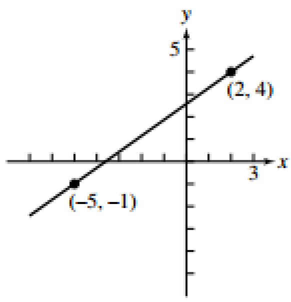
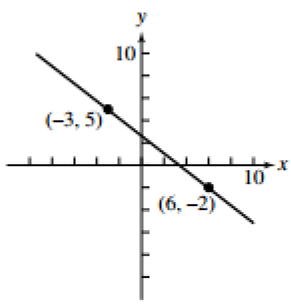
Section 2.1 Exercises

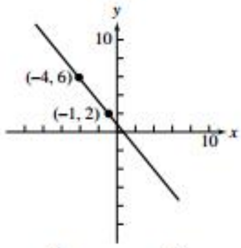
1. Not a polynomial function because of the exponent -5
2. Polynomial of degree 1 with leading coefficient 2
3. Polynomial of degree 5 with leading coefficient 2
4. Polynomial of degree 0 with leading coefficient 13
5. Not a polynomial function because of the radical
6. Polynomial of degree 2 with leading coefficient -5
7. $m = \frac{5}{7}$ so $y - 4 = \frac{5}{7}(x - 2) \Rightarrow f(x) = \frac{5}{7}x + \frac{18}{7}$



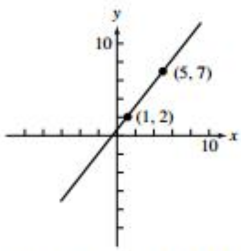
8. $m = -\frac{7}{9}$ so $y - 5 = -\frac{7}{9}(x + 3) \Rightarrow f(x) = -\frac{7}{9}x + \frac{8}{3}$



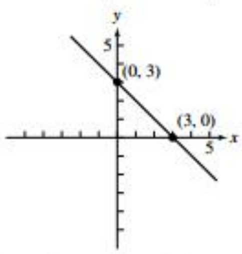
9. $m = -\frac{4}{3}$ so $y - 6 = -\frac{4}{3}(x + 4) \Rightarrow f(x) = -\frac{4}{3}x + \frac{2}{3}$



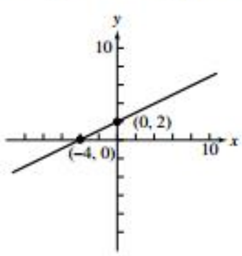
10. $m = \frac{5}{4}$ so $y - 2 = \frac{5}{4}(x - 1) \Rightarrow f(x) = \frac{5}{4}x + \frac{3}{4}$



11. $m = -1$ so $y - 3 = -1(x - 0) \Rightarrow f(x) = -x + 3$



12. $m = \frac{1}{2}$ so $y - 2 = \frac{1}{2}(x - 0) \Rightarrow f(x) = \frac{1}{2}x + 2$



13. (a)—The vertex is at $(-1, -3)$, in Quadrant III, eliminating all but (a) and (d). Since $f(0) = -1$, it must be (a).

14. (d)—The vertex is at $(-2, -7)$, in Quadrant III, eliminating all but (a) and (d). Since $f(0) = 5$, it must be (d).

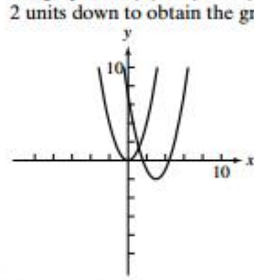
15. (b)—The vertex is in Quadrant I, at $(1, 4)$, meaning it must be either (b) or (f). Since $f(0) = 1$, it cannot be (f): if the vertex in (f) is $(1, 4)$, then the intersection with the y-axis would be about $(0, 3)$. It must be (b).

16. (f)—The vertex is in Quadrant I, at $(1, 12)$, meaning it must be either (b) or (f). Since $f(0) = 10$, it cannot be (b): if the vertex in (b) is $(1, 12)$, then the intersection with the y-axis occurs considerably lower than $(0, 10)$. It must be (f).

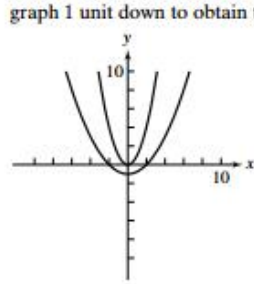
17. (e)—The vertex is at $(1, -3)$ in Quadrant IV, so it must be (e).

18. (c)—The vertex is at $(-1, 12)$ in Quadrant II and the parabola opens down, so it must be (c).

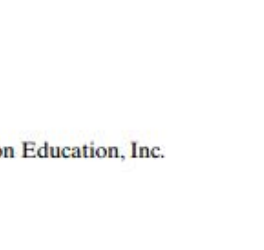
19. Translate the graph of $f(x) = x^2$ 3 units right to obtain the graph of $h(x) = (x - 3)^2$, and translate this graph 2 units down to obtain the graph of $g(x) = (x - 3)^2 - 2$.



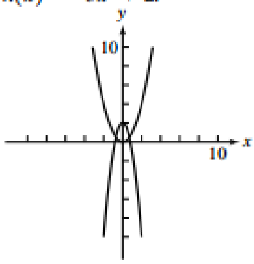
20. Vertically shrink the graph of $f(x) = x^2$ by a factor of $\frac{1}{4}$ to obtain the graph of $g(x) = \frac{1}{4}x^2$, and translate this graph 1 unit down to obtain the graph of $h(x) = \frac{1}{4}x^2 - 1$.



21. Translate the graph of $f(x) = x^2$ 2 units left to obtain the graph of $h(x) = (x + 2)^2$, vertically shrink this graph by a factor of $\frac{1}{2}$ to obtain the graph of $k(x) = \frac{1}{2}(x + 2)^2$, and translate this graph 3 units down to obtain the graph of $g(x) = \frac{1}{2}(x + 2)^2 - 3$.



22. Vertically stretch the graph of $f(x) = x^2$ by a factor of 3 to obtain the graph of $g(x) = 3x^2$, reflect this graph across the x-axis to obtain the graph of $k(x) = -3x^2$, and translate this graph up 2 units to obtain the graph of $h(x) = -3x^2 + 2$.



For #23–32, with an equation of the form $f(x) = a(x - h)^2 + k$, the vertex is (h, k) and the axis is $x = h$.

23. Vertex: $(1, 5)$; axis: $x = 1$

24. Vertex: $(-2, -1)$; axis: $x = -2$

25. Vertex: $(1, -7)$; axis: $x = 1$

26. Vertex: $(\sqrt{3}, 4)$; axis: $x = \sqrt{3}$

27. $f(x) = 3\left(x^2 + \frac{5}{3}x\right) - 4$

$= 3\left(x^2 + 2 \cdot \frac{5}{6}x + \frac{25}{36}\right) - 4 - \frac{25}{12} = 3\left(x + \frac{5}{6}\right)^2 - \frac{73}{12}$

Vertex: $\left(-\frac{5}{6}, -\frac{73}{12}\right)$; axis: $x = -\frac{5}{6}$

28. $f(x) = -2\left(x^2 - \frac{7}{2}x\right) - 3$

$= -2\left(x^2 - 2 \cdot \frac{7}{4}x + \frac{49}{16}\right) - 3 + \frac{49}{8}$

$= -2(x - \frac{7}{4})^2 + \frac{25}{8}$

Vertex: $\left(\frac{7}{4}, \frac{25}{8}\right)$; axis: $x = \frac{7}{4}$

29. $f(x) = -(x^2 - 8x) + 3$
$= -(x^2 - 2 \cdot 4x + 16) + 3 + 16 = -(x - 4)^2 + 19$
Vertex: $(4, 19)$; axis: $x = 4$

30. $f(x) = 4\left(x^2 - \frac{1}{2}x\right) + 6$

$= 4\left(x^2 - 2 \cdot \frac{1}{4}x + \frac{1}{16}\right) + 6 - \frac{1}{4} = 4\left(x - \frac{1}{4}\right)^2 + \frac{23}{4}$

Vertex: $\left(\frac{1}{4}, \frac{23}{4}\right)$; axis: $x = \frac{1}{4}$

31. $g(x) = 5\left(x^2 - \frac{6}{5}x\right) + 4$

$= 5\left(x^2 - 2 \cdot \frac{3}{5}x + \frac{9}{25}\right) + 4 - \frac{9}{5} = 5\left(x - \frac{3}{5}\right)^2 + \frac{11}{5}$

Vertex: $\left(\frac{3}{5}, \frac{11}{5}\right)$; axis: $x = \frac{3}{5}$

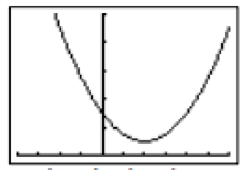
32. $h(x) = -2\left(x^2 + \frac{7}{2}x\right) - 4$

$= -2\left(x^2 + 2 \cdot \frac{7}{4}x + \frac{49}{16}\right) - 4 + \frac{49}{8}$

$= -2\left(x + \frac{7}{4}\right)^2 + \frac{17}{8}$

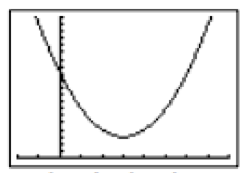
Vertex: $\left(-\frac{7}{4}, \frac{17}{8}\right)$; axis: $x = -\frac{7}{4}$

33. $f(x) = (x^2 - 4x + 4) + 6 - 4 = (x - 2)^2 + 2$.
Vertex: $(2, 2)$; axis: $x = 2$; opens upward; does not intersect x-axis.



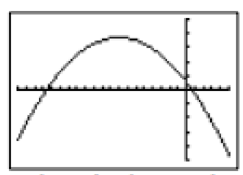
$[-4, 6]$ by $[0, 20]$

34. $g(x) = (x^2 - 6x + 9) + 12 - 9 = (x - 3)^2 + 3$.
Vertex: $(3, 3)$; axis: $x = 3$; opens upward; does not intersect x-axis.



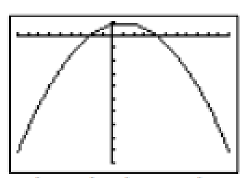
$[-2, 8]$ by $[0, 20]$

35. $f(x) = -(x^2 + 16x) + 10$
$= -(x^2 + 16x + 64) + 10 + 64 = -(x + 8)^2 + 74$.
Vertex: $(-8, 74)$; axis: $x = -8$; opens downward; intersects x-axis at about -16.602 and $0.602(-8 \pm \sqrt{74})$.



$[-20, 5]$ by $[-100, 100]$

36. $h(x) = -(x^2 - 2x) + 8 = -(x^2 - 2x + 1) + 8 + 1$
$= -(x - 1)^2 + 9$
Vertex: $(1, 9)$; axis: $x = 1$; opens downward; intersects x-axis at -2 and 4.

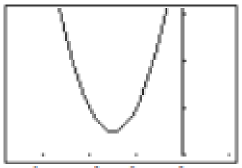


$[-9, 11]$ by $[-100, 10]$

37. $f(x) = 2(x^2 + 3x) + 7$

$= 2\left(x^2 + 3x + \frac{9}{4}\right) + 7 - \frac{9}{2} = 2\left(x + \frac{3}{2}\right)^2 + \frac{5}{2}.$

Vertex: $\left(-\frac{3}{2}, \frac{5}{2}\right)$; axis: $x = -\frac{3}{2}$; opens upward; does not intersect the x-axis; vertically stretched by 2.



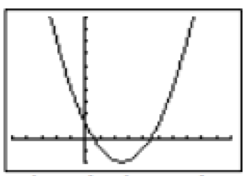
[−3.7, 1] by [2, 5.1]

38. $g(x) = 5(x^2 - 5x) + 12$

$= 5\left(x^2 - 5x + \frac{25}{4}\right) + 12 - \frac{125}{4}$

$= 5\left(x - \frac{5}{2}\right)^2 - \frac{77}{4}.$

Vertex: $\left(\frac{5}{2}, -\frac{77}{4}\right)$; axis: $x = \frac{5}{2}$; opens upward; intersects x-axis at about 0.538 and 4.462 $\left(\text{or } \frac{5}{2} \pm \frac{1}{10}\sqrt{385}\right)$; vertically stretched by 5.



[−5, 10] by [−20, 100]

For #39–44, use the form $y = a(x - h)^2 + k$, taking the vertex (h, k) from the graph or other given information.

39. $h = -1$ and $k = -3$, so $y = a(x + 1)^2 - 3$. Now substitute $x = 1$, $y = 5$ to obtain $5 = 4a - 3$, so $a = 2$: $y = 2(x + 1)^2 - 3$.

40. $h = 2$ and $k = -7$, so $y = a(x - 2)^2 - 7$. Now substitute $x = 0$, $y = 5$ to obtain $5 = 4a - 7$, so $a = 3$: $y = 3(x - 2)^2 - 7$.

41. $h = 1$ and $k = 11$, so $y = a(x - 1)^2 + 11$. Now substitute $x = 4$, $y = -7$ to obtain $-7 = 9a + 11$, so $a = -2$: $y = -2(x - 1)^2 + 11$.

42. $h = -1$ and $k = 5$, so $y = a(x + 1)^2 + 5$. Now substitute $x = 2$, $y = -13$ to obtain $-13 = 9a + 5$, so $a = -2$: $y = -2(x + 1)^2 + 5$.

43. $h = 1$ and $k = 3$, so $y = a(x - 1)^2 + 3$. Now substitute $x = 0$, $y = 5$ to obtain $5 = a + 3$, so $a = 2$: $y = 2(x - 1)^2 + 3$.

44. $h = -2$ and $k = -5$, so $y = a(x + 2)^2 - 5$. Now substitute $x = -4$, $y = -27$ to obtain $-27 = 4a - 5$, so $a = -\frac{11}{2}$: $y = -\frac{11}{2}(x + 2)^2 - 5$.

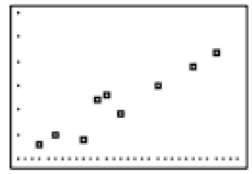
45. Strong positive

46. Strong negative

47. Weak positive

48. No correlation

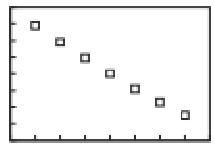
49. **(a)**



[15, 45] by [20, 50]

(b) Strong, positive, linear; $r = 0.948$

50. **(a)**



[0, 80] by [0, 80]

(b) Strong, negative, linear; $r = -0.999$

51. $m = -\frac{2350}{5} = -470$ and $b = 2350$, so $v(t) = -470t + 2350$. At $t = 3$, $v(3) = (-470)(3) + 2350 = \$940$.

52. Let x be the number of dolls produced each week and y be the average weekly costs. Then $m = 4.70$, and $b = 350$, so $y = 4.70x + 350$, or $500 = 4.70x + 350$: $x = 32$; 32 dolls are produced each week.

53. **(a)** $y \approx 0.148x + 19.56$. The slope, $m \approx 0.148$, represents the average annual increase in fuel economy for light duty trucks, about 0.15 mpg per year.

(b) Setting $x = 25$ in the regression equation leads to $y \approx 24$ mpg.

54. If the length is x, then the width is $50 - x$, so $A(x) = x(50 - x)$; maximum of 625 ft^2 when $x = 25$ (the dimensions are 25 ft × 25 ft).

55. **(a)** [0, 100] by [0, 1000] is one possibility.

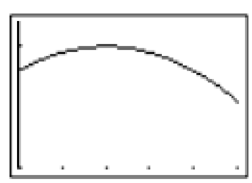
(b) When $x \approx 107.335$ or $x \approx 372.665$ — either 107,335 units or 372,665 units.

56. The area of the picture and the frame, if the width of the picture is x ft, is $A(x) = (x + 2)(x + 5)$ ft^2. This equals 208 when $x = 11$, so the painting is 11 ft × 14 ft.

57. If the strip is x feet wide, the area of the strip is $A(x) = (25 + 2x)(40 + 2x) - 1000$ ft^2. This equals 504 ft^2 when $x = 3.5$ ft.

58. **(a)** $R(x) = (800 + 20x)(300 - 5x)$.

(b) [0, 25] by [200,000, 260,000] is one possibility (shown).



[0, 25] by [200,000, 260,000]