Solution Manual for College Algebra Enhanced with Graphing Utilities 7th Edition Sullivan ISBN 0134111311 9780134111315

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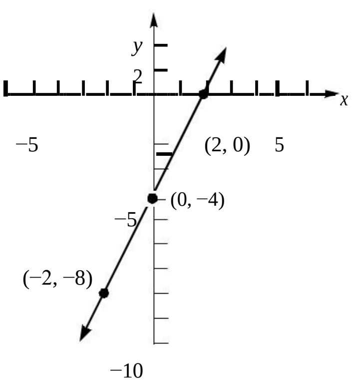
Chapter 2
Graphs

Section 2.1

$y = 2x - 4$

x	$y = 2x - 4$	(x, y)
-2	$y = 2(-2) - 4 = -8$	$(-2, -8)$
0	$y = 2(0) - 4 = -4$	$(0, -4)$
2	$y = 2(2) - 4 = 0$	$(2, 0)$



Based on the graph, the intercepts are $(2,0)$ and $0, -4)$.

$x^2 - 4x - 12 = 0$

$x - 6)(x + 2) = 0$

$x - 6 = 0$ or $x + 2 = 0$

$x = 6$ $\quad$ $x = -2$

The solution set is $\{-2, 6\}$.

intercepts

y-axis

4

$(-3, 4)$

7. True

c

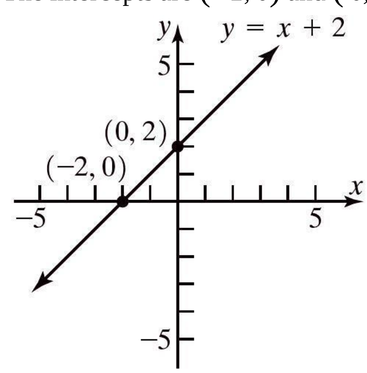
$y = x + 2$

x-intercept: $\quad$ *y*-intercept:

$0 = x + 2$ $\quad$ $y = 0 + 2$

$-2 = x$ $\quad$ $y = 2$

The intercepts are $(-2, 0)$ and $(0, 2)$.



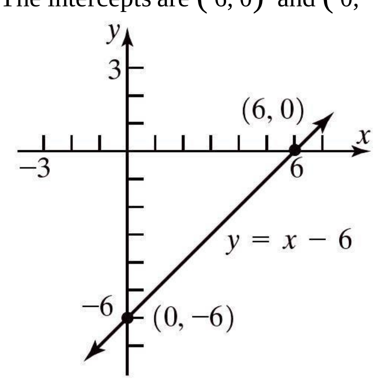
$y = x - 6$

x-intercept: $\quad$ *y*-intercept:

$0 = x - 6$ $\quad$ $y = 0 - 6$

$6 = x$ $\quad$ $y = -6$

The intercepts are $(6, 0)$ and $(0, -6)$.



13. $y = 2x + 8$

x-intercept: $\quad$ *y*-intercept:

$0 = 2x + 8$ $y = 2(0) + 8$

8. False; a graph can be symmetric with respect to $2x = -8$ $y = 8$

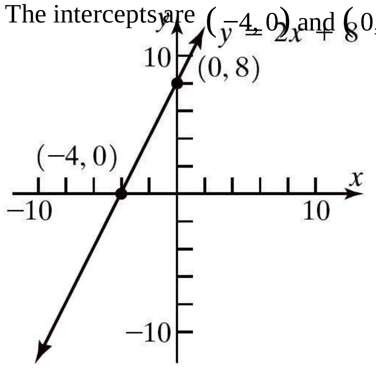
both coordinate axes (in such cases it will also be symmetric with respect to the origin).

$x = -4$

For example: $x^2 + y^2 = 1$

a

The intercepts are $(-4, 0)$ and $(0, 8)$.

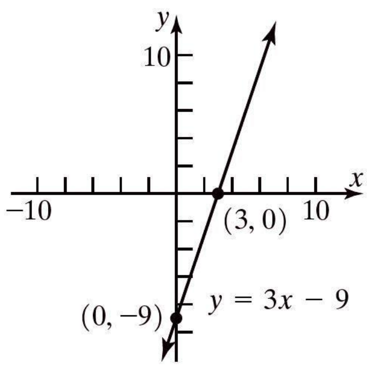


$y = 3x - 9$

x-intercept:
$= 3x -$
$9\ 3x = 9$
$x = 3$

y-intercept:
$= 3(0)$
$-\ 9\ y = -9$

The intercepts are $(3, 0)$ and $(0, -9)$.



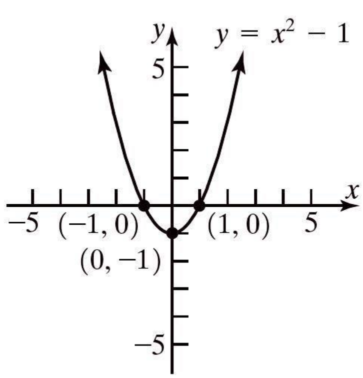
$y = x^2 - 1$

x-intercepts:
$0 = x^2 - 1$
$^2 = 1$
$x = \pm 1$

y-intercept:
$= 0^2 -$
$1\ y = -1$

The intercepts ar

, $(-1, 0)$, 1, 0), and $(0, -1$.

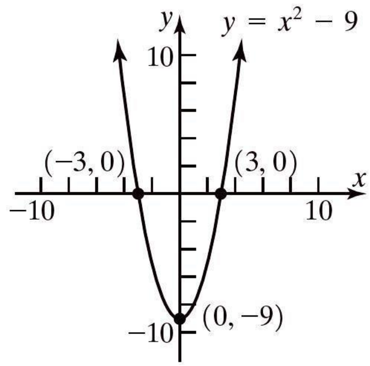


16. $y = x^2 - 9$

x-intercepts:
$0 = x^2 - 9$
$x^2 = 9$
$x = \pm 3$

y-intercept:
$y = 0^2 - 9$
$y = -9$

The intercepts are $(-3, 0)$, $(3, 0)$, and $(0, -9)$.

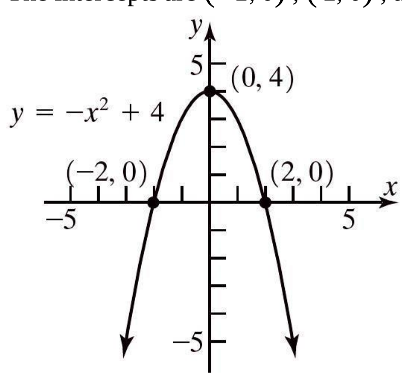


17. $y = -x^2 + 4$

x-intercepts:
$0 = -x^2 + 4$
$x^2 = 4$
$x = \pm 2$

y-intercepts:
$y = -(0)^2 + 4$
$y = 4$

The intercepts are $(-2, 0)$, $(2, 0)$, and $(0, 4)$.

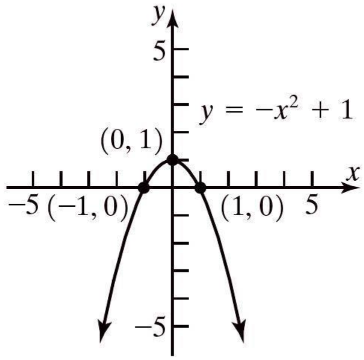


18. $y = -x^2 + 1$

x-intercepts:
$0 = -x^2 + 1$
$x^2 = 1$
$x = \pm 1$

y-intercept:
$y = -(0)^2 + 1$
$y = 1$

The intercepts are $(-1,0)$, $(1,0)$, and $(0,1)$.



19. $2x + 3y = 6$

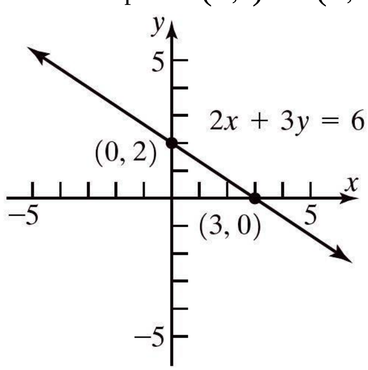
x-intercepts: y-intercept:

$2x + 3(0) = 6$ $\quad$ $2(0) + 3y = 6$

$2x = 6$ $\quad$ $3y = 6$

$x = 3$ $\quad$ $y = 2$

The intercepts are $(3,0)$ and $(0,2)$.



20. $5x + 2y = 10$

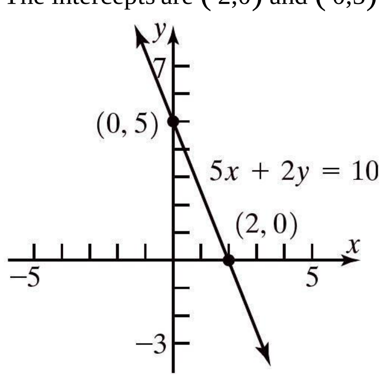
x-intercepts: y-intercept:

$5x + 2(0) = 10$ $\quad$ $5(0) + 2y = 10$

$5x = 10$ $\quad$ $2y = 10$

$x = 2$ $\quad$ $y = 5$

The intercepts are $(2,0)$ and $(0,5)$.



$9x^2 + 4y = 36$

x-intercepts: y-intercept:

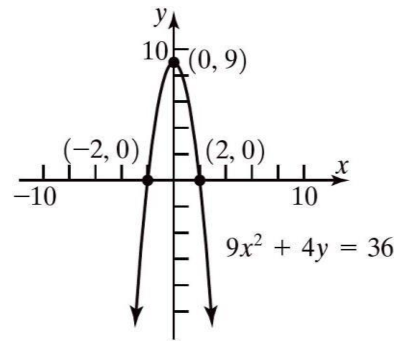
$9x^2 + 4(0) = 36$ $\quad$ $9(0)^2 + 4y = 36$

$9x^2 = 36$ $\quad$ $y = 36$

$^2 = 4$ $\quad$ $y = 9$

$x = \pm 2$

The intercepts are $-2,0)$, $(2,0)$, and $(0,9)$.



$4x^2 + y = 4$

x-intercepts: y-intercept:

$4x^2 + 0 = 4$ $\quad$ $4(0)^2 + y = 4$

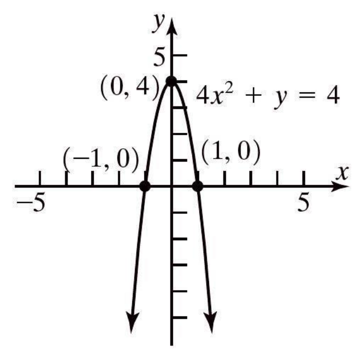
$4x^2 = 4$ $\quad$ $y = 4$

$^2 =$

1

$x = \pm 1$ $\quad$ $(-1,0)$, $(1,0)$, and $(0,4)$.

The intercepts are



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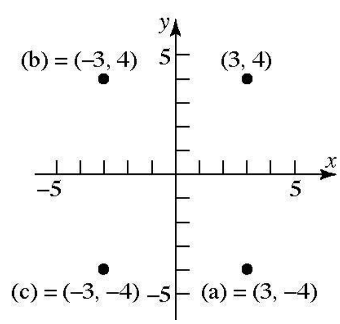

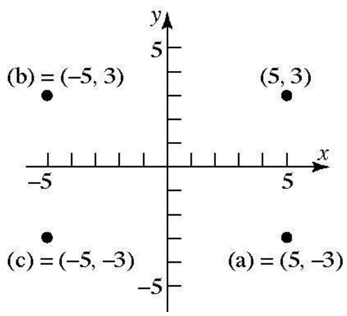

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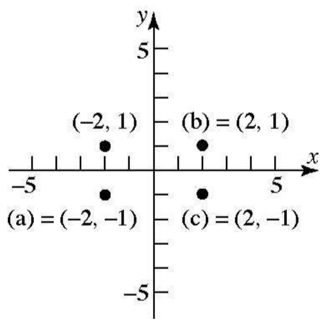

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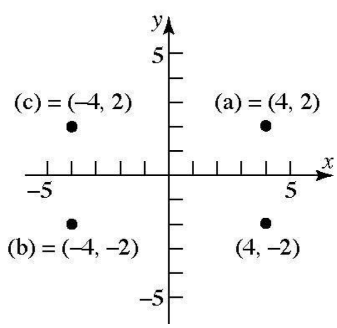

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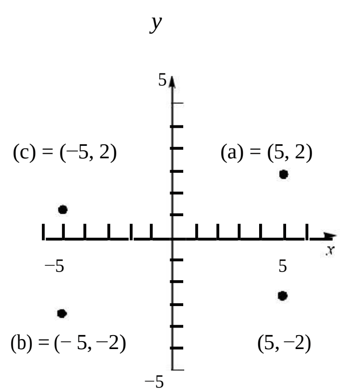

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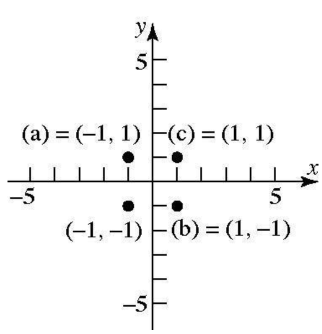

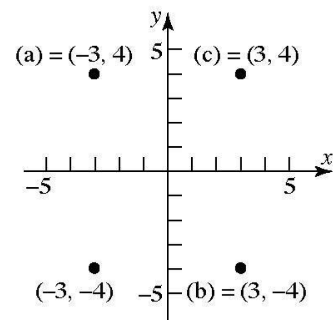

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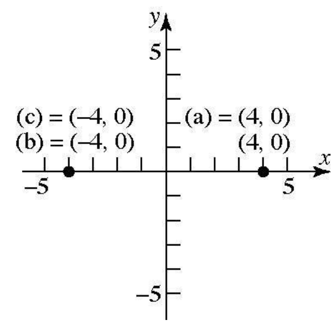

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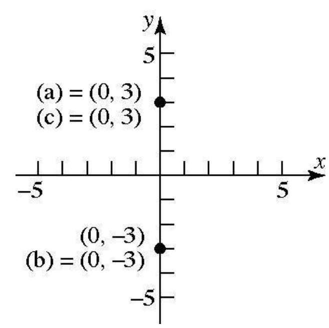

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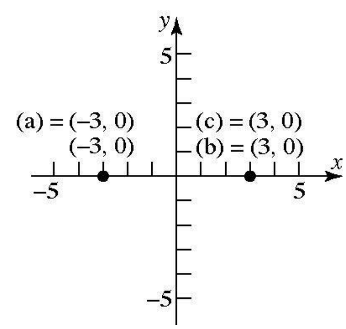

a. Intercepts: $(-1,0)$ and $(1,0)$

Symmetric with respect to the *x*-axis, *y*-axis, and the origin.

a. Intercepts: $(0,1)$

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Not symmetric to the x-axis, the y-axis, nor the origin

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a. Intercepts: $\left(-\pi,0\right)$, $\left(0,1\right)$, and $\left(\pi,0\right)$

Symmetric with respect to the *y*-axis.

a. Intercepts: $\left(-2,0\right)$, $\left(0,-3\right)$, and $\left(2,0\right)$

Symmetric with respect to the *y*-axis.

a. Intercepts: $\left(0,0\right)$

Symmetric with respect to the *x*-axis.

38. a. Intercepts: $\left(-2,0\right)$, $\left(0,2\right)$, $\left(0,-2\right)$, and $\left(2,0\right)$

Symmetric with respect to the *x*-axis, *y*-axis, and the origin.

a. Intercepts: $\left(-2,0\right)$, $\left(0,0\right)$, and $\left(2,0\right)$
Symmetric with respect to the origin.

a. Intercepts: $\left(-4,0\right)$, $\left(0,0\right)$, and $\left(4,0\right)$
Symmetric with respect to the origin.

a. x-intercept: $\left[-2,1\right]$, y-intercept 0

Not symmetric to x-axis, y-axis, or origin.

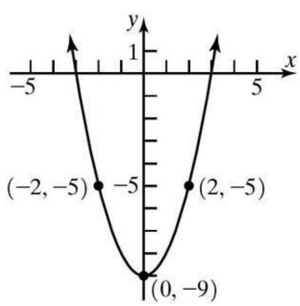
a. x-intercept: $\left[-1,2\right]$, y-intercept 0

Not symmetric to x-axis, y-axis, or origin.

a. Intercepts: none
Symmetric with respect to the origin.

a. Intercepts: none
Symmetric with respect to the *x*-axis.

45.



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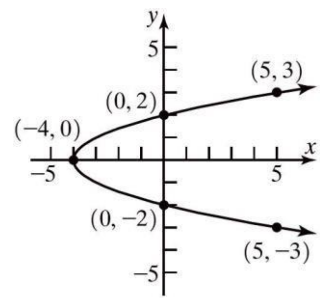

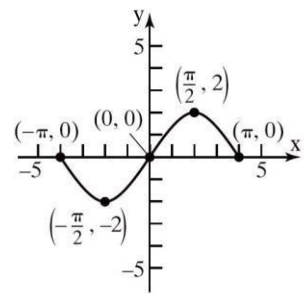

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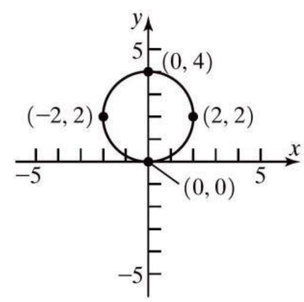
48.



49. $y^2 = x + 4$

x-intercepts:	*y*-intercepts:
$0^2 = x + 4$	$y^2 = 0 + 4$
$-4 = x$	$y^2 = 4$
	$y = \pm 2$

The intercepts are $\left(-4,0\right)$, $\left(0,-2\right)$ and $\left(0,2\right)$.

Test *x*-axis symmetry: Let $y = -y$

$(-y)^2 = x + 4$

$y^2 = x + 4$ same

Test *y*-axis symmetry: Let $x = -x$

$y^2 = -x + 4$ different

Test origin symmetry: Let $x = -x$ and $y = -y$.

$(-y)^2 = -x + 4$

$y^2 = -x + 4$ different

Therefore, the graph will have *x*-axis symmetry.

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50. $y^2 = x + 9$

x-intercepts: $(0)^2 = -x + 9$; $0 = -x + 9$; $x = 9$

y-intercepts: $y^2 = 0 + 9$; $y^2 = 9$; $y = \pm 3$

The intercepts are $(-9, 0)$, $(0, -3)$ and $(0, 3)$.

Test x-axis symmetry: Let $y = -y$

$(-y)^2 = x + 9$

$y^2 = x + 9$ same

Test y-axis symmetry: Let $x = -x$

$y^2 = -x + 9$ different

Test origin symmetry: Let $x = -x$ and $y = -y$.

$(-y)^2 = -x + 9$

$y^2 = -x + 9$ different

Therefore, the graph will have x-axis symmetry.

51. $y = \sqrt[3]{x}$

x-intercepts: $0 = \sqrt[3]{x}$; $0 = x$

y-intercepts: $y = \sqrt[3]{0} = 0$

The only intercept is $(0,0)$.

Test x-axis symmetry: Let $y = -y$

$y = \sqrt[3]{x}$ different

Test y-axis symmetry: Let $x = -x$

$y = \sqrt[3]{-x} = -\sqrt[3]{x}$ different

Test origin symmetry: Let $x = -x$ and $y = -y$

$y = \sqrt[3]{-x} = -\sqrt[3]{x}$

$y = \sqrt[3]{x}$ same

Therefore, the graph will have origin symmetry.

$y = \sqrt[5]{x}$

x-intercepts: $0 = \sqrt[3]{x}$; $0 = x$

y-intercepts: $y = \sqrt[5]{0} = 0$

The only intercept is $(0,0)$.

Test origin symmetry: Let $x = -x$ and $y = -y$

$-y = \sqrt[5]{-x} = -\sqrt[5]{x}$

$y = \sqrt[5]{x}$ same

Therefore, the graph will have origin symmetry.

53. $x^2 + y - 9 = 0$

x-intercepts: $x^2 - 9 = 0$; $x^2 = 9$; $x = \pm 3$

y-intercepts: $0^2 + y - 9 = 0$; $y = 9$

The intercepts are $(-3,0)$, $(3,0)$, and $(0,9)$.

Test x-axis symmetry: Let $y = -y$

$x^2 - y - 9 = 0$ different

Test y-axis symmetry: Let $x = -x$

$(-x)^2 + y - 9 = 0$

$x^2 + y - 9 = 0$ same

Test origin symmetry: Let $x = -x$ and $y = -y$

$(-x)^2 - y - 9 = 0$

$x^2 - y - 9 = 0$ different

Therefore, the graph will have y-axis symmetry.

54. $x^2 - y - 4 = 0$

x-intercepts: $x^2 - 0 - 4 = 0$ 2

y-intercept: $0^2 - y - 4 = 0$

Test x-axis symmetry: Let $y = -y$

$y = \sqrt[5]{x}$ different

Test y-axis symmetry: Let $x = -$

x $y = \sqrt[5]{-x} = -\sqrt[5]{x}$ different

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$x^2 = 4$ $\qquad\qquad -y = 4$

$x = \pm 2$ $\qquad\qquad y = -4$

The intercepts are $(-2,0)$, $(2,0)$, and $(0,-4)$.

<u>Test *x*-axis symmetry:</u> Let $y = -y$

$x^2 - (-y) - 4 = 0$

$x^2 + y - 4 = 0$ different

<u>Test *y*-axis symmetry:</u> Let $x = -x$

$(-x)^2 - y - 4 = 0$

$x^2 - y - 4 = 0$ same

<u>Test origin symmetry</u>: Let $x = -x$ and $y = -y$

$(-x)^2 - (-y) - 4 = 0$

$x^2 + y - 4 = 0$ different

Therefore, the graph will have *y*-axis symmetry.

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$9x^2 + 4y^2 = 36$

x-intercepts:
$9x^2 + 4(0)^2 = 36$
$9x^2 = 36$
$x^2 = 4$
$x = \pm 2$

y-intercepts:
$9(0)^2 + 4y^2 = 36$
$4y^2 = 36$
$y^2 = 9$
$y = \pm 3$

The intercepts are $(-2,0)$, $(2,0)$, $(0,-3)$, and $(0, 3)$.

Test x-axis symmetry: Let $y = -y$

$9x^2 + 4(-y)^2 = 36$

$9x^2 + 4y^2 = 36$ same

Test y-axis symmetry: Let $x = -x$

$9(-x)^2 + 4y^2 = 36$

$9x^2 + 4y^2 = 36$ same

Test origin symmetry: Let $x = -x$ and $y = -y$

$9(-x)^2 + 4(-y)^2 = 36$

$9x^2 + 4y^2 = 36$ same

Therefore, the graph will have x-axis, y-axis, and origin symmetry.

$4x^2 + y^2 = 4$

x-intercepts:
$4x^2 + 0^2 = 4$
$4x^2 = 4$
$x^2 = 1$
$x = \pm 1$

y-intercepts:
$4(0)^2 + y^2 = 4$
$y^2 = 4$
$y = \pm 2$

The intercepts are $(-1, 0)$, $(1, 0)$, $(0,-2)$, and $(0, 2)$.

Test x-axis symmetry: Let $y = -y$

$4x^2 + (-y)^2 = 4$

$4x^2 + y^2 = 4$ same

Test y-axis symmetry: Let $x = -x$

57. $y = x^3 - 27$

x-intercepts:
$0 = x^3 - 27$
$x^3 = 27$
$x = 3$

y-intercepts:
$y = 0^3 - 27$
$y = -27$

The intercepts are $(3, 0)$ and $(0, -27)$.

Test x-axis symmetry: Let $y = -y$

$y = x^3 - 27$ different

Test y-axis symmetry: Let $x = -x$

$= (-x)^3 - 27$

$= -x^3 - 27$ different

Test origin symmetry: Let $x = -x$ and $y = -y$

$-y = (-x)^3 - 27$

$y = x^3 + 27$ different

Therefore, the graph has none of the indicated symmetries.

58. $y = x^4 - 1$

x-intercepts:
$0 = x^4 - 1$
$x^4 = 1$
$x = \pm 1$

y-intercepts:
$y = 0^4 - 1$
$y = -1$

The intercepts are $(-1, 0)$, $(1, 0)$, and $(0, -1)$.

Test x-axis symmetry: Let $y = -y$

$y = x^4 - 1$ different

Test y-axis symmetry: Let $x = -x$

$= (-x)^4 - 1$

$4(-x)^2 + y^2 = 4$

$4x^2 + y^2 = 4$ same

Test origin symmetry: Let $x = -x$ and $y = -y$

$4(-x)^2 + (-y)^2 = 4$

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$y = x^4 - 1$ same

Test origin symmetry: Let $x = -x$ and $y = -y$ $y = (-x)^4 - 1$

$y = x^4 - 1$ different

$4x^2 + y^2 = 4$ same

Therefore, the graph will have x-axis, y-axis, and origin symmetry.

Therefore, the graph will have y-axis symmetry.

$y = x^2 - 3x - 4$

x-intercepts:

$0 = x^2 - 3x - 4$

$0 = (x-4)(x+1)$

$x = 4$ or $x = -1$

y-intercepts:

$y = 0^2 - 3(0) - 4$

$y = -4$

The intercepts are $(4, 0)$, $(-1, 0)$, and $(0, -4)$.

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Test x-axis symmetry: Let $y = -y$

$y = x^2 - 3x - 4$ different

Test y-axis symmetry: Let $x = -x$

$= (-x)^2 - 3(-x) - 4$

$= x^2 + 3x - 4$ different

Test origin symmetry: Let $x = -x$ and $y = -y$

$y = (-x)^2 - 3(-x) - 4$

$y = x^2 + 3x - 4$ different

Therefore, the graph has none of the indicated symmetries.

60. $y = x^2 + 4$

x-intercepts:

$0 = x^2 + 4$

$x^2 = -4$

no real solution

y-intercepts:

$y = 0^2 + 4$

$y = 4$

The only intercept is $(0,4)$.

Test x-axis symmetry: Let $y = -y$

$y = x^2 + 4$ different

Test y-axis symmetry: Let $x = -x$

$= (-x)^2 + 4$

$y = x^2 + 4$ same

Test origin symmetry: Let $x = -x$ and $y = -y$

$-y = (-x)^2 + 4$

$y = x^2 + 4$ different

Therefore, the graph will have y-axis symmetry.

$y = \frac{3x}{x^2 + 9}$

x-intercepts:

$0 = \frac{3x}{x^2 + 9}$

$3x = 0$

$x = 0$

y-intercepts:

$y = \frac{3(0)}{0^2 + 9} = \frac{0}{9} = 0$

The only intercept is $(0,0)$.

Test y-axis symmetry: Let $x = -x$

$y = \frac{3(-x)}{(-x)^2 + 9}$

$y = -\frac{3x}{x^2 + 9}$ different

Test origin symmetry: Let $x = -x$ and $y = -y$

$-y = \frac{3(-x)}{(-x)^2 + 9}$

$-y = -\frac{3x}{x^2 + 9}$

$y = \frac{3x}{x^2 + 9}$ same

Therefore, the graph has origin symmetry.

$y = \frac{x^2 - 4}{2x}$

x-intercepts:

$0 = \frac{x^2 - 4}{2x}$

$x^2 - 4 = 0$

$x^2 = 4$

$x = \pm 2$

y-intercepts:

$y = \frac{0^2 - 4}{2(0)} = \frac{-4}{0}$

undefined

The intercepts are $(-2,0)$ and $(2,0)$.

Test x-axis symmetry: Let $y = -y$

$-y = \frac{x^2 - 4}{2x}$ different

Test y-axis symmetry: Let $x = -x$

$= \frac{(-x)^2 - 4}{2(-x)}$

$y = -\frac{x^2 - 4}{2x}$ different

Test origin symmetry: Let $x = -x$ and $y = -y$

$-y = \frac{(-x)^2 - 4}{2(-x)}$

$-y = \frac{x^2 - 4}{}$

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Test x-axis symmetry: Let $y = -y$

$$-y = \frac{3x}{x^2 + 9} \quad \text{different}$$

$$y = \frac{-2x}{x^2 - 4} \cdot \frac{}{2x} \quad \text{same}$$

Therefore, the graph has origin symmetry.

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$$y = \frac{-x^3}{x^2 - 9}$$

x-intercepts:

$$0 = \frac{-x^3}{x^2 - 9}$$

$$x^3 = 0$$
$$x = 0$$

y-intercepts:

$$y = \frac{-0^3}{0^2 - 9} = \frac{0}{-9} = 0$$

The only intercept is $(0, 0)$.

Test x-axis symmetry: Let $y = -y$

$$-y = \frac{-x^3}{x^2 - 9}$$

$$y = \frac{x^3}{x^2 - 9} \quad \text{different}$$

Test y-axis symmetry: Let $x = -x$

$$y = \frac{-(-x)^3}{(-x)^2 - 9}$$

$$y = \frac{x^3}{x^2 - 9} \quad \text{different}$$

Test origin symmetry: Let $x = -x$ and $y = -y$

$$-y = \frac{-(-x)^3}{(-x)^2 - 9}$$

$$-y = \frac{x^3}{x^2 - 9}$$

$$y = \frac{-x^3}{x^2 - 9} \quad \text{same}$$

Therefore, the graph has origin symmetry.

$$y = \frac{x^4 + 1}{2x^5}$$

x-intercepts:

$$0 = \frac{x^4 + 1}{2x^5}$$

$$x^4 = -1$$

no real solution

y-intercepts:

$$y = \frac{0^4 + 1}{2(0)^5} = \frac{1}{0}$$

undefined

There are no intercepts for the graph of this equation.

Test x-axis symmetry: Let $y = -y$

$$-y = \frac{x^4 + 1}{2x^5}$$

$$y = \frac{x^4 + 1}{-2x^5} \quad \text{different}$$

Test y-axis symmetry: Let $x = -x$

$$y = \frac{(-x)^4 + 1}{2(-x)^5}$$

$$y = \frac{x^4 + 1}{-2x^5} \quad \text{different}$$

Test origin symmetry: Let $x = -x$ and $y = -y$

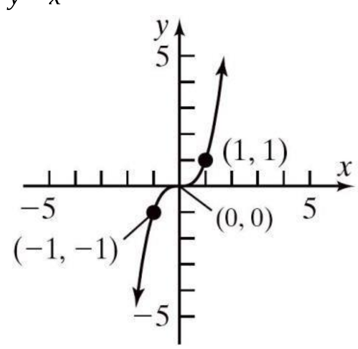
$$-y = \frac{(-x)^4 + 1}{2(-x)^5}$$

$$-y = \frac{x^4 + 1}{-2x^5}$$

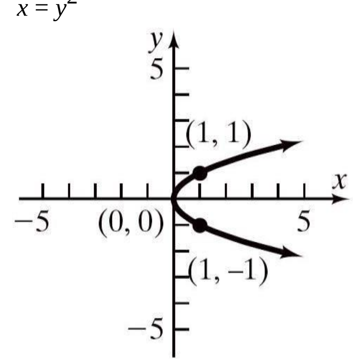
$$y = \frac{x^4 + 1}{2x^5} \quad \text{same}$$

Therefore, the graph has origin symmetry.

$y = x^3$

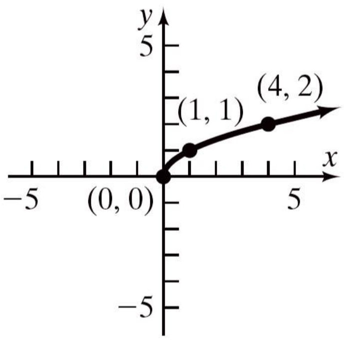


66. $x = y^2$

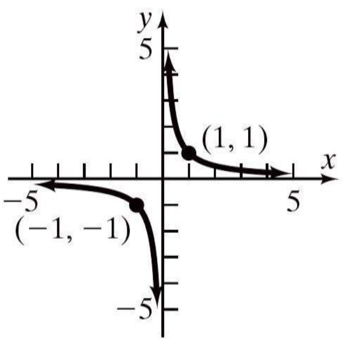


$$y = \frac{x_4 + 1}{\text{different } 2x^5}$$

$y = \sqrt{x}$



$y = \frac{1}{x}$



If the point $(3, b)$ is on the graph of $y = 4x + 1$, then we have $b = 4(3) + 1 = 12 + 1 = 13$
Thus, $b = 13$.

If the point $(-2, b)$ is on the graph of $x + 3y = 2$, then we have

$$(-2) + 3(b) = 2$$
$$-4 + 3b = 2$$
$$3b = 6$$
$$b = 2$$

Thus, $b = 2$.

If the point $(a, 4)$ is on the graph of $y = x^2 + 3x$, then we have $4 = a^2 + 3a$

$$0 = a^2 + 3a - 4$$
$$= (a + 4)(a - 1)$$
$$a + 4 = 0 \quad \text{or} \quad a - 1 = 0$$
$$a = -4 \qquad a = 1$$

Thus, $a = -4$ or $a = 1$.

If the point $(a, -5)$ is on the graph of $= x^2 + 6x$, then we have

$$-5 = a^2 + 6a$$
$$= a^2 + 6a + 5$$
$$= (a + 5)(a + 1)$$
$$a + 5 = 0 \quad \text{or} \quad a + 1 = 0$$
$$a = -5 \qquad a = -1$$

Thus, $a = -5$ or $a = -1$.

a. $0 = x^2 - 5$

$^2 = 5$

$x = \pm\sqrt{5}$

The x-intercepts are $x = -\sqrt{5}$ and $x = \sqrt{5}$.

$y = (0)^2 - 5 = -5$

The y-intercept is $y = -5$.

The intercepts are $(-\sqrt{5}, 0)$, $(\sqrt{5}, 0)$, and $0, -5)$.

b. x-axis (replace y by $-y$):

$y = x^2 - 5$

$y = 5 - x^2$ different

y-axis (replace x by $-x$):

$y = (-x)^2 - 5 = x^2 - 5$ same

origin (replace x by $-x$ and y by $-y$):

$-y = (-x)^2 - 5$

$y = 5 - x^2$ different

The equation has y-axis symmetry.

$y = x^2 - 5$

Additional points:

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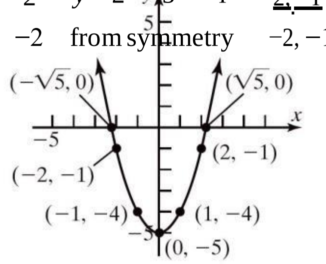
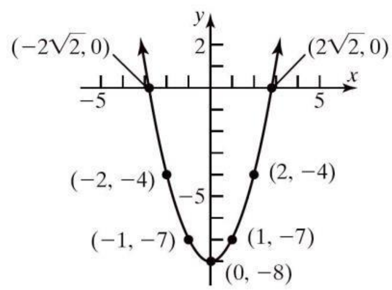
x	$y = x^2 - 5$	(x, y)
1	$y = 1^2 - 5 = -4$	$1, -4$
-1	from symmetry	$(-1, -4)$
2	$y = 2^2 - 5 = -1$	$2, -1$
-2	from symmetry	$-2, -1$



x	$y = x^2 - 5$	(x, y)
1	$y = 1^2 - 8 = -7$	$1, -7$
-1	from symmetry	$(-1, -7)$
2	$y = 2^2 - 8 = -4$	$(2, -4)$
-2	from symmetry	$(-2, -4)$



a. $0 = x^2 - 8$

$^2 = 8$

$x = \pm 2\sqrt{2}$

The x-intercepts are $x = -2\sqrt{2}$ and $x = 2\sqrt{2}$

$= (0)^2 - 8 = -8$

The y-intercept is $y = -8$.

The intercepts are $(-2\sqrt{2}, 0)$, $(2\sqrt{2}, 0)$, and $0, -8)$.

b. x-axis (replace y by $-y$):

$y = x^2 - 8$

$y = 8 - x^2$ different

y-axis (replace x by $-x$):

$y = (-x)^2 - 8 = x^2 - 8$ same

origin (replace x by $-x$ and y by $-y$):

$-y = (-x)^2 - 8$

$y = 8 - x^2$ different

a. $x - (0)^2 = -9$

$x = -9$

The x-intercept is $x = -9$.

$0) - y^2 = -9$

$y^2 = -9$

$y^2 = 9 \rightarrow y = \pm 3$

The y-intercepts are $y = -3$ and $y = 3$.

The intercepts are $(-9, 0)$, $(0, -3)$, and $0, 3)$.

b. x-axis (replace y by $-y$):

$-(-y)^2 = -9$

$-y^2 = -9$ same

y-axis (replace x by $-x$):

$x - y^2 = -9$

$x + y^2 = 9$ different

origin (replace x by $-x$ and y by $-y$):

$x - (-y)^2 = -9$

2

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The equation has y-axis symmetry.

$y = x^2 - 8$

Additional points:

$x - y \ \ = -9$

$x + y^2 = 9$ different

The equation has x-axis symmetry.

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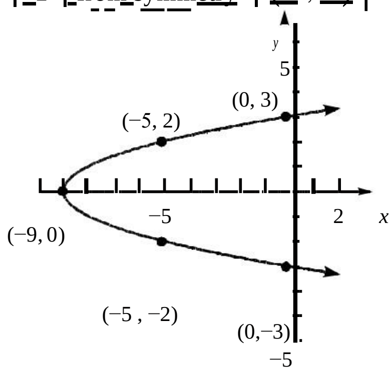
c. $x - y^2 = -9$ or $x = y^2 - 9$

Additional points:

y	$x = y^2 - 9$	(x, y)
2	$x = 2^2 - 9 = -5$	$(-5, 2)$
-2	from symmetry	$(-5, -2)$



76. a. $x + (0)^2 = 4$

$x = 4$

The x-intercept is $x = 4$.

$(0) + y^2 = 4$

$y^2 = 4 \rightarrow y = \pm 2$

The y-intercepts are $y = -2$ and $y = 2$.

The intercepts are $(4, 0)$, $(0, -2)$, and $(0, 2)$.

b. x-axis (replace y by $-y$):

$x + (-y)^2 = 4$

$x + y^2 = 4$ same

y-axis (replace x by $-x$):

$-x + y^2 = 4$

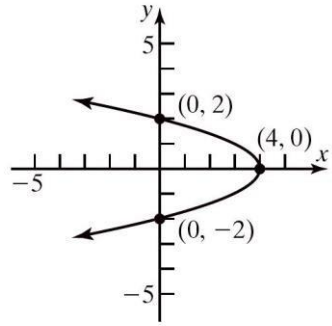
$x - y^2 = -4$ different

origin (replace x by $-x$ and y by $-y$):

$-x + (-y)^2 = 4$

$-x + y^2 = 4$

y	$x = 4 - y^2$	(x, y)
1	$x = 4 - 1^2 = 3$	$(3, 1)$
-1	from symmetry	$(3, -1)$



77. a. $x^2 + (0)^2 = 9$

$x^2 = 9$

$x = \pm 3$

The x-intercepts are $x = -3$ and $x = 3$.

$(0)^2 + y^2 = 9$

$y^2 = 9$

$y = \pm 3$

The y-intercepts are $y = -3$ and $y = 3$.

The intercepts are $(-3, 0)$, $(3, 0)$, $(0, -3)$, and $(0, 3)$.

b. x-axis (replace y by $-y$):

$x^2 + (-y)^2 = 9$

$x^2 + y^2 = 9$ same

y-axis (replace x by $-x$):

$(-x)^2 + y^2 = 9$

$x^2 + y^2 = 9$ same

origin (replace x by $-x$ and y by $-y$):

$(-x)^2 + (-y)^2 = 9$

$x^2 + y^2 = 9$ same

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$x - y^2 = -4$ different

The equation has x-axis symmetry.

c. $x + y^2 = 4$ or $x = 4 - y^2$

Additional points:

The equation has x-axis symmetry, y-axis symmetry, and origin symmetry.

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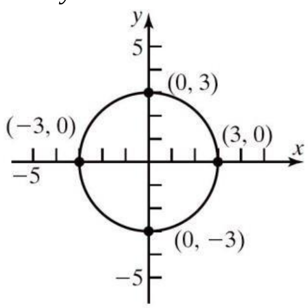
$x^2 + y^2 = 9$



a. $x^2 + (0)^2 = 16$

$^2 = 16$

$x = \pm 4$

The x-intercepts are $x = -4$ and $x = 4$.

$0)^2 + y^2 = 16$

$y^2 = 16$

$y = \pm 4$

The y-intercepts are $y = -4$ and $y = 4$. The intercepts are $(-4,0)$, $(4,0)$, $(0, -4)$, and $(0, 4)$.

x-axis (replace y by $-y$):

$x^2 + (-y)^2 = 16$

$x^2 + y^2 = 16$ same

y-axis (replace x by $-x$):

$-x)^2 + y^2 = 16$

$x^2 + y^2 = 16$ same

origin (replace x by $-x$ and y by $-y$):

$-x)^2 + (-y)^2 = 16$

$x^2 + y^2 = 16$ same

The equation has x-axis symmetry, y-axis symmetry, and origin symmetry.

c. $x^2 + y^2 = 16$

79. a. $0 = x^3 - 4x$

$0 = x\left(x^2 - 4\right)$

$x = 0$ or $x^2 - 4 = 0$

$x^2 = 4$

$x = \pm 2$

The x-intercepts are $x = 0$, $x = -2$, and $x = 2$.

$= 0^3 - 4(0) = 0$

The y-intercept is $y = 0$.

The intercepts are $(0, 0)$, $(-2, 0)$, and $2, 0)$.

b. x-axis (replace y by $-y$):

$y = x^3 - 4x$

$y = 4x - x^3$ different

y-axis (replace x by $-x$):

$= (-x)^3 - 4(-x)$

$= -x^3 + 4x$ different

origin (replace x by $-x$ and y by $-y$):

$y = (-x)^3 - 4(-x)$

$y = -x^3 + 4x$

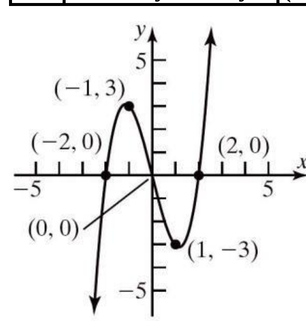
$y = x^3 - 4x$ same

The equation has origin symmetry.

$y = x^3 - 4x$

Additional points:

x	$y = x^3 - 4x$	(x, y)
1	$y = 1^3 - 4(1) = -3$	$(1, -3)$
−1	from symmetry	$(-1, 3)$



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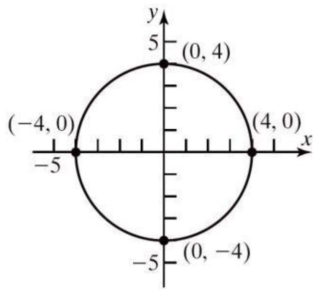

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80. a. $0 = x^3 - x$

$0 = x\left(x^2 - 1\right)$

$x = 0$ or $x^2 - 1 = 0$

$x^2 = 1$

$x = \pm 1$

The x-intercepts are $x = 0$, $x = -1$, and $= 1$.

$= 0^3 - (0) = 0$

The y-intercept is $y = 0$.

The intercepts are $(0, 0)$, $(-1, 0)$, and $(1, 0)$.

x-axis (replace y by $-y$):

$y = x^3 - x$

$y = x - x^3$ different

y-axis (replace x by $-x$):

$= (-x)^3 - (-x)$

$y = -x^3 + x$ different

origin (replace x by $-x$ and y by $-y$):

$y = (-x)^3 - (-x)$

$y = -x^3 + x$

$y = x^3 - x$ same

The equation has origin symmetry.

$y = x^3 - x$

Additional points:

x	$y = x^3 - 4x$	(x, y)
2	$y = 2^3 - (2) = 6$	$(2,6)$
-2	from symmetry	$(-2, -6)$

For a graph with origin symmetry, if the point (a, b) is on the graph, then so is the point $(-a, -b)$. Since the point $(1,2)$ is on the graph of an equation with origin symmetry, the point $(-1, -2)$ must also be on the graph.

For a graph with y-axis symmetry, if the point (a, b) is on the graph, then so is the point $(-a, b)$. Since 6 is an x-intercept in this case, the point $(6,0)$ is on the graph of the equation. Due to the y-axis symmetry, the point $(-6,0)$ must also be on the graph. Therefore, -6 is another x-intercept.

For a graph with origin symmetry, if the point (a, b) is on the graph, then so is the point $(-a, -b)$. Since -4 is an x-intercept in this case, the point $(-4,0)$ is on the graph of the equation.

Due to the origin symmetry, the point $(4,0)$ must also be on the graph. Therefore, 4 is another x-intercept.

For a graph with x-axis symmetry, if the point (a, b) is on the graph, then so is the point $(a, -b)$. Since 2 is a y-intercept in this case, the point $(0, 2)$ is on the graph of the equation. Due to the x-axis symmetry, the point $(0, -2)$ must also be on the graph. Therefore, -2 is another y-intercept.

a. $\left(x^2 + y^2 - x\right)^2 = x^2 + y^2$

x-intercepts:

$\left(x^2 + (0)^2 - x\right)^2 = x^2 + (0)^2$

$\left(x^2 - x\right)^2 = x^2$

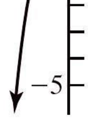
$^4 - 2x^3 + x^2 = x^2$

$^4 - 2x^3 = 0$

$x^3(x - 2) = 0$

$x^3 = 0$ or $x - 2 = 0$

$x = 0$ $\quad x = 2$


−5

y-intercepts:

$((0)^2 + y^2 - 0)^2 = (0)^2 + y^2$

$(y^2)^2 = y^2$

$y^4 = y^2$

$y^4 - y^2 = 0$

$y^2(y^2 - 1) = 0$

$y^2 = 0$ or $y^2 - 1 = 0$

$y = 0 \qquad y^2 = 1$

$y = \pm 1$

The intercepts are $(0, 0)$, $(2, 0)$, $(0, -1)$, and $(0, 1)$.

<u>Test</u> <u>x-axis symmetry:</u> Let $y = -y$

$(x^2 + (-y)^2 - x)^2 = x^2 + (-y)^2$

$(x^2 + y^2 - x)^2 = x^2 + y^2$ same

<u>Test</u> <u>y-axis symmetry:</u> Let $x = -x$

$((-x)^2 + y^2 - (-x))^2 = (-x)^2 + y^2$

$(x^2 + y^2 + x)^2 = x^2 + y^2$

different

<u>Test origin symmetry</u>: Let $x = -x$ and $y = -y$

$((-x)^2 + (-y)^2 - (-x))^2 = (-x)^2 + (-y)^2$

$(x^2 + y^2 + x)^2 = x^2 + y^2$

different

Thus, the graph will have x-axis symmetry.

a. $16y^2 = 120x - 225$

x-intercepts:

$y^2 = 120(0) - 225$

$y^2 = -225$

$y^2 = -\frac{225}{16}$

no real solution

y-intercepts:

$16(0)^2 = 120x - 225$

$= 120x - 225$

$-120x = -225$

$x = \frac{-225}{-120} = \frac{15}{8}$

The only intercept is $\left(\frac{15}{8}, 0\right)$.

<u>Test</u> <u>x-axis symmetry:</u> Let $y = -y$

$16(-y)^2 = 120x - 225$

$16y^2 = 120x - 225$ same

<u>Test</u> <u>y-axis symmetry:</u> Let $x = -x$

$16y^2 = 120(-x) - 225$

$16y^2 = -120x - 225$ different

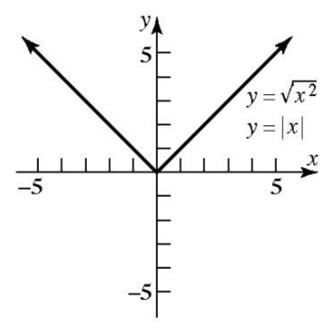
<u>Test origin symmetry</u>: Let $x = -x$ and $y = -y$

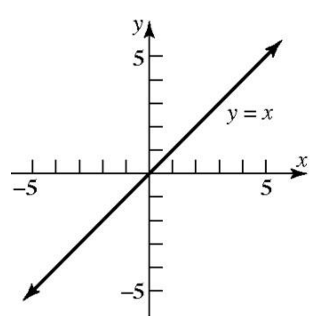
$16(-y)^2 = 120(-x) - 225$

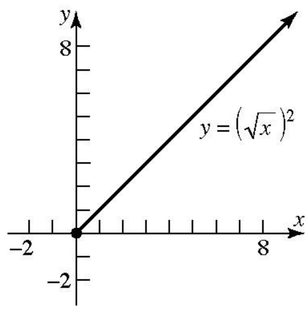
$16y^2 = -120x - 225$ different

Thus, the graph will have x-axis symmetry.

87. a.







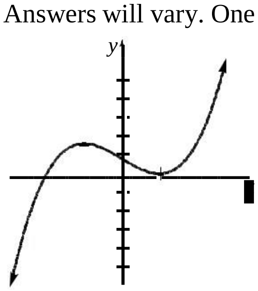
b. Since $\sqrt{x^2} = |x|$ for all x, the graphs of $y = \sqrt{x^2}$ and $y = |x|$ are the same.

c. For $y = (\sqrt{x})^2$, the domain of the variable x is $x \geq 0$; for $y = x$, the domain of the variable x is all real numbers. Thus, $(\sqrt{x})^2 = x$ only for $x \geq 0$.

d. For $y = \sqrt{x^2}$, the range of the variable y is $y \geq 0$; for $y = x$, the range of the variable y is all real numbers. Also, $\sqrt{x^2} = x$ only if $x \geq 0$. Otherwise, $\sqrt{x^2} = -x$.

88. Answers will vary. A complete graph presents enough of the graph to the viewer so they can "see" the rest of the graph as an obvious continuation of what is shown.

89. Answers will vary. One example:



90. Answers will vary

91. Answers will vary

92. Answers will vary.
Case 1: Graph has x-axis and y-axis symmetry, show origin symmetry.
(x, y) on graph $\rightarrow (x, -y)$ on graph (from x-axis symmetry)
$(x, -y)$ on graph $\rightarrow (-x, -y)$ on graph (from y-axis symmetry)
Since the point $(-x, -y)$ is also on the graph, the graph has origin symmetry.

Case 2: Graph has x-axis and origin symmetry, show y-axis symmetry.
(x, y) on graph $\rightarrow (x, -y)$ on graph (from x-axis symmetry)
$(x, -y)$ on graph $\rightarrow (-x, y)$ on graph (from origin symmetry)
Since the point $(-x, y)$ is also on the graph, the graph has y-axis symmetry.

Case 3: Graph has y-axis and origin symmetry, show x-axis symmetry.
(x, y) on graph $\rightarrow (-x, y)$ on graph (from y-axis symmetry)
$(-x, y)$ on graph $\rightarrow (x, -y)$ on graph (from origin symmetry)
Since the point $(x, -y)$ is also on the graph, the graph has x-axis symmetry.

93. Answers may vary. The graph must contain the points $(-2,5)$, $(-1,3)$, and $(0,2)$. For the graph to be symmetric about the y-axis, the graph must also contain the points $(2,5)$ and $(1,3)$ (note that (0, 2) is on the y-axis).

For the graph to also be symmetric with respect to the x-axis, the graph must also contain the points $(-2,-5)$, $(-1,-3)$, $(0,-2)$, $(2,-5)$, and $(1,-3)$. Recall that a graph with two of the symmetries (x-axis, y-axis, origin) will necessarily have the third. Therefore, if the original graph with y-axis symmetry also has x-axis symmetry, then it will also have origin symmetry.

94. $\underline{6+(-2)} = \underline{4} = \underline{1}$

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show origin symmetry.

$x, y)$ on graph $\rightarrow (x, -y)$ on graph (from x-axis symmetry)

$6-(-2)$ 8 2

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$3x^2 - 30x + 75 = 3(x$

$^2 - 10x + 25) =$

$3(x-5)(x-5) = 3(x-5)^2$

$\sqrt{-196} = \sqrt{(-1)(196)} = 14i$

$x^2 - 8x + 4 = 0$

$^2 - 8x = -4$

$^2 - 8x + 16 = -4 + 16$

$x - 4)^2 = 12$

$-4 = \pm\sqrt{12}$

$x = 4 \pm \sqrt{12}$

$= 4 \pm 2\sqrt{3}$

Section 2.2

1. undefined; 0

2. 3; 2

x-intercept: $2x + 3(0) = 6$

$2x = 6$

$x = 3$

y-intercept: $2(0) + 3y = 6$

$3y = 6$

$y = 2$

3. True

False; the slope is $\frac{3}{2}$.

$y = 3x + 5y$

$= \frac{3}{2}x + \frac{5}{2}$

True; $2(1) + (2) \stackrel{?}{=} 4$

$2 + 2 \stackrel{?}{=} 4$

$4 = 4$ True

$m_1 = m_2$; *y*-intercepts; $m_1\ m_2 = -1$

9. False; perpendicular lines have slopes that are opposite-reciprocals of each other.

10. d

11. c

12. b

13. a. Slope $= \frac{1-0}{2-0} = \frac{1}{2}$

If *x* increases by 2 units, *y* will increase by 1 unit.

14. a. Slope $= \frac{1-0}{-2-0} = -\frac{1}{2}$

If *x* increases by 2 units, *y* will decrease by 1 unit.

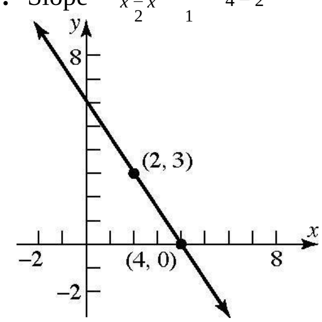
15. a. Slope $= \frac{1-2}{1-(-2)} = -\frac{1}{3}$

b. If *x* increases by 3 units, *y* will decrease by 1 unit.

16. a. Slope $= \frac{2-1}{2-(-1)} = \frac{1}{3}$

b. If *x* increases by 3 units, *y* will increase by 1 unit.

17. Slope $= \frac{y_2 - y_1}{x_2 - x_1} = \frac{0-3}{4-2} = -\frac{3}{2}$



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2

$-\frac{1}{2}$

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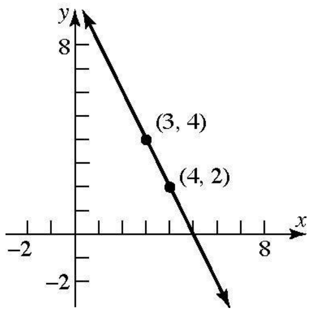
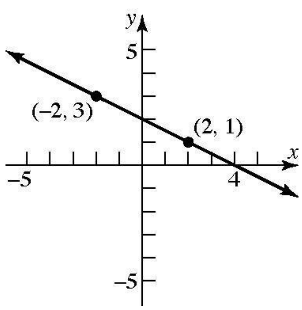
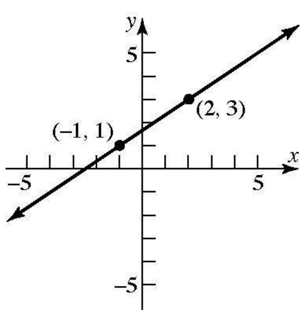
Slope $= \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{4-2}{3-4} = \dfrac{2}{-1} = -2$



Slope $= \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{1-3}{2-(-2)} = \dfrac{-2}{4} = -\dfrac{1}{2}$

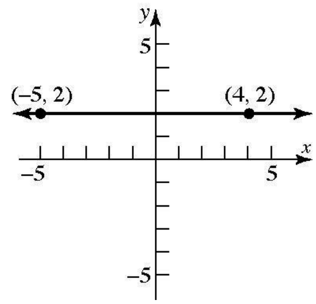


Slope $= \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{3-1}{2-(-1)} = \dfrac{2}{3}$

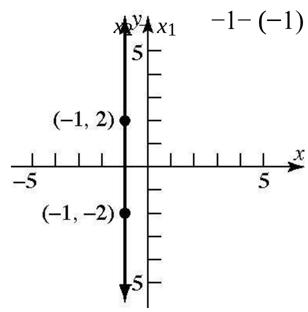


Slope $= \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{-1-(-1)}{2-(-3)} = \dfrac{0}{5} = 0$

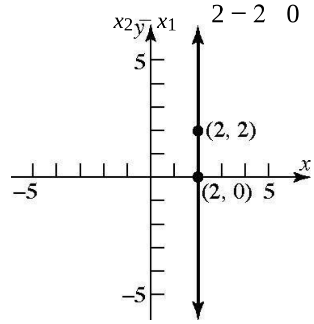
Slope $= \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{2-2}{-5-4} = \dfrac{0}{-9} = 0$



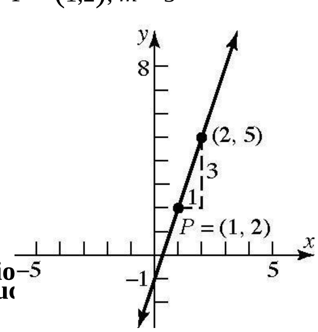
Slope $= \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{-2-2}{-1-(-1)} = \dfrac{-4}{0}$ undefined.



Slope $= \dfrac{y_2 - y_1}{x_2 - x_1} = \dfrac{2-0}{2-2} = \dfrac{2}{0}$ undefined.



$P = (1,2)$; $m = 3$



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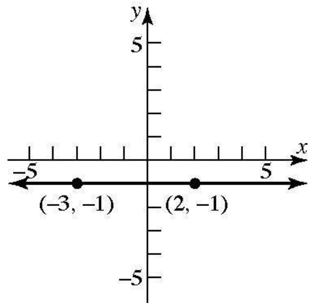

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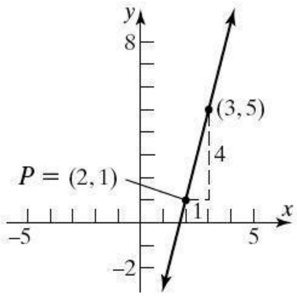
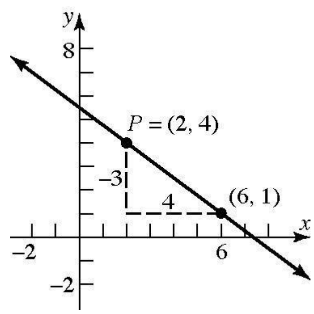
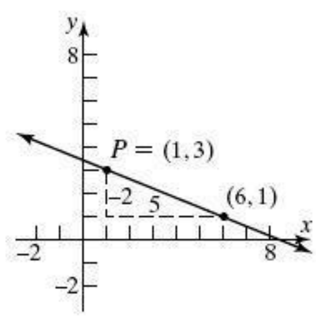
$P = (2,1)$; $m = 4$



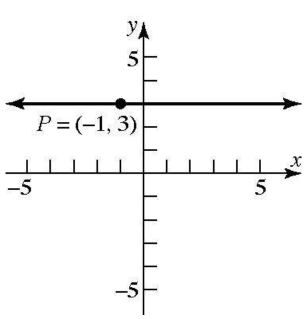
$P = (2, 4)$; $m = -\frac{3}{4}$



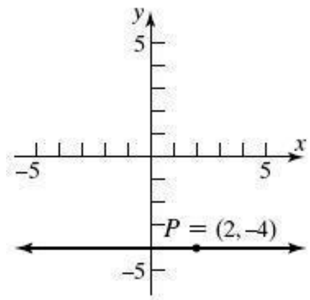
$P = (1, 3)$; $m = -\frac{2}{5}$



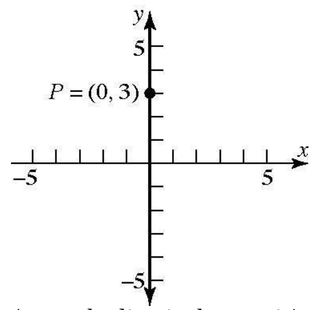
$P = (-1, 3)$; $m = 0$



$P = (2, -4)$; $m = 0$

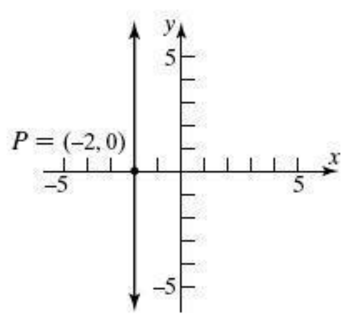


$P = (0,3)$; slope undefined



(note: the line is the *y*-axis)

$P = (-2,0)$; slope undefined



Slope $= 4 = \frac{4}{1}$; point: $(1, 2)$

If x increases by 1 unit, then y increases by 4 units.
Answers will vary. Three possible points are:

$x = 1 + 1 = 2$ and $y = 2 + 4 = 6$

$2,6)$

$= 2 + 1 = 3$ and $y = 6 + 4 = 10$

$3,10)$

$x = 3 + 1 = 4$ and $y = 10 + 4 = 14$

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4,14)

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Slope = 2 = $\frac{2}{1}$; point: $(-2, 3)$

If x increases by 1 unit, then y increases by 2 units.
Answers will vary. Three possible points are:
$x = -2 + 1 = -1$ and $y = 3 + 2 = 5$
$-1,5)$
$= -1 + 1 = 0$ and $y = 5 + 2 = 7$
$0,7)$
$x = 0 + 1 = 1$ and $y = 7 + 2 = 9$
$(1,9)$

Slope $= -\frac{3}{2} = \frac{-3}{2}$; point: $(2, -4)$

If x increases by 2 units, then y decreases by 3 units.
Answers will vary. Three possible points are:
$x = 2 + 2 = 4$ and $y = -4 - 3 = -7$
$4, -7)$
$x = 4 + 2 = 6$ and $y = -7 - 3 = -10$
$6, -10)$
$= 6 + 2 = 8$ and $y = -10 - 3 = -13$
$8, -13)$

Slope = $\frac{4}{3}$; point: $(-3,2)$

If x increases by 3 units, then y increases by 4 units.
Answers will vary. Three possible points are:
$x = -3 + 3 = 0$ and $y = 2 + 4 = 6$
$0,6)$
$= 0 + 3 = 3$ and $y = 6 + 4 = 10$
$3,10)$
$x = 3 + 3 = 6$ and $y = 10 + 4 = 14$
$6,14)$

Slope $= -2 = \frac{-2}{1}$; point: $(-2, -3)$

Answers will vary. Three possible points are:
$x = -2 + 1 = -1$ and $y = -3 - 2 = -5$
$-1, -5)$
$= -1 + 1 = 0$ and $y = -5 - 2 = -7$
$0, -7)$
$x = 0 + 1 = 1$ and $y = -7 - 2 = -9$
$(1, -9)$

Slope $= -1 = \frac{-1}{1}$; point: $(4,1)$

If x increases by 1 unit, then y decreases by 1 unit.
Answers will vary. Three possible points are:
$x = 4 + 1 = 5$ and $y = 1 - 1 = 0$
$5,0)$
$= 5 + 1 = 6$ and $y = 0 - 1 = -1$
$6, -1)$
$x = 6 + 1 = 7$ and $y = -1 - 1 = -2$
$7, -2)$

(0, 0) and (2, 1) are points on the line.

Slope $= \frac{1-0}{2-0} = \frac{1}{2}$

y-intercept is 0; using $y = mx + b$:

$y = \frac{1}{2}x + 0$

$y = x$

$0 = x - 2y$

$-2y = 0$ or $y = \frac{1}{2}x$

(0, 0) and (–2, 1) are points on the line.

Slope $= \frac{1-0}{-2-0} = \frac{1}{-2} = -\frac{1}{2}$

y-intercept is 0; using $y = mx + b$:

$= -\frac{1}{2}x$

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If x increases by 1 unit, then y decreases by 2 units.

$+\ 0\ 2y = -x$

$+\ 2y = 0$

$x + 2y = 0$ or $y = -\frac{1}{2}x$

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(–1, 3) and (1, 1) are points on the line.

Slope $= \dfrac{1-3}{1-(-1)} = \dfrac{-2}{2} = -1$

Using $y - y_1 = m(x - x_1)$

$- 1 = -1(x - 1)$

$y - 1 = -x + 1$

$y = -x + 2$

$+ y = 2$ or $y = -x + 2$

(–1, 1) and (2, 2) are points on the line.

Slope $= \dfrac{2 - 1}{2-(-1)} = \dfrac{1}{3}$

Using $y - y_1 = m(x - x_1)$

$- 1 = \frac{1}{3}(x - (-1))$

$y - 1 = \frac{1}{3}(x + 1)$

$y - 1 = \frac{1}{3}x + \frac{1}{3}$

$y = \frac{1}{3}x + \frac{4}{3}$

$- 3y = -4$ or $y = \frac{1}{3}x + \frac{4}{3}$

$y - y_1 = m(x - x_1)$, $m = 2$ y

$- 3 = 2(x - 3)$

$y - 3 = 2x - 6$

$= 2x - 3$

$2x - y = 3$ or $y = 2x - 3$

$y - y_1 = m(x - x_1)$, $m = -1$ y

$- 2 = -1(x - 1)$

$y - 2 = -x + 1$

$= -x + 3$

$+ y = 3$ or $y = -x + 3$

$y - y_1 = m(x - x_1)$, $m = -$

$\frac{1}{2}$ $y - 2 = -\frac{1}{2}(x - 1)$

$y - y_1 = m(x - x_1)$, $m =$

1 $y - 1 = 1(x - (-1))$

$- 1 = x + 1$

$y = x + 2$

$- y = -2$ or $y = x + 2$

Slope = 3; containing (–2, 3)

$y - y_1 = m(x - x_1)$

$y - 3 = 3(x - (-$

$2))$ $y - 3 = 3x + 6$

$y = 3x + 9$

$3x - y = -9$ or $y = 3x + 9$

Slope = 2; containing the point (4, –3)

$y - y_1 = m(x - x_1)$

$- (-3) = 2(x - 4)$

$y + 3 = 2x - 8$

$= 2x - 11$

$2x - y = 11$ or $y = 2x - 11$

Slope $= -\frac{2}{3}$; containing (1, –1)

$y - y_1 = m(x - x_1)$

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

$y + 1 = -\frac{2}{3}x + \frac{2}{3}$

$y = -\frac{2}{3}x - \frac{1}{3}$

$x + 3y = -1$ or $y = -\frac{2}{3}x - \frac{1}{3}$

Slope $= \frac{1}{2}$; containing the point (3, 1)

$y - y_1 = m(x - x_1)$

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

$y - 1 = \frac{1}{2}x - \frac{3}{2}$

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$$y - 2 = -\frac{1}{2}x + \frac{1}{2}$$

$$y = -\frac{1}{2}x + \frac{5}{2}$$

$$x + 2y = 5 \text{ or } y = -\frac{1}{2}x + \frac{5}{2}$$

$$y = \frac{1}{2}x - \frac{1}{2}$$

$$x - 2y = 1 \text{ or } y = \frac{1}{2}x - \frac{1}{2}$$

Slope = –3; y-intercept =3 y

$= mx + b$

$= -3x + 3$

$3x + y = 3$ or $y = -3x + 3$

Slope = –5; y-intercept = –7 y

$= mx + b$

$= -5x + (-7)$

$5x + y = -7$ or $y = -5x - 7$

Containing (1, 3) and (–1, 2)

$m = \frac{2-3}{-1-1} = \frac{-1}{-2} = \frac{1}{2}$.

$y - y_1 = m(x - x_1)$

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

$y - 3 = \frac{1}{2}x - \frac{1}{2}$

$y = \frac{1}{2}x + \frac{5}{2}$.

$x - 2y = -5$ or $y = \frac{1}{2}x + \frac{5}{2}$

Containing the points (–3, 4) and (2, 5)

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

$y - y_1 = m(x - x_1)$

$y - 5 = \frac{1}{5}(x - 2)$

$y - 5 = \frac{1}{5}x - \frac{2}{5}$

$y = \frac{1}{5}x + \frac{23}{5}$.

$x - 5y = -23$ or $y = \frac{1}{5}x + \frac{23}{5}$

x-intercept = 2; y-intercept = –1

Points are (2,0) and (0,–1)

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

$y = mx + b$

$= \frac{1}{2}x - 1$

x-intercept = –4; y-intercept = 4

Points are (–4, 0) and (0, 4)

$m = \frac{4-0}{0-(-4)} = \frac{4}{4} = 1$

$= mx + b$

$y = 1x + 4$

$y = x + 4$

$-y = -4$ or $y = x + 4$

Slope undefined; containing the point (2, 4)

This is a vertical line.

= 2No slope-intercept form.

Slope undefined; containing the point (3, 8)

This is a vertical line.

= 3No slope-intercept form.

Horizontal lines have slope $m = 0$ and take the form $y = b$. Therefore, the horizontal line passing through the point $(-3,2)$ is $y = 2$.

Vertical lines have an undefined slope and take the form $x = a$. Therefore, the vertical line passing through the point $(4, -5)$ is $x = 4$.

Parallel to $y = 4x$; Slope = 4

Containing (–1, 2)

$y - y_1 = m(x - x_1)$

$y - 2 = 4(x - (-1))$

$y - 2 = x + 4 \rightarrow y = 4x + 6$

$4x - y = -6$ or $y = 4x + 6$

Parallel to $y = -3x$; Slope = –3; Containing the point (–1, 2)

$y - y_1 = m(x - x_1)$

$y - 2 = -3(x - (-1))$

$y - 2 = -3x - 3 \rightarrow y = -3x - 1$

$3x + y = -1$ or $y = -3x - 1$

$x - 2y = 2$ or $y = \frac{1}{2}x - 1$

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Parallel to $5x - y = -2$; Slope = 5
Containing the point (0, 0)

$y - y_1 = m(x -$
$x_1)$ $y - 0 = 5(x$
$- 0)$ $y = 5x$
$5x - y = 0$ or $y = 5x$

Parallel to $x - 2y = -5$;

Slope = $\frac{1}{2}$; Containing the point $(0,0)$

$y - y_1 = m(x - x_1)$

$y - 0 = \frac{1}{2}(x - 0) \rightarrow y = \frac{1}{2}x$

–

Parallel to $x = 5$; Containing (4,2)
This is a vertical line.
= 4No slope-intercept form.

Parallel to $y = 5$; Containing the point (4, 2)
This is a horizontal line. Slope = 0
= 2

Perpendicular to $y = \frac{1}{6}x + 4$; Containing (1, –2)

Slope of perpendicular = –6

$y - y_1 = m(x - x_1)$
$-(-2) = -6(x - 1)$
$y + 2 = -6x + 2 \rightarrow y = -6x$
$6x + y = 0$ or $y = -6x$

Perpendicular to $y = 8x - 3$; Containing the point (10, –2)

Slope of perpendicular = $-\frac{1}{8}$

$y - y_1 = m(x - x_1)$
$-(-2) = -\frac{1}{8}(x - 10)$

Perpendicular to $2x + 5y = 2$; Containing the point (–3, –6)

Slope of perpendicular = $\frac{5}{2}$

$y - y_1 = m(x - x_1)$

$y - (-6) = \frac{5}{2}(x - (-3)) \rightarrow y + 6 = \frac{5}{2}x$

$+ \frac{15}{2}$ $y = \frac{5}{2}x + \frac{3}{2}$

$5x - 2y = -3$ or $y = \frac{5}{2}x + \frac{3}{2}$

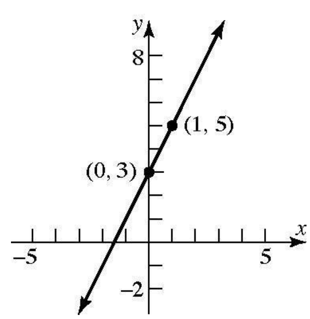
Perpendicular to $x - 3y = -12$; Containing the point (0, 4)
Slope of perpendicular = –
3 $y = mx + b$
$y = -3x + 4$
$3x + y = 4$ or $y = -3x + 4$

Perpendicular to $x = 8$; Containing (3, 4)
Slope of perpendicular = 0 (horizontal line)
$y = 4$

Perpendicular to $y = 8$;
Containing the point (3, 4)

Slope of perpendicular is undefined (vertical line). $x = 3$ No slope-intercept form.

$y = 2x + 3$; Slope = 2; y-intercept = 3



74. $y = -3x + 4$; Slope = –3; y-intercept = 4

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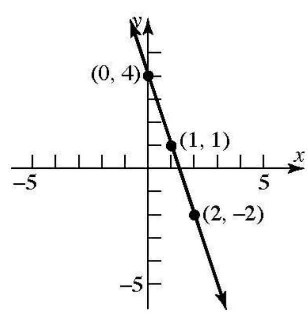
$$y + 2 = -\frac{1}{8}x + \frac{5}{4} \rightarrow y = -\frac{1}{8}x - \frac{3}{4}$$

$x + 8y = -6$ or $y = -\dfrac{1}{8}x - \dfrac{3}{4}$



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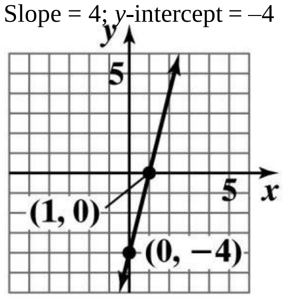
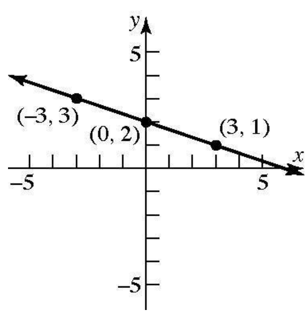
$\frac{1}{4}y = x - 1$; $y = 4x - 4$

Slope = 4; y-intercept = –4

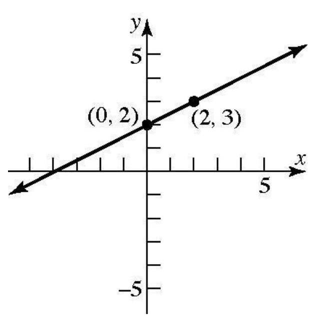


$\frac{1}{3}x + y = 2$; $y = -\frac{1}{3}x + 2$

Slope = $-\frac{1}{3}$; y-intercept = 2



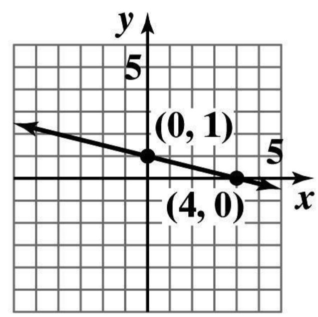
$y = \frac{1}{2}x + 2$; Slope = $\frac{1}{2}$; y-intercept = 2



78. $y = 2x + \frac{1}{2}$; Slope = 2; y-intercept = $\frac{1}{2}$

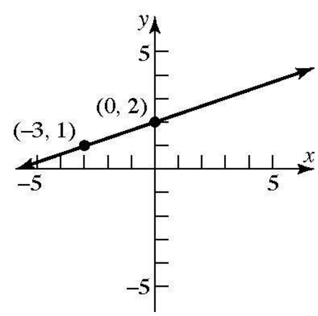
$x + 4y = 4$; $4y = -x + 4 \rightarrow y = -\frac{1}{4}x + 1$

Slope = $-\frac{1}{4}$; y-intercept = 1



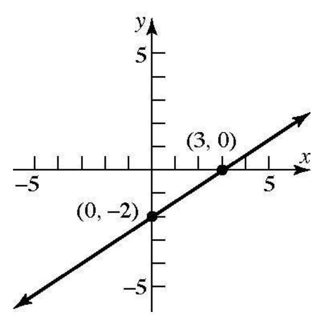
$-x + 3y = 6$; $3y = x + 6 \rightarrow y = \frac{1}{3}x + 2$

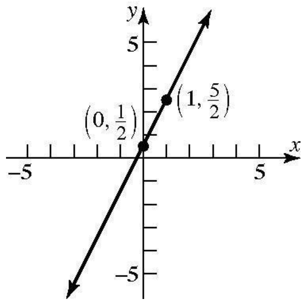
Slope = $\frac{1}{3}$; y-intercept = 2



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

Slope = $\frac{2}{3}$; y-intercept = –2





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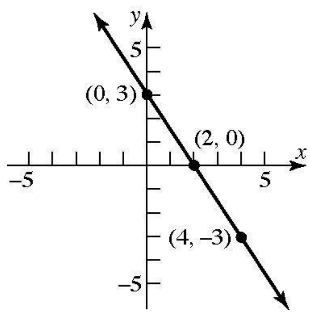
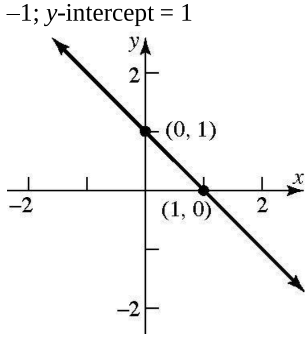
82. $3x + 2y = 6$; $2y = -3x + 6 \rightarrow y = -\frac{3}{2}x + 3$

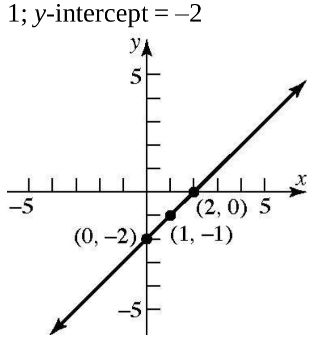
Slope $= -\frac{3}{2}$; y-intercept = 3



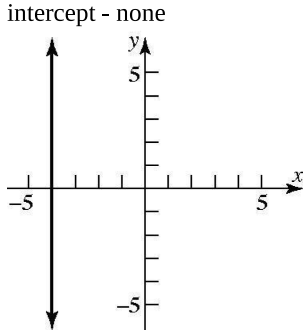
$x + y = 1$; $y = -x + 1$ Slope = –1; y-intercept = 1



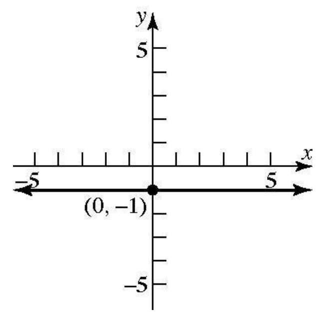
$x - y = 2$; $y = x - 2$ Slope = 1; y-intercept = –2



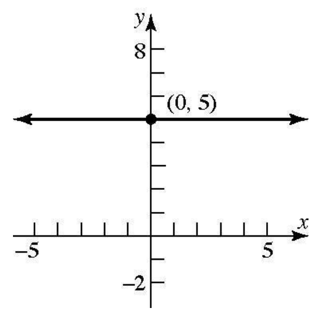
$x = -4$; Slope is undefined y-intercept - none



86. $y = -1$; Slope = 0; y-intercept = –1

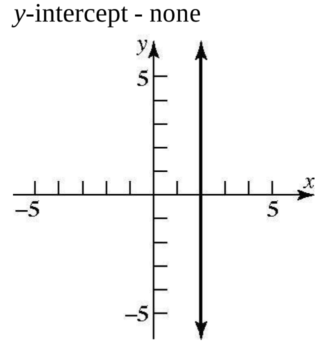


87. $y = 5$; Slope = 0; y-intercept = 5



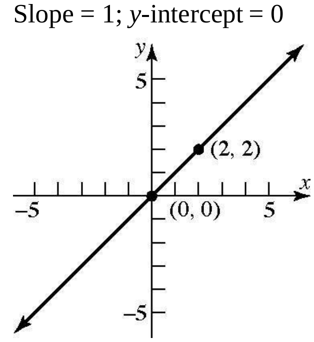
88. $x = 2$; Slope is undefined

y-intercept - none



89. $y - x = 0$; $y = x$

Slope = 1; y-intercept = 0



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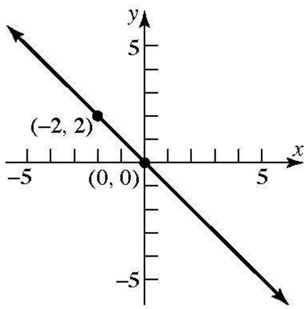
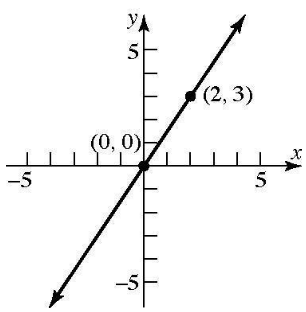
$x + y = 0$; $y = -x$

Slope = –1; y-intercept = 0



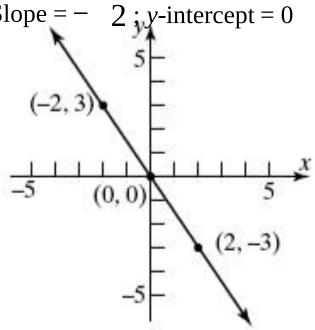
$2y - 3x = 0$; $2y = 3x \rightarrow y = \frac{3}{2}x$

Slope = $\frac{3}{2}$; y-intercept = 0



$3x + 2y = 0$; $2y = -3x \rightarrow y = -\frac{3}{2}x$

Slope = $-\frac{3}{2}$; y-intercept = 0



93. a. x-intercept: $2x + 3(0) = 6$

$2x = 6$

$x = 3$

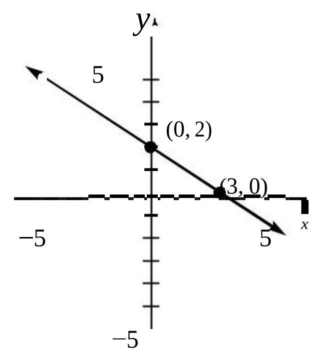
The point $(3, 0)$ is on the graph.

y-intercept: $2(0) + 3y = 6$

$3y = 6$

$y = 2$

The point $(0, 2)$ is on the graph.



a. x-intercept: $3x - 2(0) = 6$

$3x = 6$

$x = 2$

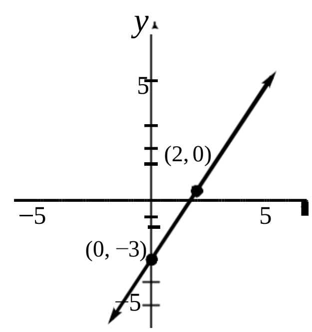
The point $(2, 0)$ is on the graph.

y-intercept: $3(0) - 2y = 6$

$-2y = 6$

$y = -3$

The point $(0, -3)$ is on the graph.



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a. x-intercept: $-4x + 5(0) = 40$

$-4x = 40$

$x = -10$

The point $(-10, 0)$ is on the graph.

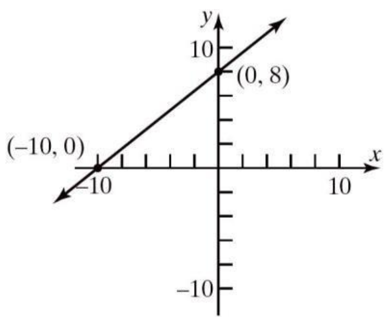
y-intercept: $-4(0) + 5y = 40$

$5y = 40$

$y = 8$

The point $(0, 8)$ is on the graph.

b.



a. x-intercept: $6x - 4(0) = 24$

$6x = 24$

$x = 4$

The point $(4, 0)$ is on the graph.

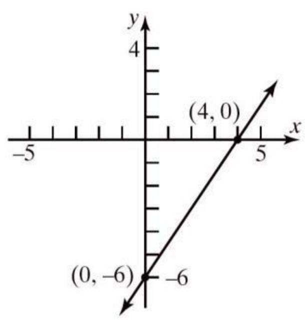
y-intercept: $6(0) - 4y = 24$

$-4y = 24$

$y = -6$

The point $(0, -6)$ is on the graph.

b.



a. x-intercept: $7x + 2(0) = 21$

$7x = 21$

$x = 3$

The point $(3, 0)$ is on the graph.

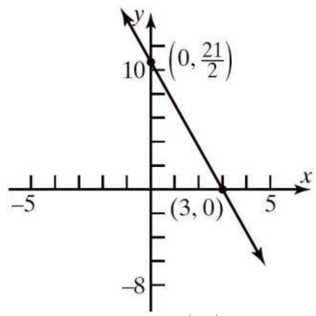
y-intercept: $7(0) + 2y = 21$

$2y = 21$

$y = \frac{21}{2}$

The point $\left(0, \frac{21}{2}\right)$ is on the graph.

b.



a. x-intercept: $5x + 3(0) = 18$

$5x = 18$

$x = \frac{18}{5}$

The point $\left(\frac{18}{5}, 0\right)$ is on the graph.

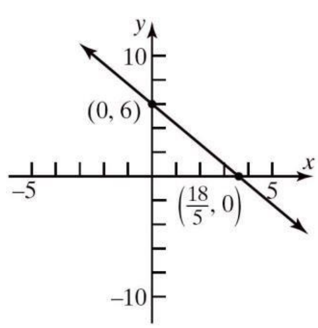
y-intercept: $5(0) + 3y = 18$

$3y = 18$

$y = 6$

The point $(0, 6)$ is on the graph.

b.



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a. x-intercept: $\frac{1}{2}x + \frac{1}{3}(0) = 1$

$$\frac{1}{2}x = 1$$
$$x = 2$$

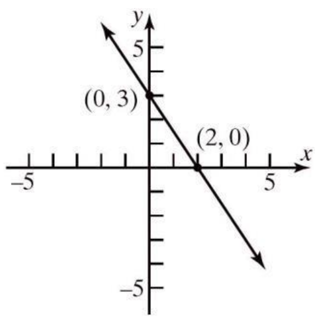
The point $(2, 0)$ is on the graph.

y-intercept: $\frac{1}{2}(0) + \frac{1}{3}y = 1$

$$y = 3$$

The point $(0, 3)$ is on the graph.

b.



a. x-intercept: $x - \frac{2}{3}(0) = 4$

$$x = 4$$

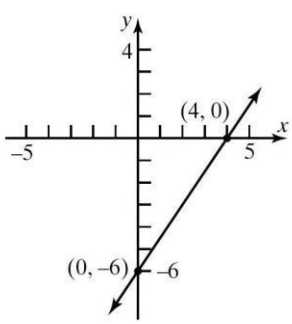
The point $(4, 0)$ is on the graph.

y-intercept: $(0) - \frac{2}{3}y = 4$

$$y = -6$$

The point $(0, -6)$ is on the graph.

b.



a. x-intercept: $0.2x - 0.5(0) = 1$

$$0.2x = 1$$
$$x = 5$$

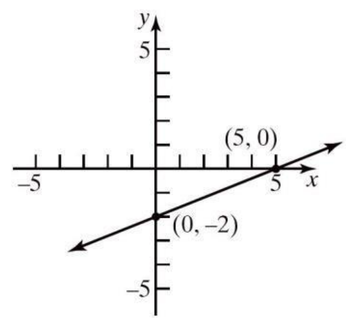
The point $(5, 0)$ is on the graph.

y-intercept: $0.2(0) - 0.5y = 1$

$$-0.5y = 1$$
$$y = -2$$

The point $(0, -2)$ is on the graph.

b.



a. x-intercept: $-0.3x + 0.4(0) = 1.2$

$$-0.3x = 1.2$$
$$x = -4$$

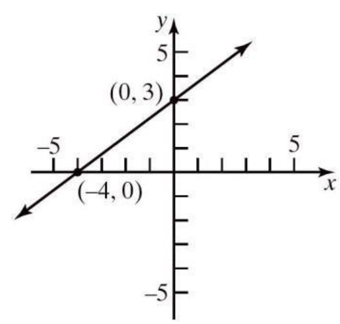
The point $(-4, 0)$ is on the graph.

y-intercept: $-0.3(0) + 0.4y = 1.2$

$$0.4y = 1.2$$
$$y = 3$$

The point $(0, 3)$ is on the graph.

b.



The equation of the x-axis is $y = 0$. (The slope is 0 and the y-intercept is 0.)

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The equation of the *y*-axis is $x = 0$. (The slope is undefined.)

The slopes are the same but the *y*-intercepts are different. Therefore, the two lines are parallel.

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The slopes are opposite-reciprocals. That is, their product is -1. Therefore, the lines are perpendicular.

The slopes are different and their product does not equal -1. Therefore, the lines are neither parallel nor perpendicular.

The slopes are different and their product does not equal -1 (in fact, the signs are the same so the product is positive). Therefore, the lines are neither parallel nor perpendicular.

Intercepts: $(0, 2)$ and $(-2, 0)$. Thus, slope = 1.
$y = x + 2$ or $x - y = -2$

Intercepts: $(0,1)$ and $(1,0)$. Thus, slope = –1. $y = -x + 1$ or $x + y = 1$

Intercepts: $(3,0)$ and $(0,1)$. Thus, slope = $-\frac{1}{3}$.

$y = -\frac{1}{3}x + 1$ or $x + 3y = 3$

Intercepts: $(0, -1)$ and $(-2,0)$. Thus, slope = $-\frac{1}{2}$.

$y = -\frac{1}{2}x - 1$ or $x + 2y = -2$

$P_1 = (-2,5)$, $P_2 = (1,3)$: $m_1 = \frac{5-3}{-2-1} = \frac{2}{-3} = -\frac{2}{3}$

$P_2 = (1,3)$, $P_3 = (-1,0)$: $m_2 = \frac{3-0}{1-(-1)} = \frac{3}{2}$

Since $m_1 \cdot m_2 = -1$, the line segments P_1P_2 and P_2P_3 are perpendicular. Thus, the points P_1, P_2, and P_3 are vertices of a right triangle.

$P_1 = (1, -1)$, $P_2 = (4,1)$, $P_3 = (2,2)$, $P_4 = (5, 4)$

$m_{12} = \frac{1-(-1)}{4-1} = \frac{2}{3}$; $m_{24} = \frac{4-1}{5-4} = 3$;

$m_{34} = \frac{4-2}{5-2} = \frac{2}{3}$; $m_{13} = \frac{2-(-1)}{2-1} = 3$

Each pair of opposite sides are parallel (same slope) and adjacent sides are not perpendicular. Therefore, the vertices are for a parallelogram.

$P_1 = (-1,0)$, $P_2 = (2,3)$, $P_3 = (1, -2)$, $P_4 = (4,1)$

$m_{12} = \frac{3-0}{2-(-1)} = \frac{3}{3} = 1$; $m_{24} = \frac{1-3}{4-2} = -1$;

$m_{34} = \frac{1-(-2)}{4-1} = \frac{3}{3} = 1$; $m_{13} = \frac{-2-0}{1-(-1)} = -1$

Opposite sides are parallel (same slope) and adjacent sides are perpendicular (product of slopes is -1). Therefore, the vertices are for a rectangle.

$P_1 = (0,0)$, $P_2 = (1,3)$, $P_3 = (4,2)$, $P_4 = (3, -1)$

$m_{12} = \frac{3-0}{1-0} = 3$; $m_{23} = \frac{2-3}{4-1} = -\frac{1}{3}$;

$m_{34} = \frac{-1-2}{3-4} = 3$; $m_{14} = \frac{-1-0}{3-0} = -\frac{1}{3}$

$d_{12} = \sqrt{(1-0)^2 + (3-0)^2} = \sqrt{1+9} = \sqrt{10}$

$d_{23} = \sqrt{(4-1)^2 + (2-3)^2} = \sqrt{9+1} = \sqrt{10}$

$d_{34} = \sqrt{(3-4)^2 + (-1-2)^2} = \sqrt{1+9} = \sqrt{10}$

$d_{14} = \sqrt{(3-0)^2 + (-1-0)^2} = \sqrt{9+1} = \sqrt{10}$

Opposite sides are parallel (same slope) and adjacent sides are perpendicular (product of slopes is -1). In addition, the length of all four sides is the same. Therefore, the vertices are for a square.

Let x = number of miles driven, and let C = cost in dollars.
Total cost = (cost per mile)(number of miles) + fixed cost
$C = 0.60x + 39$
When $x = 110$, $C = (0.60)(110) + 39 = \$105.00$.

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When $x = 230$, $C = (0.60)(230) + 39 = \$177.00$.

Let x = number of pairs of jeans manufactured, and let C = cost in dollars.
Total cost = (cost per pair)(number of pairs) + fixed cost
$C = 8x + 500$
When $x = 400$, $C = (8)(400) + 500 = \$3700$.
When $x = 740$, $C = (8)(740) + 500 = \$6420$.

Let x = number of miles driven annually, and let C = cost in dollars.
Total cost = (approx cost per mile)(number of miles) + fixed cost
$C = 0.16x + 1461$

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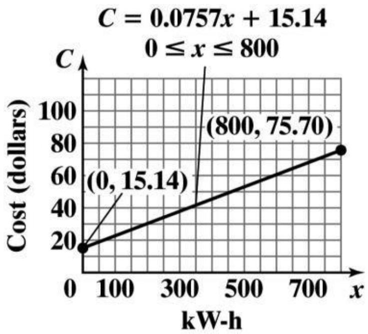
Let x = profit in dollars, and let S = salary in dollars.
Weekly salary = (% share of profit)(profit) + weekly pay
$S = 0.05x + 375$

a. $C = 0.0757x + 15.14$; $0 \le x \le 800$ **b.**



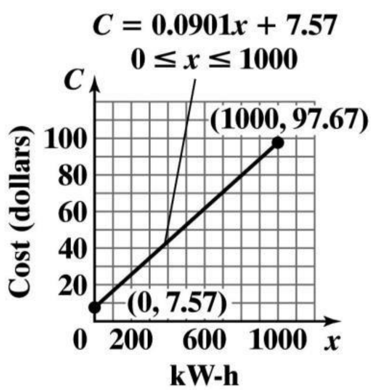
For 200 kWh,
$C = 0.0757(200) + 15.14 = \$30.28$

For 500 kWh,

$C = 0.0757(500) + 15.14 = \$52.99$

For each usage increase of 1 kWh, the monthly charge increases by \$0.0757 (that is, 7.57 cents).

a. $C = 0.0901x + 7.57$; $0 \le x \le 1000$



For 200 kWh,

$C = 0.0901(200) + 7.57 = \$25.59$

For 500 kWh,

$C = 0.0901(500) + 7.57 = \$52.62$

For each usage increase of 1 kWh, the monthly charge increases by \$0.0901 (that is, 9.01 cents).

$(°C, °F) = (0, 32)$; $(°C, °F) = (100, 212)$

$$\text{slope} = \frac{212-32}{100-0} = \frac{180}{100} = \frac{9}{5}$$

$$°F - 32 = \frac{9}{5}(°C - 0)$$

$$°C = \frac{5}{9}(°F - 32)$$

$$°C = \frac{5}{9}(70 - 32) = \frac{5}{9}(38)$$

a. $K = °C + 273$

$$°C = \frac{5}{9}(°F - 32)$$

$$K = \frac{5}{9}(°F - 32) + 273$$

$$K = \frac{5}{9}°F - \frac{160}{9} + 273$$

$$= \frac{5}{9}°F + \frac{2297}{9}$$

$$= \frac{1}{9}(5°F + 2297)$$

a. The y-intercept is (0, 30), so $b = 30$. Since the ramp drops 2 inches for every 25 inches of run, the slope is $m = \frac{-2}{25} = -\frac{2}{25}$.

Thus, the equation is $y = -\frac{2}{25}x + 30$.

Let $y = 0$.

$$0 = -\frac{2}{25}x + 30$$

$$\frac{2}{25}x = 30$$

$$\frac{25}{2}\left(\frac{2}{25}x\right) = \frac{25}{2}(30)$$

$$x = 375$$

The x-intercept is (375, 0). This means that the ramp meets the floor 375 inches (or 31.25 feet) from the base of the platform.

No. From part (b), the run is 31.25 feet which exceeds the required maximum of 30 feet. First, design requirements state that the maximum slope is a drop of 1 inch for each 12 inches of run. This means $|m| \le \frac{1}{12}$.

Second, the run is restricted to be no more than 30 feet = 360 inches. For a rise of 30 inches, this means the minimum slope is $\frac{30}{360} = \frac{1}{12}$. That is, $|m| \ge \frac{1}{12}$. Thus, the only possible slope is $|m| = \frac{1}{12}$. The diagram indicates that the slope is negative. Therefore, the only slope that can be used to obtain the 30-inch rise and still meet design requirements is $m = -\frac{1}{12}$. In words, for every 12 inches of run, the ramp must drop *exactly* 1 inch.

a. The year 2000 corresponds to $x = 0$, and the year 2013 corresponds to $x = 13$. Therefore, the points (0, 20.6) and (13, 8.5) are on the line. Thus, $m = \frac{20.6 - 8.5}{0 - 13} = \frac{12.1}{-13} = -0.93$.

The y-intercept is 20.6, so $b = 20.6$ and the equation is $y = -0.93x + 20.6$

x-intercept: $0 = -0.93x + 20.6$

$x = 22.15$

y-intercept: $y = -0.93(0) + 20.6 = 20.6$

The intercepts are (22.15, 0) and (0, 20.6).

c. The y-intercept represents the percentage of twelfth graders in 2000 who had reported daily use of cigarettes. The x-intercept represents the number of years after 2000 when 0% of twelfth graders will have reported daily use of cigarettes.

d. The year 2025 corresponds to $x = 25$.

$= -0.93(25) + 20.6 = -2.65$

This prediction is not reasonable since it is negative.

a. Let x = number of boxes to be sold, and A = money, in dollars, spent on advertising. We have the points

$(x_1, A_1) = (100{,}000, 40{,}000)$;

$(x_2, A_2) = (200{,}000, 60{,}000)$

$$\text{slope} = \frac{60{,}000 - 40{,}000}{200{,}000 - 100{,}000} = \frac{20{,}000}{100{,}000} = \frac{1}{5}$$

$$A - 40{,}000 = \frac{1}{5}(x - 100{,}000)$$

$$A - 40{,}000 = \frac{1}{5}x - 20{,}000$$

$$A = \frac{1}{5}x + 20{,}000$$

If $x = 300{,}000$, then

$$= \frac{1}{5}(300{,}000) + 20{,}000 = \$80{,}000$$

Each additional box sold requires an additional \$0.20 in advertising.

Find the slope of the line containing (a, b) and $b, a)$:

$$\text{slope} = \frac{a - b}{b - a} = -1$$

The slope of the line $y = x$ is 1.

Since $-1\ 1 = -1$, the line containing the points (a, b) and (b, a) is perpendicular to the line $y = x$.

The midpoint of (a, b) and (b, a) is

$$= \left(\frac{a+b}{2}, \frac{b+a}{2} \right).$$

Since the coordinates are the same, the midpoint lies on the line $y = x$.

Note: $\frac{a+b}{2} = \frac{b+a}{2}$

$2x - y = C$

Graph the lines:

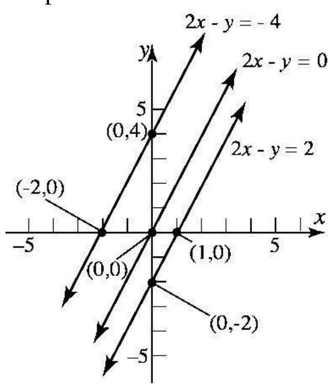
$x - y = -4$

$x - y = 0$

$x - y = 2$

All the lines have the same slope, 2. The lines

are parallel.



Refer to Figure 33.

length of $\overline{OA} = d(O, A) = \sqrt{1+m_1^2}$

length of $\overline{OB} = d(O, B) = \sqrt{1+m_2^2}$

length of $\overline{AB} = d(A, B) = m_1 - m_2$

Now consider the equation

$$\left(\sqrt{1+m_1^2}\right)^2 + \left(\sqrt{1+m_2^2}\right)^2 = (m_1 - m_2)^2$$

If this equation is valid, then AOB is a right triangle with right angle at vertex O.

$$\left(\sqrt{1+m_1^2}\right)^2 + \left(\sqrt{1+m_2^2}\right)^2 = (m_1 - m_2)^2$$
$$1+m_1^2+1+m_2^2 = m_1^2 - 2m_1m_2 + m_2^2$$
$$2+m_1^2+m_2^2 = m_1^2 - 2m_1m_2 + m_2^2$$

But we are assuming that $m_1 m_2 = -1$, so we have

$$2+m_1^2+m_2^2 = m_1^2 - 2(-1) + m_2^2$$
$$2+m_1^2+m_2^2 = m_1^2 + 2 + m_2^2$$
$$0 = 0$$

Therefore, by the converse of the Pythagorean Theorem, AOB is a right triangle with right angle at vertex O. Thus Line 1 is perpendicular to Line 2.

(b), (c), (e) and (g)
The line has positive slope and positive y-intercept.

(a), (c), and (g)
The line has negative slope and positive y-intercept.

(c)
The equation $x - y = -2$ has slope 1 and y-intercept (0, 2). The equation $x - y = 1$ has slope 1 and y-intercept (0, −1). Thus, the lines are parallel with positive slopes. One line has a positive y-intercept and the other with a negative y-intercept.

(d)
The equation $y - 2x = 2$ has slope 2 and y-intercept (0, 2). The equation $x + 2y = -1$ has slope $-\frac{1}{2}$ and y-intercept $\left(0, -\frac{1}{2}\right)$. The lines are perpendicular since $2\left(-\frac{1}{2}\right) = -1$. One line has a positive y-intercept and the other with a negative y-intercept.

135 – 137. Answers will vary.

No, the equation of a vertical line cannot be written in slope-intercept form because the slope is undefined.

No, a line does not need to have both an x-intercept and a y-intercept. Vertical and horizontal lines have only one intercept (unless they are a coordinate axis). Every line must have at least one intercept.

Two lines with equal slopes and equal y-intercepts are coinciding lines (i.e. the same).

Two lines that have the same x-intercept and y-intercept (assuming the x-intercept is not 0) are the same line since a line is uniquely defined by two distinct points.

No. Two lines with the same slope and different x-intercepts are distinct parallel lines and have no points in common.

Assume Line 1 has equation $y = mx + b_1$ and Line 2 has equation $y = mx + b_2$,

Line 1 has x-intercept $-\frac{b_1}{m}$ and y-intercept b_1. Line 2 has x-intercept $-\frac{b_2}{m}$ and y-intercept b_2 . Assume also that Line 1 and Line 2 have unequal x-intercepts.

If the lines have the same y-intercept, then $b_1 = b_2$.

$b_1 = b_2 \Rightarrow \frac{b}{m_1} = \frac{b}{m_2} \Rightarrow -\frac{b}{m_1} = -\frac{b}{m_2}$ $\Rightarrow$ Line 1 and Line 2 have the same x-intercept, which contradicts the original assumption that the lines have unequal x-intercepts. Therefore, Line 1 and Line 2 cannot have the same y-intercept.

Yes. Two distinct lines with the same y-intercept, but different slopes, can have the same x-intercept if the x-intercept is $x = 0$.

Assume Line 1 has equation $y = m_1 x + b$ and Line 2 has equation $y = m_2 x + b$,

Line 1 has x-intercept $-\frac{b}{m_1}$ and y-intercept b.

Line 2 has x-intercept $-\frac{b}{m_2}$ and y-intercept b.

Assume also that Line 1 and Line 2 have unequal slopes, that is $m_1 \neq m_2$.

If the lines have the same x-intercept, then

$$-\frac{b}{m_1} = -\frac{b}{m_2}$$

$$\frac{b}{m_1} = \frac{b}{m_2}$$

$$m_2 b = m_1 b$$

$$m_2 b - m_1 b = 0$$

But $m_2 b - m_1 b = 0 \Rightarrow b(m_2 - m_1) = 0$

$b = 0$

or $m_2 - m_1 = 0 \Rightarrow m_1 = m_2$

Since we are assuming that $m_1 \neq m_2$, the only way that the two lines can have the same x-intercept is if $b = 0$.

Answers will vary.

$$m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-4-2}{1-(-3)} = \frac{-6}{4} = -\frac{3}{2}$$

It appears that the student incorrectly found the slope by switching the direction of one of the subtractions.

146. $\left(\frac{x^4 y^5}{x^2 y^{-3}}\right)^{-2} = \left(x^2 y^8\right)^{-2} = \left(\frac{1}{x^2 y^8}\right)^{2} = \frac{1}{x^4 y^{16}}$

$$h^2 = a^2 + b^2$$

$$= 8^2 + 15^2$$

$$= 64 + 225$$

$$= 289$$

$$h = \sqrt{289} = 17$$

$$(x-3)^2 + 25 = 49$$

$$(x-3)^2 = 24$$

$$x - 3 = \pm\sqrt{24}$$

$$x - 3 = \pm 2\sqrt{6}$$

$$x = 3 \pm 2\sqrt{6}$$

The solution set is: $\{3 - 2\sqrt{6}, 3 + 2\sqrt{6}\}$.

$$|2x - 5| + 7 < 10$$

$$|2x - 5| < 3$$

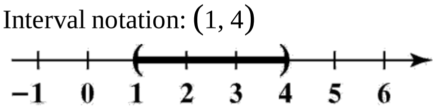
$$-3 < 2x - 5 < 3$$

$$2 < 2x < 8$$

$$1 < x < 4$$

The solution set is: $\{x \mid 1 < x < 4\}$.

Interval notation: $(1, 4)$



Section 2.3

1. add; $\left(\frac{1}{2} \cdot 10\right)^2 = 25$

$(x-2)^2 = 9$

$-2 = \pm\sqrt{9}$

$-2 = \pm 3$

$= 2 \pm 3$

$= 5$ or $x = -1$

The solution set is $\{-1, 5\}$.

False. For example, $x^2 + y^2 + 2x + 2y + 8 = 0$ is not a circle. It has no real solutions.

radius

True; $r^2 = 9 \rightarrow r = 3$

False; the center of the circle

$x+3)^2 + (y-2)^2 = 13$ is $(-3, 2)$.

d

a

Center = (2, 1)

Radius = distance from (0,1) to (2,1)

$= \sqrt{(2-0)^2 + (1-1)^2} = \sqrt{4} = 2$

Equation: $(x-2)^2 + (y-1)^2 = 4$

Center = (1, 2)

Radius = distance from (1,0) to (1,2)

$= \sqrt{(1-1)^2 + (2-0)^2} = \sqrt{4} = 2$

Equation: $(x-1)^2 + (y-2)^2 = 4$

Center = midpoint of (1, 2) and (4, 2)

$$\left(\frac{1+4}{2}, \frac{2+2}{2}\right) = \left(\frac{5}{2}, 2\right) =$$

Radius = distance from $\left(\frac{5}{2}, 2\right)$ to (4,2)

$$= \sqrt{\left(4 - \frac{5}{2}\right)^2 + (2-2)^2} = \sqrt{\frac{9}{4}} = \frac{3}{2}$$

Equation: $\left(x - \frac{5}{2}\right)^2 + (y-2)^2 = \frac{9}{4}$

Center = midpoint of (0, 1) and (2, 3)

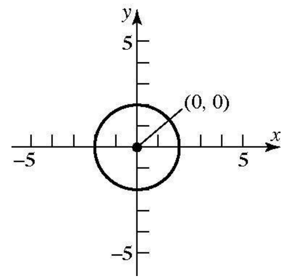
$$\left(\frac{0+2}{2}, \frac{1+3}{2}\right) = (1, 2)$$

$(x-h)^2 + (y-k)^2 = r^2$

$(x-0)^2 + (y-0)^2 = 2^2$

$x^2 + y^2 = 4$

General form: $x^2 + y^2 - 4 = 0$

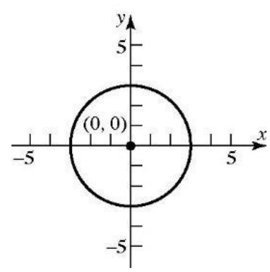


$(x-h)^2 + (y-k)^2 = r^2$

$(x-0)^2 + (y-0)^2 = 3^2$

$x^2 + y^2 = 9$

General form: $x^2 + y^2 - 9 = 0$



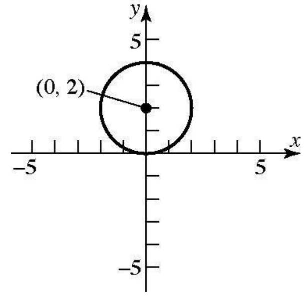
$(x-h)^2 + (y-k)^2 = r^2$

$(x-0)^2 + (y-2)^2 = 2^2$

$x^2 + (y-2)^2 = 4$

General form: $x^2 + y^2 - 4y + 4 = 4$

$x^2 + y^2 - 4y = 0$



22

Radius = distance from $(1,2)$ to $(2,3)$

$$= \sqrt{(2-1)^2 + (3-2)^2} = \sqrt{2}$$

Equation: $(x-1)^2 + (y-2)^2 = 2$

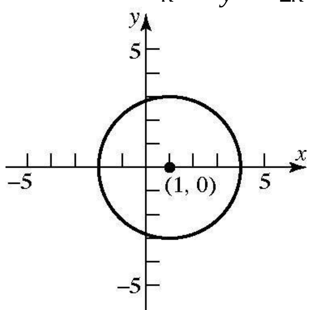
16. $(x-h)^2+(y-k)^2=r^2$

$(x-1)^2+(y-0)^2=3^2$

$(x-1)^2+y^2=9$

General form: $x^2-2x+1+y^2=9$

$x^2+y^2-2x-8=0$



$(x-h)^2+(y-k)^2=r^2$

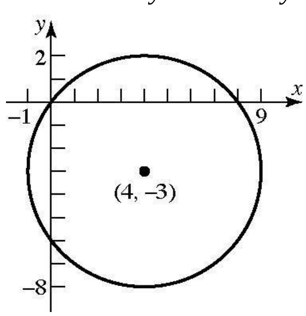
$(x-4)^2+(y-(-3))^2=5^2$

$x-4)^2+(y+3)^2=$

25 General form:

${}^2-8x+16+y^2+6y+9=25$

${}^2+y^2-8x+6y=0$



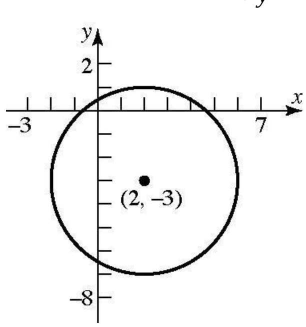
$(x-h)^2+(y-k)^2=r^2$

$(x-2)^2+(y-(-3))^2=4^2$

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

General form: $x^2-4x+4+y^2+6y+9=16$

${}^2+y^2-4x+6y-3=0$



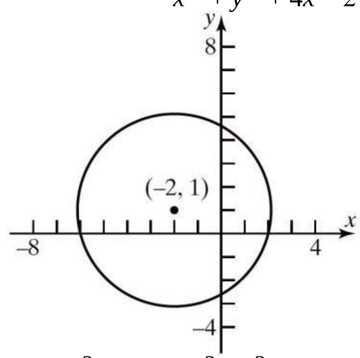
19. $(x-h)^2+(y-k)^2=r^2$

$(x-\ \ -2)^2+(y-1)^2=4^2$

$(x+2)^2+(y-1)^2=16$

General form: $x^2+4x+4+y^2-2y+1=16$

$x^2+y^2+4x-2y-11=0$



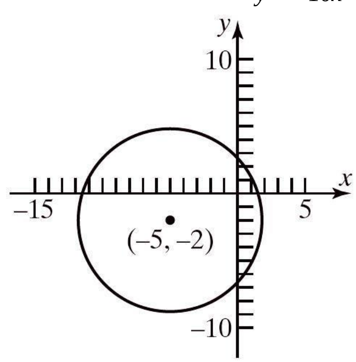
$(x-h)^2+(y-k)^2=r^2$

$(x-(-5))^2+(y-(-2))^2=7^2$

$(x+5)^2+(y+2)^2=49$

General form: $x^2+10x+25+y^2+4y+4=49$

${}^2+y^2+10x+4y-20=0$



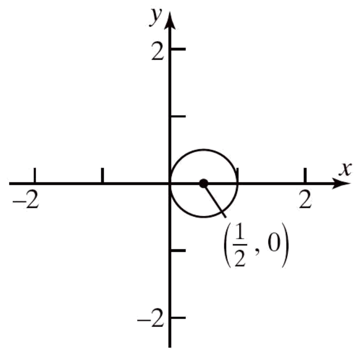
$(x-h)^2+(y-k)^2=r^2$

$\left(x-\frac{1}{2}\right)^2+(y-0)^2=\left(\frac{1}{2}\right)^2$

$\left(x-\frac{1}{2}\right)^2+y^2=\frac{1}{4}$

General form: $x^2-x+\frac{1}{4}+y^2=\frac{1}{4}$

$x^2 + y^2 - x = 0$



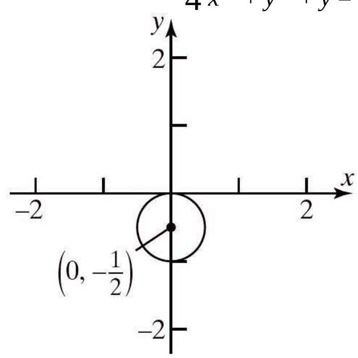
$(x-h)^2 + (y-k)^2 = r^2$

$(x-0)^2 + \left(y-\left(-\frac{1}{2}\right)\right)^2 = \left(\frac{1}{2}\right)^2$

$x^2 + \left(y+\frac{1}{2}\right)^2 = \frac{1}{4}$

General form: $x^2 + y^2 + y + \frac{1}{4} = \frac{1}{4}$

$x^2 + y^2 + y = 0$

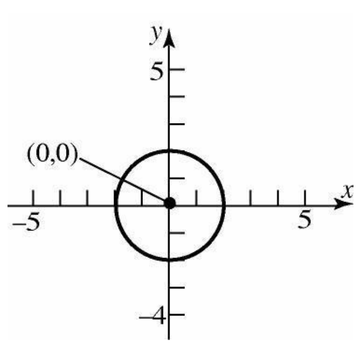


$x^2 + y^2 = 4$

$x^2 + y^2 = 2^2$

Center: (0,0); Radius = 2

b.



x-intercepts: $x^2 + (0)^2 = 4$

$^2 = 4$

$= \pm\sqrt{4} = \pm 2$

y-intercepts: $(0)^2 + y^2 = 4$

$^2 = 4$

$= \pm\sqrt{4} = \pm 2$

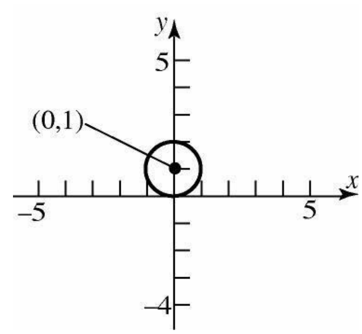
The intercepts are $(-2, 0)$, $(2, 0)$, $(0, -2)$, and $(0, 2)$.

$x^2 + (y-1)^2 = 1$

$^2 + (y-1)^2 = 1^2$

Center:(0, 1); Radius = 1

b.



x-intercepts: $x^2 + (0-1)^2 = 1$

$^2 + 1 = 1$

$x^2 = 0$

$x = \pm\sqrt{0} = 0$

y-intercepts: $(0)^2 + (y-1)^2 = 1$ (

$y-1)^2 = 1$

$y - 1 = \pm\sqrt{1}$

$y - 1 = \pm 1$

$y = 1 \pm 1$

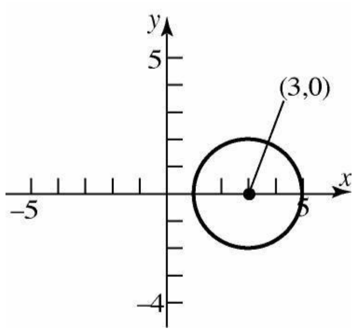
$y = 2$ or $y = 0$

The intercepts are $(0, 0)$ and $(0,2)$.

$$2(x-3)^2 + 2y^2 = 8$$
$$(x-3)^2 + y^2 = 4$$

Center: (3, 0); Radius = 2

b.



x-intercepts: $(x-3)^2 + (0)^2 = 4$
$$(x-3)^2 = 4$$
$$x-3 = \pm\sqrt{4}$$
$$x-3 = \pm 2$$
$$x = 3 \pm 2$$
$$x = 5 \quad \text{or } x = 1$$

y-intercepts: $(0-3)^2 + y^2 = 4$
$$(-3)^2 + y^2 = 4$$
$$9 + y^2 = 4$$
$$y^2 = -5$$

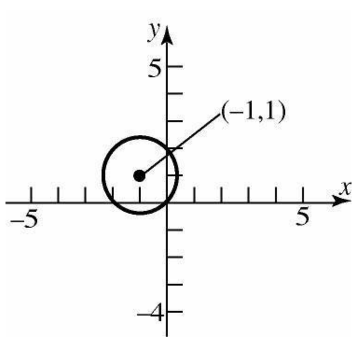
No real solution.

The intercepts are $(1, 0)$ and $(5, 0)$.

$$3(x+1)^2 + 3(y-1)^2 = 6$$
$$x+1)^2 + (y-1)^2 = 2$$

a. Center: (–1,1); Radius = $\sqrt{2}$

b.



x-intercepts: $(x+1)^2 + (0-1)^2 = 2$
$$x+1)^2 + (-1)^2 = 2$$
$$(x+1)^2 + 1 = 2$$
$$(x+1)^2 = 1$$
$$x+1 = \pm\sqrt{1}$$
$$x+1 = \pm 1$$
$$x = -1 \pm 1$$
$$x = 0 \quad \text{or } x = -2$$

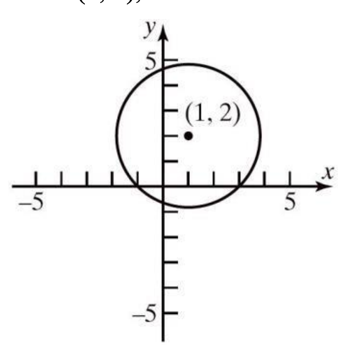
y-intercepts: $(0+1)^2 + (y-1)^2 = 2$
$$(1)^2 + (y-1)^2 = 2$$
$$1 + (y-1)^2 = 2$$
$$(y-1)^2 = 1$$
$$y-1 = \pm\sqrt{1}$$
$$y-1 = \pm 1$$
$$y = 1 \pm 1$$
$$y = 2 \quad \text{or } y = 0$$

The intercepts are $(-2, 0)$, $(0, 0)$, and $(0,2)$.

$$x^2 + y^2 - 2x - 4y - 4 = 0$$
$$x^2 - 2x + y^2 - 4y = 4$$
$$x^2 - 2x + 1) + (y^2 - 4y + 4) = 4 +$$
$$1 + 4\ (x-1)^2 + (y-2)^2 = 3^2$$

Center: (1, 2); Radius = 3

b.



x-intercepts: $(x-1)^2 + (0-2)^2 = 3^2$
$$(x-1)^2 + (-2)^2 = 3^2$$
$$(x-1)^2 + 4 = 9$$
$$(x-1)^2 = 5$$
$$x-1 = \pm\sqrt{5}$$
$$x = 1 \pm \sqrt{5}$$

y-intercepts: $(0-1)^2 + (y-2)^2 = 3^2$

$(-1)^2 + (y-2)^2 = 3^2$

$1 + (y-2)^2 = 9$

$(y-2)^2 = 8$

$y - 2 = \pm\sqrt{8}$

$y - 2 = \pm 2\sqrt{2}$

$y = 2 \pm 2\sqrt{2}$

The intercepts are $\left(1-\sqrt{5}, 0\right)$, $\left(1+\sqrt{5}, 0\right)$,

$\left(0, 2-2\sqrt{2}\right)$, and $\left(0, 2+2\sqrt{2}\right)$.

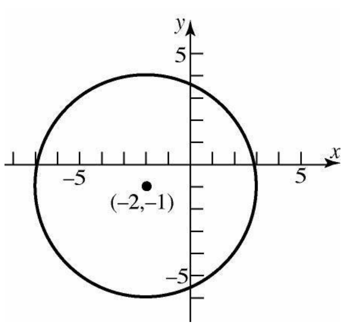
28. $x^2 + y^2 + 4x + 2y - 20 = 0$

$x^2 + 4x + y^2 + 2y = 20$

$(x^2 + 4x + 4) + (y^2 + 2y + 1) = 20 + 4 + 1$

$(x+2)^2 + (y+1)^2 = 5^2$

Center: (–2,–1); Radius = 5



b.

x-intercepts: $(x+2)^2 + (0+1)^2 = 5^2$

$(x+2)^2 + 1 = 25$

$(x+2)^2 = 24$

$x + 2 = \pm\sqrt{24}$

$x + 2 = \pm 2\sqrt{6}$

$x = -2 \pm 2\sqrt{6}$

y-intercepts: $(0+2)^2 + (y+1)^2 = 5^2$

$4 + (y+1)^2 = 25$

$(y+1)^2 = 21$

$y + 1 = \pm\sqrt{21}$

$y = -1 \pm \sqrt{21}$

The intercepts are $\left(-2-2\sqrt{6}, 0\right)$,

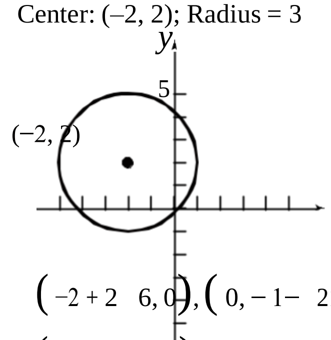
$x^2 + y^2 + 4x - 4y - 1 = 0$

$x^2 + 4x + y^2 - 4y = 1$

$(x^2 + 4x + 4) + (y^2 - 4y + 4) = 1 + 4 + 4$

$(x+2)^2 + (y-2)^2 = 3^2$

Center: (–2, 2); Radius = 3



$\left(-2+2\sqrt{6}, 0\right)$, $\left(0, -1-\sqrt{21}\right)$, and $\left(0, -1+\sqrt{21}\right)$.

-5 5 x

$-$
5

x-intercepts: $(x+2)^2 + (0-2)^2 =$
3^2 $(x+2)^2 + 4$
$= 9$ $(x+2)^2 = 5$
$x + 2 = \pm\sqrt{5}$
$x = -2 \pm \sqrt{5}$

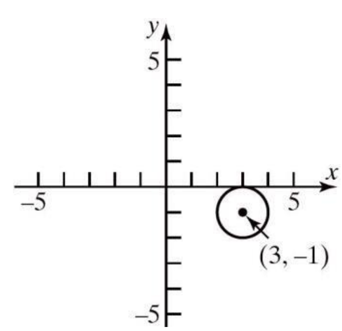
y-intercepts: $(0+2)^2 + (y-2)^2 = 3^2$
$4 + (y-2)^2$
$= 9$ $(y -$
$2)^2 = 5$
$y - 2 = \pm\sqrt{5}$
$y = 2 \pm \sqrt{5}$

The intercepts are $\left(-2-\sqrt{5},\right.$
$\left.0\right)$,
$\left(-2+\sqrt{5}, 0\right)$, $\left(0, 2-\sqrt{5}\right)$, and $\left(0, 2+\sqrt{5}\right)$.

30. $x^2 + y^2 - 6x + 2y + 9 = 0$
$x^2 - 6x + y^2 + 2y = -9$
$x^2 - 6x + 9) + (y^2 + 2y + 1) = -9 +$
9
$+ 1$ $(x-3)^2 + (y+1)^2 =$
1^2

Center: (3, –1); Radius = 1

b.



x-intercepts: $(x-3)^2 + (0+1)^2 = 1^2$

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

$(x-3)^2 = 0$

$x - 3 = 0$

$x = 3$

y-intercepts: $(0-3)^2 + (y+1)^2 = 1^2$

$9 + (y+1)^2 = 1$

$(y+1)^2 = -8$

No real solution.

The intercept only intercept is $(3,0)$.

$x^2 + y^2 - x + 2y + 1 = 0$

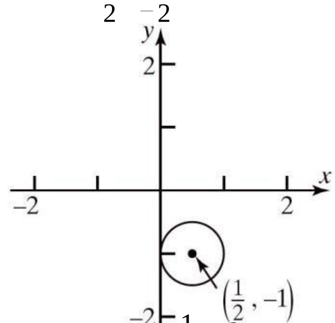
$^2 - x + y^2 + 2y = -1$

$\left(x^2 - x + \frac{1}{4}\right) + (y^2 + 2y + 1) = -1 + \frac{1}{4} + 1$

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

Center: $\left(\frac{1}{2}, -1\right)$; Radius $= \frac{1}{2}$

b.



x-intercepts: $\left(x - \frac{1}{2}\right)^2 + (0+1)^2 = \left(\frac{1}{2}\right)^2$

$\left(x - \frac{1}{2}\right)^2 + 1 = \frac{1}{4}$

$\left(x - \frac{1}{2}\right)^2 = -\frac{3}{4}$

No real solutions

y-intercepts: $\left(0 - \frac{1}{2}\right)^2 + (y+1)^2 = \left(\frac{1}{2}\right)^2$

$\frac{1}{4} + (y+1)^2 = \frac{1}{4}$

$(y+1)^2 = 0$

$y + 1 = 0$

$0, -1$.

$(\quad) \; y = -1$

$$x^2+y^2+x+y-\frac{1}{2}=0$$

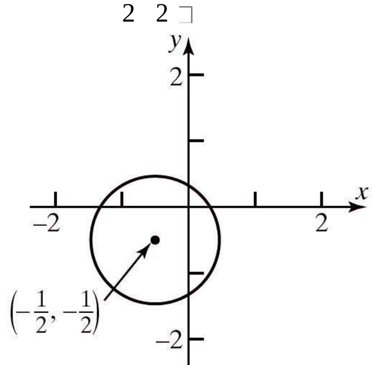
$$x^2+x+y^2+y=\frac{1}{2}$$

$$\left(x^2+x+\frac{1}{4}\right)+\left(y^2+y+\frac{1}{4}\right)=\frac{1}{2}+\frac{1}{4}+\frac{1}{4}$$

$$\left(x+\frac{1}{2}\right)^2+\left(y+\frac{1}{2}\right)^2=1$$

Center: $\left(-\frac{1}{2},-\frac{1}{2}\right)$; Radius $=1$

b.



c. x-intercepts: $\left(x+\frac{1}{2}\right)^2+\left(0+\frac{1}{2}\right)^2=1$

$$\left(x+\frac{1}{2}\right)^2+\frac{1}{4}=1$$

$$\left(x+\frac{1}{2}\right)^2=\frac{3}{4}$$

$$x+\frac{1}{2}=\pm\frac{\sqrt{3}}{2}$$

$$x=\frac{-1\pm\sqrt{3}}{2}$$

y-intercepts: $\left(0+\frac{1}{2}\right)^2+\left(y+\frac{1}{2}\right)^2=1$

$$\frac{1}{4}+\left(y+\frac{1}{2}\right)^2=1$$

$$\left(y+\frac{1}{2}\right)^2=\frac{3}{4}$$

$$y+\frac{1}{2}=\pm\frac{\sqrt{3}}{2}$$

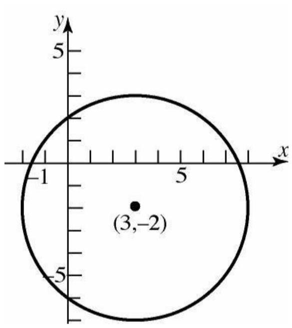
$$y=\frac{-1\pm\sqrt{3}}{2}$$

The intercepts are $\left(\frac{-1-\sqrt{3}}{2},0\right)$, $\left(\frac{-1+\sqrt{3}}{2},0\right)$, $\left(0,\frac{-1-\sqrt{3}}{2}\right)$, and $\left(0,\frac{-1+\sqrt{3}}{2}\right)$.

$$2x^2+2y^2-12x+8y-24=0$$
$$x^2+y^2-6x+4y=12$$
$$x^2-6x+y^2+4y=12$$
$$(x^2-6x+9)+(y^2+4y+4)=12+9+4$$
$$(x-3)^2+(y+2)^2=5^2$$

Center: (3,–2); Radius = 5

b.



x-intercepts: $(x-3)^2+(0+2)^2=5^2$
$$(x-3)^2+4=25$$
$$(x-3)^2=21$$
$$x-3=\pm\sqrt{21}$$
$$x=3\pm\sqrt{21}$$

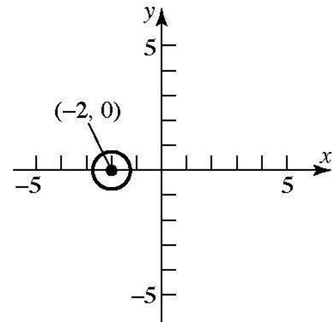
y-intercepts: $(0-3)^2+(y+2)^2=5^2$
$$9+(y+2)^2=25$$
$$(y+2)^2=16$$
$$y+2=\pm 4$$
$$y=-2\pm 4$$
$$y=2 \quad \text{or} \quad y=-6$$

The intercepts are $\left(3-\sqrt{21},0\right)$, $\left(3+\sqrt{21},0\right)$, $\left(0,-6\right)$, and $\left(0,2\right)$.

34. a. $2x^2+2y^2+8x+7=0$
$$2x^2+8x+2y^2=-7$$
$$x^2+4x+y^2=-\frac{7}{2}$$
$$(x^2+4x+4)+y^2=-\frac{7}{2}+4$$
$$(x+2)^2+y^2=\frac{1}{2}$$
$$(x+2)^2+y^2=\left(\frac{\sqrt{2}}{2}\right)^2$$

Center: (–2, 0); Radius = $\frac{\sqrt{2}}{2}$

b.



x-intercepts: $(x+2)^2+(0)^2=\frac{1}{2}$
$$(x+2)^2=\frac{1}{2}$$
$$x+2=\pm\sqrt{\frac{1}{2}}$$
$$x+2=\pm\frac{\sqrt{2}}{2}$$
$$x=-2\pm\frac{\sqrt{2}}{2}$$

y-intercepts: $(0+2)^2+y^2=\frac{1}{2}$
$$4+y^2=\frac{1}{2}$$
$$y^2=-\frac{7}{2}$$

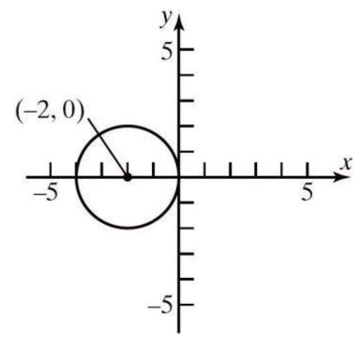
No real solutions.

The intercepts are $\left(-2-\frac{\sqrt{2}}{2},0\right)$ and $\left(-2+\frac{\sqrt{2}}{2},0\right)$.

35. $2x^2+8x+2y^2=0$
$$x^2+4x+y^2=0$$
$$x^2+4x+4+y^2=0+4$$
$$(x+2)^2+y^2=2^2$$

Center: $\left(-2, 0\right)$; Radius: $r = 2$

b.



x-intercepts: $(x+2)^2+(0)^2=2^2$

$(x+2)^2=4$

$(x+2)=\pm\sqrt{4}$

$x+2=\pm 2$

$x=-2\pm 2$

$x=0$ or $x=-4$

y-intercepts: $(0+2)^2+y^2=2^2$

$4+y^2=4$

$y^2=0$

$y=0$

The intercepts are $(-4,0)$ and $(0,0)$.

$3x^2+3y^2-12y=0$

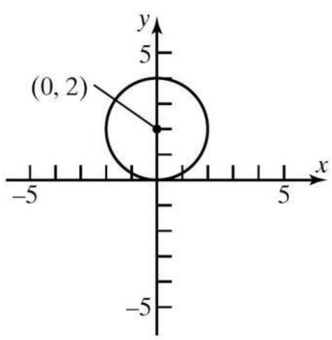
${}^2+y^2-4y=0$

${}^2+y^2-4y+4=0+4$

${}^2+(y-2)^2=4$

Center: $(0,2)$; Radius: $r=2$

b.



x-intercepts: $x^2+(0-2)^2=4$

${}^2+4=4$

$x^2=0$

$x=0$

y-intercepts: $0^2+(y-2)^2=4$

$(y-2)^2=4$

$y-2=\pm\sqrt{4}$

$y-2=\pm 2$

$y=2\pm 2$

$y=4$ or $y=0$

The intercepts are $(0,0)$ and $(0,4)$.

Center at (0, 0); containing point (–2, 3).

$r=\sqrt{(-2-0)^2+(3-0)^2}=\sqrt{4+9}=\sqrt{13}$

Equation: $(x-0)^2+(y-0)^2=(\sqrt{13})^2$

$x^2+y^2=13$

Center at (1, 0); containing point (–3, 2).

$r=\sqrt{(-3-1)^2+(2-0)^2}=\sqrt{16+4}=\sqrt{20}=2\sqrt{5}$

Equation: $(x-1)^2+(y-0)^2=(\sqrt{20})^2$

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

Center at (2, 3); tangent to the x-axis.

$r=3$

Equation: $(x-2)^2+(y-3)^2=3^2$

$(x-2)^2+(y-3)^2=9$

Center at (–3, 1); tangent to the y-axis.

$r=3$

Equation: $(x+3)^2+(y-1)^2=3^2$

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

Endpoints of a diameter are (1, 4) and (–3, 2). The center is at the midpoint of that diameter:

Center: $\left(\frac{1+(-3)}{2},\frac{4+2}{2}\right)=(-1,3)$

Radius: $r=\sqrt{(1-(-1))^2+(4-3)^2}=\sqrt{4+1}=\sqrt{5}$

Equation: $(x-(-1))^2+(y-3)^2=(\sqrt{5})^2$

$(x+1)^2+(y-3)^2=5$

Endpoints of a diameter are (4, 3) and (0, 1). The center is at the midpoint of that diameter:

Center: $\left(\frac{4+0}{2},\frac{3+1}{2}\right)=(2,2)$

Radius: $r=\sqrt{(4-2)^2+(3-2)^2}=\sqrt{4+1}=\sqrt{5}$

Equation: $(x-2)^2+(y-2)^2=(\sqrt{5})^2$

$(x-2)^2+(y-2)^2=5$

Center at (–1, 3); tangent to the line $y = 2$. This means that the circle contains the point (–1, 2), so the radius is $r = 1$.

Equation: $(x+1)^2 + (y-3)^2 = (1)^2$

$$x+1)^2 + (y-3)^2 = 1$$

Center at (4, –2); tangent to the line $x = 1$. This means that the circle contains the point (1, –2), so the radius is $r = 3$.

Equation: $(x-4)^2 + (y+2)^2 = (3)^2$

$$x-4)^2 + (y+2)^2 = 9$$

(c); Center: $(1, -2)$; Radius = 2

(d) ; Center: $(-3, 3)$; Radius = 3

(b) ; Center: $(-1, 2)$; Radius = 2

(a) ; Center: $(-3, 3)$; Radius = 3

Let the upper-right corner of the square be the point (x, y) . The circle and the square are both

centered about the origin. Because of symmetry, we have that $x = y$ at the upper-right corner of the square. Therefore, we get

$$^2 + y^2 = 9$$

$$^2 + x^2 = 9$$

$$2x^2 = 9$$

$$x^2 = \frac{9}{2}$$

$$x = \sqrt{\frac{9}{2}} = \frac{3\sqrt{2}}{2}$$

The length of one side of the square is $2x$. Thus, the area is

$$A = s^2 = \left(2 \cdot \frac{3\sqrt{2}}{2}\right)^2 = \left(3\sqrt{2}\right)^2 = 18 \text{ square units.}$$

50. The area of the shaded region is the area of the circle, less the area of the square. Let the upper-right corner of the square be the point (x, y) . The circle and the square are both centered about the origin. Because of symmetry, we have that $x = y$ at the upper-right corner of the square. Therefore, we get

$$x^2 + y^2 = 36$$

$$x^2 + x^2 = 36$$

$$x^2 = 36$$

$$x^2 = 18$$

$$x = 3\sqrt{2}$$

The length of one side of the square is $2x$. Thus, the area of the square is $\left(2 \cdot 3\sqrt{2}\right)^2 = 72$ square units. From the equation of the circle, we have $r = 6$. The area of the circle is

$r^2 = \pi\left(6\right)^2 = 36\pi$ square units.

Therefore, the area of the shaded region is $A = 36\pi - 72$ square units.

The diameter of the Ferris wheel was 250 feet, so the radius was 125 feet. The maximum height was 264 feet, so the center was at a height of $264 - 125 = 139$ feet above the ground. Since the center of the wheel is on the y-axis, it is the point (0, 139). Thus, an equation for the wheel is:

$$x-0)^2 + \left(y-139\right)^2 = 125^2$$

$$^2 + \left(y-139\right)^2 = 15,625$$

The diameter of the wheel is 520 feet, so the radius is 260 feet. The maximum height is 550 feet, so the center of the wheel is at a height of $550 - 260 = 290$ feet above the ground. Since the center of the wheel is on the y-axis, it is the point (0, 290). Thus, an equation for the wheel is:

$$x-0)^2 + \left(y-290\right)^2 = 260^2$$

$$^2 + \left(y-290\right)^2 = 67,600$$

$$x^2 + y^2 + 2x + 4y - 4091 = 0$$

$$^2 + 2x + y^2 + 4y - 4091 = 0$$

$$^2 + 2x + 1 + y^2 + 4y + 4 = 4091 + 5$$

$$x+1)^2 + \left(y+2\right)^2 = 4096$$

The circle representing Earth has center $(-1, -2)$ and radius = $\sqrt{4096} = 64$.

So the radius of the satellite's orbit is $64 + 0.6 = 64.6$ units.

The equation of the orbit is

$$x+1)^2 + \left(y+2\right)^2 = \left(64.6\right)^2$$

$$^2 + y^2 + 2x + 4y - 4168.16 = 0$$

54. a.

$$x^2 + (mx + b)^2 = r^2$$
$$x^2 + m^2x^2 + 2bmx + b^2 = r^2$$
$$(1 + m^2)x^2 + 2bmx + b^2 - r^2 = 0$$

There is one solution if and only if the discriminant is zero.

$$(2bm)^2 - 4(1 + m^2)(b^2 - r^2) = 0$$
$$4b^2m^2 - 4b^2 + 4r^2 - 4b^2m^2 + 4m^2r^2 = 0$$
$$-4b^2 + 4r^2 + 4m^2r^2 = 0$$
$$-b^2 + r^2 + m^2r^2 = 0$$
$$r^2(1 + m^2) = b^2$$

Using the quadratic formula, the result from part (a), and knowing that the discriminant is zero, we get:

$$(1 + m^2)x^2 + 2bmx + b^2 - r^2 = 0$$

$$x = \frac{-2bm}{2(1+m^2)} = \frac{-bm}{\left(\frac{b^2}{r^2}\right)} = \frac{-bmr^2}{b^2} = \frac{-mr^2}{b}$$

$$y = m\left(\frac{-mr^2}{b}\right) + b$$

$$= \frac{-m^2r^2}{b} + b = \frac{-m^2r^2 + b^2}{b} = \frac{r^2}{b}$$

The slope of the tangent line is m.

The slope of the line joining the point of tangency and the center is:

$$\frac{\left(\frac{r^2}{b} - 0\right)}{\left(\frac{-mr^2}{b} - 0\right)} = \frac{r^2}{b} \cdot \frac{b}{-mr^2} = -\frac{1}{m}$$

Therefore, the tangent line is perpendicular to the line containing the center of the circle and the point of tangency.

$x^2 + y^2 = 9$

Center: (0, 0)

Slope from center to $\left(1, 2\sqrt{2}\right)$ is

$$\frac{2\sqrt{2} - 0}{1 - 0} = \frac{2\sqrt{2}}{1} = 2\sqrt{2}.$$

Equation of the tangent line is:

$$y - 2\sqrt{2} = -\frac{\sqrt{2}}{4}(x - 1)$$
$$y - 2\sqrt{2} = -\frac{\sqrt{2}}{4}x + \frac{\sqrt{2}}{4}$$
$$4y - 8\sqrt{2} = -\sqrt{2}x + \sqrt{2}$$
$$\sqrt{2}x + 4y = 9\sqrt{2}$$
$$\sqrt{2}x + 4y - 9\sqrt{2} = 0$$

$$x^2 + y^2 - 4x + 6y + 4 = 0$$
$$(x^2 - 4x + 4) + (y^2 + 6y + 9) = -4 + 4 + 9$$
$$(x - 2)^2 + (y + 3)^2 = 9$$

Center: (2, –3)

Slope from center to $\left(3, 2\sqrt{2} - 3\right)$ is

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

Slope of the tangent line is: $\frac{-1}{2\sqrt{2}} = -\frac{\sqrt{2}}{4}$

Equation of the tangent line:

$$y - \left(2\sqrt{2} - 3\right) = -\frac{\sqrt{2}}{4}(x - 3)$$
$$y - 2\sqrt{2} + 3 = -\frac{\sqrt{2}}{4}x + \frac{3\sqrt{2}}{4}$$
$$4y - 8\sqrt{2} + 12 = -\sqrt{2}x + 3\sqrt{2}$$
$$\sqrt{2}x + 4y - 11\sqrt{2} + 12 = 0$$

Let (h, k) be the center of the circle.

$$x - 2y + 4 = 0$$
$$2y = x + 4$$
$$y = \frac{1}{2}x + 2$$

The slope of the tangent line is $\frac{1}{2}$. The slope from (h, k) to (0, 2) is –2.

$$\frac{2 - k}{0 - h} = -2$$
$$2 - k = 2h$$

Slope of the tangent line is $\frac{-1}{2\sqrt{2}} = -\frac{\sqrt{2}}{4}$.

The other tangent line is $y = 2x - 7$, and it has slope 2.

The slope from (h, k) to $(3, -1)$ is $-\frac{1}{2}$.

$\frac{-1-k}{3-h} = -\frac{1}{2}$

$2 + 2k = 3 - h$

$2k = 1 - h$

$= 1 - 2k$

Solve the two equations in h and k:

$2 - k = 2(1 - 2k)$

$2 - k = 2 - 4k$

$3k = 0$

$= 0$

$= 1 - 2(0) = 1$

The center of the circle is (1, 0).

Find the centers of the two circles:

${}^2 + y^2 - 4x + 6y + 4 = 0$

$(x^2 - 4x + 4) + (y^2 + 6y + 9) = -4 + 4 + 9$

$x - 2)^2 + (y + 3)^2 = 9$

Center: $(2, -3)$

${}^2 + y^2 + 6x + 4y + 9 = 0$

$(x^2 + 6x + 9) + (y^2 + 4y + 4) = -9 + 9 + 4$

$x + 3)^2 + (y + 2)^2 = 4$

Center: $(-3, -2)$

Find the slope of the line containing the centers:

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

Find the equation of the line containing the centers:

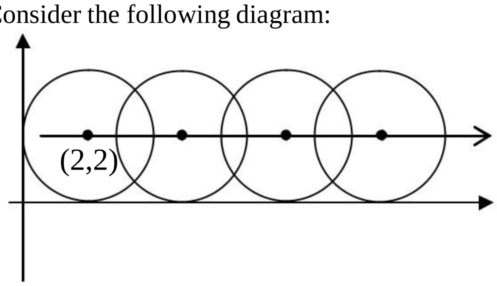
$y + 3 = -\frac{1}{5}(x - 2)$

$y + 15 = -x + 2$

$+ 5y = -13$

$+ 5y + 13 = 0$

Consider the following diagram:



$C = 2\pi r$

$6\pi = 2\pi r$

$\frac{6\pi}{2\pi} = \frac{2\pi r}{2\pi}$

$3 = r$

The radius is 3 units long.

(b), (c), (e) and (g)

We need $h, k > 0$ and $(0, 0)$ on the graph.

(b), (e) and (g)

We need $h < 0$, $k = 0$, and $|h| > |r|$.

Answers will vary.

The student has the correct radius, but the signs of the coordinates of the center are incorrect. The student needs to write the equation in the standard form $(x - h)^2 + (y - k)^2 = r^2$.

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

$x - (-3))^2 + (y - 2)^2 = 4^2$

Thus, $(h, k) = (-3, 2)$ and $r = 4$.

$A = \pi r^2$

$\pi (13)^2$

169π cm^2

$C = 2\pi r$

$2\pi (13)$

26π cm

$(3x - 2)(x^2 - 2x + 3) = 3x^3 - 6x^2 + 9x - 2x^2 + 4x - 6$

$3x^3 - 8x^2 + 13x - 6$

$2\sqrt{x^2 + 3x - 1} = x + 1$

Therefore, the path of the center of the circle has the equation $y = 2$.

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$$2x^2 + 3x - 1 = \left(x + 1\right)^2$$
$$2x^2 + 3x - 1 = x^2 + 2x + 1$$
$$x^2 + x - 2 = 0$$
$$x + 2)(x - 1) = 0$$
$$= -2 \text{ or } x = 1$$

We need to check each possible solution:

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Check $x = -2$

$\sqrt{2(-2)^2 + 3(-2) - 1} = (-2) + 1$

$\sqrt{2(4) - 6 - 1} = -1$

no

Check $x = 1$

$\sqrt{2(1)^2 + 3(1) - 1} = (1) + 1$

$\sqrt{2 + 3 - 1} = 2$

$\sqrt{4} = 2$

yes

The solution is $\{1\}$

68. Let t represent the time it takes to do the job together.

	Time to do job	Part of job done in one minute
Aaron	22	$\frac{1}{22}$
Elizabeth	28	$\frac{1}{28}$
Together	t	$\frac{1}{t}$

$\frac{1}{22} + \frac{1}{28} = \frac{1}{t}$

$14t + 11t = 308$

$25t = 308$

$= 12.32$

Working together, the job can be done in 12.32 minutes.

Section 2.4

$y = kx$

False. If y varies directly with x, then $y = kx$, where k is a constant.

b

c

$y = kx$

$2 = 10k$

$k = \frac{2}{10} = \_$

$\frac{1}{5}\ y = \frac{1}{5}x$

$v = kt$

$16 = 2k$

$8 = k$

$v = 8t$

$A = kx^2$

$4\pi = k(2)^2$

$4\pi = 4k$

$= k$

$A = \pi x^2$

$V = kx^3$

$36\pi = k(3)^3$

$36\pi = 27k$

$k = \frac{36\pi}{27} = \frac{4}{3}\pi$

$F = \frac{k}{d^2}$

$10 = \frac{k}{5^2}$

$10 = \frac{k}{25}$

$= 250$

$F = \frac{250}{d^2}$

$y = \frac{k}{\sqrt{x}}$

$4 = \frac{k}{\sqrt{9}}$

$4 = \frac{k}{3}$

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$k = 12y$

$= \frac{12}{\sqrt{x}}$

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$$z = k\left(x^2 + y^2\right)$$
$$5 = k\left(3^2 + 4^2\right)$$
$$5 = k(25)$$
$$k = \frac{5}{25} = \frac{1}{5}$$
$$z = \frac{1}{5}\left(x^2 + y^2\right)$$

$$T = k\left(\sqrt[3]{x}\right)\left(d^2\right)$$
$$18 = k\left(\sqrt[3]{8}\right)\left(3^2\right)$$
$$18 = k(18)$$
$$1 = k$$
$$T = \left(\sqrt[3]{x}\right)\left(d^2\right)$$

13. $M = \dfrac{kd^2}{\sqrt{x}}$
$$24 = \frac{k\left(4^2\right)}{\sqrt{9}}$$
$$24 = \frac{16k}{3}$$
$$k = \frac{24 \cdot 3}{16} = \frac{9}{2}$$
$$M = \frac{9d^2}{2\sqrt{x}}$$

$$z = k\left(x^3 + y^2\right)$$
$$1 = k\left(2^3 + 3^2\right)$$
$$1 = k(17)$$
$$k = \frac{1}{17}$$
$$z = \frac{1}{17}\left(x^3 + y^2\right)$$

15. $T^2 = \dfrac{ka^3}{d^2}$
$$2^2 = \frac{k\left(2^3\right)}{4^2}$$
$$4 = \frac{k(8)}{16}$$
$$4 = \frac{k}{2}$$
$$k = 8$$
$$T^2 = \frac{8a^3}{d^2}$$

$$z^3 = k\left(x^2 + y^2\right)$$
$$2^3 = k\left(9^2 + 4^2\right)$$
$$8 = k(97)$$
$$k = \frac{8}{97}$$
$$z^3 = \frac{8}{97}\left(x^2 + y^2\right)$$

17. $V = \dfrac{4\pi}{3} r^3$

18. $c^2 = a^2 + b^2$

19. $A = \dfrac{1}{2} bh$

20. $p = 2(l + w)$

21. $F = \left(6.67 \times 10^{-11}\right)\left(\dfrac{mM}{d^2}\right)$

22. $T = \dfrac{2\pi}{\sqrt{32}}\sqrt{l}$

23.
$$p = kB$$
$$6.49 = k(1000)$$
$$0.00649 = k$$

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Therefore we have the linear equation

$= 0.00649B$.

If $B = 145000$, then

$= 0.00649(145000) = \$941.05$.

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$p = kB$

$8.99 = k(1000)$

$0.00899 = k$

Therefore we have the linear equation $= 0.00899B$.

If $B = 175000$, then $= 0.00899(175000) = \$1573.25$.

$s = kt^2$

$= k(1)^2$

$= 16$

Therefore, we have equation $s = 16t^2$.

If $t = 3$ seconds, then $s = 16(3)^2 = 144$ feet.

If $s = 64$ feet, then

$64 = 16t^2$

$t^2 = 4$

$t = \pm 2$

Time must be positive, so we disregard $t = -2$.

It takes 2 seconds to fall 64 feet.

$v = kt$

$64 = k(2)$

$= 32$

Therefore, we have the linear equation $v = 32t$.

If $t = 3$ seconds, then $v = 32(3) = 96$ ft/sec.

$E = kW$

$= k(20)$

$k = \frac{3}{20}$

Therefore, we have the linear equation $E = \frac{3}{20}W$.

If $W = 15$, then $E = \frac{3}{20}(15) = 2.25$.

$R = \frac{k}{l}$

$256 = \frac{k}{48}$

$= 12,288$

If $R = 576$, then

$= \frac{12,288}{l}$

$576l = 12,288$

$l = \frac{12,288}{576} = \frac{64}{3}$ inches

$R = kg$

$47.40 = k(12)$

$3.95 = k$

Therefore, we have the linear equation $R = 3.95g$.

If $g = 10.5$, then $R = (3.95)(10.5) \approx \$41.48$.

$C = kA$

$23.75 = k(5)$

$4.75 = k$

Therefore, we have the linear equation $C = 4.75A$.

If $A = 3.5$, then $C = (4.75)(3.5) = \$16.63$.

$D = \frac{k}{p}$

a. $D = 156$, $p = 2.75$;

$156 = \frac{k}{2.75}$

$= 429$ So,

$D = \frac{429}{p}$.

$D = \frac{429}{3} = 143$ bags of candy

$t = \frac{k}{s}$

$t = 40$, $s = 30$;

$40 = \frac{k}{30}$

$k = 1200$

So, we have the equation $t = \frac{12,288}{}$

$t = \frac{1200}{40} = 30$ minutes

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Therefore, we have the equation $R = \dfrac{1200}{S}$.

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33. $V = \frac{k}{P}$

$V = 600, P = 150$;

$600 = \frac{k}{150}$

$k = 90,000$

So, we have the equation $V = \frac{90,000}{P}$

If $P = 200$, then $V = \frac{90,000}{200} = 450\text{ cm}^3$.

$i = \frac{k}{R}$

If $i = 30, R = 8$, then $30 = \frac{k}{8}$ and $k = 240$.

If $R = 10$, then $i = \frac{240}{10} = 24$ amperes .

$W = \frac{k}{d^2}$

If $W = 125$, $d = 3960$ then

$125 = \frac{k}{3960^2}$ and $k = 1,960,200,000$

So, we have the equation $W = \frac{1,960,200,000}{\quad}$.

At the top of Mt. McKinley, we have

$= 3960 + 3.8 = 3963.8$, so

$W = \frac{1,960,200,000}{(3963.8)^2} \approx 124.76$ pounds.

k

$55 = \frac{k}{3960^2}$

$= 862,488,000$

862,488,000

38. $V = \frac{\pi}{3} r^2 h$

39. $I = \frac{k}{d^2}$

If $I = 0.075$, $d = 2$, then

$\frac{k}{\quad}$

So, we have the equation $I = \frac{0.3}{d^2}$.

If $d = 5$, then $I = \frac{0.3}{5^2} = 0.012$ foot-candles.

$F = kAv^2$

$= k(20)(22)^2$

$= 9860k$

$k = \frac{11}{9680} = \frac{1}{880}$

So, we have the equation $F = \frac{1}{880} Av^2$.

$= \frac{1}{880}(47.125)(36.5)^2 \approx 71.34$ pounds.

$h = ksd^3$

$= k(75)(2)^3$

$= 600k$

$0.06 = k$

So, we have the equation $h = 0.06\, sd^3$.

If $h = 45$ and $s = 125$, then

$45 = (0.06)(125)d^3$

$= 7.5d^3$

$6 = d^3$

$d = \sqrt[3]{6} \approx 1.82$ inches

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So, we have the equation $W = \frac{\quad}{d^2}$.

If $d = 3965$, then

$$W = \frac{862,488,000}{3965^2} \approx 54.86 \text{ pounds.}$$

37. $V = \pi r^2 h$

$$V = \frac{kT}{P}$$

$$100 = \frac{k(300)}{15}$$

$$= 20k$$

$$5 = k$$

So, we have the equation $V = \frac{5T}{P}$.

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If $V = 80$ and $T = 310$, then

$$80 = \frac{5(310)}{P}$$

$$80P = 1550$$

$$P = \frac{1550}{80} = 19.375 \text{ atmospheres}$$

$$K = kmv^2$$

$$1250 = k(25)(10)^2$$

$$1250 = 2500k$$

$$= 0.5$$

So, we have the equation $K = 0.5mv^2$.
If $m = 25$ and $v = 15$, then

$$K = 0.5(25)(15)^2 = 2812.5 \text{ Joules}$$

44. $R = \dfrac{kl}{d^2}$

$$1.24 = \frac{k(432)}{(4)^2}$$

$$1.24 = 27k$$

So, we have the equation $R = \dfrac{1.24l}{27d^2}$.

If $R = 1.44$ and $d = 3$, then

$$1.44 = \frac{1.24l}{27(3)^2}$$

$$1.44 = \frac{1.24l}{243}$$

$$349.92 = 1.24l$$

$$l = \frac{349.92}{1.24} \approx 282.2 \text{ feet}$$

45. $S = \dfrac{kpd}{t}$

$$100 = \frac{k(25)(5)}{0.75}$$

$$S = \frac{kwt^2}{l}$$

$$= \frac{k(4)(2)^2}{8}$$

$$= 2k$$

$$= k$$

So, we have the equation $S = \dfrac{375wt^2}{l}$.

If $l = 10$, $w = 6$, and $t = 2$, then

$$S = \frac{375(6)(2)^2}{10} = 900 \text{ pounds.}$$

47 – 50. Answers will vary.

$$3x^3 + 25x^2 - 12x - 100$$

$$(3x^3 + 25x^2) - (12x + 100)$$

$$x^2(3x + 25) - 4(3x + 25)$$

$$(x^2 - 4)(3x + 25)$$

$$(x - 2)(x + 2)(3x + 25)$$

52.

$$\frac{5}{x+3} + \frac{x-2}{x^2+7x+12} = \frac{5}{x+3} + \frac{x-2}{(x+3)(x+4)}$$

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

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

$$= \frac{5x + 20 + x - 2}{(x+3)(x+4)}$$

$$= \frac{6x + 18}{(x+3)(x+4)}$$

$$= \frac{6(x+3)}{(x+3)(x+4)} = \frac{6}{(x+4)}$$

3 1 3

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$= 125k$

$0.6 = k$

So, we have the equation $S = \dfrac{0.6\,pd}{t}$.

If $p = 40$, $d = 8$, and $t = 0.50$, then

$S = \dfrac{0.6(40)(8)}{0.50} = 384$ psi.

53. $\dfrac{4}{25}$ 2 = $\dfrac{4}{25}$ 2

–

8

5125

23

The term needed to rationalize the denominator is $\sqrt{7} + 2$.

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Chapter 2 Review Exercises

$P_1 = (0,0)$ and $P_2 = (4,2)$

a. slope $= \frac{y}{x} = \frac{2-0}{4-0} = \frac{2}{4} = \frac{1}{2}$

For each run of 2, there is a rise of 1.

$P_1 = (1,-1)$ and $P_2 = (-2,3)$

a. slope $= \frac{y}{x} = \frac{3-(-1)}{-2-1} = \frac{4}{-3} = -\frac{4}{3}$

For each run of 3, there is a rise of −4.

$P_1 = (4,-4)$ and $P_2 = (4,8)$

a. slope $= \frac{y}{x} = \frac{8-(-4)}{4-4} = \frac{12}{0}$, undefined

An undefined slope means the points lie on a vertical line. There is no change in *x*.

$P_1 = (-2,-1)$ and $P_2 = (3,-1)$

a. slope $= \frac{y}{x} = \frac{-1-(-1)}{3-(-2)} = \frac{0}{5} = 0$

A slope of 0 means the points lie on a

horizontal line. There is no change in y.

$2x = 3y^2$

x-intercepts: $2x = 3(0)^2$, $2x = 0$, $x = 0$

y-intercepts: $2(0) = 3y^2$, $0 = y^2$, $y = 0$

The only intercept is (0, 0).

<u>Test *x*-axis symmetry</u>: Let $y = -y$

$2x = 3(-y)^2$

$2x = 3y^2$ same

<u>Test *y*-axis symmetry</u>: Let $x = -x$

$2(-x) = 3y^2$

x-intercepts: $x^2 + 4(0)^2 = 16$, $x^2 = 16$, $x = \pm 4$

y-intercepts: $(0)^2 + 4y^2 = 16$, $4y^2 = 16$, $y^2 = 4$, $y = \pm 2$

The intercepts are (−4,0), (4,0), (0, −2), and (0, 2).

<u>Test *x*-axis symmetry</u>: Let $y = -y$

$x^2 + 4(-y)^2 = 16$

$x^2 + 4y^2 = 16$ same

<u>Test *y*-axis symmetry</u>: Let $x = -x$

$-x)^2 + 4y^2 = 16$

$x^2 + 4y^2 = 16$ same

<u>Test origin symmetry</u>: Let $x = -x$ and $y = -y$.

$-x)^2 + 4(-y)^2 = 16$

$x^2 + 4y^2 = 16$ same

Therefore, the graph will have *x*-axis, *y*-axis, and origin symmetry.

$y = x^4 - 3x^2 - 4$

x-intercepts:

$0 = x^4 - 3x^2 - 4$

$0 = (x^2 - 4)(x^2 + 1)$

$x^2 - 4 = 0$

$x^2 = 4$

$x = \pm 2$

y-intercepts:

$y = (0)^4 - 3(0)^2 - 4$

$= -4$

The intercepts are (−2,0), (2,0), (0, −4), and (0, 2).

<u>Test *x*-axis symmetry</u>: Let $y = -y$

$y = x^4 - 3x^2 - 4$

$y = -x^4 + 3x^2 + 4$ different

<u>Test *y*-axis symmetry</u>: Let $x = -x$

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$-2x = 3y^2$ different

Test origin symmetry: Let $x = -x$ and $y = -y$.

$2(-x) = 3(-y)^2$

$-2x = 3y^2$ different

Therefore, the graph will have x-axis symmetry.

$x^2 + 4y^2 = 16$

$= (-x)^4 - 3(-x)^2 - 4$

$y = x^4 - 3x^2 - 4$ same

Test origin symmetry: Let $x = -x$ and $y = -y$.

$y = (-x)^4 - 3(-x)^2 - 4$

$y = x^4 - 3x^2 - 4$

$y = -x^4 + 3x^2 + 4$ different

Therefore, the graph will have y-axis symmetry.

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$y = x^3 - x$

x-intercepts: y-intercepts:

$=$ $= (0)^3 - 0$

$= x(x^2 - 1)$ $= 0$

$= x(x+1)(x-1)$

$= 0, x = -1, x = 1$ $x_3 - x$

The intercepts are $(-1, 0)$, $(0, 0)$, and $(1, 0)$.

Test x-axis symmetry: Let $= -y$

$y = x^3 - x$

$y = -x^3 + x$
different

$x = -x$

Test y-axis symmetry: Let

$= (-x)^3 - (-x)$

$y = -x^3 + x$ different

$x = -x$ and $y = -y$.

Test origin symmetry: Let

$y = (-x)^3 - (-x)$

$y = -x^3 + x$

$y = x^3 - x$ same

Therefore, the graph will have origin symmetry.

9. $x^2 + x + y^2 + 2y = 0$

x-intercepts: $x^2 + x + (0)^2 + 2(0) = 0$

$x^2 + x = 0$

$x(x+1) = 0$

$x = 0, x = -1$

y-intercepts: $(0)^2 + 0 + y^2 + 2y = 0$

$y^2 + 2y = 0$

$y(y+2) = 0$

$y = 0, y = -2$

The intercepts are $(-1, 0)$, $(0, 0)$, and $(0, -2)$.

Test x-axis symmetry: Let $y = -y$

$x^2 + x + (-y)^2 + 2(-y) = 0$

$x^2 + x + y^2 - 2y = 0$ different

Test y-axis symmetry: Let $x = -x$

$(-x)^2 + (-x) + y^2 + 2y = 0$

$x^2 - x + y^2 + 2y = 0$ different

Test origin symmetry: Let $x = -x$ and $y = -y$.

$(x-h)^2 + (y-k)^2 = r^2$

$(x-(-2))^2 + (y-3)^2 = 4^2$

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

$(x-h)^2 + (y-k)^2 = r^2$

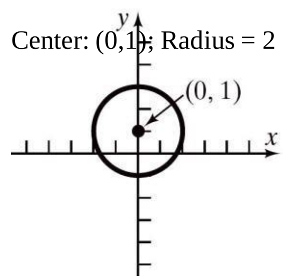
$(x-(-1))^2 + (y-(-2))^2 = 1^2$

$x + 1)^2 + (y+2)^2 = 1$

$x^2 + (y-1)^2 = 4$

$^2 + (y-1)^2 = 2^2$

Center: $(0,1)$; Radius = 2



x-intercepts: $x^2 + (0-1)^2 = 4$

$x^2 + 1 = 4$

$x^2 = 3$

$x = \pm\sqrt{3}$

y-intercepts: $0^2 + (y-1)^2 = 4$

$y - 1)^2 = 4$ y

$-1 = \pm 2$

$y = 1 \pm 2$

$y = 3$ or $y = -1$

The intercepts are $(-\sqrt{3}, 0)$, $(\sqrt{3}, 0)$, $(0, -1)$, and $(0, 3)$.

$x^2 + y^2 - 2x + 4y - 4 = 0$ $x^2 - 2x +$

$y^2 + 4y = 4$

$(x^2 - 2x + 1) + (y^2 + 4y + 4) = 4 + 1 + 4$

$x - 1)^2 + (y+2)^2 = 3^2$

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$$(-x)^2 + (-x) + (-y)^2 + 2(-y) = 0$$
$$x^2 - x + y^2 - 2y = 0 \quad \text{different}$$

The graph has none of the indicated symmetries.

Center: (1, –2) Radius = 3

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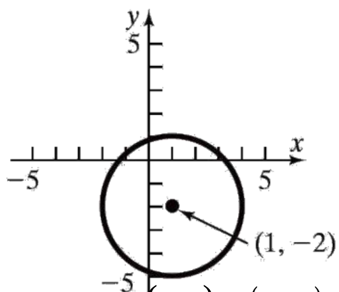


x-intercepts: $(x-1)^2+(0+2)^2=3^2$

$$(x-1)^2+4=9$$
$$(x-1)^2=5$$
$$x-1=\pm\sqrt{5}$$
$$x=1\pm\sqrt{5}$$

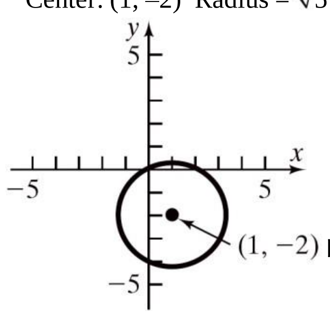
y-intercepts: $(0-1)^2+(y+2)^2=3^2$

$$1+(y+2)^2=9$$
$$(y+2)^2=8$$
$$y+2=\pm\sqrt{8}$$
$$y+2=\pm2\sqrt{2}$$
$$y=-2\pm2\sqrt{2}$$

The intercepts are $(1-\sqrt{5},0)$, $(1+\sqrt{5},0)$, $(0,-2-2\sqrt{2})$, and $(0,-2+2\sqrt{2})$.

$$3x^2+3y^2-6x+12y=0$$
$$x^2+y^2-2x+4y=0$$
$$x^2-2x+y^2+4y=0$$
$$(x^2-2x+1)+(y^2+4y+4)=1+4$$
$$(x-1)^2+(y+2)^2=(\sqrt{5})^2$$

Center: (1, –2) Radius = $\sqrt{5}$



x-intercepts: $(x-1)^2+(0+2)^2=(\sqrt{5})^2$

$$(x-1)^2+4=5$$
$$(x-1)^2=1$$
$$x-1=\pm1$$
$$x=1\pm1$$
$$x=2 \quad\text{or}\quad x=0$$

y-intercepts: $(0-1)^2+(y+2)^2=(\sqrt{5})^2$

$$1+(y+2)^2=5$$
$$(y+2)^2=4$$
$$y+2=\pm2$$
$$y=-2\pm2$$
$$y=0 \quad\text{or}\quad y=-4$$

The intercepts are $(0,0)$, $(2,0)$, and $(0,-4)$.

Slope = –2; containing (3,–1)

$$y-y_1=m(x-x_1)$$
$$-(-1)=-2(x-3)$$
$$+1=-2x+6$$
$$y=-2x+5 \quad\text{or}\quad 2x+y=5$$

16. Slope = 0; containing the point (–5, 4)

$$y-y_1=m(x-x_1)$$
$$y-4=0(x-(-5))$$
$$y-4=0$$
$$y=4$$

17. vertical; containing (–3,4)

Vertical lines have equations of the form *x* = *a*, where *a* is the *x*-intercept. Now, a vertical line containing the point (–3, 4) must have an *x*-intercept of –3, so the equation of the line is *x* = −3. The equation does not have a slope-intercept form.

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18. x-intercept = 2; containing the point (4, –5) Points are (2, 0) and (4, –5).

$$m = \frac{-5-0}{4-2} = -\frac{5}{2}$$

$$y - y_1 = m(x - x_1)$$

$$y - 0 = -\frac{5}{2}(x - 2)$$

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

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y-intercept = –2; containing (5,–3)

Points are (5,–3) and (0,–2)

$$m = \frac{-2-(-3)}{0-5} = \frac{1}{-5} = -\frac{1}{5}$$

$$y = mx + b$$

$$y = -\frac{1}{5}x - 2 \quad \text{or} \quad x + 5y = -10$$

Containing the points (3,–4) and (2, 1)

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

$$y - y_1 = m(x - x_1)$$

$$-(-4) = -5(x-3)$$

$$y + 4 = -5x + 15$$

$$y = -5x + 11 \quad \text{or} \quad 5x + y = 11$$

Parallel to $2x - 3y = -4$

$$2x - 3y = -4$$

$$-3y = -2x - 4$$

$$\frac{-3y}{-3} = \frac{-2x}{-3} - \frac{4}{-3}$$

$$y = \frac{2}{3}x + \frac{4}{3}$$

Slope = $\frac{2}{3}$; containing (–5,3)

$$y - y_1 = m(x - x_1)$$

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

$$y - 3 = \frac{2}{3}(x + 5)$$

$$y - 3 = \frac{2}{3}x + \frac{10}{3}$$

$$y = \frac{2}{3}x + \frac{19}{3} \quad \text{or} \quad 2x - 3y = -19$$

Perpendicular to $3x - y = -4$

$$3x - y = -4$$

$$y - y_1 = m(x - x_1)$$

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

$$y - 4 = -\frac{1}{3}x - \frac{2}{3}$$

$$y = -\frac{1}{3}x + \frac{10}{3} \quad \text{or} \quad x + 3y = 10$$

23. $4x - 5y = -20$

$$-5y = -4x - 20$$

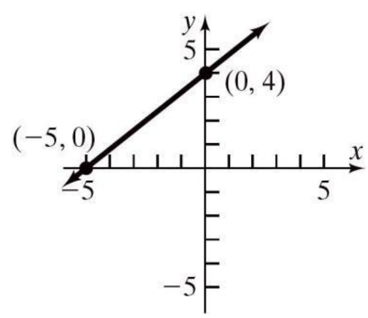
$$y = \frac{4}{5}x + 4$$

slope = $\frac{4}{5}$; y-intercept = 4

$$x - 5(0) = -20$$

$$4x = -20$$

$$= -5$$



$$\frac{1}{2}x - \frac{1}{3}y = -\frac{1}{6}$$

$$-\frac{1}{3}y = -\frac{1}{2}x - \frac{1}{6}$$

$$y = \frac{3}{2}x + \frac{1}{2}$$

slope = $\frac{3}{2}$; y-intercept = $\frac{1}{2}$

x-intercept: Let $y = 0$.

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$y = 3x + 4$

The slope of this line is 3, so the slope of a line perpendicular to it is $-\frac{1}{3}$.

Slope $= -\frac{1}{3}$; containing (–2, 4)

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

$\frac{1}{2}x = -\frac{1}{6}$

$x = -\frac{1}{3}$

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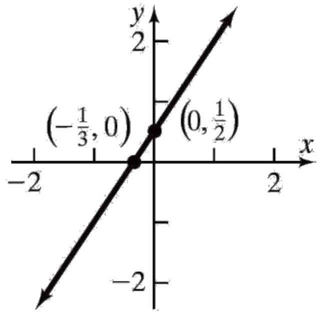
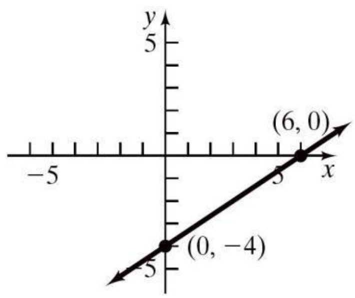


$2x - 3y = 12$

x-intercept:	*y*-intercept:
$2x - 3(0) = 12$	$2(0) - 3y = 12$
$2x = 12$	$-3y = 12$
$x = 6$	$y = -4$

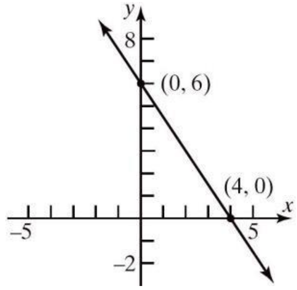
The intercepts are $(6, 0)$ and $(0, -4)$.



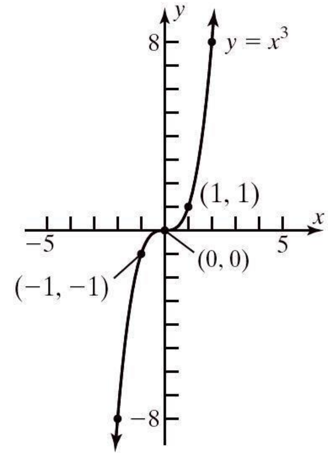
$\frac{1}{2}x + \frac{1}{3}y = 2$

x-intercept:	*y*-intercept:
$\frac{1}{2}x + \frac{1}{3}(0) = 2$	$\frac{1}{2}(0) + \frac{1}{3}y = 2$
$\frac{1}{2}x = 2$	$\frac{1}{3}y = 2$
$x = 4$	$y = 6$

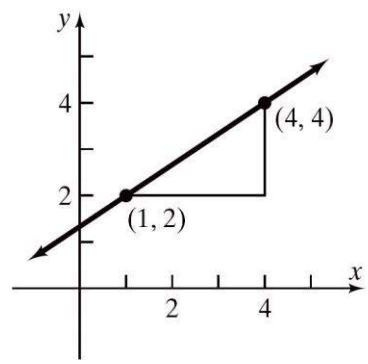
The intercepts are $(4, 0)$ and $(0, 6)$.



$y = x^3$



slope $= \frac{2}{3}$, containing the point (1,2)



Given the points $A = (-2, 0)$, $B = (-4, 4)$,

and $C = (8, 5)$.

Find the distance between each pair of points.

$d(A, B) = \sqrt{(-4-(-2))^2 + (4-0)^2}$
$\sqrt{4 + 16}$
$\sqrt{20} = 2\sqrt{5}$

$d(B, C) = \sqrt{(8-(-4))^2 + (5-4)^2}$
$\sqrt{144 + 1}$
$\sqrt{145}$

$d(A, C) = \sqrt{(8-(-2))^2 + (5-0)^2}$
$\sqrt{100 + 25}$

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$125 = 5\ 5$

$\sqrt{\quad}\ \sqrt{\ }$

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$$\left[d(A,B)\right]^2 + \left[d(A,C)\right]^2 = \left[d(B,C)\right]^2$$

$$\left(\sqrt{20}\right)^2 + \left(\sqrt{125}\right)^2 = \left(\sqrt{145}\right)^2$$

$$20 + 125 = 145$$

$$145 = 145$$

The Pythagorean Theorem is satisfied, so this is a right triangle.

Find the slopes:

$$m_{AB} = \frac{4-0}{-4-(-2)} = \frac{4}{-2} = -2$$

$$m_{BC} = \frac{5-4}{8-(-4)} = \frac{1}{12}$$

$$m_{AC} = \frac{5-0}{8-(-2)} = \frac{5}{10} = \frac{1}{2}$$

Since $m_{AB} \cdot m_{AC} = -2 \cdot \frac{1}{2} = -1$, the sides AB and AC are perpendicular and the triangle is a right triangle.

Endpoints of the diameter are (–3, 2) and (5,–6). The center is at the midpoint of the diameter:

Center: $\left(\frac{-3+5}{2}, \frac{2+(-6)}{2}\right) = (1, -2)$

Radius: $r = \sqrt{(1-(-3))^2 + (-2-2)^2}$
$= \sqrt{16+16}$
$= \sqrt{32} = 4\sqrt{2}$

Equation: $(x-1)^2 + (y+2)^2 = \left(4\sqrt{2}\right)^2$

$$(x-1)^2 + (y+2)^2 = 32$$

31. slope of $\overline{AB} = \frac{1-5}{6-2} = -1$

$\overline{}$ $\frac{-1-5}{}$

$p = kB$

$854 = k(130{,}000)$

$$k = \frac{854}{130{,}000} = \frac{427}{65{,}000}$$

Therefore, we have the equation $p = \frac{427}{65{,}000}B$.

If $B = 165{,}000$, then

$$p = \frac{427}{65{,}000}(165{,}000) = \$1083.92.$$

$$w = \frac{k}{d^2}$$

$$200 = \frac{k}{3960^2}$$

$$k = (200)\left(3960^2\right) = 3{,}136{,}320{,}000$$

Therefore, we have the equation

$$w = \frac{3{,}136{,}320{,}000}{d^2}.$$

If $d = 3960 + 1 = 3961$ miles, then

$$w = \frac{3{,}136{,}320{,}000}{3961^2} \approx 199.9 \text{ pounds.}$$

$H = ksd$

$135 = k(7.5)(40)$
$= 300k$

$k = 0.45$

So, we have the equation $H = 0.45sd$.
If $s = 12$ and $d = 35$, then
$H = 0.45(12)(35) = 189$ BTU

Chapter 2 Test

1. a. $m = \frac{y_2 - y_1}{x_2 - x_1} = \frac{-1-3}{} = \frac{-4}{} = -2$

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slope of $AC = \frac{}{8-2} = -1$

$\frac{-1-1}{}$

slope of $BC = \frac{}{8-6} = -1$

Therefore, the points lie on a line.

$x_2 - x_1 \quad 5-(-1) \quad 6 \quad 3$

If x increases by 3 units, y will decrease by 2 units.

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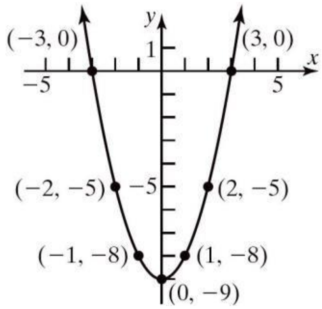
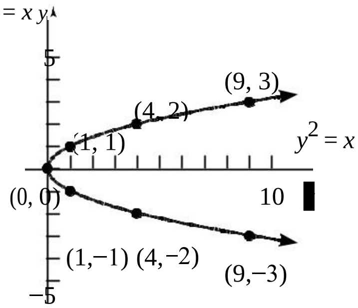
$y = x^2 - 9$



$y^2 = x$



$x^2 + y = 9$

x-intercepts:	y-intercept:
$x^2 + 0 = 9$	$(0)^2 + y = 9$
$x^2 = 9$	$y = 9$
$x = \pm 3$	

The intercepts are $(-3, 0)$, $(3, 0)$, and $(0, 9)$.

<u>Test x-axis symmetry:</u> Let $y = -y$

$x^2 + (-y) = 9$

$x^2 - y = 9$ different

<u>Test y-axis symmetry:</u> Let $x = -x$

$-x)^2 + y = 9$

$^2 + y = 9$ same

<u>Test origin symmetry</u>: Let $x = -x$ and $y = -y$

$(-x)^2 + (-y) = 9$

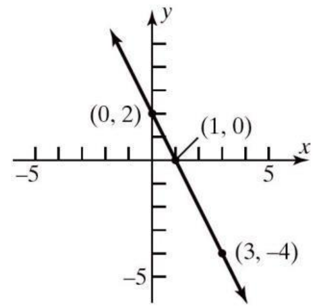
$x^2 - y = 9$ different

Therefore, the graph will have y-axis symmetry.

5. Slope $= -2$; containing $(3, -4)$

$y - y_1 = m(x - x_1)$

$y - (-4) = -2(x - 3)$



$2x + 3y = 9$

$y = -2x + 9$

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

slope $= -\frac{2}{3}$; y-intercept $= 3$

$x + 3(0) = 9$

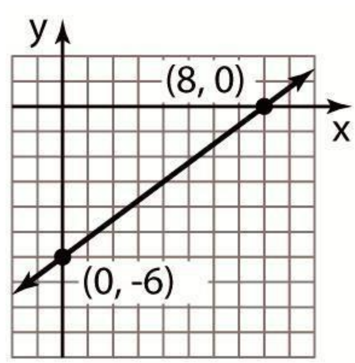
$3x = 9$

$= 3$

$3x - 4y = 24$

x-intercepts:	y-intercept:
$3x - 4(0) = 24$	$3(0) - 4y = 24$
$3x = 24$	$y = -6$
$= 8$	

The intercepts are $(8, 0)$ and $(0, -6)$.



8. $(x - h)^2 + (y - k)^2 = r^2$

$(x - 4)^2 + (y - (-3))^2 = 5^2$

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

General form: $(x - 4)^2 + (y + 3)^2 = 25$

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$$y + 4 = -2x + 6$$

$$y = -2x + 2$$

$$x^2 - 8x + 16 + y^2 + 6y + 9 = 25$$

$$x^2 + y^2 - 8x + 6y = 0$$

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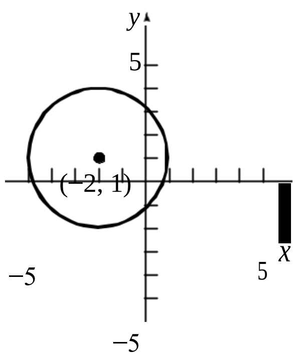
$x^2 + y^2 + 4x - 2y - 4 = 0$

$x^2 + 4x + y^2 - 2y = 4$

$x^2 + 4x + 4) + (y^2 - 2y + 1) = 4 + 4 +$

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

Center: (–2, 1); Radius = 3



$2x + 3y = 6$

$y = -2x + 6$

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

Parallel line

Any line parallel to $2x + 3y = 6$ has slope

$m = -\frac{2}{3}$. The line contains $(1, -1)$:

$y - y_1 = m(x - x_1)$

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

$y + 1 = -\frac{2}{3}x + \frac{2}{3}$

$= -\frac{2}{3}x - \frac{1}{3}$

Perpendicular line

Any line perpendicular to $2x + 3y = 6$ has slope

$m = \frac{3}{2}$. The line contains $(0, 3)$:

$y - y_1 = m(x - x_1)$ 3

2

–

Let R = the resistance, l = length, and r = radius.

Then $R = k\frac{l}{r^2}$.

Now, $R = 10$ ohms, when $r = 6\times10^{-3}$ inch, so

$l = 50$ feet and

$10 = k\frac{50}{(6\times10^{-3})^2}$

$= 10\frac{(6\times10^{-3})^2}{50} = 7.2\times10^{-6}$

Therefore, we have the equation

$= (7.2\times10^{-6})\frac{l}{r^2}$.

If $l = 100$ feet and $r = 7\times10^{-3}$ inch, then

$R = (7.2\times10^{-6})\frac{100}{(7\times10^{-3})^2} \approx 14.69$ ohms.

Chapter 2 Cumulative Review

$3x - 5 = 0$

$3x = 5$

$x = \frac{5}{3}$

The solution set is $\left\{\frac{5}{3}\right\}$.

$x^2 - x - 12 = 0$

$x - 4)(x + 3) = 0$

$= 4$ or $x = -3$

The solution set is $\{-3, 4\}$.

$2x^2 - 5x - 3 = 0$

$2x + 1)(x - 3) = 0$

$= -\frac{1}{2}$ or $x = 3$

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The solution set is $\left[-\_,3 \right]$.

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

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$x^2 - 2x - 2 = 0$

$x = \dfrac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(-2)}}{2(1)}$

$= \dfrac{2 \pm \sqrt{4+8}}{2}$

$= \dfrac{2 \pm \sqrt{12}}{2}$

$= \dfrac{2 \pm 2\sqrt{3}}{2}$

$= 1 \pm \sqrt{3}$

The solution set is $\{1 - \sqrt{3},\ 1 + \sqrt{3}\}$.

$x^2 + 2x + 5 = 0$

$x = \dfrac{-2 \pm \sqrt{2^2 - 4(1)(5)}}{2(1)}$

$= \dfrac{-2 \pm \sqrt{4 - 20}}{2}$

$= \dfrac{-2 \pm \sqrt{-16}}{2}$

No real solutions

$\sqrt{2x + 1} = 3$

$\left(\sqrt{2x + 1}\right)^2 = 3^2$

$x + 1 = 9$

$2x = 8$

$= 4$

Check: $\sqrt{2(4) + 1} = 3?$

$\sqrt{9} = 3?$

$3 = 3$ True

The solution set is $\{4\}$.

7. $|x - 2| = 1$

$x - 2 = 1$ or $x - 2 = -1$

$x = 3$ $\quad$ $x = 1$

The solution set is $\{1, 3\}$.

$\sqrt{x^2 + 4x} = 2$

$\left(\sqrt{x^2 + 4x}\right)^2 = 2^2$

$x^2 + 4x = 4$

$x^2 + 4x - 4 = 0$

$x = \dfrac{-4 \pm \sqrt{4^2 - 4(1)(-4)}}{2(1)} = \dfrac{-4 \pm \sqrt{16 + 16}}{2}$

$= \dfrac{-4 \pm \sqrt{32}}{2} = \dfrac{-4 \pm 4\sqrt{2}}{2} = -2 \pm 2\sqrt{2}$

Check $x = -2 + 2\sqrt{2}$:

$\sqrt{\left(-2 + 2\sqrt{2}\right)^2 + 4\left(-2 + 2\sqrt{2}\right)} = 2?$

$\sqrt{4 - 8\sqrt{2} + 8 - 8 + 8\sqrt{2}} = 2?$

$\sqrt{4} = 2$ True

Check $x = -2 - 2\sqrt{2}$:

$\sqrt{\left(-2 - 2\sqrt{2}\right)^2 + 4\left(-2 - 2\sqrt{2}\right)} = 2?$

$\sqrt{4 + 8\sqrt{2} + 8 - 8 - 8\sqrt{2}} = 2?$

$\sqrt{4} = 2$ True

The solution set is $\{-2 - 2\sqrt{2},\ -2 + 2\sqrt{2}\}$.

$x^2 = -9$

$x = \pm\sqrt{-9}$

$x = \pm 3i$

The solution set is $\{-3i, 3i\}$.

$x^2 - 2x + 5 = 0$

$x = \dfrac{-(-2) \pm \sqrt{(-2)^2 - 4(1)(5)}}{2(1)} = \dfrac{2 \pm \sqrt{4 - 20}}{2}$

$= \dfrac{2 \pm \sqrt{-16}}{2} = \dfrac{2 \pm 4i}{2} = 1 \pm 2i$

The solution set is $\{1 - 2i,\ 1 + 2i\}$.

$2x - 3 \le 7$

$2x \le 10$

≤ 5

$\{x \mid x \le 5\}$ or $(-\infty, 5]$

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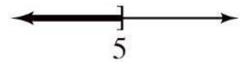

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$-1 < x + 4 < 5$

$-5 < x < 1$

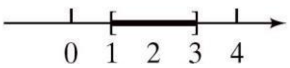
$\{x \mid -5 < x < 1\}$ or $(-5,1)$

$|x-2| \le 1$

$1 \le x - 2 \le 1$

$1 \le x \le 3$

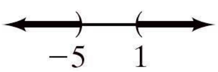
$\{x \mid 1 \le x \le 3\}$ or $[1,3]$



$|2 + x| > 3$

$2 + x < -3$ or $2 + x > 3$

$\{x \mid x < -5$ or $x > 1\}$ or $(-\infty, -5) \cup (1, \infty)$



15. $d(P,Q) = \sqrt{(-1-4)^2 + (3-(-2))^2}$

$= \sqrt{(-5)^2 + (5)^2}$

$= \sqrt{25+25}$

$= \sqrt{50} = 5\sqrt{2}$

Midpoint $= \left(\frac{-1+4}{2}, \frac{3+(-2)}{2}\right) = \left(\frac{3}{2}, \frac{1}{2}\right)$

16. $y = x^3 - 3x + 1$

$(-2,-1)$:

$(-2)^3 - (3)(-2) + 1 = -8 + 6 + 1 = -1$

$(-2,-1)$ is on the graph.

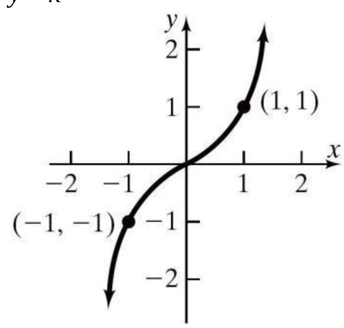
$(2,3)$:

$(2)^3 - (3)(2) + 1 = 8 - 6 + 1 = 3$ $(2,3)$ is on the graph.

$(3,1)$:

$(3)^3 - (3)(3) + 1 = 27 - 9 + 1 = 19 \ne 1$ $(3,1)$ is not on the graph.

$y = x^3$



The points (–1,4) and (2,–2) are on the line.

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

$y - y_1 = m(x - x_1)$

$y - 4 = -2(x - (-1))$

$y - 4 = -2(x + 1)$

$y = -2x - 2 + 4$

$y = -2x + 2$

19. Perpendicular to $y = 2x + 1$; Contains $(3,5)$

Slope of perpendicular $= -\frac{1}{2}$

$y - y_1 = m(x - x_1)$

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

$y - 5 = -\frac{1}{2}x + \frac{3}{2}$

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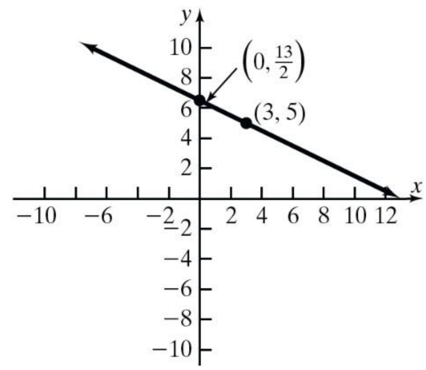
$$y = -\frac{1}{2}x + \frac{13}{2}$$



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$x^2 + y^2 - 4x + 8y - 5 = 0$

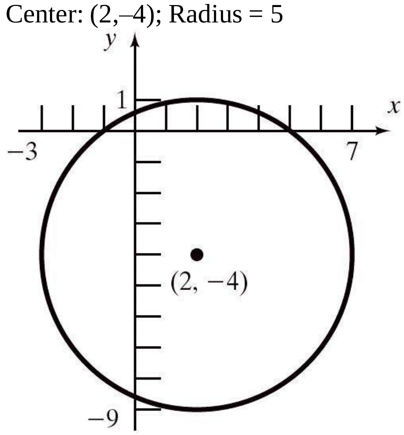
$^2 - 4x + y^2 + 8y = 5$

$x^2 - 4x + 4) + (y^2 + 8y + 16) = 5 + 4$

$+ 16\ (x - 2)^2 + (y + 4)^2 = 25$

$x - 2)^2 + (y + 4)^2 = 5^2$

Center: (2,–4); Radius = 5



Chapter 2 Project

Internet-based Project

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