AP Statistics
Chapters 11-12 Quiz Review

Name: Key
Hour: ______

1. The one sample t statistic from a sample of $n = 19$ observations for the two-sided test of H_0: $\mu = 6$, H_a: $\mu \neq 6$ has the value $t = 1.93$. Based on this information, which of the following would be true?

(A) We would reject the null hypothesis at $\alpha = 0.10$.
(B) $0.025 < p\text{-value} < 0.05$.
(C) We would reject the null hypothesis at $\alpha = 0.05$.
(D) Both (B) and (C) are correct.
(E) We would not reject the null hypothesis in a two-sided test, but would reject it in a one-sided test at $\alpha = 0.10$.

df = 18   t = 1.93
2 p-value = 2(.035)
= .07

2. When performing a significance test for a null hypothesis, H_0, against the alternative hypothesis, H_a, the p-value is...

(A) the probability that H_0 is true.
(B) the probability that H_a is true.
(C) the probability that H_0 is false.
(D) the probability of observing a value of a test statistic at least as extreme as that observed in the sample if H_0 is true.
(E) the probability of observing a value of a test statistic at least as extreme as that observed in the sample if H_a is true.

3. The mayor of a large city will run for governor if he believes that more than 30 percent of the voters in the state already support him. He will have a survey firm ask a random sample of n voters whether or not they support him. He will use a large sample test for proportions to test the null hypothesis that the proportion of all voters who support him is 30 percent or less against the alternative that the percentage is higher than 30 percent. Suppose that 35 percent of all voters in the state actually support him. In which of the following situations would the power for this test be highest?

(A) The mayor uses a significance level of 0.01 and $n = 250$ voters.
(B) The mayor uses a significance level of 0.01 and $n = 500$ voters.
(C) The mayor uses a significance level of 0.01 and $n = 1{,}000$ voters.
(D) The mayor uses a significance level of 0.05 and $n = 500$ voters.
(E) The mayor uses a significance level of 0.05 and $n = 1{,}000$ voters.

Raise power
✓ increase α
✓ increase sample size
decrease σ
change Ha

4. In a test of $H_0: \mu = 8$ versus $H_a: \mu \neq 8$, a sample of size 220 leads to a p-value of 0.034. Which of the following must be true?

(A) A 95% confidence interval for μ calculated from these data will not include $\mu = 8$.
(B) At the 5% level if H_0 is rejected, the probability of a Type II error is 0.034.
(C) The 95% confidence interval for μ calculated from these data will be centered at $\mu = 8$.
(D) The null hypothesis should not be rejected at the 5% level.
(E) The sample size is insufficient to draw a conclusion with 95% confidence.

.034 < .05
Reject Ho

5. A significance test was performed to test the null hypothesis $H_0: \mu = 2$ versus the alternative $H_a: \mu > 2$. The test statistic is $z = 1.40$. The p-value for this test is approximately...

(A) 0.16   (B) 0.08   (C) 0.003   (D) 0.92   (E) 0.70

1 − .9192 = .0808

6. In a test of the null hypothesis H_0: $\mu = 10$ against the alternative hypothesis H_a: $\mu > 10$, a sample from a normal population produces a mean of 13.4. The z-score for the sample is 2.12 and the p-value is 0.017. Based on these statistics, which of the following conclusions could be drawn?

$.017 < .05$ Reject H_0

(A) There is reason to conclude that $\mu > 10$.
(B) Due to random fluctuation, 48.3 percent of the time a sample produces a mean larger than 10.
(C) 1.7 percent of the time, rejecting the alternative hypothesis is in error.
(D) 1.7 percent of the time, the mean is above 10.
(E) 98.3 percent of the time, the mean is below 10.

7. DDT is an insecticide that accumulates up the food chain. Predator birds can be contaminated with quite high levels of the chemical by eating many lightly contaminated prey. One effect of 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. (This is one of the reasons why the condor in California is near extinction.) 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) $H_0: \mu = 0.2$ mm; $H_a: \mu < 0.2$ mm
(B) $H_0: \mu < 0.2$ mm; $H_a: \mu = 0.2$ mm
(C) $H_0: \bar{x} = 0.2$ mm; $H_a: \bar{x} < 0.2$ mm
(D) $H_0: \bar{x} = 0.19$ mm; $H_a: \bar{x} = 0.2$ mm
(E) $H_0: \mu = 0.2$ mm; $H_a: \mu \neq 0.2$ mm

8. In a test of $H_0: \mu = 40$ against $H_a: \mu \neq 40$, a sample of size 80 produces $z = 0.8$ for the value of the test statistic. The p-value of the test is thus equal to...

$2(1-.7881) = .4238$

(A) 0.20 (B) 0.40 (C) 0.29 (D) 0.42 (E) 0.21

9. In a test of $H_0: \mu = 100$ against $H_a: \mu \neq 100$, a sample of size 10 produces a sample mean of 103 and a p-value of 0.08. Thus, at the 0.05 level of significance...

$.08 > .05$ accept H_0

(A) there is sufficient evidence to conclude that $\mu \neq 100$.
(B) there is sufficient evidence to conclude that $\mu = 100$.
(C) there is insufficient evidence to conclude that $\mu = 100$.
(D) there is insufficient evidence to conclude that $\mu \neq 100$.
(E) there is sufficient evidence to conclude that $\mu = 103$.

10. A significance test allows you to reject a hypothesis H_0 in favor of an alternative H_a at the 5% level of significance. What can you say about significance at the 1% level?

(A) The H_0 is rejected at the 1% level of significance.
(B) There is insufficient evidence to reject H_0 at the 1% level of significance.
(C) There is sufficient evidence to accept H_0 at the 1% level of significance.
(D) The H_a is rejected at the 1% level of significance.
(E) The answer can't be determined from the information given.

11. What is a p-value?

Probability of a sample statistic being as extreme or more extreme as the one found if H_0 is true

12. (a) If the p-value of a test is less than α, you…

reject H_0

(b) If the p-value of a test is greater than α, you…

fail to reject H_0

13. (a) What is a Type I error?

rejecting H_0 when it is actually true

(b) What is a Type II error?

failing to reject H_0 when it is actually false

14. (a) What is power?

Probability of rejecting H_0 when it is false
(Type II error)

(b) How do you increase the power of a test?

increase sample size
increase α
decrease confidence level

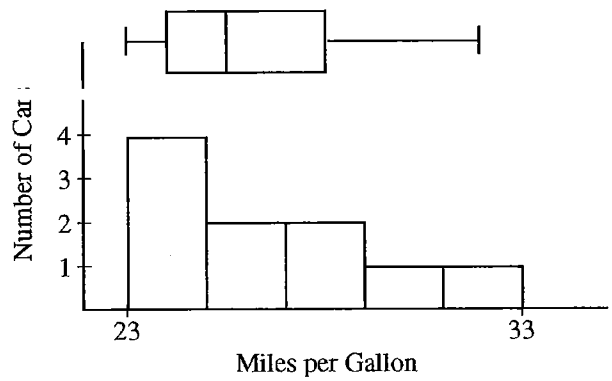
15. A consumer organization was concerned that an automobile manufacturer was misleading customers by overstating the average fuel efficiency (measured in miles per gallon, or mpg) of a particular car model. The model was advertised to get 27 mpg. To investigate, researchers selected a random sample of 10 cars of that model. Each car was then randomly assigned a different driver. Each car was driven for 5,000 miles, and the total fuel consumption was used to compute mpg for that car.

(a) Define the parameter of interest and state the null and alternative hypotheses the consumer organization is interested in testing.

μ = the average fuel efficiency (in mpg) for all cars of this particular model

$H_0: \mu = 27 \quad H_a: \mu < 27$

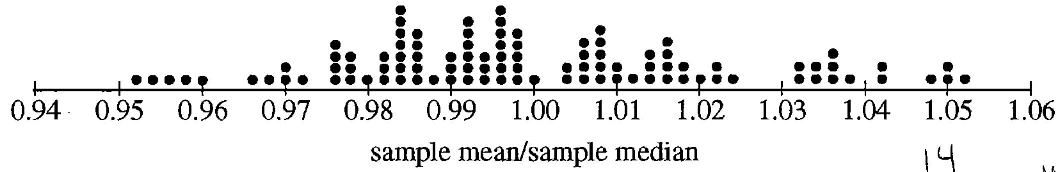
One condition for conducting a one-sample t-test in this situation is that the mpg measurements for the population of cars of this model should be normally distributed. However, the boxplot and histogram shown below indicate that the distribution of the 10 sample values is skewed to the right.



(b) One possible statistic that measures skewness is the ratio $\frac{\text{sample mean}}{\text{sample median}}$. What values of that statistic (small, large, close to one) might indicate that the population distribution of mpg values is skewed to the right? Explain.

If the population distribution is ~N, then the sample mean should equal the sample median (or they should be at least close) So if the population is ~N, then $\frac{\text{sample mean}}{\text{sample median}}$ should = 1 or very close to 1. If the population is skewed right, then the mean is larger than the median. In this case $\frac{\text{sample mean}}{\text{sample median}}$ should be large (or at least > 1).

(c) Even though the mpg values in the sample were skewed to the right, it is still possible that the population distribution of mpg values is normally distributed and that the skewness was due to sampling variability. To investigate, 100 samples, each of size 10, were taken from a normal distribution with the same mean and standard deviation as the original sample. For each of those 100 samples, the statistic $\frac{\text{sample mean}}{\text{sample median}}$ was calculated. A dotplot of the 100 simulated statistics is shown on the next page.



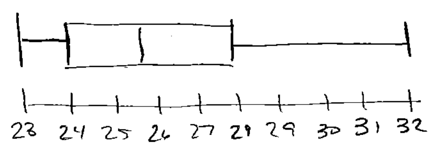
$\frac{14}{100} = .14$

In the original sample, the value of the statistic $\frac{\text{sample mean}}{\text{sample median}}$ was 1.03. Based on the value of 1.03 and the dotplot above, is it plausible that the original sample of 10 cars came from a normal population, or do the simulated results suggest the original population is really skewed to the right? Explain.

The dotplot shows 14 statistics ≥ 1.03, so since the p-value $\frac{14}{100} = .14 > \alpha = .05$. At $\alpha = .05$ we fail to reject the null hypothesis that the sample came from a normal population. There is not sufficient evidence that the original population is skewed right.

(d) The table below shows summary statistics for mpg measurements for the original sample of 10 cars.

Minimum	Q1	Median	Q3	Maximum
23	24	25.5	28	32



Choosing only from the summary statistics in the table, define a formula for a different statistic that measures skewness.

answers vary

$\frac{\text{max} - \text{median}}{\text{median} - \text{min}}$ or $\frac{\text{max} - Q_3}{Q_1 - \text{min}}$

What values of that statistic might indicate that the distribution is skewed to the right? Explain.

If the difference, max - median, is greater than median - min this would indicated skewed right and the statistic would be greater than 1.

16. The developers of a training program designed to improve manual dexterity claim that people who complete the 6-week program will increase their manual dexterity. A random sample of 12 people enrolled in the training program was selected. A measure of each person's dexterity on a scale from 1 (lowest) to 9 (highest) was recorded just before the start of and just after the completion of the 6-week program. The data are shown in the table below.

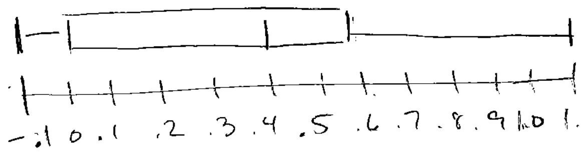
Person	Before Program	After Program	After − Before
A	6.7	7.8	1.1
B	5.4	5.9	.5
C	7.0	7.6	.6
D	6.6	6.6	0
E	6.9	7.6	.7
F	7.2	7.7	.5
G	5.5	6.0	.5
H	7.1	7.0	−.1
I	7.9	7.8	−.1
J	5.9	6.4	.5
K	8.4	8.7	.3
L	6.5	6.5	0
Total	**81.1**	**85.6**	$\bar{x} = .375$

Can one conclude that the mean manual dexterity for people who have completed the 6-week training program has significantly increased? Give appropriate statistical evidence to support your response.

① $H_0: \mu_{DIFF} = 0$ $H_a: \mu_{DIFF} > 0$ Diff (After − Before)

② One sample t-test for μ_D where μ_D = the mean difference in manual dexterity (after − before) for all people who take this 6-week training program.

③ SRS is stated in the question. $N \geq 10(12) = 120$. We will assume there are > 120 people, therefore > 120 difference, and independence is satisfied. A graph of the data is ~N so we may proceed with t procedures.



Differences in Dexterity

④ $t = \dfrac{.375 - 0}{.367/\sqrt{12}} = 3.540$ P-value = .002 df = 11

⑤ Since the p-value .002 < α = .05, we reject H_0. There is evidence that the mean difference in manual dexterity will increase for all people who complete the 6-week training program.

17. A recent report stated that less than 35 percent of the adult residents in a certain city will be able to pass a physical fitness test. Consequently, the city's Recreation Department is trying to convince the City Council to fund more physical fitness programs. The council is facing budget constraints and is skeptical of the report. The council will fund more physical fitness programs only if the Recreation Department can provide convincing evidence that the report is true.

The Recreation Department plans to collect data from a sample of 185 adult residents in the city. A test of significance will be conducted for the following hypotheses.

$$H_0: p = 0.35$$
$$H_a: p < 0.35,$$

where p is the proportion of adult residents in the city who are able to pass the physical fitness test.

(a) Describe what a Type II error would be in the context of the study, and also describe a consequence of making this type of error.

A Type II error would be concluding 35% of the adult residents in a certain city will be able to pass a physical fitness test when the percent is actually lower. The consequence may be the council will not fund more fitness programs when they actually need them.

(b) The Recreation Department recruits 185 adult residents who volunteer to take the physical fitness test. The test is passed by 77 of the 185 volunteers, resulting in a p-value of 0.97 for the hypotheses stated above. Interpret what this p-value measures in the context of this study.

.97 is the likelihood that 77 or fewer of the 185 volunteers pass the physical fitness test if the true proportion of all adult residents who would pass is actually 35%.

(c) If it was reasonable to conduct a test of significance for the hypotheses stated above using the data collected from the 185 volunteers, what would the p-value of 0.97 lead you to conclude?

Since the p-value $.97 > \alpha = .05$, we fail to reject H_0. There is not sufficient evidence that fewer than 35% of all adult residents in the city would pass the physical fitness test

(d) Describe the primary flaw in the study described in part (b), and explain why it is a concern.

This is a voluntary response sample, not an SRS. This creates a selection bias and the volunteers were most likely more fit than the average adult and $\hat{p} = \frac{77}{185}$ is higher than the true proportion p.