$ax^2+bx+c=y$

perfect squares: 1, 4, 9, 16, 25, 36, 49, 64, 81, 100, 121, 144, 169, 196, 225, ...

Activity

9-3 Rewriting Radical Expressions

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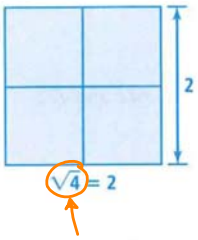
EXPLORE & REASON

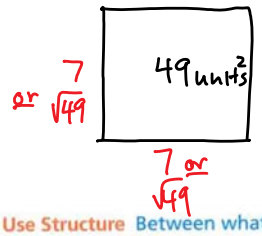
The table shows the relationship between the area of a square, the side length of the square, and the square root of the area. A square with an area of 4 and a side length of 2 is shown at the right.

radical $\sqrt{\ }$ Square Symbol

Area of Square (square units)	Area = s^2	Side Length, s (units)
1	$1=\sqrt{s}$	1
4	$4=\sqrt{s}$	2
9	$9=\sqrt{s}$	3
16	$16=\sqrt{s}$	4
25	$25=\sqrt{s}$	5



A. What is the side length of a square with an area of 49 square units?



$A=s^2$
$49=s^2$
$\sqrt{49}=\sqrt{s^2}$
$7=s$

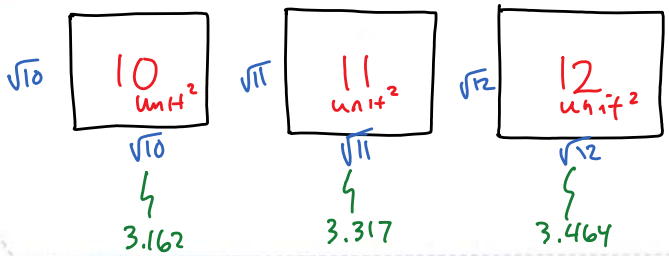
B. Use Structure Between what two consecutive integers is $\sqrt{20}$? How do you know? MP.7

$\sqrt{16}=4$
$\sqrt{20}$ — +4 → 4.4ish, 4.5 (halfway) — +5
$\sqrt{25}=5$

Calc: 4.472 ....

C. Think of three squares that have a side length between 3 and 4. What is the area of each square?

$3 < s < 4$ (9 < s < 16)



HABITS OF MIND

Communicate Precisely Is the $\sqrt{90}$ closer to 9 or 10? Explain how you know. MP.6

$\sqrt{81}$ — +9 → 9.4ish — +10 — $\sqrt{100}$

9.487

Notes

Assess

True or False

EXAMPLE 1 **Try It! Use Properties to Rewrite Radical Expressions**

1. Compare each pair of radical expressions.

a. $\sqrt{36}$ and $3\sqrt{6}$

$\sqrt{6\cdot6}$ vs. $\sqrt{3\cdot3\cdot6}$ ← $\sqrt{36}$ vs $\sqrt{54}$

not the same...

3 is $\sqrt{9}$

$\sqrt{3\cdot3}$

b. $6\sqrt{2}$ and $\sqrt{72}$

simplified radical

$\sqrt{6\cdot6\cdot2}$ vs. $\sqrt{72}$

unsimplified radical

same...

EXAMPLE 2 **Try It! Write Equivalent Radical Expressions**

2. Rewrite each expression to remove perfect square factors other than 1 in the radicand.

Simplify $\sqrt{88} = \sqrt{2\cdot2\cdot2\cdot11}$

$= 2\sqrt{2\cdot11}$

$= 2\sqrt{22}$

a. $\sqrt{44} = \sqrt{2\cdot2\cdot11}$

$= 2\sqrt{11}$ simplified radical

b. $3\sqrt{27} = 3\sqrt{3\cdot3\cdot3}$

$= 3\cdot3\sqrt{3}$

$= 9\sqrt{3}$

EXAMPLE 3 **Try It! Write Equivalent Radical Expressions With Variables**

3. Rewrite each expression to remove perfect square factors other than 1 in the radicand.

→ pairs

a. $\sqrt{25x^3} = \sqrt{5\cdot5\cdot x\cdot x\cdot x}$

$= 5\cdot x\sqrt{x}$

b. $5\sqrt{4x^{17}} = 5\sqrt{2\cdot2\cdot x^{16}}$

$17 \div 2 \rightarrow 8\frac{1}{2}$

$= 5\cdot2\sqrt{\quad}$

$= 10\,x^{8}\sqrt{x^{1}}$

HABITS OF MIND

Generalize How does the exponent of a variable help you to determine if the term is a perfect square? MP8

even #

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$\sqrt{a}\cdot\sqrt{b} = \sqrt{a\cdot b}$

Notes

Assess

EXAMPLE 4 **Try It! Multiply Radical Expressions**

4. Write an expression for each product without perfect square factors in the radicand.

pairs...?

a. $\frac{1}{2}\sqrt{21x^3}\cdot 4\sqrt{7x^2}$

$\frac{1}{2}\cdot 4\cdot\sqrt{21x^3}\cdot\sqrt{7x^2}$

$\frac{1}{2}\cdot 4\cdot\sqrt{21x^3\cdot 7x^2}$

$\frac{1}{2}\cdot 4^2\cdot x\cdot x\cdot 7\sqrt{3x}$

$14x^2\sqrt{3x}$

b. $2\sqrt{12x^9}\cdot\sqrt{18x^5}$

$2\sqrt{12x^9\,18x^5}$ → $2\sqrt{2\cdot 6\cdot 3\cdot 6\cdot x^{9+5}}$

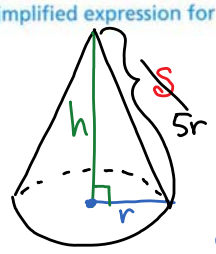
x^7

→ $2\cdot 6\cdot x^7\sqrt{2\cdot 3}$

→ $12x^7\sqrt{6}$

EXAMPLE 5 **Try It! Write a Radical Expression**

5. Another cone has a slant height s that is 5 times the radius. What is the simplified expression for the height in terms of the radius?



$h^2 + r^2 = s^2$

isolate h^2

$h^2 + r^2 = (5r)^2$

$h^2 + r^2 = 25r^2$

$-r^2 \quad -r^2$

$h^2 = 24r^2$

$h = \sqrt{24r^2}$

$24 = 2\cdot 12 = 2\cdot 6\cdot 2 = 2\cdot 2\cdot 3\cdot 2$

$h = 2r\sqrt{6}$

HABITS OF MIND

Reason When is a radical expression in simplest form? Justify your answer. MP.2

- no more factor pairs in the radical...

Assess

Do You UNDERSTAND?

1. ESSENTIAL QUESTION How does rewriting radicals in different forms help you communicate your answer?

2. **Vocabulary** State the *Product Property of Square Roots* in your own words.

3. **Communicate Precisely** Write an expression for $\sqrt{32}$ without any perfect square factors in the radicand. Explain your steps. MP.6

4. **Error Analysis** Rikki says that the product $\sqrt{3x^3} \cdot \sqrt{x}$ is $3x^2$. Explain Rikki's error and write the correct product. MP.3

5. **Construct Arguments** Is $\sqrt{45}$ in simplest form? Explain. MP.3

6. **Make Sense and Persevere** Describe how you would simplify an expression so that there are no perfect square factors in the radicand. MP.1

Do You KNOW HOW?

Factor each radicand using the Product Property of Square Roots.

7. $\sqrt{80}$

8. $\sqrt{x^7}$

9. $\sqrt{40x^4}$

10. $\sqrt{11x^5}$

11. $\sqrt{200}$

12. $8\sqrt{8}$

Write an expression for each product without a perfect square factor other than 1 in the radicand.

13. $4\sqrt{3x^3} \cdot 3\sqrt{2x^2}$

14. $x\sqrt{2x^5} \cdot 2x\sqrt{8x}$

15. $\sqrt{7x} \cdot 3\sqrt{10x^7}$

Compare each pair of radical expressions by writing each expression as a product of square roots in simplest form.

16. $\sqrt{72}$ and $2\sqrt{50}$

17. $5\sqrt{28}$ and $\sqrt{119}$

Write each expression so there are no perfect square factors other than 1 in the radicand.

18. $\sqrt{100x^8}$

19. $4x^2y\sqrt{2x^6y^6}$