

We will select two points on the graph that will allow us to find the slope of the graph. The y -intercept is at 80. Thus, one point on the graph is $(0, 80)$. In 2004, or year 39 in **Figure 3.55**, it appears that about 55% of the adult population read a daily newspaper. Let's select $(39, 55)$ as a second point.

$$\text{slope} = \frac{y_2 - y_1}{x_2 - x_1} = \frac{55 - 80}{39 - 0} = \frac{-25}{39} \approx -0.641$$

Since the slope is approximately -0.641 and the y -intercept is $(0, 80)$, the equation of the straight line is $y = -0.641x + 80$. This equation in function notation is $f(x) = -0.641x + 80$. To use this function remember that $x = 0$ represents 1965, $x = 1$ represents 1966, and so on. Note that $f(x)$, the percent, is a function of x , the number of years since 1965.

- b) To determine the approximate percent of readers in 2015, we substitute $2015 - 1965$, or 50, for x in the function.

$$\begin{aligned} f(x) &= -0.641x + 80 \\ f(50) &= -0.641(50) + 80 \\ &= -32.05 + 80 \\ &= 47.95 \end{aligned}$$

Thus, if the current trend continues, about 47.95% of adults will read a daily newspaper in 2015.

Now Try Exercise 73

EXERCISE SET 3.4



Warm-Up Exercises

Fill in the blanks with the appropriate word, phrase, or symbol(s) from the following list.

translation	parallel	slope	vertical	horizontal	rise	run
positive	negative	solve	function	standard form	slope-intercept form	rate of change

- The _____ is the measure of the steepness of a line.
- The graph of $y = 2x + 3$ is a _____ of the graph of $y = 2x$.
- A linear equation written as $ax + by = c$ is in _____.
- A linear equation written as $y = mx + b$ is in _____.
- Slope is often described as _____ over _____.
- A line that rises going left to right has a _____ slope.
- A line that falls going left to right has a _____ slope.
- A _____ line has zero slope.
- A _____ line has undefined slope.
- Two lines that have the same slope are _____ lines.
- When we give the change in y per unit change in x we are giving the slope as a _____.
- To write an equation in slope-intercept form _____ the equation for y .

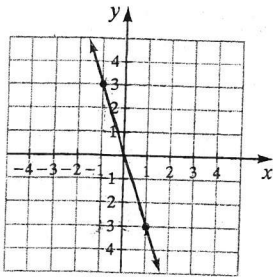
Practice the Skills

Find the slope of the line through the given points. If the slope of the line is undefined, so state.

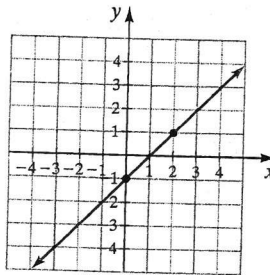
- | | | |
|-----------------------------|------------------------------|------------------------------|
| 13. $(3, 5)$ and $(1, 9)$ | 14. $(3, 4)$ and $(6, 5)$ | 15. $(5, 2)$ and $(1, 4)$ |
| 16. $(-3, 7)$ and $(7, -3)$ | 17. $(-3, 5)$ and $(1, 1)$ | 18. $(2, 6)$ and $(2, -3)$ |
| 19. $(4, 2)$ and $(4, -6)$ | 20. $(8, -4)$ and $(-1, -2)$ | 21. $(-3, 4)$ and $(-1, 4)$ |
| 22. $(2, 8)$ and $(-5, 8)$ | 23. $(0, 3)$ and $(9, -3)$ | 24. $(0, -6)$ and $(-5, -3)$ |
- Solve for the given variable if the line through the two given points is to have the given slope.
- | | | |
|--|---|---|
| 25. $(3, 2)$ and $(4, j)$, $m = 1$ | 26. $(-4, 3)$ and $(-2, r)$, $m = -3$ | 27. $(5, 0)$ and $(1, k)$, $m = \frac{1}{2}$ |
| 28. $(5, d)$ and $(9, 2)$, $m = -\frac{3}{4}$ | 29. $(x, 2)$ and $(3, -4)$, $m = 2$ | 30. $(-2, -3)$ and $(x, 5)$, $m = \frac{1}{2}$ |
| 31. $(12, -4)$ and $(r, 2)$, $m = -\frac{1}{2}$ | 32. $(-4, -4)$ and $(x, -1)$, $m = -\frac{3}{5}$ | |

Find the slope of the line in each of the figures. If the slope of the line is undefined, so state. Then write an equation of the given line.

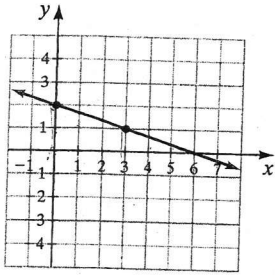
33.



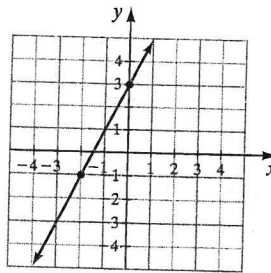
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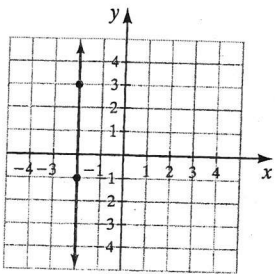
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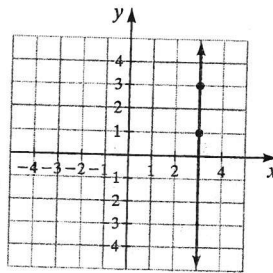
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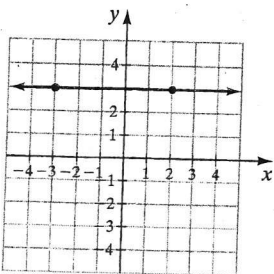
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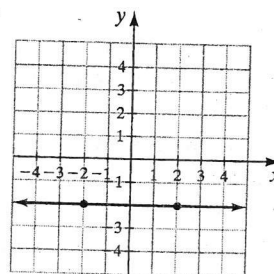
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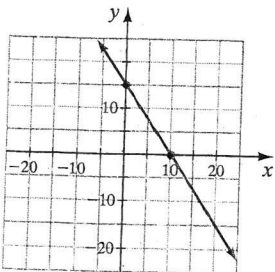
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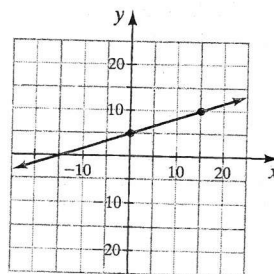
40.



41.



42.



Write each equation in slope-intercept form (if not given in that form). Determine the slope and the y-intercept and use them to draw the graph of the linear equation.

43. $y = -x + 2$

44. $-2x + y = 6$

45. $5x + 15y = 30$

46. $-2x = 3y + 6$

47. $-50x + 20y = 40$

48. $60x = -30y + 60$

Use the slope and y-intercept to graph each function.

49. $f(x) = -2x + 1$

50. $g(x) = \frac{2}{3}x - 4$

51. $h(x) = -\frac{3}{4}x + 2$

52. $h(x) = -\frac{2}{5}x + 4$

Problem Solving

53. Given the equation $y = mx + b$, for the values of m and b given, match parts **a)–d)** with the appropriate graphs labeled 1–4.

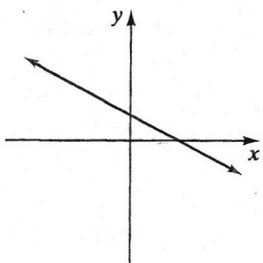
a) $m > 0, b < 0$

b) $m < 0, b < 0$

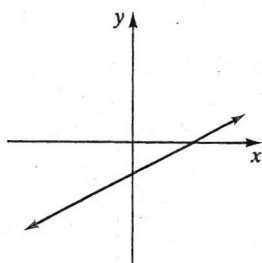
c) $m < 0, b > 0$

d) $m > 0, b > 0$ ✓

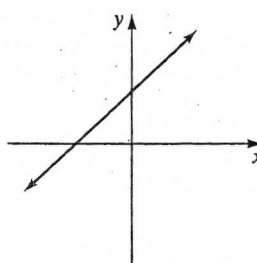
1.



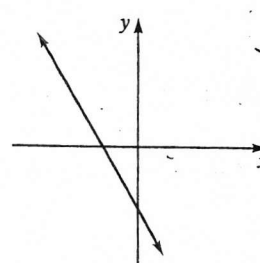
2.



3.



4.



54. Given the equation $y = mx + b$, for the values of m and b given, match parts **a)–d)** with the appropriate graphs labeled 1–4.

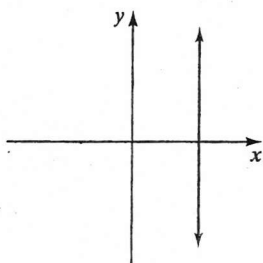
a) $m = 0, b > 0$

b) $m = 0, b < 0$

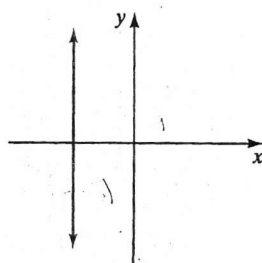
c) m is undefined, x -intercept < 0

d) m is undefined, x -intercept > 0

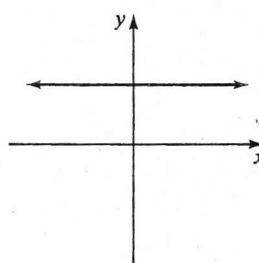
1.



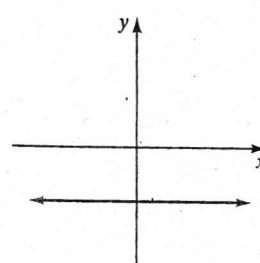
2.



3.



4.



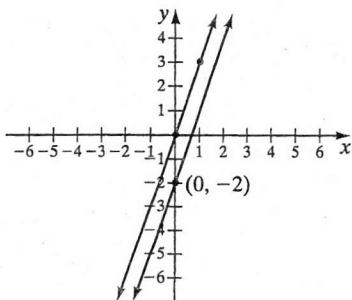
55. Explain how you could determine (without graphing) that the graphs of two equations are parallel.

56. How can you determine whether two lines are parallel?

57. If one point on a graph is $(6, 3)$ and the slope of the line is $\frac{4}{3}$, find the y-intercept of the graph.

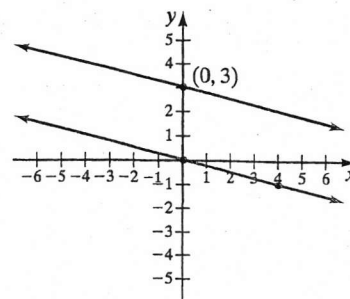
58. If one point on a graph is $(9, 2)$ and the slope of the line is $m = \frac{2}{3}$, find the y-intercept of the graph.

59. In the following figure, the green line is a translation of the blue line.



- Determine the equation of the blue line.
- Use the equation of the blue line to determine the equation of the green line.

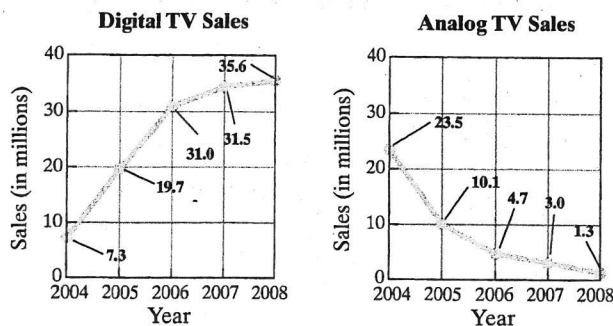
60. In the following figure, the green line is a translation of the blue line.



- Determine the equation of the blue line.
 - Use the equation of the blue line to determine the equation of the green line.
- The graph of $y = x$ is translated up 4 units. Determine
 - the slope of the translated graph.
 - the y-intercept of the translated graph.
 - the equation of the translated graph.
 - The graph of $y = -\frac{3}{2}x$ is translated down 3 units. Determine
 - the slope of the translated graph.
 - the y-intercept of the translated graph.
 - the equation of the translated graph.

63. The graph of $3x - 2y = 6$ is translated down 4 units. Find the equation of the translated graph.
64. The graph of $-3x - 5y = 15$ is translated up 3 units. Find the equation of the translated graph.
65. If a line passes through the points $(6, 4)$ and $(-4, 2)$, find the change of y with respect to a 1-unit change in x .
66. If a line passes through the points $(-3, -4)$ and $(5, 2)$, find the change of y with respect to a 1-unit change in x .

TV Sales For Exercises 67 and 68, use the graphs below. The graph on the left shows digital TV sales (in millions) and the graph on the right shows analog TV sales (in millions) for the years from 2004 to 2008.



Source: Consumer Electronics Association

67. a) For the graph of digital TV sales, determine the slope of the line segment from 2005 to 2006.
b) Is the slope of the line segment positive or negative?
c) Find the average rate of change from 2004 to 2008.
68. a) For the graph of analog TV sales, determine the slope of the line segment from 2005 to 2006.
b) Is the slope of the line segment positive or negative?
c) Find the average rate of change from 2004 to 2008.
69. **Amtrak Expenses** The following table gives the expenses, in millions of dollars, of Amtrak for selected years.

Year	Amtrak Expenses (in millions of dollars)
1995	\$ 2257
2000	\$ 2876
2004	\$ 3133
2008	\$ 3260

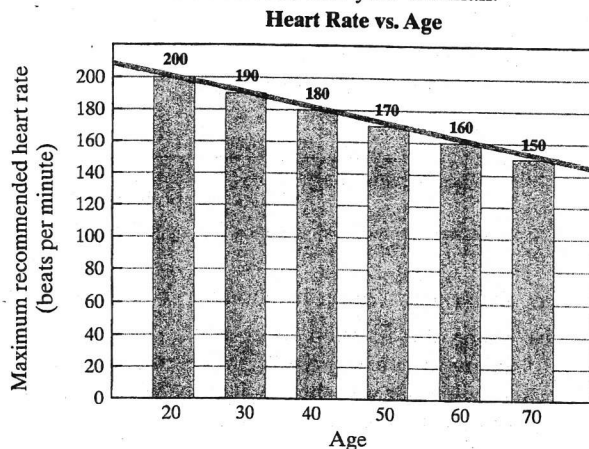
Source: Amtrak

- a) Plot these points on a graph.
b) Connect these points using line segments.
c) Determine the slopes of each of the three line segments.
d) During which period was there the greatest average rate of change? Explain.
70. **Demand for Steel** The table above and to the right gives the world demand for steel, in millions of metric tons, for the years from 2004 to 2007.
- a) Plot these points on a graph.
b) Determine the slope of each line segment.
c) Is this graph an example of a linear function? Explain.

Year	World Demand for Steel (in millions of metric tons)
2004	950
2005	1029
2006	1121
2007	1179

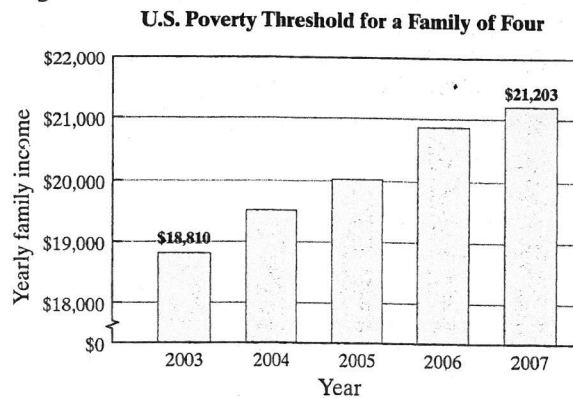
Source: International Iron and Steel Institute

- d) During which period was rate of change highest? Explain.
71. **Heart Rate** The following bar graph shows the maximum recommended heart rate, in beats per minute, under stress for men of different ages. The bars are connected by a straight line.
- a) Use the straight line to determine a function that can be used to estimate the maximum recommended heart rate, h , for $0 \leq x \leq 50$, where x is the number of years after age 20.
b) Using the function from part a), determine the maximum recommended heart rate for a 34-year-old man.



Source: The American Geriatric Society

72. **Poverty Threshold** The poverty threshold is an estimate of the annual family income necessary to have a minimally acceptable standard of living. The following bar graph shows the poverty threshold for a family of four for the years 2003 through 2007.

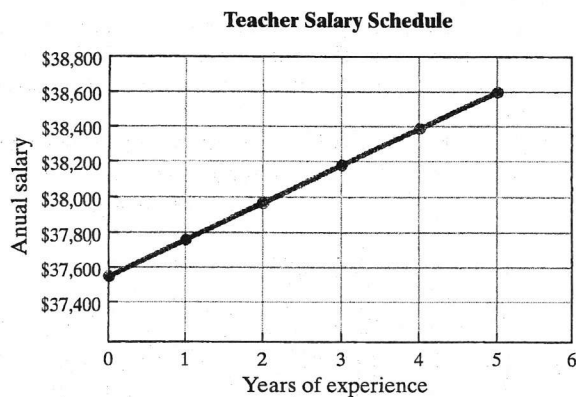


Source: U.S. Bureau of the Census

- a) Determine a linear function that can be used to estimate the poverty threshold for a family of four, P , from 2003 through 2007. Let t represent the number of years since 2003.

- b) Using the function from part a), determine the poverty threshold in 2004. Compare your answer with the graph to see whether the graph supports your answer.
- c) Assuming this trend continues, determine the poverty threshold for a family of four in the year 2015.
- d) Assuming this trend continues, in which year will the poverty threshold for a family of four reach \$22,997.75?

73. Teacher Salaries The following graph shows teacher salaries for the 2008–2009 school year in the Manatee County, Florida, school system for teachers whose highest degree is a bachelor's degree. Teachers with 0 years of experience earn \$37,550 per year and teachers with 5 years of experience earn \$38,600. Let S represent the annual teacher salary and let t represent years of experience.



Source: Manatee County School Board

- a) Determine a linear function $S(t)$ that fits this data.
 - b) Using the function from part a), estimate the annual salary for a teacher with 3 years of experience. Compare your answer with the graph to see whether the graph supports your answer.
 - c) Assuming this trend continues, what will be the annual salary for a teacher with 10 years of experience?
 - d) Assuming this trend continues, how many years of experience must a teacher have to earn \$40,070 per year?
- 74. Firefighter Salaries** In Livonia, Michigan, firefighters with 0 years of experience earn an annual salary of \$33,259 and firefighters with 5 years of experience earn an annual salary of \$47,091. Let S represent the annual firefighters salary and let t represent years of experience.

Source: www.firehouse.com



© Monkey Business Images/Shutterstock

- a) Determine a linear function $S(t)$ that fits this data.
- b) Use the function from part a) to estimate the annual salary for a firefighter with 3 years of experience.
- c) Assuming this trend continues, what will be the annual salary for a firefighter with 10 years of experience?
- d) Assuming this trend continues, how many years of experience must a firefighter have to earn an annual salary of \$52,623.80?

75. Park Ranger Salaries In Maryland, state park rangers with 0 years of experience earn an annual salary of \$37,855 and park rangers with 5 years of experience earn an annual salary of \$47,123. Let S represent the annual park ranger salary and let t represent years of experience.

Source: www.dbm.maryland.gov

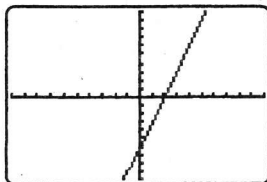
- a) Determine a linear function $S(t)$ that fits this data.
- b) Use the function from part a) to estimate the annual salary for a park ranger with 3 years of experience.
- c) Assuming this trend continues, what will be the annual salary for a park ranger with 10 years of experience?
- d) Assuming this trend continues, how many years of experience must a park ranger have to earn an annual salary of \$52,683.80?

76. Social Security The number of workers per Social Security beneficiary has been declining approximately linearly since 1970. In 1970 there were 3.7 workers per beneficiary. In 2050 it is projected there will be 2.0 workers per beneficiary. Let W be the workers per Social Security beneficiary and t be the number of years since 1970.

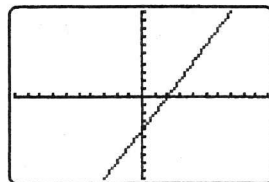
- a) Find a function $W(t)$ that fits the data.
- b) Estimate the number of workers per beneficiary in 2020.

Suppose you are attempting to graph the equations shown and you get the screens shown. Explain how you know that you have made a mistake in entering each equation. The standard window setting is used on each graph.

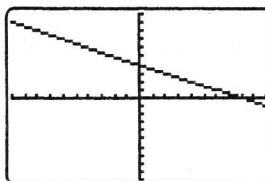
77. $y = 3x + 6$



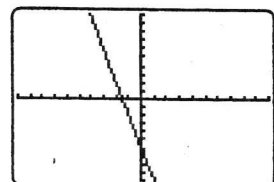
78. $y = -2x - 4$



79. $y = \frac{1}{2}x + 4$



80. $y = -4x - 1$



81

83.

b
c
d

Cum

1.4]

Solve e

2.1]