1. A company is interested in the average amount of weight their new brand of stepladders can hold before breaking. The amount of weight this brand of stepladder can hold follows a normal distribution with mean μ and standard deviation $\sigma = 10$ pounds. A simple random sample of 4 stepladders is taken and the measured amount of weight in pounds the 4 ladders held before breaking is shown below. Calculate the 90% confidence interval for μ.

351 344 363 354

2. An airline wants to know the average time it takes their passengers to claim their luggage. The time to claim luggage for this airline is known to be normally distributed with mean μ and standard deviation $\sigma = 5$ minutes. The airline took a simple random sample of 10 passengers and calculated that it took an average of 25 minutes to claim their luggage. Calculate the 99% confidence interval for μ.

3. I collect a random sample of size n from a population with standard deviation σ, and, from the data collected, I compute a 95% confidence interval for the mean of the population. Which of the following would produce a new confidence interval with smaller width (smaller margin of error), based on these same data?

a) Increase σ. b) Use a lower confidence level. C) Use a smaller sample size.

4. Which of the following is not needed to calculate the sample size for a desired margin of error in a confidence interval for μ when σ is known?

a) confidence level. b) population mean. C) population standard deviation.
d) desired margin of error.

5. An airline wants to know the average time it takes their passengers to claim their luggage. Prior knowledge indicates that the time to claim luggage for this airline is normally distributed with mean μ and standard deviation $\sigma = 5$ minutes. The airline plans to take a simple random sample of their passengers to estimate μ with a 95% confidence interval. How many passengers must the airline sample to get a margin of error of 2.5 minutes?

6. Scores on the SAT Mathematics test (SAT-M) are believed to be normally distributed with mean μ. The scores of a random sample of three students who recently took the exam are 550, 620, and 480. A 95% confidence interval for μ based on these data is

A. (408, 692) B. (421.42, 678.58) C. (444.99, 655.01) D. (376.12, 723.88)

7. 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 $\sigma = 3\ ml$. An inspector who suspects that the bottle is under-filling measures the contents of six bottles. The results are 299.4, 297.7, 301.0, 298.9, 300.2, and 297.0. Is this convincing evidence that the mean content of cola bottles is less than the advertised 300 ml?

a. State H_0 and Ha.

b. Calculate the test statistic.

c. Find the *p-value* and state your conclusion in simple language.

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

A. insist that the *P*-value be smaller than the level of significance.
B. use a very large level of significance.
C. insist that the level of significance be smaller than the *P*-value.
D. use a very small level of significance.

9. Poisoning by the pesticide DDT causes tremors and convulsions. In a study of DDT poisoning, researchers fed several rats a measured amount of DDT. They then made measurements on the rats' nervous systems that might explain how DDT poisoning causes tremors. One important variable was the "absolutely refractory period," the time required for a nerve to recover after a stimulus. This period varies normally. Measurements on four rats gave data below (in milliseconds):

1.6 1.7 1.8 1.9

Suppose that the mean absolutely refractory period for unpoisoned rats is known to be 1.3 milliseconds. DDT poisoning should slow nerve recovery and so increase this period. Do the data give good evidence for this claim?

a. State H_0 and Ha.

b. Between what levels from Table D does the *p-value* lie?

c. What do you conclude from the test?

Use the following to answer questions 10 and 11.

A researcher wished to compare the average amount of time spent in extracurricular activities by high school students in a suburban school district with that in a school district of a large city. The researcher obtained an SRS of sixty high school students in a large suburban school district and found the mean time spent in extracurricular activities per week to be 6 hours with a standard deviation 3 hours. The researcher also obtained an independent SRS of forty high school students in a large city school district and found the mean time spent in extracurricular activities per week to be 4 hours with a standard deviation 2 hours. Let μ_1 and μ_2 represent the mean amount of time spent in extracurricular activities per week by the populations of all high school students in the suburban and city school districts, respectively.

10. Assuming two sample *t* procedures are safe to use, a 95% confidence interval for $\mu_1 - \mu_2$ is (use the conservative value for the degrees of freedom)

A. (.99, 3.01) B. (1.5, 2.5) C. (.66, 3.34) D. (1.16, 2.84)

11. Assuming two sample *t* procedures are safe to use, suppose the researcher had wished to test the hypotheses H_0: $\mu_1 = \mu_2$, H_a: $\mu_1 \neq \mu_2$. The *P*-value for the test is (use the conservative value for the degrees of freedom)

A. between 0.10 and 0.05. B. between 0.05 and 0.01.
C. below 0.01. D. larger than 0.10.

12. The Acculturation Rating Scale for Mexican Americans (ARSMA) measures the extent to which Mexican Americans have adopted Anglo/English culture. The ARSMA test was compared with a similar test, the Bicultural Inventory (BI), by administering both tests to 22 Mexican Americans. Both tests have the same range of scores (1.00 to 5.00) and are scaled to have similar means for the groups used to develop them. There was a high correlation between the two scores, giving evidence that both are measuring the same characteristics. The researchers wanted to know whether the population mean scores for the two tests are the same. The differences in scores (ARSMA – BI) for the 22 subjects had $\bar{x} = 0.2519$ and $s = 0.2767$. Carry out a significance test for the hypothesis that the two tests have the same population mean.

a. State H_0 and Ha.

b. Give the *p-value* and state your conclusion in simple language.

13. In a statistical test of hypotheses, we say the data are statistically significant at level α if

A. the *P*-value is less than α. B. $\alpha = 0.05$.

C) the *P*-value is larger than α. D. α is small.

14. In a study of cereal leaf beetle damage on oats, researchers measured the number of beetle larvae per stem in small plots of oats after randomly applying one of two treatments: no pesticide or malathion at the rate of 0.25 pound per acre. The data appear roughly normal. Here are the summary statistics:

Group	Treatment	n	$\bar{x}$	s
1	Control	13	3.47	1.21
2	Malathion	14	1.36	0.52

Is there significant evidence at the level 1% that malathion reduces the mean number of larvae per stem? Be sure to state H_0 and Ha, give the *p-value* and state your conclusion.

15. A certain population follows a normal distribution with mean μ and standard deviation $\sigma = 2.5$. You collect data and test the hypotheses H_0: $\mu = 1$, H_a: $\mu \neq 1$. You obtain a *P*-value of 0.022. Which of the following is true?

A. A 99% confidence interval for μ will include the value 0

B. A 99% confidence interval for μ will include the value 1

C. A 95% confidence interval for μ will include the value 1

D. A 95% confidence interval for μ will include the value 0

16. The nicotine content in cigarettes of a certain brand is normally distributed with mean (in milligrams) μ and standard deviation $\sigma = 0.1$. The brand advertises that the mean nicotine content of their cigarettes is 1.5, but measurements on a random sample of 100 cigarettes of this brand gave a mean of 1.53. Is this evidence that the mean nicotine content is actually higher than advertised? To answer this question, test the hypotheses H_0: $\mu = 1.5$, H_a: $\mu > 1.5$ at significance level $\alpha = 0.05$. You conclude

A. that H_a should be rejected.

B. there is a 5% chance that the null hypothesis is true.

C. that H_0 should not be rejected. D. that H_0 should be rejected.

17. The Information Technology Department at a large university wishes to estimate p = the proportion of students living in the dormitories who own a computer with a 95% confidence interval. What is the minimum required sample size the IT Department should use to estimate the proportion p with a margin of error no larger than 3 percentage points?

18. The water diet requires one to drink two cups of water every half hour from when one gets up until one goes to bed, but otherwise allows one to eat whatever one likes. Four adult volunteers agree to test the diet. They are weighed prior to beginning the diet and after six weeks on the diet. The weights (in pounds) are

Person	1	2	3	4
Weight before the diet	180	125	240	150
Weight after six weeks	170	130	215	152

For the population of all adults, assume that the weight loss after six weeks on the diet (weight before beginning the diet – weight after six weeks on the diet) is normally distributed with mean μ. To determine if the diet leads to weight loss, we test the hypotheses H_0: $\mu = 0$, H_a: $\mu > 0$. Based on these data we conclude that

A. we would reject H_0 at significance level 0.05, but not at 0.01.
B. we would reject H_0 at significance level 0.01.
C. we would reject H_0 at significance level 0.10, but not at 0.05.
D. we would not reject H_0 at significance level 0.10.

19. A sprinkler system is being installed in a newly renovated building on campus. The average activation time is supposed to be at most 20 seconds. A series of 12 fire alarm/sprinkler system tests result in an average activation time of 21.5 seconds. Do these data indicate that the design specifications have not been met?

a. State the appropriate H_0 and H_a, to answer this question.

b. Assume that activation times for this system are normally distributed with σ = 3 seconds. What is the value of the test statistic?

c. What is the value of the P-value?

d. Are the data statistically significant at the 5% significance level? Explain briefly.

e. What does the decision you made mean with respect to the question “Do these data indicate that the design specifications have not been met?”

20. A simple random sample of 100 postal employees is used to test if the average time postal employees have worked for the postal service has changed from the value of 7.5 years recorded 20 years ago. The sample mean was $\bar{x}$ = 7 years with a standard deviation of s = 2 years. Assume the distribution of the time the employees have worked for the postal service is approximately normal.

a. State the appropriate H_0 and H_a

b. Find the test statistic and its *P*-value. State your conclusion in simple language.

c. What is a 95% confidence interval for μ, the population mean time the postal service employees have spent with the postal service?

21. Researchers compared two groups of competitive rowers: a group of skilled rowers and a group of novices. The researchers measured the angular velocity of each subject's right knee, which describes the rate at which the knee joint opens as the legs push the body back on the sliding seat. The sample size *n*, the sample means, and the sample standard deviations for the two groups are given below.

Group	n	Mean	Standard deviation
Skilled	16	4.2	0.6
Novice	16	3.2	0.8

a. What are the hypotheses the researchers wish to test?

b. What is the value of test statistic? What can we say about the value of *P*-value?

22. The candy company that makes M&M's claims that 10% of the M&M's it produces are green. Suppose that the candies are packaged at random in large bags of 200 M&M's. When we randomly pick a bag of M&M's we may assume that this represents a simple random sample of size $n = 200$. Suppose that in the randomly selected bag of M&M's there are only 40 green M&M's,

a. Give a 95% confidence interval for p, the population proportion of green M&M's.

b. Suppose we wish to test H_0: $p = 0.10$ versus H_a: $p \neq 0.10$, what is the value of the large-sample z statistic? What is the value of the corresponding *P*-value?

23. The candy company that makes M&M's claims that 10% of the M&M's it produces are green. Suppose that the candies are packaged at random, and the small bags contain 25 M&M's. When we randomly pick a bag of M&M's we may assume that this represents a simple random sample of size $n = 25$. Suppose that in a randomly selected small bag of M&M's there are 5 green M&M's.

a. What is the plus four estimate of the proportion of green M&M's?

b. What is a 99% plus four confidence interval for p, the population proportion of green M&M's?

24. A random sample of 900 13- to 17-year-olds found that 411 had a computer in their room with Internet access. Let p be the proportion of all teens in this age range who have a computer in their room with Internet access.
a. Give a 95% confidence interval for p.

b. Suppose you wished to see if the majority of teens in this age range have a computer in their room with Internet access, what is the value of the large-sample z statistic? What is the value of the corresponding *P*-value?

25. At a large midwestern university, a simple random sample of 100 entering freshmen in 1993 found that 20 of the sampled freshmen finished in the bottom third of their high school class. Admission standards at the university were tightened in 1995. In 1997, a simple random sample of 100 entering freshmen found that only 10 finished in the bottom third of their high school class. Let p_1 and p_2 be the proportions of all entering freshmen in 1993 and 1997, respectively, who graduated in the bottom third of their high school class.

a. What is a 90% confidence interval for $p_1 - p_2$?

b. Is there evidence that the proportion of freshmen who graduated in the bottom third of their high school classes 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, test the hypotheses H_0: $p_1 = p_2$ versus H_a: $p_1 > p_2$.

26. Last year, one county reported that among 3000 Caucasian women (Group 1) who had babies, 95 had multiples (twins, triplets, etc.). The report also stated that there were 20 multiple births to 600 African American women (Group 2). Does this indicate a racial difference in the likelihood of multiple births? The researchers would like to assess if there is a racial difference in the likelihood of multiple births.
a. State the appropriate H_0 and H_a

b. Find the test statistic and its *P*-value. State your conclusion in simple language.

27. Suppose the time that it takes a certain large bank to approve a home loan is normally distributed with mean (in days) μ and standard deviation $\sigma = 1$. The bank advertises that it approve loans in 5 days, on average, but measurements on a random sample of 400 loan applications to this bank gave a mean approval time of $\bar{x} = 5.2$ days. Is this evidence that the mean time to approval is actually more than advertised?
i) State null and alternative hypotheses. ii) Calculate the test statistic. iii) Find the p-value.
iv) State the conclusion about the null hypothesis (reject the null hypothesis or fail to reject the null hypothesis).
v) State the final conclusion that addresses the question in simple language.

28. To assess the accuracy of a laboratory scale, a standard weight that is known to weigh exactly 1 gram is repeatedly weighed a total of n times and the mean $\bar{x}$ is computed. Suppose the scale readings are normally distributed with unknown mean μ and standard deviation $\sigma =$ 0.01 g. How large should n be so that a 95% confidence interval for μ has a margin of error no larger than $\pm$ 0.0001?

29. Determine whether each of the following statements is true or false.
A) The margin of error for a 95% confidence interval for the mean μ increases as the sample size increases.
B) The margin of error for a confidence interval for the mean μ, based on a specified sample size n, increases as the confidence level decreases.
C) The margin of error for a 95% confidence interval for the mean μ decreases as the population standard deviation decreases.
D) The sample size required to obtain a confidence interval of specified margin of error m, increases as the confidence level increases.

30. A machine at AMT & Co. fills 120-ounce jugs with laundry softener. A quality control inspector wishes to test if the machine needs an adjustment or not, which is needed when the machine either overfills or underfills the jugs. Assume the distribution of the amount of laundry softener in these jugs is normal. Under "standard" circumstances, the mean amount should be 120 ounces with a standard deviation of 1 ounce. The sample mean amount in the simple random sample of 40 jugs equals 119.62 ounces.

i) State the hypotheses H_0 and H_a the quality control inspector wishes to test?

ii) Calculate the test statistic. iii) Find the p-value.

iv) State the conclusion about the null hypothesis (reject the null hypothesis or fail to reject the null hypothesis).

v) State the final conclusion in simple language

vi) Give a 95% confidence interval for the mean amount of laundry softener in these jugs.

31. A researcher believes that college students spend less time participating in extra-curricular activities than they did ten years ago. An SRS of 100 college students found that in the past year the average number of hours spent per semester in extracurricular activities was $\bar{x}$ = 107 hours, with standard deviation s = 45 hours. Assume the distribution of the number of hours spent by college students per semester participating in extracurricular activities is approximately normal, with mean μ. Are these data evidence that μ has lowered from the value of 120 hours of ten years ago?

i) State H_0 and H_a. ii) Calculate the test statistic. iii) Find the p-value.

iv) State the conclusion about the null hypothesis (reject the null hypothesis or fail to reject the null hypothesis).

v) State the final conclusion that addresses the question in simple language.

vi) Find the 95% confidence interval for the true mean μ?

32. Which of the following is an example of a matched pairs design?

a. A teacher compares the pre-test and post-test scores of students.

b. A teacher compares the scores of students using a computer-based method of instruction, with the scores of other students using a traditional method of instruction.

c. A teacher compares the scores of students in her class on a standardized test with the national average score.

d. A teacher calculates the average of scores of students on a pair of tests and wishes to see if this average is larger than 80%.

33. Some researchers have conjectured that stem-pitting disease in peach-tree seedlings might be controlled with weed and soil treatment. An experiment is conducted to compare peach-tree seedling growth when the soil and weeds are treated with one of two herbicides. In a field containing 20 seedlings, 10 are randomly selected throughout the field and assigned to receive Herbicide A. The remainder of the seedlings is assigned to receive Herbicide B. Soil and weeds for each seedling are treated with the appropriate herbicide, and at the end of the study period the height in centimeters is recorded for each seedling. The following results are obtained:

Herbicide A	$\bar{x}_1$ = 94.5 cm	s_1 = 10 cm
Herbicide B	$\bar{x}_2$ = 109.1 cm	s_2 = 9 cm

Suppose the researchers wish to determine if there tends to be a difference in height for the seedlings treated with the different herbicides

i) What are the hypotheses the researchers wish to test? State H_0 and H_a.

ii) Calculate the test statistic. iii) Find the p-value.

iv) State the conclusion about the null hypothesis (reject the null hypothesis or fail to reject the null hypothesis).

v) State the final conclusion in simple language.

vi) Give a 90% confidence interval for $\mu_1 - \mu_2$

34. Twelve runners are asked to run a 10-kilometer race on each of two consecutive weeks. In one of the races, the runners wear one brand of shoe and in the other a different brand. The brand of shoe they wear in which race is determined at random. All runners are timed and are asked to run their best in each race. The results (in minutes) are given below:

Runner	Brand 1	Brand 2
1	31.23	32.02
2	29.33	28.98
3	30.50	30.63
4	32.20	32.67
5	33.08	32.95
6	31.52	31.53
7	30.68	30.83
8	31.05	31.10
9	33.00	33.12
10	29.67	29.50
11	30.55	30.57
12	32.12	32.20

Carry out a **matched pairs test** to determine if there is evidence that times using Brand 1 tend to be faster than times using Brand 2.

i) State H_0 and H_a. ii) Calculate the test statistic. iii) Find the p-value.

iv) State the conclusion about the null hypothesis (reject the null hypothesis or fail to reject the null hypothesis).

v) State the final conclusion in simple language.

35. A recent study of newborns used umbilical cord blood to test for 25 hydroxyvitamin D, which is an indicator of vitamin D status of the baby. It was reported that 65% of babies tested were deficient in vitamin D in spite of the fact that the mothers consumed vitamin D supplements during pregnancy. A researcher in a northern region felt that this percentage was too high for this region because with the reduced hours of sunshine during winter months, pregnant women tended to use of higher doses of supplements to compensate. A sample of 125 newborns was tested, and 72 were declared to be deficient in vitamin D

i) What would be the appropriate null and alternative hypotheses that the researcher should establish for a test of significance?

ii) What is the value of the test statistic?

iii) What is the value of the corresponding *P*-value?

iv) State the conclusion about the null hypothesis (reject the null hypothesis or fail to reject the null hypothesis).

v) State the final conclusion in simple language.

36. As the newly hired manager of a company that provides cell phone service, you want to determine the proportion of adults in your state who live in a household with cell phones and no land-line phones with a 90% confidence interval. How many adults must you survey to estimate the proportion with a margin of error no larger than 4 percentage points? Assume that a recent survey suggests that about 8% of adults live in households with cell phones and no land-line phones (based on data from the National Health Interview Survey).

37. A simple random sample of 85 students is taken from a large university on the West Coast to estimate the proportion of students whose parents bought a car for them when they left for college. When interviewed, 51 students in the sample responded that their parents bought them a car. What is a 95% confidence interval for p, the population proportion of students whose parents bought a car for them when they left for college?

38. A quality manager in a small manufacturing company wants to estimate the proportion of items produced by a very specialized process that fail to meet a customer's specification. Because it is very expensive to determine if an item produced by the process meets the specification, only a very small number of items can be tested. A random sample of 15 items was selected, and in the sample three of them failed.

A) Find the plus four estimate of the true proportion of items that fail to meet the customer's specifications.

B) Calculate the 98% plus four confidence interval p, of the true proportion of items that fail to meet the customer's specifications.

39. A simple random sample of 60 households in City 1 is taken. In the sample, there are 45 households that decorate their houses with lights for the holidays. A simple random sample of 50 households is also taken from the neighboring City 2. In the sample, there are 40 households that decorate their houses. .

A) Is there evidence of a difference in population proportions of households that decorate their houses with lights for the holidays in the two neighboring towns?
i) State the hypotheses H_0 and H_a.
ii) Calculate the test statistic.
iii) Find the P-value.
iv) State the conclusion about the null hypothesis (reject the null hypothesis or fail to reject the null hypothesis).

v) State the final conclusion in simple language.

B) What is a 95% confidence interval for the difference in population proportions of households that decorate their houses with lights for the holidays?