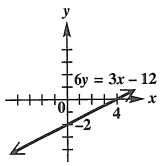
ree of the following:
1), (1995, 35), (1997, 37),
5), (2001, 28)
ree of the following:
7.8), (1998, 90.0),
3.7), (2000, 88.5),
4.3)
$\sqrt{2}$ **(b)** $(-9,-3)$
10 **(b)** $(-1,-1)$
$\sqrt{34}$ **(b)** $\left(\frac{11}{2},\frac{7}{2}\right)$
$3\sqrt{41}$ **(b)** $\left(0,\frac{5}{2}\right)$
$\sqrt{202}$ **(b)** $\left(-\frac{5}{2},-\frac{1}{2}\right)$
$2\sqrt{17}$ **(b)** $(5,2)$
$\sqrt{133}$ **(b)** $\left(2\sqrt{2},\frac{3\sqrt{5}}{2}\right)$
$3\sqrt{55}$ **(b)** $\left(2\sqrt{7},\frac{7\sqrt{3}}{2}\right)$
18. yes **19.** no
21. yes **22.** yes
24. yes **25.** no
27. no **28.** yes
2%; This is 1.1% less than
al percent of 75.3.
9 **31.** $15,481
5: 4.85 million; 1995:
ion
rdered pairs are possible in
es 33–44.

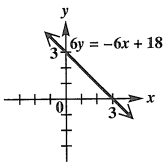
(b)

y
−2
0
−1



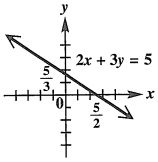
(b)

y
3
0
2



(b)

y
$\frac{5}{3}$
0
−1



7. *Percent of High School Students Who Smoke*

Year	Percent
1993	31
1995	35
1997	37
1999	35
2001	28

Source: Centers for Disease Control and Prevention.

8. *Number of Viewers of the Super Bowl*

Year	Viewers (millions)
1997	87.8
1998	90.0
1999	83.7
2000	88.5
2001	84.3

Source: Advertising Age.

For the points P and Q, find **(a)** *the distance* $d(P,Q)$ *and* **(b)** *the coordinates of the midpoint of the segment PQ. See Examples 2 and 5.*

9. $P(-5,-7)$, $Q(-13,1)$
10. $P(-4,3)$, $Q(2,-5)$
11. $P(8,2)$, $Q(3,5)$
12. $P(-6,-5)$, $Q(6,10)$
13. $P(-8,4)$, $Q(3,-5)$
14. $P(6,-2)$, $Q(4,6)$
15. $P(3\sqrt{2},4\sqrt{5})$, $Q(\sqrt{2},-\sqrt{5})$
16. $P(-\sqrt{7},8\sqrt{3})$, $Q(5\sqrt{7},-\sqrt{3})$

Determine whether the three points are the vertices of a right triangle. See Example 3.

17. $(-6,-4),(0,-2),(-10,8)$
18. $(-2,-8),(0,-4),(-4,-7)$
19. $(-4,1),(1,4),(-6,-1)$
20. $(-2,-5),(1,7),(3,15)$
21. $(-4,3),(2,5),(-1,-6)$
22. $(-7,4),(6,-2),(0,-15)$

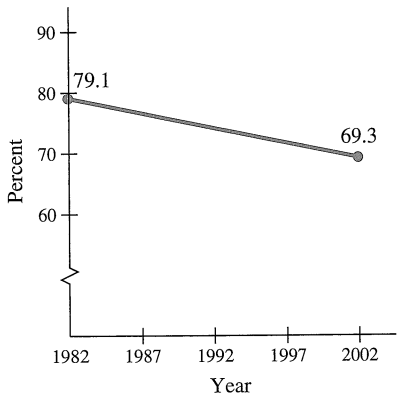
Determine whether the three points are collinear. See Example 4.

23. $(0,-7),(-3,5),(2,-15)$
24. $(-1,4),(-2,-1),(1,14)$
25. $(0,9),(-3,-7),(2,19)$
26. $(-1,-3),(-5,12),(1,-11)$
27. $(-7,4),(6,-2),(-1,1)$
28. $(-4,3),(2,5),(-1,4)$

Solve each problem. See Example 6.

29. *Aging of College Freshmen* The graph shows a straight line that approximates the results from an annual survey of college freshmen. Use the midpoint formula and the two given points to estimate the percent in 1992. Compare your answer with the actual percent of 75.3.

Percent of College Freshmen Age 18 or Younger on December 31

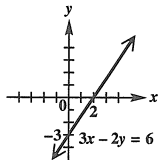


Source: Astin, A., L. Oseguera, L. Sax, and W. Korn, *The American Freshmen: Thirty-Five Year Trends*; Higher Education Research Institute, UCLA, 2002.

6. (a)

x	y
0	−3
2	0
4	3

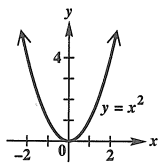
(b)



7. (a)

x	y
0	0
1	1
−2	4

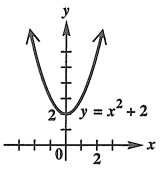
(b)



8. (a)

x	y
0	2
−1	3
2	6

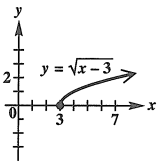
(b)



9. (a)

x	y
3	0
4	1
7	2

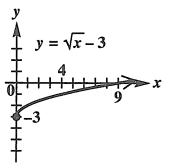
(b)



10. (a)

x	y
0	−3
4	−1
9	0

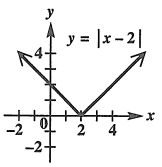
(b)



11. (a)

x	y
4	2
−2	4
0	2

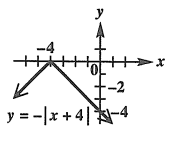
(b)



12. (a)

x	y
−2	−2
−4	0
0	−4

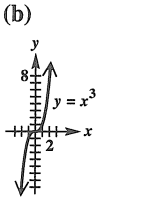
(b)



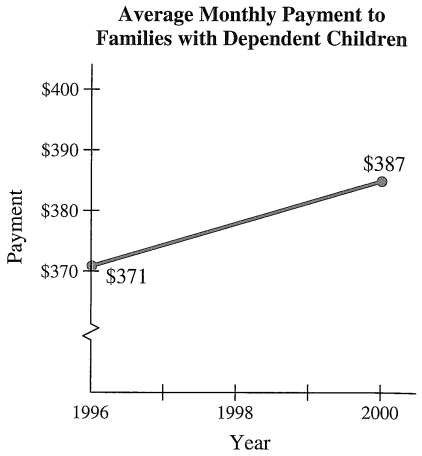
13. (a)

x	y
0	0
−1	−1
2	8

(b)



30. ***Payment to Families with Dependent Children*** The graph shows an idealized linear relationship for the average monthly family payment to families with dependent children. Based on this information, what was the average payment in 1998?



Source: U.S. Administration for Children and Families.

31. ***Poverty Level Income Cutoffs*** The table lists how poverty level income cutoffs (in dollars) for a family of four have changed over time. Use the midpoint formula to approximate the poverty level cutoff in 1995.

Year	Income (in dollars)
1960	3022
1970	3968
1980	8414
1990	13,359
2000	17,603

Source: U.S. Bureau of the Census.

32. ***Two-Year College Enrollment*** Enrollments in two-year colleges for recent years are shown in the table. Assuming a linear relationship, estimate the enrollments for 1985 and 1995.

Year	Enrollment (in millions)
1980	4.5
1990	5.2
2000	5.8

Source: Statistical Abstract of the United States.

For each equation, ***(a)*** *give a table with three ordered pairs that are solutions, and* ***(b)*** *graph the equation. (Hint: You will need more than three points for Exercises 37–44.) See Examples 7 and 8.*

33. $6y = 3x - 12$ **34.** $6y = -6x + 18$ **35.** $2x + 3y = 5$

36. $3x - 2y = 6$ **37.** $y = x^2$ **38.** $y = x^2 + 2$

39. $y = \sqrt{x - 3}$ **40.** $y = \sqrt{x} - 3$ **41.** $y = |x - 2|$

42. $y = -|x + 4|$ **43.** $y = x^3$ **44.** $y = -x^3$

In Exercises 45–52, ***(a)*** *find the center-radius form of the equation of each circle, and* ***(b)*** *graph it. See Examples 9 and 10.*

45. center $(0, 0)$, radius 6 **46.** center $(0, 0)$, radius 9 **47.** center $(2, 0)$, radius 6

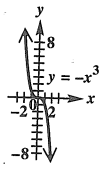
48. center $(0, -3)$, radius 7 **49.** center $(-2, 5)$, radius 4 **50.** center $(4, 3)$, radius 5

51. center $(5, -4)$, radius 7 **52.** center $(-3, -2)$, radius 6

44. (a)

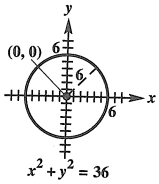
x	y
0	0
1	−1
2	−8

(b)



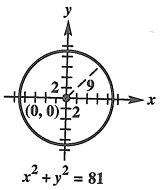
45. (a) $x^2 + y^2 = 36$

(b)



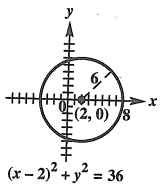
46. (a) $x^2 + y^2 = 81$

(b)



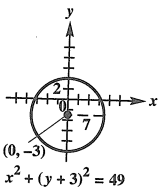
47. (a) $(x - 2)^2 + y^2 = 36$

(b)



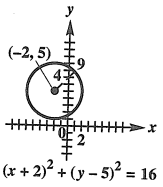
48. (a) $x^2 + (y + 3)^2 = 49$

(b)



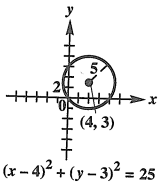
49. (a) $(x + 2)^2 + (y - 5)^2 = 16$

(b)



50. (a) $(x - 4)^2 + (y - 3)^2 = 25$

(b)



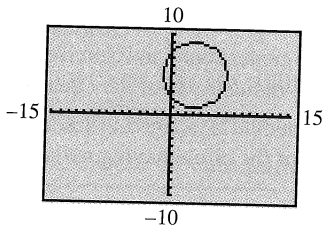
53. Find the center-radius form of the equation of a circle with center $(3, 2)$ and tangent to the x-axis. (*Hint:* A line *tangent to* a circle means touching it at exactly one point.)

54. Find the equation of a circle with center at $(-4, 3)$, passing through the point $(5, 8)$. Write it in center-radius form.

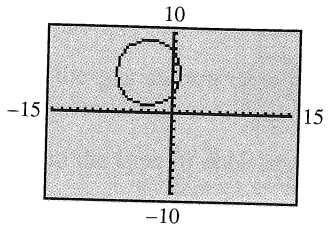
55. When the equation of a circle is written in the form $(x - h)^2 + (y - k)^2 = m$, how does the value of m indicate whether the graph is a circle, a point, or does not exist?

56. Which one of the two screens is the correct graph of the circle with center $(-3, 5)$ and radius 4?

A.



B.



Decide whether or not each equation has a circle as its graph. If it does, give the center and the radius. See Example 11.

57. $x^2 + 6x + y^2 + 8y + 9 = 0$

58. $x^2 + 8x + y^2 - 6y + 16 = 0$

59. $x^2 - 4x + y^2 + 12y = -4$

60. $x^2 - 12x + y^2 + 10y = -25$

61. $4x^2 + 4x + 4y^2 - 16y - 19 = 0$

62. $9x^2 + 12x + 9y^2 - 18y - 23 = 0$

63. $x^2 + 2x + y^2 - 6y + 14 = 0$

64. $x^2 + 4x + y^2 - 8y + 32 = 0$

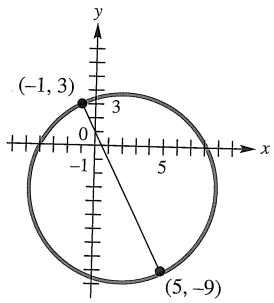
Relating Concepts

For individual or collaborative investigation

(Exercises 65–70)

The distance formula, the midpoint formula, and the center-radius form of the equation of a circle are closely related in the following problem.

A circle has a diameter with endpoints $(-1, 3)$ and $(5, -9)$. Find the center-radius form of the equation of this circle.



Work Exercises 65–70 in order, *to see the relationships among these concepts.*

65. To find the center-radius form, we must find both the radius and the coordinates of the center. Find the coordinates of the center using the midpoint formula. (The center of the circle must be the midpoint of the diameter.)

(continued)