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Lesson 4: Simplifying Square Roots

Student Outcomes

* Students use factors of a number to simplify a square root.

Lesson Notes

This lesson is optional. In this lesson, students learn to simplify square roots by examining the factors of a number and looking specifically for perfect squares. Students must learn how to work with square roots in Grade 8 in preparation for their work in Grade 9 and the quadratic formula. Though this lesson is optional, it is strongly recommended that students learn how to work with numbers in radical form in preparation for the work that they will do in Algebra I. Throughout the remaining lessons of this module students will work with dimensions in the form of a simplified square root and learn to express answers as a simplified square root to increase their fluency in working with numbers in this form.

Classwork

**Opening Exercises 1–6 (5 minutes)**

Opening Exercises 1–6

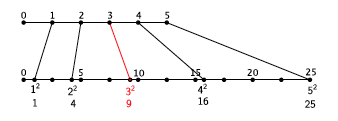
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| * 1. What does equal?   2. What does equal?   3. Does ? | * 1. What does equal?   2. What does equal?   3. Does ? |
| MP.8   * 1. What does equal?   2. What does equal?   3. Does ? | * 1. What does equal?   2. What does equal?   3. Does ? |
| 1. What is another way to write ? | 1. What is another way to write ? |

**Discussion (7 minutes)**

* We know from the last lesson that square roots can be simplified to a whole number when they are perfect squares. That is,

*Scaffolding:*

* If necessary, remind students about numbers and their squares using the visual below.



* Given (x is a positive integer and x squared is a perfect square), it is easy to see that when and that , where and are positive numbers. In terms of the previous example, when and , then
* We can show that this is true even when we do not have perfect squares. All we need to show is that when and are positive numbers and is a positive integer, that . If we can show that , then we know that

Ask students to explain why implies They should reference the definition of exponential notation that they learned in Module 1. For example, since and , and we are given that , then must be the same number as

*Scaffolding:*

* Students may know the term *product* in other contexts. For that reason, student may need to be reminded that it refers to multiplication in this context.
* Now, for the proof that the root of a number can be expressed as a product of the root of its factors:

Let and , where and are positive integers and is a positive integer greater than or equal to . We want to show that .

* Since implies , then
* Let’s look again at some concrete numbers. What is ?
* Now consider the factors of 36. Specifically those that are perfect squares. We want to rewrite as a product of perfect squares. What will that be?
* Based on what we just learned, we can write What does the last expression simplify to? How does it compare to our original statement that
  + *. The answers are the same so .*
* Simplify two different ways. Explain your work to a partner.
  + *The number is a product of multiplied by itself, which is the same as Since the square root symbol asks for the number that when multiplied by itself is , then*
  + *The number is a product of and . We can rewrite as a product of its factors, , then as . Each of the numbers and are perfect squares that can be simplified as before, so . Therefore, This means that*

Example 1 (4 minutes)

**Example 1**

**Simplify the square root as much as possible.**

* Is the number a perfect square? Explain.
  + *The number not a perfect square because there is no integer squared that equals .*
* Since is not a perfect square, when we need to simplify , we write the factors of the number looking specifically for those that are perfect squares. What are the factors of ?
* Since , then We can rewrite as a product of its factors:

Obviously, is a perfect square. Therefore , so Since is not a perfect square we will leave it as it is.

* The number is said to be in its simplified form when all perfect square factors have been simplified. Therefore, is the simplified form of
* Now that we know can be expressed as a product of its factors, we also know that we can multiply expressions containing square roots. For example, if we are given we can rewrite the expression as

Example 2 (3 minutes)

**Example 2**

**Simplify the square root as much as possible.**

* Is the number a perfect square? Explain.
  + *The number is not a perfect square because there is no integer squared that equals .*
* What are the factors of ?
* Since , then . We can rewrite as a product of its factors:

Obviously, is a perfect square. Therefore, , and Since is not a perfect square we will leave it as it is.

* The number is said to be in its simplified form when all perfect square factors have been simplified. Therefore, is the simplified form of

Exercises 7–10 (5 minutes)

Students complete Exercises 7–10 independently.

Exercises 7–10

Simplify the square roots as much as possible.

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Example 3 (4 minutes)

**Example 3**

**Simplify the square root as much as possible.**

In this example, students may or may not recognize as . The work below assumes that they do not. Consider showing students the solution below, as well as this alternative solution: .

* Is the number a perfect square? Explain.
  + *The number is not a perfect square because there is no integer squared that equals .*
* What are the factors of ?

Since , then . We know that we can simplify perfect squares so we can rewrite as because of what we know about the Laws of Exponents. Then

Each is a perfect square. Therefore, .

Example 4 (4 minutes)

**Example 4**

**Simplify the square root as much as possible.**

In this example, students may or may not recognize as The work below assumes that they do not. Consider showing students the solution below, as well as this alternative solution: .

* Is the number a perfect square? Explain.
  + *The number is not a perfect square because there is no integer squared that equals .*
* What are the factors of ?
* Since , then What do we do next?
  + *Use the Laws of Exponents to rewrite as*
* Then is equivalent to
* What does this simplify to?

Exercises 11–14 (5 minutes)

Students work independently or in pairs to complete Exercises 11–14.

*Scaffolding:*

* Some simpler problems are included here:

Simplify .

Simplify .

Simplify

Exercises 11–14

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| 1. Simplify . |  |
| 1. Simplify . |  |
| 1. Simplify . |  |
| 1. Simplify |  |

Closing (3 minutes)

Summarize, or ask students to summarize, the main points from the lesson:

* We know how to simplify a square root by using the factors of a given number, and then simplifying the perfect squares.

Lesson Summary

Square roots of non-perfect squares can be simplified by using the factors of the number. Any perfect square factors of a number can be simplified.

For example:

Exit Ticket (5 minutes)

Name Date

Lesson 4: Simplifying Square Roots

Exit Ticket

Simplify the square roots as much as possible.

Exit Ticket Sample Solutions

Simplify the square roots as much as possible.

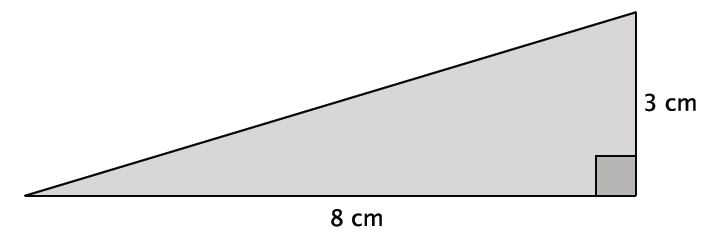
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Problem Set Sample Solutions

Simplify each of the square roots in Problems 1–5 as much as possible.

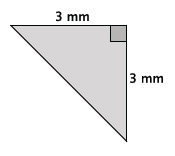
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1. What is the length of the unknown side of the right triangle? Simplify your answer.



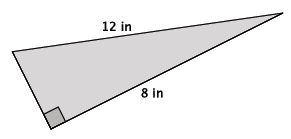
Let represent the length of the hypotenuse.

1. What is the length of the unknown side of the right triangle? Simplify your answer.



Let represent the length of the hypotenuse.

1. What is the length of the unknown side of the right triangle? Simplify your answer.



Let represent the unknown length.

1. Josue simplified as . Is he correct? Explain why or why not.

Yes, Josue is correct, because the number . The factors that are perfect squares simplify to leaving just the factor of that cannot be simplified. Therefore, .

1. Tiah was absent from school the day that you learned how to simplify a square root. Using , write Tiah an explanation for simplifying square roots.

To simplify , first write the factors of . The number . Now we can use the factors to write , which can then be expressed as . Because we want to simplify square roots, we can rewrite the factor as because of the Laws of Exponents. Now we have:

Each perfect square can be simplified:

The simplified version of .