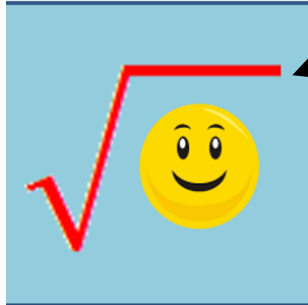


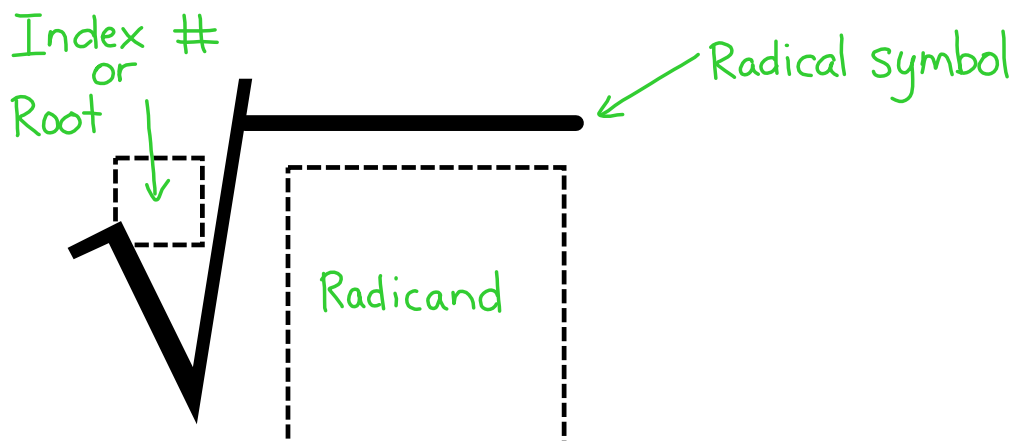
## 1.3 Simplify

# $\sqrt{\text{radicals}}$



In mathematics, a radical expression is defined as any expression containing a radical ( $\sqrt{\phantom{x}}$ ) symbol. Many people mistakenly call this a 'square root' symbol, and many times it is used to determine the square root of a number. However, it can also be used to describe a cube root, a fourth root or higher

## Parts of a Radical



If index # is not written, it is automatically a 2.

For each radical, determine the index number and radicand.

$$\sqrt{24} \quad \text{square root}$$

Index : 2

Radicand : 24

$$\sqrt[3]{27} \quad \text{cube root}$$

Index : 3

Radicand : 27

$$\sqrt[4]{16xy} \quad 4^{\text{th}} \text{ root}$$

Index : 4

Radicand :  $16xy$

$$\sqrt{128n^8} \quad \text{square root}$$

index : 2

Radicand :  $128n^8$

Write all the factor pairs for the given number, then circle the pairs that contain a perfect square.

example:

Perfect squares

24

1·24

2·12

3·8

4·6

48

1·48

2·24

3·16

4·12

6·8

20

1·20

2·10

4·5

use pull tab

80

1·80

2·40

4·20

5·16

8·10

Pull

In order to simplify square roots we must look for factors that are perfect squares.

For example: there are many ways to multiply two numbers to make 80. We are only interested in the pair that contains a perfect square.

Perfect squares

$$\begin{array}{c} \sqrt{80} \\ \swarrow \searrow \\ 5 \cdot 16 \\ \sqrt{5 \cdot 16} \\ \sqrt{5} \cdot \sqrt{16} \\ 4\sqrt{5} \end{array}$$

$$1 \cdot 80$$

$$2 \cdot 40$$

$$4 \cdot 20$$

$$5 \cdot 16$$

$$8 \cdot 10$$

which one is less work?

Choose factor pair with biggest perfect square

Alternate method is prime factorization.

$$\begin{array}{c} \sqrt{80} \\ \swarrow \searrow \\ 8 \cdot 10 \\ \swarrow \searrow \quad \swarrow \searrow \\ 2 \cdot 4 \quad 2 \cdot 5 \\ \swarrow \searrow \quad \swarrow \searrow \\ 2 \cdot 2 \quad 2 \cdot 2 \quad 5 \\ 4\sqrt{5} \end{array}$$

## Simplify: (No Calculators)

$$\sqrt{20}$$

4.5  
 $\sqrt{4} \sqrt{5}$   
 $2\sqrt{5}$

$$\sqrt{24}$$

4.6  
 $\sqrt{4} \sqrt{6}$   
 $2\sqrt{6}$

$$\sqrt{25}$$

5

$$\sqrt{32}$$

16.2  
 $\sqrt{16} \sqrt{2}$   
 $4\sqrt{2}$

$$\sqrt{165}$$

33  
 $5 \overline{)165}$   
 $\underline{-15}$   
 $15$   
 5.33  
 $\sqrt{165}$

## Simplifying radicals

Give an exact answer and an approximate answer.

$$\sqrt{12}$$

4.3  
 $2\sqrt{3}$

Exact Answer:  
(simplified radical)

$$2\sqrt{3}$$

Approximate:  
(rounded decimal)

$$3.46$$

$$\sqrt{18}$$

4.2  
 $3\sqrt{2}$

Exact Answer:  
(simplified radical)

$$3\sqrt{2}$$

Approximate:  
(rounded decimal)

$$4.36$$

$$\sqrt{48}$$

16.3  
 $4\sqrt{3}$

Exact Answer:  
(simplified radical)

$$4\sqrt{3}$$

Approximate:  
(rounded decimal)

$$6.93$$

$$\sqrt{128}$$

64.2  
 $8\sqrt{2}$

Exact Answer:  
(simplified radical)

$$8\sqrt{2}$$

Approximate:  
(rounded decimal)

$$11.31$$

How do you simplify a radical if it is not a square root?

$\sqrt[3]{32}$ $8 \cdot 4$ $\sqrt[3]{8} \cdot \sqrt[3]{4}$ $2 \sqrt[3]{4}$	$\sqrt[3]{56}$ $8 \cdot 7$ $\sqrt[3]{8} \cdot \sqrt[3]{7}$ $2 \sqrt[3]{7}$	$\sqrt[4]{32}$ $16 \cdot 2$ $\sqrt[4]{16} \cdot \sqrt[4]{2}$ $2 \sqrt[4]{2}$	$1$ $16$ $81$ $256$
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Simplify the following radicals. Leave answer in reduced radical form.

$$\sqrt{48}$$

$$16 \cdot 3$$

$$4\sqrt{3}$$

$$\sqrt{54}$$

$$9 \cdot 6$$

$$3\sqrt{6}$$

$$\sqrt[3]{48}$$

$$8 \cdot 6$$

$$2 \sqrt[3]{6}$$

$$\sqrt[3]{54}$$

$$27 \cdot 2$$

$$3 \sqrt[3]{2}$$

What happens when there is a number in front of the radical?

$$3\sqrt{8}$$

$$6\sqrt{2}$$

$$7\sqrt{12}$$

$$14\sqrt{3}$$

$$5\sqrt{24}$$

$$10\sqrt{6}$$

$$4\sqrt[3]{24}$$

$$8\sqrt[3]{3}$$

Practice: (no calculator)

$$\sqrt{105}$$

$$\sqrt{105}$$

$$2\sqrt{96}$$

$$8\sqrt{6}$$

$$\sqrt[3]{64} = 4$$

$$\sqrt[3]{128}$$

$$4\sqrt[3]{2}$$

What happens when you have variables?  
Any patterns?

$$\sqrt{x^2} = x$$

$$\overline{x^2} = \sqrt[3]{x^2}$$

$$\sqrt{x^3} = x\sqrt{x}$$

$$\overline{x^3} = x$$

$$\sqrt{x^8} = x^4$$

$$\overline{x^8} = x^2\sqrt[3]{x^2}$$

$$\sqrt{x^{10}} = x^5$$

$$\overline{x^{10}} = x^3\sqrt[3]{x}$$

## Quick Check

Simplify radical. Give exact answer.

$$\sqrt{32x^2y^3}$$

$$4xy\sqrt{2y}$$

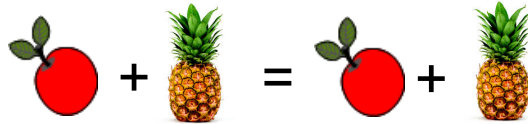
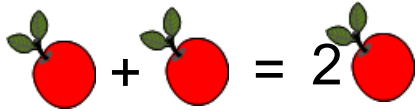
$$\sqrt[3]{64x^8y^6}$$

$$4x^2y^2\sqrt[3]{x^2}$$

## Combine

(Add and subtract)

$\sqrt{\text{radicals}}$



Can't combine because they aren't the same.

They are both fruit but they aren't the **same** fruit.

## Add or subtract the radicals

**\*\* Same index # and Radicand**

$$4\sqrt{3} + 2\sqrt{3} = 6\sqrt{3}$$

$$4\sqrt{7} - 6\sqrt{7} = -2\sqrt{7}$$

$$\begin{array}{l} \sqrt{24} + \sqrt{54} = 5\sqrt{6} \\ \begin{array}{cc} 4 \cdot 6 & 9 \cdot 6 \\ 2\sqrt{6} & + 3\sqrt{6} \end{array} \end{array}$$

$$\begin{array}{l} 4\sqrt{24} + 3\sqrt{54} = 17\sqrt{6} \\ 8\sqrt{6} + 9\sqrt{6} \end{array}$$



Simplify:

$$5\sqrt[3]{2} - \sqrt[3]{16}$$

$$5\sqrt[3]{2} - 2\sqrt[3]{2} = 3\sqrt[3]{2}$$

$$2\sqrt{3} + 5\sqrt[3]{3}$$

different index #  
simplified

$$2\sqrt{3x} + \sqrt{3x}$$

$$3\sqrt{3x}$$

$$\sqrt{12w} - \sqrt{27w}$$

$$2\sqrt{3w} - 3\sqrt{3w} - \sqrt{3w}$$