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8:1 Solving Quadratic Equations by Finding Square Roots

QUADRATIC EQUATIONS AND PARABOLAS

In this chapter, you will study:

- Solving Quadratic Equations by Finding Square Roots
- Graphs of Quadratic Equations: Parabolas
- Solving Quadratic Equations by Completing the Square
- The Quadratic Formula
- Imaginary and Complex Numbers
- Solving any Quadratic Equation

A quadratic equation is one that can be written as $ax^2 + bx + c = 0$, which is known as the standard form of the equation where *a, b, and c* are real numbers and $a \neq 0$. (*a* is the *leading coefficient – the number associated with the quadratic term).*

From Algebra 1, you should remember that positive real numbers have two square roots, $\sqrt{b}$ and $-\sqrt{b}$, the positive and the negative, which are sometimes designated by the sign $\pm\sqrt{b}$. Recall that square roots are indicated by the radical symbol, $\sqrt{}$, and the number under the radical sign is called the radicand.

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Finding the *nth* root of *b*

1. An *nth* root of b is a solution of the equation $x^n = b$.

2. a. If n is even and $b>0$, there are two roots of b.
   The <u>principal</u> (or positive) *nth* root of b is denoted $\sqrt[n]{b}$.
   The <u>other</u> root of b is denoted $-\sqrt[n]{b}$.

   b. If n is even and $b=0$, there is one *nth* root: $\sqrt[n]{0} = 0$.

   c. If n is even and $b<0$, there is <u>no real</u> *nth root* of b.

3. If n is odd, there is exactly one real *nth root* of b, whether b is positive, negative, or zero.

Example 1: Solving a Quadratic Equation

Solve:

a. $x^2 = 9$

b. $5x^2 = 15$

Solution:

a. $x^2 = 9$

$x = \pm\sqrt{9} = \pm 3$

The roots are 3 and –3

b. $5x^2 = 15$

$x^2 = 3$

$x = \pm\sqrt{3}$

The roots are $\sqrt{3}$ and $-\sqrt{3}$

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A <u>cube</u> root of a number is a solution of the equation $x^3 = b$. Every number *b,* whether positive, negative, or zero has exactly one real cube root, denoted $\sqrt[3]{b}$. The cube root of a positive number is positive and the cube root of a negative number is negative.

Example 2. Simplify.

a. $\sqrt[3]{8}$ b. $\sqrt[3]{-27}$ c. $\sqrt[3]{10^6}$

Solution:

a. $\sqrt[3]{8} = 2$ because $2^3 = 8$

b. $\sqrt[3]{-27} =$ -3 because $(-3)^3 = -27$

c. $\sqrt[3]{10^6} = 10^2 = 100$ because $\left(10^2\right)^3 = 10^6$

Example 3. Simplify.

a. $\sqrt{81}$ b. $\sqrt[3]{27}$ c. $\sqrt[5]{-32}$ d. $\sqrt[4]{-1}$

Solution:

a. $\sqrt{81} = \pm 9$ since $9^2 = 81$ and $(-9)^2 = 81$

b. $\sqrt[3]{27} = 3$ since $3^3 = 27$

c. $\sqrt[5]{-32} =$ -2 since $(-2)^5 = -32$

d. $\sqrt[4]{-1} =$ no solution. There is no real number raised to the 4^{th} power equal to –1.

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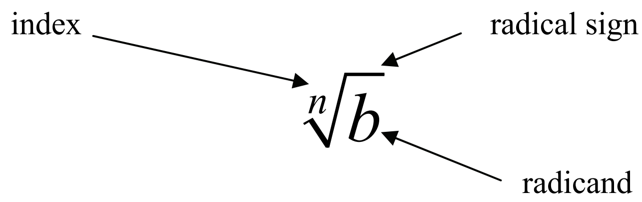
The symbol $\sqrt[n]{b}$ is called a <u>radical</u>. Each part of the radical has a name. See below:



When there is no number for an index, it is understood that it is a square root. It is customary <u>not</u> to write the *2* in the radical sign.

Properties of Radicals	**Examples**
1. $\left(\sqrt[n]{b}\right)^n = b$ because $\sqrt[n]{b}$ satisfies $x^n = b$	$\left(\sqrt{5}\right)^2 = 5$ $\left(\sqrt[3]{-5}\right)^3 = -5$
2. $\sqrt[n]{b^n} = b$ if n is odd	$\sqrt[3]{6^3} = 6$ $\sqrt[5]{x^5} = x$
3. $\sqrt[n]{b^n} = \lvert b\rvert$ if n is even, because the principal *nth root* is always non-negative for even values of *n.*	$\sqrt{(-5)^2} = \lvert -5\rvert = 5$ $\sqrt{(x-2)^2} =$ $\lvert x-2\rvert =$ $x-2, x>1$ $2-x, x<1$