

CHALLENGE AND EXTEND

36a. By choosing 25 students from each class, the freshmen are overrepresented and the sophomores and the juniors are underrepresented.

b. Possible answer : Choose 19 freshmen, 27 sophomores, 29 juniors, and 25 seniors for the sample.

37. 100 students chosen from 504 students. In this sample, about 1 in every 5 students is surveyed, where the other method results in about 1 in every 7 students surveyed. The greater fraction of students surveyed, the more accurate the results are likely to be.

$$38. \frac{\text{students surveyed who did community service}}{\text{total students surveyed}} = \frac{\text{students who did community service}}{\text{total students}}$$

$$\frac{x}{20} = \frac{646}{760}$$
$$760x = 20 \cdot 646$$
$$x = 17 \text{ students}$$

$$39. \frac{\text{defective discs}}{\text{total discs}} = \frac{\text{defective discs}}{\text{total discs}}$$

$$\frac{2}{50} = \frac{x}{1000}$$
$$50x = 2 \cdot 1000$$
$$x = 40 \text{ defective discs}$$

This represents 4% that are defective. The manufacturer will not sell this lot.

40. Answers will vary.

8-3 SURVEYS, EXPERIMENTS, AND OBSERVATIONAL STUDIES

CHECK IT OUT!

1. It is an observational study because an observation is being conducted without controlling the environment in any way.
2. The treatment in this study is website users using the old and new websites to make purchases. The treatment group is 48 users of the website using the new website to make purchases. The control group is 48 users of the website using the old website to make purchases.
3. The treatment (consuming 1000 milligrams of vitamin C each day as a dietary supplement) is both practical and ethical because it is not known to have any negative effects. Perform an experiment. Randomly choose one group of people to take the vitamin C supplements. Randomly choose another group of people to not take the vitamin C supplements. Monitor the cholesterol levels in both groups at regular intervals.
4. In method A, the researcher gives each group a treatment, so the method is an experiment. In method B, the researcher asks questions about exercise habits. This method is a survey.

In method C, the researcher observes people who do and do not exercise and monitor their health, but does not impose a treatment. This is an observational study.

Method B is least reliable, because there is no basis for comparison. Method C has a comparison group, but the members are self-selected, which 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, exercise. This method is the most reliable.

THINK AND DISCUSS

1. In an experiment, a treatment is imposed, so the individual or the environment of the individual is affected by the study. This is not the case in an observational study.
2. Possible answer: It would not be ethical to test the effects of exposure to a certain cleaning chemical on people's respiratory health.

3. Experiment: A baker testing a new brand of yeast bakes 10 loaves with the old brand and 10 with the new brand.	
Control group: 10 loaves with old brand of yeast	Treatment Group: 10 loaves with new brand of yeast

EXERCISES

GUIDED PRACTICE

1. experiment
2. randomized comparative experiment
3. The caretaker applies a treatment (giving half the elephants the new food) to some of the individuals (elephants). The situation is an example of an experiment.
4. The school board gathers data without controlling the individuals or applying a treatment. The situation is an example of an observational study.
5. The treatment in this study is drinking no more soft drinks. The treatment group consists of the fifty students who stopped drinking soft drinks, and the control group consists of the fifty students who continued to drink soft drinks.
6. The treatment in this study is reintroducing the weeds. The treatment group consists of the fish in the lake with the weeds, and the control group consists of the fish in the lake without the weeds.
7. The treatment (exposing pets to second-hand smoke) may affect the pets' health, so it is not ethical to assign individuals to a treatment group. Perform an observational study; Possible answer: Randomly choose one group of pets who are already exposed to second-hand smoke. Randomly choose another group of pets that is not exposed to second-hand smoke. Monitor the health of the pets in both groups at regular intervals.

8. The treatment (taking a particular vitamin supplement) is both practical and ethical because it is not known to have any negative effects. Perform an experiment; Possible answer: Randomly choose one group of seasonal allergy sufferers to give the supplement to. Randomly choose another group of seasonal allergy sufferers that are untreated. Monitor the severity of allergy symptoms in both groups at regular intervals.
9. The treatment (installing more stoplights on a road) is impractical. Perform an observational study; Possible answer: Randomly choose a number of different roads that already have stoplights to gather data about the number of accidents vs. the number of stoplights presently installed per mile.
10. The treatment (using a certain toothpaste) is both practical and ethical because it is not known to have any negative effects. Perform an experiment; Possible answer: Randomly choose one group of children to use the one toothpaste. Randomly choose another group of children to use the other toothpaste. See how many cavities each group gets.
11. The treatment is *eating chicken before a baseball game*. Since the treatment is not harmful to the subjects, use an experiment. Possible answer: Have a player eat chicken before some games of baseball, and not others. Record the player's number of home runs. Repeat for many games, across several players.
12. The treatment (taking ginger) is practical and ethical because it is not known to have any negative effects. However, it would not be ethical to induce seasickness in a group of people. Use an observational study; Possible answer: Randomly choose one group of seasick people to give ginger to, and another group that will not take any ginger. Record the time it takes each to report the end of seasickness.
13. In method **A**, the researcher gives one group a treatment by asking them to drink coffee, so the method is an experiment. In method **B**, the researcher asks questions about people's self-reported regular habits. This method is a survey. In method **C**, the researcher observes people who are already either coffee-drinkers or non-coffee-drinkers, but does not impose a treatment. This is an observational study. Method **B** is least reliable, because there is no basis for comparison. Method **C** has a comparison group, but the groupings are based on self-reports, which 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, whether or not they are coffee-drinkers. This method is most reliable.
14. observational study
15. experiment
16. observational study
17. experiment
18. experiment
19. The treatment in this study is switching the volunteers to the new drug. The treatment group consists of the volunteers taking the new drug, and the control group consists of the volunteers continuing with the old drug.
20. The treatment in this study is adding the detergent to the wash. The treatment group consists of the clothes washed with the detergent, and the control group consists of the clothes washed in just hot water.
21. The treatment in this study is feeding the people the new recipe. The treatment group consists of the tables served the new recipe, and the control group consists of the tables served the old recipe.
22. The treatment in this study is running the devices on the improved battery. The treatment group consists of the devices as they are running on the improved battery, and the control group consists of the devices as they are running on the original battery.
23. Riley is correct. Mr. Johnson is investigating the effect of the exposure to the weather, so that is the treatment. The part of the deck with the sealant is the control group because it is not exposed to the weather.
24. observational study (experiment not ethical due to health risks)
25. experiment (no known negative effect – practical and ethical)
26. observational study (experiment not ethical due to health risks)
27. experiment (no known negative effect – practical and ethical)
28. observational study (experiment not ethical as it requires dogs to be confined for a lifetime)
29. observational study (experiment not ethical due to health risks)
30. The treatment (using brand X motor oil) is both practical and ethical. Perform an experiment; Possible answer: Randomly choose a group of cars of the same make and model. Use brand X oil in half of them and a variety of other kinds of oil in the other half. Measure the gas mileage of the cars in both groups.
31. In method **A**, the researcher gives each group a treatment, so the method is an experiment. In method **B**, the researcher asks questions about ointments that people have used before. This method is a survey. In method **C**, the researcher observes people who have chosen different ointments, but does not impose a treatment. This is an observational study. Method **B** is least reliable, because there is no basis for comparison. Method **C** has a comparison group, but the groupings are based on self-reports, which

PRACTICE AND PROBLEM SOLVING

14. observational study
15. experiment

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 receiving vitamin D is the treatment

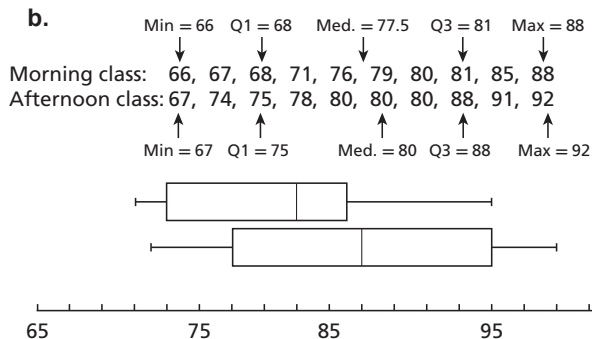
CHALLENGE AND EXTEND

- 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.



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.

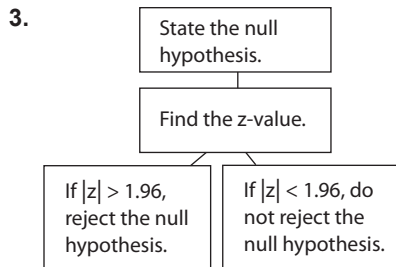
- 2. The null hypothesis is that there is no difference between the claimed population mean of \$3000 and the sample mean of \$2600. Calculate the z-value:

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

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.



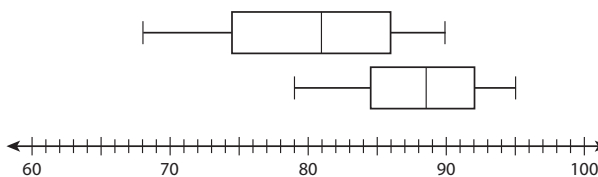
EXERCISES

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

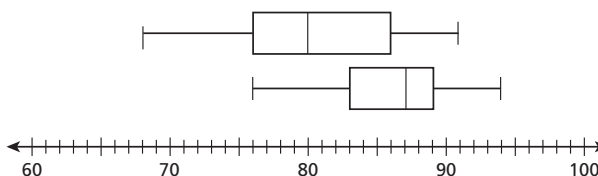


There is a large difference in the two groups that is unlikely to be caused by chance. The labor union should reject the null hypothesis, which means that the professional development program is working to increase the test scores of Company A.

- 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.