

Chapter 1 Exercises

Identify whether each statement is an example of inductive or deductive reasoning.

1. An online store determines that sales are highest on Tuesday evenings based on sales data from the past two months.
2. In order to qualify for a \$25 discount each month at Things and Stuff, you need to make three \$75 purchases during the first three weeks of the month. Emilia made purchases of \$85.53, \$75.29, and \$77.82 during the first three weeks of the month. So Emilia qualifies for the \$25 discount.

Find a counterexample to each statement

3. The Super Bowl is played on the first Sunday in February.
4. The product of an even number and an odd number is odd.
5. If the sum of two numbers is odd, then both numbers are odd.

Find the missing terms of each sequence and determine if the sequence is arithmetic, geometric, or neither. If it is an arithmetic sequence, state the common difference; if it is a geometric sequence, state the common ratio.

6. 4, 7, 10, _____, _____, _____
7. 3, 6, 18, 36, _____, _____, _____
8. $\frac{1}{3}, \frac{1}{9}, \frac{1}{27},$ _____, _____, _____

Use inductive reasoning to predict the next line of each pattern. Complete the computations to verify.

9. Consider the following pattern.

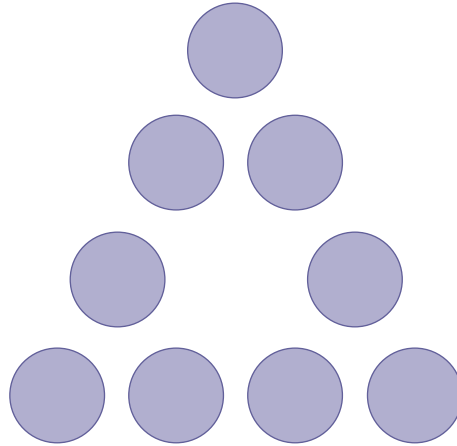
$$\begin{aligned} 1 \cdot 8 + 1 &= 9 \\ 12 \cdot 8 + 2 &= 98 \\ 123 \cdot 8 + 3 &= 987 \\ 1234 \cdot 8 + 4 &= 9876 \\ 12,345 \cdot 8 + 5 &= 98,765 \\ 123,456 \cdot 8 + 6 &= 987,654 \\ 1,234,567 \cdot 8 + 7 &= 9,876,543 \end{aligned}$$

10. Consider the following pattern.

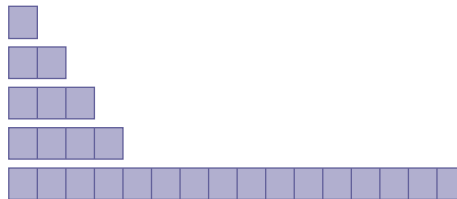
$$\begin{aligned} 999,999 \cdot 1 &= 999,999 \\ 999,999 \cdot 2 &= 1,999,998 \\ 999,999 \cdot 3 &= 2,999,997 \\ 999,999 \cdot 4 &= 3,999,996 \end{aligned}$$

11. Determine the most appropriate order of magnitude for the daily temperature in degrees Fahrenheit

12. You are hosting a graduation party for your child who just graduated from high school. Your child wants to invite 25 friends, and you will also invite 50 family members. How could you break this situation down into smaller parts to estimate the total cost of the party?
13. A local newspaper is estimating the number of people attending a championship parade based on aerial footage. A single block of the parade route is determined to hold 142 people. The parade route is 32 blocks long. Estimate the number of people who attended the parade.
14. A pet store employee counts 23 heads and 68 feet on the animals in the store. The store currently only has kittens and parakeets left in the store. How many of each are there?
15. A box office sells tickets for a concert at two different prices: \$35 and \$55. The box office sold a total of 95 tickets at a value of \$4325 today. How many of each of the different tickets did the box office sell?
16. The product of two whole numbers is 234 and their sum is 31. What are the two numbers?
17. Place the numbers 1 through 9 in the given circles so that the sum of the numbers on each side of the triangle is 20.



18. Find the sum of the whole numbers from 1 to 200.
19. How many line segments are there in each of these figures?



Chapter 2 Exercises

Determine whether each statement is true or false. If the statement is false, explain why.

- $\{3\} \in \{1, 2, 3, 4, 5, 6\}$
- $1 \in \{x \mid x \text{ is an integer}\}$
- $\{3\} \subseteq \{1, 2, 3, 4, 5, 6\}$
- $\{1\} \subset \{x \mid x \text{ is an integer}\}$
- Let $A = \{\text{red, yellow, blue}\}$. Then $|A| = 3$.
- Let $B = \{-2\}$. Then $|B| = 2$.
- $|\emptyset| = 1$
- $|\{\emptyset\}| = 1$

Write each set as indicated.

- Let the set A consist of the even counting numbers less than 14. Write A using roster notation.
- Use roster notation to write the set B that consists of the seasons of the year.
- Use set-builder notation to write the set C that consists of the set of real numbers between 100 and 1000.
- Use set-builder notation to write the set D that consists of the months of the year that have 30 days.

Use the given sets to solve each problem.

$$A = \{\text{Felix, Amber}\}$$

$$B = \{\text{moral, social, civil}\}$$

- Find $|A|$ and $|B|$.
- List all the subsets of A and subsets of B .
- List all the proper subsets of A .
- Is $A = B$? Why or why not?
- Is $A \sim B$? Why or why not?

Use the given sets to solve each problem.

$$G = \{I, II, III\}$$

$$F = \{\text{love, joy, peace}\}$$

18. Find $|G|$ and $|F|$.
19. List all the subsets of G and subsets of F .
20. List all the proper subsets of F .
21. Is $G = F$? Why or why not?
22. Is $G \sim F$? Why or why not?

Determine the number of proper subsets of each set.

23. $\{\alpha, \beta, \chi, \delta, \varepsilon, \phi, \mu, \pi\}$
24. \emptyset

Draw a Venn diagram to illustrate each group of sets. A universal set is not given, so choose one that fits and define it.

25. Parents and their children
26. Sculptors and Artists
27. Cats and Dogs
28. $A = \{x \mid x \in \mathbb{R}\}$ and $B = \{x \mid x \text{ is an integer}\}$

Use the given sets to write each set in roster notation.

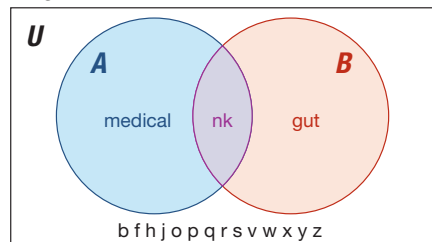
$$U = \{1, 2, 3, 4, 5, 6, 7, 8, 9, 10\}$$

$$A = \{1, 2, 3, 4, 5\}$$

$$B = \{1, 3, 5, 7\}$$

29. $A \cap B$
30. $A \cup B$
31. $A' \cap B$
32. $A' \cup B'$
33. $|A \cap B|$
34. $|(A \cup B)'|$

Use the given Venn diagram to write each set in roster notation.



35. A
36. B

Chapter 3 Exercises

Negate each statement.

1. The puppy could not keep her eyes open after 10:00.
2. Jour means “the day” in French.
3. All houses have fireplaces.
4. Every senior that graduated had a job offer.

Construct the truth table for each compound statement.

$$5. (a \vee \sim b) \Rightarrow c \qquad 6. w \wedge (x \wedge \sim y)$$

7. If you and Kathy both go to the movies, then I will go as well.
8. I don't eat dessert and do not have a cup of coffee.

Write the converse, inverse, contrapositive, and biconditional for each conditional statement.

9. If my grade in this course is an A, then I can enroll in the next course.
10. If my car runs out of gas, then my car will not start.

Solve each problem.

11. Complete the truth table for $(p \wedge (p \Rightarrow q)) \Rightarrow q$.

		Truth Table		
p	q	$p \Rightarrow q$	$p \wedge (p \Rightarrow q)$	$(p \wedge (p \Rightarrow q)) \Rightarrow q$
T	T			
T	F			
F	T			
F	F			

12. If the bakery has fresh muffins, then I will buy some for my roommates. If I buy fresh muffins then my roommates will be happy. What can you deduce from these statements?
13. Which of the following is an example of inductive logic?
 - a. If you liked all of Richie Rock's movies, then you will also like his latest movie.
 - b. If there is an accident on the freeway, then we will be late for the play.
 - c. If I get a raise next week, then I can buy a new car.
 - d. I have to leave work early if the bank closes at 5:00 today.

Determine whether each arguments is valid or invalid.

14. Eagles have feathers.
Sparrows have feathers.
Ducks have feathers.
15. All birds have wings.
Ducks are birds.
Ducks have wings.
16. Some birds have feathers.
Sparrows are birds.
Sparrows have feathers.
17. All birds can fly.
Eagles are birds.
Eagles can fly.

Identify the premise and conclusion in each statement.

18. “If the Egyptian government had been doing what the IDF is doing during the Arab Spring, it would have been a very different picture,” he said, referring to the activists who used social media to organize protests that toppled Egypt’s Hosni Mubarak last year.¹⁰
19. “The most prominent advocates of global warming aren’t scientists,” said Heartland’s president, Joseph Bast. “They are Charles Manson, a mass murderer; Fidel Castro, a tyrant; and Ted Kaczynski, the Unabomber. Global warming alarmists include Osama bin Laden and James J. Lee (who took hostages inside the headquarters of the Discovery Channel in 2010).”¹¹

Identify each type of fallacy being used.

20. If you believe that a man who can cheat on his wife of 38 years will be honest with you on all levels, than you deserve what you get for voting for him.
21. “The only question is if Washington has the courage to seize this opportunity. If they do, this moment won’t be remembered as a drawn-out partisan showdown over spending, but as the launching pad from which we began to sail into a healthier, more prosperous future.”¹²

10 CNN, <http://www.cnn.com>

11 The Heartland Institute, <http://www.heartland.org>

12 CNN, <http://www.cnn.com>

Chapter 4 Exercises

Answer each question. Round your answer to the nearest hundredth, if necessary.

1. If six out of every ten individuals in a population carry a gene for a defective enzyme, how many individuals carry the normal gene in a population of 900?
2. As part of a house renovation, the total cost to remodel the bathrooms was \$4750. The total cost of bathroom fixtures was \$3750. Write the cost of the fixtures and the total cost of the bathroom renovation as a proportion in lowest terms.
3. The ratio of apples to oranges in a basket is 3 to 4. What fraction of fruit in the basket consists of apples?
4. Suppose that the ratio of males to females in the sales field of a large company is 4:5. If there are 81 sales representatives in the company, how many are male and how many are female?
5. If Whitt wins 3 out of every 4 games of Solitaire that he plays on his computer, how many games would he need to play so that he wins 51 games?
6. Your dinner bill was \$30.00. If you leave a 15% tip, how much will this be?
7. If you wish to leave a 20% tip and your bill is \$58.50, how much tip will you leave?
8. A garden center is having a Memorial Day sale on flowers. All flowers are 15% off, but if you buy 3 flats of flowers, you save an additional 10%. How much would you pay if you purchase 3 flats of flowers that are priced at \$12 per flat?
9. The wholesale price of a laptop is \$525. The price of the laptop is marked up by 45% before it is listed as for sale on the store website. During a back-to-school sale, the laptop is marked down by 15%. What is the price of the laptop during the back-to-school sale?
10. Nate just moved from a state with an 8% sales tax to a state with a 6% sales tax. If he buys a shirt for \$35.00, how much less tax does he pay in his new state?
11. Last year, a new computer sold for \$1600. This year, the same computer can be purchased for \$1200. What percentage discount is being given from the previous year?
12. Suzanne's salary grew from \$40,000 in 2000 to \$56,000 in 2012. During the same time period, Mike's salary grew from \$38,000 to \$53,000. Whose salary grew more in absolute change? In percentage change?

Write each rate described and then convert it to a unit rate.

13. The university reported that there were 42 freshmen in the entering class for every 3 advisors.
14. Coach Burge wanted the entire class to be able to do 90 sit-ups in 2 minutes by the end of the semester.

Solve each problem. Round your answer to the nearest hundredth, if necessary.

15. Which is the better value for the money, \$5.99 for a package of 8 cold remedy capsules or \$2.85 for 2 capsules? Why?
16. Suppose at bulk rate, instant potato flakes cost 12.04 cents, or \$0.1204, per ounce.
 - a. If a box costs \$77.05, how many pounds of potato flakes are in the box? (Hint: There are 16 ounces in a pound.)
 - b. What would a 2-pound box of potato flakes cost?
17. To treat the water in a swimming pool, it is recommended to add 6.4 ounces of chlorine per 5000 gallons of water. How much chlorine is needed to treat the water in a pool that holds 24,000 gallons?
18. An advertisement for a hybrid sedan claims that the car can travel 600 miles on a full tank of gas. IF the fuel tank capacity for the sedan is 11.4 gallons, what is the miles per gallon that the sedan gets?
19. Convert the following rainfall measurements from inches per hour to millimeters per minute. Note that 1 inch is equivalent to 25.4 mm.
 - a. 0.5 inches per hour
 - b. 2 inches per hour
 - c. 0.01 inches per hour
20. A vehicle requires 0.25 gallons of fuel to travel 1 kilometer. Determine how many gallons per mile are required.
21. A restaurant sells soup in a quantity of 20 fluid ounces per container. Determine this amount as cups per container.
22. A garden snail can travel 6 centimeters per minute. Determine the speed of the snail in inches per hour.
23. A sculpture for the lawn in front of the new art gallery is 38.5 feet long. A model is being made for a display inside the gallery. The model is 14.2 inches long. Based on this scale, how long would an actual bench be on the lawn if the bench in the scale model is 2 inches?

$\frac{1}{25}$

24. A 180-pound student burns 120 calories every half hour of playing ultimate Frisbee. How many calories would he burn in
- 10 minutes?
 - One hour and 45 minutes?
25. On a G scale model train, each inch of length corresponds to 25 inches of length on the actual model train. Find the constant of proportionality for the length on the model train to the length on the actual train.
26. A force of 144 newtons stretches a spring 4 meters.
- What is the constant of proportionality?
 - How much force would be needed to stretch the spring 7.5 meters?
27. A model car has a length of 5.75 inches and a width of 2.25 inches. Find the length of the actual car if the actual car has a width of 72 inches.

Chapter 5 Exercises

1. Evaluate the function $f(x) = x^2 + 2x - 3$ for the given values.

x	$f(x) = x^2 + 2x - 3$
-3	
-2	
0	
1	
2	
3	

Determine the dependent and independent variables. Then write a function to represent each situation and answer each question.

- A car purchased in 2010 had an initial value of \$19,500. If the car depreciates at \$1200 per year, write an equation that represents the depreciation. What is the value of the car after 5 years?
- The cost to rent a car for a day is an initial cost of \$35 and \$0.25 per mile driven. Write an equation that represents to the cost of the car rental. What is the total cost if you drove 250 miles?
- Jeff delivers pizza for Papa Jim's Pizza. Papa Jim's pays Jeff an hourly wage of \$6.25. In addition to his hourly wage, Jeff earns \$0.25 for every pizza he delivers. Write an equation that represents the wages earned by Jeff, where x represents the number of pizzas delivered when Jeff works a five-hour shift. If Jeff delivers 21 pizzas during his shift, how much money will he earn?

Graph each equation.

5. $y = -2x$

6. $y = 3x + 1$

7. $y = \frac{2}{3}x - 1$

Find the slope and y -intercept of each linear equation.

8. $y = -3x + 4$

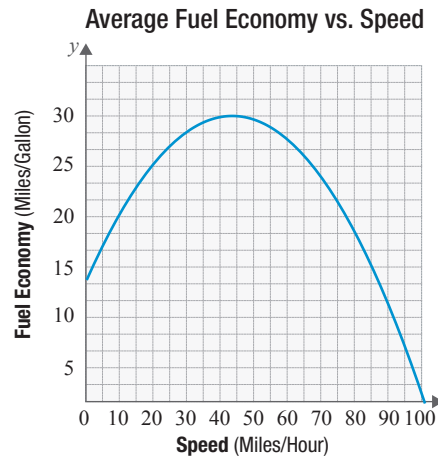
9. $y = \frac{3}{4}x - 3$

10. A medical conference has two phases. The first phase consists of a general opening speech lasting 40 minutes and several presentations for 50 minutes each. The second phase consists of the participants' reports, each lasting 55 minutes, and a fifteen-minute conclusion. The conference organizer wants to know how many speakers should participate in the conference in order for the duration of the two phases to be the same.

Write two linear functions, one for the duration of the first phase, $C(x)$, and one for the duration of the second phase, $R(x)$. Use the functions to find out how many people need to participate in the conference in order for both stages to have the same duration.

11. Mark is a beginner illusionist. To start performing, he needs to invest \$5400 on props. Also, renting a room for each performance will cost him \$1400. He plans to sell tickets for \$20, and the capacity of the room is 150 people. Suppose that, on average, the hall will be two-thirds full at each performance. Let x be the number of performances.
- Write the cost function for holding performances.
 - Write the revenue function.
 - Write the profit function for Mark.
 - Determine the x -value of the break-even point for his business.
 - If Mark holds 20 performances, what profit can he expect to make?
12. Graph the linear inequality $3x - 5y > 22$.
13. Graph the system of linear inequalities:
$$\begin{cases} 3x - 4y > 0 \\ y \geq 2x - 5 \end{cases}$$
14. A cereal manufacturer is creating a new cereal that is a mix of two previously established cereals: cinnamon squares and chocolate puffs. Cinnamon squares cost \$0.15 per ounce to make and chocolate puffs cost \$0.19 per ounce to make. Standard packaging costs \$0.45 per box. The company wants to minimize the cost of creating this cereal. Let x represent the number of ounces of cinnamon squares and let y represent the number of ounces of chocolate puffs that are added to each box of cereal. Write the objective function that describes the cost to create each box of cereal.
15. The objective function $z = 2x + 5y$ is subject to the following constraints.
 $x + 2y \leq 40$
 $y \leq 15$
 $x \geq 0$
 $y \geq 0$
Find the maximum value of z .
16. A basketball's height (in feet) is a function of time in flight (in seconds), modeled by an equation such as $h(t) = -16t^2 + 40t + 6$.
- Describe the graph of the function in terms of time in flight and height.
 - Describe how you could use the given function relating time in flight to height to find when the shot will reach the height of the basket (10 feet)?
 - Describe how you could find the time when the ball would hit the floor if it missed the basket entirely?

17. The figure contains the graph of a function, $f(x) = -0.00875x^2 + 0.775x + 13$, that measures the average fuel economy for a certain model of car based on the speed x of the car (in miles per hour).



- a. What is the miles per gallon average if the vehicle is traveling 80 miles per hour?
 - b. What is the miles per gallon average if the vehicle is traveling 40 miles per hour?
 - c. At approximately what speed will the car have the greatest fuel economy? Round your answer to the nearest whole mile per gallon.
18. The function $C(x) = 0.0086x^2 + 1.11x - 1.37$ represents the stopping distance in feet while talking on a cell phone and driving at a speed of x mph. What distance will it take you to stop while talking on a cell phone if you are driving 50 mph? 80 mph?
19. Whispertown has a population growth model of $P(t) = at^2 + bt + P_0$ where P_0 is the initial population. Suppose that the projected future population of Whispertown t years after January 1, 2012, is described by the quadratic model $P(t) = 0.8t^2 + 6t + 24,000$.
- a. What is the projected population of Whispertown on January 1, 2030?
 - b. In what month and year will the population reach 60,000?
20. A rifle fires a projectile vertically upward from a height of 150 feet above the ground, with an initial velocity of 1250 ft/sec. Recall that projectiles are modeled by the function $h(t) = -16t^2 + v_0t + y_0$.
- a. Write a quadratic equation to model the height in feet above the ground after t seconds.
 - b. During what time interval will the projectile be more than 10,000 feet above the ground?
 - c. After how many seconds will the projectile hit the ground?
21. A ball is dropped from the top of a 750-foot tall building. How long does it take the ball to hit the ground? Recall that projectiles are modeled by the function $h(t) = -16t^2 + v_0t + y_0$. (Note that $v_0 = 0$.)

Chapter 6 Exercises

Solve each problem. Round your answer to the nearest cent, if necessary.

1. Determine the interest owed on \$1200 for five years at a rate of 6.5%.
2. Assume you are purchasing a new computer with “90 days same as cash” to make the purchase. If the cost of the computer is \$1255, tax included, with an annual interest rate of 16.99%, how much would you owe on the 91st day if you make no payments during the first 90 days?
3. Use the compound interest formulas to **a.** calculate the total amount in the account after the given time period and **b.** determine the amount of interest earned.

$$P = \$5500, r = 2.5\% \text{ compounded weekly, } t = 10 \text{ years}$$

$$P = \$4755, r = 4.5\% \text{ compounded monthly, } t = 10 \text{ years}$$

$$P = \$7300, r = 19.9\% \text{ compounded continuously, } t = 20 \text{ years}$$

4. Miguel deposits \$2850. Determine the annual percentage yield for each of the following. Round each answer to the nearest hundredth of a percent.
 - a. APR of 5% compounded monthly
 - b. APR of 5% compounded weekly
 - c. APR of 5% compounded daily
5. A couple deposits \$12,500 into an account earning 2.75% annual interest for 25 years.
 - a. Calculate the future value of the investment if interest is compounded monthly.
 - b. Calculate the future value of the investment if interest is compounded weekly.

A savings account is compounded monthly for five years with an APR of 4.99%. For each principal amount, calculate the following. Round your answer to the nearest cent, if necessary.

- a. The future value of the investment
 - b. The amount of interest earned
6. \$15,000
 7. \$30,000
 8. \$60,000
 9. \$120,000

10. ABC Lending lists the following APR rates for loans. Determine the APY for each category.

First Bank of Lending	
Loan Amount	APR
< \$20,000	9.75%
\$20,000–\$99,999	5.99%
≥ \$100,000	3.75%

*Interest rates are compounded quarterly

11. Jay and Sybil are purchasing a home. They wish to save money for five years and purchase a house with a value of \$195,000 with cash. If they deposit money into an account paying 12% interest, how much do they need to deposit each month in order to make the purchase?
12. Suppose you wish to retire at the age of 65 with \$1,000,000 in savings. Determine your monthly payment into an IRA if the APR is 8.5% and you begin making payments at the following ages.
- 20 years old
 - 30 years old
 - 40 years old
13. Lacy deposits a fixed monthly amount into an annuity account for her child's college fund. She wishes to accumulate a future value of \$135,000 in 18 years.
- Assuming an APR of 6.5%, how much money should Lacy deposit monthly in order to reach her goal?
 - How much of the \$135,000 will Lacy ultimately deposit in the account, and how much is interest earned?
14. Assume you wish to borrow \$750 for two weeks and the amount of interest you must pay is \$17 per \$100 borrowed. What is the APR at which you are borrowing money? Round your answer to the nearest whole percent.
15. A payday loan is made for eight weeks, where the amount of interest owed per \$100 borrowed is \$15. Suppose you borrow \$1000 for eight weeks.
- How much do you owe at the end of eight weeks?
 - What is the APR for this transaction?

16. Ozzie bought a new car and financed \$14,950 of the purchase. He financed the car for 36 months with an APR of 5.75%. Determine each of the following.
- Ozzie's monthly payment
 - Total cost of Ozzie's car
 - Total interest Ozzie pays over the life of the loan
17. Chelsea and Bill are buying a house on a 30-year mortgage. They can pay \$1200 per month for a mortgage. If they have an APR of 4.25%, what is the maximum mortgage that they can take out?
18. Amelia decides to purchase a \$215,000 house. She wants to finance the entire balance. She has received an APR of 2.75% for a 15-year mortgage.
- What is Amelia's monthly payment?
 - What is Amelia's total cost if she takes all 15 years to pay off the house?
 - Over the course of the loan, how much interest will Amelia pay?
 - If she changed the term to 30 years instead of 15 years, what would her monthly payment be?
 - With a 30-year mortgage, what is the total cost of the house?
 - With a 30-year mortgage, how much interest will Amelia pay?
19. You want to buy a car and finance \$27,450 to do so. You can afford a payment of up to \$600 per month. The bank offers three choices for the loan: a four-year loan with an APR of 5.5%, a five-year loan with an APR of 6.5%, and a six-year loan with an APR of 7%. Which option best meets your needs, assuming you want to pay the least amount of interest?

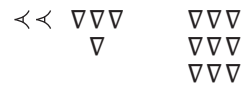
Consider a credit card with a balance of \$4875. You wish to pay off the credit card in each scenario. Calculate the following. Round your answer to the nearest cent, if necessary.

- The amount of a monthly payment within the time frame given
 - The total amount paid over the time period
20. APR of 19.99% paid off within one year
21. APR of 21.5% paid off within two years
22. APR of 29.99% paid off within three years
23. A registered nurse has an annual salary of \$57,477, earned \$115.27 of interest on their savings account, paid \$874 in student loan interest, and contributed \$2400 toward a 401(k). What is the nurse's gross income?
24. A dental assistant earns \$42,200 per year, paid \$860 in student loan interest, and contributed \$1200 to a 401(k). What is the dental assistant's adjusted gross income?

25. Keith is self-employed. Based on last year, his projected state and federal taxes for this year will be \$19,750.
- Determine how much he should prepay each quarter to meet the projected taxes by the end of the year.
 - Determine how much he should set aside each month in order to have enough to pay the estimated quarterly taxes. Round your answer to the nearest cent, if necessary.
26. William has a job where he has a take-home salary each month of \$3375. If William wants to spend no more than 25% of his income on rent, how much rent can William afford?
27. Michael rents an apartment for \$750 per month, pays his car payment of \$360 per month, has utilities that cost \$330 per month, and spends \$476 per month on food and entertainment. Determine Jack's monthly expenses.
28. A recent college graduate takes an entry-level job as an accountant. His yearly salary is \$30,500. His employer withholds \$4296 in state and federal income taxes and \$2328 in FICA taxes throughout the year. He has the following monthly costs: transportation is \$340, cell phone bill is \$65, student loan payment is \$179, HSA contribution is \$200, and rent is \$750. He is using the average monthly cost for each of the following to gain an idea of other monthly expenses: utilities are \$100, home internet is \$60, and groceries are \$250.
- Determine the accountant's monthly net pay amount.
 - Determine how much money is left each month for discretionary spending after all necessities are accounted for.


Chapter 7 Exercises

- Express the Hindu-Arabic numeral 175.83 in expanded form.
- Express the expanded form $(4 \cdot 10^3) + (1 \cdot 10^1) + (7 \cdot 10^0)$ as a Hindu-Arabic numeral.
- Write the Babylonian numeral as a Hindu-Arabic numeral.



- Write the Hindu-Arabic numeral 101 as a Babylonia numeral.
- Write the Mayan numeral as a Hindu-Arabic numeral.



- Write the Hindu-Arabic numeral 4639 as a Mayan numeral.
- Write the Egyptian numeral  as a Hindu-Arabic numeral.
- Write the Hindu-Arabic numeral 1,203,401 as an Egyptian numeral.
- Write the Ionic Greek numeral $\omega \mu \zeta$ as a Hindu-Arabic numeral.
- Write the Hindu-Arabic numeral 3704 as an Ionic Greek numeral.
- Write the Roman numeral MXLVII as a Hindu-Arabic numeral.
- Write the Hindu-Arabic numeral 716 as a Roman numeral.
- Write the Chinese numeral 六千零三十九 as a Hindu-Arabic numeral.
- Write the Hindu-Arabic numeral 20,075 as a Chinese numeral.
- Convert 2211_3 to base 10.
- Convert 125 to base 4.
- Convert 101011011_2 to base 16.
- Convert $90D_{16}$ to base 2.
- Add the numbers 330_5 and 124_5 .
- Subtract the number 65_7 from 320_7 .
- Multiply 122_3 and 11_3 .

Convert each measurement to the desired unit of measure. Round to the nearest thousandth, if necessary.

22. 516 in. = _____ ft
23. 13.5 lb = _____ oz
24. 72 fl oz = _____ pt
25. 40 hr = _____ min
26. 35 mg = _____ dag
27. 15.24 hL = _____ cL
28. 2.786 km = _____ dm
29. 5775 ha = _____ m²
30. 27 mL = _____ cm³
31. How many yards are in 52 meters?
32. How many square centimeters are in 100 square inches?
33. How many quarts are in 15 liters?
34. How many grams are in 6.5 ounces?
35. What is 85°F in degrees Celsius?
36. If a rock is thrown at a speed of 82 miles per hour, how fast is the rock moving in kilometers per minute?
37. Propane gas weighs approximately 4.2 lb/gal. How much does it weigh in grams per milliliter?
38. Kamila determined that her emergency generator uses approximately 3 gallons of propane per hour. If her propane tank holds 100 kilograms, how long will it last?

Chapter 8 Exercises

Solve each problem.

- The student government body consists of 16 females and 12 males. What is the greatest number of subgroups that can be made if each group must have the same number of males and females?
- As part of a service project, Brooke, Madison, and Collin have collected school supplies (pens, pencils, glue, and notebooks) along with toothbrushes and toothpaste to send to school kids in Haiti. They collected the following.

60 glue sticks 122 pencils 180 pens 90 notebooks
70 toothbrushes 40 tubes of toothpaste

 - If they want to make identical care packages using the supplies they collected, what is the maximum number of care packages they can make?
 - How many of each item will be in each package?
- What is the largest number that divides both 691 and 861 leaving a remainder of 11 each for each number.
- The Food Mission is a local nonprofit organization that teaches high school students how to grow a sustainable garden. They donate all the food grown to local hunger organizations. The land they have must be divided into two pieces so that they can rotate through spring and summer crops. The first garden needs to cover 400 square feet, and the second garden needs to be 340 square feet. In order to stretch donated supplies, the shared boundary between the two gardens needs to be maximized.
 - What is the maximum boundary the gardens can share?
 - What will the dimensions of each garden be if the shared boundary is maximized?
- Find the GCD of the numbers 1785 and 546. Are the numbers relatively prime?

Determine the missing digit for each 10-digit ISBN.

- | | |
|------------------|------------------|
| 6. 0-337-25?16-9 | 7. 1-00-?82634-1 |
| 8. 0-07-7734?1-1 | 9. ?-271-53981-1 |

Decide whether each barcode is valid. If it is not, state what the correct check-sum number should be.

Each of the following bar codes consists of 12 digits. To find the check-sum digit, the first 11 digits are multiplied by 3 and 1, alternatively. These multiples are summed with the last digit so that the result is 0 (mod 10).



Find the missing digit for each credit card number.

13. 4485 4217 6305 8?81

14. 6011 5341 1874 008?

15. ?465 9337 2511 334

Encode each number using the given public key.

16. Encode the number $K = 21$ using the public key $n = 77$ and $e = 13$.

17. Encode the number $T = 28,462$ using the public key $n = 5,298,463$ and $e = 99$.

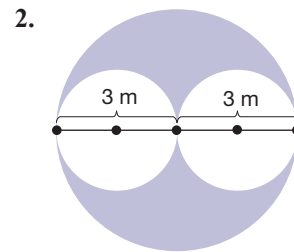
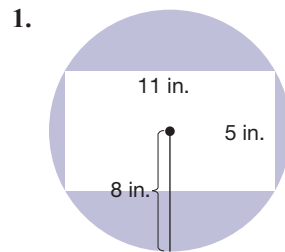
Decode each number using the given private key.

18. Decode the number 5,031,323 using the private key $d = 105,019$ and $n = 5,298,463$.

19. Decode the number 51,189,234 using the private key $d = 27,743$ and $n = 152,472,479$.

Chapter 9 Exercises

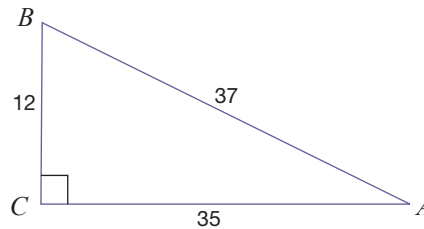
Find the area of the shaded region in each figure. Round your answer to the nearest hundredth, if necessary.



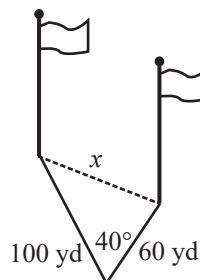
Solve each problem. Round your answer to the nearest hundredth, if necessary.

3. A window pane has dimensions of 30 inches by 22 inches. If glass sells for \$0.80 per square inch, how much will each window cost?
4. A 50-pound bag of fertilizer will cover 5500 square feet. If your lawn measures 215 feet by 168 feet, how many pounds of fertilizer will you need to cover the lawn?
5. Civil War cannonballs were made out of cast iron. A collector found a set of three cannonballs for sale at an auction. The balls had diameters of 4.52 in., 4.346 in., and 3.908 in., respectively. Find the total volume of cast iron contained in the three Civil War cannonballs.
6. Gregory wanted a soccer-ball piñata for his birthday. Find the maximum amount of candy Gregory's mother could put in the piñata if the tag describes the ball as 12 inches in diameter.
7. A tube of lip balm has a height of 2.75 in. and a diameter of 0.75 in.
 - a. If the cap on the tube is 0.20 inches high, find the maximum volume of lip balm that the tube can hold.
 - b. What are the minimum dimensions of a box that can hold 30 tubes of lip balm, which are placed in six rows, with five tubes in each row?
8. A stick of butter measures 4.5 in. long, 1.25 in. wide, and 1.25 in. deep.
 - a. How much butter is in each stick in cubic inches?
 - b. What is the minimum surface area of a box containing 4 sticks of butter?
9. An 8-ounce tub of sour cream needs to contain 19.32 in.^3 of sour cream. The tub must be in the shape of a right circular cylinder and leave a quarter inch between the top of the container and the sour cream. If the height of the container is 2 in., find the diameter of the tub of sour cream.

10. Oddie's Packaging Company always includes a serving size on its packages. The company has recently started making cheese balls and needs to estimate the number of servings in a ball with a diameter of three inches. Assuming the ball is a perfect sphere and that each serving is four fluid ounces, what should Oddie's estimate be? (**Hint:** There are 1.8 cubic inches in 1 fluid ounce.)
11. The measures of two complementary angles are $(18z + 5)^\circ$ and $(2z + 5)^\circ$. Find the measures of the angles.
12. Find $m\angle T$ if $m\angle T$ is 30 degrees larger than four times the measure of its supplement.
13. Two angles are supplementary. One angle measure is 24° larger than the other. Find the measures of the angles.
14. Use $\triangle ABC$ to find $\sin A$, $\cos A$, $\tan A$, $\sin B$, $\cos B$, and $\tan B$.



15. An 18-foot ladder is leaning against a wall where it makes an angle of 58° with the ground and 32° with the building.
- How far is the ladder base from the building?
 - How far does the ladder reach up the building?
16. A plane is flying at an altitude of 15,000 feet and needs to fly an altitude of 25,000 feet. The angle of elevation that should be used is 4° . Over how many miles will it take the plane to reach the correct height? (**Hint:** There are 5280 feet in 1 mile.)
17. The sun hits a building of unknown height so that the building casts a shadow of 410 feet. If the angle of elevation of the sun is 16° , how tall is the building?
18. Suppose you can see two flags from the point where you are standing. One flag is 60 yards away from where you are standing and the other is 100 yards away from where you are standing. The angle between the flags is 40 degrees. Determine how far apart the flags are from each other, rounded to the nearest tenth.



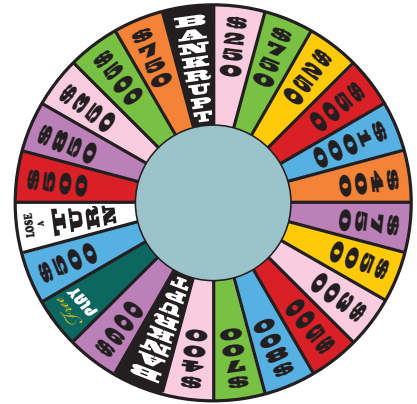
Chapter 10 Exercises

1. Ali is interested in the chance of someone buying vanilla ice cream, so he counts how many people order vanilla ice cream during two hours at a local ice cream shop. Determine whether the probability is experimental or classical.

2. Identify the sample space for Mrs. Okeela spinning the wheel once.

3. Describe how you would create the sample space for spinning the wheel twice.

4. Find the classical probability of landing on
 - a. \$300
 - b. Bankrupt
 - c. \$500
 - d. A tropical vacation



5. Mrs. Okeela was an avid viewer who kept detailed records of the contestants' spins. From her data during the last season, of the 1237 spins she recorded, "Bankrupt" came up 150 times. Find the empirical probability of landing on Bankrupt from Mrs. Okeela's data. Does it match up with what you would expect? Explain your answer.

6. Dr. Gladden was interested in studying whether gender affected students' preferred social media outlet. A random sample of students was selected from a sociology class and asked to choose their top social media site out of Facebook, Twitter, or Pinterest. Their social media choice, gender, and education level (freshman, sophomore, junior, or senior) were recorded.

- a. Find the sample space for the possible outcomes of the survey using a tree diagram.

- b. Dr. Gladden decides to add Instagram and Tumblr to the choices for preferred social media sites. She also decides to include high school students as an additional education level. Use the Fundamental Counting Principle to establish how many possible outcomes are now in the sample space.

- c. The students in the survey are asked to rank their top two social media sites from the five possibilities. How many ways are there for students to rank their top two favorites?

7. Mrs. Darcy is asked to create a 5-digit pin code for an account and decides to use the digits in her anniversary, 1/28/13. How many different codes can she create?

32. On a roulette wheel, the slots are numbered 1 through 36, 0, and 00 for a total of 38 slots. Assume you bet on a single slot. The payout for landing on a single slot is 35 to 1. If a chip is worth \$5, what is the expected value for a player that plays the number 12 repeatedly?
33. In a raffle, a ticket costs \$50. If there are 5000 tickets sold in the raffle and the payout is \$10,000, what is the expected value of purchasing one ticket?
34. In a lottery, 5% of tickets win \$100, 1% of tickets win \$500, 0.1% of tickets win \$1000, and the rest do not win anything. Find the average winnings per ticket for this lottery.
35. A weather forecast gives the following probabilities for the number of rainy days x_i on the next week.

x_i	$P(x_i)$
0	0.002
1	0.017
2	0.077
3	0.194
4	0.290
5	0.261
6	0.131
7	0.028

Find the average number of rainy days the forecast predicts.

Chapter 11 Exercises

In each scenario, identify the population, the sample, and any population parameters or sample statistics that are given.

1. The report titled *The American Freshman* looks at national norms of college freshman by analyzing the responses of 203,967 first-time, full-time freshmen entering 270 baccalaureate institutions across the United States. It found that over the past two years, the percentage of students who describe themselves as “liberal” (27.6%) or “conservative” (20.7%) has not changed significantly. The percentage of those identifying as “middle of the road” (47.4%) has risen slightly.²¹
2. *Social Metadata for Libraries, Archives, and Museums*: Executive Summary reported on work done in 2009–2010 by a 21-member RLG Partner Social Media Working Group from five countries. Their work reviewed 76 online sites that were relevant to libraries, archives, and museums. The sites supported social media features such as tagging, comments, reviews, etc. Among their findings, they reported that more than 70% of library sites have been offering social media features for 2 years or less and that 83% of respondents add new content at least monthly. Most of the respondents manage their own sites rather than use hosted services.²²

Answer each question thoughtfully.

3. Suppose you want to know the proportion of students who wear glasses on your campus. Is simply surveying your current class a good sample to choose? Why or why not?
4. Suppose that in a race, male participants are given even entry numbers and females are given odd entry numbers. Would choosing every 10th runner to answer a survey give a representative sample of all racers? What about every 5th runner? Why?
5. You are assigned the task of determining the average age of people who shop at the local mall.
 - a. Describe at least three different methods of sampling that could be used for the task. Which method would you say is the best one to use? Why?
 - b. Describe any potential for bias in your method.

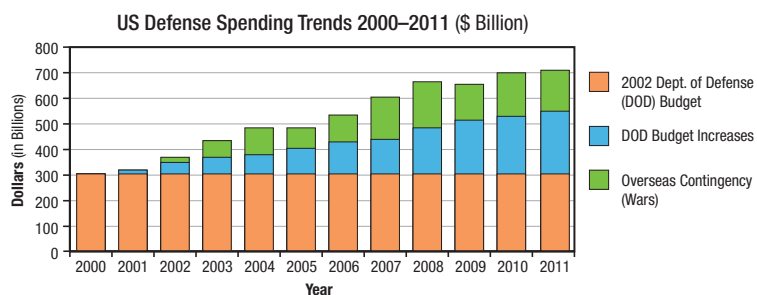
²¹ John H. Pryor et al., *The American Freshman*

²² Karen Smith-Yoshimura, *Social Metadata for Libraries, Archives, and Museums*

6. Determine which type of graph would most clearly depict the data described.
- The enrollment size at Austin Peay State University (APSU) over the past decade
 - The size of each class—freshman, sophomore, junior, senior—for the current year at APSU
 - The size of each class—freshman, sophomore, junior, senior—for the current year at APSU, specifically comparing the genders of students in each category
 - The enrollment sizes of all state universities across the country
7. A clinical trial was designed to check the side effects of the drug for insomnia. Researchers gathered a group of people who suffered from insomnia and had no other pronounced diseases. Some of the people were given the drug, and the others were given a placebo. The patients didn't know whether they were taking the drug or placebo, but the researchers did know. After two weeks, the subjects were surveyed about side effects they noticed.
- Identify the explanatory and response variables.
 - Identify the treatment in the experiment.
 - Determine which group is the treatment group and which group is the control group.
 - State whether the experiment is a single-blind or double-blind study. Do you think this is the best choice for this study?

Solve each problem.

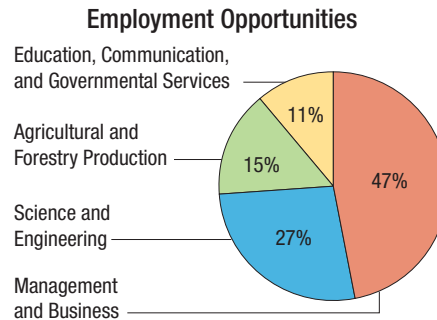
8. Use the stacked bar graph on US defense spending trends from 2000–2011 to answer the following questions.²³



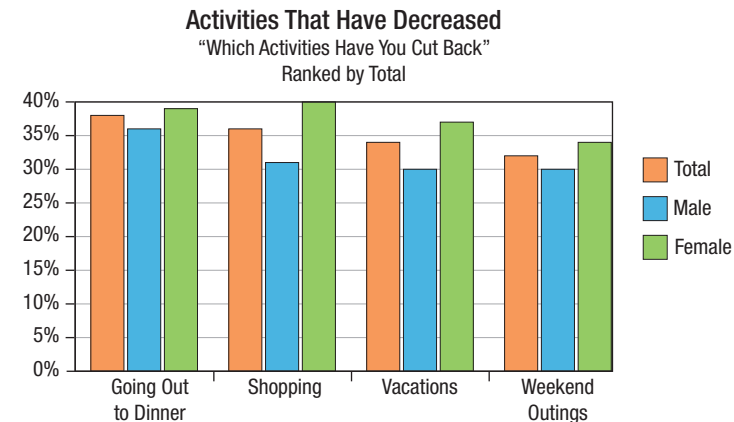
- How much is the estimated total spending for 2011?
- How much has spending increased from 2000 to 2011 in the Overseas Contingency category?
- By how much has the Department of Defense (DOD) budget increased from 2000–2011?
- Would you say that the stacked bar graph is a good way to represent the data here? Why or why not?

23 Emily Skarbek, "How Would You Cut Defense Spending?" <http://www.mygovcost.org>

9. The US Department of Agriculture estimates that between 2010 and 2015, the US economy will generate 54,000 annual openings requiring baccalaureate or higher degrees in food, renewable energy, and environmental specialties. Use the graph about employment opportunities to answer the following questions.²⁴



- What percentage of the jobs are expected to be in the business and science occupations?
 - Over the 5 years, how many total jobs openings are expected in education, communication, and governmental services?
 - How many annual openings are there expected to be in agricultural and forestry production?
 - Would you say that the pie chart is a good way to represent the data given? Why or why not?
10. Consider the following graph showing the results of a personal entertainment survey.



- Name at least two things that are missing from the graph for it to be an effective means of informing people about the data.
- List ways in which a reader might be unclear or misled about what the graph shows.

For each data set, calculate the following numerical descriptors: mean, median, mode, range, sample standard deviation, and five number summary.

11. Area prices for unleaded gasoline for the week of 1/25/2013 are found to be the following.

\$3.07 \$3.49 \$3.05 \$3.35 \$3.29 \$3.06 \$3.18 \$3.29

\$3.21 \$3.29 \$3.29 \$3.31 \$3.05 \$3.21 \$3.19

12. Whitt gathered the following data from students living in his dorm.

2	0	1
0	1	0
6	1	1
0	0	2
0	3	0
4	0	1

13. Consider the weight in grams of 15 soda cans chosen at random from a batch by a quality control inspector.

343	335	338	344	333
345	324	329	322	323
342	341	326	334	335

- Find the five-number summary of the weights.
- What percentage of weights is at or below 333 grams?
- What is the range of weights in the chosen batch?

Calculate the standard score for each given value. Round your answer to the nearest hundredth.

14. $\mu = 20, \sigma = 2$

a. $x_1 = 22$

b. $x_2 = 19$

c. $x_3 = 25$

15. $\bar{x} = 16.9, s = 0.04$

a. $x_1 = 17.15$

b. $x_2 = 16.84$

c. $x_3 = 17.4$

Solve each problem.

- Scores on a test have a mean of 86 and a standard deviation of 13. Jerrica has a score of 94. Convert Jerrica's score to a z-score.
- Hasef scored a 55 on a test with a mean of 47 and a standard deviation of 9. Kimberly had a score of 168 on a test with a mean of 145 and a standard deviation of 26. Which score was better with respect to the mean score on the given test?

Chapter 12 Exercises

- For the following research question, identify a weakness and then give three stronger, alternative questions: “Which SPF of sunscreen is best for overall skin health?”
- The owner of a shoe store wants to know how to optimize the window display to draw more customers into the store. Identify three questions that a data scientist who is unfamiliar with the specific domain knowledge indicated can ask their team to help strengthen their research process.
- For the following data file snippet, determine the delimiter that would be used to separate the data into columns and determine how many columns the data would be separated into.

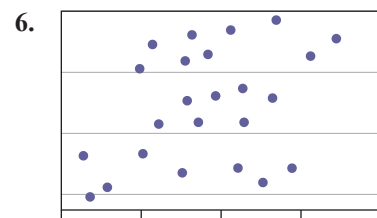
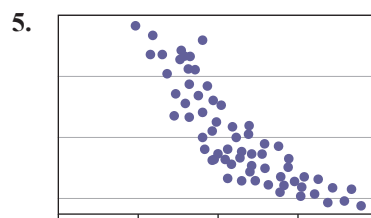
```
Date,PurchaseTotal,PaymentMethod,AccountMade,Subscription
11012021,$663.85,Paypal,yes,monthly
11072021,$627.91,Paypal,no,none
11112021,$442.23,Credit,yes,biweekly
```

- The following pivot table displays the inventory of electronic devices available to be borrowed from a local library.

Row Labels	Available	Checked Out	Grand Total
= Kids' Tablet	2	12	14
Needs Update		1	1
Up to Date	1	11	13
= Laptop	11	16	25
Needs Update		2	2
Up to Date	9	14	23
= Tablet	15	16	31
Up to Date	15	16	31
Grand Total	26	44	70

- What is the total inventory for each device that can be borrowed from the library.
- How many devices need to be updated?
- How many devices are currently checked out?
- How many total devices are in the inventory?

In each scatter plot, decide whether there appears to be a positive linear correlation, a negative linear correlation, or no linear correlation.



Consider each set of variables and predict whether the variables would have a weak negative relationship, a strong negative relationship, a weak positive relationship, a strong positive relationship, or no relationship at all.

7. Score on the ACT and first semester GPA in college
8. A person's eye color and their self-esteem

Determine whether each correlation coefficient is statistically significant at the specified level of significance for the given sample size.

9. $r = 0.913$, $\alpha = 0.01$, $n = 15$
10. $r = 0.525$, $\alpha = 0.05$, $n = 50$

For each data set, find the following.

- a. Estimate the correlation in words as positive, negative, or no correlation.
 - b. Calculate the correlation coefficient r . Round your answer to the nearest thousandth, if necessary.
 - c. Determine whether r is statistically significant at the 0.01 level of significance.
11. The following table gives the number of hours a student watches TV per week and his or her overall GPA.

TV Hours	30	10	28	12	11	13	21	9	5
GPA	1.8	2.46	2.4	3.1	3.4	3.2	3.5	3.3	3.7

12. The following table shows the annual salary of 10 adults and their corresponding years of education.

Salary (\$)	Years of Education
125,000	19
100,000	20
40,000	16
35,000	16
41,000	18
29,000	12
35,000	14
24,000	12
50,000	16
60,000	17

Use the linear regression model $\hat{y} = ax + b$ to predict the y -value for each value of x .

13. $\hat{y} = 25.33x + 353.16$

- a. $x = 8$
- b. $x = 12$
- c. $x = 18$

Solve

14. The following table shows students' test grades on the first two tests in an introductory literature class.

Test Grades on the First Two Tests in an Introductory Literature Class

Test 1 (x)	81	55	81	90	79	45	84	91	82	69	77	88
Test 2 (y)	79	68	83	87	77	55	87	90	87	71	77	74

- a. Determine the regression line $\hat{y} = ax + b$. Round the slope and y -intercept to the nearest thousandth.
 - b. Determine if the regression equation is appropriate at the 0.05 level of significance to use for making predictions. If so, answer part c.
 - c. If a student scored a 70 on his first test, make a prediction for his score on the second test, if appropriate.
15. Describe how you might design a word cloud of a horror novel to accurately convey the tone of the book.
16. Describe the benefits of using a bubble chart instead of a scatterplot to display data.

Chapter 13 Exercises

Create a preference table to show the results for each set of preference ballots.

- The candidates are: Smith (S), Patel (P), Harvey (H), Knight (K), Jordan (J).

HKPJS	PJKSH	HKPJS	SHJPK	SHKPJ
SHJPK	KJPHS	PHSJK	PJSHK	PJSHK
JPHKS	SHJKP	KPJSH	KPJSH	SHJPK
PJKSH	SHJPK	PJSHK	HKPJS	SHJPK
SHKPJ	HKPJS	PJKSH	KJPHS	KJPHS
PJKSH	KJPHS	HKPJS	KJPHS	SHJPK
KJPHS	PJSHK	SHKPJ	SHJKP	KJPHS

- Candidates in the election are: Lawson, Eric, Misty.

Misty, Eric, Lawson: 27

Lawson, Misty, Eric: 41

Misty, Lawson, Eric: 31

Eric, Misty, Lawson: 15

Eric, Lawson, Misty: 5

Lawson, Eric, Misty: 19

Calculate the number of pairwise comparisons that must be made in each election.

- Seven students are running for senior class president.
- Running for local councilman: J. Pitts, K. McMillian, J. Wallace, D. McLaughlin, K. Smith, and T. Knight.

Use the given preference table to answer each question.

- Answer the following questions about the given preference table.

	Rankings				
1st	A	E	C	C	A
2nd	D	B	A	A	E
3rd	B	C	B	E	C
4th	C	A	D	B	D
5th	E	D	E	D	B
Total Votes	221	212	109	84	167

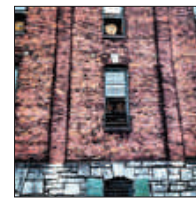
- a. How many possible unique rankings are there of the candidates in the election?
 - b. How many people voted in the election?
 - c. How many voters place Candidate A in first place?
 - d. Which candidate wins the using plurality method?
 - e. How many votes would a candidate need to have a majority?
 - f. Do any of the candidates have a majority of first-place votes?
6. A photography club held a contest where the pictures had to be taken solely with a cell phone. The club members were asked to rank the following entries in order of preference. The preference table summarizes the results of the photo contest.



1.



2.



3.



4.



5.

Preference Table for Best Photo

	Rankings				
1st	3.	3.	2.	5.	
2nd	1.	5.	4.	4.	
3rd	2.	4.	1.	3.	
4th	4.	1.	3.	2.	
5th	5.	2.	5.	1.	
Total Votes	54	83	65	92	

- a. Determine the photo winner using the Borda count method.
- b. Determine the winner using the plurality with elimination method.
- c. Determine the winner with the pairwise method of comparison.
- d. Suppose that Picture 4 was thrown out for violating the rules. Pictures ranked below Picture 4 simply move up a ranking. Which picture would be declared the winner using the Borda count method with the new preference table? Is this a different winner than in part a.?

7. In the Campus Sing-Off, each contestant is ranked by the general student body via the Internet, and by all student organizations sponsoring a contestant. The top 10 entries receive votes in each ballot. The votes are distributed in the following manner.

1st place = 12 points 2nd place = 10 points 3rd place = 8 points
 4th place = 7 points 5th place = 6 points 6th place = 5 points
 7th place = 4 points 8th place = 3 points 9th place = 2 points
 10th place = 1 point

The following table shows how the student organization ranked each contestant in the first semifinal round. The contestants are listed by their last names and sponsor organizations.

Voting Results for First Semifinal																		
Harris; SGA					1st											3rd		
Icin; Social Work Club	6th		6th	6th			7th	6th	2nd	7th	8th	3rd	2nd	10th	7th	9th	10th	5th
Green; ΑΛΠ	2nd	6th			3rd	1st	8th	3rd		8th	4th	1st	7th	6th		10th	6th	8th
Lawson; FCA	9th													7th				
Albert; GSA	1st	8th	2nd	7th		7th	1st	2nd	6th	6th	2nd	2nd	4th	9th	2nd	1st	1st	7th
Roman; ΓΒΘ	4th	7th	3rd		6th		9th	7th		3rd	5th	5th	10th	3rd	8th	6th	2nd	1st
Switzer; Galois Club		9th		4th	8th	9th				10th	10th	9th			3rd	8th	3rd	
Belton; Hispanic Culture Center			7th		9th	10th			9th									10th
Finley; History Club		4th		5th	10th		10th	10th		9th			3rd		1st			
Issen; NAEA				10th		6th			8th				10th	8th	5th	6th	4th	9th
San Marie; NBS	7th		9th		2nd												8th	
Centus; NTSS	5th	1st	1st	8th	5th	4th		8th	10th	2nd				4th			4th	3rd
Dennis; ΩΨΦ		3rd	10th	3rd		8th	2nd		3rd		7th	7th		8th	10th		5th	
Russan; ΦΑ	3rd	5th	4th	1st		5th	3rd	1st	1st	1st	9th	4th	1st		4th	2nd	9th	4th
Hunter; ΦΜΑ					4th	3rd	5th	5th	7th			6th	6th			7th		
Austin; ΣΓΡ		10th					6th	9th										
Molda; Student Design Group	8th		5th	9th	7th	2nd	4th		5th	5th	6th	8th	5th	1st	9th	5th	7th	2nd
Irene; Voices of Praise	10th	2nd	8th	2nd				4th	4th	4th	1st		9th	2nd	5th	3rd		6th

- Determine the number of total points each contestant received in the first semifinal round from the student organizations.
- Which top 10 contestants did the organizations think should move on to the second semifinal?

8. Online voting for the best student music video was available for two weeks. Students were asked to rank the videos in order of preference. The following table shows the results of the student votes.

Preference Table for Best Student Music Video						
	Rankings					
1st	Video 2	Video 1	Video 2	Video 3	Video 3	Video 4
2nd	Video 1	Video 2	Video 1	Video 4	Video 2	Video 1
3rd	Video 4	Video 3	Video 3	Video 2	Video 4	Video 2
4th	Video 3	Video 4	Video 4	Video 1	Video 1	Video 3
Total Votes	143	212	99	43	121	151

- Determine the winning video by using the plurality method.
 - Determine the winning video by using the pairwise method of comparison.
 - Determine the winning by using the plurality with elimination method.
 - If you were determining a winning video, which video would you declare the winner based on the online votes? How would you defend your choice based on the answers to a.–c.?
9. In the 1992 United States Presidential Election, three candidates shared most of the November 3 popular vote, although there was a small portion of voters for other candidates. The following table displays the breakdown of the popular vote along with the electoral vote for the election.

1992 US Presidential Election Results			
Presidential Candidate	Popular Vote		Electoral Vote
	Count	Percentage	
George H. Bush	39,104,545	37.45%	168
Bill Clinton	44,909,889	43.01%	370
Ross Perot	19,742,267	18.91%	0
Other	669,958	0.63%	0
Totals	104,426,659	100%	538

Source: Federal Election Commission. "Federal Elections 92. Election Results for the US President, the US Senate, and the US House of Representatives." June 1993.
<http://www.fec.gov/pubrec/fe1992/federaelections92.pdf>

- Who won the popular vote by plurality? Was it a majority?
- Who won the electoral vote by plurality? Was it a majority?
- Suppose Perot had dropped out of the election. Is it possible that Clinton would have lost the presidency? Explain your answer.

10. The student government is deciding which author to bring to campus next year for the annual Books to Tables talk. The possibilities are Marci Shimoff, coauthor of *Chicken Soup for the Woman's Soul*, Peter Legge, author of *How to Soar with the Eagles*, and Tania Aebi, author of *Maiden Voyage*. Complete the following preference table so that Tania Aebi wins the election using the majority rule.

Preference Table for Author for Books to Tables Talk			
	Rankings		
1st	Tania Aebi	Peter Legge	Marci Shimoff
2nd	Peter Legge	Marci Shimoff	Tania Aebi
3rd	Marci Shimoff	Tania Aebi	Peter Legge
Total Votes	?	5	4

11. The Campus Housing Welcome Back committee is deciding what movie to show free to students the first week of school. The movie options are *Django Unchained*, *Zero Dark Thirty*, *Silver Linings Playbook*, and *Life of Pi*. Students were asked to rank the movies by preference. The following preference table summarizes their selections.

Preference Table for Movie Showing							
Movie	Rankings						
1st	<i>Zero</i>	<i>Zero</i>	<i>Django</i>	<i>Silver</i>	<i>Life</i>	<i>Django</i>	<i>Django</i>
2nd	<i>Django</i>	<i>Life</i>	<i>Life</i>	<i>Zero</i>	<i>Django</i>	<i>Silver</i>	<i>Zero</i>
3rd	<i>Life</i>	<i>Silver</i>	<i>Zero</i>	<i>Django</i>	<i>Zero</i>	<i>Zero</i>	<i>Silver</i>
4th	<i>Silver</i>	<i>Django</i>	<i>Silver</i>	<i>Life</i>	<i>Silver</i>	<i>Life</i>	<i>Life</i>
Total Votes	30	23	15	16	11	15	27

- Which movie is the plurality winner?
 - Which movie wins using a pairwise method of comparison?
 - Does using the plurality method satisfy the Condorcet criterion? Explain your answer.
12. An online poll asked readers to rank the top three law schools in the country. The following preference table shows the results after two days of online voting.

Preference Table for Top Law Schools				
	Rankings			
1st	Stanford	Yale	Stanford	Harvard
2nd	Harvard	Stanford	Harvard	Yale
3rd	Yale	Harvard	Yale	Stanford
Total Votes	84	132	39	13

- Which law school would win using the majority rule if voting closed today?
- Which law school would win using the Borda count method if voting closed today?
- Does the Borda count method satisfy the majority criterion for these poll results? Explain your answer.

13. The Association of Marketing Professionals is choosing a city for its next conference. The committee making the decision asks the association’s members to rank the top five cities they would like to visit. The following preference table gives the results of the member survey. Would the plurality with elimination method satisfy the irrelevant alternatives criterion if the committee decided to eliminate Jacksonville, FL, from the options after the vote? Explain your answer.

Preference Table for Conference Location

	Rankings			
1st	Boston, MA	Nashville, TN	San Diego, CA	New Orleans, LA
2nd	New Orleans, LA	Boston, MA	Boston, MA	Nashville, TN
3rd	San Diego, CA	San Diego, CA	New Orleans, LA	San Diego, CA
4th	Nashville, TN	Jacksonville, FL	Nashville, TN	Boston, MA
5th	Jacksonville, FL	New Orleans, LA	Jacksonville, FL	Jacksonville, FL
Total Votes	375	348	289	115

14. The Chamber of Commerce is electing a new president. The candidates are N. Pitts, A. Palmer, and J. Layne. The summary of the rankings of the candidates from the members is given in the table. Is the irrelevant alternatives criterion satisfied using the Borda count method if N. Pitts has to withdraw from the ballot after votes are cast because he moved? Explain your answer.

Preference Table for Chamber of Commerce President

	Rankings			
1st	A. Palmer	N. Pitts	A. Palmer	J. Layne
2nd	N. Pitts	J. Layne	J. Layne	A. Palmer
3rd	J. Layne	A. Palmer	N. Pitts	N. Pitts
Total Votes	12	15	13	16

15. *Living Day-to-Day* magazine wants to name the number-one feature homebuyers want in a house. They ask their readers to rank eight home features in order of importance. The eight home features are open-concept homes, smaller homes, outdoor living spacings, neutral decor, modern kitchens, linen closet & smart storage options, energy-efficient fixtures & appliances, and two-car garage with organization. The following preference table displays the results of the rankings. Determine if the Condorcet criterion is satisfied if the magazine uses the plurality method to name the top feature.

Preference Table for Homebuyers’ Number One Feature

Feature	Rankings					
1st	Outdoor	Smaller	Open	Kitchen	Smaller	Outdoor
2nd	Open	Outdoor	Smaller	Outdoor	Efficient	Kitchen
3rd	Kitchen	Kitchen	Outdoor	Efficient	Garage	Storage
4th	Neutral	Efficient	Neutral	Open	Open	Efficient
5th	Efficient	Storage	Kitchen	Storage	Outdoor	Garage
6th	Garage	Garage	Storage	Garage	Kitchen	Neutral
7th	Storage	Neutral	Efficient	Smaller	Storage	Open
8th	Smaller	Open	Garage	Neutral	Neutral	Smaller
Total Votes	421	234	331	472	253	119

16. Driving Divas asks its readers to rank the following car features in order of “must haves” in a new car. The car features are remote keyless entry, OnStar system, antilock brakes (ABS), electronic stability/skid-control system, telescoping steering wheel/adjustable pedals, and rear-seat DVD player. Complete the preference table so that rear-seat DVD player is the winner using the Borda count method, but the Condorcet criterion is violated in a head-to-head matchup with antilock brakes.

Preference Table for Must-Have Car Feature

Feature	Rankings			
1st	DVD	Keyless	Adjustable	Stability
2nd	Adjustable	?	DVD	ABS
3rd	ABS	?	OnStar	OnStar
4th	Keyless	Stability	ABS	Keyless
5th	OnStar	OnStar	Stability	Adjustable
6th	Stability	Adjustable	Keyless	DVD
Total Votes	35	44	28	20

17. In his next newspaper column, Tom plans to publish his results from a study on the top six qualities that make a great leader. The following preference table summarizes the rankings for the traits. Complete the preference table so that “sense of humor” is the top trait if the site uses the Borda count method to count the votes, and the majority criterion is not violated.

Preference Table for Top Leadership Qualities

Quality	Rankings			
1st	?	Honesty	Honesty	Communication
2nd	?	Sense of Humor	Communication	Sense of Humor
3rd	Confidence	Ability to Delegate	Sense of Humor	Honesty
4th	Commitment	Commitment	Confidence	Ability to Delegate
5th	Ability to Delegate	Confidence	Ability to Delegate	Commitment
6th	Communication	Communication	Commitment	Confidence
Total Votes	159	66	42	50

Use the given table to solve each problem.

Population per County	
County	Population
A	8578
B	9878
C	10450
D	7565
E	4563
F	6347

18. Suppose a state decides to apportion 250 new highway patrol officers on the basis of number of residents in a county.
- Find the standard divisor, SD.
 - Find the standard quota, SQ, for county A and county B. Round to three decimal places.
19. Use the Hamilton method to apportion the 250 patrol officers based on the population of the county.

Use the given table to solve each problem.

Student Enrollment in the University of Texas System		
Campus	Enrollment	Full Time Equivalent (FTE)
Arlington	33,439	20,594
Austin	51,112	46,402
Brownsville	13,836	9398
Dallas	18,684	12,537
El Paso	18,160	16,271
San Antonio	30,968	23,198
Tyler	5064	4810
Permian Basin	16,266	2696
Pan American	21,016	15,494

20. The University of Texas system consists of nine campuses and has a budget of \$13.1 billion. How much money in funding would each campus receive if the system divided the money equally among the campuses (round to nearest dollar)?
21. If the state of Texas wanted to allocate the money equally based on total student enrollment, how much would be appropriated per student?
22. Based on the result from Exercise 21, how much money would the campuses of Arlington and Pan American receive based on the student enrollment on each campus.
23. If the state apportions the funds based on FTE, how much money will the campuses of Austin and Dallas receive (round to nearest dollar)?

24. The University of Texas system wants to apportion 825 new electric vehicles to their campuses. The state decides to apportion these vehicles based on the student enrollment at each university.
- Find the SD. Round to three decimal places.
 - Find the SQ for the Brownsville and Tyler campuses. Round to three decimal places.
25. Suppose the state decides to apportion the 825 electric vehicles based on FTE.
- Find the SD. Round to three decimal places.
 - Find the SQ for the San Antonio and Permian Basin campuses. Round to three decimal places.
26. Use the Jefferson method to apportion the 825 electric vehicles to all 10 campuses based on the number of students.
27. Use the Hamilton method to apportion the 825 electric vehicles to all 10 campuses based on FTE. Compare your results with the apportionments from Exercise 26 and determine if the apportionments are different when the apportionment basis is different.

Solve each problem.

28. A science teacher at a high school can teach five classes. There are 27 students enrolled in Physical Science, 24 in Biology, and 37 in Anatomy.
- Find the SD and SQ of each course. Round to three decimal places.
 - Use the Jefferson method to determine the apportionment of students to the courses to determine the number of sections needed per course.
29. Repeat Exercise 28 b. using the Huntington-Hill method.
30. Repeat Exercise 28 b. using the Hamilton method.
31. An English department uses 19 graduate assistants in teaching its undergraduate courses. The enrollments for each of the courses these students teach is as follows. Using Webster's method, how many graduate assistants should be assigned to each course?

Students per Course	
Course	Students
Comp I	675
Comp II	455
Survey of Lit	197
Poetry	385

32. A state consists of six counties: A, B, C, D, E, and F.

The senate for the state is to have 30 members apportioned to the counties based on the old populations using Webster's method. The new populations are also given.

Population by County		
County	Old Population	New Population
A	8578	9244
B	9878	9166
C	10,450	10,580
D	7565	10,254
E	4563	6680
F	6347	5993

- Apportion the members of the senate using the old populations.
 - Apportion the members of the senate using the new populations.
 - Apportion the members of the senate using the Huntington-Hill method and the old populations.
 - Apportion the members of the senate using the Huntington-Hill method and the new populations.
 - Does the population paradox occur when calculating the apportionments using the Huntington-Hill method and the old and new populations?
33. The city of Hillsboro wants to allocate \$55 million to youth sports and activity programs. The current participation rates are listed in the table.

Participants per Activity	
Activity	Number of Participants
Swimming	245
Library	2595
Baseball	1150
Softball	978
Theater	753
Computer Hobbies	477
Music	1658

- Find how much the city should allocate to each activity based on the number of participants using the Jefferson method.
- Find how much the city should allocate to each activity based on the number of participants using Webster's method.
- Find how much the city should allocate to each activity based on the number of participants using the Huntington-Hill method.
- Find how much the city should allocate to each activity based on the number of participants using the Hamilton method.

34. Three groups, A, B, and C, have the number of members shown in the table. If Jefferson's method is used to apportion the representatives of the groups on a panel, does the Alabama paradox occur if the number of representatives is increased from 40 to 41?

Members per Group	
Group	Members
A	3340
B	4500
C	8875

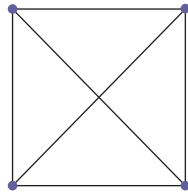
35. Using the table in Exercise 34, if Webster's method is used to apportion the representatives of the groups on a panel, does the Alabama paradox occur if the number of representatives is increased from 40 to 41?
36. What is the quota for $[8, 5, 3, 2]$ in a simple majority?
37. What is the quota for $[8, 5, 3, 2]$ for a two-thirds majority?
38. Consider the weighted voting system $[25: 9, 7, 4, 3, 2, 2, 1]$.
- What is the quota for this voting system?
 - What is the weight of P_5 ?
 - If only the last six voters vote for a motion, does the motion pass?
 - If P_1 and P_2 vote against a motion, does the motion pass?
 - What are the possible winning coalitions for this voting system?
39. Six partners in a law firm have the following voting system $[96: 34, 25, 18, 18, 12, 4]$.
- How many voters are in the system?
 - What is the quota for the system?
 - What are all of the winning coalitions?
 - Are there any critical players?
 - Do any of the players have veto power?
 - Is there a dummy player?
 - Determine the Banzhaf Power Index for each player.
40. In the weighted voting system $[q: 10, 7, 4, 4, 2, 2]$, if every voter has veto power, what is q ?
41. A voting system is represented by $[61: 35, 30, 24, 21]$.
- List all sequential coalitions in which the voter with weight 35 is pivotal.
 - List all sequential coalitions in which the voter with weight 30 is pivotal.
 - Calculate the Shapley-Shubik Power Index for each player in the system.
 - Are any of the voters dictators?
 - Do any of the voters have veto power?

42. A professional football team is getting ready for the amateur player draft. The head coach, general manager, head scout, and team physician will use the voting system $[8: 5, 4, 3, 2]$ to make decisions regarding players to draft.
- List all sequential coalitions in which P_1 is a pivotal player.
 - List all sequential coalitions in which P_2 is a pivotal player.
 - List all of the winning coalitions.
 - Calculate the Shapley-Shubik Power Index for each player.
 - Calculate the Banzhaf Power Index for each player.
 - Is there a player with veto power?

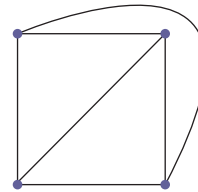
Chapter 14 Exercises

Solve each problem.

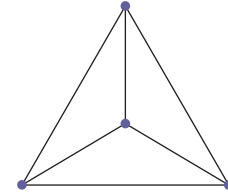
1. Draw a graph that has six vertices ($v_1, v_2, v_3, v_4, v_5, v_6$) and the edges $v_1v_4, v_1v_5, v_1v_6,$ and v_2v_3 . Is the graph connected?
2. Determine if the three graphs represent the same graph.



Graph *L*

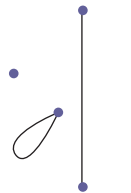


Graph *M*

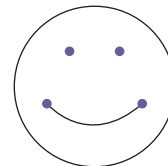


Graph *N*

3. Determine if the two graphs represent the same graph.

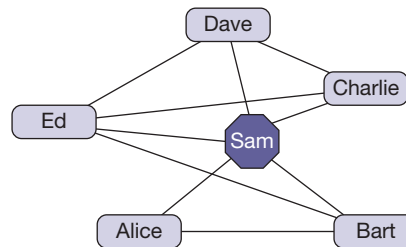


Graph *G*



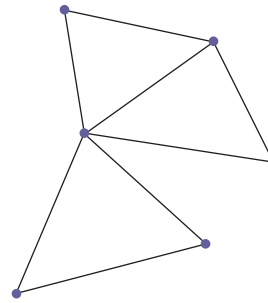
Graph *H*

4. Use the following graph to answer the questions below.



- a. What is the degree of “Sam”?
- b. Identify a path of length 5. If no such path exists explain why.
- c. Identify a path of length 6. If no such path exists explain why.
- d. Identify a cycle of length 5.

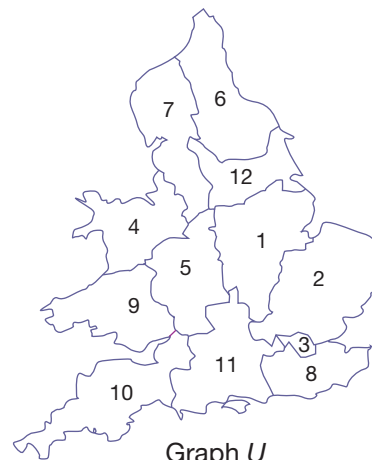
5. Find a vertex coloring of graph W . What is the chromatic number of that graph?



Graph W

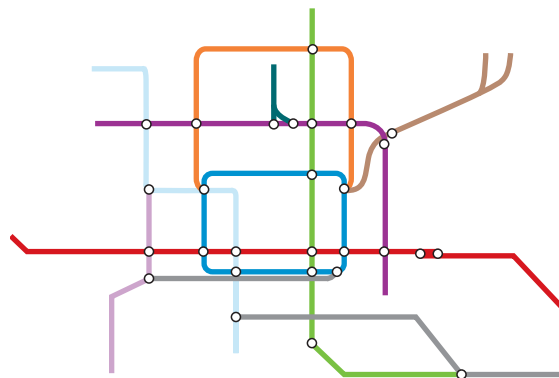
6. Use a vertex coloring to assign colors to the regional electricity companies in England and Wales so that companies whose regions share a border have different colors. What is the minimum number of colors required? Find a vertex coloring using the minimum number of colors.

Regional Electricity Companies in England and Wales

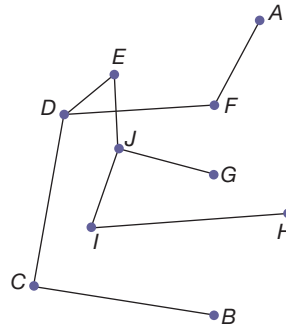


Graph U

7. Determine if the graph formed by the subway map is a tree.



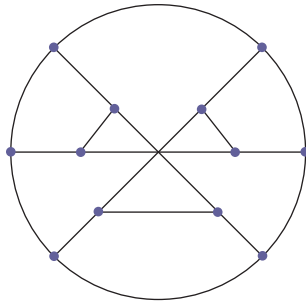
8. Determine whether the graph is a tree.



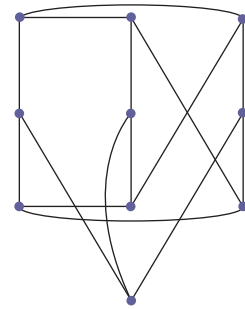
Graph *W*

Determine the number of edges needed to form a tree in each graph.

9.

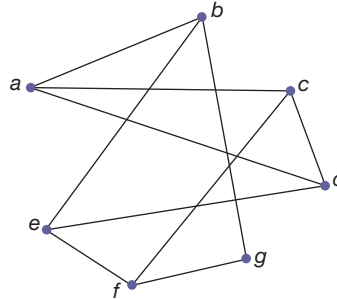


10.

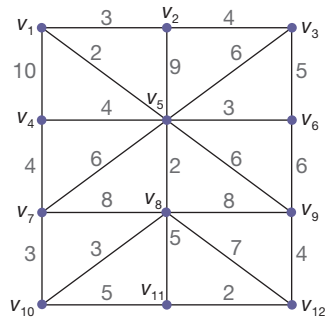


Solve each problem.

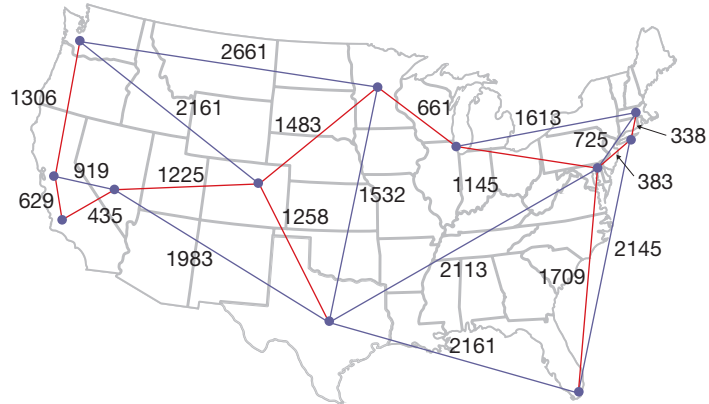
11. Find a spanning tree for the following graph.



12. Find a minimum-weight spanning tree in the following graph.

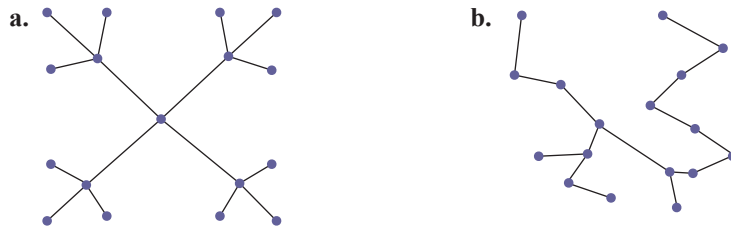


13. A national internet grid is needed to connect the cities in the following graph with optical fiber in the most cost-effective way possible. The weights on the edges represent the lengths of cable that would have to be used to connect each pair of cities, when that can be achieved.

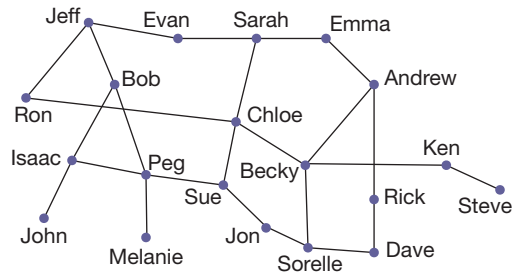


- The proposed connections are represented by the red edges. Check that this graph is a spanning tree. Explain why a spanning tree is a suitable way to lay the optical fiber.
- Is the proposed set of connections a minimum-weight spanning tree?

14. Find the number of leaves in the given trees.

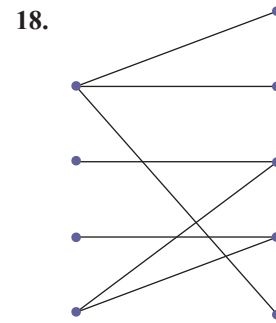
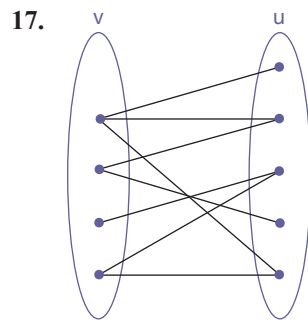


Use the given graph to identify the neighborhood of each set.

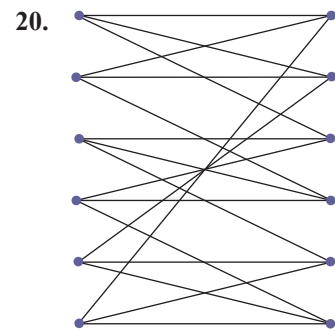
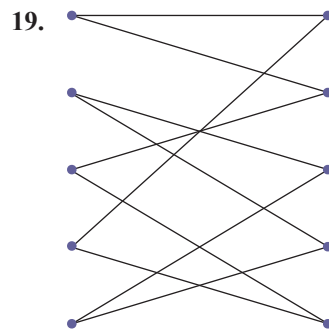


- $A = \{Bob, Evan\}$
- $A = \{Sorelle, Peg, Evan\}$

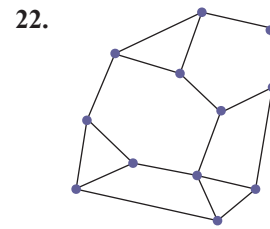
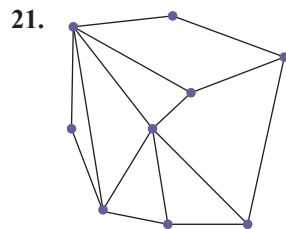
Determine if each graph has a matching. Justify your answer.



Find a matching in each regular bipartite graph.



Determine the number of faces in each planar graph.



Solve the problem.

23. Verify Euler's formula for the graphs in Exercises 21 and 22.

Determine if each graph is planar.

