13. To find the slopes of lines m and q , we must first find the equation of line n and apply Theorems 2-13 and 2-14 for parallel and perpendicular lines. Use the points $(1, -1)$ and $(4, 4)$ to find the slope of line n.

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

Notice that m is perpendicular to n, as their intersection forms a right angle. By Theorem 2-13, two non-vertical lines are perpendicular if and only if the product of the two slopes is -1. Use this to calculate the slope of line m:

$$\frac{5}{3} \times m = -1$$
$$m = -\frac{3}{5}$$

So, line m has a slope of $-\frac{3}{5}$.

Given that line m passes through the point $(2, 6)$, calculate the y-intercept of m.

$$y = mx + b$$
$$6 = \left(-\frac{3}{5}\right) \times 2 + b$$
$$6 = -\frac{6}{5} + b$$
$$b = 6 + \frac{6}{5}$$
$$b = \frac{36}{5}$$

Therefore, the equation of line m is $y = -\frac{3}{5} + \frac{36}{5}$.

Notice that line q is perpendicular to line m, as their intersection forms a right angle. By Theorem 2-13, two non-vertical lines are perpendicular if and only if the product of the two slopes is -1. Use this to calculate the slope of line q:

$$m \times \left(-\frac{3}{5}\right) = -1$$
$$m = \frac{5}{3}$$

Given that line q passes through the point $(2, 6)$, calculate the y -intercept of q.

$$y = mx + b$$
$$6 = \frac{5}{3} \times 2 + b$$
$$b = 6 - \frac{10}{3}$$
$$b = \frac{8}{3}$$

Therefore, the equation of line q is $y = \frac{5}{3}x + \frac{8}{3}$.

14. Vertical lines have undefined slope, and undefined is not a value, so it cannot be equal to another value. It also cannot be multiplied by a number to get a value, so the product of undefined and another number cannot be −1.

18. By Theorem 2-13, two non-vertical lines are parallel if and only if their slopes are equal. First, find the slopes of both lines, and then compare their values. Use the given points $(0, 20)$ and $(1, 35)$ to find the slope of $f(x)$.

$$m = \frac{35-20}{1-0} = 15$$

Use the given points $(0, 22)$ and $(1, 37)$ to find the slope of $g(x)$.

$$m = \frac{37-22}{1-0} = 15$$

Both slopes are 15, so the lines are parallel.

19. By Theorem 2-13, two non-vertical lines are parallel if and only if their slopes are equal. First, find the slopes of both lines, and then compare their values. Use the given points $(0, 5)$ and $(1, 7)$ to find the slope of $f(x)$.

$$m = \frac{7-5}{1-0} = 2$$

Use the given points $(0, 10)$ and $(1, 15)$ to find the slope of $g(x)$.

$$m = \frac{15-10}{1-0} = 5$$

The slope of $f(x)$ is 2 and the slope of $g(x)$ is 5. Since the slopes are different, the lines are not parallel.

20. By Theorem 2-13, two non-vertical lines are parallel if and only if their slopes are equal. First, find the slopes of both lines, and then compare their values. Line k falls from left to right while line j is vertical; therefore, the lines are not parallel.

21. By Theorem 2-13, two non-vertical lines are parallel if and only if their slopes are equal. First, find the slopes of both lines, and then compare their values.

By looking at the graph, we can determine that line m passes through $(-1, 4)$ and $(2, 8)$. Use these points to find the slope of line m.

$$\frac{8-4}{2-(-1)} = \frac{4}{3}$$

By looking at the graph, we can determine that line n passes through $(3, 1)$ and $(6, 6)$. Use these points to find the slope of line n.

$$\frac{6-1}{6-3} = \frac{5}{3}$$

Since the slopes are not equal, $\frac{4}{3} \neq \frac{5}{3}$, the lines are not parallel.

22. By Theorem 2-13, two non-vertical lines are parallel if and only if their slopes are equal. First, find the slopes of both lines, and then compare their values.

By looking at the graph, we can determine that line p passes through $(-1, 6)$ and $(2, 5)$. Use these points to find the slope of p.

$$\frac{5-6}{2-(-1)} = -\frac{1}{3}$$

By looking at the graph, we can determine that line q passes through $(0, -2)$ and $(3, -3)$. Use these points to find the slope of line q.

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

Since these lines have the same slope, they are parallel.

23. By Theorem 2-14, two lines are perpendicular if they are non-vertical and if the product of the two slopes is -1.

By looking at the graph, we can determine that line d passes through $(-1, 6)$ and $(-4, 0)$. Use these points to find the slope of d.

$$\frac{0-6}{-4-(-1)} = \frac{6}{3} = 2$$

By looking at the graph, we can determine that line e passes through $(-1, 3)$ and $(-3, 4)$. Use these points to find the slope of e.

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

Find the product of the two slopes:

$$2 \times \left(-\frac{1}{2}\right) = -1$$

Since the product of the two lines is equal to -1, the lines are perpendicular.

24. By Theorem 2-14, two lines are perpendicular if they are non-vertical and if the product of the two slopes is -1.

By looking at the graph, we can determine that line h passes through $(3, -1)$ and $(0, -3)$. Use these points to find the slope of h.

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

By looking at the graph, we can determine that line g passes through $(-4, 3)$ and $(-1, -2)$. Use these points to find the slope of g.

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

Since the product of the two slopes equals $\left(\frac{2}{3}\right) \times \left(-\frac{5}{3}\right) = -\frac{10}{9} \neq -1$, the lines are not perpendicular.

25. By Theorem 2-14, two lines are perpendicular if they are non-vertical and if the product of the two slopes is -1. A vertical line and a horizontal line are perpendicular to each other. Since line r is vertical and line s is horizontal, the two lines are perpendicular to each other.

26. Since Theorem 2-13 states, parallel lines have the same slope, the slope of the parallel line is –4.

$y = mx + b$
$-1 = -4 \times 6 + b$
$b = 23$

So the equation for the parallel line is $y = -4x + 23$.

Since Theorem 2-14 states, the product of the slopes of two perpendicular lines is -1, the perpendicular line has slope $\frac{1}{4}$, since $-4 \cdot \frac{1}{4} = -1$.

$y = mx + b$
$-1 = \frac{1}{4} \times 6 + b$
$b = -1 - \frac{6}{4}$
$b = -\frac{5}{2}$

So the equation for the perpendicular line is $y = \frac{1}{4}x - \frac{5}{2}$.

27. Since Theorem 2-13 states, parallel lines have the same slope, the slope of the parallel line is $\frac{3}{2}$.

$y = mx + b$
$1 = \left(\frac{3}{2}\right) \times (-1) + b$
$b = \frac{5}{2}$

So, the equation for the parallel line is $y = \frac{3}{2}x + \frac{5}{2}$.

Since Theorem 2-14 states, the product of the slopes of two perpendicular lines is -1, the perpendicular line has slope $-\frac{2}{3}$, since $\left(\frac{3}{2}\right) \times \left(-\frac{2}{3}\right) = -1$.

$y = mx + b$
$1 = (-1) \times \left(-\frac{2}{3}\right) + b$
$b = \frac{1}{3}$

So the equation for the perpendicular line is $y = -\frac{2}{3}x + \frac{1}{3}$.

28. By Theorem 2-14, the product of the slopes of two perpendicular lines is -1
.

The slope of the line connecting the cafeteria to the library is:

$$\frac{14-5}{11-5} = \frac{9}{6} = \frac{3}{2}$$

The slope of the line connecting the office to the woodshop is:

$$\frac{6-12}{11-4} = -\frac{6}{9} = -\frac{2}{3}$$

The path connecting the office and wood shop is perpendicular to the path connecting the cafeteria to the library, since $\left(\frac{3}{2}\right) \times \left(-\frac{2}{3}\right) = -1$.

29. No; Since Theorem 2-13 states, parallel lines have the same slope, we must find the slopes of the steepest parts of the two water slides to find out if they are parallel.

The slope of Slide 1: $\frac{\text{change in } y}{\text{change in } x} = -\frac{72}{40} = -\frac{9}{5}$

The slope of Slide 2: $\frac{\text{change in } y}{\text{change in } x} = -\frac{40}{24} = -\frac{5}{3}$

Since the slopes at the steepest parts of the slides are not equal, the slides are not parallel.