BLITZER BONUS

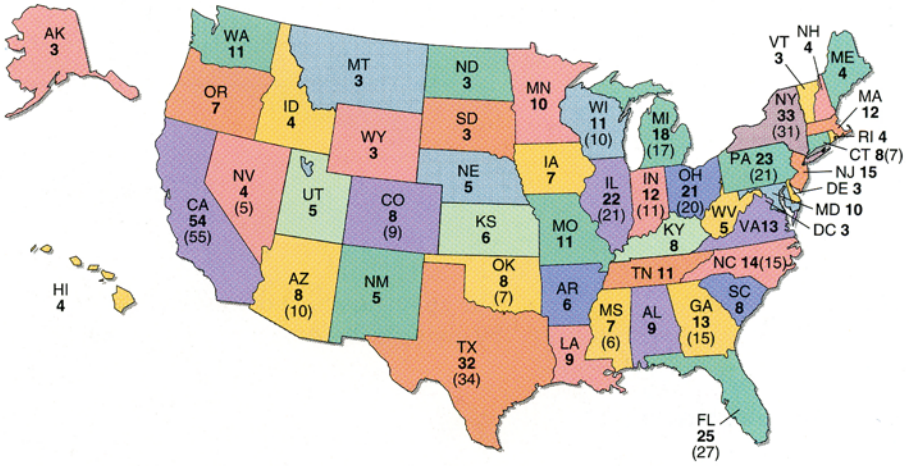
## The Electoral College

The framers of the Constitution believed that the opinion of the majority sometimes had to be tempered by the wisdom of elected representatives. Consequently, the President and the Vice President are the only elected U.S. officials who are not chosen by a direct vote of the people, but rather by the Electoral College.

Here is an outline of how the Electoral College works.

- There are a total of 538 electoral votes.
- The votes are divided by the states and among the District of Columbia. The number of electoral votes for each state is equal to its total number of Congressional senators and representatives.
- The candidate who wins a majority of popular votes in a given state earns all the votes of that state's Electoral College members.
- The candidate who wins the majority, not merely a plurality, of the electoral votes is declared the winner. A presidential candidate needs at least 270 electoral votes to win. If no candidate wins, then the election is turned over to the House of Representatives, who vote for one of the top three contenders.

**Electoral Votes for President**




Figures in boldface, based on the 1990 census, were used in the 1992, 1996, and 2000 elections. Some of the electoral votes for the 2004 election, based on the 2000 census, were different. These are given in parentheses.

*Source:* Federal Election Commission

As we know from the 2000 election, it is possible for a presidential candidate who has not won the popular vote to win the election. If a candidate wins the popular vote in large states (ones with lots of electoral votes) by only a slim margin and loses the popular vote in smaller states by a wide margin, it is possible that the popular vote winner will actually lose the election. Is George W. Bush the only U.S. president who lost the popular vote but won the election? The answer is no. In 1888, Benjamin Harrison won the popular vote over Grover Cleveland, but Cleveland won the electoral vote and became president. Also, in our next section opener, we describe how the "flawed" electoral college system led to an election debacle in 1876 reminiscent of the bitter divisiveness that tainted the 2000 election.

## EXERCISE SET 14.3

### • Practice and Application Exercises

*Throughout this exercise set, in computing standard divisors, standard quotas, and modified quotas, round to the nearest hundredth when necessary.*

*A small country is comprised of four states, A, B, C, and D. The population of each state, in thousands, is given in the following table. Use this information to solve Exercises 1–2.*

| State | A | B | C | D | Total |
|---|---|---|---|---|---|
| **Population (in thousands)** | 138 | 266 | 534 | 662 | 1600 |

1. According to the country's constitution, the congress will have 80 seats, divided among the four states according to their respective populations.
   - **a.** Find the standard divisor, in thousands. How many people are there for each seat in congress?
   - **b.** Find each state's standard quota.
   - **c.** Find each state's lower quota and upper quota.

2. According to the country's constitution, the congress will have 200 seats, divided among the four states according to their respective populations.
   - **a.** Find the standard divisor, in thousands. How many people are there for each seat in congress?
   - **b.** Find each state's standard quota.
   - **c.** Find each state's lower quota and upper quota.

3. Use Hamilton's method to find each state's apportionment of congressional seats in Exercise 1.

4. Use Hamilton's method to find each state's apportionment of congressional seats in Exercise 2.

5. A university is composed of five schools. The enrollment in each school is given in the following table.

| School | Humanities | Social Science | Engineering | Business | Education |
|---|---|---|---|---|---|
| **Enrollment** | 1050 | 1410 | 1830 | 2540 | 3580 |

There are 300 new computers to be apportioned among the five schools according to their respective enrollments. Use Hamilton's method to find each school's apportionment of computers.

**6.** A university is composed of five schools. The enrollment in each school is given in the following table.

| School | Liberal Arts | Education | Business | Engineering | Sciences |
|---|---|---|---|---|---|
| **Enrollment** | 1180 | 1290 | 2140 | 2930 | 3320 |

There are 300 new computers to be apportioned among the five schools according to their respective enrollments. Use Hamilton's method to find each school's apportionment of computers.

**7.** A small country is composed of five states, A, B, C, D, and E. The population of each state is given in the following table. Congress will have 57 seats, divided among the five states according to their respective populations. Use Jefferson's method with $d = 32{,}920$ to apportion the 57 congressional seats.

| State | A | B | C | D | E |
|---|---|---|---|---|---|
| **Population** | 126,316 | 196,492 | 425,264 | 526,664 | 725,264 |

**8.** A small country is comprised of four states, A, B, C, and D. The population of each state, in thousands, is given in the following table. Congress will have 400 seats, divided among the four states according to their respective populations. Use Jefferson's method with $d = 7.82$ to apportion the 400 congressional seats.

| State | A | B | C | D |
|---|---|---|---|---|
| **Population (in thousands)** | 424 | 664 | 892 | 1162 |

**9.** An HMO has 150 doctors to be apportioned among four clinics. The HMO decides to apportion the doctors based on the average weekly patient load for each clinic, given in the following table. Use Jefferson's method to apportion the 150 doctors. (*Hint*: Find the standard divisor. A modified divisor that is less than this standard divisor will work.)

| Clinic | A | B | C | D |
|---|---|---|---|---|
| **Average Weekly Patient Load** | 1714 | 5460 | 2440 | 5386 |

**10.** An HMO has 70 doctors to be apportioned among six clinics. The HMO decides to apportion the doctors based on the average weekly patient load for each clinic, given in the following table. Use Jefferson's method to apportion the 70 doctors. (*Hint:* A modified divisor between 39 and 40 will work.)

| Clinic | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| **Average Weekly Patient Load** | 316 | 598 | 396 | 692 | 426 | 486 |

**11.** The police department in a large city has 180 new officers to be apportioned among six high-crime precincts. Crimes by precinct are shown in the following table. Use Adams's method with $d = 16$ to apportion the new officers among the precincts.

| Precinct | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| **Crimes** | 446 | 526 | 835 | 227 | 338 | 456 |

**12.** Four people pool their money to buy 60 shares of stock. The amount that each person contributes is shown in the following table. Use Adams's method with $d = 108$ to apportion the shares of stock.

| Person | A | B | C | D |
|---|---|---|---|---|
| **Contribution** | \$2013 | \$187 | \$290 | \$3862 |

**13.** Three people pool their money to buy 30 shares of stock. The amount that each person contributes is shown in the following table. Use Adams's method to apportion the shares of stock. (*Hint:* Find the standard divisor. A modified divisor that is greater than this standard divisor will work.)

| Person | A | B | C |
|---|---|---|---|
| **Amount** | \$795 | \$705 | \$525 |

**14.** Refer to Exercise 9. Use Adams's method to apportion the 150 doctors. (*Hint:* Find the standard divisor. A modified divisor that is greater than this standard divisor will work.)

**15.** Twenty sections of bilingual math courses, taught in both English and Spanish, are to be offered in introductory algebra, intermediate algebra, and liberal arts math. The preregistration figures for the number of students planning to enroll in these bilingual sections are given in the following table. Use Webster's method with $d = 29.6$ to determine how many bilingual sections of each course should be offered.

| Course | Introductory Algebra | Intermediate Algebra | Liberal Arts Math |
|---|---|---|---|
| **Enrollment** | 130 | 282 | 188 |

**16.** Refer to the populations of the four states in Exercise 8. Unlike Exercise 8, Congress now has 314 seats to divide among the states according to their respective populations. Use Webster's method with $d = 9.98$ to apportion the 314 congressional seats.

**17.** A rapid transit service operates 200 buses along five routes, A, B, C, D, and E. The number of buses assigned to each route is based on the average number of daily passengers per route, given in the following table. Use Webster's method to apportion the buses. (*Hint*: A modified divisor between 55 and 56 will work.)

| Route | A | B | C | D | E |
|---|---|---|---|---|---|
| **Average Number of Passengers** | 1087 | 1323 | 1592 | 1596 | 5462 |

**18.** Refer to Exercise 11. Use Webster's method to apportion the 180 new officers among the precincts. (*Hint:* A modified divisor between 15 and 16 will work.)

*A hospital has a nursing staff of 250 nurses working in four shifts: A (7:00 A.M. to 1:00 P.M.), B (1:00 P.M. to 7:00 P.M.), C (7:00 P.M. to 1:00 A.M.), and D (1:00 A.M. to 7:00 A.M.). The number of nurses apportioned to each shift is based on the average number of patients per shift, given in the following table. Use this information to solve Exercises 19–22.*

| **Shift** | A | B | C | D |
|---|---|---|---|---|
| **Average Number of Patients** | 453 | 650 | 547 | 350 |

**19.** Use Hamilton's method to apportion the 250 nurses among the shifts at the hospital.

**20.** Use Jefferson's method to apportion the 250 nurses among the shifts in the hospital. (*Hint:* A modified divisor that works should be less than the standard divisor in Exercise 19.)

**21.** Use Adams's method to apportion the 250 nurses among the shifts in the hospital. (*Hint:* A modified divisor that works should be greater than the standard divisor in Exercise 19.)

**22.** Use Webster's method to apportion the 250 nurses among the shifts in the hospital. (*Hint:* A modified divisor that works is equal to the standard divisor that you found in Exercise 19.)

*The table shows the 1790 United States census. In 1793, at the direction of President George Washington, 105 seats in the House of Representatives were to be divided among the 15 states according to their 1790 populations. Use this information to solve Exercises 23–26.*

| **1790 United States Census** | | | |
|---|---|---|---|
| Connecticut | 236,841 | New York | 331,589 |
| Delaware | 55,540 | North Carolina | 353,523 |
| Georgia | 70,835 | Pennsylvania | 432,879 |
| Kentucky | 68,705 | Rhode Island | 68,446 |
| Maryland | 278,514 | South Carolina | 206,236 |
| Massachusetts | 475,327 | Vermont | 85,533 |
| New Hampshire | 141,822 | Virginia | 630,560 |
| New Jersey | 179,570 | | |

**23.** Use Hamilton's method to find each state's apportionment of congressional seats.

**24.** Use Jefferson's method with $d = 33{,}000$ to find each state's apportionment of congressional seats.

**25.** Use Adams's method with $d = 36{,}100$ to find each state's apportionment of congressional seats.

**26.** Use Webster's method with $d = 34{,}500$ to find each state's apportionment of congressional seats.

## • Writing in Mathematics

**27.** Describe how to find a standard divisor.

**28.** Describe how to determine a standard quota for a particular group.

**29.** How is the lower quota found from a standard quota?

**30.** How is the upper quota found from a standard quota?

**31.** Describe the apportionment problem.

**32.** In your own words, describe Hamilton's method of apportionment.

**33.** What is the quota rule?

**34.** Explain why Hamilton's method satisfies the quota rule.

**35.** Describe the difference between how modified quotas are rounded using Jefferson's method and Adams's method.

**36.** Suppose that you guess at a modified divisor, $d$, using Jefferson's method. How do you determine if your guess satisfies the method?

**37.** Describe the difference between the modified divisor, $d$, in terms of the standard divisor using Jefferson's method and Adams's method.

**38.** In allocating congressional seats, how does Hamilton's method choose some states over others for preferential treatment? Explain how this is avoided in Jefferson's and Adams's methods.

**39.** How are modified quotas rounded using Webster's method?

**40.** Why might it take longer to guess at a modified divisor that works using Webster's method than using Jefferson's method or Adams's method?

**41.** In this exercise set, we have used apportionment methods to divide congressional seats, assign computers to schools, assign doctors to clinics, divide police officers among precincts, divide shares of stock, assign sections of bilingual math, assign buses to city routes, and assign nurses to hospital shifts. Describe another situation that requires the use of apportionment methods.

## • Critical Thinking Exercises

**42.** In 1880, there were 300 congressional seats in the U.S. House of Representatives. The population of Alabama was 1,262,505, and its standard quota was 7.671. Find, to the nearest whole number, the U.S. population in 1880.

*A small country is composed of three states, A, B, and C. The country's constitution specifies that congressional seats will be divided among the three states according to their respective populations. In Exercises 43–45, write an apportionment problem satisfying the given criterion.*

**43.** Hamilton's method and Jefferson's method result in the same apportionment.

**44.** Hamilton's method and Adams's method result in the same apportionment.

**45.** Hamilton's method and Webster's method result in the same apportionment.

## • Group Exercises

**46.** The method currently used to apportion the U.S. House of Representatives is known as the **Huntington-Hill method**, and more commonly as the **method of equal proportions**. Research and present a group report on this method. Include the history of how the method came into use and describe how the method works.

**47.** Research and present a group report on a brief history of apportionment in the United States.