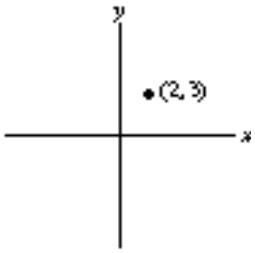
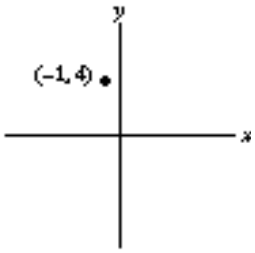
Chapter 1

Exercises 1.1

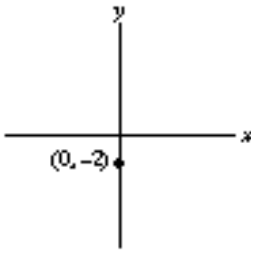
1. Right 2, up 3



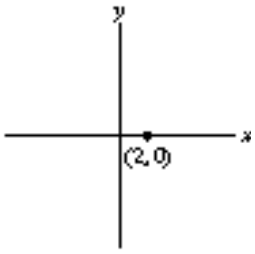
2. Left 1, up 4



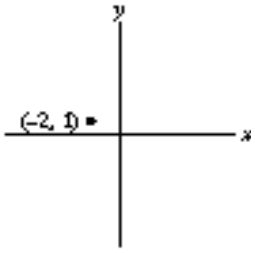
3. Down 2



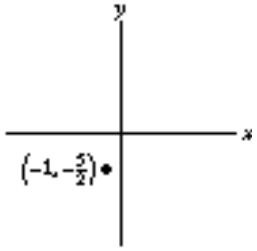
4. Right 2



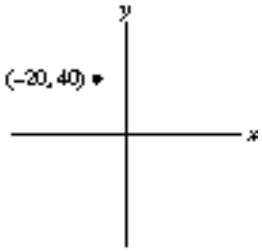
5. Left 2, up 1



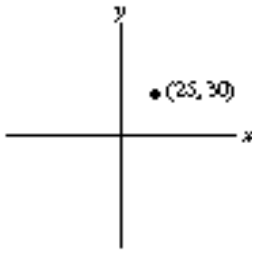
6. Left 1, down $\frac{5}{2}$



7. Left 20, up 40



8. Right 25, up 30



9. Point Q is 2 units to the left and 2 units up or $(-2, 2)$.

10. Point P is 3 units to the right and 2 units down or $(3, -2)$.

11. $-2(1)+\frac{1}{3}(3)=-2+1=-1$ so yes the point is on the line.

12. $-2(2)+\frac{1}{3}(6)=-1$ is false, so no the point is not on the line

13. $-2x+\frac{1}{3}y=-1$ Substitute the x and y coordinates of the point into the equation: $\left(\frac{1}{2},3\right)\rightarrow -2\left(\frac{1}{2}\right)+\frac{1}{3}\ 3\ =-1\rightarrow -1+1=-1$ is a false statement. So no the point is not on the line.

14. $-2\left(\frac{1}{3}\right)+\left(\frac{1}{3}\right)(-1)=-1$ is true so yes the point is on the line.

15. $m = 5$, $b = 8$

16. m = –2 and b = –6

17. $y = 0x + 3$; $m = 0$, $b = 3$

18. $y=\frac{2}{3}x+0$; $m=\frac{2}{3}$, $b=0$

19.
$$14x+7y=21$$
$$7y=-14x+21$$
$$y=-2x+3$$

20.
$$x-y=3$$
$$-y=-x+3$$
$$y=x-3$$

21.
$$3x=5$$
$$x=\frac{5}{3}$$

22.
$$-\frac{1}{2}x+\frac{2}{3}y=10$$
$$\frac{2}{3}y=\frac{1}{2}x+10$$
$$y=\frac{3}{4}x+15$$

23.
$$0=-4x+8$$
$$4x=8$$
$$x=2$$

x-intercept: (2, 0)
$y = –4(0) + 8$
$y = 8$
y-intercept: (0, 8)

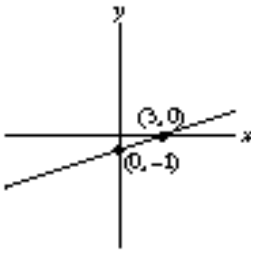
24. 0 = 5
no solution
x-intercept: none
When $x = 0$, $y = 5$
y-intercept: (0, 5)

25. When $y = 0$, $x = 7$
x-intercept: (7, 0)
0 = 7
no solution
y-intercept: none

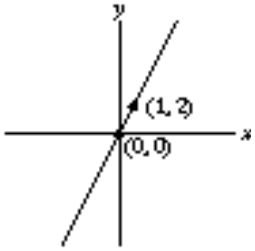
26. $0 = –8x$
$x = 0$
x-intercept: (0, 0)
$y = –8(0)$
$y = 0$
y-intercept: (0, 0)

27.
$$0=\frac{1}{3}x-1$$
$$x = 3$$

x-intercept: (3, 0)
$$y=\frac{1}{3}(0)-1$$
$y = –1$
y-intercept: (0, –1)



28. When $x = 0$, $y = 0$.
When $x = 1$, $y = 2$.



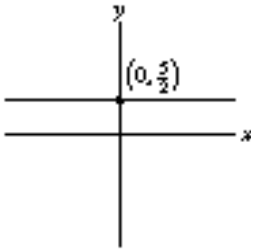
29. $0 = \frac{5}{2}$

no solution

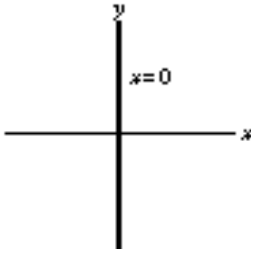
x-intercept: none

When $x = 0$, $y = \frac{5}{2}$

y-intercept: $\left(0, \frac{5}{2}\right)$



30. The line coincides with the *y*-axis.



31. $3x + 4(0) = 24$

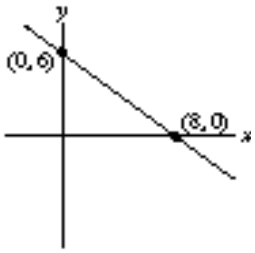
$x = 8$

x-intercept: (8, 0)

$3(0) + 4y = 24$

$y = 6$

y-intercept: (0, 6)



32. $x + 0 = 3$

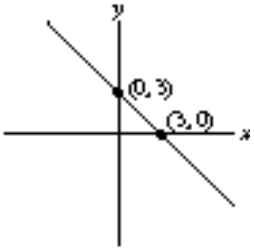
$x = 3$

x-intercept: (3, 0)

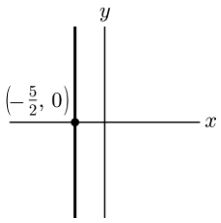
$0 + y = 3$

$y = 3$

y-intercept: (0, 3)



33. $x = -\frac{5}{2}$



34. $\frac{1}{2}x - \frac{1}{3}(0) = -1$

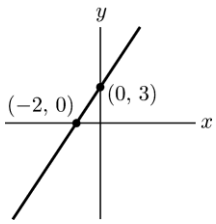
$x = -2$

x intercept (–2, 0)

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

$y = 3$

y intercept (0, 3)



35. $2x+3y=6$

$3y=-2x+6$

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

a. $4x+6y=12$

$6y=-4x+12$

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

Yes

b. Yes

c. $x=3-\frac{3}{2}y$

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

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

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

Yes

d. $6-2x-y=0$

$y=6-2x=-2x+6$

No

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

Yes

f. $x+y=1$

$y=-x+1$

No

36. $\frac{1}{2}x-5y=1$

$-5y=-\frac{1}{2}x+1$

$y=\frac{1}{10}x-\frac{1}{5}$

a. $2x-\frac{1}{5}y=1$

$-\frac{1}{5}y=-2x+1$

$y=10x-5$

No

b. $x=5y+2$

$5y=x-2$

$y=\frac{1}{5}x-\frac{2}{5}$

No

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

$-10y=-5x+2$

$y=\frac{1}{2}x-\frac{1}{5}$

No

d. $y=.1(x-2)$

$y=.1x-.2$

$y=\frac{1}{10}x-\frac{1}{5}$

Yes

e. $10y-x=-2$

$10y=x-2$

$y=\frac{1}{10}x-\frac{1}{5}$

Yes

f. $1+.5x=2+5y$

$5y=.5x-1$

$y=\frac{1}{10}x-\frac{1}{5}$

Yes

37. a. $x + y = 3$
$y = -x + 3$
$m = -1, b = 3$
L_3

b. $2x - y = -2$
$-y = -2x - 2$
$y = 2x + 2$
$m = 2, b = 2$
L_1

c. $x = 3y + 3$
$3y = x - 3$
$y = \frac{1}{3}x - 1$
$m = \frac{1}{3},\ b = -1$
L_2

38. a. No; $5 + 4 \neq 3$

b. No; $2 \neq 1 - 1$

c. Yes; $2(2) = 1 + 3$ and $2(4) = 5 + 3$

39. $y = 30x + 72$

a. When x = 0, y = 72. This is the temperature of the water at time = 0 before the kettle is turned on.

b. $y = 30(3) + 72$
$y = 162^\circ F$

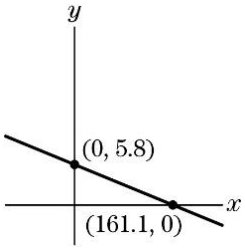
c. Water boils when y = 212 so we have $212 = 30x + 72$. Solving for x gives $x = 4\frac{2}{3}$ minutes or 4 minutes 40 seconds.

40. a. A person born in 1960 has a life expectancy of 70 years.

b. $75 = \left(\frac{1}{6}\right)x + 70$
$5 = \left(\frac{1}{6}\right)x$
$x = 30$
1960 + 30 = 1990

c. $2004 - 1960 = 44$
$y = \left(\frac{1}{6}\right)(44) + 70$
$y = 7.33 + 70$
$y = 77.33$
A person born in 2004 has a life expectancy of 77.3 years.

41. a. *x*-intercept: $\left(161\frac{1}{9}, 0\right)$
y-intercept: (0, 5.8)

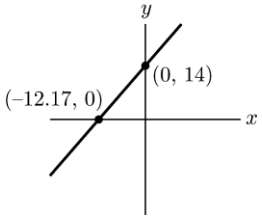


b. In 2004, 5.8 trillion cigarettes were sold.

c. $5.5 = -.036x + 5.8$
$x = 8.33$
2004 + 8 = 2012

d. 2028 – 2004 = 24
$y = -.036(24) + 5.8$
$y = 4.936$
4.9 trillion

42. a. *x*-intercept: (–12.17, 0)
y-intercept: (0, 14)

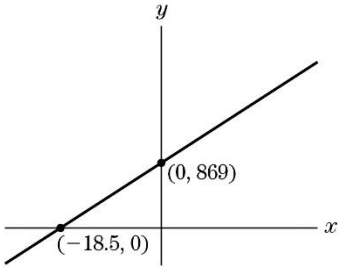


b. In 2010 the income from ecotourism was $14,000.

c. $20 = 1.15x + 14$
$x \approx 5.22$
2010 + 5.22 = 2015.22
The year 2015 should have had $20,000 in ecotourism income.

d. 2032 – 2010 = 22
y = 1.15(22) + 14
y = 39.3
$39,300

43. a. x-intercept: (–18.5, 0)
y-intercept: (0, 869)

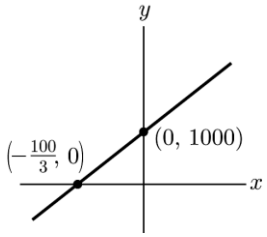


b. In 2014 the car insurance rate for a small car was $869.

c. 2017 – 2014 = 3
y = 47(3) + 869
y = 1010
$1010

d. $1480 = 47x + 869$
$611 = 47x$
$x = 13$
$2014 + 13 = 2027$
The yearly rate will be $1480 in 2027.

44. a. x-intercept: $\left(-\frac{100}{3}, 0\right)$
y-intercept: (0, 1000)



b. $y = 30(2) + 1000$
$y = 60 + 1000$
$y = 1060$
$1060 will be in the account after 2 years.

c. $1180 = 30x + 1000$
$180 = 30x$
$x = 6$
The balance will be $1180 after 6 years.

45. a. In 2010, 6.1% of entering college freshmen intended to major in biology.

b. $2019 - 2010 = 9$
$y = \frac{1}{6}(9) + 6.1$
$y = 7.6$
7.6% of college freshmen in 2019 intended to major in biology.

c. $6.8 = \frac{1}{6}x + 6.1$
$0.7 = \frac{1}{6}x$
$x = 4.2$
$2010 + 4 = 2014$
In 2014, the percent of college freshmen who intended to major in biology was 6.8%.

46. a. In 2010, 46.4% of college freshmen considered themselves middle-of-the-road politically.

b. $2016 - 2010 = 6$
$y = 46.4 - 0.31(6)$
$y = 44.54$
44.5% of college freshmen considered themselves middle-of-the-road politically in 2016.

c. $43.9 = 46.4 - 0.31x$
$-2.5 = -0.31x$
$x \approx 8$
$2010 + 8 = 2018$
In 2018, the percent of college freshmen that considered themselves middle-of-the-road was 43.9%.

47. a. $2018 - 2012 = 6$
$y = 433(6) + 21{,}593$
$y = 24{,}191$
$24,191 was the approximate average tuition in 2018.

b. $28,600 = 433x + 21,593$

$7007 = 433x$

$x \approx 16.2$

$2012 + 16 = 2028$

In 2028, the approximate average cost of tuition will be more than \$28,600.

48. a. $2015 - 2011 = 4$

$y = 1121(4) + 17,182$

$y = 21,666$

Approximately 21,666 bachelor's degrees in mathematics and statistics were awarded in 2015.

b. $34,000 = 1121x + 17,182$

$16,818 = 1121x$

$x \approx 15.002$

$2011 + 15 = 2026$

In 2026, there will be more than 34,000 bachelor's degrees in mathematics and statistics awarded.

49. $y = mx + b$

$8 = m(0) + b$

$b = 8$

$0 = m(16) + 8$

$m = -\frac{1}{2}$

$y = -\frac{1}{2}x + 8$

50. $y = mx + b$

$0.9 = m(0) + b$

$b = 0.9$

$0 = m(0.6) + 0.9$

$m = -1.5$

$y = -1.5x + 0.9$

51. $y = mx + b$

$5 = m(0) + b$

$b = 5$

$0 = m(4) + 5$

$m = -\frac{5}{4}$

$y = -\frac{5}{4}x + 5$

52. Since the equation is parallel to the *y* axis, it will be in the form *x* = a. Therefore, the equation will be x = 5.

53. On the *x*-axis, *y* = 0.

54. No, because two straight lines (the graphed line and the *x*-axis) cannot intersect more than once.

55. The equation of a line parallel to the *y* axis will be in the form *x* = a**.**

56. y = b is an equation of a line parallel to the x-axis.

57. $2x - y = -3$

58. $-3x + y = -4$

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

$2x + 3y = -15$

60. $4x - y = \frac{5}{6}$

$24x - 6y = 5$

61. Since (a,0) and (0,b) are points on the line the slope of the line is (b-0)/(0-a) = -b/a. Since the y intercept is (0,b), the equation of the line is $y = -(b/a)x + b$ or $ay = -bx + ab$. In general form, the equation is bx + ay = ab.

62. If (5, 0) and (0, 6) are on the line, then a = 5 and b = 6. Substituting these values into the equation bx + ay = ab gives 6x + 5y = 30.

63. One possible equation is $y = x - 9$.

64. One possible equation is $y = x + 10$.

65. One possible equation is $y = x + 7$.

66. One possible equation is $y = x - 6$.

67. One possible equation is $y = x + 2$.

68. One possible equation is $y = x$.

69. One possible equation is $y = x + 9$.

70. One possible equation is $y = x - 5$.

71. The x – intercept has a y coordinate of 0, therefore the x coordinate of the first equation is:

$$0 = \frac{2}{3}x - 2$$
$$2 = \frac{2}{3}x$$
$$3 = x$$

Using this x coordinate in the second equation will find the value of c.

$$0 = -4(3) + c$$
$$0 = -12 + c$$
$$12 = c$$

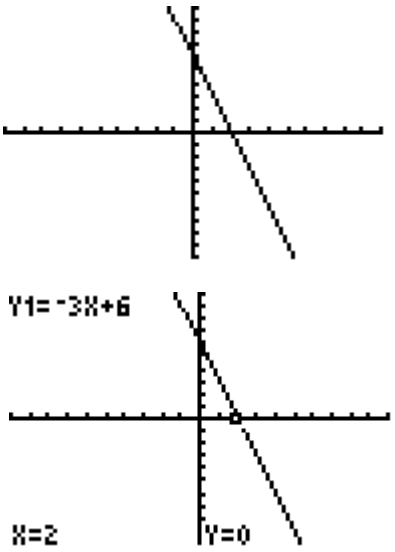
72. The y – intercept has a x coordinate of 0, therefore the y coordinate of the first equation is:

$$6(0) - 3y = 9$$
$$-3y = 9$$
$$y = -3$$

Using this y coordinate in the second equation will find the value of b.

$$-3 = 4(0) + b$$
$$-3 = b$$

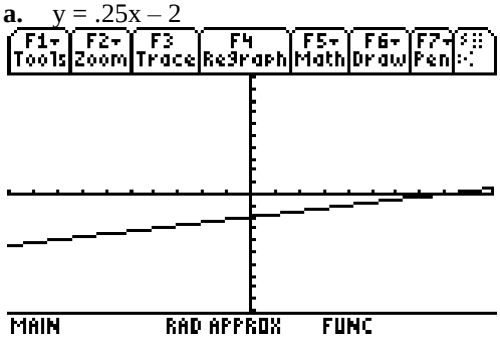
73. a. y = –3x + 6



b. The intercepts are at the points (2, 0) and (0, 6)

c. When x = 2, y = 0

74. a. y = .25x – 2

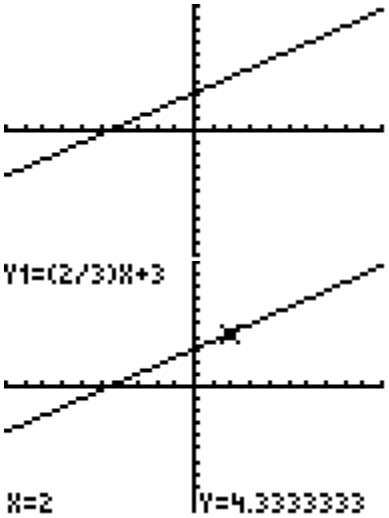


b. (0, –2) and (8,0) are intercepts

c. When x = 2, y = –1.5.

75. a. $3y - 2x = 9$

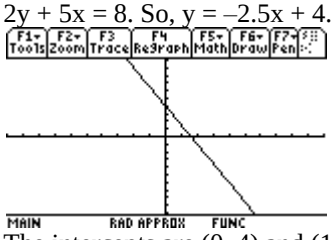
$$3y = 2x + 9$$
$$y = \frac{2}{3}x + 3$$



b. The intercepts are at the points (–4.5, 0) and (0, 3).

c. When x = 2, y = 4.33 or 13 / 3.

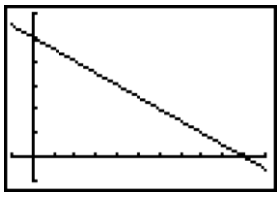
76. a. 2y + 5x = 8. So, y = –2.5x + 4.



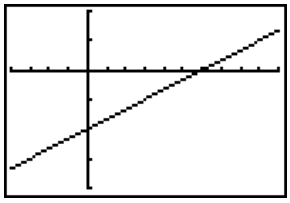
b. The intercepts are (0, 4) and (1.6, 0).

c. When x = 2 then y = –1.

77. 2y + x = 100. When y = 0, x = 100, and when x = 0, y = 50. An appropriate window might be [-10, 110] and [-10,60]. Other answers are possible.



78. x – 3y = 60. When x = 0, then y = - 20 and when y = 0 x = 60. An appropriate window might be [-40, 100] and [-40 , 20] but other answers are equally correct.



Exercises 1.2

1. $m = \frac{2}{3}$

2. $y = 0x - 4$
$m = 0$

3. $y - 3 = 5(x + 4)$
$y = 5x + 23$
$m = 5$

4. $7x + 5y = 10$

$$y = -\frac{7}{5}x + 2$$

$$m = -\frac{7}{5}$$

5. $\frac{x}{5} + \frac{y}{4} = 6$

$$\frac{4x}{5} + y = 24$$

$$y = -\frac{4}{5}x + 24$$

$$m = -\frac{4}{5}$$

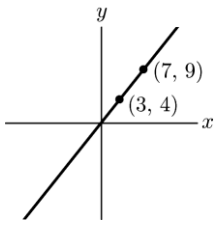
6. $\frac{x}{7} - \frac{y}{8} = 1$

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

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

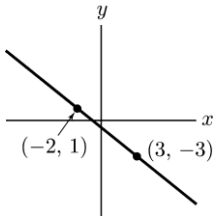
$$m = \frac{8}{7}$$

7.



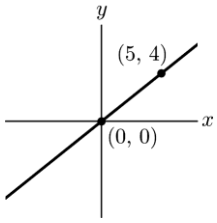
$$m = \frac{9-4}{7-3} = \frac{5}{4}$$

8.



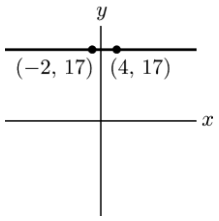
$$m = \frac{-3-1}{3-(-2)} = -\frac{4}{5}$$

9.



$$m = \frac{4-0}{5-0} = \frac{4}{5}$$

10.

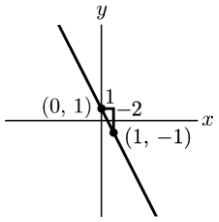


$$m = \frac{17-17}{-2-4} = 0$$

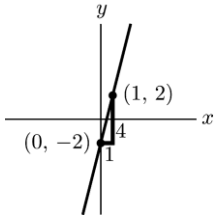
11. The slope of a vertical line is undefined.

12. The slope of a vertical line is undefined.

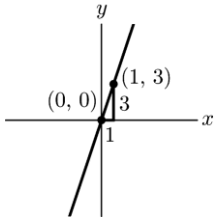
13.



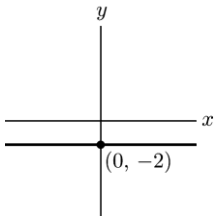
14.



15.



16.



17. $m = \dfrac{-2}{1} = -2$

$y - 3 = -2(x - 2)$

$y = -2x + 7$

18. $m = \dfrac{\frac{1}{2}}{1} = \dfrac{1}{2}$

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

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

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

$y - 0 = -2(x - 2)$

$y = -2x + 4$

20. $m = \dfrac{2-\frac{1}{2}}{1-(-1)} = \dfrac{3}{4}$

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

$y = \dfrac{3}{4}x + \dfrac{5}{4}$

21. $m = -\dfrac{1}{-4} = \dfrac{1}{4}$

$y - 2 = \dfrac{1}{4}(x - 2)$

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

22. $m = \dfrac{1}{3}$

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

$y = \dfrac{1}{3}x + \dfrac{4}{3}$

23. $m = -1$

$y - 0 = -1(x - 0)$

$y = -x$

24. $m = -\dfrac{1}{-\frac{1}{2}} = 2$

$y - (-1) = 2(x - 2)$

$y = 2x - 5$

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

$y - (1) = -2(x - 0)$

$y = -2x + 1$

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

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

$y = 3x - 2$

27. $m = \dfrac{0-2}{-4-0} = \dfrac{-2}{-4} = \dfrac{1}{2}$

$y - 0 = \dfrac{1}{2}(x+4)$

$y = \dfrac{1}{2}x + 2$

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

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

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

29. $m = 0$

$y - 3 = 0(x - 2)$

$y = 3$

30. m = undefined, therefore the equation is of the form $x = a$.

$x = 2$

31. $y - 6 = \dfrac{3}{5}(x-5)$

$y = \dfrac{3}{5}x + 3$

y-intercept: (0, 3)

32. $m = \dfrac{6-3}{4-(-1)} = \dfrac{3}{5}$

$y - 6 = \dfrac{3}{5}(x-4)$

$y - 6 = \dfrac{3}{5}x - \dfrac{12}{5}$

$y = \dfrac{3}{5}x + \dfrac{18}{5}$

y-intercept: $(0, \frac{18}{5})$

33. m = undefined, therefore the equation is of the form $x = a$.

$x = 0$

34. $m = \dfrac{4-4}{0-1} = 0$

$y - 4 = 0(x - 0)$

$y = 4$

35. Let y = cost in dollars.

$y = 9x + 3100$

36. a. p-intercept: (0, 1200); at \$1200 no one will buy the item.

b. $0 = -3q + 1200$

$q = 400$ units

q-intercept: (400, 0); even if the item is given away, only 400 will be taken.

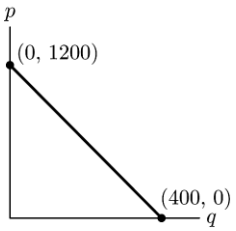
c. –3; to sell an additional item, the price must be reduced by \$3.

d. $p = -3(350) + 1200 = \$150$

e. $300 = -3q + 1200$

$q = 300$ items

f.



37. a. Let x = altitude and y = boiling point.

$m = \dfrac{212 - 202.8}{0 - 5000} = -0.00184$

$y - 212 = -0.00184(x - 0)$

$y = -0.00184x + 212$

b. $y \approx -0.00184x + 212$

$y \approx -0.00184(29029) + 212$

$y \approx 158.6^\circ \text{F}$

38. a. $m = \dfrac{172 - 124}{80 - 68} = 4$

$c - 124 = 4(F - 68)$

$c = 4F - 148$

b. $F = \frac{1}{4}c + 37$, so add 37 to the number of chirps counted in 15 seconds $\left(\frac{1}{4} \text{ of a minute}\right)$.

39. a. Let x = quantity and y = cost.

$$m = \frac{9500 - 6800}{50 - 20} = 90$$

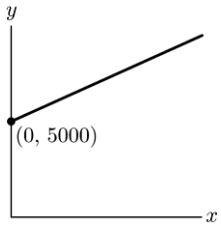
$$y - 6800 = 90(x - 20)$$

$$y = 90x + 5000$$

b. \$5000

c. \$90

d.



40. a. y = 40(100) + 2400 = \$6400

b. 3600 = 40x + 2400
x = 30 coats

c. y = 40(0) + 2400 = \$2400
(0, 2400); even if no coats are made there is a cost for having the ability to make them.

d. 40; each additional coat costs \$40 to make.

41. a. 100(300) = \$30,000

b. $6000 = 100x$
$x = 60$ coats

c. y = 100(0) = 0
(0, 0); if no coats are sold, there is no revenue.

d. 100; each additional coat yields an additional \$100 in revenue.

42. a. Profit = revenue – cost
y = 100x – (40x + 2400)
y = 60x – 2400

b. (0, –2400); if no coats are sold, \$2400 will be lost.

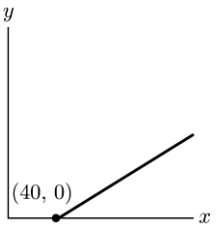
c. 0 = 60x – 2400
x = 40
(40, 0); the break-even point is 40 coats. Less than 40 coats sold yields a loss, more than 40 yields a profit.

d. 60; each additional coat sold yields an additional \$60 profit.

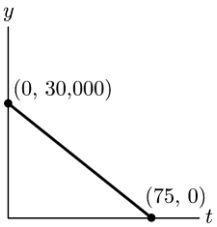
e. y = 60(80) – 2400 = \$2400

f. 6000 = 60x – 2400
x = 140 coats

g.



43. a.



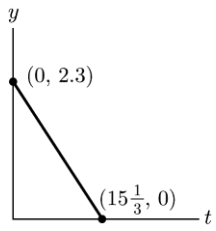
b. On February 1, 31 days have elapsed since January 1. The amount of oil y = 30,000 – 400(31) = 17,600 gallons.

c. On February 15, 45 days have elapsed since January 1. Therefore, the amount of oil would be y = 30,000- 400(45) = 12,000 gallons.

d. The significance of the y-intercept is that amount of oil present initially on January 1. This amount is 30,000 gallons.

e. The t-intercept is (75,0) and corresponds to the number of days at which the oil will be depleted.

44. a.



b. $y = 2.3 - 0.15(15) = \$0.05$ million
\$50,000

c. (0, 2.3); \$2.3 million is the amount of cash reserves on July 1.

d. $0 = 2.3 - 0.15t$

$t = 15\frac{1}{3}$

$\left(15\frac{1}{3}, 0\right)$; the cash reserves will be depleted after $15\frac{1}{3}$ days.

e. $y = 2.3 - 0.15(3) = \$1.85$ million

f. $0.8 = 2.3 - 0.15t$
$t = 10$
After 10 days, on July 11

45. a. $y = 0.10x + 310$

b. $y = 0.10(4000) + 310$
$y = 710$

c. $920 = 0.10x + 310$
$x = \$6100$

46. Each unit sold yields a commission of \$5. In addition, she receives \$60 per week base pay.

47. $m = -\frac{1}{2}$, $b = 0$

$y = -\frac{1}{2}x$

48. $m = 3$, $b = -1$
$y = 3x - 1$

49. $m = -\frac{1}{3}$

$y - (-2) = -\frac{1}{3}(x - 6)$

$y = -\frac{1}{3}x$

50. $m = 1$
$y - 2 = 1(x - 1)$
$y = x + 1$

51. $m = \frac{1}{2}$

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

$y = \frac{1}{2}x - 4$

52. $m = -7$
$y - 0 = -7(x - 5)$
$y = -7x + 35$

53. $m = -\frac{2}{5}$

$y - 5 = -\frac{2}{5}(x - 0)$

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

54. $m = 0$
$y - 4 = 0(x - 7)$
$y = 4$

55. $m = \frac{3 - (-3)}{-1 - 5} = -1$
$y - 3 = -1[x - (-1)]$
$y = -x + 2$

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

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

$y = \frac{1}{2}x$

57. $m = \frac{-1 - (-1)}{3 - 2} = 0$
$y - (-1) = 0(x - 2)$
$y = -1$

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

$y = -2x$

59. Changes in x-coordinate: 1, –1, –2
Changes in y-coordinate are m times that or 2, –2, –4: new y values are 5, 1, –1

60. Change in x coordinates are 1, 2, –1.
Change in y coordinates are m times that or –3, –6, 3. New y values are –1, –4, 5.

61. The slope is $\dfrac{-1}{4}$ Changes in x coordinates are 1, 2, –1. Changes in y coordinates are m times the x coordinate changes. New y coordinates are $\dfrac{-5}{4}, \dfrac{-3}{2}, \dfrac{-3}{4}$

62. Changes in x-coordinate: 1, 2, 3
Changes in y-coordinate are m times that:
$\dfrac{1}{3}, \dfrac{2}{3}, 1$
y-coordinates:
$2+\dfrac{1}{3}=\dfrac{7}{3},\ 2+\dfrac{2}{3}=\dfrac{8}{3},\ 2+1=3$
$\dfrac{7}{3}; \dfrac{8}{3}; 3$

63. **a.** $x + y = 1$
$y = -x + 1$
(C)

b. $x - y = 1$
$y = x - 1$
(B)

c. $x + y = -1$
$y = -x - 1$
(D)

d. $x - y = -1$
$y = x + 1$
(A)

64. $m = \dfrac{4.8-3.6}{4.9-4.8} = 12;$
$y - 6 = 12(x - 5)$
$y = 12x - 54$
$b = -54$

65. One possible equation is $y = x + 1$.

66. One possible equation is $y = -x + 1$.

67. One possible equation is $y = 5$.

68. One possible equation is $x = 2$.

69. One possible equation is $y = -\dfrac{2}{3}x$.

70. One possible equation is $y = \dfrac{6}{5}x$.

71. $m = \dfrac{212-32}{100-0} = \dfrac{9}{5}$

$F - 32 = \dfrac{9}{5}(C - 0)$

$F = \dfrac{9}{5}C + 32$

72. Let x = years B.C. and y = feet.

$m = \dfrac{8-4}{2100-1500} = \dfrac{1}{150}$

$y - 4 = \dfrac{1}{150}(x - 1500)$

$y = \dfrac{1}{150}x - 6$

$y = \dfrac{1}{150}(3000) - 6 = 14\ ft$

73. Let 2010 correspond to x = 0. So in 2018, x = 8. When x = 0, tuition is 7132. When x = 8, tuition is 9212. Using (0,7132) and (8,9212) as ordered pairs, find the slope of the line containing these points: $\dfrac{9212-7132}{8-0} = \dfrac{2080}{8}$. Since the y-intercept is 7132, the equation becomes $y = 260x + 7132$. Therefore, in 2016 when x = 6, the tuition should approximately be $y = 260\ 6\ + 7132 = \$8692.$

74. Let 2012 correspond to x = 0. So in 2018, x = 6. When x = 0, enrollment was 7.2 million. When x = 6, enrollment was 5.7 million. Using (0,7.2) and (6,5.7) as ordered pairs, find the slope of the line containing these points:
$\dfrac{5.7-7.2}{6-0} = \dfrac{-1.5}{6} = -0.25$. Since the y-intercept is 7.2, the equation becomes $y = -0.25x + 7.2$.

Therefore, the enrollment was at 6.4 million when y = 6.4 in $y = -0.25x + 7.2$

$6.4 = -0.25x + 7.2$

$3.2 = x$

Since x is the number of years after 2012, the enrollment was 6.4 million around 2015.

75. Let x = number of pounds tires are under inflated. When x = 0, the miles per gallon (y) is 25. When x = 1, mpg decreases to 24.5. The equation is $y = -\frac{1}{2}x + 25$. Thus, when x = 8 pounds the miles per gallon will be $y = -\frac{1}{2}(8) + 25 = 21$ mpg.

76. The slope is $\frac{4,599,200 - 3,439,700}{10} = 115,950$. The equation is y = 115,950x + 3,439,700. When x = 6 (2025), y = 115,950(6) + 3,439,700 =4,135,400.

77. Let 2014 correspond to x = 0 and 2019 correspond to x = 5. Then, the two ordered pairs are on the line: (0, 358132) and (5,390564). The slope of the line is $\frac{390,564 - 358,132}{5 - 0} = 6486.4$ The equation of the line is therefore $y = 6486.4x + 358,132$. In the year 2026, x = 12, so the number of Bachelor's degrees awarded can be estimated as $y = 6486.4(12) + 358,132 = 435,969$.

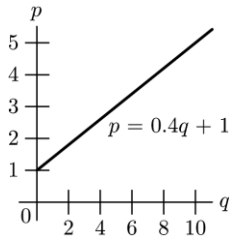
78. The slope is $\frac{6355 - 4929}{10} = 142.6$. The equation is $y = 142.6x + 4929$. Find x when y = 7355. We have $7355 = 142.6x + 4929$. Solving for x gives x about 17.01 years or in the year 2027.

79. Let 2016 correspond to x = 0 and 2021 correspond to x = 5. Then, the two ordered pairs are on the line: (0, 4.8) and (5,5.5). The slope of the line is $\frac{5.5 - 4.8}{5 - 0} = \frac{0.7}{5} = \frac{7}{50}$. The equation of the line is therefore $y = \frac{7}{50}x + 4.8$. In the year 2019, x = 3, so the cost of a 30-second advertising slot (in millions) can be estimated as $y = \frac{7}{50}(3) + 4.8 \approx \$5.2$ million.

80. The slope is $\frac{500 - 3000}{4 - 0} = -625$. The equation is $y = -625x + 3000$.

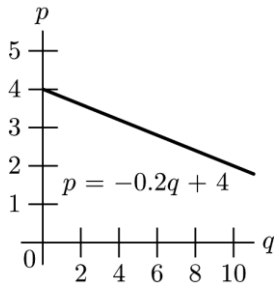
81. The slope is $\frac{3.4 - 3}{6 - 5} = 0.4$

$$p - p_1 = m(q - q_1)$$
$$p - 3 = 0.4(q - 5)$$
$$p - 3 = 0.4q - 2$$
$$p = 0.4q + 1$$



82. The slope is $\frac{3.1 - 3}{4.5 - 5} = \frac{0.1}{-0.5} = -0.2$

$$p - p_1 = m(q - q_1)$$
$$p - 3 = -0.2(q - 5)$$
$$p - 3 = -0.2q + 1$$
$$p = -0.2q + 4$$



83. $m_1 = \frac{4 - 3}{2 - 1} = 1$

$m_2 = \frac{-1 - 4}{3 - 2} = -5$

$m_1 \neq m_2$

84. Set two slopes equal:

$$\frac{7-5}{2-1}=\frac{k-7}{3-2}$$
$$2=k-7$$
$$k=9$$

85. Set slopes equal:

$$\frac{-3.1-1}{2-a}=\frac{2.4-0}{3.8-(-1)}$$
$$\frac{-4.1}{2-a}=\frac{1}{2}$$
$$-8.2=2-a$$
$$a=10.2$$

86. Make slopes negative inverses of each other:

$$\frac{-3.1-1}{2-a}=-\frac{1}{\frac{2.4-0}{3.8-(-1)}}$$
$$\frac{-4.1}{2-a}=-2$$
$$4.1=4-2a$$
$$a=-.05$$

87. Solve $mx+b=m'x+b'$

$$(m-m')x=b'-b$$
$$x=\frac{b'-b}{m-m'},$$

which is defined if and only if $m\neq m'$.

88. $l_1: y=m_1x$

$l_2: y=m_2x$

So the vertical segment lies on $x = 1$.

Then

$$1^2+m_1^2=a^2$$
$$1^2+(-m_2)^2=b^2$$

Add equations and rearrange:

$$a^2+b^2-(m_1^2+m_2^2)=2$$

l_1 and l_2 are perpendicular if and only if

$$a^2+b^2=(m_1-m_2)^2=m_1^2+m_2^2-2m_1m_2$$

or $a^2+b^2-(m_1^2+m_2^2)=-2m_1m_2$

Substitute: $2=-2m_1m_2$

Therefore, the product of the slopes are –1.

89. Let x = Centigrade temperature

y = Fahrenheit temperature

$$m=\frac{212-32}{100-0}=1.8$$
$$y=1.8x+32$$
$$y=1.8(30)+32=86^\circ\text{F}$$

90. Let x = weight

y = cost

$$m=\frac{38-5}{60-0}=\frac{11}{20}$$
$$y=\frac{11}{20}x+5$$
$$y=\frac{11}{20}(20)+5=\$16.00$$

91. Let x = number of T-shirts

profit = revenue – cost

$$65,000=12.50x-(8x+25,000)$$
$$90,000=4.50x$$
$$x=20,000$$

So 20,000 T-shirts must be produced and sold.

92. Let x = number of units

profit = revenue – cost

$$2,000,000=130x-(100x+1,000,000)$$
$$3,000,000=30x$$
$$x=100,000 \text{ units}$$

93. $q=800-4(150)$

$=200$ bikes

revenue = 150(200) = $30,000

94. $n=2200-25(8)$

$=2000$ cameras

revenue = 8(2000) = $16,000

95. Let x = variable costs

For 2021: profit = revenue – cost

$$400,000=100(50,000)-(50,000x+600,000)$$
$$50,000x=4,000,000$$
$$x=\$80 \text{ per unit}$$

For 2022:
Let y = 2022 price
profit = revenue – cost

$$400,000 = 50,000y - [80(50,000) + 600,000 + 200,000]$$
$$5,200,000 = 50,000y$$
$$y = \$104$$

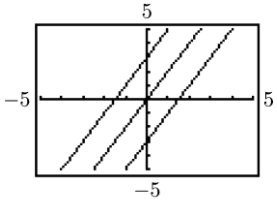
96. Let x = variable costs
For 2015: profit = revenue – costs

$$300,000 = 100(50,000) - (50,000x + 800,000)$$
$$50,000x = 3,900,000$$
$$x = \$78 \text{ per unit}$$

For 2016:
Let y = 2016 price
profit = revenue – cost

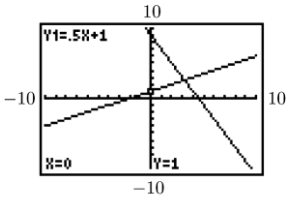
$$300,000 = 50,000y - [78(50,000) + 800,000 + 200,000]$$
$$5,200,000 = 50,000y$$
$$y = \$104$$

97

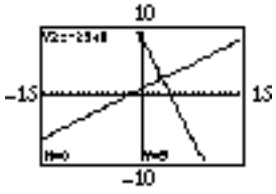


From left to right the lines are $y = 2x + 3$, $y = 2x$, and $y = 2x - 3$.
The lines are distinguished by their y-intercepts, which appear as b in the form $y = mx + b$.

98.

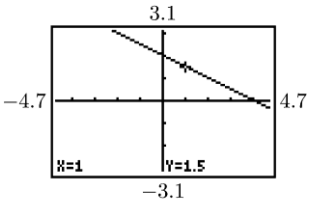


No, do not appear perpendicular



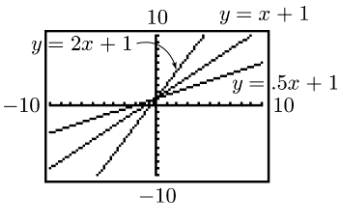
Do appear perpendicular

99.



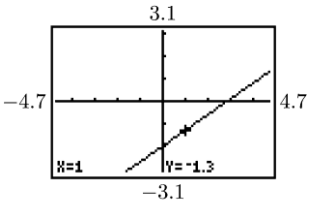
Since the slope equals $-\frac{1}{2}$, moving 2 units to the right requires moving $2 \cdot \left(-\frac{1}{2}\right) = -1$ unit up, or 1 unit down.

100.



The steeper the line, the greater the slope m in $y = mx + b$ form.

101.



Since the slope equals 0.7, moving 2 units to the right requires moving $2 \cdot 0.7 = 1.4$ units up.

Exercises 1.3

1. $4x - 5 = -2x + 7$
$6x = 12$
$x = 2$
$y = 4(2) - 5 = 3$
(2, 3)

2. $3x - 15 = -2x + 10$
$5x = 25$
$x = 5$
$y = 3(5) - 15 = 0$
(5, 0)

3. $x = 4y - 2$
$x = -2y + 4$
$4y - 2 = -2y + 4$
$6y = 6$

$y = 1$
$x = 4(1) - 2 = 2$
(2, 1)

4. $\begin{cases} 2x - 3y = 3 \\ y = 3 \end{cases}$

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

5. $y = \frac{1}{3}(12) - 1 = 3$
(12, 3)

6. $\begin{cases} 2x - 3y = 3 \\ x = 6 \end{cases}$

$y = \frac{2}{3}x - 1 = \frac{2}{3}(6) - 1 = 3$
(6, 3)

7. $\begin{cases} 6 - 3(4) = -6 \\ 3(6) - 2(4) = 10 \end{cases}$

$\begin{cases} -6 = -6 \\ 10 = 10 \end{cases}$
Yes

8. $\begin{cases} 4 = \frac{1}{3}(12) - 1 \\ 12 = 12 \end{cases}$

$\begin{cases} 4 = 3 \\ 12 = 12 \end{cases}$
No

9. $\begin{cases} y = -2x + 7 \\ y = x - 3 \end{cases}$

$-2x + 7 = x - 3$
$-3x = -10$
$x = \frac{10}{3}$
$y = \frac{10}{3} - 3 = \frac{1}{3}$
$x = \frac{10}{3},\ y = \frac{1}{3}$

10. $\begin{cases} y = -\frac{1}{2}x + 2 \\ y = -x + 6 \end{cases}$

$-\frac{1}{2}x + 2 = -x + 6$
$\frac{1}{2}x = 4$
$x = 8$
$y = -(8) + 6 = -2$
$x = 8,\ y = -2$

11. $\begin{cases} y = \frac{5}{2}x - \frac{1}{2} \\ y = -2x - 4 \end{cases}$

$\frac{5}{2}x - \frac{1}{2} = -2x - 4$
$\frac{9}{2}x = -\frac{7}{2}$
$x = -\frac{7}{9}$
$y = -2\left(-\frac{7}{9}\right) - 4 = -\frac{22}{9}$
$x = -\frac{7}{9},\ y = -\frac{22}{9}$

12. $\begin{cases} y = -\frac{1}{2}x + 3 \\ y = 3x - 12 \end{cases}$

$-\frac{1}{2}x + 3 = 3x - 12$
$-\frac{7}{2}x = -15$
$x = \frac{30}{7}$
$y = -\frac{1}{2}\left(\frac{30}{7}\right) + 3 = \frac{6}{7}$
$x = \frac{30}{7},\ y = \frac{6}{7}$

13. $\begin{cases} x = 3 \\ 2x + 3y = 18 \end{cases}$

$y = -\frac{2}{3}x + 6 = -\frac{2}{3}(3) + 6 = 4$

$A = (3, 4)$

$\begin{cases} y = 2 \\ 2x + 3y = 18 \end{cases}$

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

$B = (6, 2)$

14. $\begin{cases} y = -\frac{1}{3}x + 7 \\ x = 0 \end{cases}$

$y = -\frac{1}{3}(0) + 7 = 7$

$A = (0, 7)$

$\begin{cases} y = -\frac{1}{3}x + 7 \\ y = -x + 9 \end{cases}$

$-\frac{1}{3}x + 7 = -x + 9$

$\frac{2}{3}x = 2$

$x = 3$

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

$B = (3, 6)$

$\begin{cases} y = -x + 9 \\ y = -3x + 19 \end{cases}$

$-x + 9 = -3x + 19$

$2x = 10$

$x = 5$

$y = -(5) + 9 = 4$

$C = (5, 4)$

$\begin{cases} y = -3x + 19 \\ y = 0 \end{cases}$

$-3x + 19 = 0$

$-3x = -19$

$x = \frac{19}{3}$

$D = \left(\frac{19}{3}, 0\right)$

Point E is the origin (0,0).

15. $A = (0, 0)$

$\begin{cases} y = 2x \\ y = \frac{1}{2}x + 3 \end{cases}$

$2x = \frac{1}{2}x + 3$

$x = 2$

$y = 2(2) = 4$

$B = (2, 4)$

$\begin{cases} y = \frac{1}{2}x + 3 \\ x = 5 \end{cases}$

$y = \frac{1}{2}(5) + 3 = \frac{11}{2}$

$C = \left(5, \frac{11}{2}\right)$

$D = (5, 0)$

16. $\begin{cases} x = 0 \\ 2x + y = 14 \end{cases}$

$y = -2x + 14 = -2(0) + 14 = 14$

$A = (0, 14)$

$\begin{cases} 2x + y = 14 \\ 3x + 2y = 24 \end{cases}$

$\begin{cases} y = -2x + 14 \\ y = -\frac{3}{2}x + 12 \end{cases}$

$-2x + 14 = -\frac{3}{2}x + 12$

$-\frac{1}{2}x = -2$

$x = 4$

$y = -2(4) + 14 = 6$

$B = (4, 6)$

$\begin{cases} 3x + 2y = 24 \\ x + 2y = 12 \end{cases}$

$\begin{cases} y = -\frac{3}{2}x + 12 \\ y = -\frac{1}{2}x + 6 \end{cases}$

$-\frac{3}{2}x + 12 = -\frac{1}{2}x + 6$

$-x = -6$

$x = 6$

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

$C = (6, 3)$

$$\begin{cases} x + 2y = 12 \\ y = 0 \end{cases}$$

$x = -2y + 12 = -2(0) + 12 = 12$

$D = (12, 0)$

17. a. $p = 0.0001(19{,}500) + 0.05$
$= \$2.00$

b. $p = 0.0001(0) + 0.05$
$= \$0.05$

No units will be supplied for \$0.05 or less.

18. a. $p = -0.001(31{,}500) + 32.5$
$= \$1.00$

b. $-0.001q + 32.5 = 0$
$q = 32{,}500$ units

Quantities of 32,500 or more.

19. $$\begin{cases} p = 0.0001q + 0.05 \\ p = -0.001q + 32.5 \end{cases}$$

$0.0001q + 0.05 = -0.001q + 32.5$
$0.0011q = 32.45$
$q = 29{,}500$ units

$p = 0.0001(29{,}500) + 0.05$
$p = \$3.00$

20. $p = \frac{1}{300}q + 13$

$p = -0.03q + 19$

$\frac{1}{300}q + 13 = -0.03q + 19$

$\frac{1}{30}q = 6$

$q = 180$ books

$p = -0.03(180) + 19$
$p = \$13.60$

21. a. $p = -0.15q + 6.925$
$5.80 = -0.15q + 6.925$
$-1.125 = -0.15q$
$7.5 = q$

$p = 0.2q + 3.6$
$5.80 = 0.2q + 3.6$
$2.2 = 0.2q$
$11 = q$

Demand will be 7.5 billion bushels and supply will be 11 billion bushels

b. The equilibrium point occurs when supply is the same as demand. Therefore,

$-0.15q + 6.925 = 0.2q + 3.6$
$-0.35q = -3.325$
$q = 9.5$

To find the equilibrium price, substitute the value into either equation.

$p = -0.15(9.5) + 6.925$
$p = -1.425 + 6.925$
$p = 5.5$

Equilibrium occurs when 9.5 billion bushels are produced and sold for \$5.50 per bushel.

22. a. $p = -2.2q + 19.36$
$16.50 = -2.2q + 19.36$
$-2.86 = -2.2q$
$1.3 = q$

$p = 1.5q + 9$
$16.50 = 1.5q + 9$
$7.50 = 1.5q$
$5 = q$

Demand will be 1.3 billion bushels and supply will be 5 billion bushels.

b. The equilibrium point occurs when supply is the same as demand. Therefore,

$$\begin{aligned} -2.2q + 19.36 &= 1.5q + 9 \\ -3.7q &= -10.36 \\ q &= 2.8 \end{aligned}$$

To find the equilibrium price, substitute the value into either equation.

$$\begin{aligned} p &= -2.2(2.8) + 19.36 \\ p &= -6.16 + 19.36 \\ p &= 13.20 \end{aligned}$$

Equilibrium occurs when 2.8 billion bushels are produced and sold for \$13.20 per bushel

23. Let $C = F$, then

$$\begin{aligned} C &= \frac{5}{9}(F - 32) \\ F &= \frac{5}{9}(F - 32) \\ \frac{9F}{5} &= F - 32 \\ \frac{4F}{5} &= -32 \\ F &= -40 \end{aligned}$$

Therefore, when the temperature is -40°, it will be the same on both temperature scales.

24. **a.** $F = \frac{9}{5}(5) + 32$

$F = 41$

$F = 2(5) + 30$

$F = 40$

The two temperatures differ by 1° F.

b. $F = \frac{9}{5}(20) + 32$

$F = 68$

$F = 2(20) + 30$

$F = 70$

The two temperatures differ by 2° F.

c. $2C + 30 = \frac{9}{5}C + 32$

$$\begin{aligned} \frac{1}{5}C &= 2 \\ C &= 10 \end{aligned}$$

When the temperature is 10 degrees Celsius, the two formulas will give the same Fahrenheit temperature.

25. Let x = numbers of shirts and y = cost of manufacture.

$$\begin{cases} y = 30x + 1200 \\ y = 35x + 500 \end{cases}$$

$$\begin{aligned} 30x + 1200 &= 35x + 500 \\ -5x &= -700 \\ x &= 140 \end{aligned}$$

$y = 30x + 1200$

$y = 30(140) + 1200$

$y = 4200 + 1200$

$y = 5400$

The manufactures will charge the same \$5400 if they produce 140 shirts.

26. Let x = hours working and y = hours supervising.

$$\begin{cases} x + y = 40 \\ 24x + 30y = 1008 \end{cases}$$

$$\begin{cases} y = -x + 40 \\ y = -\frac{4}{5}x + \frac{168}{5} \end{cases}$$

$$\begin{aligned} -x + 40 &= -\frac{4}{5}x + \frac{168}{5} \\ -\frac{1}{5}x &= -\frac{32}{5} \\ x &= 32 \end{aligned}$$

$y = -32 + 40 = 8$

Working: 32; supervising: 8

27. Method A: $y = .45 + .01x$
Method B: $y = .035x$
Intersection point:
$.45 + .01x = .035x$
$.45 = .025x$
$18 = x$

For a call lasting 18 minutes, the costs for either method will be the same, $y = .035(18) = 63$. The cost will be 63cents.

28. Let x = numbers of miles towed and
y = cost of the tow.
$\begin{cases} y = 3x + 50 \\ y = 2.5x + 60 \end{cases}$
$3x + 50 = 2.5x + 60$
$0.5x = 10$
$x = 20$
$y = 3x + 50$
$y = 3(20) + 50$
$y = 60 + 50$
$y = 110$
The two companies will charge the same \$110 if they tow a car 20 miles.

29. $\begin{cases} 3x - y = 3 \\ x + y = 5 \\ y = 0 \end{cases}$
$\begin{cases} y = 3x - 3 \\ y = -x + 5 \\ y = 0 \end{cases}$
$\begin{cases} y = 3x - 3 \\ y = -x + 5 \end{cases} \Rightarrow (2, 3)$
$\begin{cases} y = -x + 5 \\ y = 0 \end{cases} \Rightarrow (5, 0)$
$\begin{cases} y = 3x - 3 \\ y = 0 \end{cases} \Rightarrow (1, 0)$
Based on the above points of intersection, the base of the triangle is $5 - 1 = 4$ and the height is 3. Therefore the area of the triangle, in square units, is:
$A = \frac{1}{2}bh$
$A = \frac{1}{2}(4)(3)$
$A = 6$

30. $\begin{cases} 3x + 4y = 24 \\ 2x - 4y = -4 \\ x = 0 \end{cases}$
$\begin{cases} y = -\frac{3}{4}x + 6 \\ y = \frac{1}{2}x + 1 \\ x = 0 \end{cases}$
$\begin{cases} y = -\frac{3}{4}x + 6 \\ y = \frac{1}{2}x + 1 \end{cases} \Rightarrow (4, 3)$
$\begin{cases} y = -\frac{3}{4}x + 6 \\ x = 0 \end{cases} \Rightarrow (0, 6)$
$\begin{cases} y = \frac{1}{2}x + 1 \\ x = 0 \end{cases} \Rightarrow (0, 1)$
Based on the above points of intersection, the base of the triangle is $6 - 1 = 5$ and the height is 4. Therefore the area of the triangle, in square units is:
$A = \frac{1}{2}bh$
$A = \frac{1}{2}(5)(4)$
$A = 10$

31. Let x = weight of first contestant
y = weight of second contestant
$\begin{cases} x + y = 700 \\ 2x = 275 + y \end{cases}$
$\begin{cases} y = 700 - x \\ y = 2x - 275 \end{cases}$
$700 - x = 2x - 275$
$975 = 3x$
$x = 325$ pounds

32. Let x = number of 43" TVs sold and
y = number of 55" TVs sold

$$\begin{cases} y = x + 5 \\ 400x + 730y = 26250 \end{cases}$$

$$\begin{cases} y = x + 5 \\ y = -\frac{40}{73}x + \frac{2625}{73} \end{cases}$$

$$x + 5 = -\frac{40}{73}x + \frac{2625}{73}$$

$$\frac{113}{73}x = \frac{2260}{73}$$

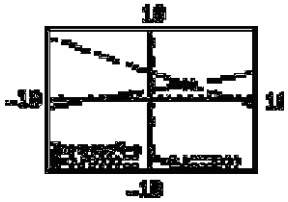
$x = 20$ TV sets

$y = 20 + 5$

$= 25$ TV sets

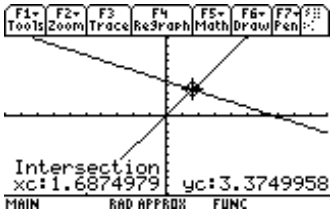
Total = 20 + 25 = 45 TV sets

33.



(3.73, 2.23)

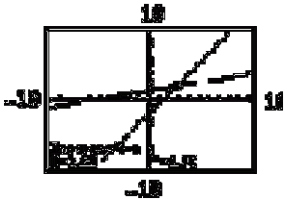
34.



(1.69, 3.38)

35. $$\begin{cases} x - 4y = -5 \\ 3x - 2y = 4.2 \end{cases}$$

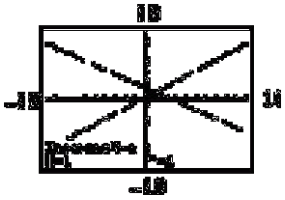
$$\begin{cases} y = \frac{1}{4}x + \frac{5}{4} \\ y = \frac{3}{2}x - 2.1 \end{cases}$$



(2.68, 1.92)

36. $$\begin{cases} 2x + 3y = 5 \\ -4x + 5y = 1 \end{cases}$$

$$\begin{cases} y = -\frac{2}{3}x + \frac{5}{3} \\ y = \frac{4}{5}x + \frac{1}{5} \end{cases}$$



(1, 1)

Exercises 1.4

1.

Data Point	Point on Line	Vertical Distance
(1, 3)	(1, 4)	1
(2, 6)	(2, 7)	1
(3, 11)	(3, 10)	1
(4, 12)	(4, 13)	1

$1^2 + 1^2 + 1^2 + 1^2 = 4$

2.

Data Point	Point on Line	Vertical Distance
(1, 11)	(1, 10)	1
(2, 7)	(2, 8)	1
(3, 5)	(3, 6)	1
(4, 5)	(4, 4)	1

$E = 1^2 + 1^2 + 1^2 + 1^2 = 4$

3. $E_1^2 = [1.1(1) + 3 - 3]^2 = 1.21$

$E_2^2 = [1.1(2) + 3 - 6]^2 = .64$

$E_3^2 = [1.1(3) + 3 - 8]^2 = 2.89$

$E_4^2 = [1.1(4) + 3 - 6]^2 = 1.96$

$E = 1.21 + .64 + 2.89 + 1.96 = 6.70$

4. $E_1^2 = [-1.3(1) + 8.3 - 8]^2 = 1.00$

$E_2^2 = [-1.3(2) + 8.3 - 5]^2 = 0.49$

$E_3^2 = [-1.3(3) + 8.3 - 3]^2 = 1.96$

$E_4^2 = [-1.3(4) + 8.3 - 4]^2 = 0.81$

$E_5^2 = [-1.3(5) + 8.3 - 2]^2 = 0.04$

$E = 1.00 + 0.49 + 1.96 + 0.81 + 0.04 = 4.3$

5.

x	y	xy	x^2
1	7	7	1
2	6	12	4
3	4	12	9
4	3	12	16
$\sum x = 10$	$\sum y = 20$	$\sum xy = 43$	$\sum x^2 = 30$

$$m = \frac{4 \cdot 43 - 10 \cdot 20}{4 \cdot 30 - 10^2} = -1.4$$

$$b = \frac{20 - (-1.4)(10)}{4} = 8.5$$

6.

x	y	xy	x^2
1	2	2	1
2	4	8	4
3	7	21	9
4	9	36	16
5	12	60	25
$\sum x = 15$	$\sum y = 34$	$\sum xy = 127$	$\sum x^2 = 55$

$$m = \frac{5 \cdot 127 - 15 \cdot 34}{5 \cdot 55 - 15^2} = 2.5$$

$$b = \frac{34 - (2.5)(15)}{5} = -0.7$$

7. $\sum x = 6, \sum y = 18, \sum xy = 45, \sum x^2 = 14$

$$m = \frac{3 \cdot 45 - 6 \cdot 18}{3 \cdot 14 - 6^2} = 4.5$$

$$b = \frac{18 - (4.5)(6)}{3} = -3$$

$y = 4.5x - 3$

8. $\sum x = 7, \sum y = 15, \sum xy = 28, \sum x^2 = 21$

$$m = \frac{3 \cdot 28 - 7 \cdot 15}{3 \cdot 21 - 7^2} = -1.5$$

$$b = \frac{15 - (-1.5)(7)}{3} = 8.5$$

$y = -1.5x + 8.5$

9. $\sum x = 10,\ \sum y = 26,\ \sum xy = 55,$
$\sum x^2 = 30$
$m = \dfrac{4\cdot 55 - 10\cdot 26}{4\cdot 30 - 10^2} = -2$

$b = \dfrac{26 - (-2)(10)}{4} = 11.5$
$y = -2x + 11.5$

10. $\sum x = 10, \sum y = 28, \sum xy = 77, \ \sum x^2 = 30$
$m = \dfrac{4\cdot 77 - 10\cdot 28}{4\cdot 30 - 10^2} = 1.4$
$b = \dfrac{28 - (1.4)(10)}{4} = 3.5$
$y = 1.4x + 3.5$

11. **a.** $\sum x = 12, \sum y = 7,\ \sum xy = 41,$
$\sum x^2 = 74$
$m = \dfrac{2\cdot 41 - 12\cdot 7}{2\cdot 74 - 12^2} = -0.5$
$b = \dfrac{7 - (-.5)(12)}{2} = 6.5$
$y = -0.5x + 6.5$
b. $m = \dfrac{4-3}{5-7} = -\dfrac{1}{2} = -0.5$
$y - 3 = -0.5(x - 7)$
$y = -0.5x + 6.5$
c. The least–squares error for the line in (b) is E=0.

12. The least–squares error for the line E=0.

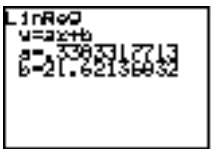
13. **a.** $\sum x = 7, \sum y = 20,\ \sum xy = 90,$
$\sum x^2 = 37$
$m = \dfrac{2\cdot 90 - 7\cdot 20}{2\cdot 37 - 7^2} = 1.6 = \dfrac{8}{5}$
$b = \dfrac{20 - (1.6)(7)}{2} = 4.4 = \dfrac{22}{5}$
$y = \dfrac{8}{5}x + \dfrac{22}{5}$
b. $E = [1.6(4) + 4.4 - 5]^2 = 33.64$

14. **a.** $\sum x = 10, \sum y = 19,\ \sum xy = 104,$
$\sum x^2 = 52$
$m = \dfrac{2\cdot 104 - 10\cdot 19}{2\cdot 52 - 10^2} = 4.5 = \dfrac{9}{2}$
$b = \dfrac{19 - (4.5)(10)}{2} = -13$
$y = \dfrac{9}{2}x - 13$
b. $E = [4.5(1) - 13 - 6]^2 = 210.25$

15. **a.** Let x represent city and y represent highway, then $\sum x = 200, \sum y = 186,\ \sum xy = 9388,$
$\sum x^2 = 10{,}118$
$m = \dfrac{4\cdot 9388 - 200\cdot 186}{4\cdot 10{,}118 - 200^2} \approx 0.7458$
$b = \dfrac{186 - (0.7458)(200)}{4} \approx 9.21$
$y = 0.7458x + 9.21$
b. $y = 0.7458(54) + 9.21$
$y \approx 49.48$ mpg
c. $50 = 0.7458x + 9.21$
$x \approx 54.69$ mpg

16. **a.** Let x represent stores (in thousands) and y represent sales (in millions), then
$\sum x = 15.576, \sum y = 12{,}595,\ \sum xy = 65357.19,$
$\sum x^2 = 81.836394$
$m = \dfrac{4\cdot 65357.19 - 15.576\cdot 12595}{4\cdot 81.836394 - 15.576^2} \approx 770.0$
$b = \dfrac{12595 - (770.05)(15.576)}{4} \approx 150.2$
$y = 770.0x + 150.2$
b. $y = 770.0(4) + 150.2$
$y = 3230.2$ million
$y = \$3{,}230{,}200{,}000$
c. $2500 = 770.0x + 150.2$
$x = 3.052$ thousand
$x = 3052$

17. **a.**



$y = .338x + 21.6$

b. 0.338(1100) + 21.6 = 393.4
There will be about 393 deaths per million males

18. a. $y = 1.913 + 55.489$

b. 1.913(18) + 55.489= 90.0
About 90% of the 2018 US adults used the internet.

c. $80 = 1.913 + 55.489$
$x \approx 12.81$
Approximately 80% of adults used the internet in the year 2000 + 13 = 2013.

19. a. Let x be the number of years after 1994, then y = 0.521x + 22.3

b. 0.521(23) + 22.3 = 34.3
About 34.3% completed four or more years of college

c. $41.1 = 0.521x + 22.3$
$x \approx 36.08$
Approximately 41.1% of persons 25 years and over will have completed 4 or more years of college in the year 1994 + 36 = 2030.

20. a. Let x be the number of years after 2010, then y = 0.59x + 13.72

b. 0.59(7) + 13.72 = 17.85
The average cost in 2017 will be approximately \$17.9 thousand or \$17,900.

c. $25 = 0.59x + 13.72$
$x \approx 19.1$
The cost will be approximately \$25,00 early in the year 2010 + 19 = 2029.

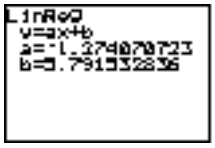
21. a. $y = 0.124x + 77.34$

b. 0.124(30) +77.34 = 81.06
A 30 – year old US male has a life expectancy of about 81.06 years

c. 0.124(50) +77.34 = 83.54
A 50 – year old US male has a life expectancy of about 83.54 years

d. 0.124(90) +77.34 = 88.5
Life expectancy will be about 88.5 years (This is an example of a fit that is not capable of extrapolating beyond the given data)

22. a.



$y = –1.274x + 5.792$

b. The higher the independence, the lower the inflation rate.

c. –1.274(.6) + 5.792 = 5.0276
About 5.0%

d. 6.8 = –1.274x + 5.792
$x \approx –.791$
About –0.8

23. a. Let x be the number of years after 2005, then y = 0.03025x + 0.802

b. 0.03025(14) + 0.802 ≈ 1.23
In the year 2019, the price of a pound of spaghetti was about \$1.23.

c. $1.47 = 0.03025x + 0.802$
$x \approx 22.08$
The price per pound of spaghetti will be \$1.47 in the year 2005 + 22 = 2027.

24. a. $y = 1.875x + 336.8$

b. The year 2012 is 32 years after the base year of 1980, therefore:
1.875(32) + 336.8 = 396.8
396.8; It is close to the actual value.

c. $425 = 1.875x + 336.8$
$x \approx 47.04$
The year is 47 years after 1980 or 2027.

Chapter 1 Fundamental Concept Check

1. To determine the *x*-coordinate (*y*-coordinate), draw a straight line through the point perpendicular through the *x*-axis (*y*-axis) and read the number on the axis.

2. The graph of an equation is the collection of points in the plane whose coordinates satisfy the equation.

3. The *y*-intercept is the point at which the graph of the line crosses the *y*-axis. To find the *y*-intercept, set $x = 0$ and solve for *y*. Then the *y*-intercept is the point (0, solution for *y*).

4. The *x*-intercept is the point at which the graph of the line crosses the *x*-axis. To find the *x*-intercept, set $y = 0$ and solve for *x*. Then the *x*-intercept is the point (solution for *x*, 0).

5. See Table 1 on page 3.

6. $cx + dy = e,$ where both *c* and *d* are not 0.

7. The slope of the line $y = mx + b$ is the number *m.* It is a measure of the steepness of the line.

8. $y = mx + b.$

9. Plot the given point, move one unit to the right the $|m|$ units in the *y*-direction (up if *m* is positive and down if *m* is negative), plot the second point, and draw a line through the two points.

10. $y - y_1 = m(x - x_1),$ where x_1, y_1 is a point on the line and *m* is the slope of the line.

11. First calculate the slope $m = \dfrac{\text{difference of } y-\text{coordinates}}{\text{difference of } x-\text{coordinates}}$. Then, use *m*, either of the two points, and the point-slope formula to write the equation for the line.

12. One slope is the negative reciprocal of the other.

13. They are the same.

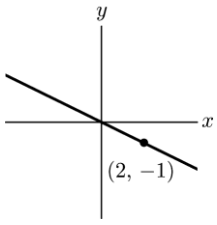
14. First, write the two linear equations in slope-intercept or vertical form. If both equations are in slope-intercept form, equate the two expressions for *y*, solve for *x*, substitute the value for *x* into one of the equations, and solve for *y*. Otherwise, substitute the value of *x* into the equation having slope-intercept form and solve for *y*.

15. The straight line that gives the best fit to a collection of points in the sense that the sum of the squares of the vertical distances from the points to the line is as small as possible.

Chapter 1 Review Exercises

1. $x = 0$

2.



3. $\begin{cases} x - 5y = 6 \\ 3x = 6 \end{cases}$

$\begin{cases} x = 5y + 6 \\ x = 2 \end{cases}$

$5y + 6 = 2$

$y = -\dfrac{4}{5}$

$\left(2, -\dfrac{4}{5}\right)$

4. $3x - 4y = 8$

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

$m = \dfrac{3}{4}$

5. $m = \dfrac{0-5}{10-0} = -\dfrac{1}{2},\ b = 5$

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

6. $\begin{cases} 2x - y = 1 \\ x + 2y = 13 \end{cases}$

$\begin{cases} y = 2x - 1 \\ y = -\frac{1}{2}x + \frac{13}{2} \end{cases}$

$2x - 1 = -\frac{1}{2}x + \frac{13}{2}$

$\frac{5}{2}x = \frac{15}{2}$

$x = 3$

$y = 2(3) - 1 = 5$

(3, 5)

7. $2x - 10y = 7$

$y = \frac{1}{5}x - \frac{7}{10}$

$m = \frac{1}{5}$

$y - 16 = \frac{1}{5}(x - 15)$

$y = \frac{1}{5}x + 13$

8. $y = 3(1) + 7 = 10$

9. (5, 0)

10. $\begin{cases} 3x - 2y = 1 \\ 2x + y = 24 \end{cases}$

$\begin{cases} y = \frac{3}{2}x - \frac{1}{2} \\ y = -2x + 24 \end{cases}$

$\frac{3}{2}x - \frac{1}{2} = -2x + 24$

$\frac{7}{2}x = \frac{49}{2}$

$x = 7$

$y = -2(7) + 24 = 10$

(7, 10)

11. $y - 9 = \frac{1}{2}(x - 4)$

$y = \frac{1}{2}x + 7$

$b = 7$

(0, 7)

12. The rate is \$35 per hour plus a flat fee of \$20.

13. $m_1 = \frac{0-2}{2-1} = -2$

$m_2 = \frac{1-0}{3-2} = 1$

$m_1 \neq m_2$

No

14. $m = \frac{-2-0}{0-3} = \frac{2}{3}$, $b = -2$

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

15. $x + 7y = 30$

$-2y + 7y = 30$

$5y = 30$

$y = 6$

16. $\begin{cases} 1.2x + 2.4y = 0.6 \\ 4.8y - 1.6x = 2.4 \end{cases}$

$\begin{cases} y = -0.5x + 0.25 \\ y = \frac{1}{3}x + 0.5 \end{cases}$

$-0.5x + 0.25 = \frac{1}{3}x + 0.5$

$-\frac{5}{6}x = 0.25$

$x = -0.3$

$y = \frac{1}{3}(-0.3) + 0.5 = 0.4$

17. $\begin{cases} y = -x + 1 \\ y = 2x + 3 \end{cases}$

$-x + 1 = 2x + 3$

$-3x = 2$

$x = -\frac{2}{3}$

$y = -\left(-\frac{2}{3}\right) + 1 = \frac{5}{3}$

$\left(-\frac{2}{3}, \frac{5}{3}\right)$

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

$$y-1=-\frac{2}{5}(x-1)$$

$$y=-\frac{2}{5}x+\frac{7}{5}$$

18. $\begin{cases}5x+2y=0\\ x+y=1\end{cases}$

$$\begin{cases}y=-\frac{5}{2}x\\ y=-x+1\end{cases}$$

$$-\frac{5}{2}x=-x+1$$

$$-\frac{3}{2}x=1$$

$$x=-\frac{2}{3}$$

$$y=-\left(-\frac{2}{3}\right)+1=\frac{5}{3}$$

Substitute $x=-\frac{2}{3}$ and $y=\frac{5}{3}$ in

$$2x-3y=1$$

$$2\left(-\frac{2}{3}\right)-3\left(\frac{5}{3}\right)=1$$

$$-\frac{19}{3}=1$$

No

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

$$y=-2x+8$$

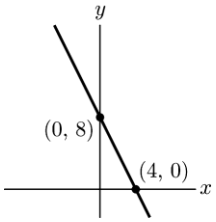
m = –2

y-intercept: (0, 8)

0 = –2x + 8

x = 4

x-intercept: (4, 0)



20. $\begin{cases}2x-3y=1\\ 3x+2y=4\end{cases}$

$$\begin{cases}y=\frac{2}{3}x-\frac{1}{3}\\ y=-\frac{3}{2}x+2\end{cases}$$

$$m_1=-\frac{1}{m_2}$$

21. **a.** 4x + y = 17

y = –4x + 17

L_3

b. y = x + 2

L_1

c. $2x+3y=11$

$$y=-\frac{2}{3}x+\frac{11}{3}$$

L_2

22. Supply curve is p = 0.005q + 0.5

Demand curve is p = –0.01q + 5

$$\begin{cases}p=0.005q+0.5\\ p=-0.01q+5\end{cases}$$

$$0.005q+0.5=-0.01q+5$$

$$0.015q=4.5$$

$$q=300 \text{ units}$$

p = 0.005(300) + 0.5 = \$2

23. **a.** In 2004, approximately 28% of University of Alabama freshmen were from out of state.

b. $2009-2004=5$

$y=3.6(5)+28$

$y=46$

46% of the freshmen in 2009 were from out of state at the University of Alabama.

c. $82=3.6x+28$

$54=3.6x$

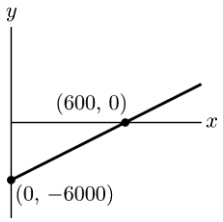
$x=15$

$2004+15=2019$

In 2019, the percent of college freshmen that are from out of state at the University of Alabama will be 82.

24. a. $m = 10$
$y - 4000 = 10(x - 1000)$
$y = 10x - 6000$

b. $0 = 10x - 6000$
$x = 600$
x-intercept: (600, 0)
y-intercept: (0, –6000)

c.


25. a. A: $y = 0.1x + 50$
B: $y = 0.2x + 40$

b. A: 0.1(80) + 50 = 58
B: 0.2(80) + 40 = 56
Company B

c. A: 0.1(160) + 50 = 66
B: 0.2(160) + 40 = 72
Company A

d. $0.1x + 50 = 0.2x + 40$
$-0.1x = -10$
$x = 100$ miles

26. a. $m = \dfrac{80-10}{56-0} = 1.25$
$y - 10 = 1.25(x - 0)$
$y = 1.25x + 10$

b. $50 = 1.25x + 10$
$40 = 1.25x$
$x = 32$
The item sold for \$50in the year 1964 + 32 = 1996.

27. (0, 725200); in 2029: (10, 864400)
$m = \dfrac{864,400 - 725,200}{10 - 0} = 13,920$
$y = 13,920x + 725,200$
For the year 2026, $x = 7$:
$y = 13,920(7) + 725,200 = 822,640.$

28. $0.03x + 200 = 0.05x + 100$
$-0.02x = -100$
$x = \$5000$

29. Let x = 0 correspond to year 1981. Then y = 42.5. When x = 36, y = 9.2. The rate of change (slope) = (9.2 – 42.5)/(36 – 0) = –.925. The equation of the line that predicts the percentage of market is y = –.925x + 42.5. When x = 34, y = 11.1%.

30. (0, 104008); in 2019: (8, 83946)
$m = \dfrac{83,946 - 104,008}{8 - 0} = -2507.75$
$y = -2507.75x + 104,008$
For the year 2024, $x = 13$:
$y = -2507.75(13) + 104,008 \approx 71,407.$

31. a. $y = –0.534x + 76.844$

b. –0.534(11) +76.844 = 70.97
About 70.97%

c. $67 = -0.534x + 76.844$
$-9.844 = -0.534$
$x \approx 18.43$
18 years after 2012 or 2030

32. a. $y = 1.305x – 19.41$

b. 1.305(78.73) – 19.41 = 83.33
Life expectancy for females in Greece will be about 83.33 years

c. $85.61 = 1.305x - 19.41$
$x \approx 80.48$
Life expectancy for males in France will be about 80.48 years

33. a. $y = 0.152x – 3.063$

b. 0.152(160) – 3.063 = 21.257
The breast cancer death rate in Denmark will be about 21.3 deaths per 100,000

c. 22 = 0.152x – 3.063
$x \approx 164.888$
The daily fat intake by women in New Zealand is about 165 grams

34. Counterclockwise

35. Up; the value of b is the y-intercept

36. A line with undefined slope is a vertical line and a line with zero slope is a horizontal line.

37. The x – intercept and the y – intercept are the same at (0, 0).

38. Yes; since the data value is on the line, there will be no vertical distance added to the least squares line.

39. No; A line that is parallel to the x axis and is not the x axis will not have an x intercept.

No; A line that is parallel to the y axis and is not the y axis will not have a y intercept

40. **a.** Infinity many

b. Answers will vary.

Chapter 1 Project

1. $p = -0.4q + 400$

2. $p = -0.4(350) + 400 = \$260$
Revenue $= 260(350{,}000) = \$91{,}000{,}000$

3. $300 = -0.4q + 400$
$q = 250$ thousand cameras
Revenue $= 300(250{,}000) = \$75{,}000{,}000$

4. $1000q(-0.4q + 400) = -400q^2 + 400{,}000q$

5. Cost $= 100{,}000q + 8{,}000{,}000$

6. On your graphing calculator, set the window values to: $x:[0,1000]$ and $y:[0,100,000,000]$ and graph both equations. The graph intersects at $x \approx 27.69$, $y \approx 10{,}768{,}890$, and $x \approx 722.31$, $y \approx 80{,}231{,}110$.

7. The break-even point is $q \approx 27.69$. That is, when 27,690 cameras are sold.

8. The company will make a profit when $27.69 < q < 722.31$.