Section 12.2

1. a. At .55 second the fireworks have just come into good view. At 5.70 seconds the fireworks have just gone out of good view.

b. In the interval between 0 and .55 seconds, the fireworks are still below the level of the balcony.

c. In the interval between 5.70 and 6.25 seconds, the fireworks have fallen below the level of the balcony.
3. Windows may vary: Xmin = 0, Xmax = 1880, Ymin = 0, Ymax = 600000

\[ y_1 = -2.5x^2 + 2450x \]

\[ y_2 = -250x + 495000 \]

Acme loses money for any value of \( x \) where the revenue function \( y_1 \) is below the cost function \( y_2 \). Acme will lose money when their widget is priced less than $234 or more than $846; \( \{ x \mid 0 \leq x < 234 \text{ or } 846 < x \} \).

5. The solutions are the values of \( y \) where the absolute value \( y_1 \) is above the line \( y_2 \).

\[ y_1 = |x - 51| \]

Percentages less than 46% or more than 56% are outside this candidate's margin of error; \( \{ x \mid 0 \leq x < 46 \text{ or } 56 < x \leq 100 \} \).

7. The inequality \( \sqrt{x} \leq 2 \) means we are looking for the values of \( x \) where the curve \( y = \sqrt{x} \) is at or below the line \( y = 2 \). Values of \( x \) between 0 and 4 satisfy these conditions; \( \{ x \mid 0 \leq x \leq 4 \} \).

9. a. The inequality \( x + 11 \leq x + 3 \) means we are looking for the values of \( x \) where the positive sloping line is below the negative sloping line. Values of \( x \) less than -4 satisfy this condition; \( \{ x \mid x < -4 \} \).

Check
\[ x + 11 \leq x + 3 \]
\[ 5 + 11 \leq (5) + 3 \] Substitute 5 for \( x \)
\[ 6 \leq 8 \] True

\[ x + 11 \leq x + 3 \]
\[ 0 + 11 \leq 0 + 3 \] Substitute 0 for \( x \)
\[ 11 \leq 3 \] False, 11 > 3

The interval \( x < -4 \) checks; we expect \( x = -5 \) to satisfy the inequality because it occurs in the interval of the solution.

b. The inequality \( x + 11 \geq x + 3 \) means we are looking for the values of \( x \) where the positive sloping line is at or above the negative sloping line. Values of \( x \) greater than or equal to 4 satisfy this condition; \( \{ x \mid x \geq 4 \} \).

Check
\[ x + 11 \geq x + 3 \]
\[ 5 + 11 \geq (5) + 3 \] Substitute 5 for \( x \)
\[ 6 \geq 8 \] False, 6 < 8

\[ x + 11 \geq x + 3 \]
\[ 0 + 11 \geq 0 + 3 \] Substitute 0 for \( x \)
\[ 11 \geq 3 \] True

The interval \( x \geq 4 \) checks; we expect \( x = 0 \) to satisfy the inequality because it occurs in the interval of the solution.

11. \( Y_1 = (X - 2)^2, Y_2 = 29 \)

Windows may vary: Xmin = -9.4, Xmax = 9.4, Ymin = -50, Ymax = 50.

The graph of the parabola \( Y_1 \) is above the line \( Y_2 \) when \( X \) is less than -3.39 or \( X \) is greater than 7.39; \( \{ x \mid x < -3.39 \text{ or } X > 7.39 \} \).

13. \( Y_1 = 4X^2, Y_2 = 20 \)

Windows may vary: Xmin = -4.7, Xmax = 4.7, Ymin = -30, Ymax = 30.

The graph of the parabola \( Y_1 \) is at or above the line \( Y_2 \) when \( X \) is less than or equal to -2.24 or \( X \) is greater than or equal to 2.24; \( \{ x \mid x \leq 2.24 \text{ or } x \geq 2.24 \} \).

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15. \( Y_1 = 0, \ Y_2 = \frac{4}{(X - 2)^2}, \ Y_3 = 1 \)

Windows may vary: \( X_{\text{min}} = -4.7, \ X_{\text{max}} = 4.7, \ Y_{\text{min}} = -2, \ Y_{\text{max}} = 2 \).

The graph of \( Y_2 = \frac{4}{x^2} \) is between the lines \( Y_1 = 0 \) and \( Y_3 = 1 \) when \( X \) is less than -2 and \( X \) is greater than 2; \( \{ x \mid x < -2 \text{ or } 2 < x \} \).

Skills and Review 12.2

17. \( 7 \leq -4x + 5 \) and \( -4x + 5 < 19 \)

\( 2 \leq -4x \) and \( -4x < 14 \)

\( \frac{1}{2} \geq x \) and \( x > \frac{7}{2} \)

\( x \leq -\frac{1}{2} \) and \( -\frac{7}{2} < x \)

The inequality symbol reverses when multiplying or dividing by a negative number.

19. \( \frac{7}{x} + \frac{5}{3x} = 13 \)

\( \frac{21}{3x} + \frac{5}{3x} = 13 \)

\( \frac{26}{3x} = 13 \)

\( 26 = 13 \times 3x \)

\( x = \frac{26}{39} = \frac{2}{3} \approx .67 \)

21. \((x - 9)^{1/4} = 2\)

\((x - 9)^{1/4} = 2^4\)

\(x - 9 = 16\)

\(x = 25\)

23. \( f(x) = x^2 + 1 \) and \( g(x) = 3x - 1 \)

a. Read \( f(g(-2)) \) as \( f \) of \( g \) of -2. It is not \( f \times g \). Recall from the order of operations we perform the work in the inner most parentheses first. Thus, evaluate the function \( g \) at \( x = -2 \). Then use that value to evaluate the function \( f \).

\( g(-2) = 3 \times (-2) - 1 \)

\( = -6 - 1 \)

\( = -7 \)

\( f(g(-2)) = f(-7) \)

\( = (-7)^2 + 1 \)

\( = 49 + 1 \)

\( = 50 \)

b. \( f(g(x)) = f(3x - 1) \)

\( = (3x - 1)^2 + 1 \)

\( = 9x^2 - 6x + 1 + 1 \)

\( = 9x^2 - 6x + 2 \)

25. \( x^2 + 8x + 11 = 0; \ a = 1, \ b = 8, \ c = 11 \)

\( x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a} \)

\( = \frac{-8 \pm \sqrt{8^2 - 4 \times 1 \times 11}}{2 \times 1} \)

\( = \frac{-8 \pm \sqrt{64 - 44}}{2} \)

\( = \frac{-8 \pm \sqrt{20}}{2} \)

\( = \frac{-8 \pm 2\sqrt{5}}{2} \)

\( = -4 \pm \sqrt{5} \)

\( x = -4 + \sqrt{5} \) or \( x = -4 - \sqrt{5} \)