Finding the square root of a number and squaring a number are inverse operations. To find the square root of a number a, you must find a number with a square of a. Similarly, the inverse of raising a number to the nth power is finding the nth root of a number.

Powers	Factors	Words	Roots
$x^3 = 64$	$4 \cdot 4 \cdot 4 = 64$	4 is a cube root of 64.	$\sqrt[3]{64} = 4$
$x^4 = 625$	$5 \cdot 5 \cdot 5 \cdot 5 = 625$	5 is a fourth root of 625.	$\sqrt[4]{625} = 5$
$x^5 = 32$	$2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 32$	2 is a fifth root of 32.	$\sqrt[5]{32} = 2$
$a^n = b$	$\underbrace{a \cdot a \cdot a \cdot \ldots \cdot a}_{n \text{ factors of } a} = b$	*a* is an *n*th root of *b*.	$\sqrt[n]{b} = a$

KeyConcept Definition of *n*th Root

Words For any real numbers *a* and *b*, and any positive integer *n*, if $a^n = b$, then *a* is an *n*th root of *b*.

Example Because $(-3)^4 = 81$, -3 is a fourth root of 81 and 3 is a principal root.

Symbol that indicates *nth* root: $\sqrt[n]{}$

Some numbers have more than one real nth root.

ex) 64 has two square roots $8^2 = 64$ and $(-8)^2 = 64$

When there is more than one real root and *n* is even, the nonnegative root is called the principal root.

8 principal root for $\sqrt{64}$

Examples of nth roots:

$\sqrt{25} = 5$ — $\sqrt{25}$ indicates the principal square root of 25.

$-\sqrt{25} = -5$ — $-\sqrt{25}$ indicates the opposite of the principal square root of 25.

$\pm\sqrt{25} = \pm 5$ — $\pm\sqrt{25}$ indicates both square roots of 25.

1. Simplify:

a. $\pm\sqrt{16y^4}$

$= \pm\sqrt{4^2(y^2)^2}$

$= \boxed{\pm 4y^2}$

b. $-\sqrt{(x^2-6)^8}$

$= -\sqrt{[(x^2-6)^4]^2}$

$= \boxed{-(x^2-6)^4}$

c. $\sqrt[5]{243a^{20}b^{25}}$

$= \sqrt[5]{3^5(a^4)^5(b^5)^5}$

$= \boxed{3a^4b^5}$

d. $\sqrt{-16x^4y^8}$

no $\mathbb{R}$ roots since $\sqrt{-16}$ not a $\mathbb{R}$ #

e. $\pm\sqrt{36x^{10}}$

$= \pm\sqrt{6^2(x^5)^2}$

$= \boxed{\pm 6x^5}$

f. $-\sqrt{(y+7)^{16}}$

$= -\sqrt{[(y+7)^8]^2}$

$= \boxed{-(y+7)^8}$

g. $\sqrt[4]{y^4}$

$= \sqrt[4]{(y)^4}$

$= \boxed{|y|}$ * since y could be neg, use absolute value to identify principal root

h. $\sqrt[6]{64(x^2-3)^{18}}$

$= \sqrt[6]{2^6[(x^2-3)^3]^6}$

$= \boxed{2\left|(x^2-3)^3\right|}$

i. $\sqrt{36y^6}$

$= \sqrt{6^2(y^3)^2}$

$= \boxed{6|y^3|}$

j. $\sqrt[4]{16(x-3)^{12}}$

$= \sqrt[4]{2^4[(x-3)^3]^4}$

$= \boxed{2|(x-3)^3|}$

k. $\pm\sqrt{100y^8}$

$\boxed{\pm 10y^4}$

l. $-\sqrt{49u^8b^{12}}$

$= \boxed{-7u^4b^6}$

m. $\sqrt{(y-6)^8}$

$= \boxed{(y-6)^4}$

n. $\sqrt[4]{16g^{16}h^{24}}$

$= \boxed{2g^4h^6}$

o. $\sqrt{-16y^4}$

$= \boxed{\text{no solution}}$

p. $\sqrt[6]{64(2y+1)^{18}}$

$= \sqrt[6]{2^6\left[(2y+1)^3\right]^6}$

$= \boxed{2\left|(2y+1)^3\right|}$