ethanol and another group given a placebo. The results are given below. Use a 0.05 significance level to test the claim that the two sample groups come from populations with the same mean. The given results are based on data from "Effects of Alcohol Intoxication on Risk Taking, Strategy, and Error Rate in Visuomotor Performance," by Streufert, et al., *Journal of Applied Psychology*, Vol. 77, No. 4.

Treatment Group:	$n_1 = 22, \bar{x}_1 = 0.049, s_1 = 0.015$
Placebo Group:	$n_2 = 22, \bar{x}_2 = 0.000, s_2 = 0.000$

28. Calculating Degrees of Freedom The confidence interval given in Exercise 2 is based on df $=$ 39, which is the "smaller of $n_1 - 1$ and $n_2 - 1$." Use Formula 9-1 to find the number of degrees of freedom. Using the number of degrees of freedom from Formula 9-1 results in this confidence interval: 11.65 cm $< \mu_1 - \mu_2 <$ 17.28 cm. In what sense is "df $=$ smaller of $n_1 - 1$ and $n_2 - 1$" a more conservative estimate of the number of degrees of freedom than the estimate obtained with Formula 9-1?

29. One Standard Deviation Known We sometimes know the value of one population standard deviation from an extensive history of data, but a new procedure or treatment results in sample values with an unknown standard deviation. If σ_1 is known but σ_2 is unknown, use the procedures in Part 1 of this section with these changes: Replace s_1 with the known value of σ_1 and find the number of degrees of freedom using the expression below. (See "The Two-Sample *t* Test with One Variance Unknown," by Maity and Sherman, *The American Statistician*, Vol. 60, No. 2.) Repeat Exercise 13 by assuming that $\sigma = 15$ for proctored tests.

$$df = \frac{\left(\dfrac{\sigma_1^2}{n_1} + \dfrac{s_2^2}{n_2}\right)^2}{\dfrac{(s_2^2/n_2)^2}{n_2 - 1}}$$

9-4 Two Dependent Samples (Matched Pairs)

Key Concept In this section we present methods for testing hypotheses and constructing confidence intervals involving the mean of the differences of the values from two populations which are dependent in the sense that the data consist of matched pairs. The pairs must be matched according to some relationship, such as before/after measurements from the same subjects or IQ scores of husbands and wives. The following two sets of sample data look similar because they both consist of two samples with five heights each, but the first case has dependent samples because there is a relationship that is a basis for matching the pairs of data. The second case consists of independent samples because there is no relationship that serves as a basis for matching the pairs of data.

Dependent Samples: Matched pairs of heights of U.S. presidents and heights of their main opponents.

Height (cm) of President	189	173	183	180	179
Height (cm) of Main Opponent	170	185	175	180	178

Independent Samples: Heights of males and females that are listed together, but there is no relationship between the males and females.

Height (cm) of Male	178.8	177.5	187.8	172.4	181.7
Height (cm) of Female	163.7	165.5	163.1	166.3	163.6