three decimal places.)

A. Mean 0, standard deviation 0.084
B. Mean 0.15, standard deviation 0.034
C. Mean 0.15, standard deviation 0.060
D. Mean 0.15, standard deviation 0.084

[1 point] 14. Independent random samples of first-year students were taken at two large universities, each with more than 4,000 first-year students. At University N, 204 of 300 sampled students lived on campus; at University S, 145 of 250 sampled students lived on campus. Which of the following is a 90 percent confidence interval for $p_N - p_S$, the difference between the proportions of all first-year students at the two universities who live on campus?

A. $(0.004,\ 0.196)$
B. $(0.019,\ 0.181)$
C. $(0.032,\ 0.168)$
D. $(0.059,\ 0.141)$

[1 point] 15. A sports physiotherapist randomly assigned 360 runners with a sprained ankle to a new balance-training program or to standard care, 180 runners to each. After eight weeks, 126 runners in the balance-training group and 117 in the standard-care group had fully recovered. A 95 percent confidence interval for $p_{\text{bal}} - p_{\text{std}}$, the difference between the proportions of such runners who would fully recover within eight weeks with each treatment, is $(-0.047, 0.147)$. Which conclusion is best supported?

A. The data give convincing evidence that the balance-training program gives a higher recovery rate, because most of the interval is positive
B. The data give convincing evidence that the two treatments give the same recovery rate, because the interval contains the value 0
C. The data give convincing evidence that the balance-training program gives a higher recovery rate, because the observed difference is above 0
D. The data do not give convincing evidence that the recovery rates differ, because 0 is one of the plausible values in the interval

[1 point] 16. A researcher selected independent random samples of households in two large towns. In Town A, 45 of 120 sampled households own a dog; in Town B, 54 of 180 sampled households own a dog. She plans a test of $H_0 : p_A = p_B$ against $H_a : p_A \neq p_B$. Which of the following correctly gives the combined (pooled) sample proportion $\hat{p}_c$ and the check of the normality condition?

A. $\hat{p}_c = 0.075$; the condition is not met, since $n_A\hat{p}_c = 120(0.075) = 9$, which is less than 10
B. $\hat{p}_c = 0.33$; the condition is met, since $n_A\hat{p}_c$, $n_A(1-\hat{p}_c)$, $n_B\hat{p}_c$ and $n_B(1-\hat{p}_c)$ are all at least 10
C. $\hat{p}_c = 0.3375$; the condition is met, since each of the two samples contains more than 30 households and both towns are large
D. $\hat{p}_c = 0.3375$; the condition is met, since $n_A\hat{p}_c$, $n_A(1-\hat{p}_c)$, $n_B\hat{p}_c$ and $n_B(1-\hat{p}_c)$ are all at least 10

[1 point] 17. Independent random samples of 500 households were taken in each of two large cities. In City M, 60 of the sampled households had a backyard vegetable garden; in City N, 42 did. A researcher tests $H_0 : p_M = p_N$ against $H_a : p_M \neq p_N$ at the $\alpha = 0.05$ level, where p_M and p_N are the proportions of all households in each city with a backyard vegetable garden. Which of the following gives the test statistic, the p-value and a correct conclusion?

A. $z \approx 1.88$ and p-value ≈ 0.030; there is convincing evidence that the proportions of households with a garden differ in the two cities

B. $z \approx 1.88$ and p-value ≈ 0.060; there is not convincing evidence that the proportions of households with a garden differ in the two cities

C. $z \approx 1.88$ and p-value ≈ 0.060; there is convincing evidence that the proportions of households with a garden are equal in the two cities

D. $z \approx 2.66$ and p-value ≈ 0.008; there is convincing evidence that the proportions of households with a garden differ in the two cities

[1 point] 18. A coffee chain wants to know whether customers' usual drink size differs among its three locations. It selects an independent random sample of 120 customers at each location and records each customer's usual drink size: small, medium or large. Which of the following gives the appropriate test and null hypothesis?

A. A chi-square test for independence, with H_0: location and usual drink size are independent in a single population of the chain's customers

B. A two-sample z-test for proportions, with H_0: the proportion of customers who usually order a large drink is the same at two of the locations

C. A chi-square test for homogeneity, with H_0: the distribution of usual drink size is the same for the customers of all three locations

D. A chi-square test for homogeneity, with H_0: the distributions of usual drink size are different for the customers of the three locations

[1 point] 19. A random sample of 300 homes in a large city was classified by type of home and main heating fuel, as shown in the table. A chi-square test will be carried out to investigate whether type of home and main heating fuel are associated for homes in the city. What are the expected count for apartments heated mainly by gas and the degrees of freedom of the test?

	Gas	Electric	Other	Total
House	84	56	20	160
Apartment	36	84	20	140
Total	120	140	40	300

A. Expected count 50; 5 degrees of freedom

B. Expected count 56; 2 degrees of freedom

C. Expected count 56; 5 degrees of freedom

D. Expected count 64; 2 degrees of freedom

[1 point] 20. A researcher randomly assigned 200 volunteers with seasonal allergies to use nasal spray A or nasal spray B for two weeks, 100 volunteers to each spray, and recorded each volunteer's improvement. The results are shown in the table. A chi-square test is carried out at the $\alpha = 0.05$ level to investigate whether the distribution of improvement differs for the two sprays. Which of the following gives the chi-square statistic, the p-value and a correct conclusion?

	Much better	Somewhat better	No improvement	Total
Spray A	38	40	22	100
Spray B	26	42	32	100
Total	64	82	54	200

A. $\chi^2 \approx 2.08$ and p-value ≈ 0.354; there is convincing evidence that the distribution of improvement is the same for the two sprays

B. $\chi^2 \approx 4.15$ and p-value ≈ 0.042; there is convincing evidence that the distribution of improvement differs for the two sprays

C. $\chi^2 \approx 4.15$ and p-value ≈ 0.126; there is convincing evidence that the distribution of improvement is the same for the two sprays

D. $\chi^2 \approx 4.15$ and p-value ≈ 0.126; there is not convincing evidence that the distribution of improvement differs for the two sprays

Calculations (1 question)

[10 points] 21. Comparing two reminder methods. A county health department wanted to know whether a text-message reminder leads to a higher flu-vaccination rate among older adults than a postcard reminder sent by mail. From the county's list of 15,000 adults aged 65 and over who had not yet had a flu shot that season, the department selected a random sample of 600 adults. It then randomly assigned 300 of them to receive a text-message reminder and the other 300 to receive a postcard reminder. The table shows how many adults in each group got a flu shot within four weeks. Use the 0.05 significance level, and give p-values to three decimal places.

	Flu shot within four weeks	No flu shot	Total
Text message	141	159	300
Postcard	114	186	300
Total	255	345	600

[2 points] (a) Define the parameters of interest, and state the null and alternative hypotheses for investigating whether a text-message reminder leads to a higher flu-vaccination rate than a postcard reminder.

[2 points] (b) Identify the appropriate inference procedure, and verify that the conditions for it are met.

[2 points] (c) Calculate the test statistic and the p-value.

[2 points] (d) State a conclusion at the 0.05 significance level, in the context of the study.

[2 points] (e) Based on your conclusion in part (d), which type of error, Type I or Type II, could the department have made? Describe that error in the context of the study, and give one possible consequence of it for the department.

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