Plot	Regular	Kiln
1	1903	2009
2	1935	1915
3	1910	2011
4	2496	2463
5	2108	2180
6	1961	1925
7	2060	2122
8	1444	1482
9	1612	1542
10	1316	1443
11	1511	1535

(a) How can the Random condition be satisfied in this study?

(b) Assuming that the Random condition has been met, do these data provide convincing evidence that drying barley seeds in a kiln increases the yield of barley, on average? Justify your answer.

Chapter 9 AP® Statistics Practice Test

Section I: Multiple Choice *Select the best answer for each question.*

T9.1 An opinion poll asks a random sample of adults whether they favor banning ownership of handguns by private citizens. A commentator believes that more than half of all adults favor such a ban. The null and alternative hypotheses you would use to test this claim are

$H_0: p = .5$
$H_a: p > .5$

(a) $H_0: \hat{p} = 0.5; H_a: \hat{p} > 0.5$
(b) $H_0: p = 0.5; H_a: p > 0.5$
(c) $H_0: p = 0.5; H_a: p < 0.5$
(d) $H_0: p = 0.5; H_a: p \neq 0.5$
(e) $H_0: p > 0.5; H_a: p = 0.5$

T9.2 You are thinking of conducting a one-sample t test about a population mean μ using a 0.05 significance level. Which of the following statements is correct?

(a) You should not carry out the test if the sample does not have a Normal distribution.

(b) You can safely carry out the test if there are no outliers, regardless of the sample size.

(c) You can carry out the test if a graph of the data shows no strong skewness, regardless of the sample size.

(d) You can carry out the test only if the population standard deviation is known.

(e) You can safely carry out the test if your sample size is at least 30.

T9.3 To determine the reliability of experts who interpret lie detector tests in criminal investigations, a random sample of 280 such cases was studied. The results were

	Suspect's True Status	
Examiner's Decision	**Innocent**	**Guilty**
"Innocent"	131	15
"Guilty"	9	125

P(type II) = 1 − 140 280

If the hypotheses are H_0: suspect is innocent versus H_a: suspect is guilty, then we could estimate the probability that experts who interpret lie detector tests will make a Type II error as

fail to reject H_0 when H_0 is false

(a) 15/280.
(b) 9/280.
(c) 15/140.
(d) 9/140.
(e) 15/146.

T9.4 A significance test allows you to reject a null hypothesis H_0 in favor of an alternative H_a at the 5% significance level. What can you say about significance at the 1% level?

(a) H_0 can be rejected at the 1% significance level.

(b) There is insufficient evidence to reject H_0 at the 1% significance level.

(c) There is sufficient evidence to accept H_0 at the 1% significance level.

(d) H_a can be rejected at the 1% significance level.

(e) The answer can't be determined from the information given.

T9.5 A random sample of 100 likely voters in a small city produced 59 voters in favor of Candidate A. The observed value of the test statistic for testing the null hypothesis $H_0: p = 0.5$ versus the alternative hypothesis $H_a: p > 0.5$ is

(a) $z = \dfrac{0.59 - 0.5}{\sqrt{\dfrac{0.59(0.41)}{100}}}$

(b) $z = \dfrac{0.59 - 0.5}{\sqrt{\dfrac{0.5(0.5)}{100}}}$

(c) $z = \dfrac{0.5 - 0.59}{\sqrt{\dfrac{0.59(0.41)}{100}}}$

(d) $z = \dfrac{0.5 - 0.59}{\sqrt{\dfrac{0.5(0.5)}{100}}}$

(e) $t = \dfrac{0.59 - 0.5}{\sqrt{\dfrac{0.5(0.5)}{100}}}$

T9.6 A researcher claims to have found a drug that causes people to grow taller. The coach of the basketball team at Brandon University has expressed interest but demands evidence. Over 1000 Brandon students volunteer to participate in an experiment to test this new drug. Fifty of the volunteers are randomly selected, their heights are measured, and they are given the drug. Two weeks later, their heights are measured again. The power of the test to detect an average increase in height of 1 inch could be increased by

n=50

α↑ Pow↑

(a) using only volunteers from the basketball team in the experiment.

(b) using $\alpha = 0.01$ instead of $\alpha = 0.05$.

(c) using $\alpha = 0.05$ instead of $\alpha = 0.01$.

(d) giving the drug to 25 randomly selected students instead of 50.

(e) using a two-sided test instead of a one-sided test.

T9.7 A 95% confidence interval for a population mean μ is calculated to be (1.7, 3.5). Assume that the conditions for performing inference are met. What conclusion can we draw for a test of $H_0: \mu = 2$ versus $H_a: \mu \neq 2$ at the $\alpha = 0.05$ level based on the confidence interval?

(a) None. We cannot carry out the test without the original data.

(b) None. We cannot draw a conclusion at the $\alpha = 0.05$ level because this test corresponds to the 97.5% confidence interval.

(c) None. Confidence intervals and significance tests are unrelated procedures.

(d) We would reject H_0 at level $\alpha = 0.05$.

(e) We would fail to reject H_0 at level $\alpha = 0.05$.

T9.8 In a test of $H_0: p = 0.4$ against $H_a: p \neq 0.4$, a random sample of size 100 yields a test statistic of $z = 1.28$. The P-value of the test is approximately equal to

(a) 0.90. (b) 0.40. (c) 0.05. (d) 0.20. (e) 0.10.

T9.9 An SRS of 100 postal employees found that the average time these employees had worked at the postal service was 7 years with standard deviation 2 years. Do these data provide convincing evidence that the mean time of employment μ for the population of postal employees has changed from the value of 7.5 that was true 20 years ago? To determine this, we test the hypotheses $H_0: \mu = 7.5$ versus $H_a: \mu \neq 7.5$ using a one-sample t test. What conclusion should we draw at the 5% significance level?

$\mu_0 = 7.5$ $\bar{x} = 7$ $s_x = 2$ calcu $t = -2.5$ $p = .014$

$p < \alpha$ - reject Ho

(a) There is convincing evidence that the mean time working with the postal service has changed.

(b) There is not convincing evidence that the mean time working with the postal service has changed.

(c) There is convincing evidence that the mean time working with the postal service is still 7.5 years.

(d) There is convincing evidence that the mean time working with the postal service is now 7 years.

(e) We cannot draw a conclusion at the 5% significance level. The sample size is too small.

T9.10 Are TV commercials louder than their surrounding programs? To find out, researchers collected data on 50 randomly selected commercials in a given week. With the television's volume at a fixed setting, they measured the maximum loudness of each commercial and the maximum loudness in the first 30 seconds of regular programming that followed. Assuming conditions for inference are met, the most appropriate method for answering the question of interest is

(a) a one-proportion z test.

(b) a one-proportion z interval.

(c) a paired t test.

(d) a paired t interval.

(e) None of these.

Section II: Free Response *Show all your work. Indicate clearly the methods you use, because you will be graded on the correctness of your methods as well as on the accuracy and completeness of your results and explanations.*

T9.11 A software company is trying to decide whether to produce an upgrade of one of its programs. Customers would have to pay $100 for the upgrade. For the upgrade to be profitable, the company needs to sell it to more than 20% of their customers. You contact a random sample of 60 customers and find that 16 would be willing to pay $100 for the upgrade.

(a) Do the sample data give good evidence that more than 20% of the company's customers are willing to purchase the upgrade? Carry out an appropriate test at the $\alpha = 0.05$ significance level.

(b) Which would be a more serious mistake in this setting—a Type I error or a Type II error? Justify your answer.

(c) Describe two ways to increase the power of the test in part (a).

T9.12 "I can't get through my day without coffee" is a common statement from many students. Assumed benefits include keeping students awake during lectures and making them more alert for exams and tests. Students in a statistics class designed an experiment to measure memory retention with and without drinking a cup of coffee one hour before a test. This experiment took place on two different days in the same week (Monday and Wednesday). Ten students were used. Each student received no coffee or one cup of coffee one hour before the test on a particular day. The test consisted of a series of words flashed on a screen, after which the student had to write down as many of the words as possible. On the other day, each student received a different amount of coffee (none or one cup).

(a) One of the researchers suggested that all the subjects in the experiment drink no coffee before Monday's test and one cup of coffee before Wednesday's test. Explain to the researcher why this is a bad idea *and* suggest a better method of deciding when each subject receives the two treatments.

(b) The data from the experiment are provided in the table below. Set up and carry out an appropriate test to determine whether there is convincing evidence that drinking coffee improves memory.

Student	No cup	One cup
1	24	25
2	30	31
3	22	23
4	24	24
5	26	27
6	23	25
7	26	28
8	20	20
9	27	27
10	28	30

T9.13 A government report says that the average amount of money spent per U.S. household per week on food is about $158. A random sample of 50 households in a small city is selected, and their weekly spending on food is recorded. The sample data have a mean of $165 and a standard deviation of $20. Is there convincing evidence that the mean weekly spending on food in this city differs from the national figure of $158?

Ch. 9

Free Response

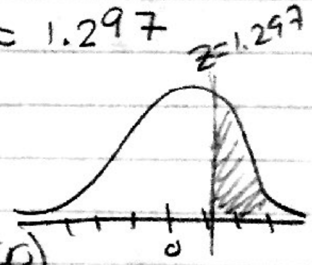
9.11 a) <u>State</u>: $H_0: p = .2$ vs. $H_a: p > .2$ with signif level $\alpha = 0.05$ where p = true proportion of customers who will do the upgrade.

<u>Plan</u>: Perform a 1 sample z test if conditions are met:

① Random sample of customers contacted
② Reasonable to assume $10(60) = 600$ > all customers
③ Large Counts - $n(p) = 60(.2) = 12 \geq 10$
$n(1-p) = 60(.8) = 48 \geq 10$

<u>DO</u>: $p_0 = .2$
$\hat{p} = 16/60 = .267$
$n = 60$

$$z = \frac{.267 - .2}{\sqrt{\frac{.2(1-.2)}{60}}} \approx 1.297$$



$P(z \geq 1.297)$
$= \text{normcdf}(1.297, 10000)$
$\approx .0973$

<u>Conclude</u>: Since p-value $= .0973 > \alpha = 0.05$, then we fail to reject H_0. There is not convincing evidence that the true proportion of customers willing to get the upgrade is more than 20%.

b) Type I: Reject H_0 when H_0 is true

Type II: fail to reject H_0 when H_a is true

* Type I b/c the company would produce the upgrade but not make a profit.

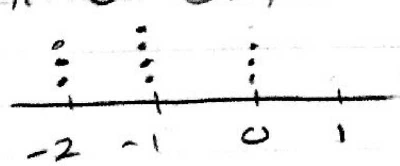
c). Increase α, increase sample size

9.2 a) Students may improve from Monday to Wednesday b/c they would have done the test once already
OR
There may be other variables that would cause confounding such as sleeping later on a Sunday night (less sleep before the Monday) than on a Wednesday night. The researcher should do random assignment using flipping a coin → heads: no cup, tails: cup on Monday then giving each student the opposite on Wednesday OR label 5 slips of paper "no cup" and the other 5 slips "cup" and have each student randomly select a slip of paper from a hat/box.

b) State: $H_0: \mu_d = 0$ vs $H_a: \mu_d < 0$ with $\alpha = 0.05$
where μ_d = true difference in test scores; "no cup" score − "cup" score

Plan: Perform a Paired t test if conditions are met

1. Random assignment to each treatment
2. $10(10) = 100 <$ population of all Students at the university
3. $n = 10 \leq 30$,

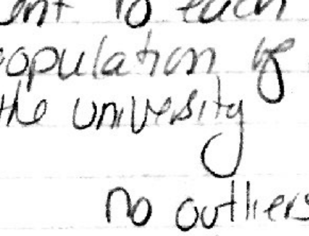


no outliers, no strong skewness → can calc. t

L_1	L_2	L_3 ($L_1 - L_2$)
24	25	-1
30	31	-1
22	23	-1
24	24	0
26	27	-1
23	25	-2
26	28	-2
20	20	0
27	27	0
28	30	-2

$\bar{x} = -1$
$S_x = .8165$

Do: $t = \dfrac{-1 - 0}{\frac{.8165}{\sqrt{10}}} = -3.873$



$P(t > 1.22) = \text{tcdf}(-10000, -3.873, 9)$
$\approx .001885$

Conclude: Since p-value $= .002 < \alpha = 0.05$, we reject H_0. There is convincing evidence that students perform better on test with coffee.

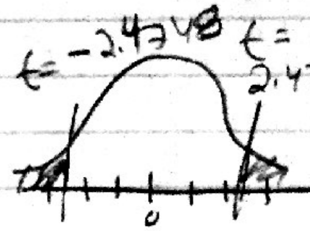
9.13 <u>State</u>: $H_o: \mu = 158$ vs. $H_a: \mu \neq 158$ @ signif. level $\alpha = 0.05$ where μ = true average amount of $ spent per U.S household per week on food.

<u>Plan</u>: Perform a 1 sample t test if conditions are met

① Random sample of households
② $10(50) = 500$; there are more than 500 households in the U.S.
③ $n = 50 \geq 30$ ∴ ~ Normal, can calculate t

<u>Do</u>: $\mu_0 = 158$
$n = 50$
$\bar{x} = 165$
$S_x = 20$

$$t = \frac{165 - 158}{\frac{20}{\sqrt{50}}} = 2.4748$$



$2 \cdot P(t > 2.4748) = 2 \cdot \text{tcdf}(2.4748, 10000, 49)$
$= .0168$

<u>Conclude</u>: Since p-value $= .0166 < \alpha = .05$, we reject H_o. There is convincing evidence that the true average $ spent on food is different from $158 per week.