10.19 In a research report, Richard H. Weindruch of the UCLA Medical School claims that mice with an average life span of 32 months will live to be about 40 months old when 40% of the calories in their diet are replaced by vitamins and protein. Is there any reason to believe that μ < 40 if 64 mice that are placed on this diet have an average life of 38 months with a standard deviation of 5.8 months? Use a P-value in your conclusion.

10.20 A random sample of 64 bags of white cheddar popcorn weighed, on average, 5.23 ounces with a standard deviation of 0.24 ounce. Test the hypothesis that μ = 5.5 ounces against the alternative hypothesis, μ < 5.5 ounces, at the 0.05 level of significance. 10.21 An electrical firm manufactures light bulbs that have a lifetime that is approximately normally distributed with a mean of 800 hours and a standard deviation of 40 hours. Test the hypothesis that μ = 800 hours against the alternative, μ   
= 800 hours, if a random sample of 30 bulbs has an average life of 788 hours. Use a P-value in your answer. 10.22 In the American Heart Association journal Hypertension, researchers report that individuals who practice Transcendental Meditation (TM) lower their blood pressure significantly. If a random sample of 225 male TM practitioners meditate for 8.5 hours per week with a standard deviation of 2.25 hours, does that suggest that, on average, men who use TM meditate more than 8 hours per week? Quote a P-value in your conclusion. 10.23 Test the hypothesis that the average content of containers of a particular lubricant is 10 liters if the contents of a random sample of 10 containers are 10.2, 9.7, 10.1, 10.3, 10.1, 9.8, 9.9, 10.4, 10.3, and 9.8 liters. Use a 0.01 level of significance and assume that the distribution of contents is normal. 10.24 The average height of females in the freshman class of a certain college has historically been 162.5 centimeters with a standard deviation of 6.9 centimeters. Is there reason to believe that there has been a change in the average height if a random sample of 50 females in the present freshman class has an average height of 165.2 centimeters? Use a P-value in your conclusion. Assume the standard deviation remains the same. 10.25 It is claimed that automobiles are driven on average more than 20,000 kilometers per year. To test this claim, 100 randomly selected automobile owners are asked to keep a record of the kilometers they travel. Would you agree with this claim if the random sample showed an average of 23,500 kilometers and a standard deviation of 3900 kilometers? Use a P-value in your conclusion. 10.26 According to a dietary study, high sodium intake may be related to ulcers, stomach cancer, and migraine headaches. The human requirement for salt is only 220 milligrams per day, which is surpassed in most single servings of ready-to-eat cereals. If a random sample of 20 similar servings of a certain cereal has a mean sodium content of 244 milligrams and a standard deviation of 24.5 milligrams, does this suggest at the 0.05 level of significance that the average sodium content for a single serving of such cereal is greater than 220 milligrams? Assume the distribution of sodium contents to be normal. / / Exercises 357 10.27 A study at the University of Colorado at Boulder shows that running increases the percent resting metabolic rate (RMR) in older women. The average RMR of 30 elderly women runners was 34.0% higher than the average RMR of 30 sedentary elderly women, and the standard deviations were reported to be 10.5 and 10.2%, respectively. Was there a significant increase in RMR of the women runners over the sedentary women? Assume the populations to be approximately normally distributed with equal variances. Use a P-value in your conclusions. 10.28 According to Chemical Engineering, an important property of fiber is its water absorbency. The average percent absorbency of 25 randomly selected pieces of cotton fiber was found to be 20 with a standard deviation of 1.5. A random sample of 25 pieces of acetate yielded an average percent of 12 with a standard deviation of 1.25. Is there strong evidence that the population mean percent absorbency is significantly higher for cotton fiber than for acetate? Assume that the percent absorbency is approximately normally distributed and that the population variances in percent absorbency for the two fibers are the same. Use a significance level of 0.05. 10.29 Past experience indicates that the time required for high school seniors to complete a standardized test is a normal random variable with a mean of 35 minutes. If a random sample of 20 high school seniors took an average of 33.1 minutes to complete this test with a standard deviation of 4.3 minutes, test the hypothesis, at the 0.05 level of significance, that μ = 35 minutes against the alternative that μ < 35 minutes. 10.30 A random sample of size n1 = 25, taken from a normal population with a standard deviation σ1 = 5.2, has a mean ¯x1 = 81. A second random sample of size n2 = 36, taken from a different normal population with a standard deviation σ2 = 3.4, has a mean ¯x2 = 76. Test the hypothesis that μ1 = μ2 against the alternative, μ1   
= μ2. Quote a P-value in your conclusion. 10.31 A manufacturer claims that the average tensile strength of thread A exceeds the average tensile strength of thread B by at least 12 kilograms. To test this claim, 50 pieces of each type of thread were tested under similar conditions. Type A thread had an average tensile strength of 86.7 kilograms with a standard deviation of 6.28 kilograms, while type B thread had an average tensile strength of 77.8 kilograms with a standard deviation of 5.61 kilograms. Test the manufacturer’s claim using a 0.05 level of significance. 10.32 Amstat News (December 2004) lists median salaries for associate professors of statistics at research institutions and at liberal arts and other institutions in the United States. Assume that a sample of 200 associate professors from research institutions has an average salary of $70,750 per year with a standard deviation of $6000. Assume also that a sample of 200 associate professors from other types of institutions has an average salary of $65,200 with a standard deviation of $5000. Test the hypothesis that the mean salary for associate professors in research institutions is $2000 higher than for those in other institutions. Use a 0.01 level of significance. 10.33 A study was conducted to see if increasing the substrate concentration has an appreciable effect on the velocity of a chemical reaction. With a substrate concentration of 1.5 moles per liter, the reaction was run 15 times, with an average velocity of 7.5 micromoles per 30 minutes and a standard deviation of 1.5. With a substrate concentration of 2.0 moles per liter, 12 runs were made, yielding an average velocity of 8.8 micromoles per 30 minutes and a sample standard deviation of 1.2. Is there any reason to believe that this increase in substrate concentration causes an increase in the mean velocity of the reaction of more than 0.5 micromole per 30 minutes? Use a 0.01 level of significance and assume the populations to be approximately normally distributed with equal variances. 10.34 A study was made to determine if the subject matter in a physics course is better understood when a lab constitutes part of the course. Students were randomly selected to participate in either a 3-semesterhour course without labs or a 4-semester-hour course with labs. In the section with labs, 11 students made an average grade of 85 with a standard deviation of 4.7, and in the section without labs, 17 students made an average grade of 79 with a standard deviation of 6.1. Would you say that the laboratory course increases the average grade by as much as 8 points? Use a P-value in your conclusion and assume the populations to be approximately normally distributed with equal variances. 10.35 To find out whether a new serum will arrest leukemia, 9 mice, all with an advanced stage of the disease, are selected. Five mice receive the treatment and 4 do not. Survival times, in years, from the time the experiment commenced are as follows: Treatment 2.1 5.3 1.4 4.6 0.9 No Treatment 1.9 0.5 2.8 3.1 At the 0.05 level of significance, can the serum be said to be effective? Assume the two populations to be normally distributed with equal variances. 10.36 Engineers at a large automobile manufacturing company are trying to decide whether to purchase brand A or brand B tires for the company’s new models. To help them arrive at a decision, an experiment is conducted using 12 of each brand. The tires are run / / 358 Chapter 10 One- and Two-Sample Tests of Hypotheses until they wear out. The results are as follows: Brand A : ¯x1 = 37,900 kilometers, s1 = 5100 kilometers. Brand B : ¯x1 = 39,800 kilometers, s2 = 5900 kilometers. Test the hypothesis that there is no difference in the average wear of the two brands of tires. Assume the populations to be approximately normally distributed with equal variances. Use a P-value. 10.37 In Exercise 9.42 on page 295, test the hypothesis that the fuel economy of Volkswagen mini-trucks, on average, exceeds that of similarly equipped Toyota mini-trucks by 4 kilometers per liter. Use a 0.10 level of significance. 10.38 A UCLA researcher claims that the average life span of mice can be extended by as much as 8 months when the calories in their diet are reduced by approximately 40% from the time they are weaned. The restricted diets are enriched to normal levels by vitamins and protein. Suppose that a random sample of 10 mice is fed a normal diet and has an average life span of 32.1 months with a standard deviation of 3.2 months, while a random sample of 15 mice is fed the restricted diet and has an average life span of 37.6 months with a standard deviation of 2.8 months. Test the hypothesis, at the 0.05 level of significance, that the average life span of mice on this restricted diet is increased by 8 months against the alternative that the increase is less than 8 months. Assume the distributions of life spans for the regular and restricted diets are approximately normal with equal variances. 10.39 The following data represent the running times of films produced by two motion-picture companies: Company Time (minutes) 1 102 86 98 109 92 2 81 165 97 134 92 87 114 Test the hypothesis that the average running time of films produced by company 2 exceeds the average running time of films produced by company 1 by 10 minutes against the one-sided alternative that the difference is less than 10 minutes. Use a 0.1 level of significance and assume the distributions of times to be approximately normal with unequal variances. 10.40 In a study conducted at Virginia Tech, the plasma ascorbic acid levels of pregnant women were compared for smokers versus nonsmokers. Thirty-two women in the last three months of pregnancy, free of major health disorders and ranging in age from 15 to 32 years, were selected for the study. Prior to the collection of 20 ml of blood, the participants were told to avoid breakfast, forgo their vitamin supplements, and avoid foods high in ascorbic acid content. From the blood samples, the following plasma ascorbic acid values were determined, in milligrams per 100 milliliters: Plasma Ascorbic Acid Values Nonsmokers Smokers 0.97 1.16 0.48 0.72 0.86 0.71 1.00 0.85 0.98 0.81 0.58 0.68 0.62 0.57 1.18 1.32 0.64 1.36 1.24 0.98 0.78 0.99 1.09 1.64 0.90 0.92 0.74 0.78 0.88 1.24 0.94 1.18 Is there sufficient evidence to conclude that there is a difference between plasma ascorbic acid levels of smokers and nonsmokers? Assume that the two sets of data came from normal populations with unequal variances. Use a P-value. 10.41 A study was conducted by the Department of Zoology at Virginia Tech to determine if there is a significant difference in the density of organisms at two different stations located on Cedar Run, a secondary stream in the Roanoke River drainage basin. Sewage from a sewage treatment plant and overflow from the Federal Mogul Corporation settling pond enter the stream near its headwaters. The following data give the density measurements, in number of organisms per square meter, at the two collecting stations: Number of Organisms per Square Meter Station 1 Station 2 5030 4980 2800 2810 13,700 11,910 4670 1330 10,730 8130 6890 3320 11,400 26,850 7720 1230 860 17,660 7030 2130 2200 22,800 7330 2190 4250 1130 15,040 1690 Can we conclude, at the 0.05 level of significance, that the average densities at the two stations are equal? Assume that the observations come from normal populations with different variances. 10.42 Five samples of a ferrous-type substance were used to determine if there is a difference between a laboratory chemical analysis and an X-ray fluorescence analysis of the iron content. Each sample was split into two subsamples and the two types of analysis were applied. Following are the coded data showing the iron content analysis: / / Exercises 359 Sample Analysis 12345 X-ray 2.0 2.0 2.3 2.1 2.4 Chemical 2.2 1.9 2.5 2.3 2.4 Assuming that the populations are normal, test at the 0.05 level of significance whether the two methods of analysis give, on the average, the same result. 10.43 According to published reports, practice under fatigued conditions distorts mechanisms that govern performance. An experiment was conducted using 15 college males, who were trained to make a continuous horizontal right-to-left arm movement from a microswitch to a barrier, knocking over the barrier coincident with the arrival of a clock sweephand to the 6 o’clock position. The absolute value of the difference between the time, in milliseconds, that it took to knock over the barrier and the time for the sweephand to reach the 6 o’clock position (500 msec) was recorded. Each participant performed the task five times under prefatigue and postfatigue conditions, and the sums of the absolute differences for the five performances were recorded. Absolute Time Differences Subject Prefatigue Postfatigue 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 158 92 65 98 33 89 148 58 142 117 74 66 109 57 85 91 59 215 226 223 91 92 177 134 116 153 219 143 164 100 An increase in the mean absolute time difference when the task is performed under postfatigue conditions would support the claim that practice under fatigued conditions distorts mechanisms that govern performance. Assuming the populations to be normally distributed, test this claim. 10.44 In a study conducted by the Department of Human Nutrition and Foods at Virginia Tech, the following data were recorded on sorbic acid residuals, in parts per million, in ham immediately after dipping in a sorbate solution and after 60 days of storage: Sorbic Acid Residuals in Ham Slice Before Storage After Storage 1 2 3 4 5 6 7 8 224 270 400 444 590 660 1400 680 116 96 239 329 437 597 689 576 Assuming the populations to be normally distributed, is there sufficient evidence, at the 0.05 level of significance, to say that the length of storage influences sorbic acid residual concentrations? 10.45 A taxi company manager is trying to decide whether the use of radial tires instead of regular belted tires improves fuel economy. Twelve cars were equipped with radial tires and driven over a prescribed test course. Without changing drivers, the same cars were then equipped with regular belted tires and driven once again over the test course. The gasoline consumption, in kilometers per liter, was recorded as follows: Kilometers per Liter Car Radial Tires Belted Tires 1 4.2 4.1 2 4.7 4.9 3 6.6 6.2 4 7.0 6.9 5 6.7 6.8 6 4.5 4.4 7 5.7 5.7 8 6.0 5.8 9 7.4 6.9 10 4.9 4.7 11 6.1 6.0 12 5.2 4.9 Can we conclude that cars equipped with radial tires give better fuel economy than those equipped with belted tires? Assume the populations to be normally distributed. Use a P-value in your conclusion. 10.46 In Review Exercise 9.91 on page 313, use the tdistribution to test the hypothesis that the diet reduces a woman’s weight by 4.5 kilograms on average against the alternative hypothesis that the mean difference in weight is less than 4.5 kilograms. Use a P-value. 10.47 How large a sample is required in Exercise 10.20 if the power of the test is to be 0.90 when the true mean is 5.20? Assume that σ = 0.24. 10.48 If the distribution of life spans in Exercise 10.19 is approximately normal, how large a sample is required in order that the probability of committing a type II error be 0.1 when the true mean is 35.9 months? Assume that σ = 5.8 months. 360 Chapter 10 One- and Two-Sample Tests of Hypotheses 10.49 How large a sample is required in Exercise 10.24 if the power of the test is to be 0.95 when the true average height differs from 162.5 by 3.1 centimeters? Use α = 0.02.