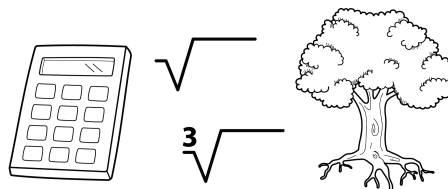


Lesson 4: Square and Cube Roots (2 Days)

☐ Getting Started

Have you ever wondered how we can "reverse" math operations? For example,

- To reverse multiplication, you divide.
- To reverse addition, you subtract.



How do you reverse an exponent?

That's exactly what square roots and cube roots are all about. These mathematical tools help us work backward from a result to figure out what number started it all.

- To reverse a square, you use a square root.
- To reverse a cube, you use a cube root.

In this lesson, you will explore how squaring and cubing connect to their "undoing" operations: square roots and cube roots. By the end, you'll be able to solve problems, recognize perfect squares and cubes, and even use a calculator to check your work. Let's uncover the secrets behind these fascinating math operations!

Stuff You Need

- calculator (kit)

Ideas to Think About

- What role do square roots and cube roots play in solving equations?
- What patterns can you observe when working with perfect squares, perfect cubes, and their corresponding roots?
- How are square roots and cube roots related to squaring and cubing numbers?

Things to Know

- An **inverse operation** is an operation that "undoes" another operation.
- A **root operation** is the inverse of an **exponent operation**.
- The 2nd root is called the **square root** ($\sqrt{}$). The root symbol with no index number is always the square root.
- The 3rd root is called the **cubed root** ($\sqrt[3]{}$).
- A **perfect square** is a number that can be made by multiplying a whole number by itself.

Activities

☐ Activity 1: Square and Cube Roots

Imagine a tree growing tall and strong. Its branches spread wide, reaching for the sky—that's like a number being squared or cubed, growing bigger and bigger. But what if you wanted to trace it back to its roots? You'd follow each branch down, uncovering the foundation of the tree. That's what we're doing today in math—learning about square roots and cube roots, the "roots" of numbers. Just like every tree starts with its roots, every square or cube comes from a smaller number. Let's dig deep and discover how it all works.

Roots and exponents—two things that are total opposites! Have you ever wondered how to "undo" an exponent? Well, just like subtraction undoes addition or division undoes multiplication, roots undo exponents, and exponents undo roots. They're called **inverse operations**, and today you are going to explore how they work.

Here's the big idea: if squaring a number (raising it to the power of 2) makes it bigger, then taking the **square root** brings it back to its original size. The same is true for cubes and **cube roots**. It's like hitting "reverse" on the math process.

For example:

If $2^2 = 4$, then the square root of 4 is 2. ($\sqrt{4} = 2$)

If $3^3 = 27$, then the cube root of 27 is 3. ($\sqrt[3]{27} = 3$)

Let's break this down in a way that makes sense. You've probably seen the square root symbol ($\sqrt{}$) before—it's like a shortcut to ask, "What number multiplies by itself to make this?" When there's no little number above the symbol, we're always talking about the square root. Easy, right? Now, let's take it up a notch: the cube root ($\sqrt[3]{}$).

This one is like the square root's cool cousin. Instead of asking what number multiplies by itself twice, it asks, "What number multiplies by itself three times to make this?" And that's why it gets its own special symbol: $\sqrt[3]{}$.

Now, let's add another important term to your math toolkit: perfect square.

A **perfect square** is a number that can be made by multiplying a whole number by itself. For example:

4 is a perfect square because $2^2 = 4$.

16 is a perfect square because $4^2 = 16$.

25 is a perfect square because $5^2 = 25$.

To learn more about how this works, watch the following video.



Math Antics - Exponents and Square Roots

www.beyondthepage.com/link/12512/

Now, it's your turn to practice. Complete the activity page titled "Square and Cube Roots."

☐ Activity 2: Using a Calculator

Welcome to the world of exponents made easy! In this activity, you'll learn how to use your calculator to solve exponent problems like a math pro. Your calculator isn't just for adding and subtracting—it's a powerful tool that can help you quickly calculate squares, cubes, and even roots of numbers. Whether you're working with positive or negative exponents, this activity will show you how to unlock the full potential of your TI-30X calculator.

Let's begin with something simple but important: squaring numbers. Let's solve 4^2 . On your calculator, locate the x^2 button. This button is specifically designed to make squaring numbers a breeze. Try this:

1. Enter the number 4.
2. Press the x^2 button.

3. Hit =, and voilà! You'll see 16 on the screen, the result of 4 squared (4×4).

Now, practice a bit. Use your calculator to square the numbers 3, 5, and 6. Write down your answers on a piece of scratch paper. Don't forget to hit the "clear" button in between problems. And remember, if you make a mistake, no worries — simply hit clear to start over!

Did you get 9, 25, and 36? Awesome!

Now that you've mastered squaring, let's reverse the process with square roots. Let's solve $\sqrt{16}$.

Look closely at your calculator. You'll notice that the square root ($\sqrt{}$) function is written in purple above the x^2 button. Since it is in purple, you need to press the 2nd key first to access it.

Follow these steps carefully:

1. Press the "2nd" key (this activates the purple functions on the calculator).
2. Press the x^2 button (since the square root is written above it in purple).
3. Enter 16 (the number you want to find the square root of).
4. Press =

The answer should be 4 because 4 is the square root of 16.

Remember, the root symbol without a number always refers to the square root (not a cube root or anything else). Now, find the square roots of 9, 25, and 36 using your calculator. Write your answers down on a piece of scratch paper.

Did you get 3, 5, and 6? Excellent!

Let's step it up and try cubing numbers. Cubing means multiplying a number by itself three times (e.g., $2^3=2 \times 2 \times 2$). To do this on your calculator:

1. Enter the number 3
2. Use the $\wedge$ key (the caret symbol) to indicate an exponent
3. Enter 3 for the cube
4. Press =

You should see 27, the result of 3^3 .

Your turn to practice. Use your calculator to cube 2, 4, and 5. Write down your answers on a piece of scratch paper.

Check your work. Did you get 8, 64, and 125? Way to go!

Finding cube roots on your calculator is just as simple as finding square roots. Today, we will use the x-root function, which is written in purple above the $\wedge$ key.

Since it is in purple, you need to press the 2nd key first to access it. Follow these steps to find the cube root of 27:

1. Enter 3 (since we are finding the cube root).
2. Press the "2nd" key (this activates the purple functions on the calculator).
3. Press the $\wedge$ key (this is where the x-root function is located).
4. Enter 27 (the number you want to find the root of).
5. Press =

Your answer should be 3, because $3 \times 3 \times 3 = 27$, so 3 is the cube root of 27.

Practice time! Find the cube roots of 8, 64, and 125. Write down your answers on a piece of scratch paper. Did you get 2, 4, and 5? You are getting great at this!

Finally, let's tackle positive and negative exponents.

For positive exponents, simply use the $\wedge$ key, as you did for cubing. For example, how do you solve 2^5 ?:

1. Enter 2.
2. Press $\wedge$.
3. Enter 5.
4. Press =.

You should get 32.

For negative exponents, use the same process but enter a negative number for the exponent. Let's solve 2^{-3} :

1. Enter 2.
2. Press $\wedge$ and enter -3.
3. Press =, and you'll see 0.125, which is $1/2^3$

Let's do one final practice. Calculate 3^{-2} , 4^3 , and 5^{-1} . Write your answers down.

Did you get 0.1111..., 64, and 0.2? You've got this!



Calculator Tutorial - Intro to the TI-30XIIS (Optional)

www.beyondthepage.com/link/12515/

If you need extra help with your calculator, you can watch this optional calculator tutorial.

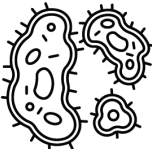
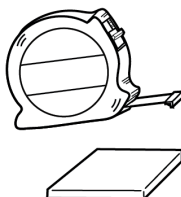
Day 2

☐ Activity 3: Real-World Word Problems

Exponents and roots are used everywhere — in science, architecture, technology, finance, and even baking. In this activity, you'll solve word problems where you'll need to decide when to square, cube, take a square root, or use an exponent to solve the problem.

Word Problem Tips:

- Exponents often appear when something grows fast or when calculating area or volume.
- Square roots help us figure out original lengths or areas.
- Cube roots help us find dimensions of 3D objects like boxes or tanks.

Exponent Word Problem	Root Word Problem
PROBLEM: A type of bacteria splits into 2 bacteria every hour. If you start with 3 bacteria, how many will there be after 4 hours?  SOLUTION: This is an example of exponential growth. Each hour, the number of bacteria doubles. Since you start with 3 bacteria, each one will split and multiply on its own. $3 \times 2 \times 2 \times 2 \times 2 = 3 \times 2^4$ $= 3 \times 16$ $= 48 \text{ bacteria}$ ANSWER: 48 bacteria after 4 hours.	PROBLEM: A square tile floor has an area of 225 square feet. You want to know the length of one side of the floor so you can buy trim to go around the edges.  SOLUTION: You need the square root of 225: $\sqrt{225} = 15 \text{ feet}$ ANSWER: Each side of the floor is 15 feet long.

On the activity page titled "Real-World Problems," think carefully about each problem: Will you need to use an exponent or a root to find the answer? Grab your calculator when you need it — and have fun putting your skills to work.

☐ **Activity 4: Review Quiz**

You will complete the "Review Quiz - Lessons 1 - 4." This review practices skills that you've learned in the first four lessons of this unit. In your answers, be sure to simplify fractions if needed and include unit labels. Use scratch paper if more room is needed to solve a problem.

Wrapping Up

You've unlocked the mysteries of square and cube roots. In this lesson, you learned how these operations "undo" exponents, just like tracing a tree back to its roots. You now understand how to work with perfect squares and perfect cubes. By mastering these concepts, you've added a powerful tool to your math toolkit that will help you tackle more advanced problems with confidence. Whether you're simplifying equations or solving real-world puzzles, square and cube roots are essential building blocks for your success in math and beyond. Keep practicing, and remember—every challenge is an opportunity to grow!

☐ **Life Application: Magic Calculator Birthday Math Trick (Optional)**

Want to have some fun with your calculator? Play the Magical Calculator Birthday Math Trick at the following link.



Magical Calculator Birthday Math Trick
www.beyondthepage.com/link/12513/

Learning Gates

Take the [Learning Gates quiz](#) for this lesson.

Square and Cube Roots

Directions: For problems 1 - 6, calculate the square or cube of the given number. Then, find the square root or cube root of the result to show how roots are the inverse of powers. No calculators please.

Example

$2^2 = 4 \longrightarrow \sqrt{4} = 2$
 $2^4 = 16 \longrightarrow \sqrt{16} = 4$

1

$3^2 =$

$\longrightarrow$

$\sqrt{}$

$=$

2

$4^2 =$

$\longrightarrow$

$\sqrt{}$

$=$

3

$5^2 =$

$\longrightarrow$

$\sqrt{}$

$=$

4

$3^3 =$

$\longrightarrow$

$\sqrt[3]{}$

$=$

5

$4^3 =$

$\longrightarrow$

$\sqrt[3]{}$

$=$

6

$5^3 =$

$\longrightarrow$

$\sqrt[3]{}$

$=$

Real-World Problems

Directions: Think about whether you need to use an exponent or a root. Use your calculator when needed.



1. A square photo frame has an area of 196 square inches. What is the length of one side?	2. A cube-shaped storage box has a volume of 1000 cubic centimeters. What is the length of one edge of the box?
3. A type of bacteria quadruples every hour. If there are 5 bacteria now, how many will there be after 4 hours?	4. A square patio has an area of 144 square feet. How long is each side of the patio?
5. A tree grows 1.5 times taller each year. If it starts at 4 feet tall, how tall will it be after 3 years?	6. A cube of ice has a volume of 343 cubic centimeters. What is the length of one side of the cube?
7. A candle factory produces 1,200 candles in its first year. Each year, it doubles its production. How many candles will the factory produce in year 3?	8. A town's population triples every 2 years. If it starts with 500 people, how many people will there be in 6 years?
9. A square park has an area of 625 square meters. How long is each side of the park?	10. A water tank shaped like a cube holds 512 cubic feet of water. What is the length of one side of the tank?

Review Quiz

Lessons**1 - 4**

Directions: Solve the following problems using the rules and skills you've learned in Lessons 1- 4. Show your work for each step. Calculators are not needed unless indicated.

Part 1: POSITIVE AND NEGATIVE NUMBERS

1. $-5 + 8 =$ _____	2. $7 - (-3) =$ _____	3. $-4 \times (-6) =$ _____	4. $-24 \div 4 =$ _____
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Part 2: FRACTIONS AND DECIMALS

5. Convert $\frac{3}{4}$ into a decimal.	6. Identify whether 0.8333... is a terminating or repeating decimal.
7. Convert 0.45 into a fraction in its simplest form.	8. Which fraction converts to a terminating decimal? A) $\frac{1}{3}$ B) $\frac{2}{5}$ C) $\frac{4}{7}$ D) $\frac{3}{8}$

Part 3: PROPERTIES OF EXPONENTS

9. Simplify 5^0 .	10. Rewrite 3^{-2} as a fraction.	11. Simplify $(2^3)^2$.
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12. Simplify $(4 \cdot 5)^2$

13. Evaluate $3^4 \cdot 3^2$

Part 4: SQUARE AND CUBE ROOTS

14. Find the square root of 36.

15. Find the cube root of 27.

16. Simplify $9^{\frac{1}{2}}$.

Part 5: WORD PROBLEMS

17. Money:

Jamie borrows \$5 from each of 3 friends. What is her total debt?

- A) -15 B) 15 C) -5 D) 5



18. Temperature:

The temperature drops 3°F per hour for 4 hours. What is the total temperature change?

- A) 12°F B) -12°F C) -7°F D) 7°F



Lesson 4: Square and Cube Roots (2 Days)

Getting Started

✿ Ideas to Think About

- What role do square roots and cube roots play in solving equations?
- What patterns can you observe when working with perfect squares, perfect cubes, and their corresponding roots?
- How are square roots and cube roots related to squaring and cubing numbers?



Things to Know

- An **inverse operation** is an operation that "undoes" another operation.
- A **root operation** is the inverse of an **exponent operation**.
- The 2nd root is called the **square root** ($\sqrt{}$). The root symbol with no index number is always the square root.
- The 3rd root is called the **cubed root** ($\sqrt[3]{}$).
- A **perfect square** is a number that can be made by multiplying a whole number by itself.

⦿ Skills

- Use square root and cube root symbols to represent solutions to equations of the form $x^2 = p$ and $x^3 = p$, where p is a positive rational number. Evaluate square roots of small perfect squares and cube roots of small perfect cubes.

Introducing the Lesson

In this lesson, your child will explore the fascinating world of square and cube roots—key concepts that are essential for understanding how numbers connect and grow. By learning that roots are the inverse of exponents, he will discover how to work backward to uncover the "original" numbers that make up perfect squares and perfect cubes. In addition, your child will learn how to use a calculator effectively to solve problems involving exponents and roots using the calculator's dedicated functions.

Activities

Activity 1: Square and Cube Roots

In this activity, your child explores the connection between exponents and roots by watching a video and working through guided practice. He learns that roots are the inverse operation of powers. He practices squaring and cubing numbers, then taking their square and cube roots to see how these operations "undo" each other. By completing this activity, he gains a deeper understanding of the relationships between powers and roots, building a strong foundation for more advanced mathematical concepts.

Answer Key:

- | | |
|---|--|
| • 1. $3^2 = 9 \rightarrow \sqrt{9} = 3$ | • 4. $3^3 = 27 \rightarrow \sqrt[3]{27} = 3$ |
| • 2. $4^2 = 16 \rightarrow \sqrt{16} = 4$ | • 5. $4^3 = 64 \rightarrow \sqrt[3]{64} = 4$ |
| • 3. $5^2 = 25 \rightarrow \sqrt{25} = 5$ | • 6. $5^3 = 125 \rightarrow \sqrt[3]{125} = 5$ |

Activity 2: Using a Calculator

In this activity, your child learns how to use a calculator to solve problems involving exponents and roots with precision and ease. He discovers how to calculate squares, cubes, and their respective roots using dedicated calculator functions, and practices handling positive and negative exponents. By mastering these calculator skills, he gains confidence in tackling a variety of exponent problems efficiently, ensuring accuracy while reinforcing his understanding of mathematical operations. This activity provides a strong foundation for solving complex equations and using technology as a valuable math tool. An optional video tutorial is also available for students who need a bit more time and practice.

Day 2**Activity 3: Real-World Word Problems**

In this activity, your child applies his understanding of exponents, square roots, and cube roots to solve real-world word problems. He learns how these mathematical concepts appear in practical situations, such as calculating area, volume, growth, and scaling recipes. By reading each problem carefully, identifying which operation to use, and practicing with his calculator when needed, your child builds flexible problem-solving skills. This activity reinforces how math connects to everyday life and deepens his ability to think critically about when and how to use exponents and roots.

Answer Key:

1. $\sqrt{196} = 14$ inches

2. $\sqrt[3]{1000} = 10$ cm

3. $5 \times 4^4 = 5 \times 256 = 1280$ bacteria

4. $\sqrt{144} = 12$ feet

5. $4 \times (1.5^3) = 4 \times 3.375 = 13.5$ feet

6. $\sqrt[3]{343} = 7$ cm

7. Candle in Year 3: $1,200 \times 2^3 = 9,600$

8. $500 \times 3^3 = 500 \times 27 = 13,500$ people

9. $\sqrt{625} = 25$ meters

10. $\sqrt[3]{512} = 8$ feet

Activity 4: Review Quiz

Your child will complete a Review Quiz. This quiz focuses on skills learned in Lessons 1-4 and encourages knowledge retention. If your child scores 80% or below on the review quiz for Lessons 1-4, don't worry! This is a great opportunity to revisit key concepts and build a stronger foundation. Start by rewatching the instructional videos for each lesson to reinforce the steps and strategies for converting fractions to decimals and vice versa. Encourage your child to review his notes in his Interactive Notebook, focusing on examples and steps he has written down.

Next, have him practice additional problems similar to the ones he struggled with on the quiz, either from his activity pages or by creating new problems together. The goal is to ensure he feels confident and comfortable before moving on to new material.

Answer Key:

1. $-5 + 8 = 3$

2. $7 - (-3) = 7 + 3 = 10$

3. $-4 \times -6 = 24$

4. $-24 \div 4 = -6$

5. $3/4 = 0.75$

6. Repeating decimal

7. $0.45 = 45/100 = 9/20$

8. $2/5$ and $3/8$

9. $5^0 = 1$

10. $3^{-2} = 1/3^2 = 1/9$

11. $(2^3)^2 = 2^{3 \cdot 2} = 2^6 = 64$

12. $(4 \cdot 5)^2 = 4^2 \cdot 5^2 = 16 \cdot 25 = 400$

13. $3^4 \cdot 3^2 = 3^{4+2} = 3^6 = 729$

14. $\sqrt{36} = 6$

15. $\sqrt[3]{27} = 3$

16. $9^{1/2} = \sqrt{9} = 3$

17. -15

18. -12 degrees F

Wrapping Up

In this lesson, your child explored how square roots and cube roots act as inverse operations to exponents, helping him "undo" squares and cubes to find original values. Through guided practice, calculator activities, and real-world word problems, he strengthened his understanding of how perfect squares and perfect cubes relate to their roots. He also built practical skills using his calculator to efficiently solve problems involving roots and exponents. This foundational knowledge will support his success in algebra and geometry and give him greater confidence when encountering roots in both math and everyday situations.

Life Application: Magic Calculator Birthday Math Trick (Optional)

As an option, the provided link turns math into a fun and engaging experience by using a calculator to perform a magical birthday trick. Follow the link with your child to enjoy this entertaining way of exploring math concepts together!

Questions to Discuss

- How are square roots and cube roots like the opposite of exponents? Can you give an example? *(Square roots and cube roots are inverse operations of exponents. For example, squaring 4 gives 16 ($4^2 = 16$), and taking the square root of 16 brings it back to 4 ($\sqrt{16} = 4$). Similarly, cubing 3 gives 27 ($3^3 = 27$), and the cube root of 27 brings it back to 3 ($\sqrt[3]{27} = 3$).)*
- What is a perfect square, and why is it important to recognize them in math? *(A perfect square is a number that is the result of multiplying a whole number by itself, like 4 (2×2) or 16 (4×4). Recognizing perfect squares makes it easier to calculate square roots and solve problems involving area or equations.)*

Things to Review

Review the "Things to Know in Lessons 1-4"