AP Statistics Chapter 10 Homework

1. A New York Times poll on women's issues interviewed 1025 women randomly selected from the United States, excluding Alaska and Hawaii. The poll found that 47% of the women said they do not get enough time to themselves.

A. The poll announced a margin of error of $\pm$ 3 percentage points for 95% confidence in its conclusions. What is the 95% confidence interval for the percent of all adult women who think they do not get enough time for themselves?

B. Explain to someone who knows no statistics why we can't just say that 47% of all adult women do not get enough time for themselves.

C. Explain what "95% confidence" means.

2. A student reads that a 95% confidence interval for the mean NAEP quantitative score for men of ages 21 to 25 is 267.8 to 276.2. Asked to explain the meaning of this interval, the student says, "95% of all young men have scores between 267.8 and 276.2." Is the student right? Justify your answer.

3. Suppose that you give the NAEP test to an SRS of 1000 people from a large population in which the scores have mean of 280 and standard deviation of σ =60. The mean $\bar{x}$ of the 1000 scores will vary if you take repeated samples.

A. The sampling distribution of $\bar{x}$ is approximately normal. What are its mean and standard deviation?

B. Sketch the normal curve that describes how $\bar{x}$ varies in many samples from this population. Mark its mean and the values one, two and three standard deviations on either side of the mean.

C. According to the 68-95-99.7 rule, about 95% of all the values of $\bar{x}$ fall within _________ of the mean of this curve. What is the missing number? Call it *m* for "margin of error". Shade the region from the mean minus *m* to the mean plus m on the axis of your sketch.

4. A study of the career paths of hotel general managers sent questionnaires to an SRS of 160 hotels belonging to major US hotel chains. There were 114 responses. The average time these 114 general managers had spent with their current company was 11.78 years. Give a 99% confidence interval for the mean number of years general managers of major-chain hotels have spent with their current company. (Take it known that the standard deviation of time with the company for all general managers is 3.2 years.)

5. The Degree of Reading Power (DRP) is a test of the reading ability of children. Here are DRP scores of a sample of 44 third-grade students in a suburban school district:

40	26	39	14	42	18	25	43	46	27	19
47	19	26	35	34	15	44	40	38	31	46
52	25	35	35	33	29	34	41	49	28	52
47	35	48	22	33	41	51	27	14	54	45

A. We expect the distribution of DRP scores to be close to normal. Make a stemplot or histogram of the distribution of these 44 scores and describe the shape.

B. Suppose that the standard deviation of the population of DRP scores is known to be σ =11. Give a 99% confidence interval for the mean score in the school district.

C. Would you trust you conclusion from (B) if these scores came from a single class in one school in the district? Why?

6. Here are measurements (in millimeters) of a critical dimension on a sample of auto engine crankshafts:

224.120	224.001	224.017	223.982	223.989	223.961	223.960	224.089
223.987	223.976	223.902	223.980	224.098	224.057	223.913	223.999

The data come from a production process that is known to have standard deviation σ =.060 mm. The process is supposed to be μ =224 mm but can drift away from this target during production.

A. We expect the distribution of the dimension to be close to normal. Make a stemplot or histogram of these data and describe the shape of the distribution.

B. Give a 95% confidence interval for the process mean at the time these crankshafts were produced.

7. A test for the level of potassium in the blood is not perfectly precise. Moreover, the actual level of potassium in a person's blood varies slightly from day to day. Suppose that repeated measurements for the same person on different days vary normally with σ =.2.

A. Julie's potassium level in measured once. The result is x = 3.2. Give a 90% confidence interval for Julie's potassium level.

B. If three measurements were taken on different days and the mean result is $\bar{x}$ = 3.2, what is a 90% confidence interval for Julie's mean blood potassium level?

8. The National Assessment of Educational Progress (NAEP) test was given to a sample of 1077 women ages 21 to 25 years. Their mean quantitative score was 275. Take it as known that the standard deviation of all individual scores is σ = 60.

A. Give a 95% confidence interval for the mean score μ in the population of all young women.

B. Give the 90% and 99% confidence intervals of μ .

C. How are the margins of error for 90%, 95%, and 99% confidence? How does increasing the confidence level affect the margin of error of a confidence interval?

9. From problem 4, how large a sample of the hotel managers would be needed to estimate the mean μ within $\pm$ 1 year with 99% confidence?

10. From problem 6, how large a sample of crankshafts would be needed to estimate the mean μ within $\pm$ 0.020 mm with 95% confidence?

11. A radio talk show invites listeners to enter a dispute about a proposed pay increase for city council members. “What yearly pay do you think council members should get? Call us with you number?” In all, 958 people call. The mean pay they suggest is $\bar{x}$ =\$8740 per year, and the standard deviation of the responses is s = 1125. For a large sample such as this, s is very close to the unknown parameter σ . The station calculates the 95% confidence interval for the mean pay μ that all citizens would propose for council members to be \$8669 to \$8811.

A. Is the station’s calculation correct?

B. Does their conclusion describe the population of all the city’s citizens? Explain your answer.

12. A closely contested presidential election putted Jimmy Carter against Gerald Ford in 1976. A poll taken immediately before the 1976 election showed that 51% of the sample intended to vote for Carter. The polling organization announced that they were 95% confident that the sample result was within $\pm$ 2 points of the true percent of all voters who favored Carter.

A. Explain the plain language to someone who knows no statistics what “95% confident” means in this announcement.

B. The poll shows Carter leading. Yet, the polling organization said the election was too close to class. Explain why.

13. The Acculturation Rating Scale for Mexican Americans (ARSMA) is a psychological test that measures the degree to which Mexican Americans have adopted Mexican/Spanish versus Anglo/English culture. The distribution of ARSMA scores in a population used to develop the test was approximately normal, with mean 3.0 and standard deviation 0.8. A further study gave ARSMA to 42 first-generation Mexican Americans. The mean of their scores was $\bar{x}$ =2.13. Assuming the standard deviation for the first-generation population is also σ = .8, give a 95% confidence interval for the mean ARSMA score for first-generation Mexican Americans.

14. Consumer can purchase nonprescription medication at food stores, mass merchandise stores such as Kmart and Wal-Mart, or pharmacies. About 45% of consumers make such purchases at pharmacies. What accounts for the popularity for pharmacies, which often charge higher prices?

A study examined consumers' prescription of overall performance of the three types of stores, using a long questionnaire that asked about such things as "neat and attractive store," "knowledgeable staff," and "assistance in choosing among various types of nonprescription medication." A performance score was based on 27 such questions. The subjects were 201 people chosen at random from the Indianapolis telephone directory. Here are the means and standard deviations of the performance scores for the sample:

Store Type	$\bar{x}$	s
Food Stores	18.67	24.95
Mass Merchandising	32.38	33.37
Pharmacies	48.60	35.62

We do not know the population standard deviations, but a sample standard deviation s from so large a sample is usually close to σ . Use *s* in place of the unknown parameter σ in this exercise.

A. What population do you think the authors of the study want to draw conclusions about? What population are you certain they can draw conclusions about?

B. Give 95% confidence intervals for the mean performance for each type of store in the population.

C. Based on these confidence intervals, are you convinced that consumers think that pharmacies offer higher performance than the other types of stores?

15. A New York Times poll on women's issues interviewed 1025 women and 472 men randomly selected from the United States, excluding Alaska and Hawaii. The poll announced a margin of error of ± 3 percentage points for 95% confidence in conclusions about women. The margin of error for 95% confidence in conclusions about women. The margin of error for results concerning men was ± 4 percentage points. Why is this larger than the margin of error for women?

16. The Survey of Study Habits and Attitudes (SSHA) is a psychological test that measures the attitude toward school and study habits of students. Scores range from 0 to 200. The mean score for US college students is about 115, and the standard deviation is about 30. A teacher suspects that older students have attitudes toward school. She gives the SSHA to 25 students who are at least 30 years of age. Assume that scores in the population of older students are normally distributed with standard deviation of σ = 30. The teachers wants to test the hypotheses

$$H_0: \mu = 115$$

$$H_a: \mu > 115$$

A. What is the sampling distribution of the mean score $\bar{x}$ of the sample of 25 older students if the null hypothesis is true? Sketch the density curve of this distribution. (Hint: Sketch a normal curve first, then mark the axis what you know about locations μ and σ .)

B. Suppose that the sample data give $\bar{x}$ = 118.6. Mark this point on the axis of your sketch. In fact, the result was $\bar{x}$ = 125.7. Mark this point on your sketch, explain in simple language why one result is good evidence that the mean score of all older students is greater than 115 and why the other outcome is not.

C. Shade the area under the curve that is the P-value for the sample result $\bar{x}$ = 118.6.

17. The Census Bureau reports that households spend an average of 31% of their total spending on housing. A homebuilders association in Cleveland believes that this average is lower in their area. They interview a sample of 40 households in the Cleveland metropolitan area to learn what percent of their spending goes toward housing. Take μ to be the mean percent of spending devoted to housing among all Cleveland households. We want to test the hypotheses

$$H_0: \mu = 31\%$$

$$H_a: \mu < 31\%$$

The population standard deviation is σ =9.6%

A. What is the sampling distribution of the mean percent $\bar{x}$ that the sample spends on housing if the null is true? Sketch the density curve of the sampling distribution. (Hint: Sketch a normal curve first, then mark the axis using what you know about locating μ and σ on a normal curve.

B. Suppose that the study finds $\bar{x}$ = 30.2% for the 40 households in the sample. Mark this point on the axis in your sketch. Then suppose that the study result is $\bar{x}$ = 27.6%. Mark this point on your sketch. Referring to your sketch, explain in simple language why one result is good evidence that average Cleveland spending on housing is less than 31% and the other result is not.

C. Shade the area under the curve that gives the P-value for the result $\bar{x}$ = 30.2%. (Note that we are looking for evidence that spending is less that null hypothesis states.)

For 18 and 19, each of the following situations calls for a significance test for a population mean μ . State the null hypothesis H_0 and the alternative hypothesis H_a in each case.

18. The diameter of a spindle in a small motor is supposed to be 5 mm. If the spindle is either too small or too large, the motor will not work properly. The manufacturer measures the diameter in a sample of motors to determine whether the mean diameter has moved away from the target.

19. Census Bureau data show that the mean household income in the area served by a shopping mall is $42,500 per year. A market research firm questions shoppers at the mall. The researchers suspect the mean household income of mall shoppers is higher than that of the general population.

20. Return to problem 16. Starting from the picture you drew there, calculate the P-values for both $\bar{x}$ = 118.6 and $\bar{x}$ = 125.7. The two P-values express in numbers the comparison you make informally in problem 16.

21. Weekly sales of regular ground coffee at the supermarket have in the recent past varied according to a normal distribution with mean μ = 354 units per week and a standard deviation σ =33 units. The store reduces the price by 5%. Sales in the next three weeks are 405, 378, and 411 units. Is this good evidence that average sales are now higher? The hypotheses are

$$H_0: \mu = 354$$

$$H_a: \mu > 354$$

Assumer the standard deviation of the population of weekly sales remains σ =33.

A. Find the sketch of the test statistics $\bar{x}$.

B. Sketch the normal curve for the sampling distribution of $\bar{x}$ when H_0 is true. Shade the area that represents the P-value for the observed outcome.

C. Calculate the P-value.

D. Is the result statistically significant at the α =.05 level? Is it significant at the α =.01 level? Do you think there is convincing evidence that mean sales are higher?

22. A social psychologist reports that "in our sample, enthnocentrism was significantly higher (P<.05) among church attenders than among non-attenders." Explain what this means in simple language understandable to someone who knows no statistics. Do not sue the word *significance* in your answer.

23. The financial aid office of a university asks a sample of students about their employment and earnings. The report says that "for academic year earnings, a significant difference (P=.038) was found between the sexes, with men earning more than average. No difference (p=.476) was found between the earning of black and white students." Explain both of these conclusions, for the effects of sex and of race on mean earnings, in language understandable to someone who knows no statistics.

24. Here are measurements (in millimeters) of a critical dimension on a sample of automobile engine crankshafts:

224.120	224.001	224.017	223.982
223.960	224.089	223.987	223.976
224.098	224.057	223.913	223.999
223.989	223.902	223.961	223.980

The manufacturing process is known to vary normally with standard deviation σ =0.060mm. The process mean is supposed to be 224 mm. Do these data give good evidence that the process mean in not equal to the target mean?

A. State the H_0 and H_a that you will test.

B. Calculate the test statistic *z*.

C. Give the P-value of the test. Are you convinced that the process mean in not 224 mm?

25. Bottles of a popular cola are supposed to contain 300 milliliters (ml) of cola. There is some variation from bottle to bottle because the filling machinery is not perfectly precise. The distribution of the contents is normal with standard deviation σ = 3 ml. An inspector who suspects that the bottler is underfilling measures the contents of six bottles. The results are

229.4	297.7	301.0	298.9	300.2	297.0

A. State the hypotheses that you will test.

B. Calculate the test statistic.

C. Find the P-value and state your conclusion.

26. A random number generator is supposed to produce random numbers that are uniformly distributed on the interval from 0 to 1. If this is true, the numbers generated come from a population with μ = 0.5 and σ = 0.2887. A command to generate 100 random numbers gives outcomes with mean $\overline{x}$=0.4365. Assume that the population σ remains fixed. We want to test

$$H_0: \mu = 0.5$$

$$H_a: \mu \neq 0.5$$

A. Calculate the value of the *z* test statistic.

B. Is the result significant at the 5% level ($\alpha = 0.05$) ?

C. Is the result significant at the 1% level ($\alpha = 0.01$) ?

D. Between which two normal critical values in the bottom row of Table C does *z* lie? Between what two numbers does the P-value lie?

27. To determine whether the mean nicotine content of a brand of cigarettes is greater than the advertised value of 1.4 milligrams, a healthy advocacy groups test

$$H_0: \mu = 1.4$$

$$H_a: \mu > 1.4$$

The calculated value of the test statistic is z =2.42.

A. Is the result significant at the 5% level?

B. Is the result significant at the 1% level?

28. Radon is a colorless, odorless gas that is naturally released by rocks and soils and may concentrate in tightly closed houses. Because radon is slightly radioactive, there is some concern that it may be a health hazard. Radon detectors are sold to homeowners worried about this risk, but the detectors may be inaccurate. University researchers placed 12 detectors in a chamber where they were exposed to 105 picocuries per liter of radon over 3 days. Here are the readings given by the detectors:

91.9	97.8	111.4	122.3	105.4	95.0
103.8	99.6	96.6	119.3	104.8	101.7

Assume (unrealistically) that you know that the standard deviation of readings for all detectors of this type is σ = 9.

A. Give a 90% confidence interval for the mean reading μ for this type of detector.

B. Is there significant evidence at the 10% level that the mean reading differs from the true value 105? State the hypotheses and base a test on your confidence interval from A.

29. The job satisfaction study measured the JDS job satisfaction score of 28 female assemblers doing both self-paced and machine-paced work. The parameter μ is the mean amount by which the self-paced score exceeds the machine-paced score in the population of all such workers. Scores are normally distributed. The population standard deviation is σ = .60. The hypotheses are

$$H_0: \mu = 0$$

$$H_a: \mu \neq 0$$

A. What is the sampling distribution of the mean JDS score $\bar{x}$ for 28 workers if the null hypothesis is true? Sketch the density curve of this distribution. (First, sketch a normal curve first, then mark the axis using what you know about locating μ and σ on a normal curve.)

B. Suppose that the study had found $\bar{x}$ = .09. Mark this point on this axis on your sketch. In fact, the study found $\bar{x}$=.27 for these 28 workers. Mark this point on your sketch. Referring to your sketch, explain in simple language why one result is good evidence that H_0 is not true, and why the other is not.

C. Make another copy of your sketch. Shade the area under the curve that gives the P-value for the result $\bar{x}$=.09. Then calculate this P-value. (Note that H_a is two-sided.)

D. Calculate the P-value for the result $\bar{x}$ = .27 also. The two P-values express your explanation in B in numbers.

30. The mean area of the several thousand apartments in a new development is advertized to be 1250 square feet. A tenant group thinks that the apartments are smaller than advertized. They hire an engineer to measure a sample of apartments to test their suspicion. What are the null hypothesis H_0 and the alternative hypothesis H_a?

31. Cobra Cheese Company buys milk from several suppliers. Cobra suspects that some producers are adding water to their milk to increase their profits. Excess water can be detected by measuring the freezing point of the milk. The freezing temperature of natural milk varies normally, with mean $\mu = -.545^O C$ and a standard deviation $\sigma = .008°C$. Added waters raises the freezing temperature toward $0°C$, the freezing point of water. Cobra's laboratory manager measures the freezing temperature of five consecutive lots of milk from one producer. The mean measurement is $\bar{x} = -.538^O C$. Is this good evidence that the producer is adding water to the milk? State the hypothesis, carry out the test, give the P-value, and state your conclusion.

32. Asked to explain the meaning of "statistically significant at the α =.05 level," a student says: "This means that the probability that the null hypothesis is true is less than .05." is this explanation correct? Why or why not?

33. Suppose that in the absence of special preparation Scholastic Assessment Test mathematics (SATM) scores vary normally with mean μ =475 and σ =100. One hundred students go through a rigorous training program designed to raise their SATM scores by improving their mathematics skills. Carry out a test of

$$H_0: \mu = 475$$

$$H_a: \mu > 475$$

in each of the following situations:

A. The students' average score is $\bar{x}$ = 491.4. Is this result significant at the 5% level?

B. The students' average score is $\bar{x}$ = 491.5. Is this result significant at the 5% level?

34. Let us suppose that SATM scores in the absence of coaching vary normally with mean $\mu = 475$ and σ =100. Suppose also that coaching may change μ but does not change σ. An increase in the SATM score from 475 to 478 is of no importance in seeking admission to college, but this is unimportant change can be statistically very significant. To see this, calculate the P-value for the test of

$$H_0\colon \mu = 475$$

$$H_a : \mu > 475$$

in each of the following situations:

A. A coaching service coaches 100 students. Their SATM scores average is $\bar{x}$ = 478.

B. By the next year, the service coached 1000 students. Their SATM scores average $\bar{x}$ = 478.

C. An advertizing campaign brings the number of students coached to 10,000. Their average score is still $\bar{x}$ = 478.

35. A local television station announces a question for a poll-in opinion poll on the six o'clock news. Today's question concerns a proposed gun-control ordinance. Of the 2372 calls received, 1921 oppose the new law. The station, following standard statistical practice, makes a confident statement: "81% of the Channel 13 Pulse Poll sample oppose gun control. We can be 95% confident that the proportion of all viewers who oppose the law is within 1.6% of the sample result." Is the station's conclusion justified?

36. A researcher looking for evidence of extrasensory perception (ESP) tests 500 subjects. Four of these subjects do significantly better (P<.01) than random guessing.

A. Is it proper to conclude that there four people have ESP? Explain your answer.

B. What should a researcher now do to test whether any of these four have ESP?

37. A company compares two package designs for a laundry detergent by placing bottles with both designs on the shelves of several markets. Checkout scanner data on more than 5000 bottles bought show that more shoppers bought Design A than Design B. the difference is statistically significant (P=.02). Can we conclude that consumers strongly prefer Design A? Explain your answer.

38. A group of psychologists once measure 77 variables on a sample of schizophrenic people and a sample of people who were not schizophrenic. They compared the two samples using 77 separate significant tests. Two of these tests were significant at the 5% level. Suppose that there is in fact no difference on any of the 77 variables between people who are and people who are not schizophrenic in the adult population. Then all 77 null hypotheses are true.

A. What is the probability that one specific test shows a difference significant at the 5% level?

B. Why is it not surprising that 2 of the 77 tests were significant at the 5% level?

39. Your company markets a computerized medical diagnostic program. The program scans the results of routine medical tests (pulse rate, blood tests, etc.) and either clears the patient or refers the case to a doctor. The program is used to screen thousands of people who do not have specific medical complaints. The program makes a decision about each person.

A. What are the two hypotheses and the two types of error that the program can make? Describe the two types of error in terms of “false positive” and “false negative” test results.

B. The program can be adjusted to decrease one error probability, at the cost of an increase in the other error probability. Which error probability would you choose to make smaller, and why? (This is a matter of judgment. There is no single correct answer.)

40. You have the NAEP quantitative scores for an SRS of 840 young men. You plan to test the hypotheses about the population mean score,

$$H_0\colon \mu = 275$$

$$H_a : \mu < 275$$

at the 1% level of significance. The population standard deviation is known to be σ =60. The *z* statistic is

$$z = \frac{\bar{x} - 275}{\frac{60}{\sqrt{840}}}$$

A. What is the rule for rejecting H_0 in terms of *z*?

B. What is the probability of a Type I error?

C. You want to know whether this test will usually reject H_0 when the true population mean is 270, 5 points lower than the null hypothesis claims. Answer this question by calculating the probability of a Type II error when μ =270.

D. Assuming your work from C is true, what is the power?

41. You have an SRS of size n=9 from a normal distribution with σ =1. You wish to test

$$H_O : \mu = 0$$

$$H_a : \mu > 0$$

A. Find the probability of at Type I error. That is, find the probability that the test rejects H_0 when in fact μ =0.

B. Find the probability of a Type II error when $\mu = .3$. That is the probability that the test accepts H_0 when in fact $\mu = .3$.

C. Assuming B is true, find the power. The probability of rejecting the null when in fact it should.