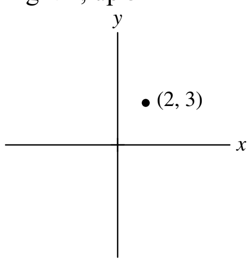
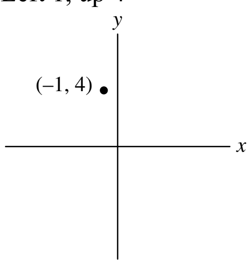
Chapter 1

Exercises 1.1

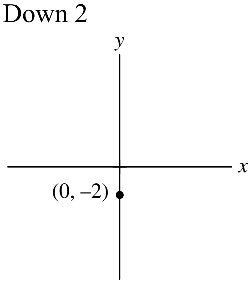
1. Right 2, up 3



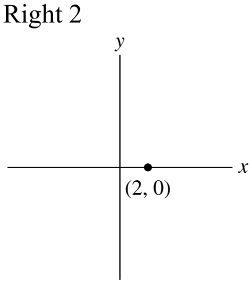
2. Left 1, up 4



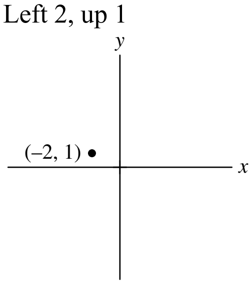
3. Down 2



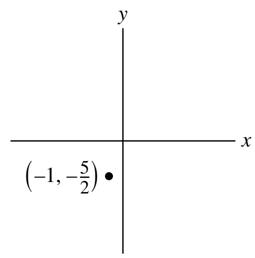
4. Right 2



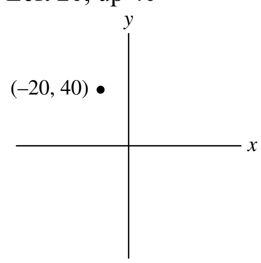
5. Left 2, up 1



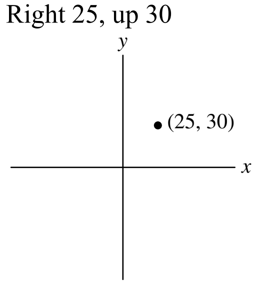
6. Left 1, down $\frac{5}{2}$



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: $\left(\frac{1}{2},3\right)\to -2\left(\frac{1}{2}\right)+\frac{1}{3}(3)=-1\to -1+1=-1$ 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.
$$\begin{aligned}14x+7y&=21\\ 7y&=-14x+21\\ y&=-2x+3\end{aligned}$$

20.
$$\begin{aligned}x-y&=3\\ -y&=-x+3\\ y&=x-3\end{aligned}$$

21.
$$\begin{aligned}3x&=5\\ x&=\frac{5}{3}\end{aligned}$$

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

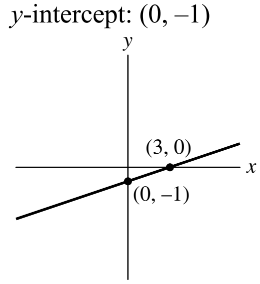
23.
$$\begin{aligned}0&=-4x+8\\ 4x&=8\\ x&=2\end{aligned}$$
x-intercept: (2, 0)
$y = –4(0) + 8$
$y = 8$
y-intercept: (0, 8)

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

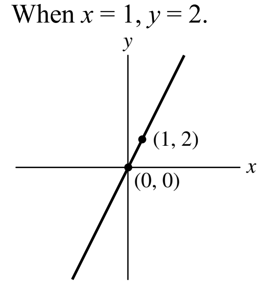
25. When $y = 0, x = 7$
x-intercept: (7, 0)
$0 = 7$
no solution
y-intercept: none

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 $x = 1, y = 2$.



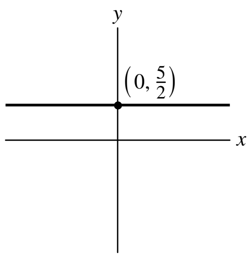
29. $0 = \frac{5}{2}$

no solution

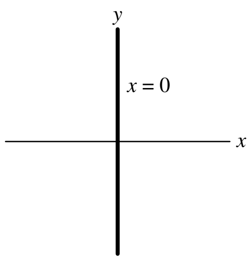
x-intercept: none

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

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



30. The line coincides with the y-axis.



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

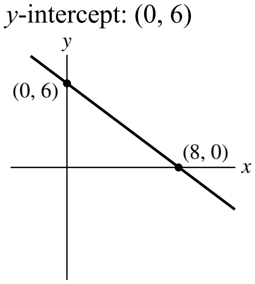
$x = 8$

x-intercept: (8, 0)

$3(0) + 4y = 24$

$y = 6$

y-intercept: (0, 6)



32. $x + 0 = 3$

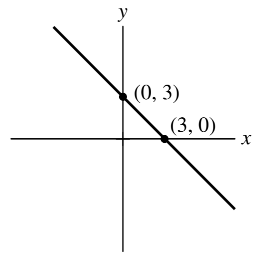
$x = 3$

x-intercept: (3, 0)

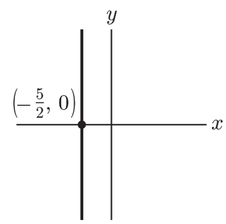
$0 + y = 3$

$y = 3$

y-intercept: (0, 3)



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



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

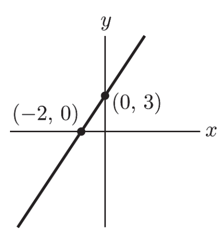
$x = -2$

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

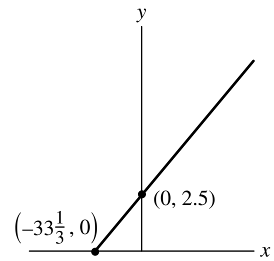
c. Water boils when y = 212 so we have $212 = 30x + 72.$ Solving for x gives $x = 4\frac{2}{3}$ minutes or 4 minutes 40 seconds.

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. $1999 - 1960 = 39$
$y = \left(\frac{1}{6}\right)(39) + 70$
$y = 6.5 + 70$
$y = 76.5$
A person born in 1999 has a life expectancy of 76.5 years.

41. a. x-intercept: $\left(-33\frac{1}{3},\ 0\right)$
y-intercept: (0, 2.5)

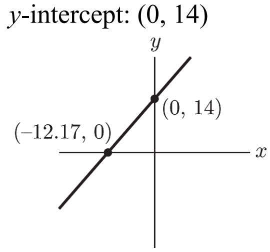


b. In 1960, 2.5 trillion cigarettes were sold.

c. $4 = .075x + 2.5$
$x = 20$
$1960 + 20 = 1980$

d. $2024 - 1960 = 64$
$y = .075(64) + 2.5$
$y = 7.3$
7.3 trillion

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

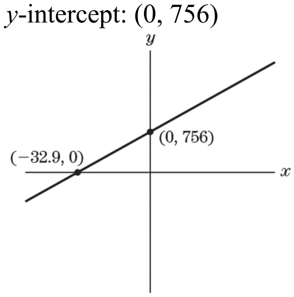


b. In 2000 the income from ecotourism was $14,000.

c. $20 = 1.15x + 14$
$x \approx 5.22$
$2000 + 5.22 = 2005.22$
The year 2005 should have had $20,000 in ecotourism income.

d. $2022 - 2000 = 22$
$y = 1.15(22) + 14$
$y = 39.3$
$39,300

43. a. x-intercept: $(-32.9, 0)$
y-intercept: $(0, 756)$

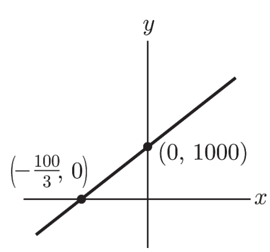


b. In 1999 the car insurance rate for a small car was $756.

c. $2007 - 1999 = 8$
$y = 23(8) + 756$
$y = 940$
$940

d.
$$1308 = 23x + 756$$
$$552 = 23x$$
$$x = 24$$
$$1999 + 24 = 2023$$
The yearly rate will be $1308 in 2023.

44. a. x-intercept: $\left(-\dfrac{100}{3}, 0\right)$
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 2000, 4.1% of entering college freshmen intended to major in biology.

b.
$$2014 - 2000 = 14$$
$$y = 0.2(14) + 4.1$$
$$y = 6.9$$
6.9% of college freshmen in 2014 intended to major in biology.

c.
$$5.5 = 0.2x + 4.1$$
$$1.4 = 0.2x$$
$$x = 7$$
$$2000 + 7 = 2007$$
In 2007, the percent of college freshmen who intended to major in biology was 5.5.

46. a. In 2004, 6.32% of college freshmen smoked.

b.
$$2014 - 2004 = 10$$
$$y = -0.46(10) + 6.32$$
$$y = 1.72$$
1.72% of college freshmen smoked in 2014.

c.
$$2.6 = -0.46x + 6.32$$
$$-3.72 = -0.46x$$
$$x \approx 8$$
$$2004 + 8 = 2012$$
In 2012, the percent of college freshmen who smoked was 2.6.

47. a.
$$2011 - 2004 = 7$$
$$y = 461(7) + 16800$$
$$y = 20,027$$
$20,027 was the approximate average tuition in 2011.

b.
$$25000 = 461x + 16800$$
$$8200 = 461x$$
$$x \approx 17.8$$
$$2004 + 17 = 2021$$
In 2021, the approximate average cost of tuition will be more than $25,000.

48. a. $2007-2003=4$

$y=667(4)+12403$

$y=15071$

Approximately 15,071 bachelor degrees in mathematics and statistics were awarded in 2007.

b. $25000=667x+12403$

$12597=667x$

$x\approx 18.89$

$2003+18=2021$

In 2021, there will be more than 25,000 bachelor 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.

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

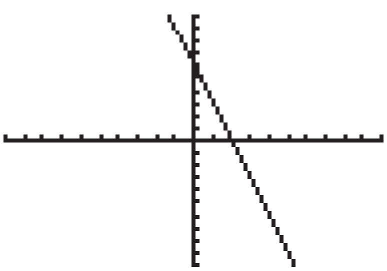
72. The y – intercept has a x coordinate of 0, therefore the y coordinate of the first equation is:

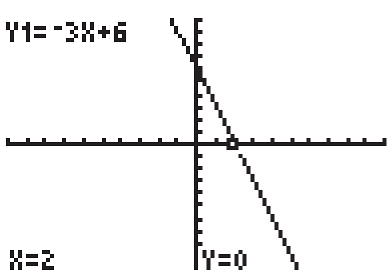
$$6(0) - 3y = 9$$
$$-3y = 9$$
$$y = -3$$

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

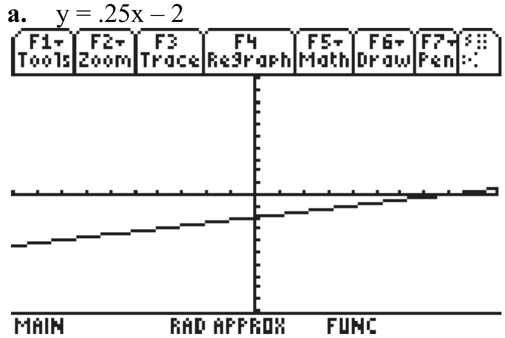




b. The intercepts are at the points (2, 0) and (0, 6)

c. When x = 2, y = 0

74. **a.** y = .25x – 2

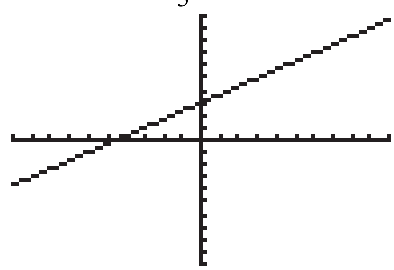


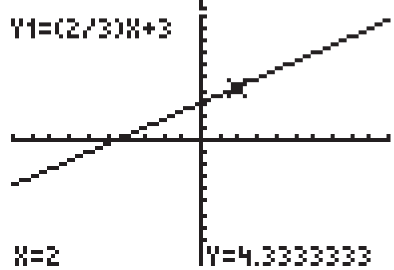
b. (0, –2) and (8,0) are intercepts

c. When x = 2, y = –1.5.

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

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

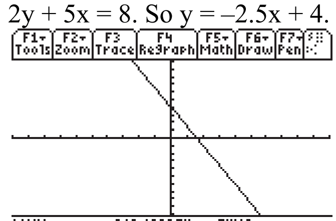




b. The intercepts are at the points (–4.5, 0) and (0, 3).

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

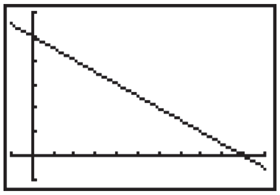
76. **a.** 2y + 5x = 8. So y = –2.5x + 4.



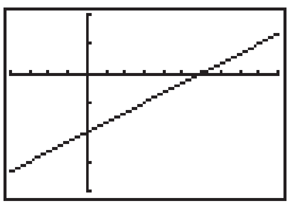
b. The intercepts are (0, 4) and (1.6, 0).

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

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

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

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

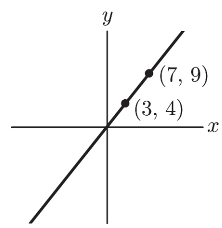
6. $\frac{x}{7}-\frac{y}{8}=1$

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

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

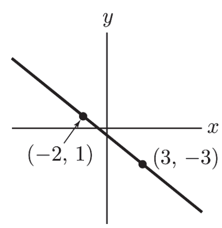
$$m=\frac{8}{7}$$

7.



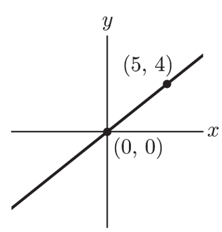
$$m=\frac{9-4}{7-3}=\frac{5}{4}$$

8.



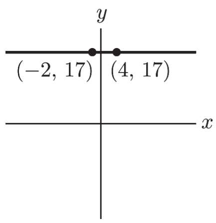
$$m=\frac{-3-1}{3-(-2)}=-\frac{4}{5}$$

9.



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

10.

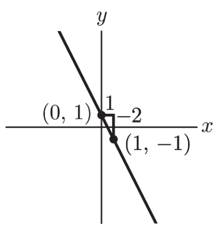


$$m = \frac{17-17}{-2-4} = 0$$

11. The slope of a vertical line is undefined.

12. The slope of a vertical line is undefined.

13.



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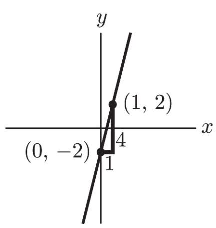

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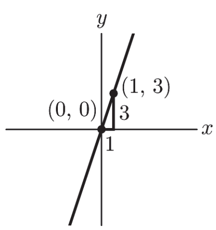

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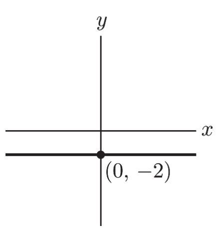


17. $m = \frac{-2}{1} = -2$

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

$y = -2x + 7$

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

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

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

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

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

$y = -2x + 4$

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

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

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

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

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

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

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

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

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

23. $m = -1$

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

$y = -x$

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

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

$y = 2x - 5$

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

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

$y = -2x + 1$

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.

$y = 4x + 2000$

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.

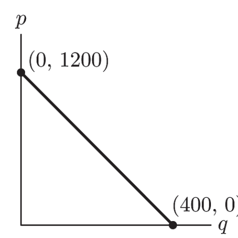
c. –3; to sell an additional item, the price must be reduced by \$3.

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 $\left(\frac{1}{4} \text{ of a minute}\right).$

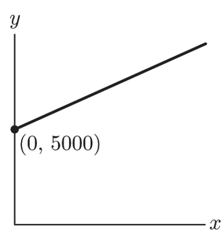
39. a. Let x = quantity and y = cost.

$$m = \frac{9500 - 6800}{50 - 20} = 90$$
$$y - 6800 = 90(x - 20)$$
$$y = 90x + 5000$$

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.

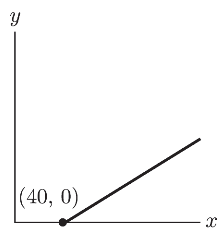
c. $0 = 60x - 2400$
$x = 40$
(40, 0); the break-even point is 40 coats. Less than 40 coats sold yields a loss, more than 40 yields a profit.

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

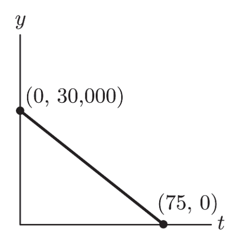
e. $y = 60(80) - 2400 = \$2400$

f. $6000 = 60x - 2400$
$x = 140$ coats

g.



43. a.



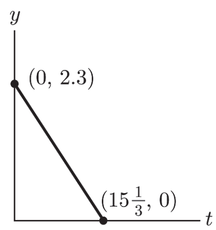
b. On February 1, 31 days have elapsed since January 1. The amount of oil y = 30,000 – 400(31) = 17,600 gallons.

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. $y = 0.10x + 220$

b. $y = 0.10(2000) + 220$
$y = 420$

c. $540 = 0.10x + 220$
$x = \$3200$

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

$y = -2x$

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 $\frac{-1}{4}$ Changes in x coordinates are 1, 2, –1. Changes in y coordinates are m times the x coordinate changes. New y coordinates are

$\frac{-5}{4}, \frac{-3}{2}, \frac{-3}{4}$

62. Changes in x-coordinate: 1, 2, 3
Changes in y-coordinate are m times that:

$\frac{1}{3}, \frac{2}{3}, 1$

y-coordinates:

$2 + \frac{1}{3} = \frac{7}{3},\ 2 + \frac{2}{3} = \frac{8}{3},\ 2 + 1 = 3$

$\frac{7}{3}; \frac{8}{3}; 3$

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. $m = \frac{4.8-3.6}{4.9-4.8} = 12;$

$y - 6 = 12(x - 5)$

$y = 12x - 54$

$b = -54$

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

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

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

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

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

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

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

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

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

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

73. Let 2001 correspond to x = 0. So in 2013, x = 12. When x = 0, tuition is 3735. When x = 12, tuition is 8312. Using (0,3735) and (12,8312) as ordered pairs, find the slope of the line containing these points: $\frac{8312-3735}{12-0} = \frac{4577}{12}$. Since the y-intercept is 3735, the equation becomes $y = \frac{4577}{12}x + 3735$. Therefore, in 2009 when x = 8, the tuition should approximately be $y = \frac{4577}{12}(8) + 3735 = \$6786.33.$

74. Let 2000 correspond to x = 0. So in 2013, x = 13. When x = 0, enrollment was 5.9 million. When x = 13, enrollment was 7.0 million. Using (0,5.9) and (13,7.0) as ordered pairs, find the slope of the line containing these points: $\frac{7.0-5.9}{13-0} = \frac{1.1}{13} = \frac{11}{130}$. Since the y-intercept is 5.9, the equation becomes $y = \frac{11}{130}x + 5.9.$

Therefore, the enrollment was at 6.5 million when $y = 6.5$ in $y = \frac{11}{130}x + 5.9$

$$6.5 = \frac{11}{130}x + 5.9$$
$$7.1 \approx x$$

Since x is the number of years after 2000, the enrollment was 6.5 million around 2007.

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 $\frac{1,261,900 - 913,500}{10} = 34840$. The equation is y = 34840x + 913,500. When x = 4 (2018), y = 34840(4) + 913,500 =1,052,860.

77. Let 2001 correspond to x = 0 and 2013 correspond to x = 12. Then, the two ordered pairs are on the line: (0, 263515) and (12,360823). The slope of the line is $\frac{360,823 - 263,515}{12 - 0} = 8109$ The equation of the line is therefore $y = 8190x + 263,515.$ In the year 2020, x = 19, so the number of Bachelor's degrees awarded can be estimated as $y = 8109(19) + 263,515 = 417,586.$

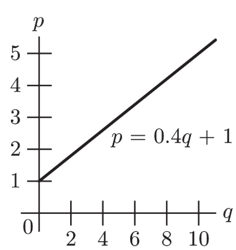
78. The slope is $\frac{4986 - 4818}{12} = 14$. The equation is $y = 14x + 4818.$ Find x when y = 5100. We have $5100 = 14x + 4818.$ Solving for x gives x about 20.1 years or in the year 2021.

79. Let 2012 correspond to x = 0 and 2015 correspond to x = 3. Then, the two ordered pairs are on the line: (0, 3.5) and (3,4.5). The slope of the line is $\frac{4.5 - 3.5}{3 - 0} = \frac{1}{3}.$ The equation of the line is therefore $y = \frac{1}{3}x + 3.5.$ In the year 2014, x = 2, so the cost of a 30-second advertising slot (in millions) can be estimated as $y = \frac{1}{3}(2) + 3.5 \approx \$4.2$ million.

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

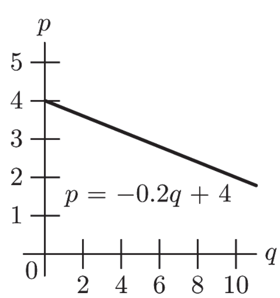
81. The slope is $\frac{3.4 - 3}{6 - 5} = 0.4$

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



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

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

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 2015: profit = revenue – cost

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

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

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

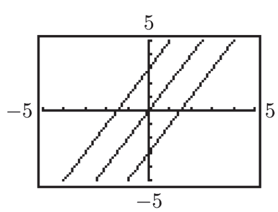
96. Let x = variable costs
For 2015: profit = revenue – costs

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

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

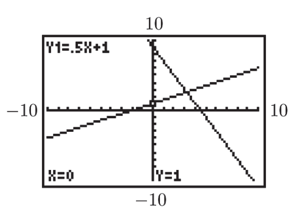
$$300,000 = 50,000y - [78(50,000) + 800,000 + 200,000]$$
$$5,200,000 = 50,000y$$
$$y = \$104$$

97

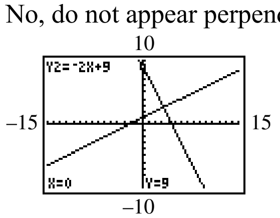


From left to right the lines are $y = 2x + 3$, $y = 2x$, and $y = 2x - 3$.
The lines are distinguished by their y-intercepts, which appear as b in the form $y = mx + b$.

98.

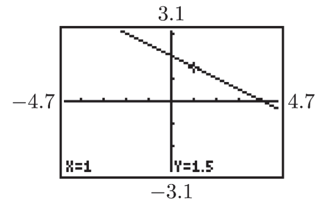


No, do not appear perpendicular



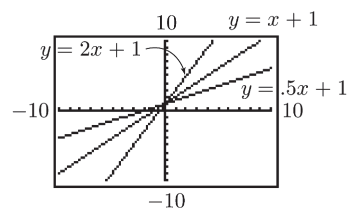
Do appear perpendicular

99.



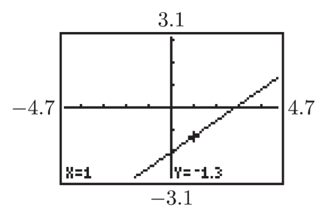
Since the slope equals $-\frac{1}{2}$, moving 2 units to the right requires moving $2\cdot\left(-\frac{1}{2}\right) = -1$ unit up, or 1 unit down.

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

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

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

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

$y = \frac{2}{3}x - 1 = \frac{2}{3}(6) - 1 = 3$
(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.** $$\begin{aligned} p &= 0.0001(19{,}500) + 0.05 \\ &= \$2.00 \end{aligned}$$

b. $$\begin{aligned} p &= 0.0001(0) + 0.05 \\ &= \$0.05 \end{aligned}$$
No units will be supplied for \$0.05 or less.

18. **a.** $$\begin{aligned} p &= -0.001(31{,}500) + 32.5 \\ &= \$1.00 \end{aligned}$$

b. $$\begin{aligned} -0.001q + 32.5 &= 0 \\ q &= 32{,}500 \text{ units} \end{aligned}$$

Quantities of 32,500 or more.

19. $$\begin{cases} p = 0.0001q + 0.05 \\ p = -0.001q + 32.5 \end{cases}$$
$$\begin{aligned} 0.0001q + 0.05 &= -0.001q + 32.5 \\ 0.0011q &= 32.45 \\ q &= 29{,}500 \text{ units} \end{aligned}$$
$$\begin{aligned} p &= 0.0001(29{,}500) + 0.05 \\ p &= \$3.00 \end{aligned}$$

20. $$p = \frac{1}{300}q + 13$$
$$p = -0.03q + 19$$
$$\begin{aligned} \frac{1}{300}q + 13 &= -0.03q + 19 \\ \frac{1}{30}q &= 6 \\ q &= 180 \text{ books} \end{aligned}$$
$$\begin{aligned} p &= -0.03(180) + 19 \\ p &= \$13.60 \end{aligned}$$

21. **a.** $$\begin{aligned} p &= -0.15q + 6.925 \\ 5.80 &= -0.15q + 6.925 \\ -1.125 &= -0.15q \\ 7.5 &= q \end{aligned}$$

$$\begin{aligned} p &= 0.2q + 3.6 \\ 5.80 &= 0.2q + 3.6 \\ 2.2 &= 0.2q \\ 11 &= q \end{aligned}$$

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,

$$\begin{aligned} -0.15q + 6.925 &= 0.2q + 3.6 \\ -0.35q &= -3.325 \\ q &= 9.5 \end{aligned}$$

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

$$\begin{aligned} p &= -0.15(9.5) + 6.925 \\ p &= -1.425 + 6.925 \\ p &= 5.5 \end{aligned}$$

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

22. **a.** $$\begin{aligned} p &= -2.2q + 19.36 \\ 16.50 &= -2.2q + 19.36 \\ -2.86 &= -2.2q \\ 1.3 &= q \end{aligned}$$

$$\begin{aligned} p &= 1.5q + 9 \\ 16.50 &= 1.5q + 9 \\ 7.50 &= 1.5q \\ 5 &= q \end{aligned}$$

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.

$$p = -2.2(2.8) + 19.36$$
$$p = -6.16 + 19.36$$
$$p = 13.20$$

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

23. Let $C = F$, then

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

Therefore, when the temperature is -40^{o}, 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. $2C + 30 = \frac{9}{5}C + 32$

$\frac{1}{5}C = 2$

$C = 10$

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.

$$\begin{cases} y = 30x + 1200 \\ y = 35x + 500 \end{cases}$$
$$30x + 1200 = 35x + 500$$
$$-5x = -700$$
$$x = 140$$
$$y = 30x + 1200$$
$$y = 30(140) + 1200$$
$$y = 4200 + 1200$$
$$y = 5400$$

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

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

$$\begin{cases} x + y = 40 \\ 12x + 15y = 504 \end{cases}$$
$$\begin{cases} y = -x + 40 \\ y = -\frac{4}{5}x + \frac{168}{5} \end{cases}$$
$$-x + 40 = -\frac{4}{5}x + \frac{168}{5}$$
$$-\frac{1}{5}x = -\frac{32}{5}$$
$$x = 32$$

$y = -32 + 40 = 8$

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

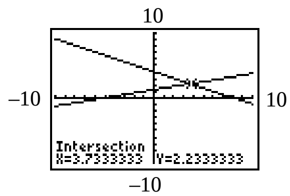
32. Let x = number of 42” TVs sold and
y = number of 55” TVs sold

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

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

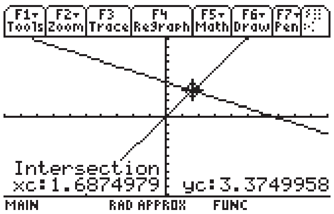
$x + 5 = -\frac{40}{73}x + \frac{2625}{73}$
$\frac{113}{73}x = \frac{2260}{73}$
$x = 20$ TV sets
$y = 20 + 5$
$= 25$ TV sets
Total = 20 + 25 = 45 TV sets

33.



(3.73, 2.23)

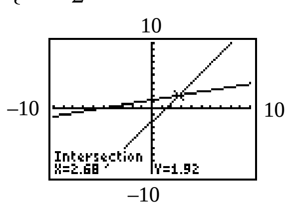
34.



(1.69, 3.38)

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

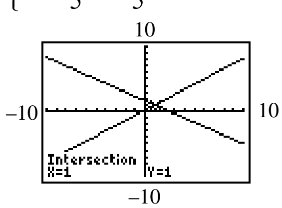
$\begin{cases} y=\dfrac{1}{4}x+\dfrac{5}{4} \\ y=\dfrac{3}{2}x-2.1 \end{cases}$



(2.68, 1.92)

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

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



(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
$\sum x = 10$	$\sum y = 20$	$\sum xy = 43$	$\sum x^2 = 30$

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

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

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
$\sum x = 15$	$\sum y = 34$	$\sum xy = 127$	$\sum x^2 = 55$

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

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

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

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

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

$y = 4.5x - 3$

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

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

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

$y = -1.5x + 8.5$

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. $\sum x = 10, \sum y = 28, \sum xy = 77, \quad \sum x^2 = 30$

$m = \dfrac{4 \cdot 77 - 10 \cdot 28}{4 \cdot 30 - 10^2} = 1.4$

$b = \dfrac{28 - (1.4)(10)}{4} = 3.5$

$y = 1.4x + 3.5$

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 $\sum x = 191, \sum y = 175, \sum xy = 8431,$

$\sum x^2 = 9201$

$m = \dfrac{4 \cdot 8431 - 191 \cdot 175}{4 \cdot 9201 - 191^2} \approx 0.9257$

$b = \dfrac{175 - (0.9257)(191)}{4} \approx -0.452$

$y = 0.9257x - 0.452$

b. $y = 0.9257(47) - 0.452$

$y = 43.06$ mpg

c. $47 = 0.9257x - 0.452$

$x = 51.26$ mpg

16. **a.** Let *x* represent stores (in thousands) and *y* represent sales (in millions), then $\sum x = 18.409, \sum y = 15{,}010, \sum xy = 74741.65,$

$\sum x^2 = 90.295421$

$m = \dfrac{4 \cdot 74741.65 - 18.409 \cdot 15010}{4 \cdot 90.295421 - 18.409^2} = 1016$

$b = \dfrac{15010 - (1016)(18.409)}{4} = -923.5$

$y = 1016x - 923.5$

b. $y = 1016(4) - 923.5$

$y = 3140.5$ million

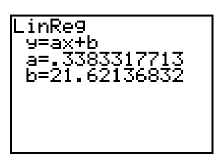
$y = \$3{,}140{,}500{,}000$

c. $2000 = 1016x - 923.5$

$x = 2.877$ thousand

$x = 2877$

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. $y = -0.46x + 6.3$

b. $-0.46(5) + 6.3 = 4$
About 4% of the 2009 freshman class smoked.

c. $4.9 = -0.46x + 6.3$
$x \approx 3.04$
Approximately 4.9% of the freshman class smoked in the year 2004 + 3 = 2007.

19. a. Let x be the number of years after 1989, then y = $0.451x + 20.6$

b. $0.451(23) + 20.6 = 30.973$
About 31% completed four or more years of college

c. $35 = 0.451x + 20.6$
$x \approx 31.93$
Approximately 35% of persons 25 years and over will have completed 4 or more years of college in the year 1989 + 31 = 2020.

20. a. Let x be the number of years after 2005, then y = $0.65x + 10.4$

b. $0.65(5) + 10.4 = 13.65$
The average cost in 2010 will be approximately \$13.7 thousand or \$13,700.

c. $22 = 0.65x + 10.4$
$x \approx 17.8$
The cost will be approximately \$22,00 late in the year 2005 + 17 = 2022.

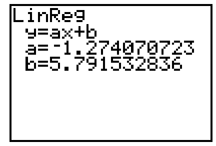
21. a. $y = 0.141x + 74.8$

b. $0.141(30) + 74.8 = 79.0$
A 30 – year old US male has a life expectancy of about 79.1 years

c. $0.141(50) + 74.8 = 81.9$
A 50 – year old US male has a life expectancy of about 81.9 years

d. $0.141(90) + 74.8 = 87.5$
Life expectancy will be about 87.5 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 2000, then y = $0.028x + 0.845$

b. $0.028(13) + 0.845 \approx 1.21$
In the year 2013, the price of a pound of spaghetti was about \$1.21.

c. $1.45 = 0.028x + 0.845$
$x \approx 21.6$
The price per pound of spaghetti will be \$1.45 in the year 2000 + 21 = 2021.

24. a. $y = 1.63x + 322$

b. The year 2008 is 40 years after the base year of 1968, therefore:
$1.63(40) + 322 = 387$
387; It is close to the actual value.

c. $408 = 1.63x + 322$
$x \approx 52.8$
The year is 52 years after 1968 or 2020.

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 the tinted box on page 5.

6. $ax + by = c$, where both a and b 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. $y = mx + b$ or $x = a$.

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.

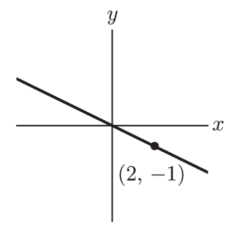
14. First put the two linear equations into standard form. If both equations have the form $y =$ *something*, equate the two expressions for y, solve for x, substitute the value for x into one of the equations, and solve for y. Otherwise, substitute the value of x into the equation containing y and solve 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. $\begin{cases} x - 5y = 6 \\ \quad 3x = 6 \end{cases}$

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

$5y + 6 = 2$

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

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

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

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

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

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

$x = 3$

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

(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.
$$\begin{aligned} x + 7y &= 30 \\ -2y + 7y &= 30 \\ 5y &= 30 \\ y &= 6 \end{aligned}$$

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

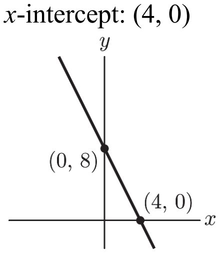
$$2x-3y=1$$
$$2\left(-\frac{2}{3}\right)-3\left(\frac{5}{3}\right)=1$$
$$-\frac{19}{3}=1$$

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 $p = -0.01q + 5$

$$\begin{cases}p=0.005q+0.5\\p=-0.01q+5\end{cases}$$
$$0.005q+0.5=-0.01q+5$$
$$0.015q=4.5$$
$$q=300 \text{ units}$$
$p = 0.005(300) + 0.5 = \$2$

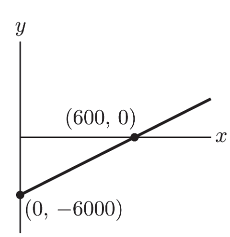
23. a. In 2004, approximately 28% of University of Alabama freshmen were from out of state.

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.** $m = \dfrac{5.45 - 3.20}{12 - 0} = 0.1875$
$y - 3.20 = 0.1875(x - 0)$
$y = 0.1875x + 3.20$

b. $4.60 = 0.1875x + 3.20$
$1.40 = 0.1875x$
$x \approx 7.47$
Bacon was an average $4.60 per pound in the year 2003 + 7 = 2010.

27. (0, 591300) ; in 2024: (10, 730200)
$m = \dfrac{730,200 - 591,300}{10 - 0} = 13,890$
$y = 13,890x + 591,300$
For the year 2020, $x = 6$:
$y = 13,890(6) + 591,300 = 674,640.$

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

29. Let x = 0 correspond to year 2000. Then y = 20.4. When x = 10, y = 17.0. The rate of change (slope) = (17.0 – 20.4)/(10 – 0) = –.34. The equation of the line that predicts the percentage of market is y = –.34x + 20.4. When x = 8, y = 17.7%.

30. (0, 107238) ; in 2013: (7, 104647)
$m = \dfrac{104,647 - 107,238}{7 - 0} = -370.1$
$y = -370.1x + 107,238$
For the year 2019, $x = 13$:
$y = -370.1(13) + 107,238 \approx 102,427.$

31. **a.** $y = -0.65x + 76.1$

b. $-0.65(5) + 76.1 = 72.9$
About 72.9%

c. $67 = -0.65x + 76.1$
$-9.1 = -0.65$
$x = 14$
14 years after 2012 or 2026

32. **a.** $y = 1.53x - 36.8$

b. $1.53(77.8) - 36.8 = 82.2$
Life expectancy for women in Greece will be about 82.2 years

c. $85.0 = 1.53x - 36.8$
$x \approx 79.6$
Life expectancy for men in France will be about 79.6 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 $27.69 < q < 722.31$.

