Method 2: *p*-Values

The output screen in Step 3 displays the p-value = 0.074407. Since the p-value is less than our level of significance, $\alpha = 0.10$, we reject the null hypothesis.

Interpretation: Thus, the researchers can conclude that there is sufficient evidence, at the 0.10 level of significance, to support the claim that at least one of the population means is different. That is, the evidence suggests that the mean decrease in a woman's cholesterol level for at least one of the drugs is different from the others. However, we cannot conclude, from the one-way ANOVA test alone, how the population means differ. Looking at the descriptive statistics for the sample data, we see that Drugs 1 and 3 lowered the women's cholesterol levels by a mean of 20.1 points and Drug 2 lowered the women's cholesterol levels by a mean of 18.2 points, which suggests that the population mean for Drug 2 differs from the others, but we cannot make this conclusion from the one-way ANOVA test alone.

Note that the one-way ANOVA test only tells us whether there exists a difference between the population means. It does not tell you which mean, or means, are different from the others. If you want to determine which means are different, you would use a multiple comparisons test such a Tukey, Dunnet, or an MCB test, which are beyond the scope of this book.

11.6 Section Exercises

Critical Values for One-Way ANOVA Tests

Find the critical value for a one-way ANOVA test using the given information.

1. $\alpha = 0.05,\ df_1 = 10,\ df_2 = 12$

2. $\alpha = 0.01,\ df_1 = 9,\ df_2 = 15$

3. $\alpha = 0.10,\ df_1 = 7,\ df_2 = 8$

4. $\alpha = 0.05,\ df_1 = 3,\ df_2 = 9$

5. $\alpha = 0.10,\ df_1 = 1,\ df_2 = 5$

6. $\alpha = 0.01,\ df_1 = 6,\ df_2 = 4$

ANOVA Tables

Complete each ANOVA table.

7.

	SS	*df*	*MS*	*F*
Treatments (T)	4	5		
Error (E)	11	6		
Total				

8.

	SS	*df*	*MS*	*F*
Treatments (T)	49.3	4		
Error (E)		3		
Total	142.5			

9.

	SS	*df*	*MS*	*F*
Treatments (T)	50		12.5	
Error (E)		3		
Total	74			

10.	*SS*	*df*	*MS*	*F*
Treatments (T)		9		
Error (E)	21.8		5.45	
Total	101.9			

One-Way ANOVA Tests

Perform each one-way ANOVA test. Assume that the population distributions for each test are all approximately normal with equal population variances. For each exercise, complete the following steps.

a. Find all the values for the ANOVA table.b. Draw a conclusion and interpret the decision.

c. If there is enough evidence to support the claim that at least one of the population means differs from the others, determine, if possible, which population mean(s) is (are) different.

11. A regional manager wants to know if there is a difference between the mean amounts of time that customers wait in line at the drive-through window for the three stores in her region. She randomly samples the wait times at each store. Her data are given in the following table. Use a one-way ANOVA test to determine if there is a difference between the mean wait times for the three stores, at the 0.05 level of significance.

Drive-Through Wait Times (in Minutes)

Store 1	Store 2	Store 3
2.34	2.87	1.32
1.23	1.94	1.45
1.89	2.36	1.78
2.31	1.85	2.01
3.02	1.75	2.45
1.95	2.82	1.92
2.45	3.32	1.83

12. A manager is concerned that one of his workers is producing more defective parts, on average, than the other similarly skilled workers. He records the number of defective parts made by this worker and two others with similar experience during their shifts each day for one week. The results are provided in the following table. At the 0.10 level of significance, can you conclude that there is a difference between the mean numbers of defective parts produced each day by these three workers?

Number of Defective Parts per Day

Worker A	Worker B	Worker C
3	2	1
2	2	2
2	1	1
4	0	1
2	1	2

13. The Panhellenic Council is comparing the mean GPAs of four sororities on campus. The GPAs for 10 girls in each sorority are given in the following table. Based on these data, can you conclude that there is a difference between the mean GPAs for these four sororities? Use a 0.05 level of significance.

Sorority GPAs

ΛΧΒ	ΩΣ	ΘΠ	ΔΜΟ
2.5	3.1	2.7	3.1
3.4	3.4	2.9	3.2
4.0	3.6	2.8	3.1
3.8	3.6	2.8	2.8
2.7	3.7	2.9	2.9
2.8	3.0	3.1	3.1
2.8	4.0	2.9	3.0
3.2	3.9	2.7	3.3
3.1	4.0	2.6	2.7
3.9	3.4	3.3	2.6

14. A group of paramedics does not believe that the mean numbers of calls received in one shift are the same for the morning, afternoon, and night shifts. To test this claim, they record the number of calls received during each shift for seven days. Based on this evidence, can the paramedics conclude that the mean numbers of calls are different for the three shifts? Use a 0.01 level of significance.

Number of Calls per Shift

Morning	Afternoon	Night
2	3	5
3	4	4
2	4	5
4	5	3
3	3	2
1	2	5
3	5	6

15. A researcher believes there is a difference in the mean number of days before visible results begin to show among three types of facial creams that reduce wrinkle lines. Several consumers are randomly selected and given one of the three creams. Each participant then recorded the number of days it took to see results. The results are shown in the table. Based on these data, can you conclude that there is a difference between the mean number of days for these three creams? Use a 0.01 level of significance.

Cream #1	Cream #2	Cream #3
16	14	12
14	17	17
21	15	12
15	20	15
19		

16. A local weather team is comparing the mean amount of snowfall reported by viewers in four different regions of the city. Based on the data, can you conclude that there is a difference between the mean amount of snowfall for these four regions? Use a 0.10 level of significance.

Region 1	Region 2	Region 3	Region 4
3.26	2.34	2.80	2.34
2.22	2.38	2.87	2.43
3.26	3.31	3.03	2.38
3.39	2.39	2.49	3.31
2.84	3.40	2.84	2.39
3.01	2.70	3.23	3.40
3.13	2.34	3.49	2.71
2.84	2.11	3.59	2.34
3.00		3.81	
2.74			