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Chapter 2 LINEAR EQUATIONS, GRAPHS, AND FUNCTIONS

2.3 Writing Equations of Lines

Learning Objectives	
1	Write an equation of a line given its slope and *y*-intercept.
2	Graph a line using its slope and *y*-intercept.
3	Write an equation of a line given its slope and a point on the line.
4	Write an equation of a line given two points on the line.
5	Write equations of horizontal and vertical lines.
6	Write an equation of a line parallel or perpendicular to a given line.
7	Write an equation of a line that models real data.

Key Terms

Use the vocabulary terms listed below to complete each statement in exercises 1−3.

slope-intercept form **point-slope form** **standard form**

1. A linear equation in the form $y - y_1 = m(x - x_1)$ is written in _____.

2. A linear equation in the form $Ax + By = C$ is written in _____.

3. A linear equation in the form $y = mx + b$ is written in _____.

Objective 1 Write an equation of a line given its slope and *y*-intercept.

Review this example for Objective 1:

1. Write an equation of the line with slope $\frac{5}{7}$ and *y*-intercept (0, –6).

Here, $m = \frac{5}{7}$ and $b = -6$, so we can write the following equation.

$y = mx + b$

$y = \frac{5}{7}x + (-6)$, or $y = \frac{5}{7}x - 6$

Now Try:

1. Write an equation of the line with slope $\frac{7}{9}$ and *y*-intercept (0, 8).

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Objective 1 Practice Exercises

For extra help, see Example 1 on page 176 of your text.

Write the slope-intercept form equation of the line with the given slope and y-intercept.

1. $m = \frac{3}{2};\ b = -\frac{2}{3}$ **1.** _____

2. $m = -7;\ b = -2$ **2.** _____

3. Slope: $-\frac{6}{5}$; y-intercept $\left(0,\ \frac{2}{5}\right)$ **3.** _____

Objective 2 Graph a line using its slope and *y*-intercept.

Review this example for Objective 2:

2. Graph the equation by using the slope and y-intercept.

$2x - 3y = 6$

Solve for y to write the equation in slope-intercept form.

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

The y-intercept is (0,–2). Graph this point.

The slope is $\frac{2}{3}$. By definition,

$$\text{slope } m = \frac{\text{change in } y \text{ (rise)}}{\text{change in } x \text{ (run)}} = \frac{2}{3}$$

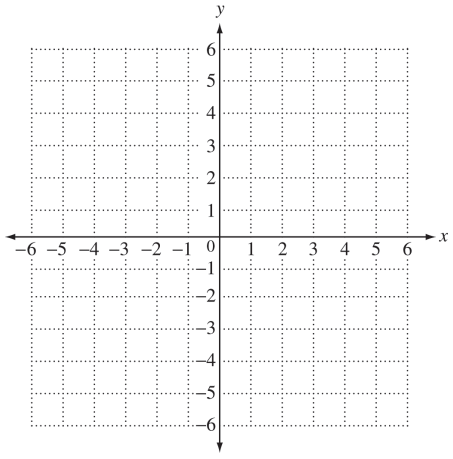
From the y-intercept, count up 2 units and to the right 3 units to obtain the point (3, 0).

Draw the line through the points (0,–2) and (3, 0) to obtain the graph.

Now Try:

2. Graph the equation by using the slope and y-intercept.

$2x - 3y = 0$



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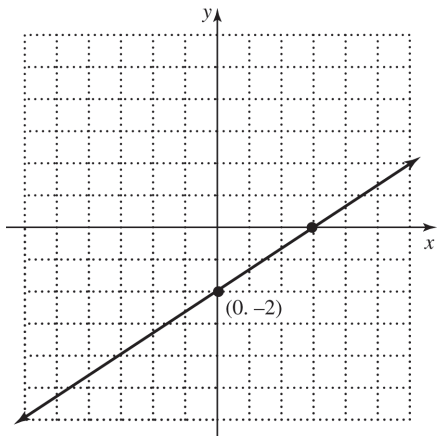


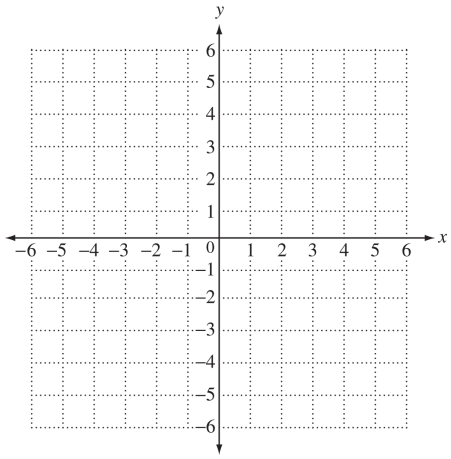
Objective 2 Practice Exercises

For extra help, see Example 2 on page 177 of your text.

Graph each equation by using the slope and y-intercept.

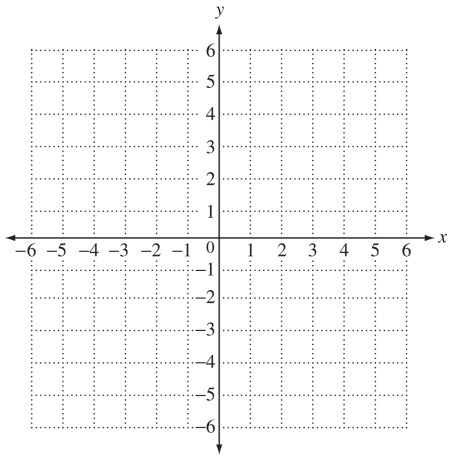
4. $4x - y = 4$

4.



5. $y = -3x + 6$

5.



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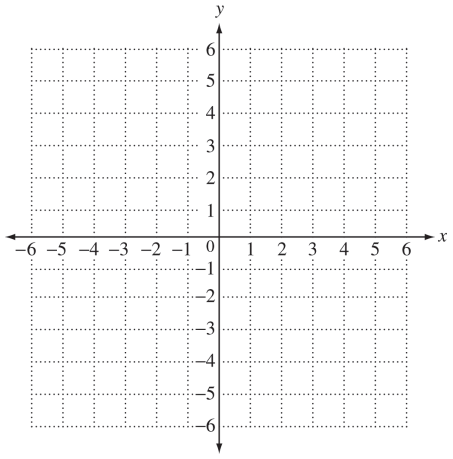
Graph the line passing through the given point and having the given slope.

6. $(-2,-2);\ m=0$

6.



Objective 3 Write an equation of a line given its slope and a point on the line.

Review this example for Objective 3:

3. Write an equation of the line with slope $\frac{2}{3}$ passing through the point (4,–7).

Method 1 Use point-slope form, with $(x_1, y_1) = (4,-7)$ and $m = \frac{2}{3}$.

$$y - y_1 = m(x - x_1)$$
$$y - (-7) = \frac{2}{3}(x - 4)$$
$$y + 7 = \frac{2}{3}(x - 4)$$
$$3y + 21 = 2x - 8$$
$$3y = 2x - 29$$
$$y = \frac{2}{3}x - \frac{29}{3}$$

Method 2 Use slope-intercept form, with $(x_1, y_1) = (4,-7)$ and $m = \frac{2}{3}$.

$$y = mx + b$$
$$-7 = \frac{2}{3}(4) + b$$
$$-7 = \frac{8}{3} + b$$
$$-\frac{29}{3} = b, \text{ or } b = -\frac{29}{3}$$

Now Try:

3. Write an equation of the line with slope $\frac{4}{5}$ passing through the point (6,–4).

_____

Knowing $m = \frac{2}{3}$ and $b = -\frac{29}{3}$ gives the equation $y = \frac{2}{3}x - \frac{29}{3}$, same as Method 1.

Objective 3 Practice Exercises

For extra help, see Example 3 on page 178 of your text.

Write the equation in standard form of the line satisfying the given conditions.

7. $(-3, 4);\ m = -\frac{3}{5}$ **7.** _____

8. $(-4, -7);\ m = \frac{4}{3}$ **8.** _____

9. $(-1, 2);\ m = \frac{2}{3}$ **9.** _____

Objective 4 Write an equation of a line given two points on the line.

Review this example for Objective 4:

4. Write the equation of the line passing through the point (6, 8) and (–3, 5). Give the final answer in slope-intercept form and then in standard form.

First, find the slope of the line.

$(x_1, y_1) = (6,\ 8)$ and $(x_2, y_2) = (-3,\ 5)$

$$\text{slope } m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{5-8}{-3-6} = \frac{-3}{-9} = \frac{1}{3}$$

Now use (x_1, y_1), here (6, 8) and point-slope

Now Try:

4. Write the equation of the line passing through the point (7, 15) and (15, 9). Give the final answer in slope-intercept form and then in standard form.

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form.

$$y - y_1 = m(x - x_1)$$
$$y - 8 = \frac{1}{3}(x - 6)$$
$$y - 8 = \frac{1}{3}x - 2$$
$$y = \frac{1}{3}x + 6 \quad \text{Slope-intercept form}$$
$$3y = x + 18$$
$$-x + 3y = 18$$
$$x - 3y = -18 \quad \text{Standard form}$$

Objective 4 Practice Exercises

For extra help, see Example 4 on page 179 of your text.

Write the equation in standard form of the line through the given points.

10. (3, 7), (5, 4) **10.** _____

11. (2,–1), (5,–2) **11.** _____

12. (–1,–4), (–2,–3) **12.** _____

Objective 5 Write equations of horizontal and vertical lines.

Review these examples for Objective 5:

5. Write an equation of the line passing through the point (2,–2) that satisfies the given condition.

a. The line has slope 0.

Since the slope is 0, this is a horizontal line.

$y = -2$.

b. The line has undefined slope.

This is a vertical line, since the slope is undefined.

$x = 2$

Now Try:

5. Write an equation of the line passing through the point (–5, 5) that satisfies the given condition.

a. The line has slope 0.

_____

b. The line has undefined slope.

_____

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Objective 5 Practice Exercises

For extra help, see Example 5 on page 180 of your text.

Write the equation in standard form of the line through the given points.

13. (–1, –7), (–1, 8) **13.** _____

14. (0, 2), (0, –6) **14.** _____

15. (4,–5), (8,–5) **15.** _____

Objective 6 Write an equation of a line parallel or perpendicular to a given line.

Review these examples for Objective 6:

6. Write an equation in slope-intercept form of the line passing through the point (–4, 5) that satisfies the given condition.

a. The line is parallel to $5x+2y=10$.

First, find the slope of the given line.

$$5x+2y=10$$
$$2y=-5x+10$$
$$y=-\frac{5}{2}x+5$$

The slope is $-\frac{5}{2}$.

Use point-slope form with $(x_1, y_1)=(-4,\ 5)$ and $m=-\frac{5}{2}$.

Now Try:

6. Write an equation in slope-intercept form of the line passing through the point (–6, 8) that satisfies the given condition.

a. The line is parallel to $3x+4y=12$.

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$$y - y_1 = m(x - x_1)$$
$$y - 5 = -\frac{5}{2}(x - (-4))$$
$$y - 5 = -\frac{5}{2}(x + 4)$$
$$y - 5 = -\frac{5}{2}x - 10$$
$$y = -\frac{5}{2}x - 5$$

b. The line is perpendicular to $5x + 2y = 10$.

From part (a), the line in slope-intercept form is $y = -\frac{5}{2}x + 5$.

The line perpendicular to this line must have slope $\frac{2}{5}$, the negative reciprocal of $-\frac{5}{2}$.

Use point-slope form with $(x_1, y_1) = (-4,\ 5)$ and $m = \frac{2}{5}$.

$$y - y_1 = m(x - x_1)$$
$$y - 5 = \frac{2}{5}(x - (-4))$$
$$y - 5 = \frac{2}{5}(x + 4)$$
$$y - 5 = \frac{2}{5}x + \frac{8}{5}$$
$$y = \frac{2}{5}x + \frac{33}{5}$$

b. The line is perpendicular to $3x + 4y = 12$.

_____

Objective 6 Practice Exercises

For extra help, see Example 6 on pages 180–181 of your text.

Write the equation in standard form of the line satisfying the given conditions.

16. parallel to $2x + 3y = -12$, through $(9, -3)$ **16.** _____

17. parallel to $4x - 3y = 8$, through $(-2, 3)$. **17.** _____

18. perpendicular to $x - 3y = 0$, through $(-10, 2)$ **18.** _____

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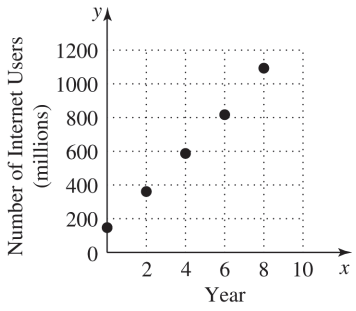
Objective 7 Write an equation of a line that models real data.

Review these examples for Objective 7:

8. The table and scatter graph shows the number of internet users in the world from 1998 to 2005, where year 0 represents 1998.

Year	Number of Internet Users (millions)
0	147
2	361
4	587
6	817
8	1093



a. Find an equation that models the data.

The points appear to lie approximately in a straight line. y represents the number of internet users in year x. To find an equation of the line, we choose the ordered pairs (0, 147) and (8, 1093) from the table and find the slope of the line through these points.

$$(x_1, y_1) = (0,\ 147) \text{ and } (x_2, y_2) = (8,\ 1093)$$

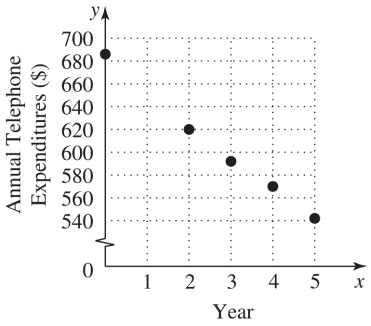
$$\text{slope } m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{1093 - 147}{8 - 0} = \frac{946}{8}$$

$$= 118.25$$

Now Try:

8. The table and scatter graph shows the average annual telephone expenditures for residential and pay telephones from 2001 to 2006, where year 0 represents 2001.

Year	Annual Telephone Expenditures
0	\$686
2	\$620
3	\$592
4	\$570
5	\$542



a. Find an equation that models the data.

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Use the slope, 118.25, and the point (0, 147) in slope-intercept form.

$$y = mx + b$$
$$147 = 118.25(0) + b$$
$$147 = b$$

Thus, $m = 118.25$ and $b = 147$, so the equation of the line is $y = 118.25x + 147$.

b. Find and interpret the ordered pair associated with the equation for $x = 5$.

If $x = 5$, then

$$y = 118.25(5) + 147$$
$$= 591.25 + 147$$
$$= 738.25$$

In 2003, there were 738.25 million internet users.

b. Find the ordered pair associated with the equation for $x = 1$.

_____

Objective 7 Practice Exercises

For extra help, see Examples 7–9 on pages 182–185 of your text.

Solve each problem.

19. To run a newspaper ad, there is a $25 set up fee plus a charge of $1.25 per line of type in the ad. Let x represent the number of lines in the ad so that y represents the total cost of the ad (in dollars).
a. Write an equation in the form $y = mx + b$.
b. Give three ordered pairs associated with the equation for x-values 0, 5, and 10.

19.

a. _____

b. _____

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20. The table and scatter graph shows the U.S. municipal solid waste recycling percent since 1985, where year 0 represents 1985.

a. Find an equation that models the data.

b. Use the equation from part (a) to predict the percent of municipal solid waste recycling in the year 2015.

20.

a. _____

b. _____

Year	Recycling Percent
0	10.1
5	16.2
10	26.0
15	29.1
20	32.5