INSTRUCTOR'S SOLUTIONS MANUAL

DIACRITECH

ELEMENTARY & INTERMEDIATE ALGEBRA: FUNCTIONS AND AUTHENTIC APPLICATIONS

THIRD EDITION

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Pearson

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Chapter 1
Introduction to Modeling

Homework 1.1

2. In 2015, Chris Davis hit 47 home runs.

4. In 2011, about 60 percent of children aged 5–18 participated in organized physical activity.

6. In 2015, 11.1 percent of American workers were in unions.

8. The temperature is $-10°\text{F}$. That is the temperature is 10 degrees below 0 (in Fahrenheit).

10. The statement $t = 13$ represents the year 2018 (13 years after 2005).

12. The statement $t = -2$ represents the year 2008 (2 years before 2010).

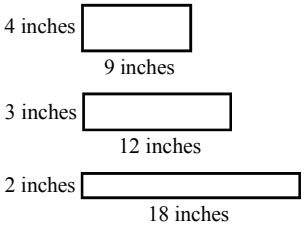
14. Answers may vary. Example:
Let t be the amount of time (in hours) that a student prepares for an exam. Then t can represent the numbers 0 and 4, but t cannot represent the numbers -1 and -3.

16. Answers may vary. Example:
Let n be the number of students enrolled in an algebra class. Then n can represent the numbers 15 and 28, but n cannot represent the numbers -20 and 0.5.

18. Answers may vary. Example:
Let T be the temperature (in degrees Fahrenheit) in an oven. Then T can represent the numbers 300 and 450, but T cannot represent the numbers -300 and -450.

20. Answers may vary. Example:
Let v be the value (in thousands of dollars) of a new home. Then v can represent the numbers 100 and 250, but v cannot represent the numbers -100 and -250.

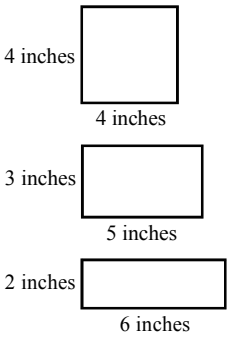
22. a. Answers may vary. Example:



b. In the described situation, the symbols W and L are variables. Their values can change.

c. In the described situation, the symbol A is a constant. Its value is fixed at 36 square inches.

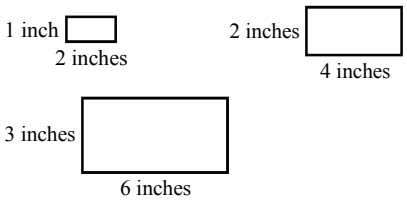
24. a. Answers may vary. Example:



b. In the described situation, the symbols W and L are variables. Their values can change.

c. In the described situation, the symbol P is a constant. Its value is fixed at 16 feet.

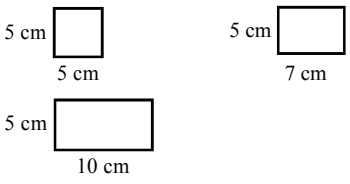
26. a. Answers may vary. Example:



b. In the described situation, the symbols W, L, and A are all variables. All of their values can change.

c. In the described situation, none of the symbols are constants. All of their values can change.

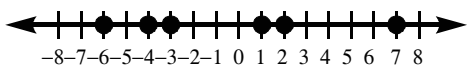
28. a. Answers may vary. Example:



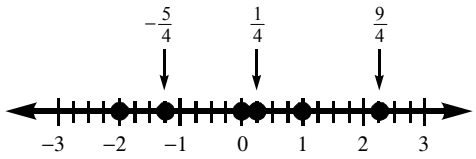
b. In the described situation, the symbols L and A are variables. Their values can change.

c. In the described situation, the symbol W is a constant. Its value is fixed at 5 cm.

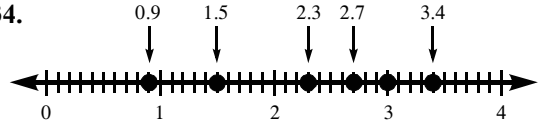
30.



32.



34.



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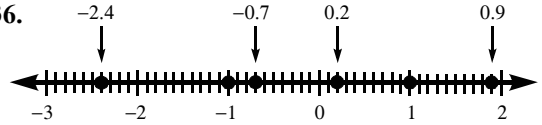
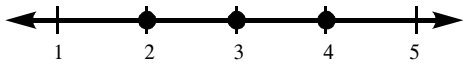
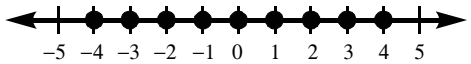


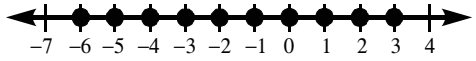
38. The counting numbers between 1 and 5 are 2, 3, and 4.



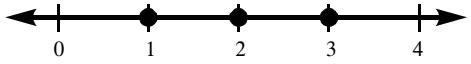
40. The integers between -4 and 4, inclusive, are $-4, -3, -2, -1, 0, 1, 2, 3$, and 4.



42. The integers between -6 and 3, inclusive, are $-6, -5, -4, -3, -2, -1, 0, 1, 2$, and 3.



44. The positive integers between -4 and 4 are 1, 2, and 3.



46. The integers in the list are -4, 0, and 3.

48. The rational numbers in the list are $-9.7, -4, 0, \frac{3}{5}$, and 3.

50. The real numbers in the list are $-9.7, -4, 0, \frac{3}{5}, \sqrt{7}, 3$, and π.

52. Answers may vary. Example: 1, 5, and 12

54. Answers may vary. Example: $-1, -2$, and -3

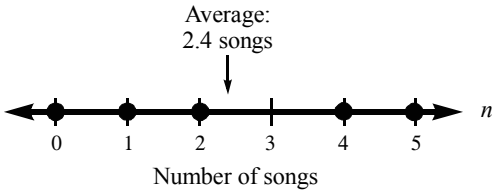
56. Answers may vary. Example: $\frac{1}{2}, \frac{3}{4}$, and $\frac{7}{9}$

58. Answers may vary. Example: $\sqrt{2}, \sqrt{5}$, and π

60. Answers may vary. Example: $\sqrt{2}, \sqrt{5}$, and π

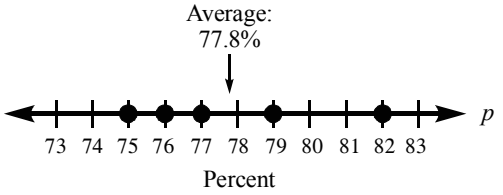
62. $\frac{2+0+1+5+4}{5} = \frac{12}{5} = 2.4$

The average number of songs downloaded per visit is 2.4 songs.

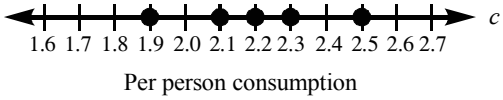


64. $\frac{79+82+75+77+76}{5} = \frac{389}{5} = 77.8$

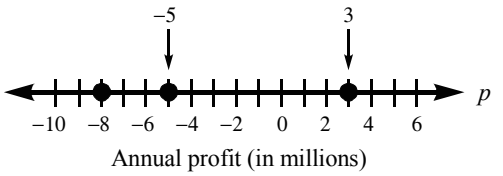
The average percentage of flights in a year that are on time is 77.8% per year.



66.

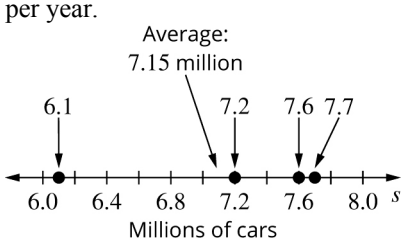


68.



70. a. $\frac{6.1+7.2+7.6+7.7}{4}=\frac{28.6}{4}=7.15$

The average sales are about \$7.15 million per year.



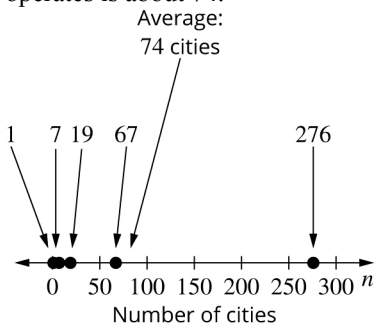
b. Car sales increased from 2011 to 2014. Sales went up each year.

c. The increases in car sales decreased from 2011 to 2014. The decreases were:

Years	Decrease
2011 to 2012	$7.2-6.1=1.1$
2012 to 2013	$7.6-7.2=0.4$
2013 to 2014	$7.7-7.6=0.1$

72. a. $\frac{1+7+19+67+276}{5}=\frac{370}{5}=74$

The average number of cities where Uber operates is about 74.



b. The number of cities where Uber operates increased from 2010 to 2014. The number of cities where Uber operates went up each year.

c. The increases in the number of cities where Uber operates increased from 2010 to 2014. The increases were

Years	Increase
2010 to 2011	$7-1=6$
2011 to 2012	$19-7=8$
2012 to 2013	$67-19=48$
2013 to 2014	$276-67=209$

74. No. Answers may vary. Example:
The numbers 2 and 5 are not "between 2 and 5." The numbers between 2 and 5 are simply 3 and 4.

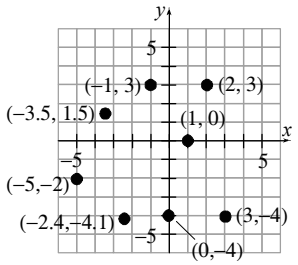
76. Two consecutive integers are 1 unit apart on the number line.
Two consecutive even integers are 2 units apart on the number line.
Two consecutive odd integers are 2 units apart on the number line.

78. Answers may vary. Example:
90 points; the fifth score did not change the average, so it must be the same as the average.

80. Answers may vary. Example:
Negative quantities are graphed to the left of 0 on the number line.

Homework 1.2

2–16 even.



18. The y-coordinate is -4.

20. Presumably, the longer a person works for a company, the higher his or her salary will be. So, the salary s depends on the number of years t. Thus, t is the independent variable and s is the dependent variable.

22. As a student's GPA increases, the percentage of college that would accept him or her would increase. So, the percentage p depends on the GPA g. Thus, g is the independent variable and p is the dependent variable.

24. As the age of men increases, the percentage with gray hair also increases. So, the percentage p depends on the age a. Thus, a is the independent variable and p is the dependent variable.

26. The longer the potato has been out of the oven, the cooler it will be (until it is cooled completely). So, the temperature of the potato F depends on the number of minutes t since it was removed from the oven. Thus, t is the

independent variable and F is the dependent variable.

28. The percentage p of people who own computers will change by age a. Thus, p is the independent variable and a is the dependent variable.

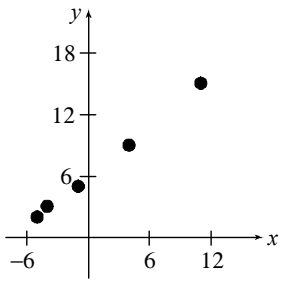
30. The total cost depends on the number of pens purchased. So, n is the independent variable and c is the dependent variable. The ordered pair (5, 10) means that $n = 5$ and $c = 10$. The cost of buying 5 pens is \$10.

32. The percentage of Internet users who use social networking sites depends on the number of social networking sites. So, n is the independent variable and p is the dependent variable. The ordered pair (4,5) means that $n = 4$ and $p = 5$. So, 5% of Internet users use 4 social networking sites.

34. The number of ads in millions blocked by Google depends on the year. So, t is the independent variable and n is the dependent variable. The ordered pair (5, 780) means that $t = 5$ and $n = 780$. In $2010 + 5 = 2015$, 780 million ads were blocked by Google.

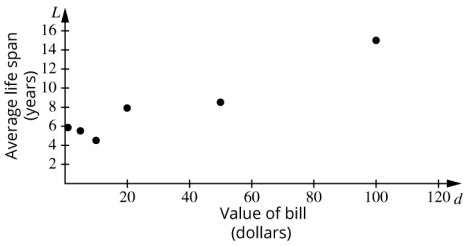
36. The percentage of Americans who are satisfied with the size and influence of major corporations depends on the year. So, t is the independent variable and p is the dependent variable. The ordered pair $(-1, 35)$ means that $t = -1$ and $p = 35$. In $2015 - 1 = 2014$, 35% of Americans felt satisfied with the size and influence of major corporations.

38.



40. Point A is 2 units to the left of the origin and 4 units down. Thus, its coordinates are $(-2, -4)$.
Point B is 3 units to the left of the origin on the x-axis. Thus, its coordinates are $(-3, 0)$.
Point C is 5 units to the left of the origin and 4 units up. Thus, its coordinates are $(-5, 4)$.
Point D is 4 units to the right of the origin and 2 units up. Thus, its coordinates are $(4, 2)$.
Point E is 3 units below the origin on the y-axis. Thus, its coordinates are $(0, -3)$.
Point F is 3 units to the right of the origin and 2 units down. Thus, its coordinates are $(3, -2)$.

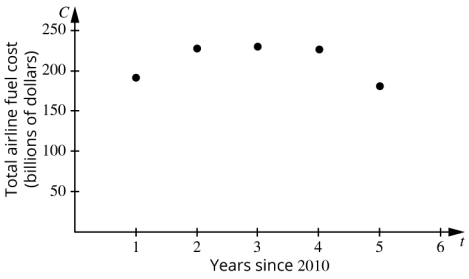
42. a.



b. Answers may vary. Example: The average life span of a \$100 bill is greater than the average life span of a \$10 bill since \$100 bills are used less often than \$10 bills.

c. Answers may vary. Example: Each year, many more \$10 bills are printed than \$100 bills since there is a larger demand for bills with lower value that tend to be used on a more regular basis.

44. a.

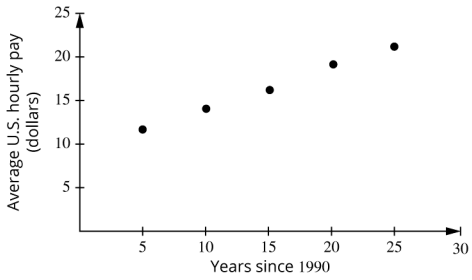


b. The total airline fuel cost was the least in 2015. In 2015, the total airline fuel cost was \$181 billion.

c. The total airline fuel cost was the greatest in 2013. In 2013, the total airline fuel cost was \$230 billion.

d. No. Answers may vary. Example: The total fuel cost may not be the greatest in the same year as the average price per barrel of crude oil since total fuel cost depends on many factors, including the types of planes that were being utilized by airlines as well as flight paths (distances various fleets flew). Such factors would mean more barrels of crude oil were being used.

46. a.



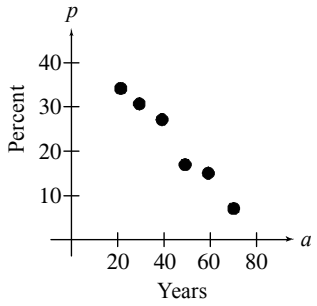
b. The average U.S. hourly pay increased. In each year, the average hourly pay was greater than the previous year.

c. The five-year increase in the average U.S. hourly pay did not follow a pattern of increase or decrease.

Years	Change
1995 to 2000	$14.03 - 11.67 = 2.36$
2000 to 2005	$16.15 - 14.03 = 2.12$
2005 to 2010	$19.06 - 16.15 = 2.91$
2010 to 2015	$21.05 - 19.06 = 1.99$

From 1995 to 2005, the change in average U.S. hourly pay decreased. However, from 2005 to 2010, the change in average hourly pay increased.

48. a.

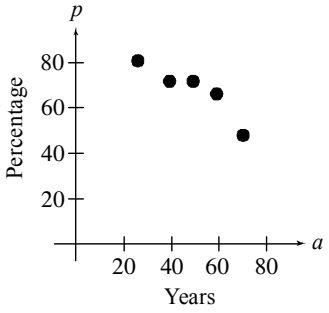


b. The highest point in the scatterplot is (21.0, 34). Answers may vary Example: It means that the 18–24 age group has the highest percentage who are ordering more takeout food than they did two years ago.

c. The lowest point in the scatterplot is (70.0, 7). Answers may vary. Example: It means that the "over 64" age group has the lowest percentage who are ordering more takeout food than they did two years ago.

d. The heights of the points decrease from left to right. Answers may vary. Example: Younger age groups have higher percentages than older age groups who are ordering more takeout food than they did two years ago.

50. a.



b. The 18–34 age group has the most faith in single men raising children on their own

c. The "over 64" age group has the least faith in single men raising children on their own.

d. The percentages of adults of various age groups who approve of single men raising children on their own are decreasing as the age group increases. Therefore, the student's opinion based on the data is correct.

52. a. Robin Ventura's number of career grand slams is 18.

b. The player who holds the record for the greatest number of career grand slams is Alex Rodriguez with 25.

c. The player who hit exactly 21 grand slams is Manny Ramirez.

54. The ordered pairs selected and scatterplots may vary. The points will lie on the same horizontal line. Answers may vary.

56. There are an infinite number of possibilities for the positions of the other two vertices. Answers may vary. Example: (2, 3) and (7, 3); (2, 2) and (7, 2); (2, 10) and (7, 10); $(2,-2)$ and $(7,-2)$.

58. All points on a coordinate system with an x-coordinate of 0 make up the y-axis.

60. Answers may vary.

Homework 1.3

2. The line contains the point $(4,-1)$, so $y=-1$ when $x=4$.

4. The line contains the point $(-6, 4)$, so $x = -6$ when $y = 4$.

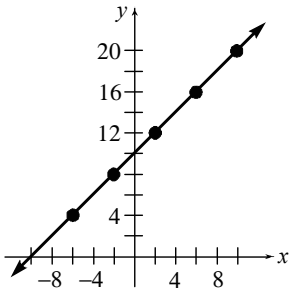
6. The line and the y-axis intersect at $(0, 1)$, so the y-intercept is $(0, 1)$.

8. The line contains the point $(6, 1)$, so $y = 1$ when $x = 6$.

10. The line contains the point $(3, 0)$, so $x = 3$ when $y = 0$.

12. The line and the x-axis intersect at $(3, 0)$, so the x-intercept is $(3, 0)$.

14. a–b.



c. The line contains the point $(4, 14)$, so $y = 14$ when $x = 4$.

d. The line contains the point $(8, 17)$, so $x = 8$ when $y = 17$.

e. The line and the y-axis intersect at $(0, 10)$, so the y-intercept is $(0, 10)$.

f. The line and the x-axis intersect at $(-10, 0)$, so the x-intercept is $(-10, 0)$.

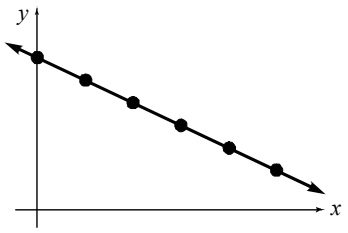
16. a. The line contains the point (3, 1500), so $B = 1500$ when $t = 3$. This means the balance 3 months after the account was opened was \$1500.

b. The line contains the point (5, 500), so $t = 5$ when $B = 500$. This means that 5 months after the account was opened, the balance was \$500.

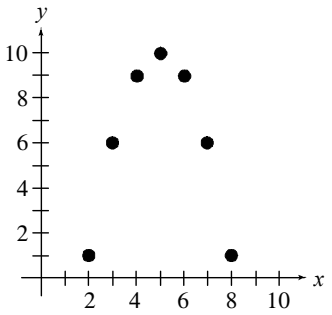
c. The line and the B-axis intersect at (0, 3000), so $B = 3000$ when $t = 0$. This means that the beginning balance of the account was \$3000.

d. The line and the t-axis intersect at (6, 0), so $t = 6$ when $B = 0$. This means that the account will be empty after 6 months.

18. Yes.

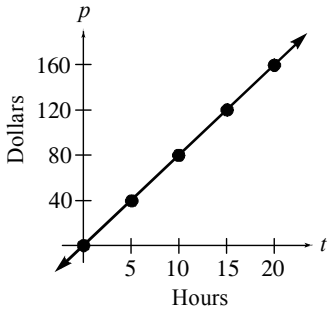


20. a.



b. No, there is not a linear relationship between x and y. The data points do not lie close to one line.

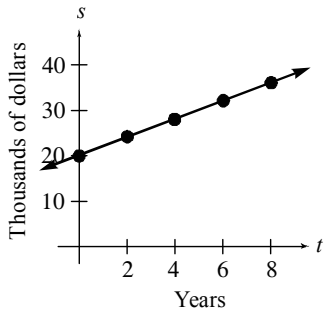
22. a.



b. The line contains the point (7, 56), so $p = 56$ when $t = 7$. This means the student's pay for working 7 hours is \$56.

c. The line contains the point (12, 96), so $t = 12$ when $p = 96$. This means that the student must work 12 hours to earn \$96.

24. a.

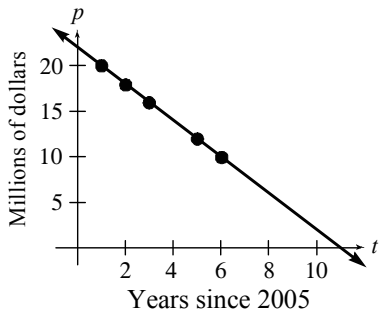


b. The line contains the point (5, 30), so $s = 30$ when $t = 5$. We estimate that person's salary will be \$30 thousand after he has worked 5 years at the company.

c. The line contains the point (7, 34), so $t = 7$ when $s = 34$. We estimate that the person will have worked 7 years at the company when his salary is \$34 thousand.

d. The line and the s-axis intersect at (0, 20), so $s = 20$ when $t = 0$. This means that the person's beginning salary at the company was \$20 thousand.

26. a.

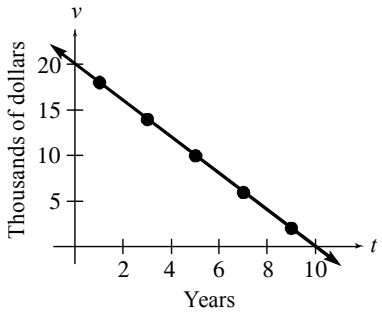


b. The line contains the point (10, 2), so $t = 10$ when $p = 2$. This means that the company's annual profit will be \$2 million in the year 2005 + 10 = 2015.

c. The line and the p-axis intersect at (0, 22), so $p = 22$ when $t = 0$. This means that the company's annual profit was \$22 million in the year 2005.

d. The line and the t-axis intersect at (11, 0), so $t = 11$ when $p = 0$. This means that the company's annual profit will be \$0 in the year 2005 + 11 = 2016.

28. a.



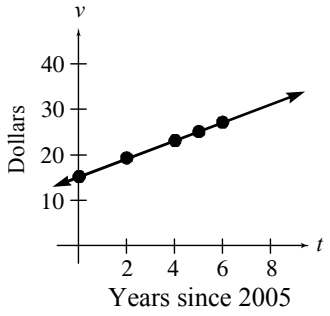
b. The line contains the point (8, 4), so $v = 4$ when $t = 8$. This means that the car will be worth \$4 thousand when it is 8 years old.

c. The line contains the point (6, 8), so $v = 8$ when $t = 6$. This means the value of the car will be \$8 thousand when it is 6 years old.

d. The line and the v-axis intersect at (0, 20), so $v = 20$ when $t = 0$. This means that the value of the car was \$20 thousand when new.

e. The line and the t-axis intersect at (10, 0), so $t = 10$ when $v = 0$. This means that the car will have no value after 10 years.

30. a.

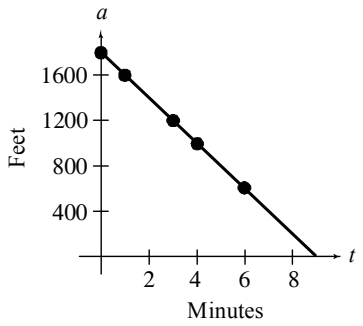


b. The line contains the point (3, 21), so $v = 21$ when $t = 3$. This means the value of the stock was \$21 in the year 2008.

c. The line contains the point (10, 35), so $t = 10$ when $v = 35$. This means the value of the stock will be \$35 in 2005 + 10 = 2015.

d. The line and the v-axis intersect at (0, 15), so $v = 15$ when $t = 0$. This means that the value of the stock was \$15 in the year 2005.

32. a.

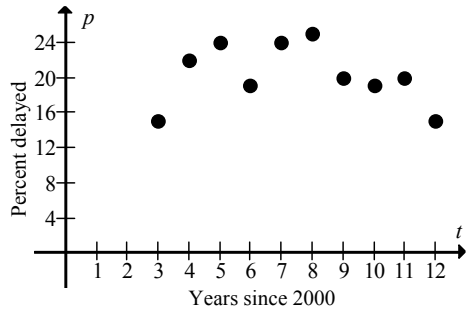


b. The line contains the point (5, 800), so $a = 800$ when $t = 5$. This means the altitude of the balloon is 800 feet after air has been released for 5 minutes.

c. The line contains the point (9, 0), so $t = 9$ when $a = 0$. This means that it will take 9 minutes for the balloon to reach the ground.

d. The prediction in part (c) will be an overestimate. A faster decent the last 400 feet means it will take less time to reach the ground than predicted.

34. a.



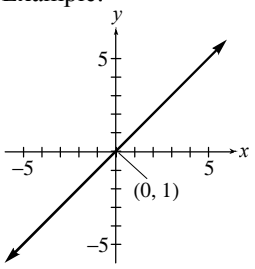
b. No, there is not a linear relationship between t and p. The data points do not lie close to one line.

36. No. The -3 is the x-coordinate of ordered pair $(-3, 4)$, not the x-intercept.

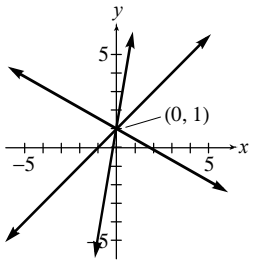
38. No. The x-coordinate of a y-intercept must be 0. The y-intercept might be (0, 5), but not (5, 0).

40. Yes. Any line that passes through the origin (0, 0) will have an x-intercept that is the same as the y-intercept. Answers may vary.

Example:



42. Answers may vary. Example:



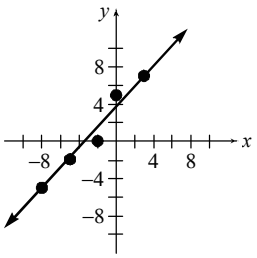
44. Answers may vary. Example:
Every point on the y-axis has an x-coordinate of 0. So the y-intercept of a line must have an x-coordinate of 0.

46. Answers may vary. Example:
A linear model is a line that describes the relationship between two quantities in an authentic situation.

Homework 1.4

Throughout this section, answers may vary.

2. a.



b. The variables are approximately linearly related.

c. Draw a line that comes close to the points. See the graph in part (a).

d. Approximately $(-1, 2.6)$

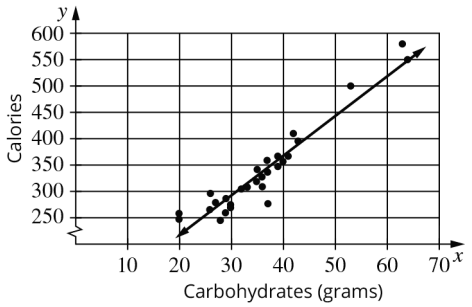
e. Approximately $(-6.2, -3)$

f. Approximately (0, 3.7)

g. Approximately $(-3.4, 0)$

4. a. The variables x and y are approximately linearly related. The points in the scatterplot lie close to a line.

b. Draw a line that comes close to the points to create the linear model as shown.

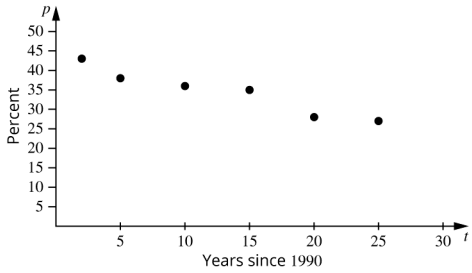


c. A pizza with 30 carbohydrates has about 290 calories. We performed interpolation because we used a part of the model whose x-coordinates are between the x-coordinates of two data points.

d. A pizza with 450 calories has about 51 carbohydrates. We performed interpolation because we used a part of the model whose x-coordinates are between the x-coordinates of two data points.

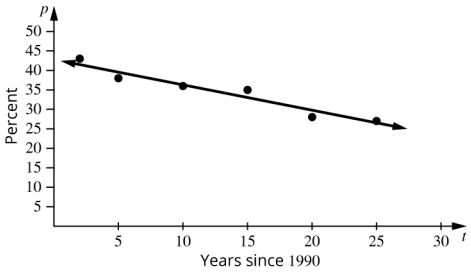
e. The line in the scatterplot goes up from left to right. Answers may vary. Example: A line going up from left to right makes sense because it shows that an increase in the number of carbohydrates results in an increase in the number of calories.

6. a.



b. The variables t and p are approximately linearly related. The points in the scatterplot lie close to a line.

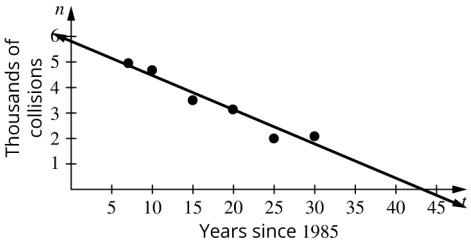
c. Draw a line that comes close to the points to create the linear model as shown.



d. According to the model, 31% of Americans said there should be a ban on possession of handguns around 2014.

e. According to the model, about 27% of Americans will say there should be a ban on possession of handguns in 2021.

8. a.



Note in the table below the difference in t-values when calculating t based on years since 1990 as in problem #7 (t_1) and years since 1985 as in problem #8 (t_2). A model using t_2 values interpolates n between t =7 and t = 30. A model using t_1 values interpolates n between t = 2 and t = 25.

t_1	t_2	n
2	7	4.9
5	10	4.6
10	15	3.5
15	20	3.1
20	25	2.0
25	30	2.1

b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).

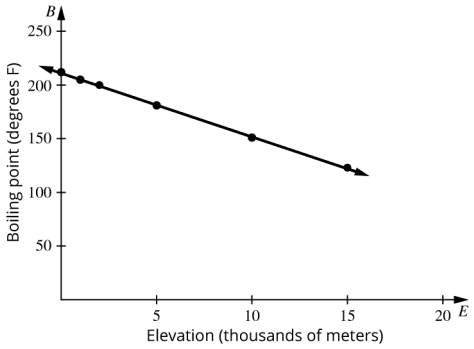
c. According to the model, the number of collisions in 2007 (t = 22) is about 2.8 thousand. We performed interpolation because we used a part of the model whose

t-coordinates are between the *t*-coordinates of two data points. The response here is the same as in #7c. The value of *t* is different than in #7c, but the year itself has not changed and therefore the value of *n* does not change.

d. According to the model, there will be 1.0 thousand collisions by around 2020 ($t = 35$). We performed extrapolation because we used a part of the model whose *t*-coordinates are not between the *t*-coordinates of two data points. That is, the final data value occurs at $t = 30$, which is smaller than the value of *t* used to predict collisions in 2020.The response here is the same as in #8c. The value of *n* (1.0 thousand) has not changed. Since *n* correlates to a specific year (2020), the year remains the same so the data value remains unchanged.

e. The *t*-intercept (the point where the model intersects the *t*-axis) is (43, 0). This means, according to the model, there will be no collisions in 2028. Model breakdown has likely occurred at this point and all years that follow since it is unlikely that in any year there would be no collisions at all (and certainly not a negative number of collisions). Note that the *t*-intercept is different than in #7e. It has shifted to the right by 5 compared with the value in #7e. The value of *t* must change in order for the data point "year 2028" and "0 collisions" to remain unchanged. The value of *t* consistently increases or decreases by 5 because we are calculating the values of *t* based on time periods that are 5 years apart. Note that the actual data does not change (that is, no matter the value of *t*, the years still correspond to specific numbers of collisions). Only the reference points for calculating *t* changes: (43, 0) represents 0 collisions in 2028 just as (38, 0) did in #7e.

10.a.



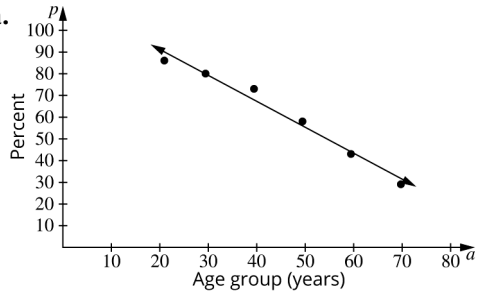
b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).

c. According to the model, the boiling point of water at Mt. Everest's peak (8850 meters) is about 160°F .

d. According to the model, the elevation at which a temperature of 98.6°F would feel like boiling water would be around 19 thousand meters. We performed extrapolation because we used a part of the model whose *E*-coordinates are not between the *E*-coordinates of two data points.

e. It takes more time to hard-boil eggs at higher altitudes. The heat that cooks the eggs comes from the boiling water. Since the temperature at which water boils is lower, water vaporizes sooner, meaning there is less actual water retaining heat inside the cooking pot. Therefore, it actually takes longer to hard-boil an egg at a higher altitude.

12. a.



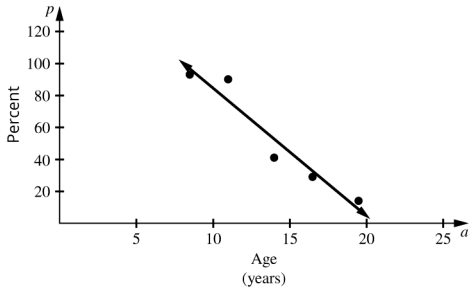
b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).

c. According to the model, 70% of Americans have a profile page around 38 years of age.

d. The p-intercept of the model is (0, 115). This means 115% of newborns have a personal profile page. Model breakdown has occurred.

e. The a-intercept of the model is (96, 0). This means no 96-year-olds have a personal profile page. Model breakdown is likely since there may be some 96-year-olds with personal profile pages.

14. a.



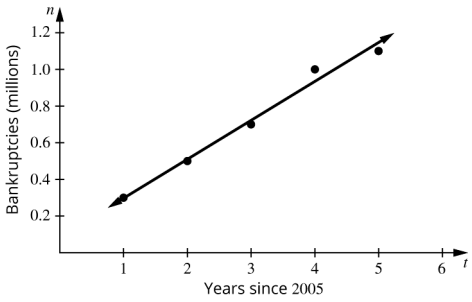
b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).

c. According to the model, the percentage of 13-year-olds who said their parents know where they go online is about 61%.

d. According to the model, the age at which all children, or 100%, say their parents know where they go online is about 8 years.

e. The a-intercept is (21, 0). This means that no 21-year-olds say their parents know where they go online. In this situation, model breakdown has likely occurred since there are probably some individuals among this age group whose parents know where they go online.

16. a.



b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).

c. According to the model, the number of bankruptcy filings in 2015 was about 2.2 million.

d. According to the table, in 2015, there were actually 0.5 million bankruptcy filings. The error is therefore $2.2 - 0.5 = 1.7$ million filings. The error is likely so large since we extrapolated the number of bankruptcies in 2015 using the model.

18. a. To find the t-intercept, estimate what the temperature will be when $w = 0$. This estimate is approximately (13, 0). This means that if the wind speed is 10 mph and the temperature is 13 degrees Fahrenheit, it will feel like it is 0 degrees Fahrenheit.

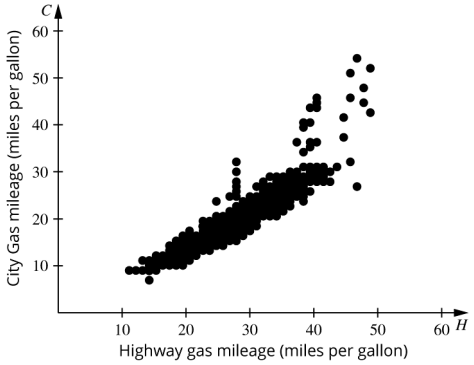
b. To find the w-intercept, estimate what the windchill will be when $t = 0$. This estimate is approximately (0, −16). This means that if the wind speed is 10 mph and the temperature is 0 degrees Fahrenheit, it will feel like it is 16 degrees Fahrenheit below 0.

20. a. According to the model, the number of ride-related injuries in 2013 was about 1.2 thousand.

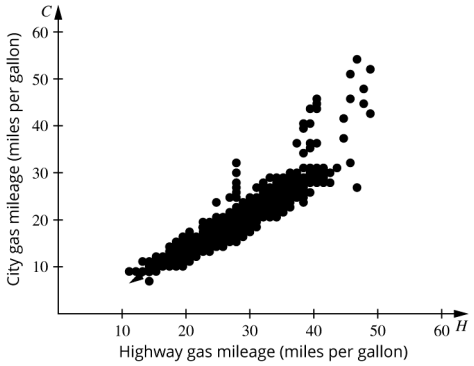
b. According to the table, the actual number of ride-related injuries in 2013 was 1.4 thousand.

c. The result in part (a) is an underestimate. The line is below the data point. The error is $1.4 - 1.2 = 0.2$ thousand injuries.

22. a.



b.



c. According to the model, the city gas mileage for a car with a highway gas mileage of 30 miles per gallon is about 22 miles per gallon.

d. According to the model, the highway gas mileage of a car with a city gas mileage of 14 miles per gallon is about 20 miles per gallon.

e. The H-intercept is (3.3, 0). This means that a car with a highway gas mileage of 3.3 miles per gallon has a city gas mileage of 0 miles per gallon. This seems unlikely since a car must use some amount of gas to run, and we assume that the cars in question are cars that run on gas. Model breakdown occurs in this case.

f. Going back to the original data, if you sort the data numerically, you will see that there are cars for which the highway and city gas mileages match. For example, there are several cars that have a city gas mileage of 13 and a highway gas mileage of 19. In other cases, there are cars whose city and gas mileages are unique and therefore don't match other cars. When the data is graphed on a scatterplot, we cannot show how a point like (13, 19) represents multiple cars; we see just one point at (13, 19). We may see other points like this that represent multiple cars, but there is no way for us to tell looking at the scatterplot alone. In other cases, a single point represents just one car since there are cars whose city and gas mileages are unique. Because a single data point might possibly represent gas mileages of several cars and another data point might represent only a single car, we shouldn't give the same weight to each data point. In other words, using a scatterplot, we cannot know which data values occur most frequently. Therefore, the line we draw is not necessarily the best one since it may not trend toward the points where the data is actually the most frequent.

g. The data points that are farthest from the model are mostly above the trendline. The type of car that most of these points represent is the hybrid, which makes sense because a hybrid vehicle tends to get better city mileage than highway mileage.

24. The model underestimates the value of p when $t = c$. In this case, (t, p) represents a point on the model, whereas (c, d) is an actual data point. Since (c, d) is above the model, then the point on the model at (t, p) is an underestimate.

26. It is more desirable to find a linear model that does not contain any data points but comes close to all data points. Answers may vary.

28. This short cut is dangerous because the linear model may not come close to the non-selected data points. Answers may vary.

30. No, this is not an example of model breakdown. Answers may vary. Example: Although time cannot be negative, the number of years since 2010 can be negative. A negative value for t means that the event occurs before 2010.

32. Answers may vary.

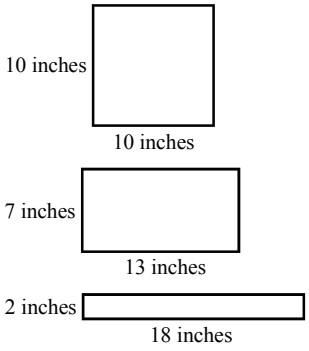
Chapter 1 Review Exercises

1. If B represents the total box office gross in billions of dollars and if $B = 11.13$ in 2015, then this means in 2015, the total box office gross was \$11.13 billion.

2. $t = 21$ represents the year $1995 + 21 = 2016$.

3. Answers may vary. Example:
Let p be the percentage of students who are full-time students. Then p can represent the numbers 60 and 70, but p cannot represent the numbers -12 and 107.

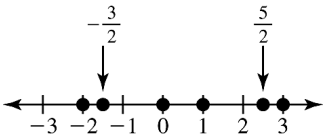
4. a. Answers may vary. Example:



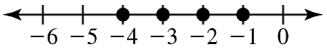
b. In the described situation, the symbols W and L are variables. Their values can change.

c. In the described situation, the symbol P is a constant. Its value is fixed at 40 inches.

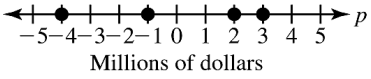
5.



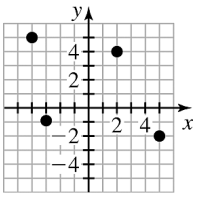
6. The negative integers between -5 and 5 are $-4, -3, -2,$ and -1.



7. The numbers listed (in millions) are: 2, $-4, -1$, and 3.



8.



9. The y-coordinate is -6.

10. The x-coordinate is -4.

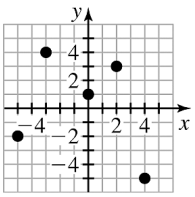
11. The percentage p of home owners depends on age a. Thus, a is the independent variable and p is the dependent variable.

12. Presumably, the more education a person has, the higher his or her salary will be. So, the average salary a depends on the years of education t. Thus, t is the independent variable and a is the dependent variable.

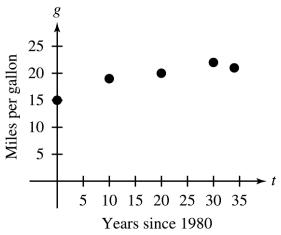
13. If n represents the total number of U.S. billionaires at t years since 2010, then n is the response variable and t is the explanatory variable which takes the form (t, n) as an ordered pair. So, the ordered pair (6, 540) means that in 2016 ($2010 + 6 = 2016$), there were 540 billionaires in the United States.

14. If r represents the annual revenue (in billions of dollars) from ADHD drugs at t years since 2000, then r is the response variable and t is the explanatory variable which takes the form (t, r). So, the ordered pair (14, 11) means that in 2014 ($2000 + 14 = 2014$), the annual revenue from ADHD drugs was \$11 billion.

15.



16. a.



b. According to the table, the average gas mileage of cars was the highest in 2010.

c. According to the table, the average gas mileage of cars was the lowest in 1980.

17. a. The country that generates the largest percentage of its electricity by nuclear power is France at about 76%.

b. Of the countries listed, the two that generate the smallest percentage of their electricity by nuclear power are Belgium and Slovenia, each at about 38%.

c. The percentage of Ukraine's electricity that is generated by nuclear power is about 57%.

18. The line contains the point $(-2,-1)$, so $y=-1$ when $x=-2$.

19. The line contains the point $(6,-5)$, so $y=-5$ when $x=6$.

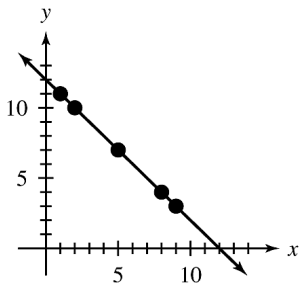
20. The line contains the point $(4,-4)$, so $x=4$ when $y=-4$.

21. The line contains the point $(-6,1)$, so $x=-6$ when $y=1$.

22. The line and the y-axis intersect at $(0,-2)$, so the y-intercept is $(0,-2)$.

23. The line and the x-axis intersect at $(-4,0)$, so the x-intercept is $(-4,0)$.

24. a.



b. See the graph in part (a).

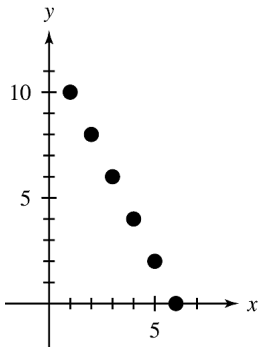
c. The line contains the point (11, 1), so $y = 1$ when $x = 11$.

d. The line contains the point (7, 5), so $x = 7$ when $y = 5$.

e. The line and the x-axis intersect at (12, 0), so the x-intercept is (12, 0).

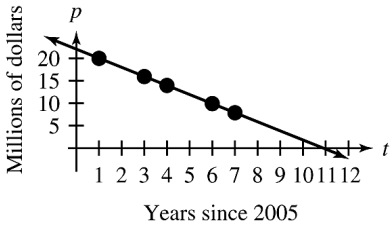
f. The line and the y-axis intersect at (0, 12), so the y-intercept is (0, 12).

25. a.



b. The variables x and y are linearly related.

26. a.



b. The year 2015 is represented by $t = 10$. The line contains the point (10, 2), so $p = 2$ when $t = 10$. We estimate that the annual profit is \$2 million in 2015.

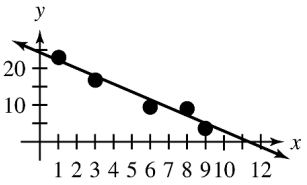
c. The line contains the point (2, 18), so $t = 2$ when $p = 18$. We estimate that the annual profit was \$18 million in the year 2005 + 2 = 2007.

d. The line and the p-axis intersect at (0, 22), so $p = 22$ when $t = 0$. This means that the annual profit was \$22 million in the year 2005.

e. The line and the t-axis intersect at (11, 0), so $t = 11$ when $p = 0$. This means that the annual profit will be \$0 in the year 2016.

27. The y-coordinate of an x-intercept of a line is 0.

28. a.



b. The variables are approximately linearly related.

c. See the graph in part (a).

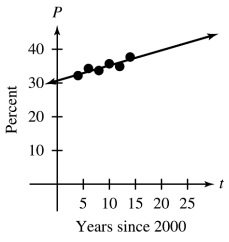
d. (5, 13.5)

e. (2, 20)

f. (0, 24.3)

g. (11.2, 0)

29. a.



b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).

c. According to the model, the percentage of American adults who will be obese 2021 is about 40%.

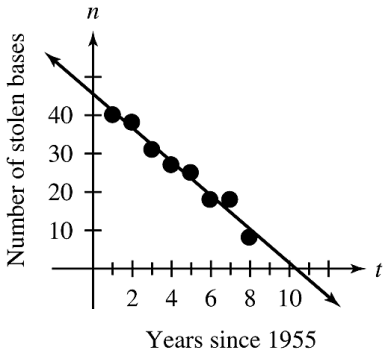
d. According to the model, 41% of Americans will be obese in 2023.

e. Answers may vary. Example: Since participants in the Gallup study gave self-reported heights and weights, it is likely the data is more variable since the methods used to take heights and weights varied (for example, participants were not all weighed on the same scale). It is also the case that self-reported data is often biased. That is, the participants may have provided less accurate measurements (for example, they may have indicated their weights were lower than they actually were and/or indicated they were taller than they actually were)

30. a. First, we list the values of t and n in the table below. For example, $t = 1$ represents 1956 because 1956 is 1 year after 1955.

Years since 1955 t	Stolen Bases n
1	40
2	38
3	31
4	27
5	25
6	18
7	18
8	8

We then create the scatterplot.



b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).

c. The line and the n-axis intersect at (0, 45.2), so $n = 45.2$ when $t = 0$. This means that, according to the model, Mays stole 45 bases in 1955.

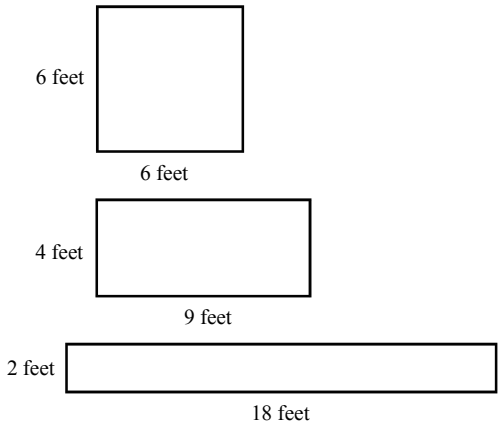
d. The line and the t-axis intersect at (10.4, 0), so $t = 10.4$ when $v = 0$. Now 1955 + 10.4 = 1965.4. According to the model, Mays did not steal any bases in 1965.

e. Since the predicted number of stolen bases (45) is higher than the actual number of stolen bases (24), the prediction is an overestimate. Model breakdown has occurred. Answers may vary.

f. For the year 1971, our linear model will predict a negative number of stolen bases, which is an underestimate. Model breakdown has occurred. Answers may vary.

Chapter 1 Test

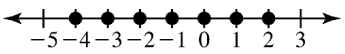
1. a. Answers may vary. Example:



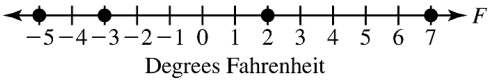
b. In the described situation, the symbols W and L are variables. Their values can change.

c. In the described situation, the symbol A is a constant. Its value is fixed at 36 square feet.

2. The integers between -4 and 2, inclusive, are $-4, -3, -2, -1, 0, 1,$ and 2.

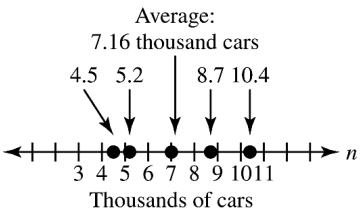


3. The numbers listed are: -5, 7, 2, and -3.



4. $\dfrac{4.5+5.2+7.0+8.7+10.4}{5} = \dfrac{35.8}{5} = 7.16$

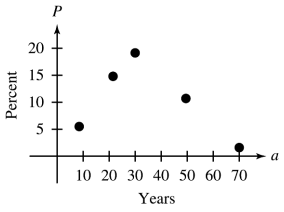
The average number of electric cars in use per year is 7.16 thousand cars.



5. As the number of tickets increases, so will the cost. So, the cost c depends on the number of tickets n. Thus, n is the independent variable and c is the dependent variable.

6. If s represents the salary in millions of dollars of Joe Mauer in the year that is t years since 2010, then s is the response variable and t is the explanatory variable which takes the form (t, s) as an ordered pair. So, the ordered pair (6, 23) means that in 2016 ($2010+6=2016$), Joe Mauer earned a salary of \$23 million.

7. a.



b. The highest point in the scatterplot is (30, 18.5). Since 30 represents the age group 26–34 and this value corresponds to 18.5%, this means that Americans in the age group 26–34 are the most likely to be without health insurance at 18.5%.

c. The lowest point in the scatterplot is (70, 1.6). Since 70 represents the age group "over 64," this means that Americans who are older than 64 years are the least likely to be without health insurance at 1.6%.

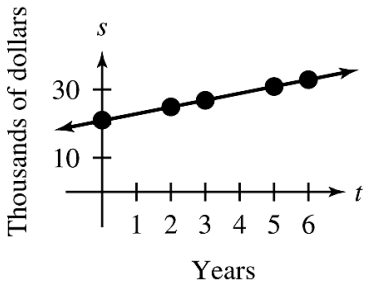
8. The line contains the point $(-4,-3)$, so $y=-3$ when $x=-4$.

9. The line contains the point $(4,1)$, so $x=4$ when $y=1$.

10. The line and the y-axis intersect at $(0,-1)$, so the y-intercept is $(0,-1)$.

11. The line and the x-axis intersect at $(2,0)$, so the x-intercept is $(2,0)$.

12. a.



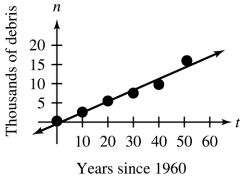
b. The line contains the point (4, 29), so $s = 29$ when $t = 4$. We predict the person's salary will be \$29 thousand after she has worked 4 years at the company.

c. The line contains the point (7, 35), so $t = 7$ when $s = 35$. We predict that person's salary will be \$35 thousand after she has worked 7 years at the company.

d. The line and the s-axis intersect at (0, 21), so $s = 21$ when $t = 0$. This means that, when the person was initially hired, her salary was \$21 thousand.

13. Answers may vary.

14. a.



b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).

c. According to the model, there were 9 thousand space debris in around $1960+32=1992$.

d. According to the model, the number of space debris in 2010 ($t = 50$) was about 14.2 thousand.

e. The total number of debris created by the events in 2007 and 2009 was about 1.8 thousand. We estimate the debris, using the model, to be about 14 thousand in 2009 ($t = 49$). (We use 2009 since it includes debris amounts from the 2009 event as well as the 2007 event.) If we remove the actual data point (50, 16) and adjust our model with a new line, we can estimate the amount of debris had the events from 2007 and 2009 not occurred. In that case, we estimate the amount of debris to be about 12.2 thousand. By subtracting the two estimates, we get a value of 1.8 thousand pieces of debris. This is the amount of extra debris resulting from the events in 2007 and 2009.

15. If the data point (c, p) is below the linear model, then the model will overestimate the value of p when $t = c$.

Chapter 2
Operations and Expressions

Homework 2.1

2. Substitute 6 for x in $5+x$: $5+(6)=11$

4. Substitute 6 for x in $x-4$: $(6)-4=2$

6. Substitute 6 for x in $x(9)$: $(6)(9)=54$

8. Substitute 6 for x in $30\div x$: $30\div 6=5$

10. Substitute 6 for x in $x-x$: $(6)-(6)=0$

12. Substitute 6 for x in $x\div x$: $(6)\div(6)=1$

14. Substitute 440 for T in $T\div 5$: $440\div 5=88$
The student's average test score was 88.

16. Substitute 60.9 for F in $F+17.3$:
$60.9+17.3=78.2$
So, the number of General Motors employees in 2016 was 78.2 thousand.

18. a.

Speed Limit (miles per hour)	Driving Speed (miles per hour)
35	$35+5$
40	$40+5$
45	$45+5$
50	$50+5$
s	$s+5$

The expression $s+5$ represents the driving speed if the speed limit is s miles per hour.

b. Substitute 65 for s in $s+5$:
$65+5=70$
So, if the speed limit is 65 miles per hour, the person will be driving 70 miles per hour.

20. a.

Number of Pairs	Total Cost (dollars)
1	$4.05\cdot 1$
2	$4.05\cdot 2$
3	$4.05\cdot 3$
4	$4.05\cdot 4$
n	$4.05\cdot n$

b. Substitute 9 for n in $4.05\cdot n$:
$4.05\cdot 9=36.45$
So, the total cost of 9 pairs Nike Men's Elite Basketball Crew socks is $36.45.

22. a.

Width (feet)	Area (square feet)
1	$20\cdot 1$
2	$20\cdot 2$
3	$20\cdot 3$
4	$20\cdot 4$
w	$20w$

The expression $20w$ represents the area of the garden (in square feet) if the width is w feet.

b. Substitute 10 for w in $20w$: $20(10)=200$
So, the area of the garden will be 200 square feet if the width is 10 feet.

24. $8-x$
Substitute 8 for x in $8-x$: $8-(8)=0$

26. $6+x$
Substitute 8 for x in $6+x$: $6+(8)=14$

28. $x+15$
Substitute 8 for x in $x+15$: $(8)+15=23$

30. $x-7$
Substitute 8 for x in $x-7$: $(8)-7=1$

32. $5x$
Substitute 8 for x in $5x$: $5(8)=40$

34. The quotient of 6 and the number

36. Two less than the number

38. The sum of 4 and the number

40. The product of the number and 5

42. The sum of the number and 3

44. The quotient of the number and 5

46. Substitute 6 for x and 3 for y in the expression $y + x$: $(3) + (6) = 9$

48. Substitute 6 for x and 3 for y in the expression xy: $(6)(3) = 18$

50. Substitute 6 for x and 3 for y in the expression $x \div y$: $6 \div 3 = 2$

52. $x + y$

Substitute 9 for x and 3 for y in the expression $x + y$: $(9) + (3) = 12$

54. $x \div y$

Substitute 9 for x and 3 for y in the expression $x \div y$: $(9) \div (3) = 3$

56. Substitute 3758 for b and 994 for d in the expression $b - d$: $(3758) - (994) = 2764$

So, the new balance is \$2764 after a check is written for \$994.

58. Substitute 9000 for T and 20 for n in the expression $T \div n$: $9000 \div 20 = 450$

So, if 20 students go on a ski trip that costs \$9000, the cost per student is \$450.

60. Substitute 501 for E and 17 for t (2009 is 17 years after 1992) in the expression $E + t$: $501 + 17 = 518$

So, if the average verbal score was 501 points in 2009, the average math score was 518.

62. a.

n	$3n$
1	$3 \cdot 1 = 3$
2	$3 \cdot 2 = 6$
3	$3 \cdot 3 = 9$
4	$3 \cdot 4 = 12$

So, the cost of 1, 2, 3, or 4 loaves is \$3, \$6, \$9, or \$12, respectively.

b. Each loaf costs \$3. The price per loaf is a constant while the number of loaves is a variable. In the expression $3n$, the constant is 3 and the variable is n.

c. Answers may vary. Example:
For each additional loaf purchased, the total cost increases by \$3.

64. a.

t	$2t$
1	$2 \cdot 1 = 2$
2	$2 \cdot 2 = 4$
3	$2 \cdot 3 = 6$
4	$2 \cdot 4 = 8$

So, the elevator rises 2, 4, 6, or 8 yards after 1, 2, 3, or 4 seconds, respectively.

b. The elevator is rising at a rate of 2 yards per second. The speed is a constant while the number of seconds rising is a variable. In the expression, $2t$, the constant is 2 and the variable is t.

c. Answers may vary. Example:
For each additional second the elevator rises, the total distance risen increases by 2 yards.

66. Answers may vary.

68. Answers may vary.

70. Answers may vary.

Homework 2.2

2. The numerator of $\frac{2}{5}$ is 2.

4. $18 = 2 \cdot 9 = 2 \cdot (3 \cdot 3) = 2 \cdot 3 \cdot 3$

6. $24 = 4 \cdot 6 = (2 \cdot 2) \cdot (2 \cdot 3) = 2 \cdot 2 \cdot 2 \cdot 3$

8. $27 = 3 \cdot 9 = 3 \cdot (3 \cdot 3) = 3 \cdot 3 \cdot 3$

10. $105 = 5 \cdot 21 = 5 \cdot (3 \cdot 7) = 3 \cdot 5 \cdot 7$

12. $\frac{10}{14} = \frac{2 \cdot 5}{2 \cdot 7} = \frac{2}{2} \cdot \frac{5}{7} = \frac{5}{7}$

14. $\frac{7}{28} = \frac{7 \cdot 1}{7 \cdot 4} = \frac{7}{7} \cdot \frac{1}{4} = \frac{1}{4}$

16. $\frac{27}{54} = \frac{3 \cdot 3 \cdot 3}{3 \cdot 3 \cdot 3 \cdot 2} = \frac{3 \cdot 3 \cdot 3}{3 \cdot 3 \cdot 3} \cdot \frac{1}{2} = \frac{1}{2}$

18. $\frac{49}{63} = \frac{7 \cdot 7}{7 \cdot 3 \cdot 3} = \frac{7}{7} \cdot \frac{7}{3 \cdot 3} = \frac{7}{3 \cdot 3} = \frac{7}{9}$

20. $\frac{9}{81} = \frac{3 \cdot 3}{3 \cdot 3 \cdot 3 \cdot 3} = \frac{3 \cdot 3}{3 \cdot 3} \cdot \frac{1}{3 \cdot 3} = \frac{1}{3 \cdot 3} = \frac{1}{9}$

22. $\frac{15}{18}=\frac{3\cdot 5}{3\cdot 3\cdot 2}=\frac{3}{3}\cdot\frac{5}{3\cdot 2}=\frac{5}{3\cdot 2}=\frac{5}{6}$

24. $\frac{6}{7}\cdot\frac{4}{9}=\frac{6\cdot 4}{7\cdot 9}=\frac{2\cdot 3\cdot 2\cdot 2}{7\cdot 3\cdot 3}=\frac{2\cdot 2\cdot 2}{7\cdot 3}=\frac{8}{21}$

26. $\frac{2}{3}\cdot\frac{5}{6}=\frac{2\cdot 5}{3\cdot 6}=\frac{2\cdot 5}{3\cdot 2\cdot 3}=\frac{5}{3\cdot 3}=\frac{5}{9}$

28. $\frac{5}{12}\cdot 2=\frac{5}{12}\cdot\frac{2}{1}=\frac{5\cdot 2}{2\cdot 2\cdot 3}=\frac{5}{2\cdot 3}=\frac{5}{6}$

30. $\frac{7}{12}\div\frac{2}{3}=\frac{7}{12}\cdot\frac{3}{2}=\frac{7\cdot 3}{12\cdot 2}=\frac{7\cdot 3}{2\cdot 2\cdot 3\cdot 2}=\frac{7}{2\cdot 2\cdot 2}=\frac{7}{8}$

32. $\frac{4}{7}\div\frac{8}{3}=\frac{4}{7}\cdot\frac{3}{8}=\frac{4\cdot 3}{7\cdot 8}=\frac{2\cdot 2\cdot 3}{7\cdot 2\cdot 2\cdot 2}=\frac{3}{7\cdot 2}=\frac{3}{14}$

34. $\frac{4}{9}\div 2=\frac{4}{9}\cdot\frac{1}{2}=\frac{4\cdot 1}{9\cdot 2}=\frac{2\cdot 2}{3\cdot 3\cdot 2}=\frac{2}{3\cdot 3}=\frac{2}{9}$

36. $\frac{5}{9}+\frac{2}{9}=\frac{5+2}{9}=\frac{7}{9}$

38. $\frac{2}{15}+\frac{8}{15}=\frac{2+8}{15}=\frac{10}{15}=\frac{2\cdot 5}{3\cdot 5}=\frac{2}{3}$

40. $\frac{5}{7}-\frac{2}{7}=\frac{5-2}{7}=\frac{3}{7}$

42. $\frac{13}{18}-\frac{9}{18}=\frac{13-9}{18}=\frac{4}{18}=\frac{2\cdot 2}{2\cdot 3\cdot 3}=\frac{2}{3\cdot 3}=\frac{2}{9}$

44. The LCD is 9:

$\frac{1}{3}+\frac{5}{9}=\frac{1}{3}\cdot\frac{3}{3}+\frac{5}{9}=\frac{3}{9}+\frac{5}{9}=\frac{8}{9}$

46. The LCD is 24:

$\frac{3}{8}+\frac{1}{6}=\frac{3}{8}\cdot\frac{3}{3}+\frac{1}{6}\cdot\frac{4}{4}=\frac{9}{24}+\frac{4}{24}=\frac{13}{24}$

48. The LCD is 7:

$2+\frac{3}{7}=\frac{2}{1}\cdot\frac{7}{7}+\frac{3}{7}=\frac{14}{7}+\frac{3}{7}=\frac{17}{7}$

50. The LCD is 4:

$\frac{3}{4}-\frac{1}{2}=\frac{3}{4}-\frac{1}{2}\cdot\frac{2}{2}=\frac{3}{4}-\frac{2}{4}=\frac{1}{4}$

52. The LCD is 42:

$\frac{5}{6}-\frac{4}{7}=\frac{5}{6}\cdot\frac{7}{7}-\frac{4}{7}\cdot\frac{6}{6}=\frac{35}{42}-\frac{24}{42}=\frac{11}{42}$

54. The LCD is 7:

$1-\frac{9}{7}=\frac{1}{1}\cdot\frac{7}{7}-\frac{9}{7}=\frac{7}{7}-\frac{9}{7}=\frac{-2}{7}=-\frac{2}{7}$

56. $\frac{62}{62}=1$

58. $\frac{215}{1}=215$

60. $\frac{713}{0}$ is undefined since division by 0 is not defined.

62. $\frac{0}{798}=0$

64. $\frac{173}{190}\cdot\frac{190}{173}=\frac{173\cdot 190}{173\cdot 190}=1$

66. $\frac{345}{917}-\frac{345}{917}=\frac{345-345}{917}=\frac{0}{917}=0$

68. Substitute 3 for x and 12 for z in the expression $\frac{z}{x}$:

$\frac{12}{3}=\frac{3\cdot 2\cdot 2}{3\cdot 1}=\frac{2\cdot 2}{1}=\frac{4}{1}=4$

70. Substitute 4 for w, 3 for x, 5 for y, and 12 for z in the expression $\frac{y}{z}\cdot\frac{w}{x}$:

$\frac{5}{12}\cdot\frac{4}{3}=\frac{5\cdot 2\cdot 2}{2\cdot 2\cdot 3\cdot 3}=\frac{5}{3\cdot 3}=\frac{5}{9}$

72. Substitute 3 for x, 5 for y, and 12 for z in the expression $\frac{y}{x}+\frac{y}{z}$: $\frac{5}{3}+\frac{5}{12}$

The LCD is 12:

$\frac{5}{3}+\frac{5}{12}=\frac{5}{3}\cdot\frac{4}{4}+\frac{5}{12}=\frac{20}{12}+\frac{5}{12}=\frac{25}{12}$

74.

```
(67/71)*(381/399
)
      .9010907551
```

$\frac{67}{71}\cdot\frac{381}{399}\approx 0.901$

76.

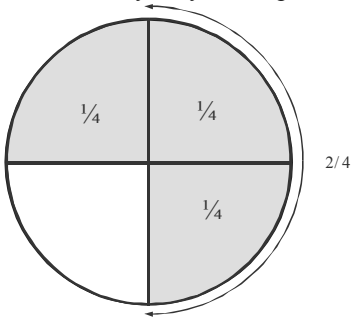
```
(149/215)/(31/52
)
      1.162490623
```

$\frac{149}{215}\div\frac{31}{52}\approx 1.162$

78.
```
(614/701)+(391/4
00)
      1.853391583
```

$\frac{614}{701}+\frac{391}{400}\approx 1.853$

80. Answers may vary. Example:



82. The perimeter of a rectangle is given by the expression $2L+2W$. Substitute $\frac{2}{3}$ for W and $\frac{3}{4}$ for L in the expression.

$$2\cdot\frac{3}{4}+2\cdot\frac{2}{3}=\frac{2}{1}\cdot\frac{3}{4}+\frac{2}{1}\cdot\frac{2}{3}$$
$$=\frac{2\cdot 3}{2\cdot 2}+\frac{2\cdot 2}{3}$$
$$=\frac{3}{2}+\frac{4}{3}$$

The LCD is 6:

$$\frac{3}{2}\cdot\frac{3}{3}+\frac{4}{3}\cdot\frac{2}{2}=\frac{9}{6}+\frac{8}{6}=\frac{17}{6}$$

The perimeter of the picture is $\frac{17}{6}$ feet.

84. Let m be the fraction of income for mortgage and f be the fraction of income for food. The fraction remaining is given by the expression $1-m-f$. Substitute $\frac{1}{3}$ for m and $\frac{1}{6}$ for f in the expression.

$$1-m-f=1-\frac{1}{3}-\frac{1}{6}$$
$$=\frac{1}{1}\cdot\frac{6}{6}-\frac{1}{3}\cdot\frac{2}{2}-\frac{1}{6}$$
$$=\frac{6}{6}-\frac{2}{6}-\frac{1}{6}$$
$$=\frac{6-2-1}{6}$$
$$=\frac{3}{6}$$
$$=\frac{1}{2}$$

So, $\frac{1}{2}$ of the income remains.

86. The quotient of 5 and the number.

88.

Total Time (hours)	Cost per Hour (dollars per hour)
2	$45\div 2$
3	$45\div 3$
4	$45\div 4$
5	$45\div 5$
t	$45\div t$

So, if a session lasts for t hours, the total cost per hour will be $45\div t$ dollars.

90. a. i. $\frac{2}{3}\cdot\frac{3}{2}=\frac{2\cdot 3}{3\cdot 2}=\frac{6}{6}=1$

ii. $\frac{4}{7}\cdot\frac{7}{4}=\frac{4\cdot 7}{7\cdot 4}=\frac{28}{28}=1$

iii. $\frac{1}{6}\cdot\frac{6}{1}=\frac{1\cdot 6}{6\cdot 1}=\frac{6}{6}=1$

b. Answers may vary. Example:
The product of a fraction and its reciprocal equals 1.

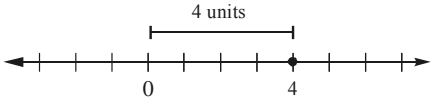
92. Answers may vary. Example:
For addition of fractions, one cannot simply add the numerators and denominators. First get a common denominator, then add numerators, keeping the common denominator.

$$\frac{2}{3}+\frac{5}{6}=\frac{2}{3}\cdot\frac{2}{2}+\frac{5}{6}=\frac{4}{6}+\frac{5}{6}=\frac{4+5}{6}=\frac{9}{6}=\frac{3}{2}$$

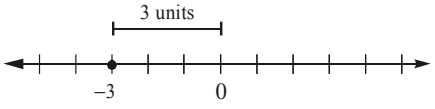
94. Answers may vary. Example:
The student should have multiplied the numerator by 3 instead of the denominator. Rewrite 3 as $\frac{3}{1}$ and then multiply across.

$$3\cdot\frac{7}{2}=\frac{3}{1}\cdot\frac{7}{2}=\frac{3\cdot 7}{1\cdot 2}=\frac{21}{2}$$

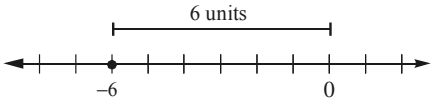
96. a. i. The distance between 0 and 4 is 4 units.



ii. The distance between 0 and -3 is 3 units.



iii. The distance between 0 and -6 is 6 units.



b. The distance between 0 and a number on a number line is equal to the absolute value of the number.

98. a. i. $5+(-2)=3$

ii. $7+(-1)=6$

iii. $8+(-3)=5$

b. When adding two numbers with different signs, if the positive number is farther from 0 on a number line, the result will be positive.

c. i. $2+(-5)=-3$

ii. $1+(-7)=-6$

iii. $3+(-8)=-5$

d. When adding two numbers with different signs, if the positive number is closer to 0 on a number line, the result will be negative.

e. i. $4+(-4)=0$

ii. $7+(-7)=0$

iii. $9+(-9)=0$

f. When adding two numbers with different signs, if the two numbers are the same distance from 0 on a number line, the result will be 0.

g. i. $6+(-4)=2$

ii. $3+(-7)=-4$

iii. $6+(-6)=0$

h. Answers may vary. Example:
When adding two numbers with different signs, take the absolute value of the two numbers and subtract the smaller absolute value from the larger. The sign of the result is the same as the sign of the number with the larger absolute value.

100. Answers may vary. Example:
The denominator of a fraction is the name of the things it represents. The numerator of a fraction is the number of those things it represents. When we add two fractions with the same denominator, we keep the same denominator, or name, and add the two numerators, or number of things.

Homework 2.3

2. $-(-9)=9$

4. $-(-(-2))=-(2)=-2$

6. $|6|=6$ because 6 is a distance of 6 units from 0 on a number line.

8. $|-1|=1$ because -1 is a distance of 1 unit from 0 on a number line.

10. $-|5|=-(5)=-5$

12. $-|-9|=-(9)=-9$

14. The numbers have different signs so subtract the smaller absolute value from the larger.
$|5|-|-3|=5-3=2$
Since $|5|$ is greater than $|-3|$, the sum is positive.
$5+(-3)=2$

16. The numbers have the same sign so add the absolute values.
$|-3|+|-2|=3+2=5$
The numbers are negative, so the sum is negative.
$-3+(-2)=-5$

18. The numbers have different signs so subtract the smaller absolute value from the larger.
$|-9|-|6|=9-6=3$
Since $|-9|$ is greater than $|6|$, the sum is negative.
$6+(-9)=-3$

20. The numbers have different signs so subtract the smaller absolute value from the larger.
$|4|-|-3|=4-3=1$
Since $|4|$ is greater than $|-3|$, the sum is positive.
$-3+4=1$

22. The numbers have the same sign so add the absolute values.
$|-9|+|-5|=9+5=14$
The numbers are negative, so the sum is negative.
$-9+(-5)=-14$

24. The numbers have different signs so subtract the smaller absolute value from the larger.
$|8|-|-2|=8-2=6$
Since $|8|$ is greater than $|-2|$, the sum is positive.
$8+(-2)=6$

26. $8+(-8)=0$ because the numbers are opposites and the sum of opposites is 0.

28. $-7+7=0$ because the numbers are opposites and the sum of opposites is 0.

30. The numbers have different signs so subtract the smaller absolute value from the larger.
$|17|-|-14|=17-14=3$
Since $|17|$ is greater than $|-14|$, the sum is positive.
$17+(-14)=3$

32. The numbers have different signs so subtract the smaller absolute value from the larger.
$|-89|-|57|=89-57=32$
Since $|-89|$ is greater than $|57|$, the sum is negative.
$-89+57=-32$

34. The numbers have the same sign so add the absolute values.
$|-347|+|-594|=347+594=941$
The numbers are negative, so the sum is negative.
$-347+(-594)=-941$

36. $127,512+(-127,512)=0$ because the numbers are opposites and the sum of opposites is 0.

38. The numbers have the same sign so add the absolute values.
$|-3.7|+|-9.9|=3.7+9.9=13.6$
The numbers are negative, so the sum is negative.
$-3.7+(-9.9)=-13.6$

40. The numbers have different signs so subtract the smaller absolute value from the larger.
$|7|-|-0.3|=7-0.3=6.7$
Since $|7|$ is greater than $|-0.3|$, the sum is positive.
$-0.3+7=6.7$

42. The numbers have different signs so subtract the smaller absolute value from the larger.
$|37.05|-|-19.26|=37.05-19.26=17.79$
Since $|37.05|$ is greater than $|-19.26|$, the sum is positive.
$37.05+(-19.26)=17.79$

44. The numbers have different signs so subtract the smaller absolute value from the larger.
$\left|\frac{2}{5}\right|-\left|-\frac{1}{5}\right|=\frac{2}{5}-\frac{1}{5}=\frac{1}{5}$
Since $\left|\frac{2}{5}\right|$ is greater than $\left|-\frac{1}{5}\right|$, the sum is positive.
$\frac{2}{5}+\left(-\frac{1}{5}\right)=\frac{1}{5}$

46. The numbers have different signs so subtract the smaller absolute value from the larger.
$\left|-\frac{5}{6}\right|-\left|\frac{1}{6}\right|=\frac{5}{6}-\frac{1}{6}=\frac{4}{6}=\frac{2}{3}$
Since $\left|-\frac{5}{6}\right|$ is greater than $\left|\frac{1}{6}\right|$, the sum is negative.
$-\frac{5}{6}+\frac{1}{6}=-\frac{2}{3}$

48. The numbers have the same sign so add the absolute values.

$$\left|-\frac{2}{3}\right|+\left|-\frac{5}{6}\right|=\frac{2}{3}+\frac{5}{6}=\frac{2}{3}\cdot\frac{2}{2}+\frac{5}{6}=\frac{4}{6}+\frac{5}{6}=\frac{9}{6}=\frac{3}{2}$$

The numbers are negative, so the sum is negative.

$$-\frac{2}{3}+\left(-\frac{5}{6}\right)=-\frac{3}{2}$$

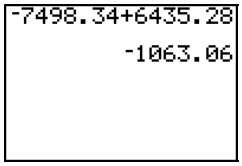
50. The numbers have different signs so subtract the smaller absolute value from the larger.

$$\left|-\frac{3}{4}\right|-\left|\frac{2}{3}\right|=\frac{3}{4}-\frac{2}{3}=\frac{3}{4}\cdot\frac{3}{3}-\frac{2}{3}\cdot\frac{4}{4}=\frac{9}{12}-\frac{8}{12}=\frac{1}{12}$$

Since $\left|-\frac{3}{4}\right|$ is greater than $\left|\frac{2}{3}\right|$, the sum is negative.

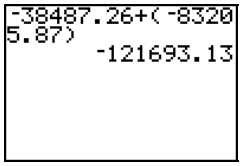
$$\frac{2}{3}+\left(-\frac{3}{4}\right)=-\frac{1}{12}$$

52.



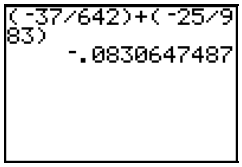
$-7498.34+6435.28=-1063.06$

54.



$-38,487.26+(-83,205.87)=-121,693.13$

56.



$$-\frac{37}{642}+\left(-\frac{25}{983}\right)\approx-0.08$$

58. Substitute -4 for a and 3 for b in the expression $b+a$ and then find the sum:

$(3)+(-4)=-4+3=-1$

60. Substitute 3 for b and -2 for c in the expression $b+c$ and then find the sum:

$(3)+(-2)=-2+3=1$

62. $x+3$

Substitute -6 for x in the expression and then find the sum: $(-6)+3=-3$

64. $x+(-8)$

Substitute -6 for x in the expression and then find the sum: $(-6)+(-8)=-14$

66. The balance is $-112.50+170$ dollars.

The numbers have different signs so subtract the smaller absolute value from the larger.

$|170|-|-112.50|=170-112.50=57.50$

Since $|170|$ is greater than $|-112.50|$, the sum is positive: $-112.50+170=57.50$

So, the balance is \$57.50.

68. We can find the final balance by finding the balance after each transaction.

Transaction	Balance
Paycheck	$-135.00+549.00=414.00$
FedEx Office	$414.00-10.74=403.26$
ATM	$403.26-21.50=381.76$
Barnes & Noble	$381.76-17.19=364.57$

So, the final balance is \$364.57.

70. The new balance is $-2739+530$.

The numbers have different signs so subtract the smaller absolute value from the larger.

$|-2739|-|530|=2739-530=2209$

Since $|-2739|$ is greater than $|530|$, the sum is negative.

$-2739+530=-2209$

So, the new balance is -2209 dollars.

72. The balance after sending the check is $-873+500=-373$.

The balance after buying the racquet is $-373+(-249)=-622$.

The balance after buying the outfit is $-622+(-87)=-709$.

So, the final balance is -709 dollars.

74. The current temperature is $-12+8$.
The numbers have different signs so subtract the smaller absolute value from the larger.
$|-12|-|8|=12-8=4$
Since $|-12|$ is greater than $|8|$, the sum is negative.
$-12+8=-4$
So, the current temperature is $-4°$ F.

76. a.

Retail Price (dollars)	Sale Price (dollars)
350	$350+(-35)$
400	$400+(-35)$
450	$450+(-35)$
500	$500+(-35)$
r	$r+(-35)$

From the last row of the table, we see that the expression $r+(-35)$ represents the sale price (in dollars).

b. Evaluate $r+(-35)$ for $r=470$.
$470+(-35)=435$
So, if the retail price is \$470, the sale price is \$435.

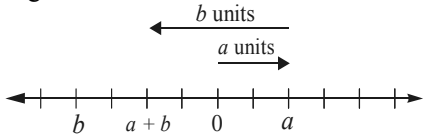
78. a.

Decrease in Temp (°F)	Current Temp (°F)
1	$-2+(-1)$
2	$-2+(-2)$
3	$-2+(-3)$
4	$-2+(-4)$
x	$-2+(-x)$

From the last row of the table, we see that the expression $-2+(-x)$ represents the current temperature (in °F).

b. Evaluate $-2+(-x)$ for $x=7$.
$-2+(-7)=-9$
The current temperature is -9 °F.

80. If a is positive and b is negative (but with a larger absolute value), the sum $a+b$ will be negative.



82. If $a+b$ is positive, then both numbers are positive, or the numbers have opposite signs but the number with the larger absolute value is positive.

84. a. Substitute -2 for a and 5 for b:
$a+b=(-2)+5=3$

b. Substitute -2 for a and 5 for b:
$b+a=5+(-2)=3$

c. The results are the same.

d. Substitute -4 for a and -9 for b:
$a+b=-4+(-9)=-13$
$b+a=-9+(-4)=-13$
The results are the same.

e. Answers may vary.

f. Yes; when adding two quantities, the order of the addition does not matter.

Homework 2.4

2. $3-7=3+(-7)=-4$

4. $-3-9=-3+(-9)=-12$

6. $5-(-1)=5+1=6$

8. $-7-(-3)=-7+3=-4$

10. $-4-7=-4+(-7)=-11$

12. $-4-(-7)=-4+7=3$

14. $-7-7=-7+(-7)=-14$

16. $-100-257=-100+(-257)=-357$

18. $-1939-(-352)=-1939+352=-1587$

20. $5.8-3.7=5.8+(-3.7)=2.1$

22. $-1.7-7.4=-1.7+(-7.4)=-9.1$

24. $3.1-(-3.1)=3.1+3.1=6.2$

26. $-159.24-(-7.8)=-159.24+7.8=-151.44$

28. $-\frac{1}{5}-\frac{4}{5}=-\frac{1}{5}+\left(-\frac{4}{5}\right)=-\frac{5}{5}=-1$

30. $-\frac{4}{9}-\left(-\frac{7}{9}\right)=-\frac{4}{9}+\frac{7}{9}=\frac{3}{9}=\frac{1}{3}$

32. $\frac{5}{12}-\left(-\frac{1}{6}\right)=\frac{5}{12}+\frac{1}{6}=\frac{5}{12}+\frac{1}{6}\cdot\frac{2}{2}=\frac{5}{12}+\frac{2}{12}=\frac{7}{12}$

34. $-\frac{2}{3}-\frac{2}{5}=-\frac{2}{3}+\left(-\frac{2}{5}\right)$

$=-\frac{2}{3}\cdot\frac{5}{5}+\left(-\frac{2}{5}\cdot\frac{3}{3}\right)$

$=-\frac{10}{15}+\left(-\frac{6}{15}\right)$

$=-\frac{16}{15}$

36. $-3+9=6$

38. $-4-(-3)=-4+3=-1$

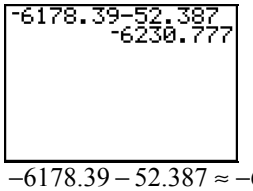
40. $-\frac{5}{6}+\frac{1}{6}=-\frac{4}{6}=-\frac{2}{3}$

42. $-6.4+3.5=-2.9$

44. $-5+(-8)=-13$

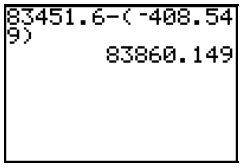
46. $5-9=5+(-9)=-4$

48.



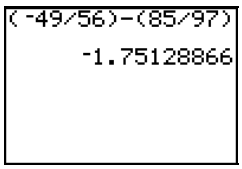
$-6178.39-52.387\approx-6230.78$

50.



$83,451.6-(-408.549)\approx 83,860.15$

52.



$-\frac{49}{56}-\frac{85}{97}\approx-1.75$

54. $-12+18=6$

So, the current temperature is $6°\,\text{F}$.

56. $-13-(-2)=-13+2=-11$

The change in temperature is $-11°\,\text{F}$.

58. a. $9-(-6)=9+6=15$

The change in temperature is $15°\,\text{F}$.

b. To estimate the change in temperature over the past hour, we divide the change over three hours by 3.

$\frac{15}{3}=5$

The estimated change in temperature over the past hour is $5°\,\text{F}$.

c. Answers may vary. Example:
The change in temperature is affected by the time of day in addition to the weather conditions. Thus, temperature change need not be uniform.

60. $29,035-(-1312)=29,035+1312=30,347$

The change in elevation is 30,347 feet.

62. a.

Year	Population	Change in Population
2008	124	–
2009	96	$96-124=-28$
2010	97	$97-96=1$
2011	98	$98-97=1$
2012	83	$83-98=-15$
2013	95	$95-83=12$
2014	104	$104-95=9$

b. The population increased the most from 2012 to 2013 with an increase of 12 wolves.

c. The population decreased the most from 2008 to 2009 with a decrease of 28 wolves.

d. No. The change in population is the difference between births and deaths. An increase of 9 wolves means there were 9 more births than deaths.

64. a. To find the number of groups in 2015, we add the changes in the number of groups from 2009 to 2015:
$512+312+450+86+(-264)+(-222)+124$
$=998$
So, there were 998 Patriot Groups in 2015.

b. Increasing numbers of groups are indicated by positive changes. Therefore, the number of Patriot Groups was increasing from 2009 to 2012 and from 2014 to 2015.

c. Decreasing numbers of groups are indicated by negative changes. Therefore, the number of Patriot Groups was decreasing from 2012 to 2014.

66. a.

Current Value (dollars)	Change in Value (dollars)
30	$30-35$
35	$35-35$
40	$40-35$
45	$45-35$
x	$x-35$

From the last row of the table, we see that the expression $x-35$ represents the change in value (in dollars) of the stock.

b. Evaluate $x-35$ for $x=44$:
$44-35=9$
So, if the current value is \$44, the stock has increased in value by \$9 from last year.

68. a.

Change in Population	Current Population
10	$10+820$
20	$20+820$
30	$30+820$
40	$40+820$
c	$c+820$

From the last row of the table, we see that the expression $c+820$ represents the current population.

b. Evaluate $c+820$ for $c=-25$:
$-25+820=795$
So, if the change in population is -25, the current population would be 795 due to the decrease in population of 25 deer in the past year.

70. Evaluate $a+c$ for $a=-5$ and $c=-7$:
$(-5)+(-7)=-12$

72. Evaluate $c-a$ for $a=-5$ and $c=-7$:
$(-7)-(-5)=-7+5=-2$

74. Evaluate $b-a$ for $a=-5$ and $b=2$:
$(2)-(-5)=2+5=7$

76. $x-4$
Evaluate the expression for $x=-5$:
$-5-4=-5+(-4)=-9$

78. $x-5$
Evaluate the expression for $x=-5$:
$(-5)-5=-5+(-5)=-10$

80. $x-(-6)$
Evaluate the expression for $x=-5$:
$(-5)-(-6)=-5+6=1$

82. The student changed the order of subtraction without changing the sign of the result.
$2-6=2+(-6)=-4$

84. a. i. $2-8=2+(-8)=-6$

ii. $3-9=3+(-9)=-6$

iii. $1-5=1+(-5)=-4$

b. Answers may vary. Example:
Since the quantity decreased, the final number is smaller than the beginning number. When finding the change in quantity, we subtract the beginning number from the final number. Since the final number is smaller, the result will be negative.

86. a. i. $-2(-5)=10$

ii. $-4(-6)=24$

iii. $-7(-9)=63$

b. Answers may vary. Example:
The results are all positive.

c. $-3(-7) = 3(7) = 21$

d. Answers may vary. Example:
To multiply two negative numbers, multiply their absolute values.

88. Answers may vary. Example:
In the first situation, the values were on the same side of 0 on a number line, so we subtract to find the distance between the two values on the number line. In the second situation, the values are on opposite sides of 0 on a number line. In this case, we add the distance each number is from 0 to get the overall distance between the numbers.

90. Answers may vary. Example:
It is impossible to find the sign. If $|x|$ is greater than $|y|$, then $x - y$ is negative. If $|x|$ is less than $|y|$, then $x - y$ is positive.

Homework 2.5

2. $91\% = 91.0\% = 0.91$

4. $4\% = 4.0\% = 0.04$

6. $0.01 = 1\%$

8. $3.8\% = 0.038$

10. $0.089 = 8.9\%$

12. To find 67% of 4500 computers, we multiply 0.67 by 4500: $0.67(4500) = 3015$. So 67% of 4500 computers is 3015 computers.

14. To find the 3% grocery tax on the purchase of \$125.35 worth of groceries, we multiply 0.03 by 125.35: $0.03(125.35) = 3.7605$. So the sales tax is about \$3.76.

16. To find the number of undergraduates who lived on campus, we multiply 0.26 by 23,357: $0.26(23{,}357) = 6072.82$. So, the number of undergraduates who lived on campus in the spring semester 2017 at the University of Iowa was about 6073.

18. Since the numbers have different signs, the product is negative: $-5(4) = -20$

20. Since the numbers have the same sign, the product is positive: $-8(-9) = 72$

22. Since the numbers have different signs, the product is negative: $5(-2) = -10$

24. Since the numbers have different signs, the quotient is negative: $-63 \div 7 = -9$

26. Since the numbers have different signs, the quotient is negative: $24 \div (-3) = -8$

28. Since the numbers have the same sign, the quotient is positive: $-1 \div (-1) = 1$

30. Since the numbers have the same sign, the product is positive: $-124(-29) = 3596$

32. Since the numbers have different signs, the quotient is negative: $1008 \div (-21) = -48$

34. Since the numbers have the same sign, the product is positive: $-0.3(-0.3) = 0.09$

36. Since the numbers have different signs, the product is negative: $3.7(-5.24) = -19.388$

38. Since the numbers have different signs, the quotient is negative: $-0.12 \div 0.3 = -0.4$

40. Since the numbers have different signs, the quotient is negative: $\dfrac{9}{-3} = 9 \div (-3) = -3$

42. Since the numbers have the same sign, the quotient is positive: $\dfrac{-72}{-8} = -72 \div (-8) = 9$

44. Since the numbers have different signs, the product is negative: $\dfrac{1}{3}\left(-\dfrac{7}{5}\right) = -\dfrac{7}{15}$

46. Since the numbers have the same sign, the product is positive: $\left(-\dfrac{7}{25}\right)\left(-\dfrac{5}{21}\right) = \dfrac{35}{525} = \dfrac{1}{15}$

48. Since the numbers have different signs, the quotient is negative:
$$-\frac{5}{7} \div \frac{15}{8} = -\frac{5}{7} \cdot \frac{8}{15} = -\frac{40}{105} = -\frac{8}{21}$$

50. Since the numbers have the same sign, the quotient is positive:
$$-\frac{3}{8} \div \left(-\frac{9}{20}\right) = \frac{3}{8} \cdot \frac{20}{9} = \frac{60}{72} = \frac{5}{6}$$

52. $-9+(-4)=-13$

54. $-49\div(7)=-7$

56. $-2-7=-2+(-7)=-9$

58. $(-5)(-9)=45$

60.
$$\begin{aligned}-\frac{8}{3}+\left(-\frac{5}{9}\right)&=-\frac{8}{3}\cdot\frac{3}{3}+\left(-\frac{5}{9}\right)\\&=-\frac{24}{9}+\left(-\frac{5}{9}\right)\\&=\frac{-24+(-5)}{9}\\&=-\frac{29}{9}\end{aligned}$$

62. $\frac{9}{2}\left(-\frac{4}{21}\right)=-\frac{36}{42}=-\frac{6}{7}$

64.
$$\begin{aligned}-\frac{3}{8}-\left(-\frac{1}{10}\right)&=-\frac{3}{8}+\frac{1}{10}\\&=-\frac{3}{8}\cdot\frac{5}{5}+\frac{1}{10}\cdot\frac{4}{4}\\&=-\frac{15}{40}+\frac{4}{40}\\&=\frac{-15+4}{40}\\&=-\frac{11}{40}\end{aligned}$$

66.
$$\begin{aligned}-\frac{22}{9}\div\left(-\frac{33}{18}\right)&=-\frac{22}{9}\cdot\left(-\frac{18}{33}\right)\\&=\frac{2\cdot11\cdot2\cdot9}{9\cdot3\cdot11}\\&=\frac{2\cdot2}{3}\\&=\frac{4}{3}\end{aligned}$$

68. $\frac{-15}{35}=-\frac{3\cdot5}{7\cdot5}=-\frac{3}{7}$

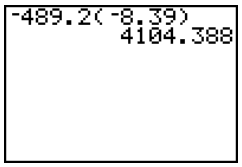
70. $\frac{-35}{-21}=\frac{7\cdot5}{7\cdot3}=\frac{5}{3}$

72. $\frac{5}{-6}+\frac{1}{6}=\frac{-5}{6}+\frac{1}{6}=\frac{-5+1}{6}=\frac{-4}{6}=-\frac{2}{3}$

74. $\frac{2}{3}-\left(\frac{1}{-3}\right)=\frac{2}{3}+\frac{1}{3}=\frac{2+1}{3}=\frac{3}{3}=1$

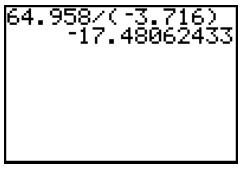
76.
$$\begin{aligned}\frac{1}{4}+\frac{5}{-6}&=\frac{1}{4}\cdot\frac{3}{3}+\frac{-5}{6}\cdot\frac{2}{2}\\&=\frac{3}{12}+\frac{-10}{12}\\&=\frac{3+(-10)}{12}\\&=-\frac{7}{12}\end{aligned}$$

78.



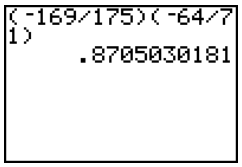
$-489.2(-8.39)\approx 4104.39$

80.



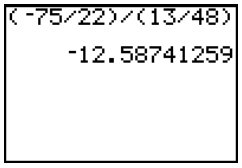
$64.958\div(-3.716)\approx -17.48$

82.



$-\frac{169}{175}\left(-\frac{64}{71}\right)\approx 0.87$

84.



$-\frac{75}{22}\div\frac{13}{48}\approx -12.59$

86. Evaluate ac for $a=-6$ and $c=-8$:
$(-6)(-8)=48$

88. Evaluate $\frac{b}{a}$ for $a=-6$ and $b=4$:
$\frac{4}{-6}=-\frac{2}{3}$

90. Evaluate $-bc$ for $b=4$ and $c=-8$:
$-(4)(-8)=-(-32)=32$

92. Evaluate $-\frac{a}{c}$ for $a=-6$ and $c=-8$:

$$-\frac{(-6)}{(-8)}=-\frac{3}{4}$$

94. $\frac{w}{4}$; Evaluate the expression for $w=-8$:

$$\frac{(-8)}{4}=-2$$

96. $-2w$; Evaluate the expression for $w=-8$:

$$-2(-8)=16$$

98. $\frac{9}{15}=\frac{3}{5}$

100. $\frac{1032}{45}\approx\frac{22.93}{1}$

Since 1945, the United States has conducted about 22.93 times the number of nuclear bomb tests as has China.

102. $\frac{4.79}{3.77}\approx\frac{1.27}{1}$

On average, there were about 1.27 million more viewers of the *Today* show than of the show *CBS This Morning* in December 2016.

104. a. $\frac{2 \text{ c mushrooms}}{4 \text{ c cooked noodles}}=\frac{0.5 \text{ c mushrooms}}{1 \text{ c cooked noodles}}$

For each cup of cooked noodles, a half cup of sliced mushrooms is required.

b. $\frac{4 \text{ c cooked noodles}}{2 \text{ c mushrooms}}=\frac{2 \text{ c cooked noodles}}{1 \text{ c mushrooms}}$

For each cup of sliced mushrooms, 2 cups of cooked noodles are required.

106. a. $\frac{19,795,791}{8,958,013}\approx\frac{2.21}{1}$

The population of New York is about 2.21 times larger than that of New Jersey.

b. $\frac{571,951}{155,959}\approx\frac{3.67}{1}$

The land area of Alaska is about 3.67 times larger than that of California.

c. Alaska: $\frac{738,432}{571,951}\approx\frac{1.29}{1}$

California: $\frac{39,144,818}{155,959}\approx\frac{250.99}{1}$

Michigan: $\frac{9,922,576}{56,804}\approx\frac{174.68}{1}$

New Jersey: $\frac{8,958,013}{7417}\approx\frac{1207.77}{1}$

New York: $\frac{19,795,791}{47,214}=\frac{419.28}{1}$

d. The state with the greatest population density is New Jersey. The state with the least dense population is Alaska.

e. The person is not correct.
Answers may vary. Example:
Although Michigan has a larger population than New Jersey, it also has a larger land area which serves to lower its population density.

108. a. $\frac{-6810 \text{ dollars}}{-2950 \text{ dollars}}=\frac{681}{295}\approx\frac{2.31}{1}$

b. For each \$1 he pays towards his Sears account, he should pay about \$2.31 towards his Visa account.

110. $0.35(1590)=556.50$

$-1590+556.5=-1033.50$

The new balance would be -1033.50 dollars.

112. $3(89.50)=268.50$

$0-268.50=-268.50$

The new balance is $-\$268.50$.

114. a. $-2+3=1$

b. $-2(3)=-6$

c. The first statement is clearer because it indicates an operation as well. From parts (a) and (b), we see that just having one negative number and one positive number is not enough to guarantee that the result is negative.

d. Answers may vary.

116. a. Negative; the quotient of two numbers with opposite signs is negative.

b. Negative; the quotient of two numbers with opposite signs is negative.

c. No; the variables a and b can take on positive or negative values, so the sign of the result is not clear without knowing the signs of a and b.

118. Answers may vary. Example:
$$(-4)(5) = (-4)+(-4)+(-4)+(-4)+(-4)$$
$$= -20$$

120. If ab is positive, we can say that the two numbers have the same sign. We cannot say if the two numbers are positive or negative, but we do know they have the same sign.

122. If $\frac{a}{b}$ is negative, we can say that the two numbers have different signs. We cannot say which is positive and which is negative, but we do know they have different signs.

124. a. $(-1)(-1) = 1$
$(-1)(-1)(-1) = -1$
$(-1)(-1)(-1)(-1) = 1$
$(-1)(-1)(-1)(-1)(-1) = -1$

b. Multiplying -1 by itself an even number of times yields 1 as the result, while doing so an odd number of times results in -1.

c. Since the number of -1 's is even, the result will be 1.

d. Since the number of -1 's is odd, the result will be -1.

126. a. Answers may vary. Example:
$2,\ 3,\ 4$

b. Answers may vary. Example:
$0.1,\ 0.2,\ 0.3$

c. For $\frac{2}{x}$ to equal 2, x must be 1.

Homework 2.6

2. $3^4 = 3\cdot 3\cdot 3\cdot 3 = 9\cdot 3\cdot 3 = 27\cdot 3 = 81$

4. $5^3 = 5\cdot 5\cdot 5 = 25\cdot 5 = 125$

6. $-7^2 = -(7\cdot 7) = -49$

8. $(-7)^2 = (-7)(-7) = 49$

10. $\left(\frac{3}{5}\right)^3 = \left(\frac{3}{5}\right)\left(\frac{3}{5}\right)\left(\frac{3}{5}\right) = \frac{27}{125}$

12. $8\cdot(2-6) = 8(-4) = -32$

14. $(2+8)(3-8) = (10)(-5) = -50$

16. $-6-(4-7)+5 = -6-(-3)+5$
$= -6+3+5$
$= -3+5$
$= 2$

18. $\frac{3-9}{2-4} = \frac{-6}{-2} = 3$

20. $\frac{4-7}{-3-(-1)} = \frac{-3}{-3+1} = \frac{-3}{-2} = \frac{3}{2}$

22. $\frac{1-9}{2-(-4)} = \frac{-8}{2+4} = \frac{-8}{6} = -\frac{4}{3}$

24. $2-3\cdot 5 = 2-15 = -13$

26. $1+9\cdot(-4) = 1+(-36) = -35$

28. $-16\div(-4)\cdot 2 = 4\cdot 2 = 8$

30. $3-7+1 = -4+1 = -3$

32. $2-4(9-6) = 2-4(3)$
$= 2-12$
$= -10$

34. $2(2-5)+10\div 5 = 2(-3)+10\div 5$
$= -6+10\div 5$
$= -6+2$
$= -4$

36. $6(2+3)-5\cdot 7 = 6(5)-5\cdot 7 = 30-35 = -5$

38. $-3-\left[6+2(4-8)\right] = -3-\left[6+2(-4)\right]$
$= -3-[6-8]$
$= -3-[-2]$
$= -1$

40. $-2\left[4(3-8)+1\right] = -2\left[4(-5)+1\right]$
$= -2\left[-20+1\right]$
$= -2\left[-19\right]$
$= 38$

42. $\frac{5}{6}+\frac{2}{3}\div\frac{2}{5} = \frac{5}{6}+\frac{2}{3}\cdot\frac{5}{2} = \frac{5}{6}+\frac{10}{6} = \frac{15}{6} = \frac{5}{2}$

44. $8-3^2 = 8-9 = -1$

46. $8(-2)^3 = 8(-8) = -64$

48. $\frac{5^2}{2^5} = \frac{5\cdot 5}{2\cdot 2\cdot 2\cdot 2\cdot 2} = \frac{25}{32}$

50. $5^2+2^5 = 25+32 = 57$

52. $-20\div 2^2 = -20\div 4 = -5$

54. $4^3-(-4)^3 = 64-(-64) = 64+64 = 128$

56. $4(-2)^2-3 = 4(4)-3 = 16-3 = 13$

58. $2(-4)^2+3(-4)-7 = 2(16)+3(-4)-7$
$= 32+(-12)-7$
$= 20-7$
$= 13$

60. $\frac{10-(-2)^2}{3^3} = \frac{10-(4)}{27} = \frac{6}{27} = \frac{2}{9}$

62. $4+(3-6)^2-2 = 4+(-3)^2-2$
$= 4+9-2$
$= 13-2$
$= 11$

64. $(9-7)^2\cdot(-3)-2^4 = (2)^2\cdot(-3)-2^4$
$= 4(-3)-16$
$= -12-16$
$= -12+(-16)$
$= -28$

66.
```
8.53/5.26+24.91-
78.3(45.3)
    -3520.458327
```
$8.53\div 5.26+24.91-78.3(45.3)\approx -3520.46$

68.
```
1.98+8.22^5*5.29
      198526.7766
```
$1.98+8.22^5\cdot 5.29\approx 198{,}526.78$

70.
```
(53.25+99.83)/(3
1.28-6.31*89.11)
     -.2882840264
```
$\frac{53.25+99.83}{31.28-(6.31)(89.11)}\approx -0.29$

72. Evaluate $ac-b$ for $a=-2$, $b=-4$, and $c=3$: $(-2)(3)-(-4) = -6+4 = -2$

74. Evaluate $c\div a+abc$ for $a=-2$, $b=-4$, and $c=3$:
$3\div(-2)+(-2)(-4)(3) = -\frac{3}{2}+24$
$= -\frac{3}{2}+\frac{48}{2}$
$= \frac{45}{2}$

76. Evaluate c^2-b^2 for $b=-4$ and $c=3$:
$(3)^2-(-4)^2 = 9-16 = -7$

78. Evaluate $-cb^2+a^2$ for $a=-2$, $b=-4$, and $c=3$:
$-(3)(-4)^2+(-2)^2 = -3(16)+(-2)^2$
$= -48+4$
$= -44$

80. Evaluate $\frac{a^2-b}{c^2-b}$ for $a=-2$, $b=-4$, and $c=3$:
$\frac{(-2)^2-(-4)}{(3)^2-(-4)} = \frac{4-(-4)}{9-(-4)} = \frac{4+4}{9+4} = \frac{8}{13}$

82. Substitute $a=5$, $b=-1$, $c=-4$, and $d=7$ in the expression $\dfrac{a-b}{c-d}$:

$$\frac{(5)-(-1)}{(-4)-(7)}=\frac{5+1}{-4+(-7)}=\frac{6}{-11}=-\frac{6}{11}$$

84. Substitute $a=-2$, $b=6$, $c=5$, and $d=-1$ in the expression $\dfrac{a-b}{c-d}$:

$$\frac{(-2)-(6)}{(5)-(-1)}=\frac{-2+(-6)}{5+1}=\frac{-8}{6}=-\frac{4}{3}$$

86. Substitute $a=-3$, $b=-5$, $c=-8$, and $d=-3$ in the expression $\dfrac{a-b}{c-d}$:

$$\frac{(-3)-(-5)}{(-8)-(-3)}=\frac{-3+5}{-8+3}=\frac{2}{-5}=-\frac{2}{5}$$

88. Evaluate $5x^2$ for $x=-3$:

$$5(-3)^2=5(9)=45$$

90. Evaluate $-4x^2+4$ for $x=-3$:

$$\begin{aligned}-4(-3)^2+4&=-4(9)+4\\&=-36+4\\&=-32\end{aligned}$$

92. Evaluate $4x^2+x-2$ for $x=-3$:

$$\begin{aligned}4(-3)^2+(-3)-2&=4(9)+(-3)-2\\&=36+(-3)-2\\&=33-2\\&=31\end{aligned}$$

94. $-3-\dfrac{8}{x}$

Evaluate the expression for $x=-4$:

$$\begin{aligned}-3-\frac{8}{-4}&=-3-(-2)\\&=-3+2\\&=-1\end{aligned}$$

96. $x+x(-5)$

Evaluate the expression for $x=-4$:

$$-4+(-4)(-5)=-4+20=16$$

98. a.

Years since 2014	Number of Countries
0	$70\cdot 0+8.8$
1	$70\cdot 1+8.8$
2	$70\cdot 2+8.8$
3	$70\cdot 3+8.8$
4	$70\cdot 4+8.8$
t	$70t+8.8$

b. Substitute 8 for t in $70t+8.8$:

$$70(8)+8.8=560+8.8=568.8$$

So, in 2022 (8 years after 2014) the number of countries requiring picture warnings on cigarette packages was about 569.

100. a.

Years Since 1990	Percent
0	$-1.1\cdot 0+85$
1	$-1.1\cdot 1+85$
2	$-1.1\cdot 2+85$
3	$-1.1\cdot 3+85$
4	$-1.1\cdot 4+85$
t	$-1.1t+85$

From the last row of the table, we see that the expression $-1.1t+85$ represents the percentage of companies offering traditional benefit plans t years since 1990.

b. Substitute 31 for t in $-1.1t+85$:

$$-1.1(31)+85=-34.1+85=50.9$$

So, in 2021 (31 years after 1990) the percentage of companies offering traditional benefit plans will be about 50.9%.

102. To find the digital ad revenue in 2015, we first need to find 20.4% of \$49.5 billion. To do this multiply: $0.204(49.5)=10.098$.

Now add 10.098 to the 2014 revenue, which is $10.098+49.5=59.598$. The digital ad revenue in 2015 was about \$59.6 billion.

104. To find Nike's North American revenue in 2016, we first need to find 8% of \$13.7 billion. To do this, multiply: $0.8(13.7)=1.096$.

Now add 1.096 to the 2015 revenue of \$13.7 billion, which is $13.7+1.096=14.796$. Nike's North American revenue in 2016 was about \$14.8 billion.

106. To find the number of Kmart stores in 2016, we first need to find 59.2% of 2165 stores. To do this, multiply: $0.592(2165) = 1281.68$.

Now subtract 1281.68 from the number of Kmart stores in 2000, which is $2165 - 1281.68 = 883.32$. The number of Kmart stores in 2016 was about 883.

108. To find the number of people who participated in the Supplemental Nutrition Assistance Program in 2016, we first need to find 2.3% of 46.5 million. To do this, multiply $0.023(46.5) = 1.0695$ or about 1.07 million.

Now subtract 1.07 million people from the number of people who participated in the program in 2015, which is $46.5 - 1.07 = 45.43$ million. The number of people who participated in the Supplemental Nutrition Assistance Program in 2016 was about 45.43 million people.

110. Substitute 3 for r in the expression $\frac{4}{3}\pi r^3$:

$$\frac{4}{3}\pi(3)^3 = \frac{4}{3}\pi(27) = 36\pi$$

So, the volume is $36\pi \approx 113.10$ cubic inches.

112. In the first line, the student only squared 3 instead of -3. Should be:

$$(-3)^2 + 4(-3) + 5 = 9 + (-12) + 5 = -3 + 5 = 2$$

114. The student did not perform multiplication and division in the correct order (from left to right). $16 \div 2 \cdot 4 = 8 \cdot 4 = 32$.

116. a. $(12 \div 3) \cdot 2 = 4 \cdot 2 = 8$

b. $12 \div (3 \cdot 2) = 12 \div 6 = 2$

c. Yes, the order makes a difference:
L-R: $12 \div 3 \cdot 2 = 4 \cdot 2 = 8$ (part (a))
R-L: $12 \div 3 \cdot 2 = 12 \div 6 = 2$ (part (b))

d. Order of operations dictates that we multiply and divide from left to right in the order that they appear. Therefore, $12 \div 3 \cdot 2 = 4 \cdot 2 = 8$

118. a. $(2 + 3) + 4 = 5 + 4 = 9$

b. $2 + (3 + 4) = 2 + 7 = 9$

c. The results are the same.

d. $(4 + (-2)) + 5 = 2 + 5 = 7$
$4 + (-2 + 5) = 4 + 3 = 7$
The results are the same.

e. Answers may vary. Example:
In each case, the results should be the same.

f. Yes; this is the associative property of addition.

g. Answers may vary. Example:
For a series of additions, the way in which the additions are grouped does not matter.

120. a. i. $(-1)^2 = (-1)(-1) = 1$

ii. $(-1)^3 = (-1)^2(-1) = 1(-1) = -1$

iii. $(-1)^4 = (-1)^3(-1) = (-1)(-1) = 1$

iv. $(-1)^5 = (-1)^4(-1) = 1(-1) = -1$

v. $(-1)^{87} = (-1)^{86}(-1) = 1(-1) = -1$

vi. $(-1)^{596} = 1$

b. $(-1)^n = 1$ when n is an even counting number. Answers may vary. Example:
The product of an even number of negative numbers is positive.

c. $(-1)^n = -1$ when n is an odd counting number. Answers may vary. Example:
The product of an odd number of negative numbers is negative.

122. Answers may vary.

Chapter 2 Review Exercises

1. $8 + (-2) = 6$

2. $(-5) + (-7) = -12$

3. $6 - 9 = 6 + (-9) = -3$

4. $8-(-2)=8+2=10$

5. Since the numbers have different signs, the product will be negative: $8(-2)=-16$

6. Since the numbers have different signs, the quotient will be negative: $8\div(-2)=-4$

7. $-24\div(10-2)=-24\div(8)=-3$

8. $(2-6)(5-8)=(-4)(-3)=12$

9. $\dfrac{7-2}{2-7}=\dfrac{5}{-5}=-\dfrac{5}{5}=-1$

10. $\dfrac{2-8}{3-(-1)}=\dfrac{2-8}{3+1}=\dfrac{-6}{4}=-\dfrac{6}{4}=-\dfrac{3}{2}$

11. $$\begin{aligned}\frac{3-5(-6)}{-2-1}&=\frac{3-(-30)}{-2-1}\\&=\frac{3+30}{-2+(-1)}\\&=\frac{33}{-3}\\&=-\frac{33}{3}\\&=-11\end{aligned}$$

12. $3(-5)+2=-15+2=-13$

13. $-4+2(-6)=-4+(-12)=-16$

14. $2-12\div 2=2-6=-4$

15. $8\div(-2)\cdot 5=(-4)\cdot 5=-20$

16. $4-6(7-2)=4-6(5)=4-30=-26$

17. $$\begin{aligned}2(4-7)-(8-2)&=2(-3)-(6)\\&=(-6)-(6)\\&=(-6)+(-6)\\&=-12\end{aligned}$$

18. $$\begin{aligned}-2(3-6)+18\div(-9)&=-2(-3)+18\div(-9)\\&=6+18\div(-9)\\&=6+(-2)\\&=4\end{aligned}$$

19. $$\begin{aligned}-14\div(-7)-3(1-5)&=-14\div(-7)-3(-4)\\&=2-3(-4)\\&=2-(-12)\\&=2+12\\&=14\end{aligned}$$

20. $$\begin{aligned}-5-\left[3+2(1-7)\right]&=-5-\left[3+2(-6)\right]\\&=-5-[3-12]\\&=-5-[-9]\\&=-5+9\\&=4\end{aligned}$$

21. $4.2-(-6.7)=4.2+6.7=10.9$

22. $\dfrac{4}{9}\left(-\dfrac{3}{10}\right)=-\dfrac{12}{90}=-\dfrac{2}{15}$

23. $$\begin{aligned}\left(-\frac{8}{15}\right)\div\left(-\frac{16}{25}\right)&=\left(-\frac{8}{15}\right)\left(-\frac{25}{16}\right)\\&=\frac{8}{15}\cdot\frac{25}{16}\\&=\frac{200}{240}\\&=\frac{5}{6}\end{aligned}$$

24. $\dfrac{5}{9}-\left(-\dfrac{2}{9}\right)=\dfrac{5}{9}+\dfrac{2}{9}=\dfrac{5+2}{9}=\dfrac{7}{9}$

25. $$\begin{aligned}-\frac{5}{6}+\frac{7}{8}&=-\frac{5}{6}\cdot\frac{4}{4}+\frac{7}{8}\cdot\frac{3}{3}\\&=\frac{-20}{24}+\frac{21}{24}\\&=\frac{-20+21}{24}\\&=\frac{1}{24}\end{aligned}$$

26. $$\begin{aligned}\frac{-5}{2}-\frac{7}{-3}&=\frac{-5}{2}+\frac{7}{3}\\&=\frac{-5}{2}\cdot\frac{3}{3}+\frac{7}{3}\cdot\frac{2}{2}\\&=\frac{-15}{6}+\frac{14}{6}\\&=\frac{-15+14}{6}\\&=-\frac{1}{6}\end{aligned}$$

27. $(-8)^2 = (-8)(-8) = 64$

28. $-8^2 = -(8 \cdot 8) = -64$

29. $2^4 = 2 \cdot 2 \cdot 2 \cdot 2 = 16$

30. $\left(\frac{3}{4}\right)^3 = \frac{3}{4} \cdot \frac{3}{4} \cdot \frac{3}{4} = \frac{3 \cdot 3 \cdot 3}{4 \cdot 4 \cdot 4} = \frac{27}{64}$

31. $-6(3)^2 = -6(3 \cdot 3) = -6(9) = -54$

32. $24 \div 2^3 = 24 \div (2 \cdot 2 \cdot 2) = 24 \div 8 = 3$

33. $(-2)^3 - 4(-2) = (-2)(-2)(-2) - 4(-2)$
$= -8 - 4(-2)$
$= -8 - (-8)$
$= -8 + 8$
$= 0$

34. $\frac{2^3}{3 + 3^2} = \frac{2 \cdot 2 \cdot 2}{3 + (3 \cdot 3)} = \frac{8}{3 + 9} = \frac{8}{12} = \frac{2}{3}$

35. $\frac{17 - (-3)^2}{5 - 4^2} = \frac{17 - (-3)(-3)}{5 - (4 \cdot 4)}$
$= \frac{17 - 9}{5 - 16}$
$= \frac{8}{-11}$
$= -\frac{8}{11}$

36. $-3(2)^2 - 4(2) + 1 = -3(2 \cdot 2) - 4(2) + 1$
$= -3(4) - 4(2) + 1$
$= -12 - 8 + 1$
$= -20 + 1$
$= -19$

37. $24 \div (3 - 5)^3 = 24 \div (-2)^3$
$= 24 \div [(-2)(-2)(-2)]$
$= 24 \div (-8)$
$= -3$

38. $7^2 - 3(2 - 5)^2 \div (-3)$
$= 7^2 - 3(-3)^2 \div (-3)$
$= (7 \cdot 7) - 3[(-3)(-3)] \div (-3)$
$= 49 - 27 \div (-3)$
$= 49 - (-9)$
$= 49 + 9$
$= 58$

39. $\frac{-18}{-24} = \frac{18}{24} = \frac{2 \cdot 3 \cdot 3}{2 \cdot 2 \cdot 2 \cdot 3} = \frac{3}{2 \cdot 2} = \frac{3}{4}$

40. $\frac{-28}{35} = -\frac{28}{35} = -\frac{2 \cdot 2 \cdot 7}{5 \cdot 7} = -\frac{2 \cdot 2}{5} = -\frac{4}{5}$

41.
```
-5.7+2.3^4/(-9.4
)
    -8.677031915
```
$-5.7 + 2.3^4 \div (-9.4) \approx -8.68$

42.
```
(3.5(17.4)-97.6)
/(54.2/8.4-65.3)
     .6236446027
```
$\frac{3.5(17.4) - 97.6}{54.2 \div 8.4 - 65.3} \approx 0.62$

43. Substitute $\frac{1}{4}$ for W and $\frac{5}{6}$ for L in the expression $2L + 2W$:

$2\left(\frac{5}{6}\right) + 2\left(\frac{1}{4}\right) = \frac{2}{1} \cdot \frac{5}{6} + \frac{2}{1} \cdot \frac{1}{4}$
$= \frac{10}{6} + \frac{2}{4}$
$= \frac{10}{6} + \frac{1}{2}$
$= \frac{10}{6} + \frac{1}{2} \cdot \frac{3}{3}$
$= \frac{10}{6} + \frac{3}{6}$
$= \frac{13}{6}$

So, the perimeter of the rectangle is $\frac{13}{6} = 2\frac{1}{6}$ yards.

44. $-4789+800-(102.99+3.50)$
$=-4789+800-106.49$
$=-3989-106.49$
$=-4095.49$
The student now owes the credit card company $4095.49.

45. $27,800-32,500=-4700$
The plane had a change in altitude of -4700 feet.

46. **a.** $-8-4=-12$
The change in temperature is $-12°\text{F}$.

b. Divide the change for the past three hours by 3 to estimate the change over 1 hour.
$\frac{-12}{3}=-4$
The estimated change for the past hour is $-4°\text{F}$.

c. Answers may vary. Example: Temperature need not change uniformly.

47. **a.** The change in the annual contributions to the Democratic nominee from 2000 to 2004 can be found by subtracting 631 from 824, which is $824-631=193$.
So, the change in annual contributions to the Democratic nominee from 2000 to 2004 is an increase of $193 million.

b. The change in the annual contribution to the Republican nominee from 2004 to 2008 can be found by subtracting 981 from 920, which is $920-981=-61$.
So, the change in annual contribution to the Republican nominee from 2004 to 2008 is a decrease of $61 million.

c.

Years	Change (millions of dollars)
$2000-2004$	$824-631=193$
$2004-2008$	$962-824=138$
$2008-2012$	$1070-962=108$

The greatest change in annual contribution to the Democratic nominee occurred over the period 2000-2004 with an increase of $193 million.

d.

Years	Change (millions of dollars)
$2000-2004$	$981-923=58$
$2004-2008$	$920-981=-61$
$2008-2012$	$1022-920=102$

The greatest change in annual contribution to the Republican nominee occurred over the period 2008-2012 with an increase of $102 million.

48. To find the unit ratio of the average daily number of texts sent or received by female teens to the average daily number of texts sent or received by male teens, divide:
$\frac{79}{56}\approx\frac{1.41}{1}$.
On average, the number of texts sent or received by female teens is about 1.41 larger than the number sent or received by male teens.

49. $75\%=75.0\%=0.75$

50. $2.9\%=0.029$

51. To find the number of those surveyed who said Five Guys has the best hamburger, find 15% of 1.2 million Americans. To do this, multiply: $0.15(1.2)=0.18$.
So, about 0.18 million Americans (or 180 thousand) said Five Guys has the best hamburger.

52. To find the number of those aged at least 12 years who said they used marijuana in the past month in a survey, find 7.3% of 68,300. To do this, multiply: $0.073(68,300)=4985.9$.
So, according to the survey, about 4985.9 people at least 12 years of age used marijuana in the past month.

53. $-5493+0.2(5493)=-5493+1098.6$
$=-4394.4$
The new balance is -4394.4 dollars.

54. Substitute 2 for a and -4 for c in the expression $ac+c\div a$:
$(2)(-4)+(-4)\div(2)=-8+(-4)\div(2)$
$=-8+(-2)$
$=-10$

55. Substitute 2 for a, -5 for b, and -4 for c in the expression b^2-4ac:

$$\begin{aligned}(-5)^2-4(2)(-4)&=(-5)(-5)-4(2)(-4)\\&=25-(-32)\\&=25+32\\&=57\end{aligned}$$

56. Substitute 2 for a, -5 for b, and -4 for c in the expression $a(b-c)$:

$$(2)\big((-5)-(-4)\big)=2(-5+4)=2(-1)=-2$$

57. Substitute 2 for a, -5 for b, and -4 for c in the expression $\dfrac{-b-c^2}{2a}$:

$$\begin{aligned}\frac{-(-5)-(-4)^2}{2(2)}&=\frac{-(-5)-(-4)(-4)}{2(2)}\\&=\frac{5-16}{4}\\&=\frac{-11}{4}\\&=-\frac{11}{4}\end{aligned}$$

58. Substitute -4 for c in the expression $2c^2-5c+3$:

$$\begin{aligned}2(-4)^2-5(-4)+3&=2(-4)(-4)-5(-4)+3\\&=32-(-20)+3\\&=32+20+3\\&=55\end{aligned}$$

59. Substitute 2 for a, -5 for b, -4 for c, and 10 for d in the expression $\dfrac{a-b}{c-d}$:

$$\frac{(2)-(-5)}{(-4)-(10)}=\frac{2+5}{-4+(-10)}=\frac{7}{-14}=-\frac{7}{14}=-\frac{1}{2}$$

60. $x+5$

Evaluate the expression for $x=-3$:

$$(-3)+5=2$$

61. $-7-x$

Evaluate the expression for $x=-3$:

$$-7-(-3)=-7+3=-4$$

62. $2-x(4)$

Evaluate the expression for $x=-3$:

$$2-(-3)(4)=2-(-12)=2+12=14$$

63. $1+\dfrac{-24}{x}$

Evaluate the expression for $x=-3$:

$$1+\frac{-24}{-3}=1+8=9$$

64. Substitute 650 for T and 13 for n.

$$\frac{650}{13}=50$$

Each player must pay \$50 for the team to join the softball league.

65. a.

Time (hours)	Volume of Water (cubic feet)
0	$-50\cdot 0+400$
1	$-50\cdot 1+400$
2	$-50\cdot 2+400$
3	$-50\cdot 3+400$
4	$-50\cdot 4+400$
t	$-50\cdot t+400$

From the last row of the table, we see that the expression $-50t+400$ represents the volume of water (in cubic feet) remaining in the basement after water has been pumped out for t hours.

b. Substitute 7 for t in $-50t+400$:

$$-50(7)+400=-350+400=50$$

After 7 hours of pumping, there will be 50 cubic feet of water remaining in the basement.

66. To find the number of Americans who flew to Europe in 2014, we first need to find 10.2% of 10.8 million. To do this, multiply: $0.102(10.8)\approx 1.10$.

Now add 1.10 million people to 10.8 million people, which is: $1.10+10.8=11.9$ million people. So, the number of Americans who flew to Europe in 2014 was about 11.9 million people.

Chapter 2 Test

1. $-8-5=-8+(-5)=-13$

2. Since the two numbers have the same sign, the product will be positive: $-7(-9)=63$

3. $-3+9\div(-3)=-3+(-3)=-6$

4. $(4-2)(3-7)=(2)(-4)=-8$

5. $\dfrac{4-7}{-1-5}=\dfrac{-3}{-6}=\dfrac{1}{2}$

6. $5-(2-10)\div(-4)=5-(-8)\div(-4)=5-2=3$

7. $-20\div 5-(2-9)(-3)=-20\div 5-(-7)(-3)$
$=-4-21$
$=-25$

8. Since the two numbers have different signs, the product will be negative:
$0.4(-0.2)=-0.08$

9. $-\dfrac{27}{10}\div\dfrac{18}{75}=-\dfrac{27}{10}\cdot\dfrac{75}{18}$
$=-\dfrac{3\cdot 3\cdot 3\cdot 3\cdot 5\cdot 5}{2\cdot 5\cdot 2\cdot 3\cdot 3}$
$=-\dfrac{3\cdot 3\cdot 5}{2\cdot 2}$
$=-\dfrac{45}{4}$

10. $-\dfrac{3}{10}+\dfrac{5}{8}=-\dfrac{3}{10}\cdot\dfrac{4}{4}+\dfrac{5}{8}\cdot\dfrac{5}{5}$
$=\dfrac{-12}{40}+\dfrac{25}{40}$
$=\dfrac{-12+25}{40}$
$=\dfrac{13}{40}$

11. $3^4=3\cdot 3\cdot 3\cdot 3=81$

12. $-4^2=-(4\cdot 4)=-16$

13. $7+2^3-3^2=7+(2\cdot 2\cdot 2)-(3\cdot 3)$
$=7+8-9$
$=15-9$
$=6$

14. $1-(3-7)^2+10\div(-5)$
$=1-(-4)^2+10\div(-5)$
$=1-(-4)(-4)+10\div(-5)$
$=1-16+(-2)$
$=-15+(-2)$
$=-17$

15. $\dfrac{84}{-16}=-\dfrac{84}{16}=-\dfrac{2\cdot 2\cdot 3\cdot 7}{2\cdot 2\cdot 2\cdot 2}=-\dfrac{3\cdot 7}{2\cdot 2}=-\dfrac{21}{4}$

16. $5-9=5+(-9)=-4$
The current temperature is $-4°\,\text{F}$.

17. a. The change in the tax audit rate from 2003 to 2005 can be found by subtracting: $9.7-6.5=3.2$.
So, from 2003 to 2005, the tax audit rate increased by 3.2 audits per 1000 tax returns.

b. The change in the tax audit rate from 2013 to 2015 can be found by subtracting: $8.4-9.6=-1.2$.
So, from 2013 to 2015, the tax audit rate decreased by 1.2 audits per 1000 tax returns.

c.

Years	Change
2003 – 2005	$9.7-6.5=3.2$
2005 – 2007	$10.3-9.7=0.6$
2007 – 2009	$10.3-10.3=0.0$
2009 – 2011	$11.1-10.3=0.8$
2011 – 2013	$9.6-11.1=-1.5$
2013 – 2015	$8.4-9.6=-1.2$

The 2-year period for which the change in tax audit rate was the most was from 2003 to 2005 with an increase of 3.2 audits for every 1000 tax returns filed.

18. To find the unit ratio of the number of background checks conducted for gun purchases in 2015 to the number in 2000, divide: $\dfrac{23\text{ million}}{8.4\text{ million}}\approx\dfrac{2.74}{1}$.
The number of background checks conducted for gun purchases in 2015 is about 2.74 million times the number conducted in 2000.

19. Substitute -6 for a, -2 for b, and 5 for c in the expression $ac-\dfrac{a}{b}$:
$(-6)(5)-\dfrac{(-6)}{(-2)}=-30-\dfrac{(-6)}{(-2)}$
$=-30-3$
$=-30+(-3)$
$=-33$

20. Substitute -6 for a, -2 for b, 5 for c, and -1 for d in the expression $\dfrac{a-b}{c-d}$:

$$\frac{(-6)-(-2)}{(5)-(-1)}=\frac{-6+2}{5+1}=\frac{-4}{6}=-\frac{4}{6}=-\frac{2}{3}$$

21. Substitute -6 for a, -2 for b, and 5 for c in the expression $a+b^3+c^2$:

$$\begin{aligned}(-6)+(-2)^3+(5)^2&=(-6)+(-2)(-2)(-2)+(5\cdot 5)\\&=-6+(-8)+25\\&=-14+25\\&=11\end{aligned}$$

22. Substitute -6 for a, -2 for b, and 5 for c in the expression b^2-4ac:

$$\begin{aligned}(-2)^2-4(-6)(5)&=(-2)(-2)-4(-6)(5)\\&=4-(-120)\\&=4+120\\&=124\end{aligned}$$

23. $2x-3x$

Evaluate the expression for $x=-5$:

$$2(-5)-3(-5)=-10-(-15)=-10+15=5$$

24. $\dfrac{-10}{x}-6$

Evaluate the expression for $x=-5$:

$$\frac{-10}{-5}-6=2-6=-4$$

25. a.

Years since 2014	First-Class Mail Volume (billions of pieces)
0	$-2.1\cdot 0+63.8$
1	$-2.1\cdot 1+63.8$
2	$-2.1\cdot 2+63.8$
3	$-2.1\cdot 3+63.8$
4	$-2.1\cdot 4+63.8$
t	$-2.1t+63.8$

b. Substitute 7 for t in $-2.1t+63.8$:

$$-2.1(7)+63.8=-14.7+63.8=49.1$$

So, in 2021 (7 years after 2014) the U.S. Postal Service first-class mail volume was 49.1 billion pieces.

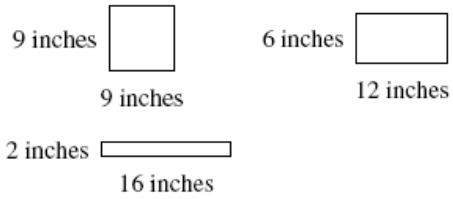
26. To find the number of bats broken in MLB games in 2014, we first need to find 63% of 2400 bats. To do this, multiply:

$0.63(2400)=1512$.

Now subtract 1512 bats from 2400 bats, which is: $2400-1512=888$ bats. So, the number of bats broken at MLB games in 2014 was 888.

Cumulative Review of Chapters 1 and 2

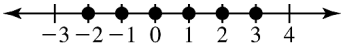
1. a. Answers may vary. Example:



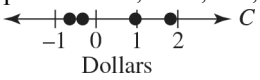
b. W and L are variables because their values are not fixed.

c. P is a constant because the perimeter is fixed at 36 inches.

2.



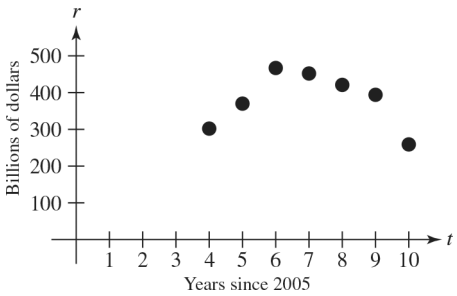
3. Decreases indicate negative values and increases indicate positive values. Graph the points $-0.67, -0.36, 0.96,$ and 1.82.



4. The x-coordinate is -5.

5. Independent variable: t
Dependent variable: V

6. a.



b. According to the table, the year in which the revenue was the most was 2011. The revenue in that year was \$467 billion.

c. According to the table, the year in which the revenue was the least was 2015. The revenue in that year was \$259 billion.

d.

Years	Change
2009 – 2010	370 – 302 = 68
2010 – 2011	467 – 370 = 97
2011 – 2012	452 – 467 = –15
2012 – 2013	421 – 452 = –31
2013 – 2014	394 – 421 = –27
2014 – 2015	259 – 394 = –135

The annual revenue decreased the most from 2014 to 2015. The decrease in revenue during that period was \$135 billion.

e. The annual revenue increased the most from 2010 to 2011. The increase in revenue during that period was \$97 billion.

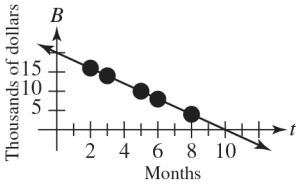
7. The input $x = -4$ leads to the output $y = -3$, so $y = -3$ when $x = -4$.

8. The output $y = 1$ originates from the input $x = 4$, so $y = 1$ when $x = 4$.

9. The line and the *y*-axis intersect at the point $(0, -1)$ so the *y*-intercept is $(0, -1)$.

10. The line and the *x*-axis intersect at the point $(2, 0)$, so the *x*-intercept is $(2, 0)$.

11. a.



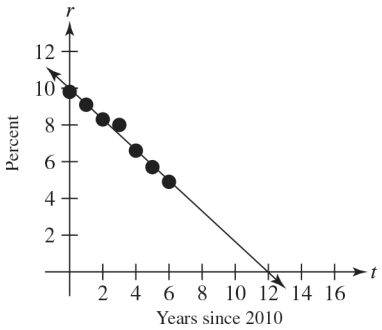
b. The balance in the checking account 4 months after the person was laid off was \$12 thousand.

c. The balance in the checking account was \$6 thousand 7 months after the person was laid off.

d. The *B*-intercept is (0, 20). This means when the person was laid off, her checking account balance was \$20 thousand.

e. The *t*-intercept is (10, 0). This means that there was no money in the checking account 10 months after she was laid off.

12. a.



b. According to the model, the unemployment rate in 2013 ($t = 3$) is about 7.5%. According to the table, the unemployment rate in 2013 is 8.0%. The error is -0.5%.

c. The *r*-intercept of the model is (0, 10). This means in 2010 the unemployment rate was 10%.

d. The *t*-intercept of the model is (12, 0). This means in 2022 the unemployment rate will be 0%. Since it is unlikely that there will ever be an unemployment rate of 0%, model breakdown has occurred.

13. $$\frac{3(-8)+15}{2-7(2)} = \frac{-24+15}{2-14} = \frac{-9}{-12} = \frac{3}{4}$$

14.
$$\begin{aligned} -4(3)+6-20\div(-10) &= -12+6-20\div(-10) \\ &= -12+6-(-2) \\ &= -12+6+2 \\ &= -6+2 \\ &= -4 \end{aligned}$$

15.
$$\begin{aligned} \left(-\frac{14}{15}\right)\div\left(-\frac{35}{27}\right) &= \left(-\frac{14}{15}\right)\left(-\frac{27}{35}\right) \\ &= \frac{14}{15}\cdot\frac{27}{35} \\ &= \frac{2\cdot 7\cdot 3\cdot 3\cdot 3}{3\cdot 5\cdot 5\cdot 7} \\ &= \frac{2\cdot 3\cdot 3}{5\cdot 5} \\ &= \frac{18}{25} \end{aligned}$$

16. $$\frac{3}{8}-\frac{5}{6} = \frac{3}{8}\cdot\frac{3}{3}-\frac{5}{6}\cdot\frac{4}{4} = \frac{9}{24}-\frac{20}{24} = \frac{9-20}{24} = -\frac{11}{24}$$

17. $4-(7-9)^4+20\div(-4)$
$=4-(-2)^4+20\div(-4)$
$=4-(-2)(-2)(-2)(-2)+20\div(-4)$
$=4-16+20\div(-4)$
$=4-16+(-5)$
$=-12+(-5)$
$=-17$

18. $\dfrac{5-3^2}{4^2+2}=\dfrac{5-(3\cdot 3)}{(4\cdot 4)+2}=\dfrac{5-9}{16+2}=\dfrac{-4}{18}=-\dfrac{4}{18}=-\dfrac{2}{9}$

19. To find the change in low temperature, find the difference. Subtract: $-5-20=-25$.
The change in low temperature was $-25°\text{F}$.
(This means the temperature dropped $-25°\text{F}$ from $20°\text{F}$ on December 17 to $-5°\text{F}$ on December 18.)

20. $-2692+850-23=-1842-23=-1865$
The student will now owe the credit card company $1865.

21. Substitute 1 for a, -4 for b, -3 for c, and 7 for d in the expression $\dfrac{a-b}{c-d}$:
$\dfrac{(1)-(-4)}{(-3)-(7)}=\dfrac{1+4}{-3+(-7)}=\dfrac{5}{-10}=-\dfrac{5}{10}=-\dfrac{1}{2}$

22. Substitute 2 for a, -3 for b, and -5 for c in the expression b^2-4ac:
$(-3)^2-4(2)(-5)=(-3)(-3)-4(2)(-5)$
$=9-(-40)$
$=9+40$
$=49$

23. $x-\dfrac{(-12)}{x}$
Evaluate the expression for $x=-4$:
$(-4)-\dfrac{(-12)}{(-4)}=(-4)-3=(-4)+(-3)=-7$

24. $-2x+7$
Evaluate the expression for $x=-4$:
$-2(-4)+7=8+7=15$

25. Evaluate $\dfrac{100(v-42)}{42}$ for $v=45$:
$\dfrac{100(45-42)}{42}=\dfrac{100(3)}{42}=\dfrac{300}{42}=\dfrac{50}{7}\approx 7.14$
A stock value today of \$45 represents about a 7.14% growth of the investment.

26. a.

Years since 2013	Enrollment (thousands of students)
0	$-11.3\cdot 0+67$
1	$-11.3\cdot 1+67$
2	$-11.3\cdot 2+67$
3	$-11.3\cdot 3+67$
4	$-11.3\cdot 4+67$
t	$-11.3t+67$

b. Substitute 5 for t in $-11.3t+67$:
$-11.3(5)+67=-56.5+67=10.5$
So, in 2018 (5 years after 2013) will be about 10.5 thousand students.