1.1 Exercises

See CalcChat.com for tutorial help and worked-out solutions to odd-numbered exercises.

For instructions on how to use a graphing utility, see Appendix A.

Vocabulary and Concept Check

1. Match each equation with its form.

   a. $Ax + By + C = 0$ i. vertical line

   b. $x = a$ ii. slope-intercept form

   c. $y = b$ iii. general form

   d. $y = mx + b$
                                                 iv. point-slope form
   e. $y - y_1 = m(x - x_1)$

                                                 v. horizontal line

In Exercises 2 and 3, fill in the blank.

2. For a line, the ratio of the change in y to the change in x is called the ____ of the line.

3. Two lines are ____ if and only if their slopes are equal.

4. What is the relationship between two lines whose slopes are -3 and $\frac{1}{3}$?
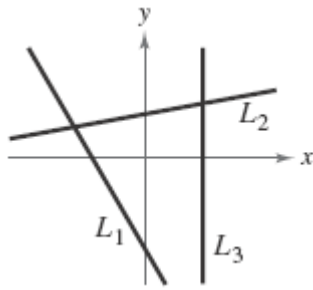
5. What is the slope of a line that is perpendicular to the line represented by $x = 3$?

6. Give the coordinates of a point on the line whose equation in point-slope form is $y - (-1) = \frac{1}{4}(x - 8)$.

Procedures and Problem Solving

Using Slope In Exercises 7 and 8, identify the line that has the indicated slope.
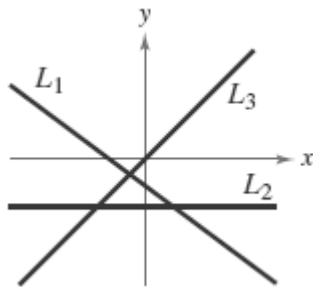
7.

a. $m = \dfrac{2}{3}$
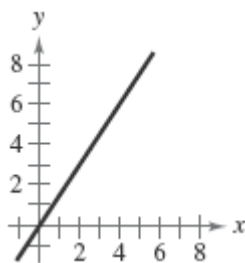
b. m is undefined.
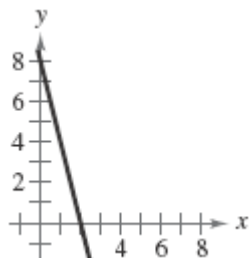
c. $m = -2$

8.

a. $m = 0$

b. $m = -\dfrac{3}{4}$

c. $m = 1$

Estimating Slope In Exercises 9 and 10, estimate the slope of the line.

9.

10.

Sketching Lines In Exercises 11 and 12, sketch the lines through the point with the indicated slopes on the same set of coordinate axes.

11.

Point	Slopes
$(2, 3)$	a. 0
	b. 1
	c. 2
	d. −3

12.

Point	Slopes
$(-4, 1)$	a. 4
	b. −2
	c. $\dfrac{1}{2}$
	d. Undefined

Finding the Slope of a Line In Exercises 13, 14, 15, and 16, find the slope of the line passing through the pair of points. Then use a graphing utility to plot the points and use the *draw* feature to graph the line segment connecting the two points. (Use a *square setting*.)

13. $(0, -10)$, $(-4, 0)$

14. $(2, 4)$, $(4, -4)$

15. $(-6, -1)$, $(-6, 4)$

16. $(4, 9)$, $(6, 12)$

Using Slope In Exercises 17, 18, 19, 20, 21, 22, 23, and 24, use the point on the line and the slope of the line to find three additional points through which the line passes. (There are many correct answers.)

17.

Point	Slope
$(2, 1)$	$m = 0$

18.

Point	Slope
$(3, -2)$	$m = 0$

19.

Point	Slope
$(1, 5)$	m is undefined.

20.

Point	Slope
$(-4, 1)$	m is undefined.

21.

Point	Slope
$(0, -9)$	$m = -2$

22.

Point	Slope
$(-5, 4)$	$m = 4$

23.

Point	Slope
$(7, -2)$	$m = \dfrac{1}{2}$

24.

Point	Slope
$(-1, -6)$	$m = -\dfrac{1}{3}$

The Point-Slope Form of the Equation of a Line In Exercises 25, 26, 27, 28, 29, 30, 31, and 32, find an equation of the line that passes through the given point and has

the indicated slope. Sketch the line by hand. Use a graphing utility to verify your sketch, if possible.

25. $(0, -2), \quad m = 3$

26. $(-3, 6), \quad m = -3$

27. $(2, -3), \quad m = -\dfrac{1}{2}$

28. $(-2, -5), \quad m = \dfrac{3}{4}$

29. $(6, -1), \quad m$ is undefined.

30. $(-10, 4), \quad m$ is undefined.

31. $\left(-\dfrac{1}{2}, \dfrac{3}{2}\right), \quad m = 0$

32. $(2.3, -8.5), \quad m = 0$

33. **Finance** The median player salary for the New York Yankees was $\$1.5$ million in 2007 and $\$1.7$ million in 2013. Write a linear equation giving the median salary y in terms of the year x. Then use the equation to predict the median salary in 2020.

34. **Finance** The median player salary for the Dallas Cowboys was $\$348,000$ in 2004 and $\$555,000$ in 2013. Write a linear equation giving the median salary y in terms of the year x. Then use the equation to predict the median salary in 2019.

Using the Slope-Intercept Form In Exercises 35, 36, 37, 38, 39, 40, 41, and 42, determine the slope and y-intercept (if possible) of the linear equation. Then describe its graph.

35. $2x - 3y = 9$

36. $3x + 4y = 1$

37. $2x - 5y + 10 = 0$

38. $4x - 3y - 9 = 0$

39. $x = -6$

40. $y = 12$

41. $3y + 2 = 0$

42. $2x - 5 = 0$

Using the Slope-Intercept Form In Exercises 43, 44, 45, 46, 47, and 48,

    a. find the slope and y-intercept (if possible) of the equation of the line algebraically, and

    b. sketch the line by hand.

Use a graphing utility to verify your answers to parts (a) and (b).

43. $5x - y + 3 = 0$
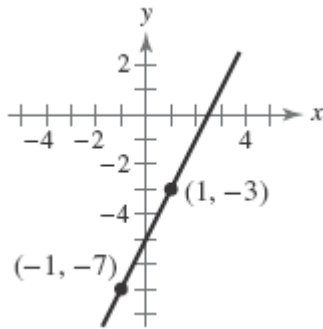
44. $2x + 3y - 9 = 0$

45. $5x - 2 = 0$
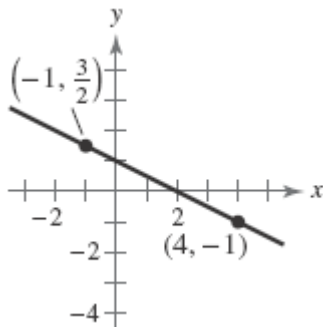
46. $3x + 7 = 0$

47. $3y + 5 = 0$

48. $-11 - 4y = 0$

Finding the Slope-Intercept Form In Exercises 49 and 50, find the slope-intercept form of the equation of the line shown.

49.

50.

Finding the Slope-Intercept Form In Exercises 51, 52, 53, 54, 55, 56, 57, 58, 59, and 60, write an equation of the line that passes through the points. Use the slope-intercept form (if possible). If not possible, explain why and use the general form. Use a graphing utility to graph the line (if possible).

51. $(5, -1), (-5, 5)$

52. $(4, 3), (-4, -4)$

53. $(-8, 1), (-8, 7)$

54. $(-1, 6), (5, 6)$

55. $\left(2, \dfrac{1}{2}\right), \left(\dfrac{1}{2}, \dfrac{5}{4}\right)$

56. $(1, 1), \left(6, -\dfrac{2}{3}\right)$

57. $\left(-\dfrac{1}{10}, -\dfrac{3}{5}\right), \left(\dfrac{9}{10}, -\dfrac{9}{5}\right)$

58. $\left(\dfrac{3}{4}, \dfrac{3}{2}\right), \left(-\dfrac{4}{3}, \dfrac{7}{4}\right)$

59. $(1, 0.6), (-2, -0.6)$

60. $(-8, 0.6), (2, -2.4)$

Different Viewing Windows In Exercises 61 and 62, use a graphing utility to graph the equation using each viewing window. Describe the differences in the graphs.

61. $y = 0.25x - 2$

Xmin = −1	Xmin = −5	Xmin = −5
Xmax = 9	Xmax = 10	Xmax = 10
Xscl = 1	Xscl = 1	Xscl = 1
Ymin = −5	Ymin = −3	Ymin = −5
Ymax = 4	Ymax = 4	Ymax = 5
Yscl = 1	Yscl = 1	Yscl = 1

62. $y = -8x + 5$

Xmin = −5	Xmin = −5	Xmin = −5
Xmax = 5	Xmax = 10	Xmax = 13
Xscl = 1	Xscl = 1	Xscl = 1
Ymin = −10	Ymin = −80	Ymin = −2
Ymax = 10	Ymax = 80	Ymax = 10
Yscl = 1	Yscl = 20	Yscl = 1

Parallel and Perpendicular Lines In Exercises 63, 64, 65, and 66, determine whether the lines L_1 and L_2 passing through the pairs of points are parallel, perpendicular, or neither.

63. L_1: $(0, -1)$, $(5, 9)$

   L_2: $(0, 3)$, $(4, 1)$

64. L_1: $(-2, -1)$, $(1, 5)$

   L_2: $(1, 3)$, $(5, -5)$

65. L_1: $(3, 6)$, $(-6, 0)$

   L_2: $(0, -1)$, $\left(5, \dfrac{7}{3}\right)$

66. L_1: $(4, 8)$, $(-4, 2)$

   L_2: $(3, -5)$, $\left(-1, \dfrac{1}{3}\right)$

Equations of Parallel and Perpendicular Lines In Exercises 67, 68, 69, 70, 71, 72, 73, 74, 75, and 76, write the slope-intercept forms of the equations of the lines through the given point

   a. parallel to the given line and

   b. perpendicular to the given line.

67. $(2, 1)$, $4x - 2y = 3$

68. $(-3, 2)$, $x + y = 7$

69. $\left(-\dfrac{2}{3}, \dfrac{7}{8}\right)$, $3x + 4y = 7$

70. $\left(\dfrac{2}{5}, -1\right)$, $3x - 2y = 6$

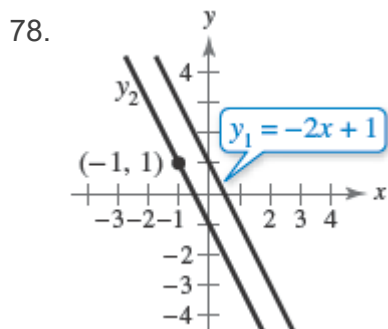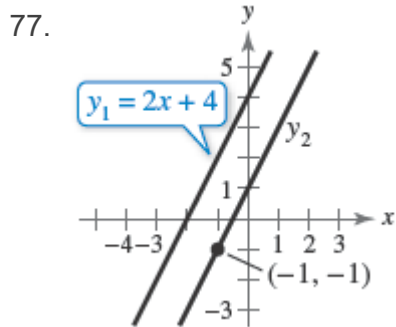71. $(-3.9, -1.4)$, $6x + 5y = 9$

72. $(-1.2, 2.4)$, $5x + 4y = 1$

73. $(3, -2)$, $x - 4 = 0$
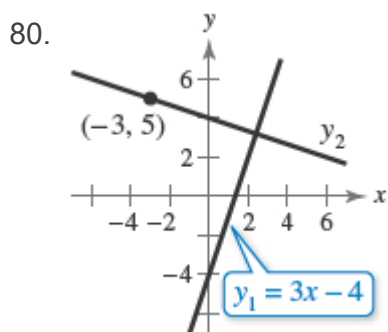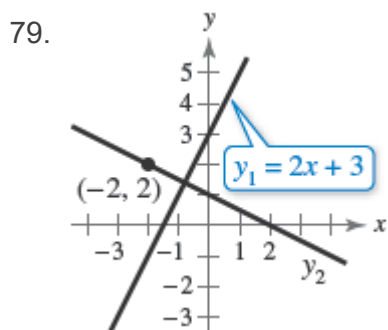
74. $(3, -1)$, $y - 2 = 0$

75. $(-5, 1)$, $y + 2 = 0$

76. $(-2, 4), \quad x + 5 = 0$

Equations of Parallel Lines In Exercises 77 and 78, the lines are parallel. Find the slope-intercept form of the equation of line y_2.

77.

78.

Equations of Perpendicular Lines In Exercises 79 and 80, the lines are perpendicular. Find the slope-intercept form of the equation of line y_2.

79.

80.

Graphs of Parallel and Perpendicular Lines In Exercises 81, 82, 83, and 84, identify any relationships that exist among the lines, and then use a graphing utility to graph the three equations in the same viewing window. Adjust the viewing window so that

each slope appears visually correct. Use the slopes of the lines to verify your results.

81.

a. $y = 4x$

b. $y = -4x$

c. $y = \dfrac{1}{4}x$

82.

a. $y = \dfrac{2}{3}x$

b. $y = -\dfrac{3}{2}x$

c. $y = \dfrac{2}{3}x + 2$

83.

a. $y = -\dfrac{1}{2}x$

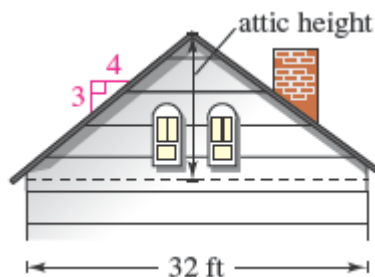b. $y = -\dfrac{1}{2}x + 3$

c. $y = 2x - 4$

84.

a. $y = x - 8$

b. $y = x + 1$

c. $y = -x + 3$

85. Architectural Design The rise-to-run ratio of the roof of a house determines the steepness of the roof. The rise-to-run ratio of the roof in the figure is 3 to 4. Determine the maximum height in the attic of the house if the house is 32 feet wide.

86. **Highway Engineering** When driving down a mountain road, you notice warning signs indicating that it is a "12% grade." This means that the slope of the road is $-\dfrac{12}{100}$. Approximate the amount of horizontal change in your position if you note from elevation markers that you have descended 2000 feet vertically.

87. **Modeling Data** The graph shows the sales y (in billions of dollars) of the Coca-Cola Company each year x from 2005 through 2012, where $x = 5$ represents 2005. (Source: Coca-Cola Company)
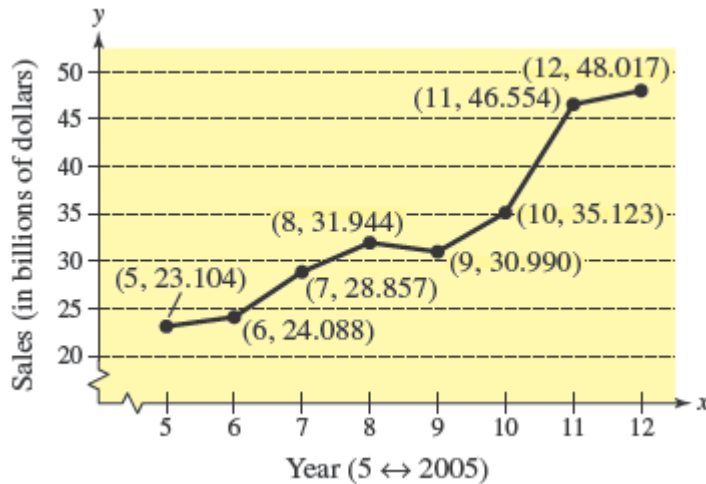
a. Use the slopes to determine the years in which the sales showed the greatest increase and greatest decrease.

b. Find the equation of the line between the years 2005 and 2012.

c. Interpret the meaning of the slope of the line from part (b) in the context of the problem.

d. Use the equation from part (b) to estimate the sales of the Coca-Cola Company in 2017. Do you think this is an accurate estimate? Explain.

88. **Modeling Data** The table shows the profits y (in millions of dollars) for Buffalo Wild Wings for each year x from 2007 through 2013, where $x = 7$ represents 2007. (Source: Buffalo Wild Wings, Inc.)

Year, x	Profits, y
7	19.7
8	24.4
9	30.7

Year, x	Profits, y
10	38.4
11	50.4
12	57.3
13	71.6

Spreadsheet at LarsonPrecalculus.com

a. Sketch a graph of the data.

b. Use the slopes to determine the years in which the profits showed the greatest and least increases.

c. Find the equation of the line between the years 2007 and 2013.

d. Interpret the meaning of the slope of the line from part (c) in the context of the problem.

e. Use the equation from part (c) to estimate the profit for Buffalo Wild Wings in 2017. Do you think this is an accurate estimate? Explain.

Using a Rate of Change to Write an Equation In Exercises 89, 90, 91, and 92, you are given the dollar value of a product in 2015 and the rate at which the value of the product is expected to change during the next 5 years. Write a linear equation that gives the dollar value V of the product in terms of the year t. (Let $t = 15$ represent 2015.)

89.

2015 Value	Rate
$2540	$125 increase per year

90.

2015 Value	Rate
$156	$5.50 increase per year

91.

2015 Value	Rate
$20,400	$2000 decrease per year

92.

2015 Value	Rate
$245,000	$5600 decrease per year

93. **Accounting** A school district purchases a high-volume printer, copier, and scanner for $25,000. After 10 years, the equipment will have to be replaced. Its value at that time is expected to be $2000.

t	0	1	2	3	4	5	6	7	8	9	10
V											

    a. Write a linear equation giving the value V of the equipment for each year t during its 10 years of use.

    b. Use a graphing utility to graph the linear equation representing the depreciation of the equipment, and use the *value* or *trace* feature to complete the table. Verify your answers algebraically by using the equation you found in part (a).

94. **Meterology** Recall that water freezes at $0°C$ ($32°F$) and boils at $100°C$ ($212°F$).

    a. Find an equation of the line that shows the relationship between the temperature in degrees Celsius C and degrees Fahrenheit F.

    b. Use the result of part (a) to complete the table.

C		$-10°$	$10°$			$177°$
F	$0°$			$68°$	$90°$	

95. **Business** A contractor purchases a bulldozer for $36,500. The bulldozer requires an average expenditure of $11.25 per hour for fuel and maintenance, and the operator is paid $19.50 per hour.

a. Write a linear equation giving the total cost C of operating the bulldozer for t hours. (Include the purchase cost of the bulldozer.)

b. Assuming that customers are charged $80 per hour of bulldozer use, write an equation for the revenue R derived from t hours of use.

c. Use the profit formula $(P = R - C)$ to write an equation for the profit gained from t hours of use.

d. Use the result of part (c) to find the break-even point (the number of hours the bulldozer must be used to gain a profit of 0 dollars).

96. **Real Estate** A real estate office handles an apartment complex with 50 units. When the rent per unit is $580 per month, all 50 units are occupied. However, when the rent is $625 per month, the average number of occupied units drops to 47. Assume that the relationship between the monthly rent p and the demand x is linear.

a. Write an equation of the line giving the demand x in terms of the rent p.

b. Use a graphing utility to graph the demand equation and use the *trace* feature to estimate the number of units occupied when the rent is $655. Verify your answer algebraically.

c. Use the demand equation to predict the number of units occupied when the rent is lowered to $595. Verify your answer graphically.

97. **Why You Should Learn It** *(1.1 Lines in the Plane)* In 1994, Penn State University had an enrollment of $73,500$ students. By 2013, the enrollment had increased to $98,097$. (Source: Penn State Fact Book)

a. What was the average annual change in enrollment from 1994 to 2013?

b. Use the average annual change in enrollment to estimate the enrollments in 1996, 2006, and 2011.

c. Write an equation of a line that represents the given data. What is its slope? Interpret the slope in the context of the problem.

98. **Writing** Using the results of Exercise 97, write a short paragraph discussing the concepts of *slope* and *average rate of change*.

Conclusions

True or False? In Exercises 99 and 100, determine whether the statement is true or false. Justify your answer.

99. The line through $(-8, 2)$ and $(-1, 4)$ and the line through $(0, -4)$ and $(-7, 7)$ are parallel.

   True   False

100. If the points $(10, -3)$ and $(2, -9)$ lie on the same line, then the point $\left(-12, -\dfrac{37}{2}\right)$ also lies on that line.

Exploration In Exercises 101, 102, 103, and 104, use a graphing utility to graph the equation of the line in the form

$$\frac{x}{a} + \frac{y}{b} = 1, \quad a \neq 0, b \neq 0.$$

Use the graphs to make a conjecture about what a and b represent. Verify your conjecture.

101. $\dfrac{x}{7} + \dfrac{y}{-3} = 1$

102. $\dfrac{x}{-6} + \dfrac{y}{2} = 1$

103. $\dfrac{x}{4} + \dfrac{y}{-\dfrac{2}{3}} = 1$

104. $\dfrac{x}{\dfrac{1}{2}} + \dfrac{y}{5} = 1$

Using Intercepts In Exercises 105, 106, 107, and 108, use the results of Exercises 101, 102, 103, and 104 to write an equation of the line that passes through the points.

105. x-intercept: $(2, 0)$

   y-intercept: $(0, 9)$

106. x-intercept: $(-5, 0)$

   y-intercept: $(0, -4)$

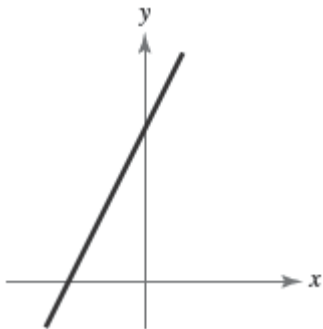107. x-intercept: $\left(-\dfrac{1}{6}, 0\right)$

   y-intercept: $\left(0, -\dfrac{2}{3}\right)$

108. x-intercept: $\left(\dfrac{3}{4}, 0\right)$

y-intercept: $\left(0, \dfrac{4}{3}\right)$

Think about It In Exercises 109 and 110, determine which equation(s) may be represented by the graphs shown. (There may be more than one correct answer.)
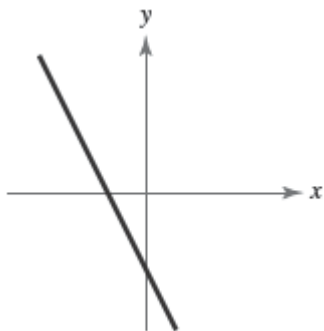
109.

a. $2x - y = -10$

b. $2x + y = 10$

c. $x - 2y = 10$

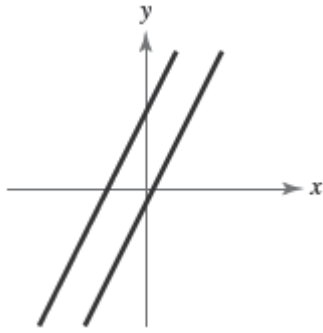d. $x + 2y = 10$

110.

a. $2x + y = 5$

b. $2x + y = -5$

c. $x - 2y = 5$

d. $x - 2y = -5$

Think about It In Exercises 111 and 112, determine which pair of equations may be represented by the graphs shown.

111.

a.
$2x - y = 5$
$2x - y = 1$

b.
$2x + y = -5$
$2x + y = 1$

c.
$2x - y = -5$
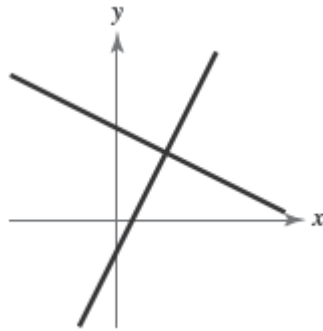$2x - y = 1$

d.
$x - 2y = -5$
$x - 2y = -1$

112.

a.
$2x - y = 2$
$x + 2y = 12$

b.
$x - y = 1$
$x + y = 6$

c.
$2x + y = 2$
$x - 2y = 12$

d.
$x - 2y = 2$
$x + 2y = 12$

113. Think about It Does every line have both an x-intercept and a y-intercept? Explain.

114. Think about It Can every line be written in slope-intercept form? Explain.

115. **Think about It** Does every line have an infinite number of lines that are parallel to it? Explain.

116. **How Do You See It?** Match the description with its graph. Determine the slope and y-intercept of each graph and interpret their meaning in the context of the problem. [The graphs are labeled (i), (ii), (iii), and (iv).]

i.

50

0
0   8

ii.

125

0
0   10

iii.

25

0
0   10

iv.

600

0
0   6
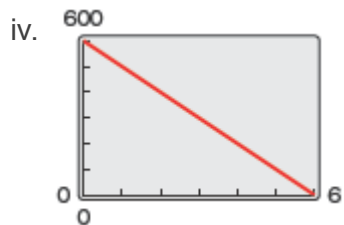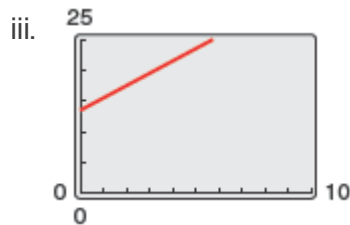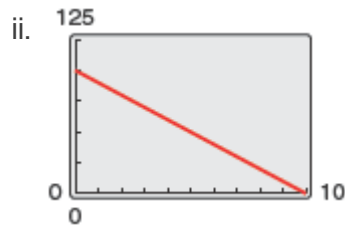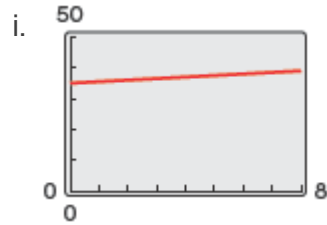
   a. You are paying $10 per week to repay a $100 loan.

   b. An employee is paid $13.50 per hour plus $2 for each unit produced per hour.

   c. A sales representative receives $35 per day for food plus $0.50 for each mile traveled.

   d. A tablet computer that was purchased for $600 depreciates $100 per year.

Cumulative Mixed Review

Identifying Polynomials In Exercises 117, 118, 119, 120, 121, and 122, determine whether the expression is a polynomial. If it is, write the polynomial in standard form.

117. $x + 20$

118. $3x - 10x^2 + 1$

119. $4x^2 + x^{-1} - 3$

120. $2x^2 - 2x^4 - x^3 + \sqrt{2}$

121. $\dfrac{x^2 + 3x + 4}{x^2 - 9}$

122. $\sqrt{x^2 + 7x + 6}$

Factoring Trinomials In Exercises 123, 124, 125, and 126, factor the trinomial.

123. $x^2 - 6x - 27$

124. $x^2 + 11x + 28$

125. $2x^2 + 11x - 40$

126. $3x^2 - 16x + 5$

127. Make a Decision ✳ To work an extended application analyzing the numbers of bachelor's degrees earned by women in the United States from 2001 through 2012, visit this textbook's website at LarsonPrecalulus.com. (Data Source: National Center for Education Statistics)