enter. The calculator also asks you to make a guess. See Fig. 1.27(b). The more accurate the guess, the faster the calculator will find the zero. The solution to the equation rounded to two decimal places is $-21.97$. See Fig. 1.27(c). As always, consult your calculator manual if you are having difficulty.

**TRY THIS.** Use a graphing calculator to solve $0.34(x - 2.3) + 4.5 = 0$.

**FOR THOUGHT...** True or False? Explain.

1. The point $(2, -3)$ is in quadrant II. F
2. The point $(4, 0)$ is in quadrant I. F
3. The distance between $(a, b)$ and $(c, d)$ is $\sqrt{(a - b)^2 + (c - d)^2}$. F
4. The equation $3x^2 + y = 5$ is a linear equation. F
5. The solution to $7x - 9 = 0$ is the $x$-coordinate of the $x$-intercept of $y = 7x - 9$. T
6. $\sqrt{7^2 + 9^2} = 7 + 9$ F
7. The origin lies midway between $(1, 3)$ and $(-1, -3)$. T
8. The distance between $(3, -7)$ and $(3, 3)$ is 10. T
9. The $x$-intercept for the graph of $3x - 2y = 7$ is $(7/3, 0)$. T
10. The graph of $(x + 2)^2 + (y - 1)^2 = 5$ is a circle centered at $(-2, 1)$ with radius 5. F

Scan this code to link to section lecture videos.

## 1.3 EXERCISES

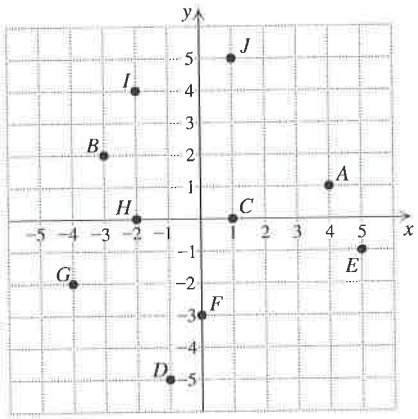
### CONCEPTS

*Fill in the blank.*

1. If $x$ and $y$ are real numbers, then $(x, y)$ is a(n) _____ pair of real numbers. ordered
2. The first coordinate in $(x, y)$ is the _____ and the second coordinate is the _____. abscissa, ordinate
3. Ordered pairs are graphed in the rectangular coordinate system or the _____ coordinate system. Cartesian
4. The intersection of the $x$-axis and the $y$-axis is the _____. origin
5. The set of all points in a plane that lie a fixed distance from a given point in the plane is a(n) _____. circle
6. Finding the third term of a perfect square trinomial when given the first two is _____. completing the square
7. An equation of the form $Ax + By = C$ is a(n) _____ in two variables. linear equation
8. The point where a line crosses the $y$-axis is the _____. $y$-intercept

### SKILLS

*In Exercises 9–18, for each point shown in the xy-plane, write the corresponding ordered pair and name the quadrant in which it lies or the axis on which it lies.* (Example 1)




9. $A$ $(4, 1)$, I
10. $B$ $(-3, 2)$, II
11. $C$ $(1, 0)$, $x$-axis
12. $D$ $(-1, -5)$, III
13. $E$ $(5, -1)$, IV
14. $F$ $(0, -3)$, $y$-axis
15. $G$ $(-4, -2)$, III
16. $H$ $(-2, 0)$, $x$-axis
17. $I$ $(-2, 4)$, II
18. $J$ $(1, 5)$, I

*For each pair of points find the distance between them and the midpoint of the line segment joining them.* (Examples 2–4)

**19.** $(1, 3), (4, 7)$ $5, (2.5, 5)$

**20.** $(-3, -2), (9, 3)$ $13, (3, 0.5)$

**21.** $(-1, -2), (1, 0)$ $2\sqrt{2}, (0, -1)$

**22.** $(-1, 0), (1, 2)$ $2\sqrt{2}, (0, 1)$

**23.** $(12, -11), (5, 13)$ $25, (17/2, 1)$

**24.** $(-4, -7), (4, 8)$ $17, (0, 1/2)$

**25.** $(-1, 1), \left(-1 + 3\sqrt{3}, 4\right)$ $6, \left(\frac{-2 + 3\sqrt{3}}{2}, \frac{5}{2}\right)$

**26.** $\left(1 + \sqrt{2}, -2\right), \left(1 - \sqrt{2}, 2\right)$ $2\sqrt{6}, (1, 0)$

**27.** $(1.2, 4.8), (-3.8, -2.2)$ $\sqrt{74}, (-1.3, 1.3)$

**28.** $(-2.3, 1.5), (4.7, -7.5)$ $\sqrt{130}, (1.2, -3)$

**29.** $(a, 0), (b, 0)$ $|a - b|, \left(\frac{a + b}{2}, 0\right)$

**30.** $(a, 0), \left(\frac{a + b}{2}, 0\right)$ $\frac{|a - b|}{2}, \left(\frac{3a + b}{4}, 0\right)$

**31.** $(\pi, 0), (\pi/2, 1)$ $\frac{\sqrt{\pi^2 + 4}}{2}, \left(\frac{3\pi}{4}, \frac{1}{2}\right)$

**32.** $(0, 0), (\pi/2, 1)$ $\frac{\sqrt{\pi^2 + 4}}{2}, \left(\frac{\pi}{4}, \frac{1}{2}\right)$

*Determine the center and radius of each circle and sketch the graph.* (Example 5)†

**33.** $x^2 + y^2 = 16$ $(0, 0), 4$

**34.** $x^2 + y^2 = 1$ $(0, 0), 1$

**35.** $(x + 6)^2 + y^2 = 36$ $(-6, 0), 6$

**36.** $x^2 + (y - 2)^2 = 16$ $(0, 2), 4$

**37.** $y^2 = 25 - (x + 1)^2$ $(-1, 0), 5$

**38.** $x^2 = 9 - (y - 3)^2$ $(0, 3), 3$

**39.** $(x - 2)^2 = 8 - (y + 2)^2$ $(2, -2), 2\sqrt{2}$

**40.** $(y + 2)^2 = 20 - (x - 4)^2$ $(4, -2), 2\sqrt{5}$

*Write the standard equation for each circle.* (Example 6)

**41.** Center at $(0, 0)$ with radius 7 $x^2 + y^2 = 49$

**42.** Center at $(0, 0)$ with radius 5 $x^2 + y^2 = 25$

**43.** Center at $(-2, 5)$ with radius $1/2$ $(x + 2)^2 + (y - 5)^2 = 1/4$

**44.** Center at $(-1, -6)$ with radius $1/3$ $(x + 1)^2 + (y + 6)^2 = 1/9$

**45.** Center at $(3, 5)$ and passing through the origin $(x - 3)^2 + (y - 5)^2 = 34$

**46.** Center at $(-3, 9)$ and passing through the origin $(x + 3)^2 + (y - 9)^2 = 90$

**47.** Center at $(5, -1)$ and passing through $(1, 3)$ $(x - 5)^2 + (y + 1)^2 = 32$

**48.** Center at $(-2, -3)$ and passing through $(2, 5)$ $(x + 2)^2 + (y + 3)^2 = 80$

*Determine the center and radius of each circle and sketch the graph. See the rule for completing the square on page 108.* (Examples 5–7)

**49.** $x^2 + y^2 = 9$ $(0, 0), 3$

**50.** $x^2 + y^2 = 100$ $(0, 0), 10$

**51.** $x^2 + y^2 + 6y = 0$ $(0, -3), 3$

**52.** $x^2 + y^2 = 4x$ $(2, 0), 2$

**53.** $x^2 + 6x + y^2 + 8y = 0$ $(-3, -4), 5$

**54.** $x^2 - 8x + y^2 - 10y = -5$ $(4, 5), 6$

**55.** $x^2 - 3x + y^2 + 2y = \frac{3}{4}$ $(3/2, -1), 2$

**56.** $x^2 + 5x + y^2 - y = \frac{5}{2}$ $(-5/2, 1/2), 3$

**57.** $x^2 - 6x + y^2 - 8y = 0$ $(3, 4), 5$

**58.** $x^2 + 10x + y^2 - 8y = -40$ $(-5, 4), 1$

**59.** $x^2 + y^2 = 4x + 3y$ $(2, 3/2), 5/2$

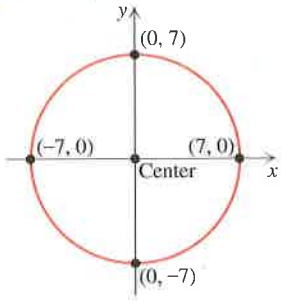
**60.** $x^2 + y^2 = 5x - 6y$ $(5/2, -3), \sqrt{61}/2$

**61.** $x^2 + y^2 = \frac{x}{2} - \frac{y}{3} - \frac{1}{16}$ $(1/4, -1/6), 1/6$

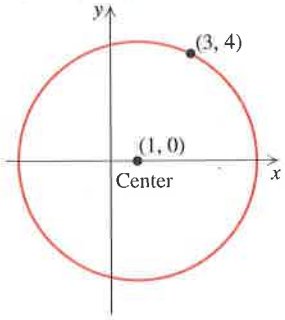
**62.** $x^2 + y^2 = x - y + \frac{1}{2}$ $(0.5, -0.5), 1$

*Write the standard equation for each of the following circles.* (Examples 1–7)

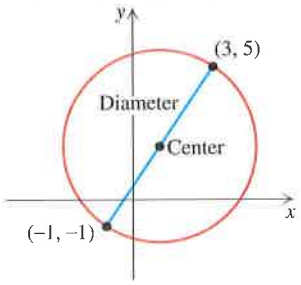
**63.** **a.** $x^2 + y^2 = 49$



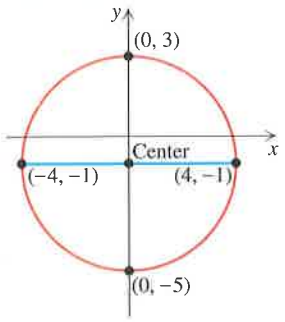

**b.** $(x - 1)^2 + y^2 = 20$



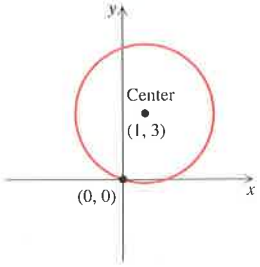

**c.** $(x - 1)^2 + (y - 2)^2 = 13$



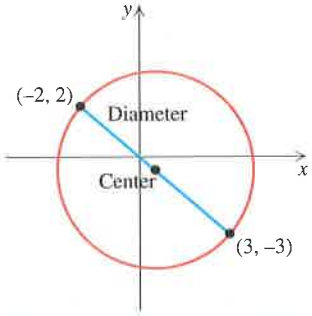

**64.** **a.** $x^2 + (y + 1)^2 = 16$




**b.** $(x - 1)^2 + (y - 3)^2 = 10$



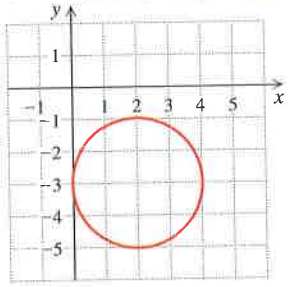

**c.** $\left(x - \frac{1}{2}\right)^2 + \left(y + \frac{1}{2}\right)^2 = \frac{25}{2}$



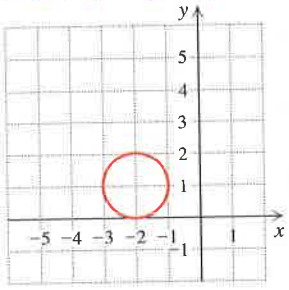

†Due to space constrictions, answers to these exercises may be found in Answers to Exercises beginning on page A-1 in the back of the book.

*Write the equation of each circle in standard form. The coordinates of the center and the radius for each circle are integers.* *(Examples 1–7)*

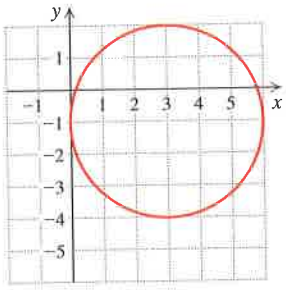
**65. a.** $(x-2)^2+(y+3)^2=4$



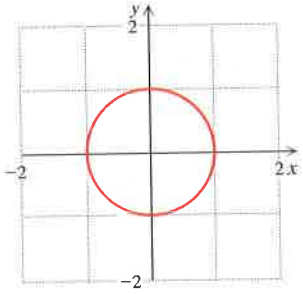
**b.** $(x+2)^2+(y-1)^2=1$



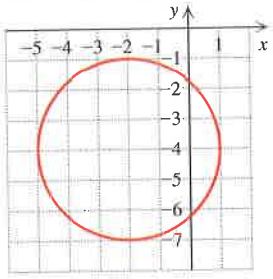
**c.** $(x-3)^2+(y+1)^2=9$



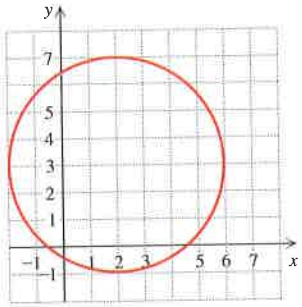
**d.** $x^2+y^2=1$



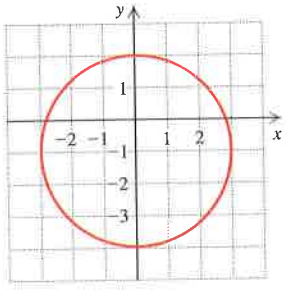
**66. a.** $(x+2)^2+(y+4)^2=9$



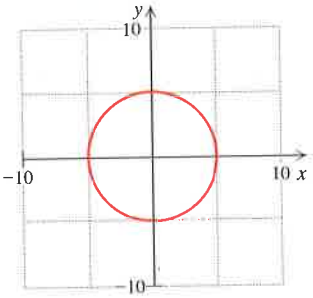
**b.** $(x-2)^2+(y-3)^2=16$



**c.** $x^2+(y+1)^2=9$



**d.** $x^2+y^2=25$



*Sketch the graph of each linear equation. Be sure to find and show the x- and y-intercepts.* *(Example 8)*

**67.** $y=3x-4$ $(0,-4),(4/3,0)$

**68.** $y=5x-5$ $(0,-5),(1,0)$

**69.** $3x-y=6$ $(0,-6),(2,0)$

**70.** $5x-2y=10$ $(0,-5),(2,0)$

**71.** $x=3y-90$ $(0,30),(-90,0)$

**72.** $x=80-2y$ $(0,40),(80,0)$

**73.** $\frac{2}{3}y-\frac{1}{2}x=400$ $(0,600),(-800,0)$

**74.** $\frac{1}{2}x-\frac{1}{3}y=600$ $(0,-1800),(1200,0)$

**75.** $2x+4y=0.01$ $(0,0.0025),(0.005,0)$

**76.** $3x-5y=1.5$ $(0,-0.3),(0.5,0)$

**77.** $0.03x+0.06y=150$ $(0,2500),(5000,0)$

**78.** $0.09x-0.06y=54$ $(0,-900),(600,0)$

*Graph each equation in the rectangular coordinate system.* *(Example 9)*

**79.** $x=5$

**80.** $y=-2$

**81.** $y=4$

**82.** $x=-3$

**83.** $x=-4$

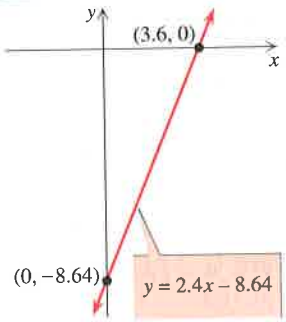
**84.** $y=5$

**85.** $y-1=0$

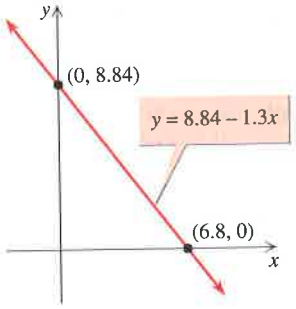
**86.** $5-x=4$

*Find the solution to each equation by reading the accompanying graph.* *(Example 10)*

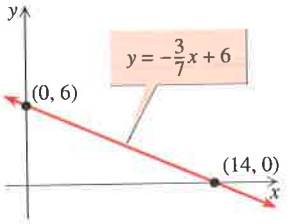
**87.** $2.4x-8.64=0$ {3.6}



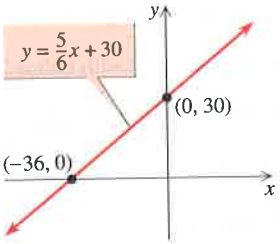

**88.** $8.84-1.3x=0$ {6.8}




**89.** $-\frac{3}{7}x+6=0$ {14}




**90.** $\frac{5}{6}x+30=0$ {−36}




*Use a graphing calculator to estimate the solution to each equation to two decimal places. Then find the solution algebraically and compare it with your estimate.* *(Example 10)*

**91.** $1.2x+3.4=0$ {−2.83}

**92.** $3.2x-4.5=0$ {1.41}

**93.** $1.23x-687=0$ {558.54}

**94.** $-2.46x+1500=0$ {609.76}

**95.** $0.03x-3497=0$ {116,566.67}

**96.** $0.09x+2000=0$ {−22,222.22}

**97.** $4.3-3.1(2.3x-9.9)=0$ {4.91}

**98.** $9.4x-4.37(3.5x-9.76)=0$ {7.24}

## MODELING

*Solve each problem.*

**99.** *Full Conduit* A conduit with an inside diameter of 4 cm can accommodate two round wires that each have a diameter of

2 cm, as shown in the accompanying figure. Two smaller wires will also fit on the sides.

**a.** What is the diameter of each smaller wire? 4/3 cm

**b.** Find the equations of the two smallest circles in the accompanying figure.
$(x - 4/3)^2 + y^2 = 4/9$, $(x + 4/3)^2 + y^2 = 4/9$

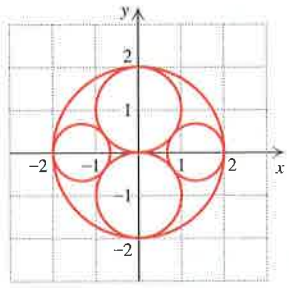



**Figure for Exercise 99**

**100.** *Perpendicular Tangents* A circle of radius 5 intersects a circle of radius 12 so that the tangent lines at the points of intersection are perpendicular. What is the distance between the centers of the circles? 13

**101.** *Unmarried Couples* The number of unmarried-couple households $h$ (in millions) can be modeled using the equation $h = 0.229n + 2.913$, where $n$ is the number of years since 1990 (U.S. Census Bureau, www.census.gov).

**a.** Find and interpret the $n$-intercept for the line. Does it make sense? (−12.72, 0). There were no unmarried-couple households in 1977. Nonsense.

**b.** Find and interpret the $h$-intercept for the line. (0, 2.913). There were 2,913,000 unmarried-couple households in 1990.

**c.** Use the equation to find the number of unmarried-couple households in 2015. 8.6 million

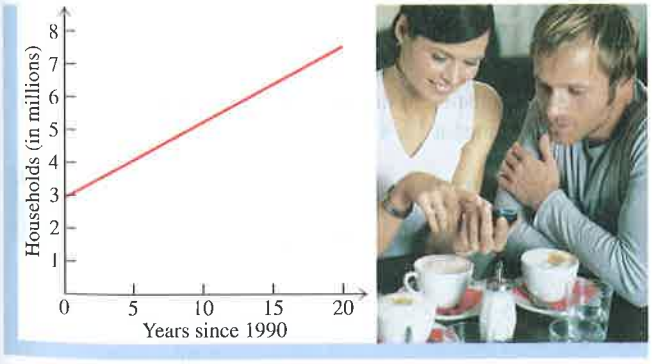



**Figure for Exercise 101**

**102.** *First Marriage* The median age at first marriage for women went from 20.8 in 1970 to 26.1 in 2012 as shown in the accompanying figure (U.S. Census Bureau, www.census.gov). Find the midpoint of the line segment in the figure and interpret your result. (21, 23.5). The median age at first marriage in 1991 was 23.5.

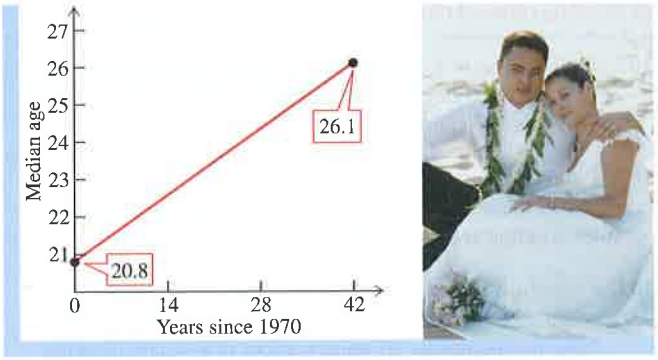



**Figure for Exercise 102**

**103.** *Capsize Control* The capsize screening value $C$ is an indicator of a sailboat's suitability for extended offshore sailing. $C$ is determined by the formula

$$C = 4D^{-1/3}B,$$

where $D$ is the displacement of the boat in pounds and $B$ is its beam (or width) in feet. Sketch the graph of this equation for $B$ ranging from 0 to 20 ft, assuming that $D$ is fixed at 22,800 lb. Find $C$ for the Island Packet 40, which has a displacement of 22,800 pounds and a beam of 12 ft 11 in. (Island Packet Yachts, www.ipy.com). $C = 1.8$

**104.** *Limiting the Beam* The International Offshore Rules require that the capsize screening value $C$ (from the previous exercise) be less than or equal to 2 for safety. What is the maximum allowable beam (to the nearest inch) for a boat with a displacement of 22,800 lb? For a fixed displacement, is a boat more or less likely to capsize as its beam gets larger? 14 ft 2 in., more likely

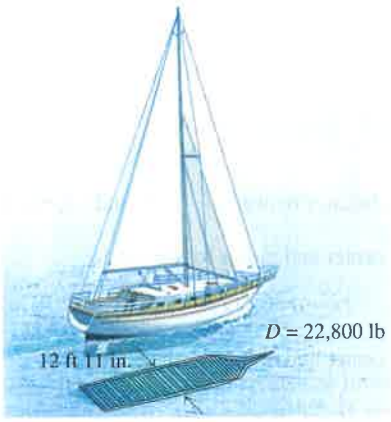



**Figure for Exercises 103 and 104**

**105.** Show that the points $A(-4, -5)$, $B(1, 1)$, and $C(6, 7)$ are colinear.

HINT Points $A$, $B$, and $C$ lie on a straight line if $AB + BC = AC$.

**106.** Show that the midpoint of the hypotenuse of any right triangle is equidistant from all three vertices.

## WRITING/DISCUSSION

**107.** *Finding Points* Can you find two points such that their coordinates are integers and the distance between them is 10? $\sqrt{10}$? $\sqrt{19}$? Explain.

**108.** *Plotting Points* Plot at least five points in the $xy$-plane that satisfy the inequality $y > 2x$. Give a verbal description of the solution set to $y > 2x$. All points above $y = 2x$

**109.** *Cooperative Learning* Work in a small group to plot the points $(-1, 3)$ and $(4, 1)$ on graph paper. Assuming that these two points are adjacent vertices of a square, find the other two vertices. Next select your own pair of adjacent vertices and "complete the square." Now generalize your results. Start with the points $(x_1, y_1)$ and $(x_2, y_2)$ as adjacent vertices of a square and write expressions for the coordinates of the other two vertices. Repeat this exercise, assuming that the first two points are opposite vertices of a square.

**110.** *Distance to the Origin* Let $m$ and $n$ be any real numbers. What is the distance between $(0, 0)$ and $(2m, m^2 - 1)$? What is the distance between $(0, 0)$ and $(2mn, m^2 - n^2)$?
$m^2 + 1, m^2 + n^2$

## REVIEW

**111.** Identify each equation as an identity, inconsistent equation, or conditional equation.

**a.** $2x + 4 = 5$ Conditional equation

**b.** $2x + 4 = 2(x + 2)$ Identity

**c.** $2x + 4 = 2x$ Inconsistent equation

**112.** Solve $\dfrac{4}{x-3} + \dfrac{1}{x+3} = \dfrac{x}{x^2-9}$. $\{-9/4\}$

**113.** Solve $\dfrac{x-2}{x+3} = \dfrac{x+4}{x+9}$. $\varnothing$

**114.** The Wilsons got \$180,780 for their house after paying a sales commission that was 8% of the selling price. What was the selling price? \$196,500

**115.** Solve $ax + b = cx + d$ for $x$. $x = \frac{d-b}{a-c}$

**116.** Simplify $\left(\dfrac{-6a^3b^{-2}}{-2a^{-6}b^{-7}}\right)^3$. $27a^{27}b^{15}$

## OUTSIDE THE BOX

**117.** *Methodical Mower* Eugene is mowing a rectangular lawn that is 300 ft by 400 ft. He starts at one corner and mows a swath of uniform width around the outside edge in a clockwise direction. He continues going clockwise, widening the swath that is mowed and shrinking the rectangular section that is yet to be mowed. When he is half done with the lawn, how wide is the swath? 50 feet

**118.** *Large Integer* The number $10^{40}$ is a very large integer. How many factors does it have? 1681

## 1.3 POP QUIZ

**1.** Find the distance between $(-1, 3)$ and $(3, 5)$. $2\sqrt{5}$

**2.** Find the center and radius for the circle

$$(x - 3)^2 + (y + 5)^2 = 81.$$ $(3, -5), 9$

**3.** Find the center and radius for the circle

$$x^2 + 4x + y^2 - 10y = -28.$$ $(-2, 5), 1$

**4.** Find the equation of the circle that passes through the origin and has center at $(3, 4)$. $(x - 3)^2 + (y - 4)^2 = 25$

**5.** Find all intercepts for $2x - 3y = 12$. $(0, -4), (6, 0)$

**6.** Which point is on both of the lines $x = 5$ and $y = -1$?
$(5, -1)$