could lead to bias. In method **A**, the members of each group are randomly selected, which makes the two groups theoretically similar except for the variable, the different ointments. This method is most reliable.

TEST PREP

32. B

33. J; because receving vitamin D is the treatment

CHALLENGE AND EXTEND

34. Answers will vary.

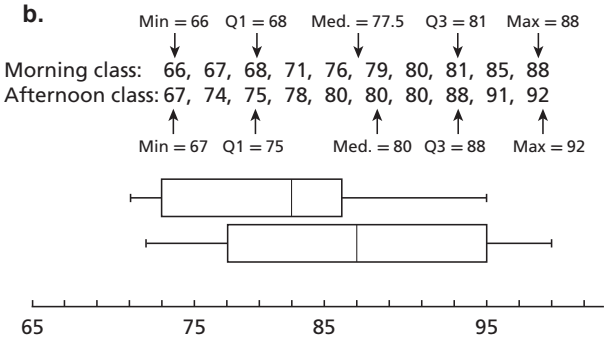
35. Answers will vary.

8-4 SIGNIFICANCE OF EXPERIMENTAL RESULTS

CHECK IT OUT!

1a. The students in the morning class will have the same test scores as the students in the afternoon class.

b.



Yes; there is a large difference in the test scores of the two classes. The teacher does have enough evidence to reject the null hypothesis, so she can conclude that students perform better on tests given in the afternoon class.

2. The null hypothesis is that there is no difference between the claimed population mean of \$3000 and the sample mean of \$2600. Calculate the *z*-value:

$$\frac{2600 - 3000}{\frac{300}{\sqrt{40}}} \approx \frac{-400}{47.43} \approx -8.43$$

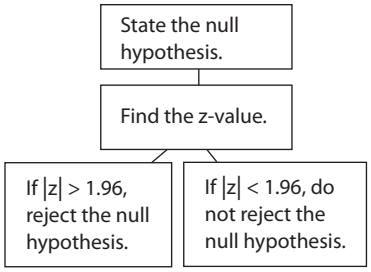
Because $|z| = 8.43 > 1.96$, you can reject the claim of the tax preparer.

THINK AND DISCUSS

1. Possible answer: This fertilizer will not be effective in increasing the yield of this year's crops.

2. If you do not reject the null hypothesis, you have only shown that a claim might still be true.

3.



EXERCISES

GUIDED PRACTICE

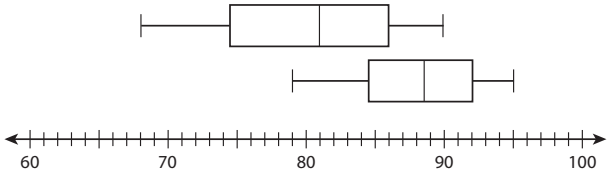
1. chance **2.** null hypothesis

3a. The test scores will be the same for both groups of new employees at Company A.

b. Arrange the data in order and find the median, quartiles, minimum and maximum for both the control and treatment group.

Control : 68, 70, 72, 77, 78, 80, 82, 82, 85, 87, 88, 90
Min: 68, Q1: 74.5, Median: 81, Q3: 86,
Max 90

Treatment: 79, 84, 84, 85, 85, 88, 89, 90, 92, 92, 94, 95
Min: 79, Q1: 84.5, Median: 88.5, Q3: 92,
Max 95



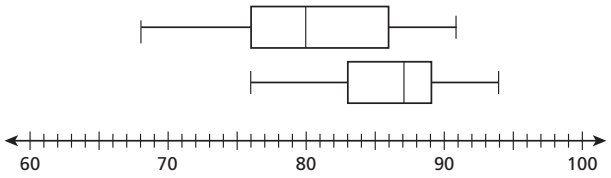
There is a large difference in the two groups that is unlikely to be caused by chance. The labor union should reject the null hypothesis, which means that the professional development program is working to increase the test scores of Company A.

4a. The test scores will be the same for both groups of new employees at Company B.

b. Arrange the data in order and find the median, quartiles, minimum and maximum for both the control and treatment group.

Control : 68, 74, 75, 77, 78, 80, 80, 82, 83, 89, 89, 91
Min: 68, Q One: 76, Median: 80, Q Three: 86, Max 91

Treatment: 76, 79, 82, 84, 85, 87, 87, 88, 88, 90, 92, 94
Min: 76, Q One: 83, Median: 87, Q Three: 89, Max 94



There is a large difference in the two groups that is unlikely to be caused by chance. The labor union should reject the null hypothesis, which means that the professional development program is working to increase the text scores of Company B.

5. population mean (μ) = 0.2 sample mean ($\bar{x}$) = 0.185 standard deviation (σ) = 0.04 sample size (n) = 50

Find the z-value $\dfrac{0.185 - 0.2}{\dfrac{0.04}{\sqrt{50}}} = \dfrac{-0.015}{0.00566} \approx -2.65$

Because the absolute value of the z-value is > 1.96, you can reject the firm's claim.

6. population mean (μ) = 0.85 sample mean ($\bar{x}$) = 0.88 standard deviation (σ) = 0.08 sample size (n) = 20

Find the z-value $\dfrac{0.88 - 0.85}{\dfrac{0.08}{\sqrt{20}}} = \dfrac{0.03}{0.0178} \approx 1.68$

Because the absolute value of the z-value is < 1.96, there is not enough evidence to reject the publisher's claim.

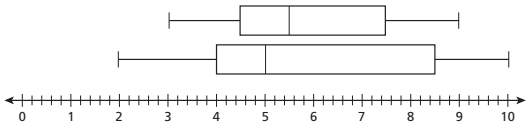
PRACTICE AND PROBLEM SOLVING

7a. The levels of the substance will be the same for residents of both cities

b. Arrange the data in order and find the median, quartiles, minimum and maximum for both the control and treatment group.

Known quality : 3, 4, 4, 5, 5, 5, 6, 7, 7, 8, 8, 9
Min: 3, Q1: 4.5, Median: 5.5, Q3: 7.5, Max 9

Unknown quality: 2, 2, 4, 4, 5, 5, 5, 7, 8, 9, 9, 10
Min: 2, Q1: Three, Median: 5, Q3: 8.5,
Max 10



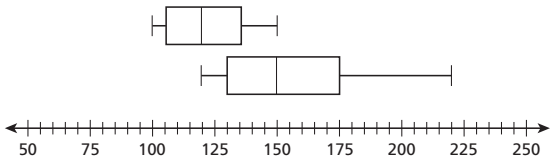
The data is spread evenly in the two groups, so any difference is likely to be caused by chance. The null hypothesis cannot be rejected based on these results.

8a. The nitrogen levels will be the same in the treated and untreated plants.

b. Arrange the data in order and find the median, quartiles, minimum and maximum for both the control and treatment group.

Untreated plants : 100, 100, 110, 120, 120, 130, 130, 140, 150
Min: 100, Q One: 105, Median: 120, Q Three: 135, Max 150

Treated plants: 120, 130, 130, 150, 150, 160, 170, 180, 220
Min: 120, Q One: 130, Median: 150, Q Three: 175, Max 220



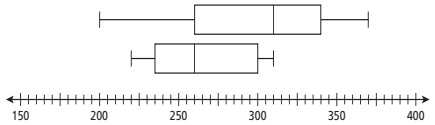
There is a large difference in the two groups that is unlikely to be caused by chance. The null hypothesis should be rejected.

9a. The potassium levels will be the same in the treated and untreated plants.

b. Arrange the data in order and find the median, quartiles, minimum and maximum for both the control and treatment group.

Treated plants : 200, 250, 270, 310, 310, 320, 340, 340, 370
Min: 200, Q1: 260, Median: 310, Q3: 340,
Max 370

Treated plants: 220, 220, 250, 260, 260, 280, 290, 310, 310
Min: 220, Q1: 235, Median: 260, Q3: 300,
Max 310



The data is spread about evenly in the two groups, so any difference is likely to be caused by chance. The null hypothesis cannot be rejected based on these results.

10a. population mean (μ) = 120 sample mean ($\bar{x}$) = 122 standard deviation (σ) = 10 sample size (n) = 20

Find the z-value $\dfrac{122 - 120}{\dfrac{10}{\sqrt{20}}} = \dfrac{2}{2.23} \approx 0.89$

b. Because the absolute value of the z-value is < 1.96, you cannot reject the company's claim.

c. population mean (μ) = 80 sample mean ($\bar{x}$) = 85 standard deviation (σ) = 8 sample size (n) = 20

Find the z-value $\dfrac{85 - 80}{\dfrac{8}{\sqrt{20}}} = \dfrac{5}{1.79} \approx 2.80$

d. Because the absolute value of the z-value is > 1.96, you can reject the company's claim.

11. population mean (μ) = 0.92 sample mean ($\bar{x}$) = 0.87 standard deviation (σ) 0.07 sample size (n) = 25

Find the z-value $\dfrac{0.87 - 0.92}{\dfrac{0.07}{\sqrt{25}}} = \dfrac{-0.05}{0.014} \approx -3.57$

Because the absolute value of the z-value is > 1.96, you can reject the teacher's claim.

12. population mean (μ) = 0.15 sample mean ($\bar{x}$) = 0.08 standard deviation (σ) = 0.02 sample size (n) = 30

Find the z-value $\dfrac{0.08 - 0.15}{\dfrac{0.02}{\sqrt{30}}} = \dfrac{-0.07}{0.0037} \approx -19.17$

Because the absolute value of the z-value is > 1.96, you can reject the insurance company's claim.

13. population mean (μ) = 0.15 sample mean ($\bar{x}$) = 0.14 standard deviation (σ) = 0.05 sample size (n) = 25

Find the z-value $\dfrac{0.14 - 0.15}{\dfrac{0.05}{\sqrt{25}}} = \dfrac{-0.01}{0.01} \approx -1$

Because the absolute value of the z-value is < 1.96, you cannot reject the firm's claim.

14. The z-value is calculated by first finding the mean of the sample population then subtracting the mean of the entire population. This number goes in the numerator. The denominator is found by dividing the standard deviation of the sample population by the square root of the sample size. Divide the numerator by the denominator to find the z-value.

15. Statement 1 is a candidate for hypothesis testing. A population mean can be determined by finding the insulin levels in a given population. A sample population can be determined by giving a sample of the population the drug and finding insulin levels in the sample population. A z-value can then be determined.

None of these things can be done with statement 2.

Neither statement can be proved *with certainty* today. Statement 1 cannot be proven true at all, it can only be tested and proven false with a large degree of certainty. Statement 2 can only be proved true tomorrow, when it either rains or does not rain.

16. As the denominator in the formula for finding the z-value is always positive, the sign of the z-value is determined by the numerator. A positive z-value means that the value of the mean in the sample is greater than the value of the mean in the entire population. A negative z-value means that the value of the mean in the sample is smaller than the value of the mean in the entire population.

17. Shondell has calculated the z-value correctly. Mandy made an error when she went to divide -2 by ¾ after the third step. Instead of multiplying by the reciprocal, the proper way to divide fractions, she multiplied by the fraction itself and so came up with the incorrect z-value.

TEST PREP

18. A; standard deviation of the population is not used to calculate the z-value; however, each of the measures in B, C, and D are used.

19. F; $\dfrac{5 - 4.7}{\dfrac{0.5}{\sqrt{49}}} \approx \dfrac{0.3}{0.0714286} \approx 4.2$

CHALLENGE AND EXTEND

20a. The mean of the scores of the students in her class is 86.8. The standard deviation is 4.95, or about 5.

b. Math skills do not have any correlation to foreign language skills.

c. population mean (μ) $= 87.6$ sample mean ($\bar{x}$) $= 86.8$ standard deviation (σ) $= 5$ sample size (n) $= 5$

Find the z-value $\dfrac{86.8 - 87.6}{\dfrac{5}{\sqrt{5}}} = \dfrac{-0.8}{\sqrt{5}} \approx -0.36$

Because the absolute value of the z-value is $<$ 1.96, you cannot reject the teacher's claim, so it is possible that math skills are a good indicator of foreign language skills.

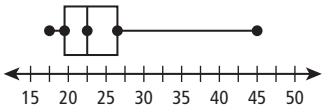
21. Billy is correct. The fact that their results fall well outside the expected range only makes it unlikely that they performed the experiment wrong; their results are not in and of themselves conclusive proof of incorrectly conducting the experiment.

READY TO GO ON?

1. expected value
$= 0(0.82) + 1(0.11) + 2(0.04) + 3(0.02) + 4(0.01)$
$= 0.29$

2. 17, 18, 21, 22, 23, 25, 28, 45

minimum: 17	first quartile: 19.5
maximum: 45	third quartile: 26.5
median: 22.5	IQR: 7



3. mean: 23; standard deviation: ≈ 6.9856997
The lengths 16.01 in. to 29.99 in. are 1 standard deviation away from the mean.

4. mean: 55; standard deviation: ≈ 54.3

5. The sample could be biased because it is a convenience sample that will likely only be filled out by those with exceptionally good or bad service.

6. 12 out of 30 employees said they would prefer a company-sponsored lunch. So:
$\dfrac{12}{30} = \dfrac{x}{250}$
$30x = 3000$
$x = 100$

7. It would be unethical to risk injuring a person's vision in an experiment. Perform an observational study: compare the visual acuity of people before and after accidental exposure to x-rays.

8. An experiment can be run without causing harm. Perform an experiment: select two of the same model of car, and run one with and one without the additive.

9. The null hypothesis is that there is no difference between the mean of the sample and the mean of the population. The mean of a sample is being compared to the mean of a population, so use $z = \dfrac{\bar{x} - \mu}{\dfrac{\sigma}{\sqrt{n}}}$. Because $\bar{x} = 0.08$, $\mu = 0.09$, $\sigma = 0.04$, and $n = 35$, then $z = \dfrac{0.08 - 0.09}{\dfrac{0.04}{\sqrt{35}}} \approx -1.48$.

Because $|z| = 1.48 < 1.96$, there is not enough evidence to reject the claim.