# *Finite Mathematics and Its Applications 13th edition Goldstein Solutions Manual*

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# INSTRUCTOR'S SOLUTIONS MANUAL

# FINITE MATHEMATICS AND ITS APPLICATIONS

## THIRTEENTH EDITION


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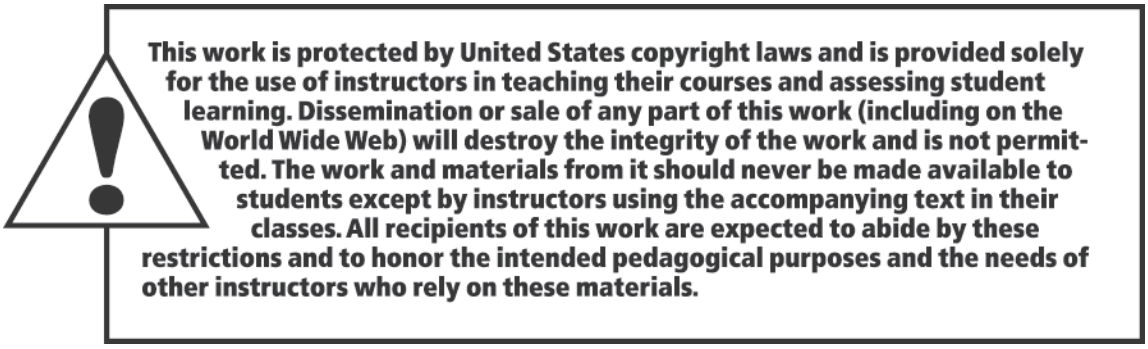
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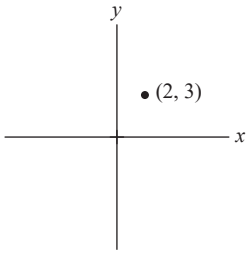

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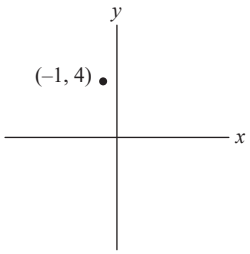
# Chapter 1

**Exercises 1.1**

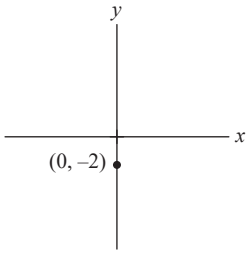
**1.** Right 2, up 3



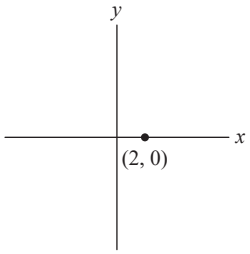

**2.** Left 1, up 4



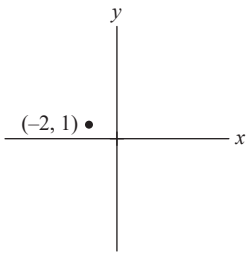

**3.** Down 2



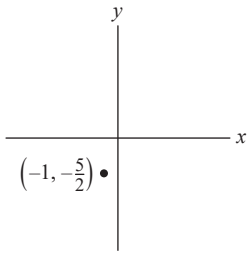

**4.** Right 2



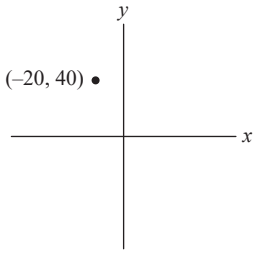

**5.** Left 2, up 1



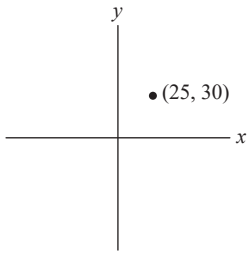

**6.** Left 1, down $\frac{5}{2}$




**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

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

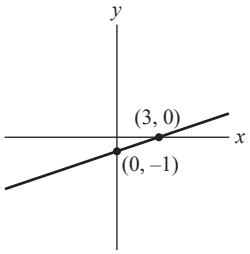
**23.** $0=-4x+8$
$4x=8$
$x=2$
*x*-intercept: (2, 0)
$y = –4(0) + 8$
$y = 8$
*y*-intercept: (0, 8)

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

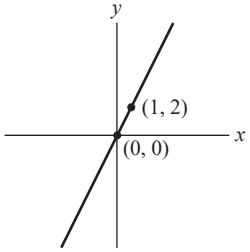
**25.** When $y = 0, x = 7$
*x*-intercept: (7, 0)
$0 = 7$
no solution
*y*-intercept: none

**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 $x = 1, y = 2$.





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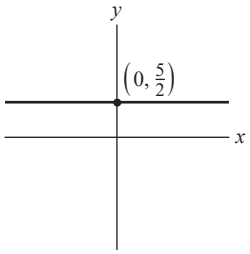
**29.** $0 = \frac{5}{2}$

no solution

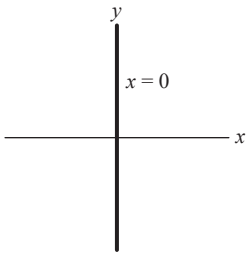
$x$-intercept: none

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

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




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




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

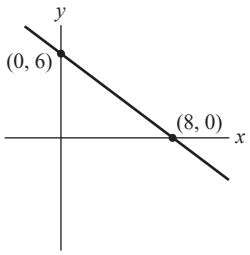
$x = 8$

$x$-intercept: (8, 0)

$3(0) + 4y = 24$

$y = 6$

$y$-intercept: (0, 6)




**32.** $x + 0 = 3$

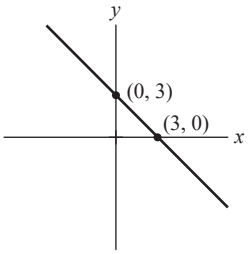
$x = 3$

$x$-intercept: (3, 0)

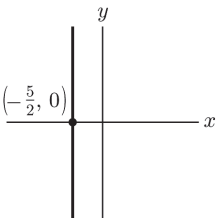
$0 + y = 3$

$y = 3$

$y$-intercept: (0, 3)




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




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

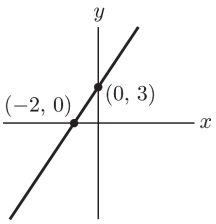
$x = -2$

x intercept (–2, 0)

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

$y = 3$

$y$ intercept (0, 3)




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**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


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

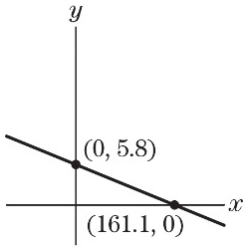
**c.** Water boils when y = 212 so we have $212 = 30x + 72$. Solving for x gives $x = 4\frac{2}{3}$ minutes or 4 minutes 40 seconds.

**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)

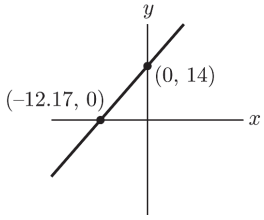



**b.** In 2004, 5.8 trillion cigarettes were sold.

**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.

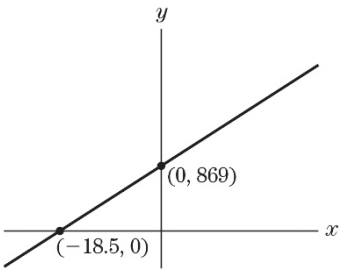
**c.** $20 = 1.15x + 14$
$x \approx 5.22$
2010 + 5.22 = 2015.22
The year 2015 should have had $20,000 in ecotourism income.

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

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

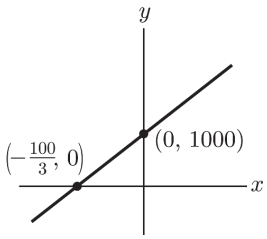



**b.** In 2014 the car insurance rate for a small car was \$869.

**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.


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**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 $y = x + 9$.

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**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 $c$.

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

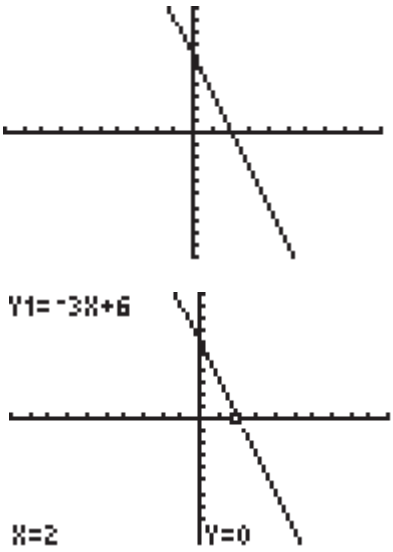
**72.** The $y$ – intercept has a $x$ coordinate of 0, therefore the $y$ coordinate of the first equation is:

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

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

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

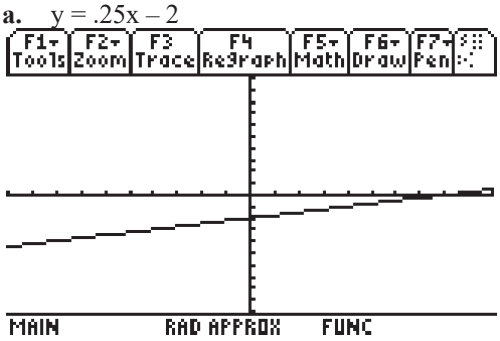
**73. a.** y = –3x + 6




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

**c.** When $x = 2$, $y = 0$

**74. a.** y = .25x – 2

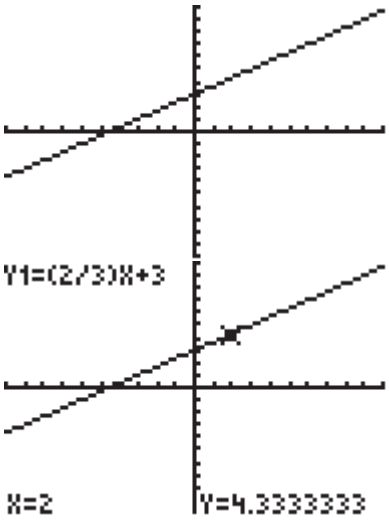



**b.** (0, –2) and (8,0) are intercepts

**c.** When x = 2, y = –1.5.

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

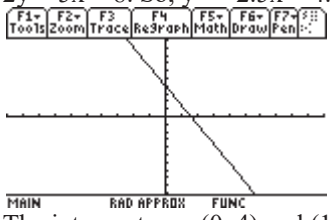
$$3y = 2x + 9$$
$$y = \frac{2}{3}x + 3$$




**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.



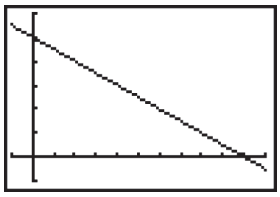

**b.** The intercepts are (0, 4) and (1.6, 0).

**c.** When x = 2 then y = –1.

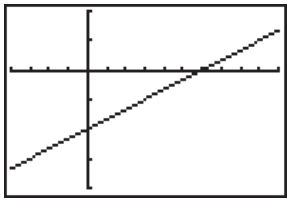

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**77.** $2y + x = 100$. When $y = 0$, $x = 100$, and when $x = 0$, $y = 50$. An appropriate window might be $[-10, 110]$ and $[-10,60]$. Other answers are possible.



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

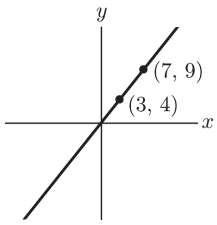
**3.** $y - 3 = 5(x + 4)$
$y = 5x + 23$
$m = 5$

**4.** $7x + 5y = 10$
$y = -\frac{7}{5}x + 2$
$m = -\frac{7}{5}$

**5.** $\frac{x}{5} + \frac{y}{4} = 6$
$\frac{4x}{5} + y = 24$
$y = -\frac{4}{5}x + 24$
$m = -\frac{4}{5}$

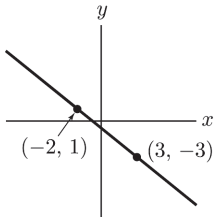
**6.** $\frac{x}{7} - \frac{y}{8} = 1$
$\frac{8x}{7} - y = 8$
$y = \frac{8}{7}x - 8$
$m = \frac{8}{7}$

**7.**



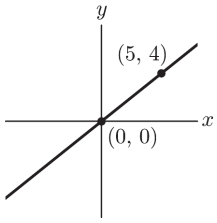

$m = \frac{9-4}{7-3} = \frac{5}{4}$

**8.**




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

**9.**

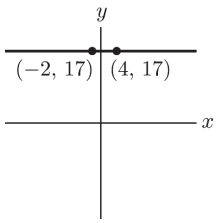



$m = \frac{4-0}{5-0} = \frac{4}{5}$

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**10.**

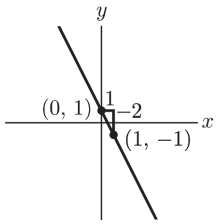



$$m = \frac{17-17}{-2-4} = 0$$

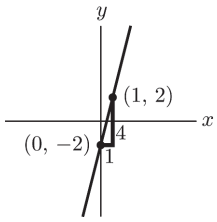
**11.** The slope of a vertical line is undefined.

**12.** The slope of a vertical line is undefined.

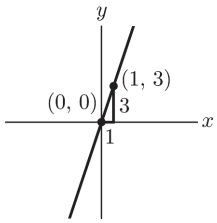
**13.**



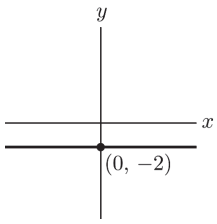

**14.**




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

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

$y = -2x + 1$


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**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.

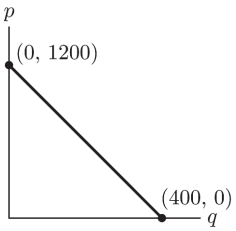
**c.** –3; to sell an additional item, the price must be reduced by \$3.

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

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

$c = 4F - 148$

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**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.

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

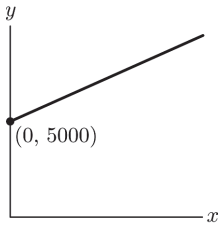
$$y - 6800 = 90(x - 20)$$

$$y = 90x + 5000$$

**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.

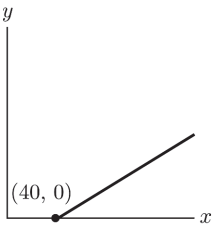
**d.** 60; each additional coat sold yields an additional \$60 profit.

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

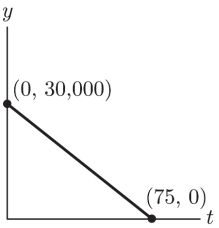
**f.** $6000 = 60x - 2400$

$x = 140$ 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.

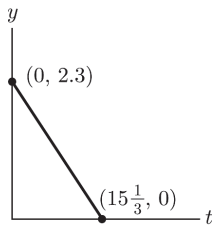
**d.** The significance of the y-intercept is that amount of oil present initially on January 1. This amount is 30,000 gallons.

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


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

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**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 $y = -0.25x + 7.2$

$6.4 = -0.25x + 7.2$

$3.2 = x$


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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 $y = 6486.4(12) + 358,132 = 435,969$.

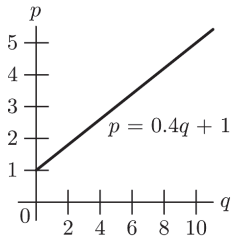
**78.** The slope is $\frac{6355 - 4929}{10} = 142.6$. The equation is $y = 142.6x + 4929$. Find x when y = 7355. We have $7355 = 142.6x + 4929$. Solving for x gives x about 17.01 years or in the year 2027.

**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 $y = -625x + 3000$.

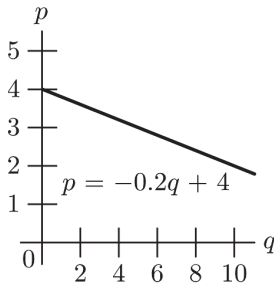
**81.** The slope is $\frac{3.4 - 3}{6 - 5} = 0.4$

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




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

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

$m_1 \neq m_2$

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**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 2021: profit = revenue – cost

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

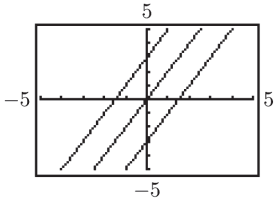

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For 2022:
Let $y$ = 2022 price
profit = revenue – cost
$$400,000 = 50,000y - [80(50,000) + 600,000 + 200,000]$$
$$5,200,000 = 50,000y$$
$$y = \$104$$

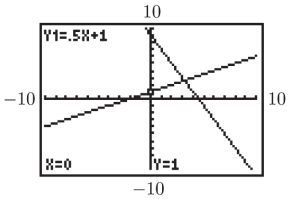
**96.** Let $x$ = variable costs
For 2015: profit = revenue – costs
$$300,000 = 100(50,000) - (50,000x + 800,000)$$
$$50,000x = 3,900,000$$
$$x = \$78 \text{ per unit}$$
For 2016:
Let $y$ = 2016 price
profit = revenue – cost
$$300,000 = 50,000y - [78(50,000) + 800,000 + 200,000]$$
$$5,200,000 = 50,000y$$
$$y = \$104$$

**97**

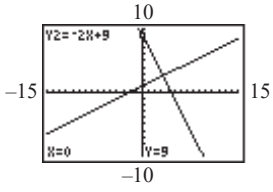



From left to right the lines are $y = 2x + 3$, $y = 2x$, and $y = 2x - 3$.
The lines are distinguished by their $y$-intercepts, which appear as $b$ in the form $y = mx + b$.

**98.**

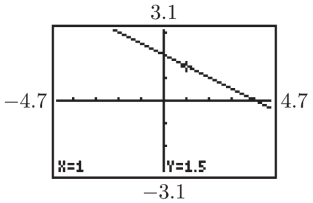



No, do not appear perpendicular



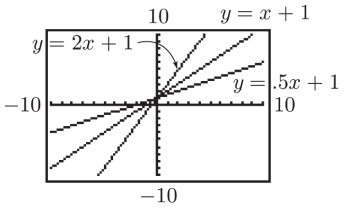

Do appear perpendicular

**99.**



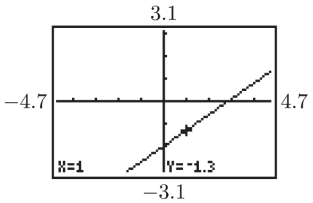

Since the slope equals $-\frac{1}{2}$, moving 2 units to the right requires moving $2 \cdot \left(-\frac{1}{2}\right) = -1$ unit up, or 1 unit down.

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

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

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

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


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

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

$A = (0, 14)$

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

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

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

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

$x = 4$

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

$B = (4, 6)$

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

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

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

$-x = -6$

$x = 6$

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$$y = -\frac{1}{2}(6) + 6 = 3$$
$C = (6, 3)$
$\begin{cases} x + 2y = 12 \\ y = 0 \end{cases}$
$x = -2y + 12 = -2(0) + 12 = 12$
$D = (12, 0)$

**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.


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**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 $-40^\circ$, it will be the same on both temperature scales.

**24. a.**

$$\begin{aligned} F &= \frac{9}{5}(5) + 32 \\ F &= 41 \\ F &= 2(5) + 30 \\ F &= 40 \end{aligned}$$

The two temperatures differ by 1° F.

**b.**

$$\begin{aligned} F &= \frac{9}{5}(20) + 32 \\ F &= 68 \\ F &= 2(20) + 30 \\ F &= 70 \end{aligned}$$

The two temperatures differ by 2° F.

**c.**

$$\begin{aligned} 2C + 30 &= \frac{9}{5}C + 32 \\ \frac{1}{5}C &= 2 \\ C &= 10 \end{aligned}$$

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.

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

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

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

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**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


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

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

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

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

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

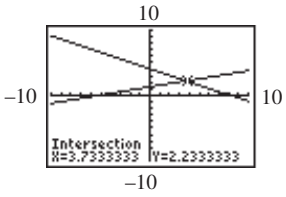
$x = 20$ TV sets

$y = 20 + 5$

$= 25$ TV sets

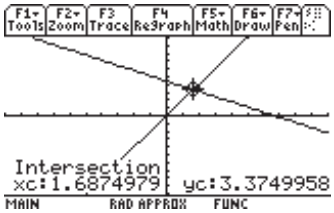
Total = 20 + 25 = 45 TV sets

**33.**




(3.73, 2.23)

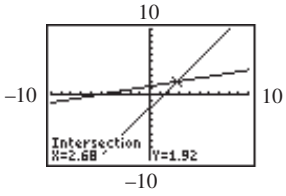
**34.**




(1.69, 3.38)

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

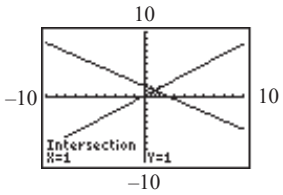
$$\begin{cases} y = \frac{1}{4}x + \frac{5}{4} \\ y = \frac{3}{2}x - 2.1 \end{cases}$$




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

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

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

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

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

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

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

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

$y = -1.5x + 8.5$


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**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 $\sum x = 200, \sum y = 186, \sum xy = 9388,$
$\sum x^2 = 10{,}118$
$m = \dfrac{4 \cdot 9388 - 200 \cdot 186}{4 \cdot 10{,}118 - 200^2} \approx 0.7458$
$b = \dfrac{186 - (0.7458)(200)}{4} \approx 9.21$
$y = 0.7458x + 9.21$

**b.** $y = 0.7458(54) + 9.21$
$y \approx 49.48$ mpg

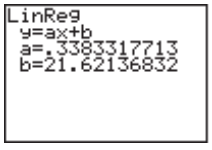
**c.** $50 = 0.7458x + 9.21$
$x \approx 54.69$ mpg

**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.**




$y = .338x + 21.6$

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**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 = 0.521$x$ + 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 = 0.59$x$ + 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.

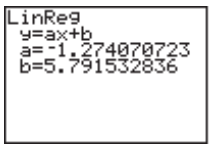
**21. a.** $y = 0.124x + 77.34$

**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 = 0.03025$x$ + 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.


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