

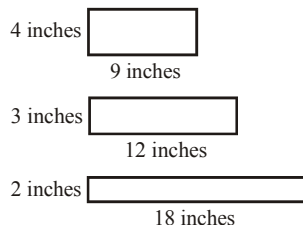
Chapter 1

Introduction to Modeling

Homework 1.1

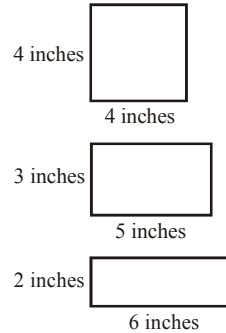
2. In 2011, Jose Bautista hit 43 home runs.
4. In 2011, about 39% of children ages 9–13 participated in organized physical activity.
6. In 2011, 11.8% of American workers were in unions.
8. The temperature is -10°F . That is the temperature is 10 degrees below 0 (in Fahrenheit).
10. The statement $t = 13$ 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:



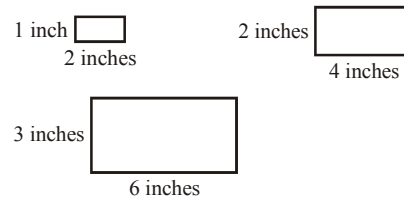
- b. In the described situation, the symbols W and L are variables. Their values can change.
- c. In the described situation, the symbol A is a constant. Its value is fixed at 36 square inches.

24. a. Answers may vary. Example:



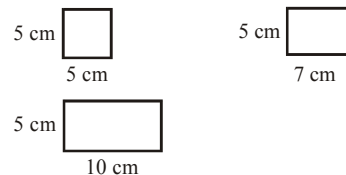
- b. In the described situation, the symbols W and L are variables. Their values can change.
- c. In the described situation, the symbol P is a constant. Its value is fixed at 16 feet.

26. a. Answers may vary. Example:



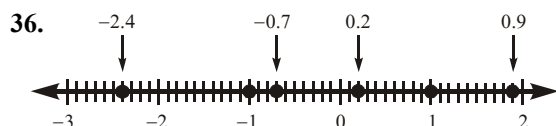
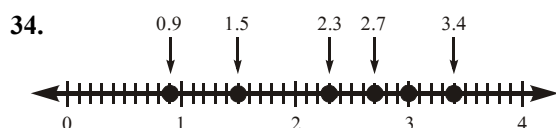
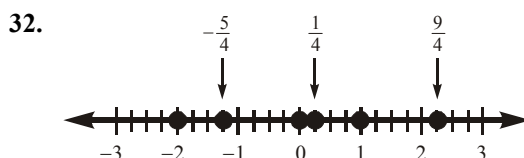
- b. In the described situation, the symbols W , L , and A are all variables. All of their values can change.
- c. In the described situation, none of the symbols are constants. All of their values can change.

28. a. Answers may vary. Example:



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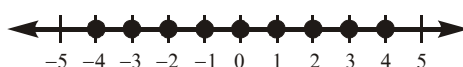
- b. In the described situation, the symbols L and A are variables. Their values can change.
- c. In the described situation, the symbol W is a constant. Its value is fixed at 5 cm.



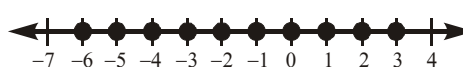
38. The counting numbers between 1 and 5 are 2, 3, and 4.



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

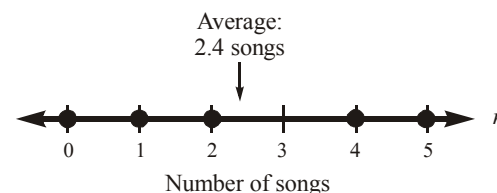
56. Answers may vary. Example: $\frac{1}{2}, \frac{3}{4}$, and $\frac{7}{9}$

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

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

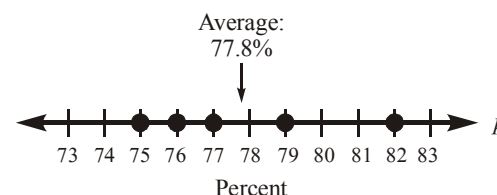
62. $\frac{2+0+1+5+4}{5} = \frac{12}{5} = 2.4$

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.

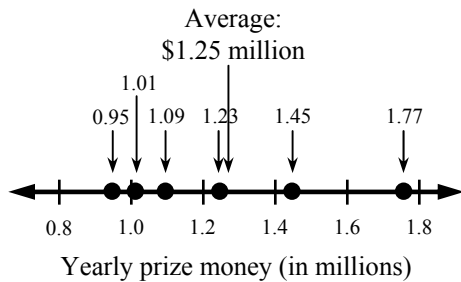


- 66.
- Per person consumption

- 68.
- Annual profit (in millions)

70. a.
$$\frac{0.95 + 1.01 + 1.09 + 1.23 + 1.45 + 1.77}{6}$$
$$= \frac{7.5}{6} = 1.25$$

The average prize money is 1.25 million dollars per year.

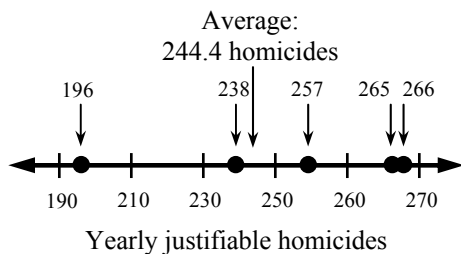


- b. The prize money increased from 2006 to 2011. The amount of money awarded went up each year.
- c. The *increases* in prize money increased from 2006 to 2011. The increases were:

Years	Increase
2006 to 2007	$1.01 - 0.95 = 0.06$
2007 to 2008	$1.09 - 1.01 = 0.08$
2008 to 2009	$1.23 - 1.09 = 0.14$
2009 to 2010	$1.45 - 1.23 = 0.22$
2010 to 2011	$1.77 - 1.45 = 0.32$

72. a.
$$\frac{196 + 238 + 257 + 265 + 266}{5} = \frac{1222}{5} = 244.4$$

The average number of justifiable homicides is 244.4 per year.



- b. The number of justifiable homicides increased from 2005 to 2009. The total number went up each year.

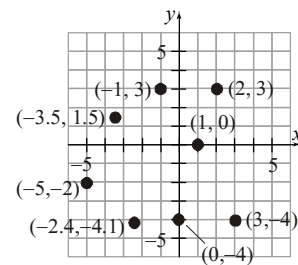
- c. The *increases* in the number of justifiable homicides decreased from 2005 to 2009. The annual increases were:

Years	Increase
2005 to 2006	$238 - 196 = 42$
2006 to 2007	$257 - 238 = 19$
2007 to 2008	$265 - 257 = 8$
2008 to 2009	$266 - 265 = 1$

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.

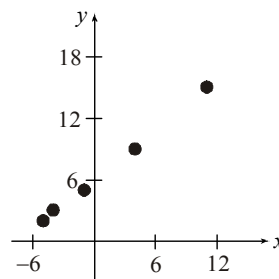


18. The y-coordinate is -4 .
20. Presumably, the longer a person works for a company, the higher his or her salary will be. So, the salary s depends on the number of years t . Thus, t is the independent variable and s is the dependent variable.
22. As a student’s GPA increases, the percentage of college 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.

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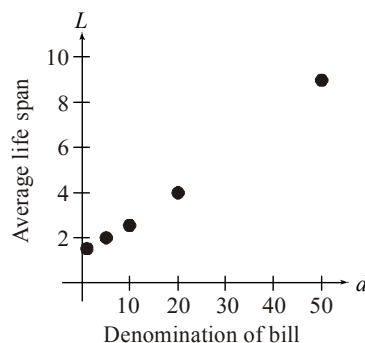
24. As the age of men increases, the percentage with gray hair also increases. So, the percentage p depends on the age a . Thus, a is the independent variable and p is the dependent variable.
26. The longer the potato has been out of the oven, the cooler it will be (until it is cooled completely). So, 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 Americans who have ever watched a movie by streaming it to their computer depends on year. So, t is the independent variable and p is the dependent variable. The ordered pair $(6, 42)$ means that $t = 6$ and $p = 42$. This means that, as of the year $2005 + 6 = 2011$, 42% of Americans had watched a movie by streaming it to their computer.
34. The total amount of money Google spent to advertise its own products depends on the year. So, t is the independent variable and a is the dependent variable. The ordered pair $(1, 213)$ means that $t = 1$ and $a = 213$. This means that a total of \$213 million was spent by Google to advertise its own products in the year $2010 + 1 = 2011$.
36. The percentage of Americans who are satisfied with the size and power of major corporations depends on the year. So, t is the independent variable and p is the dependent variable. The ordered pair $(-2, 35)$ means that $t = -2$ and $p = 35$. This means that 35% of Americans were satisfied with the size and power of major corporations in the year $2010 + (-2) = 2008$.

38.



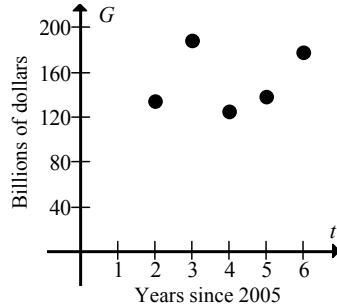
40. Point A is 2 units to the left of the origin and 4 units down. Thus, its coordinates are $(-2, -4)$. Point B is 3 units to the left of the origin on the x -axis. Thus, its coordinates are $(-3, 0)$. Point C is 5 units to the left of the origin and 4 units up. Thus, its coordinates are $(-5, 4)$.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



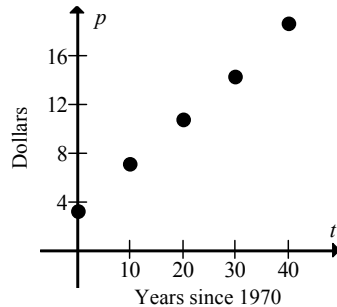
- b. Answers may vary. Example:
The average life span of a \$50 bill is greater than the average life span of a \$1 bill because \$50 bills are used less often, which means they would not wear out as quickly.
- c. Answers may vary. Example:
(1) It takes fifty \$1 bills to be equivalent to one \$50 bill.
(2) \$1 bills wear out quickly so they must be replaced more often than \$50 bills.

44. a.



- b. The total airline fuel cost was the least in 2009. That year, the cost was \$125 billion.
- c. The total airline fuel cost was the greatest in 2008. That year, the cost was \$189 billion.
- d. No. Answers may vary. Example: The total airline fuel cost depends on more than just the cost of crude oil. Other possible factors are the number of miles flown, the efficiency of the planes used, and the actual cost of jet fuel.

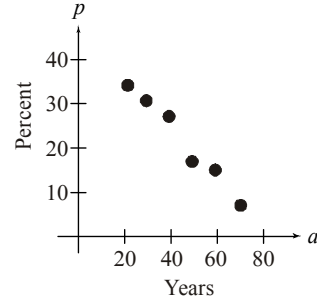
46. a.



- b. The average hourly manufacturing pay increased from 1970 to 2010. For each year, the hourly pay was greater than it was in the previous year.
- c. The annual *increase* in average hourly manufacturing pay stayed approximately constant from 1970 to 2010. The annual increases were

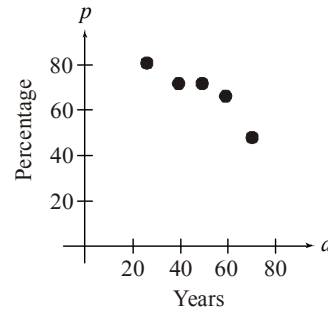
Years	Increase in Hourly Pay
1970 to 1980	$7.15 - 3.24 = 3.91$
1980 to 1990	$10.78 - 7.15 = 3.63$
1990 to 2000	$14.32 - 10.78 = 3.54$
2000 to 2010	$18.61 - 14.32 = 4.29$

48. a.



- b. The highest point in the scattergram 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 scattergram 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.

52. a. According to the graph, Robin Ventura hit 18 grand slams during his career.

- b. According to the graph, Lou Gehrig and Alex Rodriguez are tied for the record number of career grand slams. They each hit 23 grand slams.

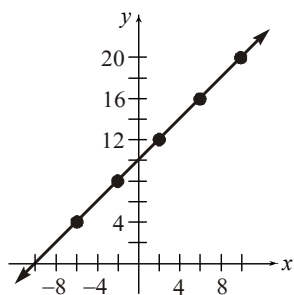
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- c. According to the graph, Manny Ramirez has 21 career grand slams. He needs to hit $23 - 21 = 2$ more grand slams in order to tie the record.
54. The ordered pairs selected and scattergrams may vary. The points will lie on the same horizontal line. 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 $(3, 0)$.

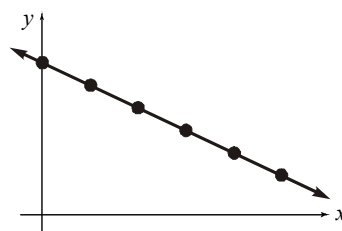
14. a–b.



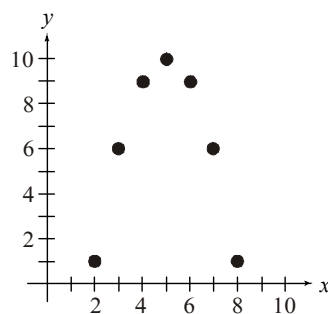
- c. The line contains the point $(4, 14)$, so $y = 14$ when $x = 4$.

- 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.

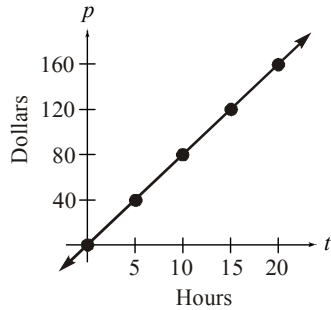


20. a.



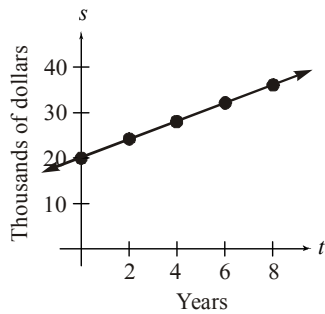
- b. No, there is not a linear relationship between x and y . The data points do not lie close to one line.

22. a.



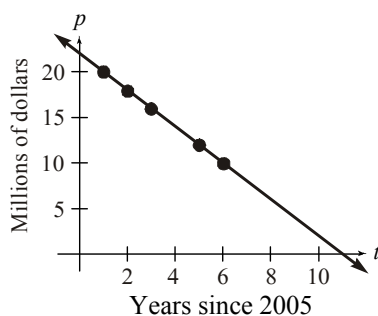
- b. The line contains the point (7, 56), so $p = 56$ when $t = 7$. This means the student's pay for working 7 hours is \$56.
- c. The line contains the point (12, 96), so $t = 12$ when $p = 96$. This means that the student must work 12 hours to earn \$96.

24. a.



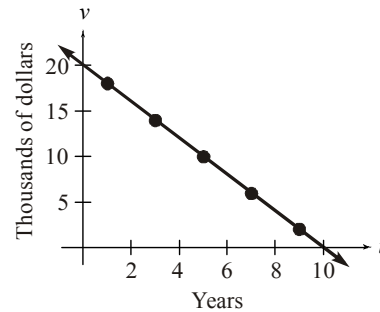
- b. The line contains the point (5, 30), so $s = 30$ when $t = 5$. We estimate that person's salary will be \$30 thousand after he has worked 5 years at the company.
- c. The line contains the point (7, 34), so $t = 7$ when $s = 34$. We estimate that the person will have worked 7 years at the company 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.



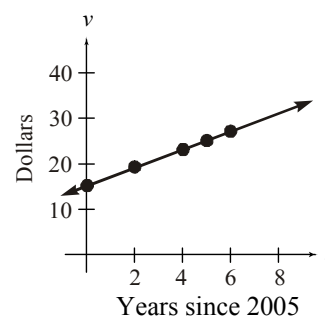
- b. The line contains the point (10, 2), so $t = 10$ when $p = 2$. This means that the company's annual profit will be \$2 million in the year $2005 + 10 = 2015$.
- c. The line and the p -axis intersect at (0, 22), so $p = 22$ when $t = 0$. This means that the company's annual profit was \$22 million 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.



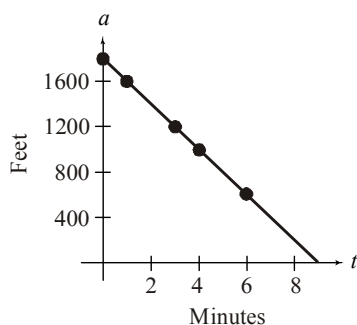
- b. The line contains the point (8, 4), so $v = 4$ when $t = 8$. This means that the car will be worth \$4 thousand when it is 8 years old.
- c. The line contains the point (6, 8), so $v = 8$ when $t = 6$. This means the value of the car will be \$8 thousand when it is 6 years old.
- d. The line and 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.



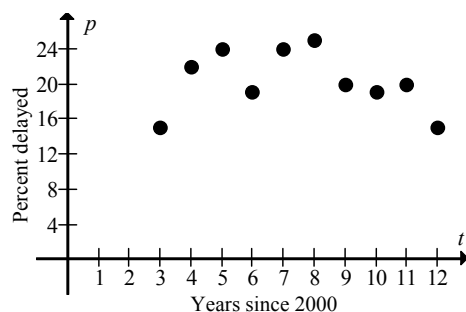
- b. The line contains the point $(3, 21)$, so $v = 21$ when $t = 3$. This means the value of the stock was \$21 in the year 2008.
- c. The line contains the point $(10, 35)$, so $t = 10$ when $v = 35$. This means the value of the stock will be \$35 in $2005 + 10 = 2015$.
- d. The line and the v -axis 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.

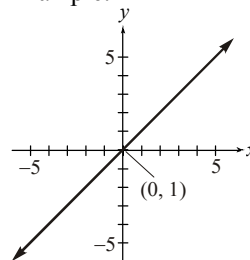


- b. No, there is not a linear relationship between t and p . The data points do not lie close to one line.

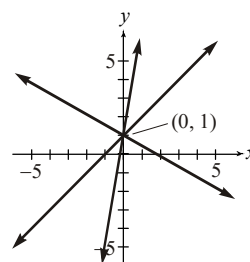
36. No. The -3 is the x -coordinate of ordered pair $(-3, 4)$, not the x -intercept.

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:



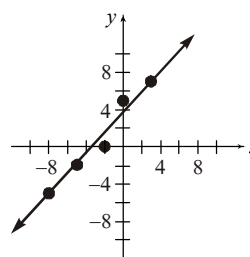
44. Answers may vary. Example: Every point on the y -axis has an x -coordinate of 0. So the y -intercept of a line must have an x -coordinate of 0.

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.

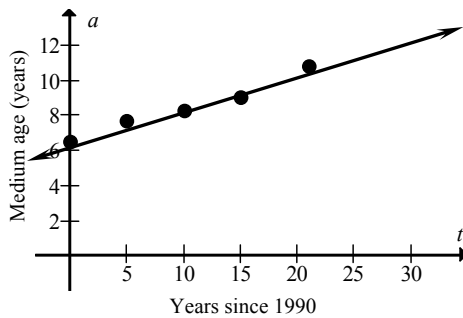


- b. The variables are approximately linearly related.

- 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. First, we list the values of t and a in the table below. For example, $t = 5$ represents 1995 because 1995 is 5 years after 1990.

Years since 1990	Median Age (years)
t	a
0	6.5
5	7.7
10	8.3
15	9.0
21	10.8

We then create the scatter plot.

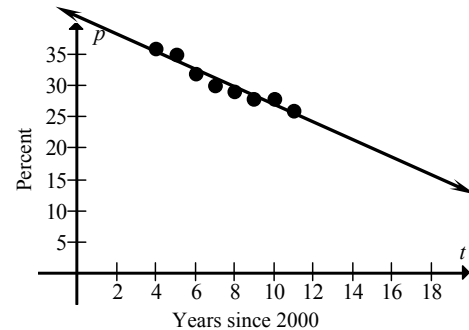


- b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).
- c. The year 2008 corresponds to $t = 18$. We estimate that the line contains the point $(18, 9.9)$, so $a = 9.9$ when $t = 18$. We estimate that the median age of cars was 9.9 years in 2008.
- d. We estimate that the line contains the point $(29, 12)$, so $t = 29$ when $a = 12$. We estimate the median age of cars is 12 years in $1990 + 29 = 2019$.

- 6. a. First, we list the values of t and p in the table below. For example, $t = 4$ represents 2004 because 2004 is 4 years after 2000.

Years since 2000	Percent
t	p
4	36
5	35
6	32
7	30
8	29
9	28
10	28
11	26

We then create the scatter plot.

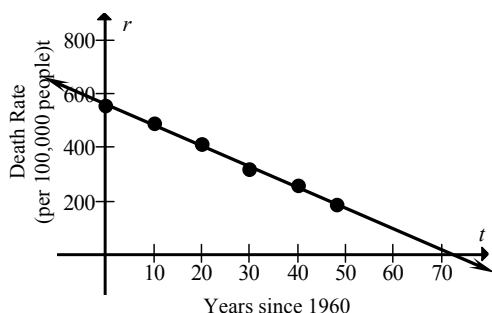


- b. The variables are approximately linearly related. The points in the scattergram lie close to a line.
- c. Draw a line that comes close to the points to create the linear model. See the graph in part (a).
- d. The year 2018 corresponds to $t = 18$. We estimate that the line contains the point $(18, 16)$, so $p = 16$ when $t = 18$. We predict that in 2018, 16% of Americans will say there should be a ban on the possession of handguns.
- e. We estimate that the line contains the point $(15, 20)$, so $t = 15$ when $p = 20$. We predict that 20% of Americans will say there should be a ban on the possession of handguns in 2015.

8. a. First, we list the values of t and r in the table below. For example, $t = 10$ represents 1970 because 1970 is 10 years after 1960.

Years since 1960 t	Death Rate (number of deaths per 100,000 people) r
0	559
10	493
20	412
30	322
40	258
48	187

We then create the scatter plot.

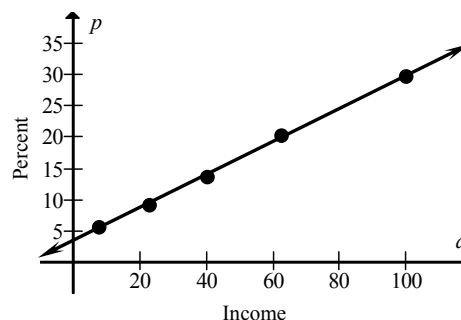


- b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).
- c. We estimate that the line and the t -axis intersect at $(72, 0)$, so $t = 72$ when $r = 0$. This means that the death rate due to heart disease will be 0 in the year $1960 + 72 = 2032$. Model breakdown has likely occurred.
- d. The year 2018 corresponds to $t = 58$. We estimate that the line contains the point $(58, 110)$, so $r = 110$ when $t = 58$. We predict that the death rate in 2018 will be 110 people per 100,000 people. If the population of the U.S. is 335 million in 2018, then the number of people who will die from heart disease that year will be:

$$335,000,000 \cdot \frac{110}{100,000} = 368,500.$$

We predict that 368,500 people in the U. S. will die from heart disease in 2018.

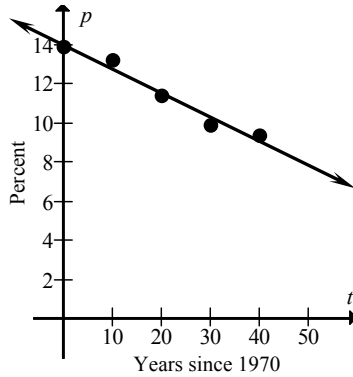
10. a. Create the scatter plot.



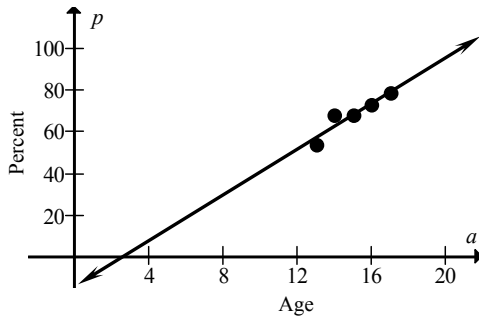
- b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).
- c. We estimate that the line contains the point $(50, 17)$, so $p = 17$ when $d = 50$. We estimate that 17% of elementary school students from households with income of \$50 thousand participate in an after-school arts activity.
- d. We estimate that the line contains the point $(82, 25)$, so $d = 82$ when $p = 25$. We estimate that the income is \$82 thousand in households from which 25% of elementary school students participate in an after-school arts activity.
- e. We estimate that the p -intercept is about $(0, 3)$. This means that approximately 3% of elementary school students from households with no income participate in an after-school arts activity.
12. a. First, we list the values of t and p in the table below. For example, $t = 10$ represents 1980 because 1980 is 10 years after 1970.

Years since 1970 t	Percent p
0	13.9
10	13.2
20	11.4
30	9.9
40	9.4

We then create the scatter plot.



- b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).
- c. The year 2018 is represented by $t = 48$. We estimate that the line contains the point $(48, 8)$, so $p = 8$ when $t = 48$. We estimate that 8% of disposable income will be spent on food in 2018.
- d. Answers may vary.
14. a. Create the scatter plot.



- b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).
- c. We estimate that the line contains the point $(18, 85)$, so $p = 85$ when $a = 18$. We estimate that 85% of 18-year-old teens have cell phones.
- d. We estimate that the line contains the point $(21, 100)$, so $p = 100$ when $a = 21$. We estimate that by the age of 21, all people have cell phones.

- e. The a -intercept is about $(0, 2.5)$. This means that before age 2.5, people do not have cell phones.

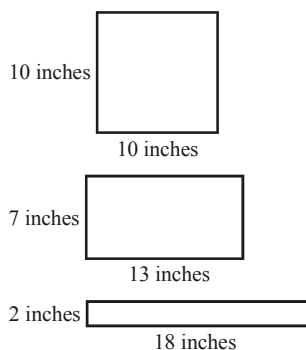
16. a. From the linear model, there were about 2.2 thousand injuries in 2002.
- b. From the table, there were 2.5 thousand injuries in 2002.
- c. Since the predicted rate is lower than the actual rate, the prediction is an underestimate. We can tell this from the graph since the line is below the data point. The error in the estimate is $2.5 - 2.2 = 0.3$ thousand, or 300 injuries.
18. If the linear model is below the data point (c, p) , then the model will underestimate the value of p when $t = c$.
20. 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.
22. This short cut is dangerous because the linear model may not come close to the non-selected data points. Answers may vary.
24. 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.

Chapter 1 Review

- The total box office gross from U.S. and Canada movie theaters was \$10.58 billion in 2010.
- $t = 21$ represents the year $1995 + 21 = 2016$.
- 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.

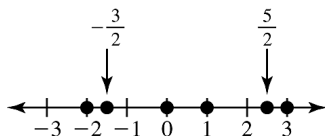
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4. a. Answers may vary. Example:

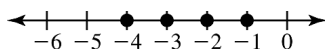


- b. In the described situation, the symbols W and L are variables. Their values can change.
- c. In the described situation, the symbol P is a constant. Its value is fixed at 40 inches.

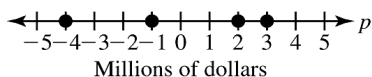
5.



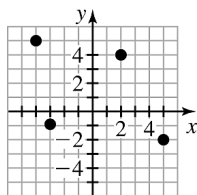
6. The negative integers between -5 and 5 are $-4, -3, -2$, and -1 .



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



8.



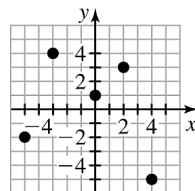
9. The y -coordinate is -6 .
10. The x -coordinate is -4 .
11. The percentage p of home owners depends on age a . Thus, a is the independent variable and p is the dependent variable.

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.

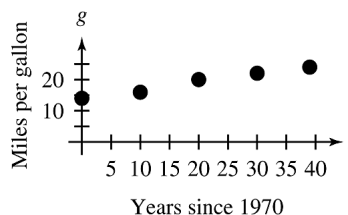
13. The number of billionaires depends on the year. So, t is the independent variable and n is the dependent variable. The ordered pair $(11, 413)$ means that $t = 11$ and $n = 413$. This means that there were 413 U.S. billionaires in the year $2000 + 11 = 2011$.

14. The annual revenue from ADHD drugs depends on the year. So, t is the independent variable and r is the dependent variable. The ordered pair $(5, 7)$ means that $t = 5$ and $r = 7$. This means that the annual revenue from ADHD drugs was \$7 billion in the year $2005 + 5 = 2010$.

15.

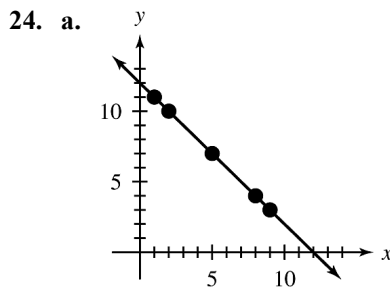


16. a.

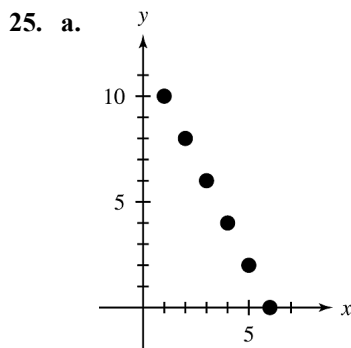


- b. The average gas mileage was highest in the year 2009.
- c. The average gas mileage was lowest in the year 1970.
17. a. France generates the largest percentage of its electricity by nuclear power. This percentage is about 78%.
- b. The United States generates the smallest percentage of its electricity by nuclear power. This percentage is about 20%.
- c. Sweden generates about 50% of its electricity by nuclear power.
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 $(-4, 0)$.



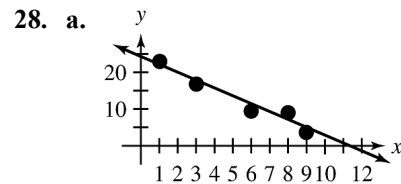
- b. See the graph in part (a).
- c. The line contains the point $(11, 1)$, so $y = 1$ when $x = 11$.
- d. The line contains the point $(7, 5)$, so $x = 7$ when $y = 5$.
- e. The line and the x -axis intersect at $(12, 0)$, so the x -intercept is $(12, 0)$.
- f. The line and the y -axis intersect at $(0, 12)$, so the y -intercept is $(0, 12)$.



- 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 profit is \$2 million in 2015.
- c. The line contains the point $(2, 18)$, so $t = 2$ when $p = 18$. We estimate that the 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 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 profit will be \$0 in the year 2016.

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

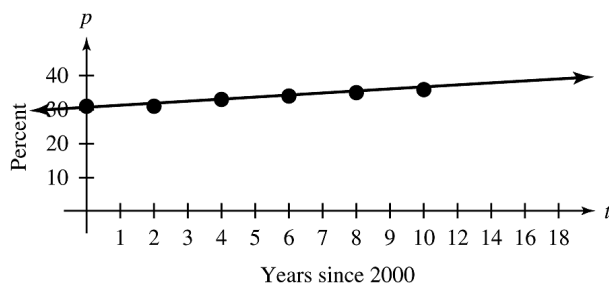


- b. The variables are approximately linearly related.
- c. See the graph in part (a).
- d. $(5, 13.5)$
- e. $(2, 20)$
- f. $(0, 24.3)$
- g. $(11.2, 0)$

29. a. First, we list the values of t and p in the table below. For example, $t = 2$ represents 2002 because 2002 is 2 years after 2000.

Years since 2000	Percent
t	p
0	31
2	31
4	33
6	34
8	35
10	36

We then create the scatter plot.

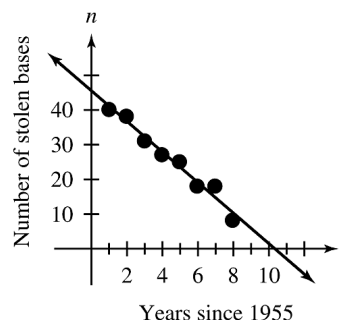


- b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).
- c. The year 2016 corresponds to $t = 16$. We estimate that the line contains the point $(16, 39)$, so $p = 39$ when $t = 16$. We predict that 39% of American adults will be obese in the year 2016.
- d. We estimate that the line contains the point $(17, 40)$, so $t = 17$ when $p = 40$. We predict that 40% of American adults will be obese in the year $2000 + 17 = 2017$.

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

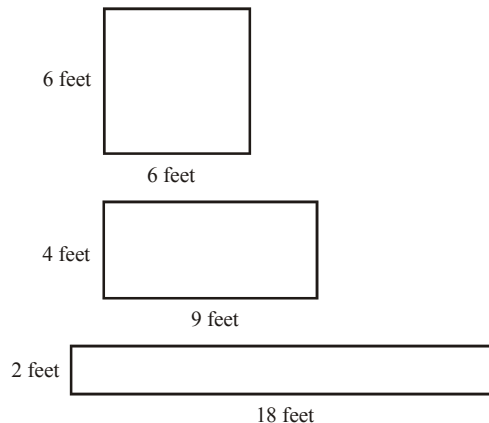
We then create the scatter plot.



- 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 $n = 0$. 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

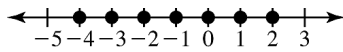
1. a. Answers may vary. Example:



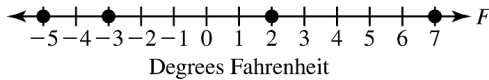
b. In the described situation, the symbols W and L are variables. Their values can change.

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 .

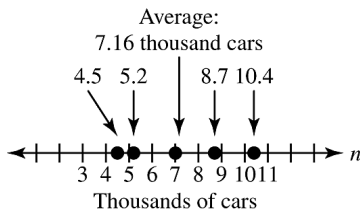


3. The numbers listed are: $-5, 7, 2$, and -3 .



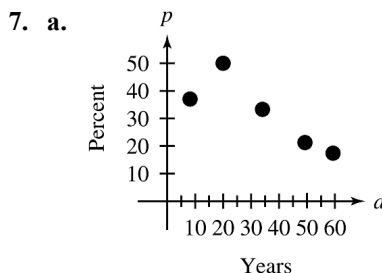
$$4. \frac{4.5 + 5.2 + 7.0 + 8.7 + 10.4}{5} = \frac{35.8}{5} = 7.16$$

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



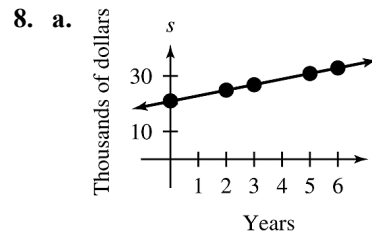
5. As the number of tickets increases, so will the cost. So, the cost c depends on the number of tickets n . Thus, n is the independent variable and c is the dependent variable.

6. The salary of Alex Rodriguez depends on the year. So, t is the independent variable and s is the dependent variable. The ordered pair $(2, 30)$ means that $t = 2$ and $s = 30$. This means that in $2010 + 2 = 2012$, Alex Rodriguez's salary was \$30 million.



b. The point $(21, 50)$ is the highest point. This means that Americans in the age group 18–24 are the most likely to be without health insurance.

c. The point $(59.5, 17)$ is the lowest point. This means that Americans in the age group 55–64 are the least likely to be without health insurance.



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.

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

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

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

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

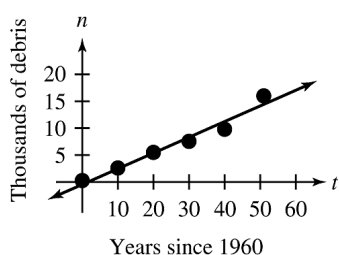
13. Answers may vary.

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14. a. First, we list the values of t and n in the table below. For example, $t = 10$ represents 1970 because 1970 is 10 years after 1960.

Years since 1960 t	Number of Space Debris (thousands) n
0	0.02
10	2.6
20	5.5
30	7.5
40	9.8
51	16.0

We then create the scatter plot.



- b. Draw a line that comes close to the points to create the linear model. See the graph in part (a).
- c. We estimate that the line contains the point $(33, 9)$, so $t = 33$ when $n = 9$. We estimate that there were 9 thousand space debris in the year $1960 + 33 = 1993$.
- d. The year 2020 corresponds to $t = 60$. We estimate that the line contains the point $(60, 17.1)$, so $n = 17.1$ when $t = 60$. We predict that there will be 17.1 thousand space debris in the year 2020.
15. If the data point (c, p) is below the linear model, then the model will overestimate the value of p when $t = c$.