Complete Solutions Manual

Finite Mathematics

EIGHTH EDITION

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Prepared by

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ISBN-13: 978-1-285-08497-8
ISBN-10: 1-285-08497-7

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Printed in the United States of America
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Chapter 1
Functions and Lines

1.1 Functions

1. $y = 15x + 20$ is the rule. The numbers in the domain represent the number of hours worked. The numbers in the range represent the number of dollars of fee.

2. $y = 40x + 30$

3. **(a)** $f(5) = \$33.75$ **(b)** $f(3) = \$20.25$

4.

Number of Tickets	Total Admission
1	\$14
2	\$28
3	\$42
4	\$56
5	\$70
6	\$84

5. **(a)** $f(1) = 4(1) - 3 = 4 - 3 = 1$ **(b)** $f(-2) = 4(-2) - 3 = -8 - 3 = -11$
(c) $f(1/2) = 4(1/2) - 3 = 2 - 3 = -1$ **(d)** $f(a) = 4a - 3$

6. **(a)** $f(3) = 3[2(3) - 1]=3(6 - 1) = 3(5) = 15$
(b) $f(-2) = -2[2(-2) - 1] = -2(-4 - 1) = -2(-5) = 10$
(c) $f(0) = 0[2(0) - 1] = 0(-1) = 0$
(d) $f(b) =b(2b - 1) = 2b^2 - 1$

7. **(a)** $f(5) = \frac{5+1}{5-1} = \frac{6}{4} = \frac{3}{2}$ **(b)** $f(-6) = \frac{-6+1}{-6-1} = \frac{5}{7}$
(c) $f(0) = \frac{0+1}{0-1} = \frac{1}{-1} = -1$ **(d)** $f(2c) = \frac{2c+1}{2c-1}$

8. **(a)** $f(a) = -4a + 7$ **(b)** $f(y) = -4y + 7$
(c) $f(a + 1) = -4(a + 1) + 7 = -4a - 4 + 7 = -4a + 3$
(d) $f(a + h) = -4(a + h) + 7 = -4a - 4h + 7$ **(e)** $f(3a) = -4(3a) + 7 = -12a + 7$
(f) $f(2b + 1) = -4(2b + 1) + 7 = -8b - 4 + 7 = -8b + 3$

9. **(a)** $p(2010) = 1.32(2010) - 2589.5 = 2653.2 - 2589.5 = 63.7$, an estimated 63.7 thousand people.
$p(2020) = 1.32(2020) - 2589.5 = 2666.4 - 2589.5 = 76.9$, an estimated 76.9 thousand people.
(b) When will $p(t) = 100.0$?
$100.0 = 1.32t - 2589.5$
$2689.5 = 1.32t$
$t = \frac{2689.5}{1.32} = 2037.5$
The number is estimated to reach 100,000 in 2037.

10. **(a)** $x = 15$ so $g(x) = 3(15) + 25 = 45 + 25 = 70$
Antonio's grade is 70.
(b) $g(x) = 88$ so $88 = 3x + 25$
$3x = 63$
$x = 21$
Belinda must answer 21 questions correctly to get an 88.

11. **(a)** The slope is negative, so the rate is decreasing.
(b) For the year 2010, $x = 20$
$R(20) = -0.58(20) + 23.9 = 12.3$
The estimated abortion rate for 2010 is 12.3.
For the year 2015, $x = 25$
$R(25) = -0.58(25) + 23.9 = 9.45$ The estimated abortion rate for 2015 is 9.45.
(c) $R(x) = 8$ so
$8 = -0.58x + 23.9$
$0.58x = 23.9 - 8 = 15.9$
$x = 15.9/0.58 = 27.4$
The estimated date for a rate of 8 is in the year 1990 + 27.4 = 2017.4, in the year 2017.

12. Let x = number of pounds, y = cost.
$y = 0.89x$

13. Let x = number of hamburgers, y = cost.
$y = 3.40x + 25$

14. Let x = amount of sales, y = monthly income.
$y = 0.05x + 500$

15. Let x = regular price, y = sale price.
$y = x - 0.20x$ or $y = 0.80x$

16. Let x = number of dollars advertising, y = weekly sales.
$y = 3x + 1200$

17. Let x = number of loads, y = overhead cost.
$y = 0.80x + 12$

18. Let x = number of hours, y = price.
$y = 7x + 10$

19. Let x = number of students, y = operating budget.
$y = 3500x + 5{,}000{,}000$

20. Let x = number of checks, y = monthly service charge.
$y = 0.10x + 2$

21. Let x = list price, y = invoice cost.
$y = 0.88x$

22. Let x = number of calls, y = monthly rate.
$y = 0.05x + 7.60$

23. **(a)** $S(2.5) = 11.25(2.5) + 300 = 328.125$ rounded to \$328.13.
(b) $h = 5$ so $S(h) = 11.25(5) + 300 = 356.25$
Her weekly salary was \$356.25.
(c) $S(h) = 395.63$ so
$395.63 = 11.25h + 300$
$11.25h = 395.63 - 300 = 95.63$
$h = 95.63/11.25 = 8.5004$ which we round to 8.5.
She worked 8.5 hours of overtime.

24. $f(3) + g(2) = (3 + 2)(3 - 1) + \dfrac{7(2)+4}{2+1} = (5)(2) + \dfrac{18}{3} = 10 + 6 = 16$

25. (a) $A = \pi r^2$ is a function.
(b) Domain: positive numbers; Range: positive numbers

26. (a) P = 4L is a function.
(b) Domain: positive numbers; Range: positive numbers

27. (a) p = price per pound times w is a function.
(b) Domain: positive numbers; Range: positive numbers

28. (a) GPA = f(N) is a function because each student has a unique GPA, but there is no formula that applies to all students.
(b) Domain: 9-digit Social Security numbers; Range: the numbers zero through 4 for a four-point GPA scale

29. (a) $y = x^2$ is a function.
(b) Domain: all real numbers; Range: All nonnegative numbers

30. (a) $y = x^3$ is a function.
(b) Domain: all real numbers; Range: All real numbers

31. y is not a function of x. There can be more than one person with a given family name. x is function of y.

32. Not a function because for a given positive number, like 4, there are two values of y whose squares are 4 (namely 2 and –2).

33. Not a function because two classes can have the same number of boys, but with combined weights different.

34. Not a function because two girls of the same age can be of different heights.

35. Not a function because two families with the same number of children can have a different number of boys.

36. (a) A function because for a given price there is just one price rounded to the nearest dollar.
(b) Domain: positive numbers of dollars and cents; Range: Positive integer number of dollars

37. The domain is the set of numbers in the interval [–2, 4]. The range is the set of numbers in the interval [–1, 3].

38. The domain is the set of numbers in the interval [–3, 5] and the range is the set of numbers in the interval [–1, 6].

39. The domain is the set of numbers in the intervals [0, 4] or [7, 12] and the range is the set of numbers in the interval [–4, 8].

40. The domain is the set of numbers in the intervals [1, 15] and the range is the set of numbers in the intervals [–1, 5] or (7, 19]

42. **(a)** For 2005, $x = 20$ $y = -0.47(20) + 47.1 = 37.7$
An estimated 37.7% in the 18 -25 age group used cigarettes in 2005.
For 2015, $x = 30$ so $y = -0.47(30) + 47.1 = 33$. The estimated percentage is 33%.
An estimated 33.0% in the 18 – 25 age group will use cigarettes in 2015.
For 2025, $x = 35$so $y = -0.47(35) + 47.1 = 30.65$.
An estimated 30.7% in the 18 – 25 age group will use cigarettes in 2025.

(b) $20 = -0.47x + 47.1$
$0.47x = 27.1$
$x = 27.1/0.47 = 57.7$
The estimated percentage usage drops to 20 in the year 1985 + 57 = 2042.

(c) It will be a long time until the percentage drops to 20, however, any projection that far into the future should be considered unreliable.

43. Let x = a person's age and p = pulse rate.
(a) $p = 0.40(220 - x)$ **(b)** $p = 0.70(220 - x)$

44. **(a)** $x = 10$ for 2005 so $y = 0.11(10) + 1.08 = 2.18$, \$2.18 trillion
(b) $x = 17$ for 2012 so $y = 0.11(17) + 1.08 = 2.95$, \$2.95 trillion
$x = 20$ for 2015 so $y = 0.11(20) + 1.08 = 3.28$, \$3.28 trillion
$x = 25$ for 2020 so $y = 0.11(25) + 1.08 = 3.83$, \$3.83 trillion
(c) $4 = 0.11x + 1.08$
$0.11x = 4 - 1.08 = 2.92$
$x = 2.92/0.11 = 26.5$
The consumer debt is estimated to reach \$4 trillion in the year 1995 + 26 = 2021

45. **(a)** $d = 1.1(30) + 0.055(30)^2 = 33 + 49.5 = 82.5$ About 83 feet are required.
(b) $d = 1.1(60) + 0.055(60)^2 = 66 + 198.0 = 264$ About 264 feet are required to stop.

46. **(a)** $f(1.2) = 4.0$ **(b)** $f(4.1) = 8.35$ **(c)** $f(-3.7) = -3.35$

47. **(a)** $f(225) = 12.47$ **(b)** $f(416) = 23.93$ **(c)** $f(367) = 20.99$

48. **(a)** $f(2.5) = 108.5$ **(b)** $f(3.4) = 196.16$ **(c)** $f(-5.1) = 401.86$

49. **(a)** $f(4.5) = 57.6625$ **(b)** $f(3.3) = 32.4205$ **(c)** $f(8.2) = 258.776$

50. **(a)** For 1950, $x = -10$. $y = 0.20(-10) + 65.9 = 63.9$ years.
For 1980, $x = 20$. $y = 0.20(20) + 65.9 = 69.9$ years.
For 2010, $x = 50$. $y = 0.20(50) + 65.9 = 75.9$ years.
For 2025, $x = 65$. $y = 0.20(65) + 65.9 = 78.9$ years.
For 2050, $x = 90$. $y = 0.20(90) + 65.9 = 83.9$ years.
(b) For 1950, $x = -10$. $y = 0.15(-10) + 73.6 = 72.1$ years.
For 1980, $x = 20$. $y = 0.15(20) + 73.6 = 76.6$ years.
For 2010, $x = 50$. $y = 0.15(50) + 73.6 = 81.1$ years.
For 2025, $x = 65$. $y = 0.15(65) + 73.6 = 83.4$ years.
For 2050, $x = 90$. $y = 0.15(90) + 73.6 = 87.1$ years.

(c) $100 = 0.20x + 65.9$
$100 - 65.9 = 0.20x$
$0.20x = 34.1$
$x = 34.1/0.20 = 170.5$
This estimates a life expectancy of 100 for males in the year 1960 + 170 = 2130.

(d) $100 = 0.15x + 73.6$
$100 - 73.6 = 0.15x$
$0.15x = 26.4$
$x = 26.4/0.15 = 176$
This estimates a life expectancy of 100 for females in the year 1960 + 176 = 2136.

51. **(a)** For 2010, $x = 13$ so $y = 0.42(13) + 68.8 = 74.26$. The actual percentage was 74.5.
(b) For 2015, $x = 18$ so $y = 0.42(18) + 68.8 = 76.36$.
(c) For 2020, $x = 23$ so $y = 0.42(23) + 68.8 = 78.46$.
(d) $90 = 0.42x + 68.8$
$0.42x = 90 - 68.8 = 21.2$
$x = 21.2/0.42 = 50.5$
It is estimated that 90% will be reached in the year 1997 + 50 = 2047.

52. **(a)** For 2000, $x = 20$. $y = -0.08(20) + 15.4 = 13.8$. The actual rate was 13.4.
(b) For 2015, $x = 35$. $y = -0.08(35) + 15.4 = 12.6$.
(c) For 2025, $x = 45$. $y = -0.08(45) + 15.4 = 11.8$.

53. **(a)** 65.5 million **(b)** 149.4 million **(c)** 296.3 million
(d) 325.7 million **(e)** 422.3 million
(f) The population is estimated to reach 405.3 million by 2045 so it reaches 400 million before 2045.
The population is estimated to reach 493.7 million by 2070 so it will not reach 500 million by 2070.

54. **(a)** $x = 7$, so $y = 1280(7)+ 875 = 9835$. The estimated cost is \$9835.
(b) $15,000 = 1280x + 875$
$1280x = 15,000 - 875 = 14125$
$x = 14,125/1280 = 11.04$
The budget allows for 11 new employees.

55. **(a)** $x = 6$, so $y = -125(6) + 4590 = 3840$ tons
(b) $3000 = -125x + 4590$
$125x = 4590 - 3000 = 1590$
$x = 1590/125 = 12.72$
It will reach 3000 tons annually in about the 13th year.
(c) The annual decline is the slope of the function, 125 tons.

56. $y = 11, 27, 31, 63$

57. $y = 6, 3, -6, -18, -45$

58. $y = -5, 27, 21.25, 40$

59. $y = 39.28, 46.48, 104.24$

60. $y = 477.5$

61. $y = 16, 19, 22, 25, 28$

62. $y = 0.0111, 1.204, 1.4245, 1.5698, 1.9824$

Using Your TI Graphing Calculator

1. y = 3, 27, 51

2. y = 395

3. y = 9, 9, 14, 30

4. y = 0, 1, 9, 16

5. y = 0, –0.25, –1.6, and 8.9231

6. y = 9.0868, 13.225, 16.294

Using EXCEL

1. Enter =A4+B4 in C4

2. Enter =A1+B1+C1 in D1

3. Enter =C4+C5 in C6

4. Enter =A4–B4 in C4

5. Enter =B2*B3 in B4

6. Enter =C2/D2 in E2

7. Enter =(B1+B2)/2 in B3

8. Enter =2*B3+6 in C3

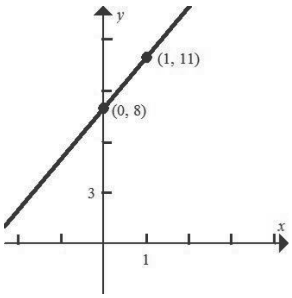
9. Enter =2.1*A5–1.8 in B5

10. Enter =2*A1–3 in B1, then drag through B4

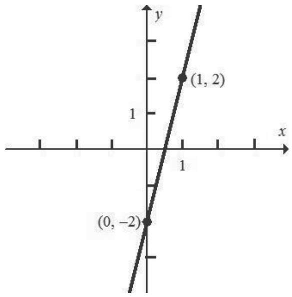
11. Enter =1.5*A1+3.25 in B1 and drag through B6

1.2 Graphs and Lines

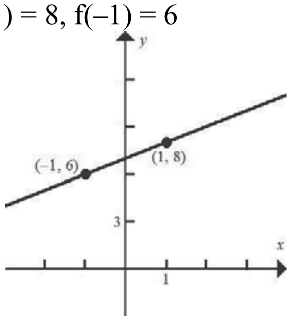
1. $f(x) = 3x + 8$
$f(0) = 8, f(1) = 11$



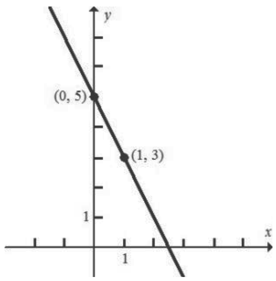
2. $f(x) = 4x – 2$
$f(0) = –2, f(1) = 2$



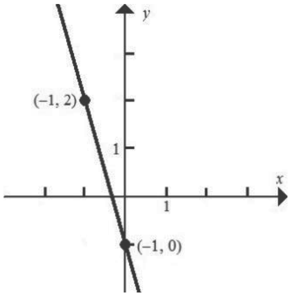
3. $f(x) = x + 7$
$f(1) = 8, f(–1) = 6$



4. $f(x) = –2x + 5$
$f(0) = 5, f(1) = 3$

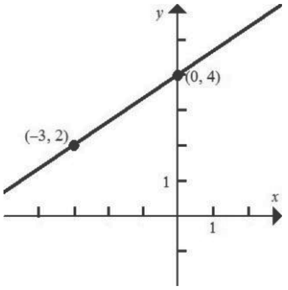


5. $f(x) = -3x - 1$
$f(0) = -1$, $f(-1) = 2$



6. $f(x) = \frac{2}{3}x + 4$

$f(0) = 4$, $f(-3) = 2$



7. Slope = 7, y-intercept = 22

8. Slope = 13, y-intercept = –4

9. Slope = –2/5, y-intercept = 6

10. Slope = –1/4, y-intercept = –1/3

11. $5y = -2x + 3$
$y = -\frac{2}{5}x + \frac{3}{5}$
Slope = –2/5, y-intercept = 3/5

12. $y = -4x + 3$
Slope = –4, y-intercept = 3

13. $3y = x + 6$
$y = \frac{1}{3}x + 2$
Slope = 1/3, y-intercept = 2

14. $2y = 5x - 7$
$y = \frac{5}{2}x - \frac{7}{2}$
Slope = 5/2, y-intercept = –7/2

15. $m = \frac{4-2}{3-1} = \frac{2}{2} = 1$

16. $m = \frac{1-3}{-3-2} = \frac{-2}{-5} = \frac{2}{5}$

17. $m = \frac{-5-(-1)}{-1-(-4)} = -\frac{4}{3}$

18. $m = \frac{-3-(-4)}{6-2} = \frac{1}{4}$

19. Negative

20. Zero

21. Positive

22. Positive

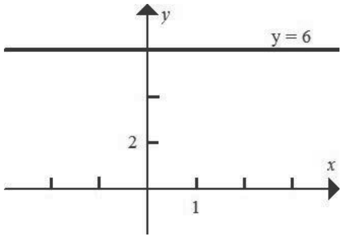
23. $y = -2$

24. $y = 3$

25. $y = 0$

26. $y = 0$

27.



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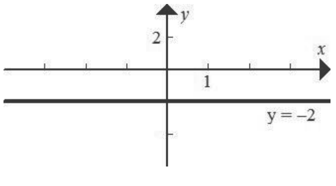

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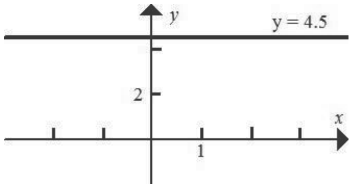

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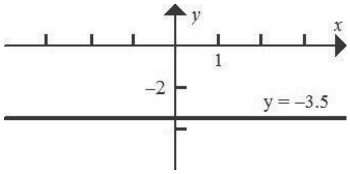


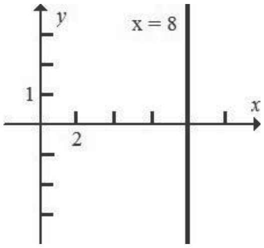
31. $m = \dfrac{5-2}{3-3} = \dfrac{3}{0}$ m is undefined, so the graph is a vertical line x = 3

32. Vertical line x = –4

33. Vertical line x = 10

34. Vertical line x = –6

35.



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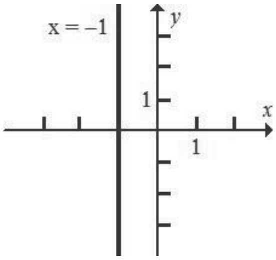

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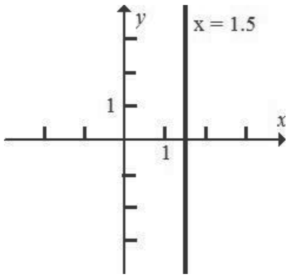

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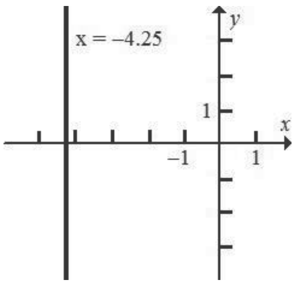


39. $y = 4x + 3$

40. $y = -2x + 5$

41. $y = -x + 6$

42. $y = -\dfrac{3}{4}x + 7$

43. $y = \dfrac{1}{2}x$

44. $y = 3.5x - 1.5$

45.
$y = -4x + b$
$1 = -4(2) + b$
$b = 9$
$y = -4x + 9$

46.
$y = 6x + b$
$-1 = 6(-1) + b$
$b = 5$
$y = 6x + 5$

47.
$y = \dfrac{1}{2}x + b$
$4 = \dfrac{1}{2}(5) + b$
$b = \dfrac{3}{2}$
$y = \dfrac{1}{2}x + \dfrac{3}{2}$

48. Using the point-slope equation,
$y - 5.2 = -1.5(x - 2.6)$
$y = -1.5x + 3.9 + 5.2$
$y = -1.5x + 9.1$

49. Using the point–slope equation, we have
$y - 9 = 0(x - 5)$
$y = 9$

50. Using the point-slope form,
$y - 3/2 = -6(x - 7/2)$
$y - 3/2 = -6x + 21$
$y = -6x + 45/2$

51. $y - 5 = 7(x - 1)$
$y = 7x - 7 + 5$
$y = 7x - 2$

52. $y - 1 = -2(x - 3)$
$y = -2x + 6 + 1$
$y = -2x + 7$

53. $y - 6 = \dfrac{1}{5}(x - 9)$

$y = \dfrac{1}{5}x - \dfrac{9}{5} + 6$

$y = \dfrac{1}{5}x + \dfrac{21}{5}$

54. $y - 4 = -\dfrac{2}{3}(x + 1)$

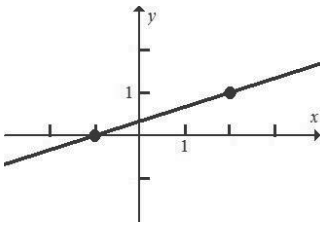
$y = -\dfrac{2}{3}x - \dfrac{2}{3} + 4$

$y = -\dfrac{2}{3}x + \dfrac{10}{3}$

55. $m = \dfrac{1-0}{2+1} = \dfrac{1}{3}$

$y - 0 = \dfrac{1}{3}(x + 1)$

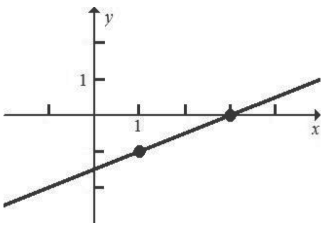
$y = \dfrac{1}{3}x + \dfrac{1}{3}$



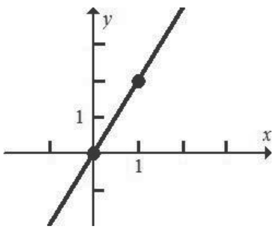
56. $m = \dfrac{-1-0}{1-3} = \dfrac{-1}{-2} = \dfrac{1}{2}$

$y - 0 = \dfrac{1}{2}(x - 3)$

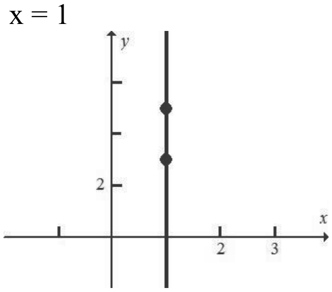
$y = \dfrac{1}{2}x - \dfrac{3}{2}$



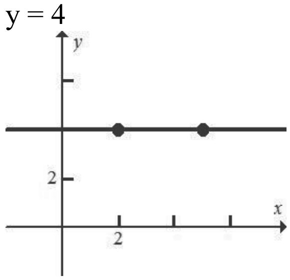
57. $m = \dfrac{2-0}{1-0} = \dfrac{2}{1} = 2$
$y - 0 = 2(x - 0)$
$y = 2x$



58. $x = 1$



59. $y = 4$

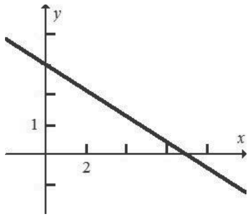


60.

$$m = \frac{0-3}{7-0} = -\frac{3}{7}$$

$$y - 0 = -\frac{3}{7}(x-7)$$

$$y = -\frac{3}{7}x + 3$$



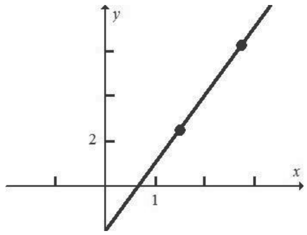
61.

$$m = \frac{\frac{25}{4}-\frac{5}{2}}{\frac{11}{4}-\frac{3}{2}} = \frac{\frac{15}{4}}{\frac{5}{4}} = 3$$

$$y - \frac{5}{2} = 3\left(x - \frac{3}{2}\right)$$

$$y = 3x - \frac{9}{2} + \frac{5}{2}$$

$$y = 3x - 2$$



62.

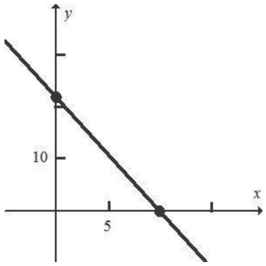
$$m = \frac{22-0}{0-10} = -\frac{11}{5}$$

Using the point (0, 22)

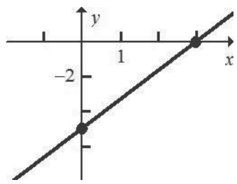
$$y - 22 = -\frac{11}{5}(x-0)$$

$$y = -\frac{11}{5}x + 22 \text{ or}$$

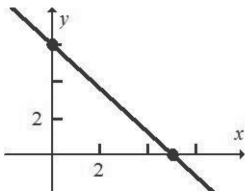
$$11x + 5y = 110$$



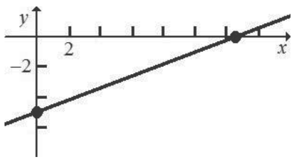
63. $x = 0$: $-3y = 15$, so $y = -5$ is the y-intercept.
$y = 0$: $5x = 15$, so $x = 3$ is the x-intercept.



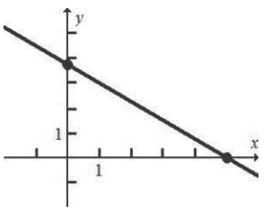
64. When $x = 0$, $5y = 30$ so $y = 6$ is the y-intercept.
When $y = 0$, $6x = 30$ so $x = 5$ is the x-intercept.



65. When $x = 0$, $-5y = 25$ so $y = -5$ is the y-intercept
When $y = 0$, $2x = 25$, so $x = 12.5$ is the x-intercept



66. When x = 0, 4y = 15, so y = 15/4 is the y-intercept
When y = 0, 3x = 15, so x = 5 is the x-intercept



67. Line through (8, 2) and (3, –3) has slope $m_1 = \dfrac{-3-2}{3-8} = \dfrac{-5}{-5} = 1.$

Line through (6, –1) and (16, 9) has slope $m_2 = \dfrac{9+1}{16-6} = \dfrac{10}{10} = 1.$

The lines are parallel.

68. Line through (9, –1) and (2, 8) has slope $m_1 = \dfrac{8-9}{2-9} = \dfrac{9}{-7} = -\dfrac{9}{7}$

Line through (3, 5) and (10, –4) has slope $m_2 = \dfrac{-4-5}{10-3} = -\dfrac{9}{7}$

The lines are parallel.

69. Line through (5, 4) and (1, –2) has slope $m_1 = \dfrac{-2-4}{1-5} = \dfrac{-6}{-4} = \dfrac{3}{2}$

Line through (1, 2) and (6, 8) has slope $m_2 = \dfrac{8-2}{6-1} = \dfrac{6}{5}$

The lines are not parallel.

70. Line through (6, 2) and (–3, 5) has slope $m_1 = \dfrac{5-2}{-3-6} = \dfrac{3}{-9} = -\dfrac{1}{3}$

Line through (4, 1) and (0, 5) has slope $m_2 = \dfrac{5-1}{0-4} = \dfrac{4}{-4} = -1$

The lines are not parallel.

71. $m_1 = 6 = m_2$ (parallel)

72. The first line may be written $y = -\dfrac{3}{5}x + \dfrac{5}{2}$ so $m_1 = -\dfrac{3}{2}$

The second line may be written $y = -\dfrac{3}{5}x + \dfrac{15}{4}$ so $m_2 = -\dfrac{3}{2}$

The lines are parallel.

73. The first line may be written $y = \dfrac{1}{2}x - \dfrac{3}{2}$ so $m_1 = \dfrac{1}{2}$

The second line may be written $y = -2x + 1$ so $m_2 = -2$

The lines are not parallel.

74. The first line may be written $y = \frac{3}{5}x - \frac{4}{5}$ so $m_1 = \frac{3}{5}$

The second line may be written $y = \frac{3}{5}x - \frac{4}{5}$ so $m_1 = \frac{3}{5}$

The lines are parallel, actually they coincide.

75. Solving for y in $4x - 3y = 14$, we have

$3y = 4x - 14$

$y = \frac{4}{3}x - \frac{14}{3}$ so the slope is $\frac{4}{3}$

Solving for y in $4x + 3y = 26$, we have

$3y = 26 - 4x$

$y = \frac{26}{3} - \frac{4}{3}x$ so the slope is $-\frac{4}{3}$

The slopes of the two lines are not equal so the lines are not parallel.

76. Solving for y in $7x - 5y = 6$, we have

$5y = 7x - 6$

$y = \frac{7}{5}x - \frac{6}{5}$ so the slope is $\frac{7}{5}$

Solving for y in $3x + 8y = 22$, we have

$8y = 22 - 3x$

$y = \frac{22}{8} - \frac{3}{8}x$ so the slope is $-\frac{3}{8}$

Since the slopes of the two lines are not equal, the lines are not parallel.

77. The product of the slopes is $-2 \times 0.5 = -1$ so the lines are perpendicular.

78. The product of slopes is $-\frac{6}{5} \times \frac{10}{12} = -1$ so the lines are perpendicular.

79. The product of slopes is $3 \times 5 = 15 \neq -1$ so the lines are not perpendicular.

80. The product of slopes is $\frac{2}{7} \times \frac{7}{2} = 1 \neq -1$ so the lines are not perpendicular.

81. The slope of $y = 3x + 4$ is $m = 3$ which must be the slope of the parallel line. Using the point-slope formula

$y - 5 = 3(x + 1)$

$y = 3x + 3 + 5$

$y = 3x + 8$

82. The slope of $3x + 2y = 17$ is $m = -\frac{3}{2}$ which must be the slope of the parallel line.

Using the point-slope formula

$y - 6 = -\frac{3}{2}(x - 2)$

$y = -\frac{3}{2}x + 3 + 6$

$y = -\frac{3}{2}x + 9$

83. The slope of 5x + 7y = –2 is $m = -\frac{5}{7}$ which must be the slope of the parallel line. Using the slope-intercept formula

$y = -\frac{5}{7}x + 8$

84. The slope of 5x – 2y = 20 is $m = \frac{5}{2}$ so the point-slope formula gives the equation is

$y - 2 = \frac{5}{2}(x - 6)$ which reduces to $y = \frac{5}{2}x - 13$

85. For Exercise 82, $y = -\frac{3}{2}x + 9$ is written $3x + 2y = 18$

For Exercise 83, $y = -\frac{5}{7}x + 8$ is written $5x + 7y = 56$

For Exercise 84, $y = \frac{5}{2}x - 13$ is written as $5x - 2y = 26$

86. $y = 2.3x$

87. Using the point-slope formula, $y - 5 = \frac{2}{3}(x - 2)$.

When x = 0, $y = \frac{2}{3}(0 - 2) + 5 = -\frac{4}{3} + 5 = \frac{11}{3}$, so the y-intercept is $\frac{11}{3}$.

88. The slope of the perpendicular line is $m = -\frac{1}{0.25} = -4$ so the equation of the line is

$y - 7 = -4(x - 5)$
$y = -4x + 27$

89. The slope of the given line is $m = -\frac{5}{3}$ so the slope of the perpendicular line is $\frac{3}{5}$.

$y - 3 = \frac{3}{5}(x - 2)$
$5y - 15 = 3x - 6$
$3x - 5y = -9$

90. The slope of the line is $m = \frac{6.8 - 1.9}{2 - 6} = \frac{4.9}{-4} = -1.225$
Using the point (2, 6.8) we have the equation
$y - 6.8 = -1.225(x - 2)$
$y = -1.225x + 2.45 + 6.8$
$y = -1.225x + 9.25$

91. You may use any two of the given points. We choose (2.1, –3.66) and (5.7, 9.30).
$m = \frac{9.30 - (-3.66)}{5.7 - 2.1} = \frac{12.96}{3.6} = 3.6$
Then $y - 9.30 = 3.6(x - 5.7)$
$y = 3.6x - 20.52 + 9.30$
$y = 3.6x - 11.22$

92. **(a)** This is a linear cost function with x = number of weeks and y = total cost; $y = 35x + 100$

(b) Let x = number of pairs and y = the cost. This is not a linear function, the slope changes when x is greater than 5.

(c) This is a linear function where x = number of returns and y = cost; $y = 3.50x + 400$

(d) This is not a linear function because the unit price (slope) depends on whether you buy individual or by the dozen.

93. **(a)** Tax is a function of taxable income, but the rule changes at taxable incomes of \$8375, \$34,000, and \$82,000 so this is not a linear function.

(b) The CEO salary is a function of profits, but the rule changes at \$5 million and \$15 million profit so this is not a linear function.

(c) Ted's cost (y) is a function of the number (x) of hamburgers ordered. It is a linear function: $y = 8.95x$.

(d) The cost (y) is a linear function of the number of lessons (x); $y = 10x + 42$

94. Let x = number of weeks since the job started and y = amount of savings. Then m = \$9 per week, and (11, 315) is a point on the line.

$y - 315 = 9(x - 11)$
$y = 9x - 99 + 315$
$y = 9x + 216$

95. Let x = number of weeks from start of the diet and y = weight. Then $m = -3$, the change in weight per week, and (14, 196) is a point on the line.

(a) A point and a slope.

(b) $y - 196 = -3(x - 14)$
$y = -3x + 42 + 196$
$y = -3x + 238$

(c) At the start of the diet x = 0 so $y = -3(0) + 238$
He weighed 238 pounds at the start of the diet.

96. Let x = number of KWH used and y = the monthly bill.

(a) Two points, (1170, 100.02) and (1420, 120.27) are points on the line.

(b) $m = \frac{120.27 - 100.02}{1420 - 1170} = \frac{20.25}{250} = 0.081$ (cost per kWh)
$y - 100.02 = 0.081(x - 1170)$
$y = 0.081x - 94.77 + 100.02$
$y = 0.081x + 5.25$

97. Let x = number of items and y = the cost. Then (500, 1340) and (800, 1760) are points on the line, so

$$m = \frac{1760\text{-}1340}{800\text{-}500} = \frac{420}{300} = 1.4$$
$y - 1340 = 1.4(x - 500)$
$y = 1.4x - 700 + 1340$
$y = 1.4x + 640$

98. **(a)** We have two points on the line, (0, 8654) and (8, 14257).
$m = (14,257 - 8654)/(8 - 0) = 5603/8 = 700$ (rounded)
At x = 0, b = 8654 so the equation is
$y = 700x + 8654$

(b) For 2015, x = 15 so $y = 700(15) + 8654 = 19,154$. The estimated annual cost for 2015 is \$19,154.

99. **(a)** $\frac{y-3}{-1-2}=3$
y – 3 = –9
y = –6

(b) $\frac{3-2}{x-1}=-4$
–4x + 4 = 1
–4x = –3
x = $\frac{3}{4}$

(c) $\frac{y-0}{5+2}=\frac{3}{4}$
y = $7\left(\frac{3}{4}\right)$
y = $\frac{21}{4}$

(d) $\frac{4+3}{x+1} = -\frac{1}{2}$
$-\frac{1}{2}x - \frac{1}{2} = 7$
–x –1 = 14
x = –15

100. Let x = number of pounds gained, y = calorie intake, and m = 3500 calories per pound. When there is no weight gain, y = 3000, so the y-intercept is 3000.
Then y = 3500x + 3000

101. **(a)** We have two points on the line, (0, 21855) and (8, 31704).
m = (31,704 – 21,855)/(8 – 0) = 9849/8 = 1231 (rounded)
At x = 0, b = 21,855 so the equation is
y = 1231x + 21,855
(b) For 2015, x = 15 so y =1231(15) + 21,855 = 40,320. The estimated annual cost for 2015 is $40,320.

102. Let C = degrees Celsius and F = degrees Fahrenheit. Then the points (100, 212) and (0, 32) are points on the line and 32 is the y-intercept, so
m = $\frac{212-32}{100-0} = \frac{180}{100} = 1.8$
F = 1.8C + 32

103. Let x = the year since 2008 and y = tuition per semester hour.
m = 50 and (0, 375) is a point on the line.
y – 375 = 50(x)
y = 50x + 375

104. Let x = years since 1997 and y = cost. We have two points (0, 48) and (11, 92).
m = $\frac{92-48}{11}=\frac{44}{11}=4$
y – 92 = 4(x – 11) which reduces to y = 4x + 48

105. **(a)** A point (0, 5.00) and slope 0.078.
(b) x = kWh used, y = amount of bill
y = 0.078x + 5

106. **(a)** x = kWh used, y = amount of bill
y = 0.082(x – 50) + 7.50
y = 0.082x + 3.4

(b) x > 50 because y = 7.50 describes the bill when less than 50 kWh is used.
(c) $7.50

107. **(a)** Increases 4 **(b)** Decreases 3
(c) Increases 2/3 **(d)** Decreases 1/2
(e) $y = -\frac{2}{3}x + \frac{4}{3}$ so it decreases 2/3 **(f)** No change

108. Let x = number of pounds lost per day and y = number of calories.
m = –3500 and y = 2100 when x = 0, so

$$y = -3500x + 2100$$

109. Let x = number of miles and y = cost. Then the points (125, 63.75) and (265, 112.75) are on the line, so

$$m = \frac{112.75 - 63.75}{265 - 125} = \frac{49}{140} = 0.35$$

The slope is \$0.35 per mile and (125, 63.75) is a point on the line, so the point-slope formula gives

$$y - 63.75 = 0.35\,(x - 125)$$
$$y = 0.35x - 43.75 + 63.75$$
$$y = 0.35x + 20$$

110. Let x = minutes called and y = total monthly cost.
The y-intercept is \$4.95, the cost if no calls are made and the slope is \$0.12 per minute.

$$y = 0.12x + 4.95$$

111. **(a)** Let x = the number of years since 2008 and y = the number of smart phones sold. We are given the point (0, 28.6), the y-intercept, and the slope = 12.7 (the increase per year). The slope-intercept form of the equation is y = 12.7x +28.6

(b) For 2015, x = 7 so y = 12.7(7) + 28.6 = 117.5
Sales are estimated to be 117.5 million in 2015.

(c) y = 150 so 150 = 12.7x + 28.6
12.7x = 150 – 28.6 = 121.4
x = 121.4/12.7 = 9.6
Sales are estimated to reach 150 million in 2008 + 9.6 = 2017.6, in the year 2017.

112. **(a)** Let x = number of years since 1990 and y = per capita income. We then have the points (0, 14899) and (20, 33000).

$$m = \frac{33000 - 14899}{20} = \frac{18101}{20} = 905.05, \text{ or } 905 \text{ (rounded)}$$

We use m = 905 and the point (0, 14899). The equation of the line is

$$y - 14899 = 905x$$
$$y = 905x + 14899$$

(b) For 2003, x = 13, so

$$y = 905(13) + 14899 = 26664$$

The linear equation gives a high estimate for 2003.

113. Let x = taxable income. The slope of the line m = 0.25 and (34001, 3927.5) is a point on the line.

$$y - 3927.5 = 0.25(x - 34{,}001)$$
$$y = 0.25(x - 34{,}001) + 3927.5$$
$$y = 0.25x - 4572.75$$

This equation is valid only when x is in the interval [34001, 82400).

114. We assume a linear relationship with x representing the number of trucks and y representing the tons of trash. We then have two points on the line, (35, 178) and (47, 230).

$$m = \frac{230-178}{47-35} = \frac{52}{12} = 4.33 \text{ tons of trash per truck}$$

$y - 178 = 4.33(x - 35)$

$y = 4.33x + 26.45$

If y = 255,

$255 = 4.33x + 26.45$

$4.33x = 228.55$

$x = 52.78$ 53 trucks will be required.

115. Let x = taxable income. The slope of the line m = 0.15 and (16751, 1075) is a point on the line.

$y - 1075 = 0.15(x - 16{,}751)$

$y - 1075 = 0.15x - 2512.65$

$y = 0.15x - 1437.65$

This equation holds for $16{,}751 \le x \le 68{,}000$.

116. **(d)** Let x = years since 1990 and y = per cent increase.

For **(a)** we have the points (0, 0) and (15, 298)

$m = 298/15 = 19.9$, and $b = 0$

$y = 19.9x$

For **(b)** we have the points (0, 0) and (15, 107)

$m = 107/15 = 7.1$, $b = 0$

$y = 7.1x$

For **(c)** we have the points (0, 0) and (15, –9)

$m = -9/15 = -0.6$

$y = -0.6x$

(e) For 2015, x = 25

For **(a)** $y = 19.9(25) = 497.5$; this estimates that by 2015 the average CEOs' pay will increase about 498% since 1990.

For **(b)** $y = 7.1(25) = 177.5$; this estimates that by 2015 the average corporate profit will increase about 178% since 1990.

For **(c)** $y = -0.6(25) = -15$; this estimates that by 2015 the average minimum wage will decrease about 15% since 1990.

117. **(a)** Let x = number of years with x = 0 for 1980, and y = birth rate.

We are given two points (0, 13.7) and (24, 9.6). The slope of the line is

$$m = \frac{9.6-13.7}{24-0} = \frac{-4.1}{24} = -0.17$$

The y-intercept is 13.7 so the linear function is $y = -0.17x + 13.7$

(b) For 2010 x = 30 so the birth rate for 2010 is estimated to be $y = -0.17(30) + 13.7 = 8.6$. The linear function gives a high estimate for 2010.

(c) The birth rate will reach zero when y = 0 so

$0 = -0.17x + 13.7$

$x = 13.7/0.17 = 80.59$

This function estimates that Japan's birth rate will drop to zero in the year 1980 + 80 = 2060. This conclusion is based on the assumption that birth rates will drop in a linear manner at the same rate they dropped in 1980-2004. It is unrealistic to expect that no babies will be born in an entire year, so the linear function is not a valid long-term estimate.

118. **(a)** Let x = number of years from 2000 and y = percent of males who never married. Then we have two points on the line (0, 51.7) and (10, 62.2).

(i) The slope of the line through these points is 1.05, the y-intercept is 51.7 so the equation of the line is $y = 1.05x + 51.7$.

(ii) For the year 2008, x = 8. Thus, $y = 1.05(8) + 51.7 = 60.1$. This estimates, for 1998, the percent of males in the age range 25–29 who never married was 60.1%.

(iii) The percent estimated by the linear function is 2.5% too high so the linear function found is a rather poor predictor.

(b) **(i)** Let x = time in years with x = 0 for 2000 and y = percent. Then we have two points on the line (0, 38.9) and (10, 47.8). The slope of the line through these two points is 0.89 and the y-intercept is 38.9 so the linear function is $y = 0.89x + 38.9$.

(ii) For the year 2008, x = 8 $y = 0.89(8) + 38.9 = 46.02$. The estimated percent of females in the age range 25–29 is 46% for the year 2008.

(iii) The estimated percent differs from the actual 2008 percent by 2.6%. The linear function found provides a poor estimate for 2008.

119. **(a)** Let x be the admission price and y the estimated attendance. The given information gives two points on a line, (5, 185) and (6, 140). The slope of the line through these points is –45 and the equation of the line is $y - 185 = -45(x - 5)$ which reduces to $y = -45x + 410$.

(b) When admission is \$7, x = 7 and attendance = $-45(7) + 410 = 95$.

(c) When attendance is 250

$$250 = -45x + 410$$
$$45x = 160$$
$$x = 3.555$$

For an estimated attendance of 250, the manager would likely round the admission of 3.555 to \$3.55.

(d) For an attendance of zero

$$0 = -45x + 410$$
$$x = 9.111$$

An admission of \$9.11, or more, would result in no attendance.

(e) If admission were free, x = 0 and the estimated attendance would be

$$y = -45(0) + 410 = 410$$

120. **(a)** Let x = the number of years since 2008 and y = the median age. We are given m = 0.5, the age increase per year, and the y–intercept, point (1, 28.1). The equation is

$y - 28.1 = 0.5(x - 1)$

$y = 0.5x + 27.6$

(b) For 2018, x – 10 so $y = 0.5(10) + 27.6 = 32.6$. The function estimates the median age at first marriage for males to be 32.6 in 2018.

121. **(a)** The decline of 0.2% per year indicates m = –0.2 and the unemployment rate of 7.1 when x = 0 gives the y–intercept of 7.1. The equation is

$$y = -0.2x + 7.1$$

(b) For x = 4, $y = -0.2(4) + 7.1 = 6.3$

For x = 5, $y = -0.2(5) + 7.1 = 6.1$

The unemployment rate for the next two years is estimated to be 6.3% and 6.1%.

122. **(a)** For China we have two points, (0. 2.8) and (8, 6.5). The slope $m = (6.5 - 2.8)/8 = 0.46$ and $b = 2.8$. The equation is $y = 0.46x + 2.8$
For the U. S. we have two points (0, 5.9) and (8, 5.8). The slope $m = (5.8 - 5.9)/8 = -0.013$ and $b = 5.9$. The equation is $y = -0.013x + 5.9$
For India we have two points (0, 1.0) and (8, 1.5). The slope $m = (1.5 - 1.0)/8 = 0.06$ and $b = 1.0$. The equation is $y = 0.06x + 1.0$

(b) $x = 50$ for 2050, so the estimated carbon emissions for 2050 is:
China: $y = 0.46(50) + 2.8 = 25.8$ trillion tons
U. S.: $y = -0.013(50) + 5.9 = 5.25$ trillion tons.
India: $y = 0.06(50) + 1.0 = 4.0$ trillion tons.

(c) The 2050 total of the three nations is $25.8 + 5.25 + 4.0 = 35.05$, more than the 2008 worldwide total.

123. Let x = depth in feet and y = water pressure in pounds per square inch.
We have two points on the line, (18, 8) and (90, 40).

$$m = \frac{40-8}{90-18} = \frac{32}{72} = 0.4444$$
$$y - 8 = 0.4444(x - 18)$$
$$y = 0.4444x$$

At 561 feet $y = 0.4444(561) = 249.3$ so the pressure is approximately 249 pounds per square inch.

125. $y = -x + c$

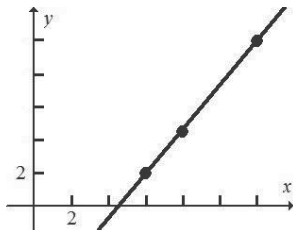
126. Solve for y in the equation and obtain $y = -\frac{A}{B}x + \frac{C}{B}$. This is the slope-intercept form of the line.

(a) From the slope-intercept form, $m = -\frac{A}{B}$.

(b) From the slope-intercept form, the y-intercept is $\frac{C}{B}$.

(c) To find the x-intercept, set $y = 0$ and solve for x. This gives $x = \frac{C}{A}$.

127. If we let $x = 0$ at midnight, we have the points (6, 2), (8, 4.5), and (12, 10). This gives the graph



Projecting back, the line crosses the x-axis at about 4:30 am.

128. The low and high quantities are 115 and 195 so we use the points (115, 374) and (195, 624).

$$m = \frac{624-374}{195-115} = \frac{250}{80} = 3.125$$
$$y - 374 = 3.125(x - 115)$$

$y = 3.125x + 14.625$ which we can round to $y = 3.125x + 15$

129. The low and high quantities are 3,850 and 6,350 so we use the two points (3850, 8850) and (6350, 13650).

$$m=\frac{13{,}650-8850}{6350-3850}=\frac{4800}{2500}=1.92$$

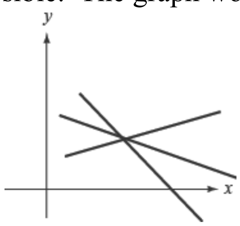
$y - 8850 = 1.92(x - 3850)$
$y = 1.92x + 1458$

130. Both statements are in error. If both sides of a linear equation are multiplied by a nonzero constant, the graph remains the same.

131. This is in error. Two different parallel lines do not intersect. If two equations have the same graph, they intersect in an infinite number of points.

132. This is correct. If the result is 0 = a nonzero constant like 0 = 5, the lines are different and parallel. If the result is 0 = 0, the lines coincide and we say they are parallel.

133. It is possible. The graph would look something like this



134. The linear function y = 0 coincides with the x-axis so they intersect at all points on the x-axis. Thus, there are two points, and more, that are x-intercepts. No other linear function can intersect on more than one point. If Veronica had said exactly two points, she would be in error. Damien is correct because all functions of the form y = c, where $c \neq 0$, do not intersect the x-axis.

135. Let x = 0 for 1979-1980 and x = 10 for 1989-1990. Then we have the points (0, 48.4) and (10, 52.3).

(a) $m=\frac{52.3-48.4}{10-0}=\frac{3.9}{10}=0.39$

Using the point (0, 48.4) we have
$y - 48.4 = 0.39(x - 0)$
$y = 0.39x + 48.4$

(b) For 2003–2004, x = 2003 – 1979 = 24
$y = 0.39(24) + 48.4 = 57.76$ (rounded to 57.8)
For 2003–2004, the equation estimates that 57.8% of the degrees were conferred on women. The U. S. Department of Education indicated that the percent was 58.6%.
For 2009-2010, x = 2009-1979 = 30.
$y = 0.39(30) + 48.4 = 60.1$
For 2009-2010, 60.1% of the degrees will be conferred on women. The U. S. Department of Education projects about 57.1% for 2009-2010

136. They are parallel lines.

137. All have y-intercepts of 4, but they are not parallel.

138. All are horizontal lines.

139. All go through the origin.

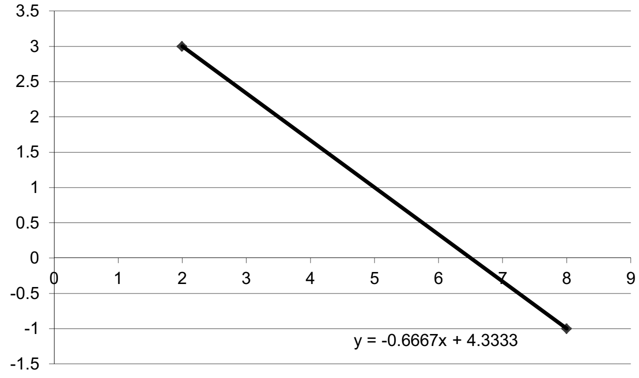
140. **(h)** An uphill line has a positive slope and a downhill line has a negative slope.

141. $m = -10/3$

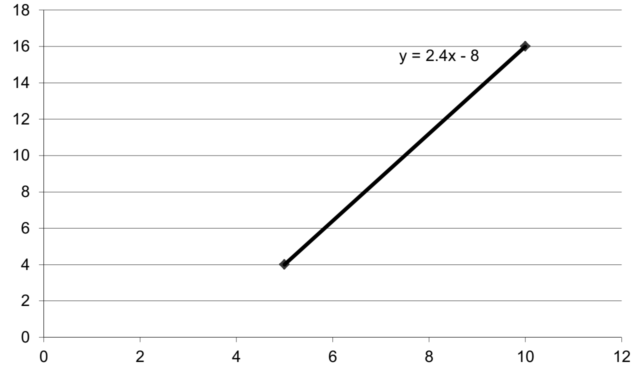
142. $m = 2.636$

143. $m = 1.240$

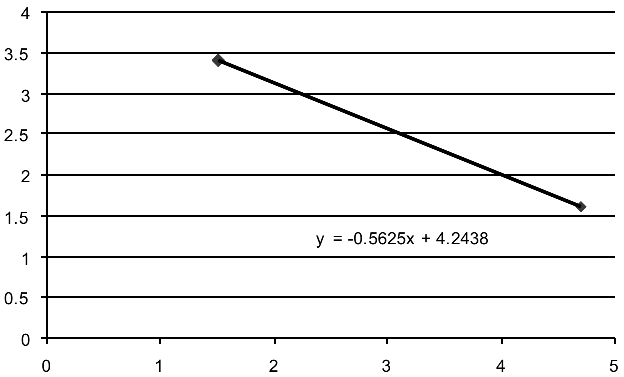
144. The equation of the line is
$y = -0.67x + 4.33$



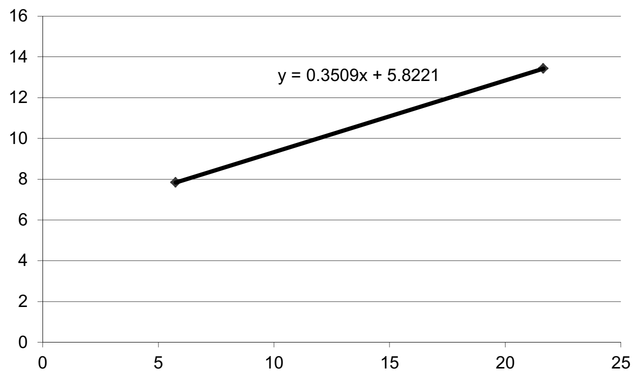
145. The equation is $y = 2.4x - 8$



146. The equation of the line is
$y = -0.5625x + 4.2438$



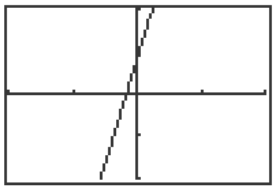
147. The equation of the line is
$y = 0.351x + 5.822$



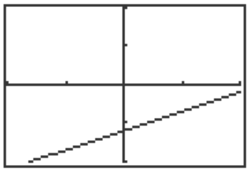
148. **(a)** $y = 0.125(10) + 22.4 = 23.7$ years **(b)** $y = 0.125(35) + 22.4 = 26.8$ years
(c) $y = 0.125(45) + 22.4 = 28.0$ years **(d)** $y = 0.125(70) + 22.4 = 31.2$years

Using Your TI Graphing Calculator

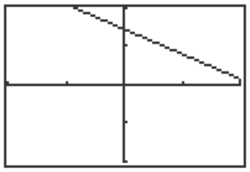
1.



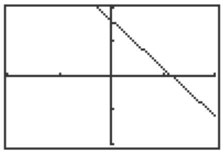
2.



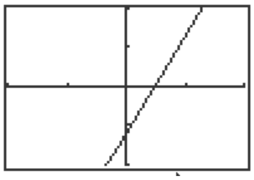
3.



4.

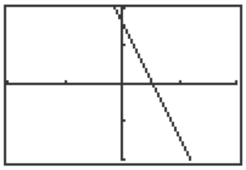


5.



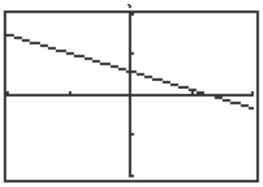
Write the equation as $y = (5x - 12)/2$

6.



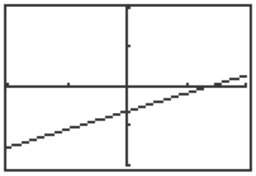
Write the equation as $y = 8 - 3x$

7.



Write the equation as $y = (15.6 - 2.4x)/5.3$

8.



Write the equation as
$y = (3.3x - 22.8)/7.2$

9. y = 18.59 when x = 4.5.

10. y = 9.0868 when x = 6.16.

11. For x = 6.16, y = 35.54. For x = –3.2, y = –7.52. For x = 4.1, y = 26.06.

12. For x = –1.1, y = 6.27. For x = 3.9, y = 2.76. For x = 7.8, y = 0.011

Using Excel

1. m = 0.25

2. m = –3.33

3. m = 2.73

4. m = 1.24

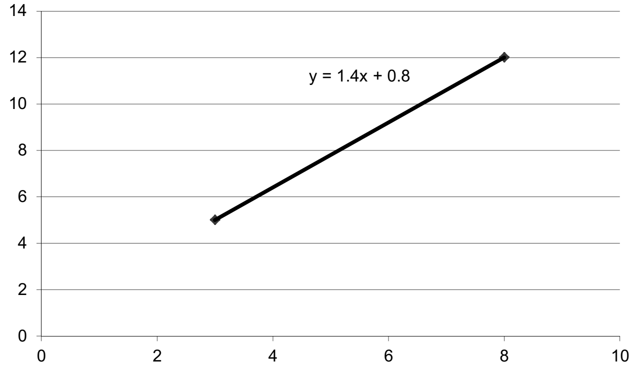
5. y = –0.67x + 4.33

6. y = 2.4x – 8

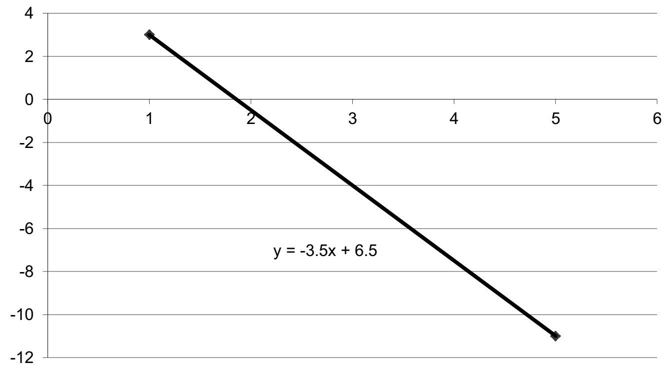
7. y = –0.56x + 4.24

Excel Graph Exercises

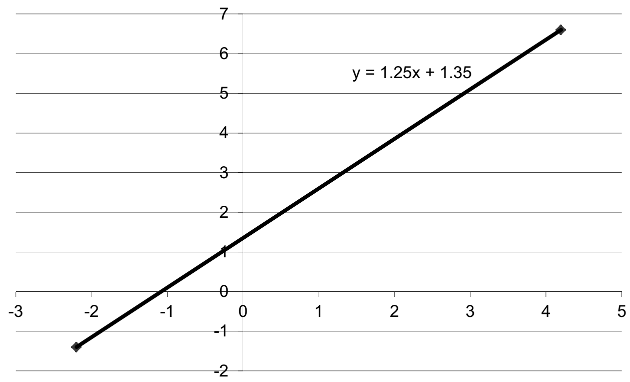
1.



2.



3.



1.3 Mathematical Models and Applications of Linear Functions

1. **(a)** C(180) = 43(180) + 2300 = $10,040
(b) Solve 43x + 2300 = 11,889
43x = 9589
x = 223 bikes
(c) Unit cost is $43, fixed cost is $2,300

2. **(a)** C(2500) = 16.25(2500) + 28,300 = $68,925
(b) Solve 16.25x + 28,300 = 63,010
16.25x = 34710
x = 2136 systems
(c) Unit cost is $16.25, fixed cost is $28,300

3. **(a)** Fixed cost is $400, unit cost is $3
(b) For 600 units, C(600) = 3(600) + 400 = $2200
For 1,000 units, C(1000) = 3(1000) + 400 = $3400

4. Fixed cost is $750, unit cost is $2.50
(a) C(100) = 2.5(100) + 750 = 250 + 750 = $1,000
(b) C(300) = 2.5(300) + 750 = 750 + 750 = $1,500
(c) C(650) = 2.5(650) + 750 = $2,375

5. **(a)** R(x) = 62x
(b) R(78) = 62(78) = $4,836
(c) Solve 62x = 1302
x = 21 pairs

6. Let x = number of DVD's and R(x) = revenue.
(a) R(x) = 12.95x **(b)** R(265) = 12.95(265) = $3431.75

7. Let x = number of pizzas and R(x) = revenue.
(a) R(x) = 3.39x **(b)** R(834) = 3.39(834) = $2,827.26

8. Let x = number of cookies and R(x) = revenue.

(a) R(x) = 0.60x

(b) Solve 0.60x = 343.80

x = 573 cookies

9. Let x = number of coats.

(a) C(x) = 57x + 780

(b) R(x) = 79x

(c) Break–even occurs when 79x = 57x +780,

22x = 780

x = 35.45, so the break–even number is 36 coats.

10. C(x) = 2.5x + 700, C(400) = 2.5(400) + 700 = $1,700

11. C(x) = 4x + 500, C(800) = 4(800) + 500 = $3,700

12. Break-even occurs when

37.50x = 22x + 870

15.50x = 870

x = 56.129

So use 57 as the break even value of x.

13. **(a)** Let x = number of T-shirts and C = the cost.

Then the points (600, 1400) and (700, 1600) lie on the line, so

$$m = \frac{1600-1400}{700-600} = \frac{200}{100} = 2$$

y – 1600 = 2(x – 700)

y = 2x – 1400 + 1600

C(x) = 2x + 200

(b) $200 **(c)** $2

14. Break-even occurs when

0.055x = 3690 + 0.025x

0.03x = 3690

x = 123,000

15. **(a)** C(x) = 649x + 1500 **(b)** R(x) = 899x

(c) C(37) = 649(37) + 1500 = $25,513

(d) R(37) = 899(37) = $33,263

(e) 899x = 649x + 1500

250x = 1500

x = 6 computers

16. **(a)** Let x = number of cars and C = cost. Then the points (500, 1000) and (900, 1200) are on the line, so

$$m = \frac{1200-1000}{900-500} = \frac{200}{400} = \frac{1}{2}$$

$$y - 1000 = \frac{1}{2}(x - 500)$$

$$y = \frac{1}{2}x - 250 + 1000$$

$$C(x) = \frac{1}{2}x + 750$$

(b) \$750 = fixed cost, \$0.50 = unit cost

(c) $C(200) = \frac{1}{2}(1200) + 750 = \$1350$

17. **(a)** Let x = number of years and BV = the book value. Then the points (0, 425) and (8, 25) are on the line, so

$$m = \frac{425 - 25}{0 - 8} = \frac{400}{-8} = -50$$

BV – 425 = –50x
BV = –50x + 425

(b) Annual depreciation is \$50

(c) BV(3) = –50(3) + 425 = –150 + 425 = \$275

18. **(a)** Let x = number of years and BV = the book value. Then the points (0, 1500) and (10, 200) lie on the line, so

$$m = \frac{200 - 1500}{10 - 0} = \frac{-1300}{10} = -130$$

BV – 1500 = –130x
BV = –130x + 1500

(b) \$130

(c) BV(7) = –130(7) + 1500 = \$590

19. **(a)** Let x = number of years and BV = the book value. Then the points (0, 16750) and (6, 400) lie on the line, so

$$m = \frac{16{,}750 - 400}{0 - 6} = \frac{16{,}350}{-6} = -2725$$

BV – 16,750 = –2725x
BV = –2725x + 16750

(b) \$2,725

(c) BV(2) = –2725(2) + 16750 = \$11,300
BV(5) = –2725(5) + 16750 = \$3,125

(d) The auto might have been abused or been in a wreck.

20. Let x = number of years and BV = the book value. Then the points (0, 13500) and (12, 0) lie on the line, so

$$m = \frac{0 - 13{,}500}{12 - 0} = \frac{-13{,}500}{12} = -1125$$

BV = –1125x + 13,500

21. P(x) = R(x) – C(x)
= 22x – 14x – 54
= 8x – 54

22. P(x) = R(x) – C(x)
= 28.65x – 13.9x – 68.2
= 14.75x – 68.2

23. $P(x) = R(x) - C(x)$
$= 148.8x - 76.4x - 593$
$= 72.4x - 593$

24. $P(x) = R(x) - C(x)$
$= 398.50x - 117.24x - 3148$
$= 281.26x - 3148$

25. Revenue must be greater than costs, so
$0.95x > 0.47x + 675$
$0.48x > 675$
$x > 1406.25$ at break-even, so at least 1,407 cookies must be sold to make a profit.

26. Revenue must be greater than costs, so
$145x > 70x + 225{,}000$
$75x > 225{,}000$
$x > 3{,}000$, so at least 3,001 items must be sold to make a profit.

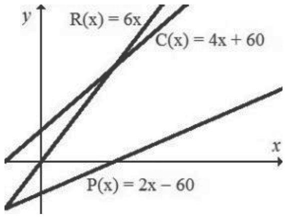
27. The cost function is $y = 22x + 845$ and the revenue function is $y = 41x$ where x is the number of ties sold in a week.
Profit $= 41x - (22x + 845) = 19x - 845$
Profit occurs when
$19x - 845 > 0$
$19x > 845$
$x > 44.47$
The shop must sell at least 45 ties per week to make a profit.

28. Cost function: $y = 0.33x + 8200$
Revenue function: $y = 1.75x$ where x is the number of pretzels sold in a month.
Profit $= 1.75x - (0.33x + 8200) = 1.42x - 8200$
A profit occurs when
$1.42x - 8200 > 0$
$1.42x > 8200$
$x > 5774.65$
They must sell at least 5775 pretzels each month to make a profit.

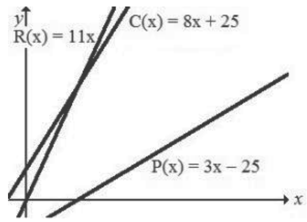
29. Cost function: $y = 0.32x + (300 + 130 + 1800 + 90) = 0.32x + 2320$ where x is the number of bagels sold per week.
Revenue function: $y = 0.95x$
Profit $= 0.95x - (0.32x + 2320) = 0.63x - 2320$
Profit occurs when
$0.63x - 2320 > 0$
$0.63x > 2320$
$x > 3682.5$
He must sell at least 3683 bagels per week to make a profit.

30. Cost function: $y = 0.17x + 2500$
Revenue function: $y = px$ where x is the number of donuts sold per week and p is the price per donut.
Profit $= px - (0.17x + 2500)$ where $x = 4400$
Profit $= 4400p - 748 - 2500 = 4400p - 3248$
Profit occurs when
$4400p - 3248 > 0$
$4400p > 3248$
$p > 0.7382$
Tina must charge at least \$0.74 per donut to make a profit.

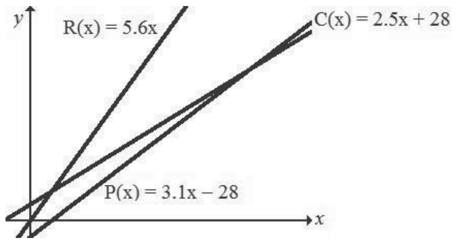
31. $P(x) = 6x - 4x - 60 = 2x - 60$



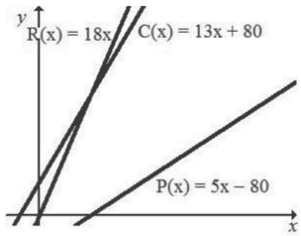
32. $P(x) = 11x - 8x - 25 = 3x - 25$



33. $P(x) = 5.6x - 2.5x - 28$
$= 3.1x - 28$



34. $P(x) = 18x - 13x - 80$
$= 5x - 80$



35. Let x = number of miles traveled. The weekly costs for Company A, $C(x) = 0.24x + 105$, must be less than the weekly costs for Company B, $C(x) = 0.20x + 161$.

$0.24x + 105 < 0.20x + 161$
$0.04x < 56$
$x < 1400$

Company A is the better deal when the weekly mileage is less than 1400 miles.

36. The salary under the first plan, $0.02x + 1000$, must be less than the salary under the second plan, $0.075x$, so

$0.02x + 1000 < 0.075x$
$1000 < 0.055x$
$x > 18{,}181.818$, so the second plan is better when sales are greater than \$18,181.

37. Let x = number of copies sold. A profit occurs when

$0.85x + 0.20x > 0.40x + 1400$
$0.65x > 1400$
$x > 2153.8$, so at least 2,154 copies must be sold to make a profit.

38. **(a)** Let x = admission price. Then revenue = 1200x and costs = 0.30(1200)x + 1000. Thus,

$(0.30)(1200)x + 1000 < 3000$
$360x < 2000$
$x < 5.556$, so admission is less than \$5.56

(b) $(0.30)(1200)x + 1000 + 2500 < 1200x$

$840x > 3500$
$x > 4.167$, so admission should be at least \$4.17

39. Let x = number of books. The unit cost gives m = 12.65. The point (2700, 36295) lies on the line so

$y - 36{,}295 = 12.65(x - 2700)$
$y = 12.65x + 2140$

40. Let x = number of stands.
$62x = 48x + 28{,}000$
$14x = 28{,}000$
$x = 2{,}000$

41. **(a)** Let x = the number of years since 2000, so x = 0 for 2000 and x = 8 for 2008. Let y = the percent of obese adults.
We have the points (0, 30) and (8, 34). The slope of the line through these points is

$$m = \frac{34-30}{8-0} = \frac{4}{8} = 0.5$$

Since the y-intercept is 30, the linear equation is
$y = 0.5x + 30$

(b) For 2015, x = 15.
$y = 0.5(15) + 30 = 37.5$
This estimates that 37.5% of adults will be obese in 2015.

42. **(a)** Let x = number of years since 1991 (x = 0 for 1991) and y = number of viewers. We have the points (0, 5.7) and (14, 3.5) from which we obtain the slope

$$m = \frac{3.5-5.7}{14-0} = \frac{-2.2}{14} = -0.157$$

The linear function then is $y = -0.157x + 5.7$.

(b) For 2010, x = 19
$y = -0.157(19) + 5.7 = 2.72$
This estimates 2.72 million viewers in 2010.
For 2015, x = 24
$y = -0.157(24) + 5.7 = 1.93$
This estimates 1.93 million viewers in 2015.

43. Let x = number of tickets.
(a) $6x = 650 + 45 + 2.20x$
$3.8x = 695$
x = 182.89, so 183 tickets must be sold to break even.
(b) $6x = 650 + 45 + 2.20x + 700$
$3.8x = 1395$
x = 367.105, so 368, or more, tickets must be sold to clear $700.
(c) $7.5x = 2.20x + 1395$
$5.3x = 1395$
x = 263.208, so 264 tickets must be sold to clear $700.

44. Let x = number of items.
(a) $C(x) = 24x + 360$
(b) At the break-even point cost equals revenue
$R(75) = (24)(75) + 360 = 2160$
Since $R(x) = ax$, $a(75) = 2160$ and $a = 28.8$
$R(x) = 28.8x$

45. Let x = number of members
(a) $R(x) = 35x$
(b) $R(1238) = 35(1238) = \$43{,}330$
(c) Solve $35x = 595$
$x = 17$

46. Let x = number of items.
The cost function is of the form C(x) = mx + 1850.
Solve (m)(320) + 1850 = 3178
320m = 1328
m = 4.15, so C(x) = 4.15x + 1850

47. **(a)** Let x = number of years and BV = book value, so the points (3, 14175) and (7, 8475) lie on the line, so

$$m = \frac{8475 - 14{,}175}{7-3} = \frac{-5700}{4} = -1425$$

BV – 14,175 = –1425(x – 3)
BV = –1425x + 18,450

(b) \$1,425 **(c)** BV(0) = \$18,450

48. Solve a(65) = (28)(65) + 650 = 2470
65a = 2470
a = 38, so R(x) = 38x

49. Let x = number of memberships.
(a) Solve a(260) = 3120
a = 12 so R(x) = 12x
(b) The break-even membership is 260 and break-even revenue is 3120. Thus, (260, 3120) is on the cost line. The revenue for 200 memberships is \$2400, \$330 less than the cost, so the point (200, 2730) is on the cost line.

From these two points $m = \frac{3120 - 2730}{260 - 200} = \frac{390}{60} = 6.5$

y – 2730 = 6.5(x – 200)
y = 6.5x – 1300 + 2730
C(x) = 6.5x + 1430

50. **(a)** P(x) = 52x – 28x – 465 = 24x – 465
(b) P(25) = 24(25) – 465 = \$135

51. **(a)** P(x) = 210x – 1200 – 130x = 80x – 1200
(b) P(18) = 80(18) – 1200 = \$240

52. **(a)** P(x) = 225x – 145x – 5200 = 80x – 5200
(b) P(75) = 80(75) – 5200 = \$800

53. **(a)** Solve a(1465) = 32,962.50
a = 22.5, so R(x) = 22.5x
(b) The points (1465, 26405.50) and (940, 17638) lie on the line, so

$$m = \frac{26{,}405.50 - 17{,}638}{1465 - 940} = \frac{8767.5}{525} = 16.7$$

y – 17,638 = 16.7(x – 940)
y = 16.7x – 15,698 + 17,638
C(x) = 16.7x + 1940

(c) Solve 22.5x = 16.7x + 1940
5.8x = 1940
x = 334.48, so use 335 for break-even quantity.

54. If 27 briefcases sold for \$1134, then they sold for \$42 each. Thus, $R(x) = 42x$.
The break-even point occurs at 88 briefcases, so the cost and revenue of 88 briefcases is $42(88) = 3696$. Thus, (88, 3696) is a point on the cost line. The revenue for 100 briefcases is \$4200, \$132 above cost so the point (100, 4068) is on the cost line. The slope of the line through these two points is

$$m = \frac{4068 - 3696}{100 - 88} = \frac{372}{12} = 31$$

The line is

$$y - 4068 = 31(x - 100)$$

$y = 31x + 968$, so the cost function is $C(x) = 31x + 968$

55. Let x = number of minutes called and y = total monthly cost.
The cost of the first option is $y = 0.06x + 7.95$
The cost of the second option is $y = 0.09x$

(a) The two options cost the same when

$$0.09x = 0.06x + 7.95$$

$$0.03x = 7.95 \qquad x = 265$$

The two options cost the same for 265 minutes per month.

(b) We are to solve

$$0.06x + 7.95 < 0.09x$$

$$7.95 < 0.03x$$

$$x > \frac{7.95}{0.03} = 265$$

The first option costs less when use is more than 265 minutes.

56. **(a)** Let $x = 0$ for 1999 and $x = 11$ for 2010. Let y = world population. We are given two points (0, 6.01) and (11, 6.85).

$$m = \frac{6.85 - 6.01}{11} = \frac{0.84}{11} = 0.076$$

The y–intercept is $b = 6.01$ so the equation is

$$y = 0.076x + 6.01$$

(b) For 2025, $x = 26$ and

$y = 0.076(26) + 6.01 = 7.986$

This estimates the world population as 8.0 billion in 2025.

For 2050, $x = 51$ and

$$y = 0.076(51) + 6.01 = 9.886$$

This estimates the world population as 9.9 billion in 2050.

(c) The equation estimates the 2025 world population as 8.0 billion compared to the United Nations projection of 7.9 billion.
The equation estimates the 2050 world population as 9.9 billion compared to the United Nations projection of 9.3 billion.
The linear equation estimates compare quite well to the United Nations projections.

57. **(a)** Let $x = 0$ for 1998 and $x = 12$ for 2010. Let y = U. S. population. We are given two points (0, 270.3) and (12, 310.2).

$$m = \frac{310.2 - 270.3}{12} = \frac{39.9}{12} = 3.325$$

The y-intercept is $b = 270.3$ so the equation is

$$y = 3.325x + 270.3$$

(b) For 2025, x = 27 and

$$y = 3.325(27) + 270.3 = 360.075$$

This estimates the U. S. population as 360.1 million in 2025.
For 2050, x = 52 and y = 3.325(52) + 270.3 = 443.2
This estimates the U. S. population as 443.2 million in 2050.

(c) The equation estimates the 2025 U. S. population as 360.1 million compared to the Census Bureau projection of 357.5 million.
The equation estimates the 2050 U. S. population as 443.2 million compared to the Census Bureau projection of 439.0 million.
The linear equation estimates exceed the Census Bureau projections by about 0.7% and 1%. This is good, but it indicates the linear estimate becomes poorer for years farther in the future.

58. **(a)** Let y = Russia population. We are given two points (0, 148.2) and (14, 139.4).

$$m = \frac{139.4 - 148.2}{14} = \frac{-8.8}{14} = -0.63$$

The y-intercept is b = 148.2 so the equation is

$$y = -0.63x + 148.2$$

(b) For 2025, x = 29 and

$$y = -0.63\,(29) + 148.2 = 129.9$$

This estimates the Russia population as129.9 million in 2025.
For 2050, x = 54 and y = –0.63(54) + 148.2 = 114.2
This estimates the Russia population as 114.2 million in 2050.

(c) The equation estimates the 2025 Russia population as 129.9 million compared to the Census Bureau projection of 128.2 million.
The equation estimates the 2050 Russia population as 114.2 million compared to the Census Bureau projection of 109.2 million.
The linear gives a good estimate for 2025 and a poor one for 2050. It appears that the linear equation gives poorer estimates for years beyond 2025.

59. **(a)** Let x = 0 for 1990 and y = the number living below the poverty level. We have two points on the line, (0, 33.6) and (15, 37.0).

$$m = \frac{37.0 - 33.6}{15 - 0} = \frac{3.4}{15} = 0.23$$

The y-intercept is 33.6 so the equation is y = 0.23x + 33.6

(b) For 2009, x = 19 and y = 0.23(19) + 33.6 = 37.97, an estimated 38.0 million lived below the poverty level.

(c) The equation is a poor estimator for the future.

60. **(a)** Let x = number of years since 1997 (x = 0 for 1997) and y = number of elliptical machine users. We have the points (0, 1.1) and (8, 6.7) so

$$m = \frac{6.7 - 1.1}{8 - 0} = \frac{5.6}{8} = 0.7$$

The linear function is y = 0.7x + 1.1

(b) The number of elliptical machine users reaches 10.9 million when y = 10.9.

$$10.9 = 0.7x + 1.1$$
$$0.7x = 9.8$$
$$x = 14$$

The number of elliptical machine users is estimated to reach 10.9 million in 1997 + 14 = 2011, that is, in the year 2011.

61. **(a)** $m = \dfrac{417 - 382}{2 - 1} = 35$

$y - 382 = 35(x - 1)$

$y = 35x + 347$

For $x = 4$, $y = 35(4) + 417 = 487$

An estimated 487 volunteers

(b) $m = \dfrac{455 - 382}{3 - 1} = \dfrac{73}{2} = 36.5$

$y - 382 = 36.5(x - 1)$

$y = 36.5x + 345.5$

For $x = 4$, $y = 36.5(4) + 345.5 = 491.5$

An estimated 492 volunteers

(c) $m = \dfrac{455 - 417}{3 - 2} = 38$

$y - 417 = 38(x - 2)$

$y = 38x + 341$

For $x = 4$, $y = 38(4) + 341 = 493$

An estimated 493 volunteers

The estimates 487, 492, and 493 are close enough to suggest a linear trend.

62. **(a)** $m = \dfrac{4.42 - 4.65}{2 - 1} = -0.23$

$y - 4.65 = -0.23(x - 1)$

$y = -0.23x + 4.88$

For $x = 4$, $y = -0.23(4) + 4.88 = 3.96$

Estimated sales of $3.96 million.

(b) $m = \dfrac{4.17 - 4.65}{3 - 1} = -0.24$

$y - 4.65 = -0.24(x - 1)$

$y = -0.24x + 4.89$

For $x = 4$,

$y = -0.24(4) + 4.89 = 3.93$

Estimated sales of $3.93 million.

(c) $m = \dfrac{4.17 - 4.42}{3 - 2} = -0.25$

$y - 4.42 = -0.25(x - 2)$

$y = -0.25x + 4.92$

For $x = 4$, $y = -0.25(4) + 4.92 = 3.92$

Estimated sales of $3.92 million.

The estimated sales of $3.96 million, $3.93 million, and $3.92 million are close and suggest a linear trend.

63. **(a)** $m = \dfrac{17300 - 15200}{2 - 1} = 2100$

$y - 15200 = 2100(x - 1)$

$y = 2100x + 13100$

For $x = 4$, $y = 2100(4) + 13100 = 21500$

Fourth year taxes estimated as $21,500

(b) $m = \dfrac{16500 - 15200}{3 - 1} = 650$

$y - 15200 = 650(x - 1)$

$y = 650x + 14550$

For $x = 4$,

$y = 650(4) + 14550 = 17150$

Fourth year taxes estimated as $17,150

(c) $m = \dfrac{16500 - 17300}{3 - 2} = -800$

$y - 17300 = -800(x - 2)$

$y = -800x + 18900$

For $x = 4$, $y = -800(4) + 18900 = 15700$

Fourth year taxes estimated as $15,700

The variation of estimated values, $21,500, $17,150, and $15,700 suggest Mr. Winfro's taxes do not follow a linear trend.

64. **(a)** $m = \dfrac{960-1040}{2-1} = -80$

$y - 1040 = -80(x - 1)$

$y = -80x + 1120$

For $x = 4$, $y = -80(4) + 1120 = 800$

Fourth year SAT scores estimated as 800.

(b) $m = \dfrac{1020-1040}{3-1} = -10$

$y - 1020 = -10(x - 3)$

$y = -10x + 1050$

For $x = 4$, $y = -10(4) + 1050 = 1010$

Fourth year SAT scores estimated as 1010.

(c) $m = \dfrac{1020-960}{3-2} = 60$

$y - 960 = 60(x - 2)$

$y = 60x + 840$

For $x = 4$, $y = 60(4) + 840 = 1080$

Fourth year SAT scores estimated as 1080.

The variation of estimated SAT averages, 800, 1010, and 1080 suggest the average SAT scores do not follow a linear trend.

65. **(a)** Let x = the number of years since 2004 (x = 0 for 2004) and y = the retention rate. We are given the points (0, 83) and (8, 93) so

$$m = \frac{93-83}{8} = \frac{10}{8} = 1.25$$

Since the y-intercept is 83,

$$y = 1.25x + 83$$

(b)

Year	Retention Rate
2004	83
2005	1.25(1) + 83 = 84.25
2006	1.25(2) + 83 = 85.50
2007	1.25(3) + 83 = 86.75
2008	1.25(4) + 83 = 88.00
2009	1.25(5) + 83 = 89.25
2010	1.25(6) + 83 = 90.50
2011	1.25(7) + 83 = 91.75
2012	1.25(8) + 83 = 93.00

66. **(a)** Income = disbursements when

$$21.27x + 264.70 = 13.29x + 226.53$$
$$21.27x - 13.29x = 226.53 - 264.70$$
$$7.98x = -38.17$$
$$x = -4.78$$

The negative value of x suggests that equality occurred before 1990. Actually, income exceeded disbursements during 1990-2003. The slope of the income equation is 21.27, which is greater than the slope of the disbursement equation, 13.29. Thus, income is increasing faster than disbursements so the lines do not meet in future years.

(b) Since income is increasing faster than disbursements, based only on these linear trends, the Social Security fund is not headed for trouble, but will be increasingly healthy.

(c) The data for 1990-2003 is based on the populations that pay into the Social Security fund and those that secure payments from the fund. The relative size of these populations will change as Baby Boomers retire. The Baby Boomers are the generation for which there was a significantly higher birth rate. As they retire, the population of Social Security recipients will increase and those paying into the fund will decrease. Thus, income will decrease and disbursements will increase. This effect is not included in trends based on past income and disbursements.

67. **(a)** Since the slope of the disbursements, 24.2, is greater than 23.0, the income slope, disbursements are increasing faster than income.

(b) The trends intersect when

$23.0x + 152.4 = 24.2x + 131.5$
$23.0x - 24.2x = 131.5 - 152.4$
$-1.2x = -20.9$
$x = 17.4$ years

Using $x = 17.4$ we find y:

$y = 23.0(17.4) + 152.4 = 552.6$

The trends intersect in 1995 + 17.4 = 2012.4 for y = \$552.6. This estimates that income and expenditures will each be about 552.6 billion in 2012.

(c) The deficit function is $d(x) = 23.0x + 152.4 - 24.2x - 131.5 = -1.2x + 20.9$.
Slope = –1.2 indicates that the deficit will increase \$1.2 billion per year after the income and expenditure lines intersect, after 2012.

68. **(a)** Average cost $C(12500)/12500 = (0.23(12500) + 475)/12500 = 3350/12500 = \$0.268$

(b) The average cost per cup of 700 cups is $\dfrac{C(700)}{700} = \dfrac{0.35(700)+255}{700} = \dfrac{500}{700} = 0.714$

The average cost is \$0.714

(c) The average cost is $\dfrac{C(120)}{120} = \dfrac{7.85(120)+82.5}{120} = \dfrac{1024.5}{120} = 8.5375$

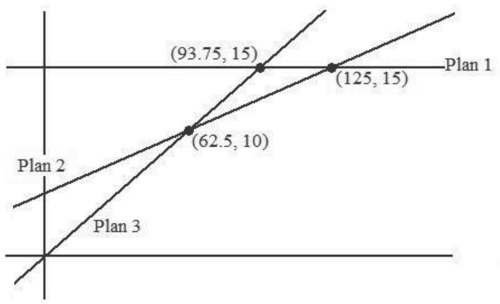
The average cost is \$8.54.

(d) The average cost is $\dfrac{C(x)}{x} = \dfrac{0.125x+382}{x} = 0.125 + \dfrac{382}{x}$

69. Each plan can be written with a linear equation where x = number of checks per month written and y = total monthly charge.

Plan 1: $y = 15$
Plan 2: $y = 5 + 0.08x$
Plan 3: $y = 0.16x$

The graph of Plan 2 lies below the graphs of both Plan 1 and Plan 3 between $x = 62.5$ and $x = 125$ so Plan 2 is better when the number of checks written in a month is more than 62 and less than 125.



70. Let x = years since 2001 (x = 0 at 2001) and y = poverty rate.

(a) Use the points (0, 11.7) and (8, 14.3) to find the linear equation.

$$m = \frac{14.3 - 11.7}{8 - 0} = \frac{2.6}{8} = 0.325$$

Then, by the slope-intercept form

$y = 0.325x + 11.7$

(b) For 2012, x = 11 so

$y = 0.325(11) + 11.7 = 15.275$

The poverty rate for 2012 is estimated to be about 15.3%.

For 2015, x = 14 so

$y = 0.325(14) + 11.7 = 16.25$

The poverty rate for 2015 is estimated to be about 16.3%.

71. **(a)** Let x = years since 2003 (x = 0 at 2003) and y = average price. We then have two points on the line, (0, 6000) and (2, 3400).

$$m = \frac{6000 - 3400}{0 - 2} = \frac{2600}{-2} = -1300$$

Then the slope–intercept equation is

$y = -1300x + 6000$

(b) For 2007, x = 4 so

$y = -1300(4) + 6000 = 800$

For 2010, x = 7 so

$y = -1300(7) + 6000 = -3100$

The linear equation estimates the price of a 42-inch high-def display to be \$800 in 2007 and –\$3100 in 2010.

(c) It is possible that prices might fall as low as \$800 in 2007, but it is impossible to have a negative \$3100 price, as estimated in 2010. Thus, if there was a linear trend, it doesn't apply rather quickly after 2005.

72. **(a)** Two points on the line represent the value of the vehicle, (2, 19981) and (3, 16000).

$$m = \frac{19981 - 16000}{2 - 3} = \frac{3981}{-1} = -3981$$

The equation of the line is

$y - 16000 = -3981(x - 3)$

$y = -3981x + 27{,}943$

The cost is \$27,943

(b) The Blue Book value reaches \$1000 when y = 1000

$1000 = -3981x + 27{,}943$

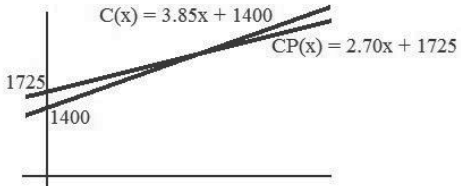
$$x = \frac{26943}{3981} = 6.77$$

The Blue Book value is \$1000 after about 7 years.

(c) The time at which the value falls to \$1000 is not realistic. A vehicle in reasonably good condition will retain its value longer. Note: The actual pattern of the depreciation of a vehicle does not follow a straight line. The annual depreciation is large at the beginning and decreases over time.

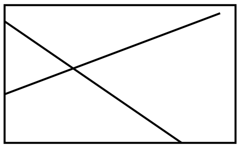
73. Let x be the number of knives produced daily. The cost function for the current process is $C(x) = 3.85x + 1400$. The cost function for the proposed process is $CP(x) = 2.70x + 1725$.

Graph both functions.
The lines intersect when
$3.85x + 1400 = 2.70x + 1725$
$1.15x = 325$
$x = 282.6$
The new process is more economical when the plant produces more than 282 knives per day.



74. **(a)** $P(x) = R(x) - C(x) = 29.95x - 32.50x - 785 = -2.55x - 785$
(b) For all positive values of x, the profit is negative. Thus, Al is selling below cost.

75. **(a)**

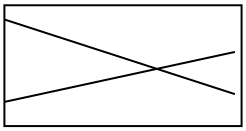


(b) When the price is \$200, demand = 10.4 and supply = 5.9, so there is a shortage.

(c) When the price = \$300, demand = 6.4 and supply = 11.8, so there is a surplus.

(d) When the demand is 20, the price is –\$40 so people must be paid to purchase. It is unrealistic to expect a demand of 20.

76. **(a)**

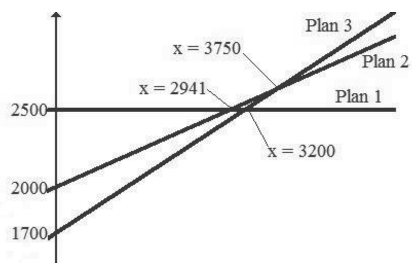


(b) The lines intersect at (2990, 165.70). There is a surplus when the price is greater than \$165.70.
(c) There is a shortage when the price is less than \$165.70.

77. Because costs cannot exceed \$100,000,
$16700 + 140x \le 100,000$
$140x \le 83300$
$x = 595$ is the maximum production.

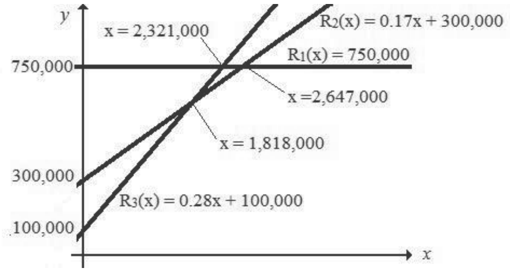
78. Let x = number of kilowatt hours (kWh) and y = monthly charge.
(a) For the first company, $y = 0.075x + 8$
For the second company, $y = 0.066x + 20$
(b) The lines intersect at (1333.3, 108). The first company charges are less when kWh use is less than 1333.3 kWh.

79. Let x = monthly sales. Then the three plans are:
Plan 1: $y = 2500$; Plan 2: $y = 0.17x + 2000$;
Plan 3: $y = 0.25x + 1700$
Plan 1 and Plan 2 intersect when
$2500 = 2000 + 0.17x$, when x = \$2,941.
Plan 1 and Plan 3 intersect when
$2500 = 1700 + 0.25x$, when x = \$3,200.
Plan 2 and Plan 3 intersect when
$2000 + 0.17x = 1700 + 0.25x$, when x = \$3,750.
Plan 1 is better when sales are less than \$2941.
Plan 2 is better when sales are between \$2941 and \$3750.
Plan 3 is better when sales are greater than \$3750.



80. Let x = gross sales. The income from each plan is:

Publisher A: $R_1(x) = 750{,}000$
Publisher B: $R_2(x) = 300{,}000 + 0.17x$
Publisher C: $R_3(x) = 100{,}000 + 0.28x$



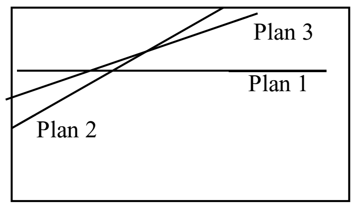
R_1 and R_2 intersect when $750{,}000 = 300{,}000 + 0.17x$, that is when $x = 2{,}647{,}000$.
R_1 and R_3 intersect when $750{,}000 = 100{,}000 + 0.28x$, that is, when $x = 2{,}321{,}000$.
R_2 and R_3 intersect when $300{,}000 + 0.17x = 100{,}000 + 0.28x$, when $200{,}000 = 0.11x$, that is when $x = 1{,}818{,}000$.
Plan A is better if gross sales are less than \$2,321,000.
Plan B is never better.
Plan C is better when gross sales are greater than \$2,321,000.

81. **(a)** Let x = number of tickets sold. The cost at the Convention Center is $C(x) = 20x + 600$. The cost at the Ferrell Center is $C(x) = 17x + 1300$. Break even at the Convention Center occurs when $35x = 20x + 2000 + 700 + 600 = 20x + 3300$. $x = 220$.
They must sell 220 tickets to break even.

(b) Break even at the Ferrell Center occurs when $35x = 17x + 2000 + 700 + 1300 = 17x + 4000$.
$x = 222.22$. They must sell 223 to break even.

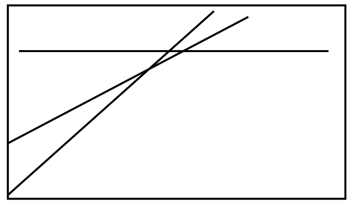
(c) At the Convention Center the profit is
$P(x) = 35x – 20x – 3300 = 15x – 3300$
At the Ferrell Center the profit is
$P(x) = 35x – 17x – 4000 = 18x – 4000$
These lines intersect at $x = 233.3$. The Ferrell Center is more profitable when more than 233 tickets are sold, otherwise the Convention Center is more profitable.

82. Let x = number of miles driven per day and y = daily cost.
The linear equations representing these plans are:
Plan 1: $y = 35$
Plan 2: $y = 0.10x + 20$
Plan 3: $y = 0.08x + 25$
Plan 1 and Plan 2 intersect at $x = 150$.
Plan 1 and Plan 3 intersect at $x = 125$.
Plan 2 and Plan 3 intersect at $x = 250$.
Plan 2 is better when $x < 150$.
Plan 1 is better otherwise.
Plan 3 is never better.



83. **(a)** For 10 trips, Plan 1 = \$2500, Plan 2 = \$1600, and Plan 3 = \$1650. Plan 2 is better at a cost of \$1600.
For 15 trips, Plan 1 = \$2500, Plan 2 = \$2250, and Plan 3 = \$2475. Plan 2 is better at a cost of \$2250.

(b) Let x = number of trips and y = total cost.
The linear equations for the three plans are:
Plan 1: $y = 2500$
Plan 2: $y = 130x + 300$
Plan 3: $y = 165x$
Plan 1 and Plan 2 intersect at $x = 16.9$.
Plan 1 and Plan 3 intersect at $x = 15.15$.
Plan 2 and Plan 3 intersect at $x = 8.57$.
Plan 3 is better for less than 9 trips.
Plan 2 is better for 9 through 16 trips.



[0, 25] [0, 3000]

84. $C(700) = 3400$, $C(1200) = 5400$

85. **(a)** $y = 3.1(1500) + 950 = 5600$ Cost = \$5600
(b) $y = 3.1(2250) + 950 = 7925$ Cost = \$7925

86. **(a)** **(i)** $P(x) = 215x - (97x + 785) = 118x - 785$
(ii) $P(30) = 2755$ Profit = \$2755
$P(426) = 49483$ Profit = \$49,483
(b) **(i)** $P(x) = 234x - (1620 + 143x) = 91x - 1620$
(ii) $P(27) = 837$ Profit = \$837
$P(42) = 2202$ Profit = \$2207

87. $P(x) = 96x - (42x + 1380) = 54x - 1380$
For $x = 10$, \$840 loss. For $x = 30$, \$240 profit. For $x = 45$, \$1050 profit. For $x = 62$, \$1968 profit.

88. $P(x) = 99x - (37x + 2470) = 62x - 2470$
For $x = 33$, \$424 loss. For $x = 47$, \$444 profit. For $x = 74$, \$2118 profit.

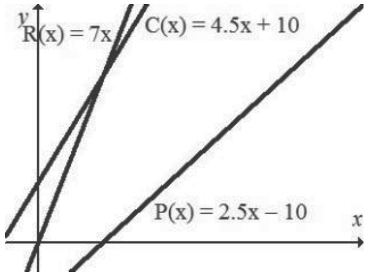
89. Break even when $8.7x + 350.88 = 21.6x$
$350.88 = 12.9x$
$27.2 = x$
$y = 21.6(27.2) = 587.52$
Break-even point is (27.2, 587.52)

90. Break even when $49.5x + 2167 = 98.75x$
$2167 = 49.25x$
$x = 44$
$y = 98.75(44) = 4345$
Break-even point is (44, 4345)

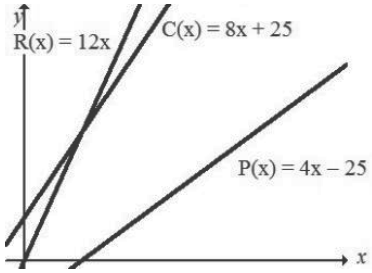
91. **(a)** $P(x) = 79.50x - (39.25x + 2576) = 40.25x - 2576$
Break even occurs when $P(x) = 0$, at (64, 5088)
(b) $2300 = 40.25x - 2576$
$40.25x = 4876$
$x = 121.14$
(c) $-675 = 40.25x - 2576$
$40.25x = 1901$
$x = 47.23$

92. **(a)** (114, 27816)
(b) $x = 266.778$ which we can round to 267.
(c) $x = 76.96$ which we can round to 77.

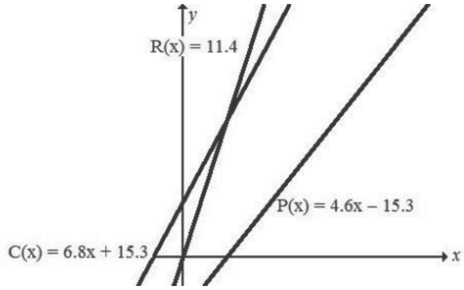
93. P(x) = 2.5x – 10



94. P(x) = 4x – 25



95. P(x) = 4.6x – 15.3



Using Your TI Graphing Calculator

1. (4, 7)

2. (6.5, 8)

3. (4.27, 0.91)

4. (0.952, 7.301)

5. (2, 6)

6. (3.56, 6.02)

Using Excel

1. –\$35, \$215, \$590, \$1015, and \$1490

2. \$8,537.50; \$12,452.50; \$18,325.00; and \$25,720.00

3. –\$1396; \$16,709; \$52,919; \$77,059; \$127,753

4. (60, 750)

5. (44.13, 2144.66)

6. **(a)** (15.6, 280.8)
(b) x = 119.767 which should be rounded to 120 when x represents a number of items.
(c) For x = 10, there is a loss of \$80.64. For x = 33, there is a profit of \$250.56.

Chapter 1 Review Exercises

1. **(a)** $f(5) = \dfrac{7 \times 5 - 3}{2} = 16$ **(b)** $f(1) = 2$

(c) $f(4) = 12.5$ **(d)** $f(b) = \dfrac{7b - 3}{2}$

2. **(a)** $f(2) = 8(2) - 4 = 16 - 4 = 12$ **(b)** $f(-3) = 8(-3) - 4 = -24 - 4 = -28$

(c) $f(1/2) = 8(1/2) - 4 = 4 - 4 = 0$ **(d)** $f(c) = 8c - 4$

3. $f(2) + g(3) = \dfrac{2 + 2}{2 - 1} + 5(3) + 3 = \dfrac{4}{1} + 15 + 3 = 22$

4. **(a)** $f(1) = (1 + 5)(2 \times 1 - 1) = (6)(1) = 6$

(b) $f(0) = (0 + 5)(2 \times 0 - 1) = (5)(-1) = -5$

(c) $f(-5) = (-5 + 5)(2 \times (-5) - 1) = (0)(-11) = 0$

(d) $f(a - 5) = (a - 5 + 5)[2(a - 5) - 1] = a(2a - 11) = 2a^2 - 11a$

5. **(a)** $f(3.5) = 1.20(3.5) = \$4.20$

(b) Solve $1.20x = 3.30$

$x = 2.75$ pounds

6. **(a)** $f(15) = 135(15) + 450 = \$2{,}475$

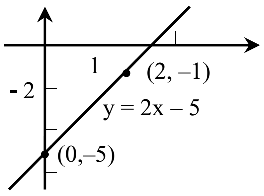
(b) Solve $135x + 450 = 2205$

$135x = 1755$

$x = 13$ hours

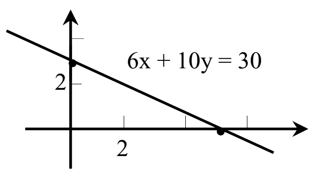
7. **(a)** $f(x) = 29.95x$ **(b)** $f(x) = 2.25x + 40$

8. **(a)** $f(0) = -5;\ f(2) = -1$

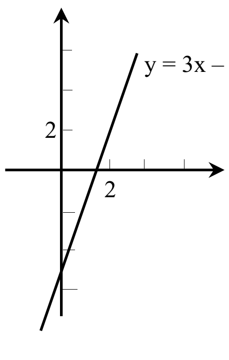


(b) $x = 0$: $10y = 30$ $y = 3$

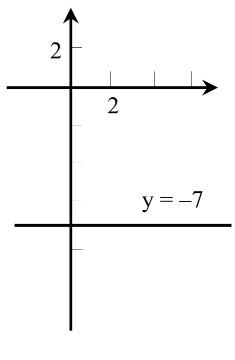
$y = 0$: $6x = 30$ $x = 5$



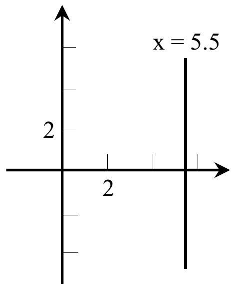
9. **(a)**



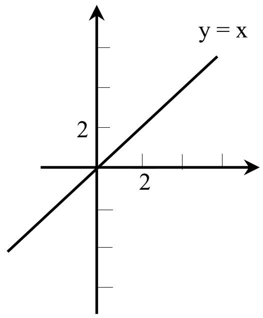
(b)



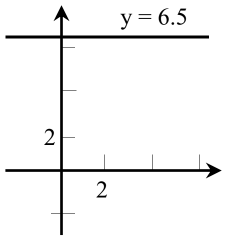
(c)



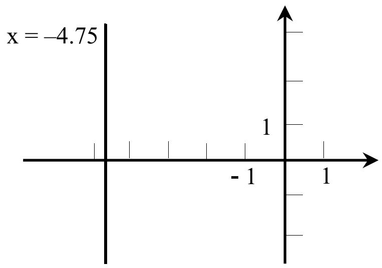
(d)



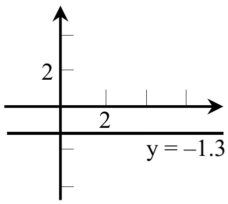
10. **(a)**



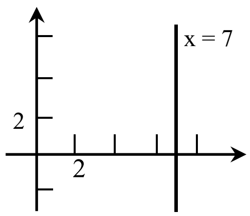
(b)



(c)



(d)



11. **(a)** Slope is –2, y-intercept is 3 **(b)** Slope is 2/3, y-intercept is –4

(c) $y = \frac{5}{4}x + \frac{3}{2}$ slope is $\frac{5}{4}$, y-intercept is $\frac{3}{2}$

(d) $y = -\frac{6}{7}x - \frac{5}{7}$ slope is $-\frac{6}{7}$, y-intercept is $-\frac{5}{7}$

12. **(a)** $m = \frac{4-7}{-3-2} = \frac{-3}{-5} = \frac{3}{5}$ **(b)** $m = \frac{8-8}{-11-6} = \frac{0}{-17} = 0$

(c) $m = \frac{6-2}{4-4} = \frac{4}{0}$ undefined

13. $y = -\frac{6}{5}x + 3$

(a) $m = -\frac{6}{5}$ **(b)** y-intercept = 3

(c) When y = 0, x = 5/2, so x-intercept = 5/2

14. $y = \frac{2}{9}x + \frac{2}{3}$

(a) $m = 2/9$

(b) y-intercept $= \frac{2}{3}$

(c) x-intercept = –3

15. **(a)** $y = -\frac{3}{4}x + 5$

(b) $y = 8x - 3$

(c) $y + 1 = -2(x - 5)$
$y = -2x + 10 - 1$
$y = -2x + 9$

(d) Horizontal line, $y = 6$

(e) $m = \frac{4-3}{-1-5} = \frac{1}{-6}$

$y - 3 = -\frac{1}{6}(x - 5)$

$y = -\frac{1}{6}x + \frac{5}{6} + 3$

$y = -\frac{1}{6}x + \frac{23}{6}$

(f) Vertical line, $x = -2$

(g) $4x - 3y = 22$ may be written $y = \frac{4}{3}x - \frac{22}{3}$, so $m = \frac{4}{3}$

$y - 7 = \frac{4}{3}(x - 2)$

$y = \frac{4}{3}x - \frac{8}{3} + 7$

$y = \frac{4}{3}x + \frac{13}{3}$, or $4x - 3y = -13$

16. **(a)** $y + 1 = 5(x - 2)$
$y = 5x - 11$

(b) $y - 4 = -\frac{2}{3}(x - 5)$

$y = -\frac{2}{3}x + \frac{22}{3}$

(c) $y - 6 = 0(x - 7)$
$y = 6$

(d) $y + 2 = 1(x + 2)$
$y = x$

17. **(a)** $m = \frac{2-2}{3-6} = 0$
$y - 2 = 0(x - 6)$
$y = 2$

(b) $m = \frac{-2-5}{-4+4}$
slope undefined, $x = -4$

(c) $m = \frac{10-0}{5-5}$; slope undefined, $x = 5$

(d) $m = \frac{6-6}{7+7} = 0$, so $y = 6$

18. **(a)** The first line may be written $y = \frac{7}{4}x - 3$, so $m_1 = \frac{7}{4}$

The second line may be written $y = \frac{7}{4}x + \frac{17}{12}$, so $m_2 = \frac{7}{4}$

The lines are parallel.

(b) The first line may be written $y = -\frac{3}{2}x + \frac{13}{2}$, so $m_1 = -\frac{3}{2}$

The second line may be written $y = \frac{2}{3}x - \frac{28}{3}$, so $m_2 = \frac{2}{3}$

The lines are not parallel.

19. The line through (5, 19) and (–2, 7) has slope $m_1 = \frac{19-7}{5+2} = \frac{12}{7}$

The line through (11, 3) and (–1, –5) has slope $m_2 = \frac{3+5}{11+1} = \frac{8}{12} = \frac{2}{3}$ The lines are not parallel.

20. The line through (4, 0) and (7, –2) has slope $m_1 = \frac{0+2}{4-7} = -\frac{2}{3}$

The line through (7, 4) and (10, 2) has slope $m_2 = \frac{4-2}{7-10} = -\frac{2}{3}$ The lines are parallel.

21. The given line has slope m = –2. The line through (8, 6) and (–3, 14) has slope

$m = \frac{14-6}{-3-8} = \frac{8}{-11} = -\frac{8}{11}$ The lines are not parallel.

22. The given line has slope m = 3. The line through (–2.5, 0) and (–1, 4.5) has slope

$m = \frac{4.5-0}{-1+2.5} = \frac{4.5}{1.5} = 3$ The lines are parallel.

23. The given line has slope $m = \frac{3}{2}$. The line through (9, 10) and (5, 6) has slope

$m = \frac{10-6}{9-5} = 1$ The lines are not parallel.

24. **(a)** Both lines have slope 5, so they are parallel.
(b) Both lines have slope –3, so they are parallel.
(c) The lines have slopes 8/9 and 9/8, so they are not parallel.
(d) The lines have slopes 12/5 and –6, so they are not parallel.

25. Let x = number of items produced.
C(x) = 36x + 12,800

26. **(a)** Fixed costs are \$960 **(b)** Unit cost is \$83

27. **(a)** C(580) = 3.60(580) + 2850 = \$4,938
(b) Solve 3.60x + 2850 = 5208
3.60x = 2358 x = 655 bags

28. R(x) = 28.50x

29. **(a)** R(x) = 11x **(b)** C(x) = 6.5x + 675
(c) Solve 11x = 6.5x + 675
4.5x = 675
x = 150
Break even occurs when 150 T-shirts are sold.

30. Solve 17.45x = 9.3x + 17,604
8.15x = 17,604
x = 2160
To break even, 2160 calculators must be sold.

31. R(x) = 19.5x
The points (1840, 25260) and (2315, 31102.5) lie on the cost line, so,
$$m = \frac{31102.5 - 25260}{2315 - 1840} = \frac{5842.5}{475} = 12.3$$
y – 25260 = 12.3(x – 1840)
C(x) = 12.3x + 2628
To find the break-even quantity, solve
19.5x = 12.3x + 2628
7.2x = 2628
x = 365 watches

32. **(a)** m = 6, so an equation is
y – 7 = 6(x – 5)
y = 6x – 23

(b) $m = \frac{5+2}{9-4} = \frac{7}{5}$ so an equation is
$$y + 5 = \frac{7}{5}(x + 2)$$
$$y = \frac{7}{5}x - \frac{11}{5} \quad \text{or } 7x - 5y = 11$$

(c) Since the line passes through (0, 6) and (2, –5), $m = \frac{-5-6}{2-0} = -\frac{11}{2}$ and $y = -\frac{11}{2}x + 6$

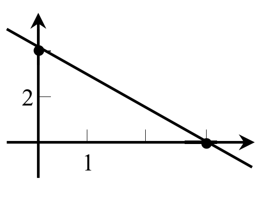
33. **(a)** The points (0, 17500) and (8, 900) lie on the line, so
$$m = \frac{900 - 17500}{8 - 0} = \frac{-16600}{8} = -2075$$
BV = –2075x + 17500

(b) \$2,075 **(c)** BV(5) = –2075(5) + 17500 = \$7,125

34. **(a)** Cost = f(0) = \$16,500
(b) Scrap value = f(7) = –2300(7) + 16500 = \$400

35. The points (0, 1540) and (5, 60) lie on the line, so
$$m = \frac{1540 - 60}{0 - 5} = \frac{1480}{-5} = -296 \qquad BV = -296x + 1540$$

36. x-intercept: y = 0 gives 8x = 24, x = 3
y-intercept: x = 0 gives 6y = 24, y = 4



37. The slope of the given line is 4/5, so $\frac{k-9}{-3-2} = \frac{4}{5}$ k – 9 = –4 k = 5

38. Let x = number of lawn mowers.
C(x) = 85x + 4250

39. The points (0, 22000) and (5, 3000) lie on the line, so

$m = \dfrac{3000 - 22{,}000}{5 - 0} = \dfrac{-19{,}000}{5} = -3800$ BV = –3800x + 22,000

40. Let x = number of items and y = cost. Then the points (940, 48840) and (810, 42535) lie on the line,

$$m = \frac{48{,}840 - 42{,}535}{940 - 810} = \frac{6305}{130} = 48.5$$

y – 48,840 = 48.5(x – 940)
C(x) = 48.5x + 3250

41. Let x = number of hamburgers and y = cost. Then m = 0.67, and the point (1150, 1250.5) lies on the line, so

y – 1250.5 = 0.67(x – 1150)
y = 0.67x – 770.5 + 1250.5
C(x) = 0.67x + 480

42. Let x = monthly receipts.
C(x) = 0.041x + 1200

43. Let x = number of items sold. The second option is better when 0.75x + 2000 > 17,000
0.75x > 15,000x > 20,000
The second plan is better when sales exceed 20,000 items.

44. Let x = number who pay deposits.
0.92x = 2300 gives x = 2500

45. $\dfrac{k-4}{-2-9} = -2$ k – 4 = 22 k = 26

46. Let x = number of guests and y = cost. Then the points (350, 3475) and (290, 2695) lie on the line, so

$$m = \frac{3475 - 2695}{350 - 290} = \frac{780}{60} = 13$$

y – 3475 = 13(x – 350)
C(x) = 13x – 1075

47. Let x = number of dolls and C(x) = total cost. Since the unit cost is \$6.82, m = 6.82, and the point (1730, 12813.60) lies on the line,

y – 12813.60 = 6.82(x – 1730)
C(x) = 6.82x + 1015

The fixed cost is \$1015.

48. Let x = number of weeks and y = amount in reserve, m = –620, the amount the reserve reduces each week. Then

(a) y = –620x + 12,000
(b) When x = 8, y = –620(8) + 12000 = 7040, so \$7040 remains after 8 weeks.
(c) The fund is depleted when

–620x + 12000 = 0
–620x = –12000
x = 19.35

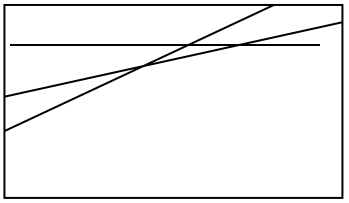
The fund is depleted by the 20th week.

49. Let x = sales, then the plans can be represented by:

Plan 1: $y = 2500$

Plan 2: $y = 0.15x + 2000$

Plan 3: $y = 0.30x + 1700$
Plan 1 and Plan 2 intersect at $x = 3333.3$
Plan 1 and Plan 3 intersect at $x = 2666.7$
Plan 2 and Plan 3 intersect at $x = 2000$
Plan 1 is better when sales are less than \$2667.
Plan 3 is better when sales are greater than \$2667.
Plan 2 is never better.



[0, 4000] [0, 3000]

50. **(a)** Let x be the number of cups of coffee sold.
$C(x) = 0.85x + 215$ $R(x) = 2.25x$
At break-even, $2.25x = 0.85x + 215$
$1.40x = 215$
$x = 153.6$
154 cups must be sold to break even.

(b) Let x_1 = number of small size and let x_2 = number of regular size. The unit cost for the small size is half the cost of the regular size, $0.85/2 = 0.425$
Cost $= 0.425x_1 + 0.85x_2 + 265$
Revenue $= 1.25x_1 + 2.25x_2$
At break-even,
$1.25x_1 + 2.25x_2 = 0.425x_1 + 0.85x_2 + 265$
$0.825x_1 + 1.40x_2 = 265$

51. **(a)** $y = 120x + 8400$

(b) $10{,}000 = 120x + 8400$
$120x = 1600$
$x = 13.33$
The library holdings will reach 10,000 books during the 14th month.

52. **(a)** Let x = 0 for 1996 and x = 14 for 2010. Let y = Uganda population. We are given two points (0, 20.2) and (14, 33.4).

$$m = \frac{33.4 - 20.2}{14 - 0} = \frac{13.2}{14} = 0.94$$

The y-intercept is b = 20.2 so the equation is $y = 0.94x + 20.2$.

(b) For 2025, x = 29 and

$$y = 0.94(29) + 20.2 = 47.46$$

This estimates the Uganda population as about 47.5 million in 2025.
For 2050, x = 54 and $y = 0.94(54) + 20.2 = 70.96$
This estimates the Uganda population as about 71.0 million in 2050.

(c) The equation estimates the 2025 Uganda population as 47.5 million compared to the Census Bureau projection of 56.7 million.
The equation estimates the 2050 Uganda population as 71.0 million compared to the Census Bureau projection of 128.0 million.
In this case the linear equation gives poor estimates of future population of Uganda. It appears that the Census Bureau did not use a linear function to make their projections.

53. $y = 500x - 1700$

54. **(a)** Let $x = 0$ for 1994 and $x = 8$ for 2002. Let y = percent overweight.
We have the points (0, 47.5) and (8, 52.8). The slope of the line through these points is

$$m = \frac{52.8 - 47.5}{8 - 0} = \frac{5.3}{8} = 0.6625$$

Since 47.5 = the y-intercept, the point-slope equation gives

$$y = 0.6625x + 47.5$$

(b) For 2015, $x = 21$. Then

$$y = 0.6625(21) + 47.5 = 61.4$$

By the year 2015 the estimated percent in the 20 through 34 age group reaches 61.4%.

55. **(a)** Let y = percent with disabilities, $x = 0$ for 1990 – 1991, and $x = 7$ for 1997 – 1998. Then the points (0, 11.43) and (7, 12.80) lie on the line and gives the slope

$$m = \frac{12.80 - 11.43}{7} = \frac{1.37}{7} = 0.196$$

$$y - 11.43 = 0.196(x - 0)$$

$$y = 0.196x + 11.43$$

(b) For 1999 – 2000, $x = 9$

$$y = 0.196(9) + 11.43 = 13.19$$

This result is close to the actual value of 13.33.

(c) The percent will reach 15% when $y = 15$.

$$15 = 0.196x + 11.43$$

$$0.196x = 3.57$$

$$x = \frac{3.57}{0.196} = 18.2$$

The percent is estimated to reach 15% by 1990 + 18.2 = 2008.2, that is, during the 2008 – 2009 school year.

56. **(a)** The linear trends intersect when

$$8.2x + 75.7 = 5.9x + 81.0$$

$$8.2x - 5.9x = 81.0 - 75.7$$

$$2.3x = 5.3$$

$$x = 2.3$$

The trends intersect in the year 1990 + 2.3 = 1992.3, that is, during 1992. The income/disbursement = $94.6 billion.

(b) The trends indicate that income equaled disbursements in 1992. Since the income slope, 8.2, is greater than 5.9, the disbursements slope, disbursements exceeded income before 1992, but income will be the greater after 1992 and the Fund will be in good financial shape after 1992. The historical year-by-year figures show a deficit before 1998 and a surplus thereafter.

57. **(a)** Let x = years since 1999 ($x = 0$ for 1999) and y = average winter heating cost. We have two points on the line, (0, 564) and (6, 989). This gives

$$m = \frac{989 - 564}{6 - 0} = \frac{425}{6} = 70.83$$

Using the slope-intercept form, the linear equation is

$$y = 70.83x + 564$$

(b) For 2015, x = 16

$$y = 70.83(16) + 564 = 1697.28$$

The average winter heating cost for 2015 is estimated to be about $1697.

(c) When y = 2256,

$$2256 = 70.83x + 564$$
$$70.83x = 1692$$
$$x = \frac{1692}{70.83} = 23.9$$

The average costs are estimated to quadruple the 1999 cost in year 1999 + 23.9 = 2022.9, in about the year 2022.

58. **(a)** Let x = number of years since 2000 and y = percentage never married. We have two points (0, 23.9) and (9, 26.1).

$$m = \frac{26.1 - 23.9}{9 - 0} = \frac{2.2}{9} = 0.24$$
$$b = 23.9$$

The equation is y = 0.24x + 23.9

(b) For 2015, x = 15 so y = 0.24(15) + 23.9 = 27.5

This estimates for 2015 that 27.5% never marry.

(c) y = 50

50 = 0.24x + 23.9

0.24x = 50 – 23.9 = 26.1

x = 26.1/0.24 = 108.75

This estimates that in the year 2000 + 108.75 or in 2108, 50% never marry.

This illustrates that a model, linear or otherwise, may be unreliable for a long term.