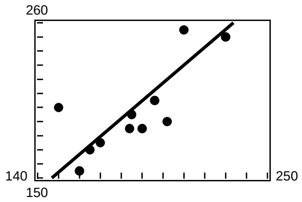
69. (a), (b)



(c) For $y \geq 200$, $x \geq 186.23$ pounds

(d) The model is not accurate. The data is not linear. Other factors include muscle strength, height, physical condition, etc.

71. $\left|\dfrac{h - 68.5}{2.7}\right| \leq 1$

$|h - 68.5| \leq 2.7$

$-2.7 \leq h - 68.5 \leq 2.7$

$65.8 \leq h \leq 71.2$

h lies in the interval $[65.8, 71.2]$

73. (a) If $t = 2$, $u \approx 330$ vibrations per second.

(b) If $u = 600$, $t \approx 3.6$ mm.

(c) If $200 \leq u \leq 400$, then $1.2 \leq t \leq 2.4$.

(d) If $t < 3$, then $u < 500$ vibrations per second.

75. False. If $-10 \leq x \leq 8$, then $10 \geq -x$ and $-x \geq -8$.

77. (a) The polynomial is zero at $x = a$ and $x = b$.

(b)

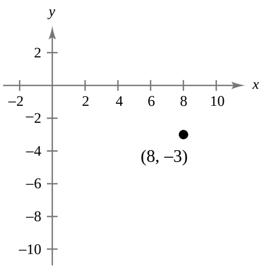
Interval	*Sign of* $(x - a)$	*Sign of* $(x - b)$	*Sign of product*
$(-\infty, a)$	$-$	$-$	$+$
(a, b)	$+$	$-$	$-$
(b, ∞)	$+$	$+$	$+$

(c) The zeros of a polynomial are the only places where a polynomial can change signs.

Review for Chapter P

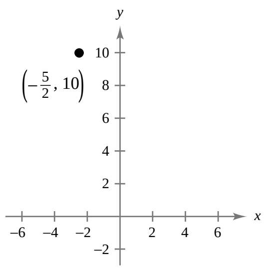
Solutions to Odd-Numbered Exercises

1.



Quadrant IV

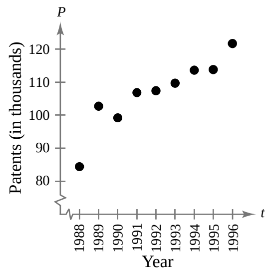
3.



Quadrant II

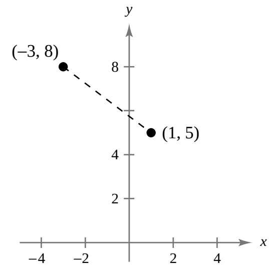
5. $x > 0, y = -2 \rightarrow$ Quadrant IV

7. (a)

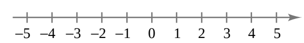


(b) The number of patents increases from 1990 to 1996.

9. $(-3, 8), \ (1, 5)$



$$d = \sqrt{(1-(-3))^2 + (5-8)^2}$$
$$= \sqrt{4^2 + 3^2} = \sqrt{25} = 5$$



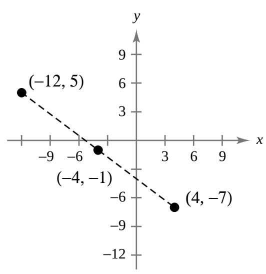
11. $d_1 = \sqrt{(22-3)^2 + (5-2)^2} = \sqrt{19^2 + 3^2} = \sqrt{370}$

$d_2 = \sqrt{(22-11)^2 + (5-13)^2} = \sqrt{11^2 + 8^2} = \sqrt{185}$

$d_3 = \sqrt{(11-3)^2 + (13-2)^2} = \sqrt{64 + 121} = \sqrt{185}$

$d_2{}^2 + d_3{}^2 = d_1{}^2 = 370$

13.



Midpoint: $\left(\dfrac{-12+4}{2}, \dfrac{5-7}{2}\right) = (-4, -1)$

15. (a) Using the midpoint to estimate 1997 revenues,

$$\left(\frac{1996 + 1998}{2}, \frac{329.5 + 375.2}{2}\right) = (1997, 352.35)$$

Revenues were approximately 352.35 million in 1997

(b) The estimate is fairly accurate: Error: $352.35 - 349.4 = 2.95$ million

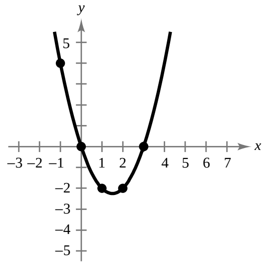
17. Center: $\left(\dfrac{-4+1-}{2}, \dfrac{6-2}{2}\right) = (3, 2)$

Radius: $\frac{1}{2}\sqrt{(10+4)^2 + (-2-6)^2} = \frac{1}{2}\sqrt{14^2 + 8^2} = \sqrt{65}$

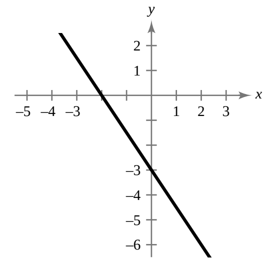
Circle: $(x-3)^2 + (y-2)^2 = 65$

19.

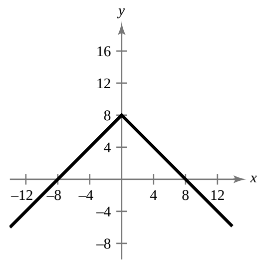
x	-1	0	1	2	3
y	4	0	-2	-2	0



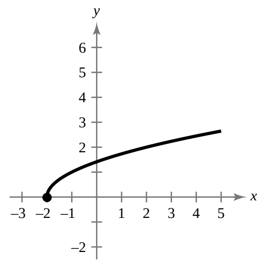
21.



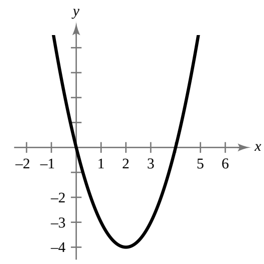
23.



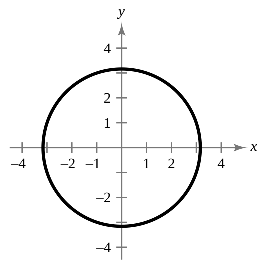
25.



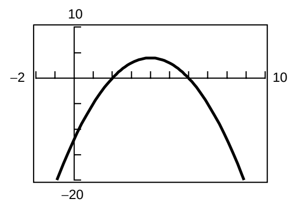
27.



29.

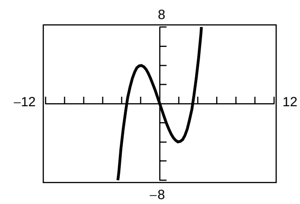


31.



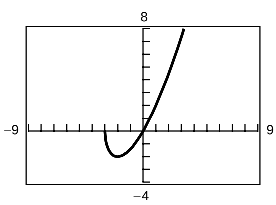
Intercepts:
$(6, 0), (2, 0), (0, -12)$

33.



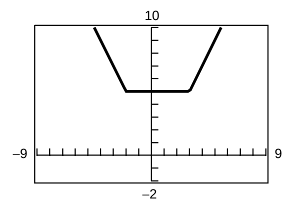
Intercepts: $(0, 0), \left(\pm 2\sqrt{3}, 0\right)$

35.



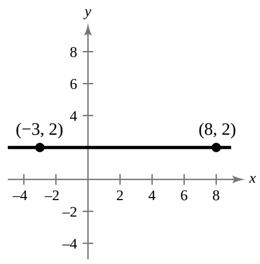
Intercepts: $(0, 0), (-3, 0)$

37.

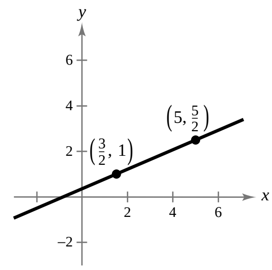


Intercept: $(0, 5)$

39. $m = \dfrac{2 - 2}{8 - (-3)} = \dfrac{0}{11} = 0$

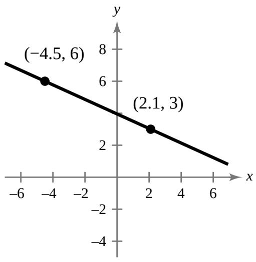


41. $m = \dfrac{5/2 - 1}{5 - 3/2} = \dfrac{3/2}{7/2} = \dfrac{3}{7}$



43. $(-4.5, 6)$, $(2.1, 3)$

$$m = \frac{3 - 6}{2.1 - (-4.5)} = \frac{-3}{6.6} = -\frac{30}{66} = -\frac{5}{11}$$



45. $(-2, 5)$, $(0, t)$, $(1, 1)$ are collinear.

$$\frac{t - 5}{0 - (-2)} = \frac{1 - 5}{1 - (-2)}$$
$$\frac{t - 5}{2} = \frac{-4}{3}$$
$$3(t - 5) = -8$$
$$3t - 15 = -8$$
$$3t = 7$$
$$t = \frac{7}{3}$$

47. The line through $(1, -4)$ and $(5, 10)$ is:

$$y + 4 = \frac{10 + 4}{5 - 1}(x - 1)$$
$$y + 4 = \frac{7}{2}(x - 1)$$
$$2y + 8 = 7(x - 1)$$
$$2y + 8 = 7x - 7$$
$$7x - 2y = 15$$

For $(t, 3)$ to be on this line also, it must satisfy the equation $7x - 2y = 15$.

$$7(t) - 2(3) = 15$$
$$7t = 21$$

Thus, $t = 3$.

49. (a) $y + 1 = \frac{1}{4}(x - 2)$

$4y + 4 = x - 2$

$4y - x = -6$

(b) Three additional points:

$(2 + 4, -1 + 1) = (6, 0)$

$(6 + 4, 0 + 1) = (10, 1)$

$(10 + 4, 1 + 1) = (14, 2)$

(other answers possible)

51. (a) $y + 5 = \frac{3}{2}(x - 0)$

$2y + 10 = 3x$

$2y - 3x = -10$

(b) Three additional points:

$(0 + 2, -5 + 3) = (2, -2)$

$(2 + 2, -2 + 3) = (4, 1)$

$(4 + 2, 1 + 3) = (6, 4)$

(other answers possible)

53. (a) $y + 5 = -1\left(x - \frac{1}{5}\right)$

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

$5y + 25 = -5x + 1$

$5x + 5y = -24$

(b) Three additional points:

$\left(\frac{1}{5} + 1, -5 - 1\right) = \left(\frac{6}{5}, -6\right)$

$\left(\frac{6}{5} + 1, -6 - 1\right) = \left(\frac{11}{5}, -7\right)$

$\left(\frac{11}{5} + 1, -7 - 1\right) = \left(\frac{16}{5}, -8\right)$

(other answers possible)

55. (a) $y - 6 = 0(x + 2)$

$y - 6 = 0$

$y = 6$

(b) Three additional points:

$(0, 6)$, $(1, 6)$, $(2, 6)$

(other answers possible)

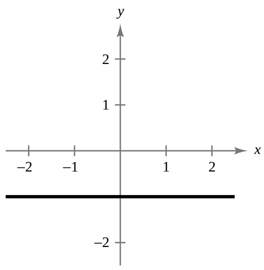
57. (a) m is undefined means that the line is vertical.

$x = 10$

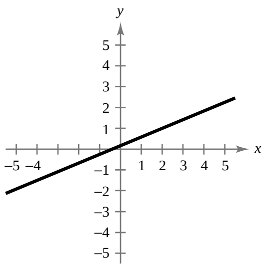
(b) Three additional points: $(10, 0)$, $(10, 1)$, $(10, 2)$

(other answers possible)

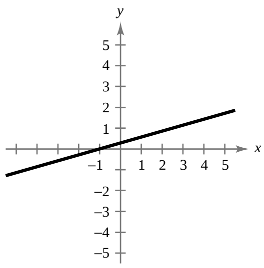
59. (a) $y + 1 = \dfrac{-1 + 1}{4 - 2}(x - 2) = 0(x - 2) = 0 \Longrightarrow y = -1$ (slope = 0) (b)



61. (a) $y - 1 = \dfrac{6 - 1}{14 - 2}(x - 2) = \dfrac{5}{12}(x - 2) = \dfrac{5}{12}x - \dfrac{5}{6} \Longrightarrow y = \dfrac{5}{12}x + \dfrac{1}{6}$ (b)



63. (a) $y - 0 = \dfrac{2 - 0}{6 - (-1)}(x + 1) = \dfrac{2}{7}(x + 1) = \dfrac{2}{7}x + \dfrac{2}{7} \Longrightarrow y = \dfrac{2}{7}x + \dfrac{2}{7}$ (b)



65. $5x - 4y = 8 \quad \Longrightarrow \quad y = \frac{5}{4}x - 2$ and $m = \frac{5}{4}$

(a) Parallel slope: $m = \frac{5}{4}$

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

$4y + 8 = 5x - 15$

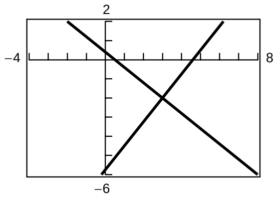
$0 = 5x - 4y - 23$

(b) Perpendicular slope: $m = -\frac{4}{5}$

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

$5y + 10 = -4x + 12$

$4x + 5y - 2 = 0$



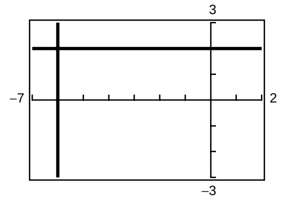
67. $x = 4$ is a vertical line; the slope is not defined.

(a) Parallel line: $x = -6$

(b) Perpendicular slope: $m = 0$

Perpendicular line:

$y - 2 = 0(x + 6) = 0 \Longrightarrow y = 2$



69. $14 + \frac{2}{x-1} = 10$

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

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

$$2 = -4x + 4$$

$$4x = 2$$

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

71. $\frac{9x}{3x-1} - \frac{4}{3x+1} = 3$

$$9x(3x+1) - 4(3x-1) = 3(3x-1)(3x+1)$$

$$27x^2 + 9x - 12x + 4 = 3(9x^2 - 1)$$

$$27x^2 - 3x + 4 = 27x^2 - 3$$

$$-3x = -7$$

$$x = \frac{7}{3}$$

73. $-x + y = 3$

Let $x = 0$: $y = 3$. y-intercept: $(0, 3)$

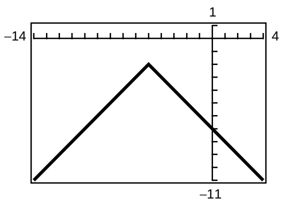
Let $y = 0$: $x = -3$. x-intercept: $(-3, 0)$

75. $y = x^2 - 9x + 8 = (x-8)(x-1)$

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

Let $y = 0$: $x = 1, 8$. x-intercepts: $(1, 0), (8, 0)$

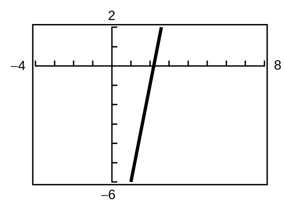
77. $y = -|x+5| - 2$



y-intercept: $(0, -7)$

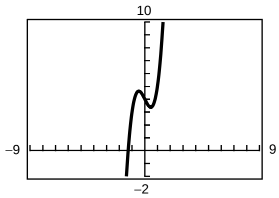
No x-intercepts

79.



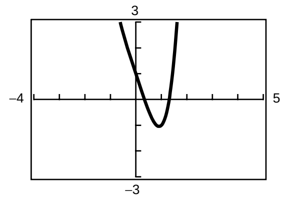
Solution: $x = 2.2$

81.



Solution: $x = -1.301$

83.



Solutions: $x = 1.307, x = 0.338$

85. $3x + 5y = -7$

$-x - 2y = 3$

From second equation, $x = -2y - 3$. Then

$3(-2y - 3) + 5y = 7$

$$-y - 9 = -7$$

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

Intersection point $(1, -2)$

87. $x^2 + 2y = 14$

$3x + 4y = 1$

From equation 2, $y = \frac{1}{4}(1 - 3x)$. Then

$x^2 + 2\left(\frac{1}{4}\right)(1 - 3x) = 14$

$$x^2 + \frac{1}{2} - \frac{3}{2}x = 14$$

$$2x^2 - 3x - 27 = 0$$

$$(2x - 9)(x + 3) = 0$$

$x = \frac{9}{2} \implies y = \frac{1}{4}\left(1 - 3\left(\frac{9}{2}\right)\right) = -\frac{25}{8}$

$x = -3 \implies y = \frac{1}{4}\left(1 - 3(-3)\right) = \frac{5}{2}$

Intersection points: $\left(-3, \frac{5}{2}\right), \left(\frac{9}{2}, -\frac{25}{8}\right)$

89. $6x = 3x^2$

$$0 = 3x^2 - 6x$$
$$0 = 3x(x - 2)$$
$$3x = 0 \implies x = 0$$
$$x - 2 = 0 \implies x = 2$$

91. $(x + 4)^2 = 18$

$$x + 4 = \pm\sqrt{18}$$
$$x = -4 \pm 3\sqrt{2}$$

93. $x^2 - 12x + 30 = 0$

$$x^2 - 12x = -30$$
$$x^2 - 12x + 36 = -30 + 36$$
$$(x - 6)^2 = 6$$
$$x - 6 = \pm\sqrt{6}$$
$$x = 6 \pm \sqrt{6}$$

95. $2x^2 + 9x - 5 = 0$

$$(2x - 1)(x + 5) = 0$$
$$x = \tfrac{1}{2}, -5$$

97. $x^2 - 4x - 10 = 0$

$$x = \frac{4 \pm \sqrt{(-4)^2 - 4(-10)}}{2}$$
$$= \frac{4 \pm \sqrt{56}}{2}$$
$$= 2 \pm \sqrt{14}$$

99. $3x^3 - 26x^2 + 16x = 0$

$$x(3x^2 - 26x + 16) = 0$$
$$x(3x - 2)(x - 8) = 0$$
$$x = 0, \tfrac{2}{3}, 8$$

101. $5x^4 - 12x^3 = 0$

$$x^3(5x - 12) = 0$$
$$x^3 = 0 \quad \text{or} \quad 5x - 12 = 0$$
$$x = 0 \quad \text{or} \quad x = \tfrac{12}{5}$$

103. $\sqrt{x + 4} = 3$

$$\left(\sqrt{x + 4}\right)^2 = (3)^2$$
$$x + 4 = 9$$
$$x = 5$$

105. $\sqrt{2x + 3} + \sqrt{x - 2} = 2$

$$\left(\sqrt{2x + 3}\right)^2 = \left(2 - \sqrt{x - 2}\right)^2$$
$$2x + 3 = 4 - 4\sqrt{x - 2} + x - 2$$
$$x + 1 = -4\sqrt{x - 2}$$
$$(x + 1)^2 = \left(-4\sqrt{x - 2}\right)^2$$
$$x^2 + 2x + 1 = 16(x - 2)$$
$$x^2 - 14x + 33 = 0$$
$$(x - 3)(x - 11) = 0$$

$x = 3$, extraneous or $x = 11$, extraneous
No solution. (You can verify that the graph of $y = \sqrt{2x + 3} + \sqrt{x - 2} - 2$ lies above the x-axis.)

107. $(x - 1)^{2/3} - 25 = 0$

$$(x - 1)^{2/3} = 25$$
$$(x - 1)^2 = 25^3$$
$$x - 1 = \pm\sqrt{25^3}$$
$$x = 1 \pm 125$$
$$x = 126 \quad \text{or} \quad x = -124$$

109. $3\left(1 - \frac{1}{5t}\right) = 0$

$1 - \frac{1}{5t} = 0$

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

$5t = 1$

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

111. $\frac{4}{(x-4)^2} = 1$

$4 = (x-4)^2$

$\pm 2 = x - 4$

$4 \pm 2 = x$

$x = 6$ or $x = 2$

113. $|x - 5| = 10$

$x - 5 = -10$ or $x - 5 = 10$

$x = -5$ $\quad$ $x = 15$

115. $|x^2 - 3| = 2x$

$x^2 - 3 = 2x$ OR $x^2 - 3 = -$

$x^2 - 2x - 3 = 0$ $\quad$ $x^2 + 2x - 3 = 0$

$(x-3)(x+1) = 0$ $\quad$ $(x+3)(x-1) = 0$

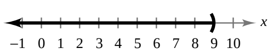
$x = 3$ or $x = -1$ $\quad$ $x = -3$ or $x = 1$

The only solutions to the original equation are $x =$ or $x = 1$. ($x = -3$ and $x = -1$ are extraneous.)

117. $8x - 3 < 6x + 15$

$2x < 18$

$x < 9$

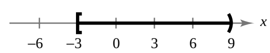


119. $-2 < -x + 7 \le 10$

$-9 < -x \le 3$

$9 > x \ge -3$

$-3 \le x < 9$

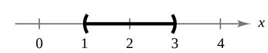


121. $|x - 2| < 1$

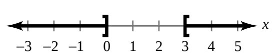
$-1 < x - 2 < 1$

$1 < x < 3$

which can be written as (1, 3)



123. $\left|x - \frac{3}{2}\right| \ge \frac{3}{2}$



$x - \frac{3}{2} \le -\frac{3}{2}$ or $x - \frac{3}{2} \ge \frac{3}{2}$

$x \le 0$ or $x \ge 3$

125. $4|3 - 2x| \le 16$

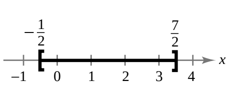
$|3 - 2x| \le 4$

$-4 \le 3 - 2x \le 4$

$-7 \le -2x \le 1$

$\frac{7}{2} \ge x \ge -\frac{1}{2}$

$-\frac{1}{2} \le x \le \frac{7}{2}$



127. $x^2 - 2x \ge 3$

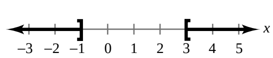
$x^2 - 2x - 3 \ge 0$

$(x-3)(x+1) \ge 0$

Test intervals: $(-\infty, -1), (-1, 3), (3, \infty)$

$x \ge 3$ or $x \le -1$

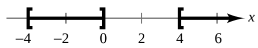
$(-\infty, -1] \cup [3, \infty)$



129. $x^3 - 16x \geq 0$

$x(x - 4)(x + 4) \geq 0$

Critical numbers: 0, 4, -4. Testing the four intervals, we obtain $-4 \leq x \leq 0$ or $x \geq 4$



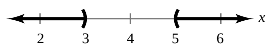
131. $\dfrac{x - 5}{3 - x} < 0$

Critical numbers: $x = 5, x = 3$

Test intervals: $(-\infty, 3), (3, 5), (5, \infty)$

Test: Is $\dfrac{x - 5}{3 - x} < 0$?

Solution set: $(-\infty, 3) \cup (5, \infty)$



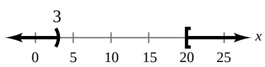
133.

$$\frac{3x + 8}{x - 3} - 4 \leq 0$$

$$\frac{3x + 8 - 4(x - 3)}{x - 3} \leq 0$$

$$\frac{20 - x}{x - 3} \leq 0$$

$$\frac{x - 20}{x - 3} \geq 0$$



Critical numbers: $x = 3, 20$. Testing the three intervals, we obtain $x \geq 20$ or $x < 3$.

135. $\left(20.8 - \frac{1}{16}\right)^2 \leq \text{Area} \leq \left(20.8 + \frac{1}{16}\right)^2$

$430.044 \leq \text{Area} \leq 435.244$ square inches

137. True. For example, $x^2 + y^2 = 1$

139. They are the same. A point $(a, 0)$ is an x-intercept if it is a solution point of the equation. In other words, a is a zero of the equation.