9.3 Start Thinking

Use a graphing calculator to complete the table.

Function	Number of zeros
$f(x) = x^2 - 4$	
$f(x) = x^2 - 9$	
$f(x) = x^2$	
$f(x) = -x^2$	
$f(x) = x^2 + 4$	
$f(x) = x^2 + 9$	

In each function in the table, replace $f(x)$ with zero and move the constant to the opposite side of the equation. Describe the pattern between the sign of the constant in the equations and the number of zeros in the function.

9.3 Warm Up

Solve.

1. $2x - 2 = 8$

2. $7 = 3x - 11$

3. $2 + 4w = -6$

4. $8a + 19 = 3$

9.3 Cumulative Review Warm Up

Determine whether the function is *even*, *odd*, or *neither*.

1. $y = x^2 - 3$

2. $f(x) = -4x^2 - 11x - 4$

3. $f(x) = -2x^2 - 3x - 1$

4. $y = -3x$

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9.3 Practice A

In Exercises 1–3, determine the number of real solutions of the equation. Then solve the equation using square roots.

1. $x^2 = 36$ **2.** $x^2 = -16$ **3.** $x^2 = 0$

In Exercises 4–12, solve the equation using square roots.

4. $x^2 - 9 = 0$ **5.** $x^2 + 8 = 0$ **6.** $2x^2 + 10 = 0$

7. $x^2 - 24 = 40$ **8.** $2x^2 - 72 = 0$ **9.** $-x^2 + 25 = 25$

10. $(x - 4)^2 = 0$ **11.** $(x + 2)^2 = 9$ **12.** $(3x + 1)^2 = 49$

In Exercises 13–15, solve the equation using square roots. Round your solutions to the nearest hundredth.

13. $x^2 + 5 = 11$ **14.** $x^2 - 8 = 10$ **15.** $3x^2 - 1 = 14$

16. Describe and correct the error in solving the equation $x^2 - 9 = 16$ using square roots.

$$\begin{aligned} x^2 - 9 &= 16 \\ x - 3 &= 4 \\ x &= 7 \end{aligned}$$

17. A rectangular box has a height of 7 centimeters and a volume of 336 cubic centimeters. The length of the box is three times the width.

a. Write an equation describing this situation.

b. Find the length and width of the box.

18. Without graphing, where do the graphs of $y = x^2$ and $y = 25$ intersect? Explain.

19. Without graphing, where do the graphs of $y = x^2$ and $y = 1.21$ intersect? Explain.

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9.3 Practice B

In Exercises 1–3, determine the number of real solutions of the equation. Then solve the equation using square roots.

1. $x^2 = 121$ **2.** $x^2 = -15$ **3.** $x^2 = 196$

In Exercises 4–12, solve the equation using square roots.

4. $x^2 + 9 = 0$ **5.** $4x^2 - 16 = 0$ **6.** $-2x^2 + 10 = 10$

7. $5x^2 - 21 = 24$ **8.** $9x^2 + 7 = 8$ **9.** $4x^2 - 38 = 43$

10. $(x + 5)^2 = 49$ **11.** $(4x - 3)^2 = 25$ **12.** $25(x - 1)^2 = 49$

In Exercises 13–15, solve the equation using square roots. Round your solutions to the nearest hundredth.

13. $2x^2 + 7 = 21$ **14.** $-16 = 8 - 3x^2$ **15.** $5 = 9x^2 - 6$

16. Describe and correct the error in solving the equation $x^2 + 25 = 9$ using square roots.

$$\begin{aligned} x^2 + 25 &= 9 \\ x^2 &= -16 \\ x &= \pm 4 \end{aligned}$$

17. A can of juice has a height of 10 inches and a volume of 160π cubic inches. The volume of a can with radius r is given by the formula $V = \pi r^2 h$.

a. Write an equation describing this situation, where r is the radius of the can.

b. Find the radius of the can.

18. Solve each equation without graphing.

a. $x^2 + 6x + 9 = 25$

b. $x^2 - 10x + 25 = 49$

c. $x^2 - 1 = 24$

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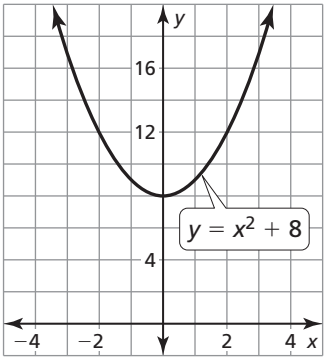
9.3 Enrichment and Extension

Imaginary Solutions

While solving quadratic equations, you have learned how to find roots of real numbers, whether they are rational or irrational roots. You have also been able to estimate the roots using a calculator. These are all considered real number roots. However, what happens when a parabola does not cross the x-axis? Is there still a solution to the problem? The answer is yes. A non-real solution to a quadratic equation is known as an *imaginary* or *complex solution*, and you must use $i = \sqrt{-1}$ to solve the problem.



Example: Solve $y = x^2 + 8$ by taking square roots.

$0 = x^2 + 8$	Set equation to 0.
$-8 = x^2$	Subtract 8 from each side.
$\pm\sqrt{-8} = \sqrt{x^2}$	Take square root of each side.
$\pm 2i\sqrt{2} = x$	Simplify radical by using $i = \sqrt{-1}$.

Solve the equation by taking square roots. State whether the roots are *rational*, *irrational*, or *imaginary*.

1. $y = -x^2$
2. $y = x^2 + 1$
3. $y = -x^2 - 5$
4. $y = \frac{1}{2}x^2 - 6$
5. $y = 2x^2 - 3$
6. $y = 3x^2 + 4$
7. $y = 5x^2 + 20$
8. $y = -6x^2 - 15$
9. $y = (x - 2)^2 + 4$

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9.3 Puzzle Time

What Did The Chef Say To The Hungry Watch?

Write the letter of each answer in the box containing the exercise number.

Solve the equation using square roots. Round your solutions to the nearest hundredth, if necessary.

1. $x^2 = 49$

2. $x^2 = -121$

3. $x^2 - 64 = 0$

4. $5x^2 - 20 = 0$

5. $x^2 + 8 = 15$

6. $-4x^2 - 9 = -9$

7. $16x^2 + 3 = 4$

8. $7x^2 - 10 = 11$

9. $(x + 4)^2 = 0$

10. $(x - 2)^2 = 25$

11. $(5x + 1)^2 = 196$

12. $9(x + 3)^2 = 36$

13. $6x^2 - 15 = 21$

14. $25(x - 8)^2 = 81$

15. You drop a feather from a height of 160 centimeters. The function $h = -16x^2 + 160$ represents the height h (in centimeters) of the feather after x seconds. How long does it take the feather to touch the ground?

Answers

C. -4

W. no real solution

S. $-3, \frac{13}{5}$

E. $-2.65, 2.65$

A. $-\frac{1}{4}, \frac{1}{4}$

B. $-2.45, 2.45$

N. $-8, 8$

O. $\frac{31}{5}, \frac{49}{5}$

S. $-2, 2$

O. 3.16

U. $-1.73, 1.73$

D. $-5, -1$

O. $-7, 7$

H. 0

T. $-3, 7$

6	14	2		7	13	1	8	10		11	5	9	15	3	12	4