

Simplifying Radical Expressions

List examples of numbers that are **perfect squares**

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To *simplify* means to find another expression with the same value. It does not mean to find a decimal approximation.

To simplify or reduce a radical,

1. find the **largest** perfect square which will divide evenly into the number under your radical sign. This means that when you divide, you get no remainders, no decimals, no fractions.

Simplify $\sqrt{48}$ *What is the largest perfect square that divides into 48?*

2. write the number appearing under your radical as the product (multiplication) of the perfect square and your answer from dividing. $\sqrt{48} = \sqrt{\quad \times \quad}$
3. give each number in the product its own radical sign. $\sqrt{48} = \sqrt{\quad} \times \sqrt{\quad}$
4. reduce the "perfect" radical which you have now created. $\sqrt{48} = \sqrt{\quad} \times \sqrt{\quad} =$
5. you now have your answer. $\sqrt{48} = \sqrt{\quad} \times \sqrt{\quad} =$

If the number under your radical cannot be divided evenly by any of the perfect squares, your radical is already in simplest form and cannot be reduced further.

Example

Simplify $3\sqrt{50}$

The largest perfect square dividing evenly into 50 is 25.

$$3\sqrt{50} = 3\sqrt{25 \cdot 2} = 3\sqrt{25} \sqrt{2}$$

Reduce the "perfect" radical and multiply times the 3 (who is "along for the ride")

$$3\sqrt{25} \sqrt{2} = 3 \cdot 5 \sqrt{2} = 15\sqrt{2}$$

Don't let the number in front of the radical distract you. It is simply "along for the ride" and will be multiplied times our final answer.

PRACTICE 1

Simplify.

a) $\sqrt{72}$

b) $\sqrt{54}$

c) $\sqrt{8}$

d) $\sqrt{28}$

e) $\sqrt{40}$

f) $\sqrt{48}$

Addition and Subtraction of Radicals

Simplify $3\sqrt{5} + 4\sqrt{5}$	Simplify $2\sqrt{6} + 3\sqrt{7}$
Since the radicals are the same, simply add the numbers in front of the radicals (do NOT add the numbers under the radicals).	Since the radicals are not the same, and both are in their simplest form, there is no way to combine them. The answer is the same as the problem.

Example

Simplify $2\sqrt{75} + 5\sqrt{3}$

$$= 2\sqrt{3}\sqrt{25} + 5\sqrt{3} \quad \text{Simplify radicals if possible}$$

$$= 2 \times 5\sqrt{3} + 5\sqrt{3}$$

$$= 10\sqrt{3} + 5\sqrt{3} \quad \text{Simplify and add like radicals}$$

$$= 15\sqrt{3}$$

Try another one... $5\sqrt{8} - 3\sqrt{18} + \sqrt{3}$

PRACTICE 2

1. Simplify.

a) $3\sqrt{2} - \sqrt{2} + 4\sqrt{2}$

b) $\sqrt{7} - 2\sqrt{7} - 3\sqrt{7}$

c) $\sqrt{2} + \sqrt{3} - 4\sqrt{3} - 2\sqrt{2} + 5\sqrt{3}$

d) $5\sqrt{3} - 2\sqrt{6} - 2\sqrt{3} + 6\sqrt{6}$

2. Simplify.

a) $\sqrt{28} + \sqrt{63}$

b) $\sqrt{20} + \sqrt{40} - \sqrt{45} + \sqrt{90}$

c) $5\sqrt{27} - 4\sqrt{12} - \sqrt{80} + 3\sqrt{45}$

d) $-2\sqrt{20} + 4\sqrt{125} - 3\sqrt{500} + \sqrt{45}$

3. Simplify.

a) $\frac{10 + 25\sqrt{5}}{5}$

b) $\frac{6 - 3\sqrt{3}}{3}$

c) $\frac{\sqrt{20} + 16}{2}$

d) $\frac{-32 - \sqrt{75}}{10}$

Multiplication and Division of Radicals

Examples

Multiply and simplify $2\sqrt{18} \times 2\sqrt{3}$

$$\begin{aligned}2\sqrt{18} \times 2\sqrt{3} &= 2 \times 2\sqrt{18}\sqrt{3} \\ &= 4\sqrt{72} \\ &= 4\sqrt{36}\sqrt{2} \\ &= 4 \times 6\sqrt{2} \\ &= 24\sqrt{2}\end{aligned}$$

Divide and simplify $\frac{-12\sqrt{24}}{3\sqrt{2}}$

$$\begin{aligned}\frac{-12\sqrt{24}}{3\sqrt{2}} &= -4\sqrt{12} \\ &= -4\sqrt{4}\sqrt{3} \\ &= -8\sqrt{3}\end{aligned}$$

When **multiplying** radicals, one must multiply the numbers **OUTSIDE (O)** the radicals **AND** then multiply the numbers **INSIDE (I)** the radicals.

When **dividing** radicals, one must divide the numbers **OUTSIDE (O)** the radicals **AND** then divide the numbers **INSIDE (I)** the radicals.

PRACTICE 3

1. Simplify.

a) $\frac{\sqrt{21}}{\sqrt{3}}$

b) $\frac{\sqrt{35}}{\sqrt{5}}$

c) $\frac{\sqrt{32}}{\sqrt{9}}$

d) $\sqrt{13} \times \sqrt{13}$

e) $2\sqrt{7} \times 2\sqrt{7}$

f) $3\sqrt{2} \times 2\sqrt{3} \times \sqrt{6}$

2. Expand and simplify.

a) $\sqrt{5}(\sqrt{10}-1)$

b) $(3\sqrt{5}+1)(3\sqrt{5}-1)$

c) $(6-\sqrt{2})^2$

d) $(3\sqrt{7}-2\sqrt{5})(5\sqrt{7}-4\sqrt{5})$

3. What are the roots of the following equation? $x^2 - 6x + 13 = 0$
Write the roots in simplest radical form.

4. Write and simplify an expression for each of the following.

a) the area of the rectangle

b) the perimeter of the rectangle



