Additional Exercises

1. Black Bark, a Colorado based company, makes wood burning stoves. They are interested in comparing two designs to determine which design will produce a stove with a greater average burning time. Several prototypes of each design are tested and the time required to burn 15 pounds of wood was measured (the burning time is measured in hours). The results of the test are as follows.

Burning Time for Stoves (Hours)			
	n	$\bar{x}$	s
Stove A	32	9.35	0.50
Stove B	35	9.75	0.75

Is there sufficient evidence at $\alpha = 0.05$ for Black Bark to conclude that the mean burning time for Stove B is greater than for Stove A? Assume that the population standard deviations are equal. Let Population 1 be Stove A burning times and let Population 2 be Stove B burning times.

2. In each of the following experimental situations give the appropriate null and alternative hypotheses to be tested. Define all terms that appear in these hypotheses.

a. Independent random samples of 50 male nurses and 50 female nurses are selected from a hospital. Each nurse is asked whether he or she is satisfied with the working conditions in the hospital. It is of interest to see if there is a difference between male nurses and female nurses on satisfaction with working conditions.

b. A group of 45 high school seniors take the SAT reasoning test both before and after a 3-month training course, which is designed to improve SAT scores. We wish to determine if the training course is effective.

c. Starting salaries are determined for 40 computer science majors and 40 computer engineering majors. It is of interest to determine if computer science majors tend to have higher starting salaries than computer engineers.

d. Random and independent samples of younger (age ≤ 30) and older (age > 30) automobile drivers are chosen and asked whether they have had a speeding ticket in the past 12 months. Are younger drivers more likely than older drivers to have had a speeding ticket in the past 12 months?

e. Do adjunct faculty receive lower ratings than tenured faculty on course evaluations? Random and independent samples of 10 course evaluations of adjunct faculty members and 10 tenured faculty members are collected and compared.

3. A nutritionist is interested in determining the decrease in cholesterol level which a person can achieve by following a particular diet that is low in fat and high in fiber. Seven subjects are randomly selected to try the diet for six months, and their cholesterol levels are measured both before and after the diet. The results of the study are as follows. Let Population 1 be the cholesterol levels before the diet and Population 2 be the cholesterol levels after the diet.

Cholesterol Levels							
Subject	**1**	**2**	**3**	**4**	**5**	**6**	**7**
Before Diet	155	170	145	200	162	180	160
After Diet	152	168	148	195	162	178	157

a. Is a paired design appropriate for the above experiment? Explain.

b. What assumption must be made in order to perform the test of hypothesis?

c. Does the data appear to satisfy the assumption described in part **b.**? Why or why not?

d. Can the nutritionist conclude that there is a significant decrease in average cholesterol level when the diet is used? Use $\alpha = 0.01$.

4. The design group for a monofilament cord manufacturer is testing two possible compositions of the cord for tensile strength. Composition A is more difficult to manufacture than Composition B, so the design group has decided that it will recommend Composition A only if the mean tensile strength for Composition A is shown to be significantly greater than the mean tensile strength for Composition B. Several monofilament cords of each sample are tested and the tensile strengths are measured in pounds per square inch. Assume that the population variances are unequal. Let Population 1 be the tensile strengths of Composition A and Population 2 be the tensile strengths of Composition B.

Tensile Strength (Pounds per Square Inch)			
	n	$\bar{x}$	***s***
Composition A	20	52,907	2575
Composition B	20	50,219	1210

a. What assumptions must be made in order to perform the hypothesis test?

b. Will the design group recommend Composition A or Composition B for the monofilament cord at $\alpha = 0.10$?

5. Typically, the fastest players on a football team are the cornerbacks and wide receivers. The primary responsibility of wide receivers is to catch passes down the field, while cornerbacks must possess the speed necessary to prevent them from making significant plays. To obtain a representative sample of all NFL players, we can examine the data from the participants of the NFL combine, an annual showcase event held prior to the draft. A sample of 77 wide receivers had an average 40-yard dash time of 4.50 seconds, while 60 cornerbacks had an average of 4.47 seconds. The standard deviations of these samples were 0.10 and 0.09 seconds, respectively, and assume the population standard deviations are equal. Let Population 1 be wide receivers and Population 2 be cornerbacks.

a. Test whether there is a significant difference in speed between the two groups of football players using $\alpha = 0.05$.

b. Construct a 95% confidence interval for the true mean difference between the speed of the wide receivers and the cornerbacks. Interpret this interval in context.

6. The manufacturer of Big Bang energy drinks claims that their drink has less caffeine, so is therefore healthier than their competitor Black Mustang. Twenty 16-oz. energy drinks are sampled from each manufacturer. The average caffeine content in the sample of Big Bang energy drinks was 162 mg with a standard deviation of 7 mg. The average caffeine content in the sample of Black Mustang energy drinks was 173 with a standard deviation of 5 mg. Assume the population standard deviations are equal. Let Population 1 be Big Bang energy drinks and Population 2 be Black Mustang energy drinks.

a. Is there evidence to refute the manufacturer's claim at $\alpha = 0.05$?

b. Construct an 85% confidence interval for the true mean difference in caffeine content between Big Bang and Black Mustang.

7. A team of organizational behavior managers investigated the effects of an orientation program on "first day of work" anxiety levels of new employees. Seventy-two new employees were randomly assigned to receive or not to receive a two-day company orientation program prior to their first day at work. Two hours after beginning work, each employee was given a test to measure his or her level of anxiety. The mean score was 1002 for the 37 receiving orientation and 1018 for the 35 who did not receive the orientation. Scores of employees who attended similar orientation programs in the past have had a standard deviation of 142. Scores of employees that did not attend the orientation program had this same standard deviation. Let Population 1 be employees who attended the orientation program and Population 2 be employees who did not attend the orientation program.

a. Test to see if there is evidence of a difference in the mean test scores between those who participate in an orientation program and those who do not. Use a level of significance equal to 0.05.

b. Calculate the observed significance level (*P*-value) of this test.

8. For a consumer product, the mean dollar sales per retail outlet last year in a sample of 25 stores were \$3425 with a standard deviation of \$400. For a second product, the mean dollar sales per outlet in a sample of 16 stores were \$3250 with a standard deviation of \$175. The sales amounts per outlet are assumed to be approximately normally distributed for both products. Test to see if the first product has a better mean dollar sales record than the second product. Use the *P*-value approach and base your decision on a significance level of 0.01. Assume that the population variances are not equal.

9. A random sample of 10 filled sports drink bottles is taken in one bottling plant (Plant 1), and the mean weight of the bottles is found to be 22 ounces with a variance of 0.09 ounces squared. At another plant (Plant 2), 10 randomly selected bottles have a mean weight of 21 ounces with a variance of 0.04 ounces squared. Assuming the weights in both populations are normally distributed and the population variances are equal, test whether there is a difference between the average weights of the bottles being filled at the two plants. Use $\alpha = 0.05$.

10. The teenage rite of passage of rushing to the DMV on your birthday to get your driver's license may be losing its allure among young people. Social researchers believe that teens are no longer in a hurry to get their driver's licenses. In a national study conducted in 1983 with a sample of 10,000 16-year-olds in the U.S., 46% had their licenses. In a similar study in 2018, surveying a sample of 10,000 16-year-olds

in the U.S., only 25% had their licenses.[4] Using the information provided, test to determine if there is a significant difference between the proportion of 16-year-olds that had their licenses in 1983 and 2018. Use a significance level of 0.05. Let Population 1 be 16-year-olds in 1983 and Population 2 be 16-year-olds in 2018.

11. A new method for temporarily relieving the lung congestion of cystic fibrosis patients has been introduced. The traditional method of relieving the congestion involves a series of manual techniques where the chest and back area are pounded and massaged. The new method is a mechanical vest which has been designed to perform the manual techniques. A study is conducted to measure the effectiveness of the new vest. Five cystic fibrosis patients are randomly selected and the diameter of the blood vessels in their lungs are measured after using the traditional treatment and after using the vest treatment. The larger the diameter of the blood vessels within the lungs the better the treatment. If the study provides conclusive evidence that the vest is at least as effective as the manual method in increasing the diameter of the blood vessels, the hospital will recommend the vest to its patients because the vest allows the patients to be much more independent. The results of the study are shown in the following table. Let Population 1 be patients using the traditional method and Population 2 be patients using the vest method.

Diameter of Lung Blood Vessels (in mm)					
Subject	**1**	**2**	**3**	**4**	**5**
After Traditional Method	0.5	0.4	0.7	0.6	0.2
After Vest Method	0.6	0.6	0.7	0.7	0.5

a. Is a paired design appropriate for the above experiment? Explain.

b. What assumption must be made in order to perform the test of hypothesis?

c. Does the data appear to satisfy the assumption described in part **b.**? Why or why not?

d. Based on the data will the hospital recommend the Vest method to its cystic fibrosis patients? Use $\alpha = 0.05$.

12. A company believes that the variance in revenue from products produced in two facilities, measured in millions of dollars, is greater for Facility A than for Facility B. The sample standard deviation of a random sample of 19 products from Facility A is 1.5984 million of dollars. The sample standard deviation for a random sample of 18 products from Facility B is 1.0426 million of dollars. Assume that both population distributions are approximately normal and test the company's claim using a 0.10 level of significance. Does the evidence support the company's claim? Let the products produced in Facility A be Population 1 and let the products produced in Facility B be Population 2.

13. Shirley is analyzing her family's budget regarding how much they spend when eating out. She believes that the variance in expenditures when eating out is less when she uses cash as compared to when she uses her credit card. The following data represent a random sample of her family's cash and credit card purchases when eating out last month. Assume that both population distributions are approximately normal and test Shirley's claim using a 0.05 level of significance. Let Population 1 be the cash purchases and let Population 2 be the credit card purchases.

Cash	$24.24	$26.96	$22.48	$26.45	$26.74	$23.99	$25.70	$26.73	$25.12	$24.23
Credit Card	$20.46	$25.02	$26.36	$23.95	$25.84	$24.96	$20.82	$23.41	$24.70	$23.58